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# **Article II.**—THE AQUATIC MOLLUSKS OF THE BELGIAN CONGO. WITH A GEOGRAPHICAL AND ECOLOGICAL ACCOUNT OF CONGO MALACOLOGY[1]

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With Field Notes by the Collectors, H. Lang and J. P. Chapin

Plates X to LXXVII, 15 Maps, and 93 Text Figures

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[1]Scientific Results of The American Museum of Natural History Congo Expedition. General Invertebrate Zoölogy, No. 10.
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## INTRODUCTION

The present report, like its predecessor treating of the land mollusks of the Belgian Congo, is based primarily upon the collections of Herbert Lang and James P. Chapin of the American Museum Congo Expedition, 1909–1915. This material is extensive, comprising over 15,000 specimens and representing 68 species, subspecies, and mutations. Several of these forms are present in large series, of great interest for a study of variation. These collections were supplemented by material taken by the junior author in 1913–1915, as well as by specimens from the Congo Museum at Tervueren, Belgium, and from the Academy of Natural Sciences of Philadelphia. Altogether, 183 species and subspecies were studied, of which about 180 are either represented in the present collection, or will be added to it through the courtesy of the above-named institutions. The total number of aquatic mollusks at present known from the Belgian Congo is 328, which includes the fauna of the Great Lakes and also some rather dubious records. Credit has been given to each collector under the respective species.

Brief definitions of the genera and higher groups, original or adapted, and figures of most species in our possession have been given to make the work useful to traveller-naturalists and to other interested students who may be stationed in the Belgian Congo out of reach of scientific libraries.

Since practically all publications upon fresh-water mollusks of the Ethiopian Region had to be consulted in the course of our work, we have added a reference list of the species of this region to our discussion of the material in hand. Experience has shown the need of such a list; in fact, something of the sort must be compiled by anyone working systematically on the fauna.[1] In so wide a field as that of African conchological literature it may be expected that we have overlooked some hidden species, or even missed one in the open, but it is hoped that our round-up will be found reasonably complete.

While the fauna of northwestern Africa was not considered in the course of our work, many of the forms described from Lower Egypt were listed, especially in the typically Ethiopian genera; but no claim to completeness is made for that region. As a rule we have given only the localities mentioned in connection with the original descriptions, since it is frequently impossible to judge of the correctness of subsequent identifications without a study of the material on which they were based. It will be noticed too that we have not always accepted the synonymies proposed by previous writers: in many cases these may have been correct, but frequently they were made without examination of original or topotypic material.

The authors desire to express their great indebtness to Professor Henry Fairfield Osborn, President of the American Museum, for the keen interest he has taken in this work. His continuous encouragement and generous support have rendered possible the completion of this report and its early publication. In form, it has been designed for incorporation as a part of The Zoölogy of The Belgiam Congo, the series planned by President Osborn on the scientific results of the American Museum Congo Expedition.

For the privilege of studying these extensive collections and for generous assistance extended during the course of our work, we are grateful to Dr. F. A. Lucas, Honorary Director of the American Museum, and Dr. Roy W. Miner, Curator of Lower Invertebrates.

As in the past, Mr. Herbert Lang, leader of the Congo Expedition, has unreservedly placed at our disposal all possible information and help.

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[1]Kobelt, 1909, Abh. Senckenberg. Naturf. Ges., XXXIII, pp. 53–97, has listed the mollusks of the Ethiopian Region, but without references or localities. His list is therefore of little practical use; moreover, it is marred by many omissions and inaccuracies.

We have been fortunate also in securing his collaboration in the matter of ecological notes on some of the more interesting species. Dr. James P. Chapin kindly furnished accounts of African birds feeding on mollusks, based on his extensive field work.

We also wish to thank Dr. H. Schouteden, Curator of the Natural History Section of the Congo Museum at Tervueren, Belgium, for the opportunity of examining the collections in his care, thus enabling us to secure first-hand information on many rare and obscure forms.

To Dr. Bryant Walker we are indebted for expert advice regarding the difficult family Ancylidæ.

The splendid photographs taken in the field, for the most part illustrating the ecological chapters, are to be credited to Mr. Herbert Lang whenever not otherwise specified. For the privilege of here reproducing other photographs our gratitude is due to Professor Edmond Leplae, of the Department of Agriculture, Belgian Colonial Office, to Mr. Harry C. Raven, to Mr. Rudolph Grauer, and to Dr. Gilbert Grosvenor, Editor of the National Geographic Magazine, through whose courtesy permission was granted for the use of pictures taken in Mt. Ruwenzori by Mr. Vittorio Sella.

Finally, the authors are again glad to acknowledge the excellent work of Miss Helen Winchester upon the drawings and photographs of shells.

## New Genera and Subgenera, with their Type Species



## New Species, Subspecies, and Mutations, with their Type Localities

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| *Mutela iris.* | Lualaba River at Mulongo | 434 |
| *Pseudospatha ortmanni* | Bay of Toa, Lake Tanganyika | 446 |
| " *stappersi.* | Bay of Kilewa, Lake Tanganyika | 446 |

The following new names are also proposed:

*Melanoides tuberculata* var. *dautzenbergi*, p. 257; for *Melania tuberculata* var. *victoriæ* Dautzenberg, 1908; not *Melania victoriæ* Dohrn, 1865

*Melampus moreleti*, p.100; for *Melampus granum* Morelet, 1872; not *Melampus granum* Gassies, 1869.

*Unio fayumensis*, p. 381; for *Unio schweinfurthi* E. v. Martens, 1886; not *Unio parreysi* var. *schweinfurthi* E. v. Martens, 1876.

## Additional List of Geographical Items Mentioned in this Paper

The following directory contains only the geographical items which were not previously listed in the senior author's 'Review of the Land Mollusks of the Belgian Congo.'[1] It may be well to point out that the two lists contain all African localities mentioned in the two reports and not only those of the Belgian Congo; also that, while different spellings or names of the same locality have been listed in the directories, a uniform spelling of each of them has been strictly adhered to in the text. There is therefore no duplication of records on that account, except in a few dubious cases when this is expressly stated. In the Belgian Congo terrestrial and aquatic mollusks have been collected thus far in not more than 400 localities (including mountains, rivers, and lakes).

Abaja (L.).—6° 30′ N., 38° E.
Abaya (L.), see Abaja (L.).
Abetifi.—6° 40′ N., 0° 50′ W.
Addas (R.), near Adi Caie.
Ad-Duwen.—14° N., 33° E.
Aden.—12° 50′ N., 45° E.
Adi Caie.—14° 50′ N., 39° 20′ E.
Adi Cani, near Saganeiti.
Adi Ugri.—14° 55′ N., 38° 50′ E.
Adowa, see Adua.
Adua.—14° 10′ N., 38° 55′ E.
Adue, Fayûm.
Affenfluss, affluent of the Limpopo.
Aggherrer, Italian Somaliland.
Ailat, see Ailet.
Ailet.—15° 40′ N., 39° 5′ E.
Ain Zaba, see Anseba (R.).
Akra.—5° 40′ N., 0° 15′ W.
Alberta.—2° 10′ N., 22° 30′ E.
Alexandria.—31° 20′ N., 30° E.
Alhi Plains, see Athi Plains.
Amanzimtoti (R.).—30° 5′ S., 30° 50′ E.
Amelia Bay.—10° 25′ S., 34° 30′ E.
Am Raya, Bahr el Ghazal.
Andobed (R.), Abyssinia.
Angoniland.—14° S., 34° E.
Anseba (R.).—15° to 17° 10′ N., 38° 45′ to 39° E.
Archimedes (Bay of the).—21° N., 16° 50′ W.
Arezzal, Eroug.
Aru.—3° 15′ N., 31° E.
Asmara.—15° 20′ N., 39° E.
Assinie.—5° N., 3° 20′ W.

[1]1919, Bull. American Mus. Nat. Hist., XL, pp. 12-21, with 3 maps. Map 15 (p. 551) should be consulted for the hydrography of the Congo basin and adjacent river systems.

Assouan, see Assuan.
Assuan.—24° 25′ N., 32°50′ E.
Atbara (R.).—12° 30′ to 17° 40′ N., 34° to 37° E.
Athi Plains.—About 1° 20′ S., 37° 10′ E.
Azaouad.—19° N., 2° to 3° W.

Bafuka.—4° 20′ N., 27° 50′ E.
Bagamoyo.—6° 25′ S., 38° 55′ E.
Bahr-el-Abiad.—12° N., 32° 50′ E.
Bahr-el-Asrak, see Bahr-el-Asrek.
Bahr-el-Asrek.—13° N., 34° E.
Bahr-el-Seraf.—7° 20′ to 9° 25′ N., 30° 40′ to 31° 10′ E.
Bakel.—14° 50′ N., 12° 30′ W.
Bakoy (R.).—13° 45′ N., 10° to 11° W.
Ballat (L.), Lower Egypt.
Bamako.—12° 40′ N., 7° 55′ W.
Bamakou, see Bamako.
Bambili.—3° 45′ N., 26° 10′ E.
Banalia.—1° 30′ N., 25° 40′ E.
Bangoran (R.).—8° 35′ N., 19° 50′ E.
Bani (R.).—12° 30′ to 14° 30′ N., 4° to 6° 30′ W.
Baraka.—4° 15′ S., 28° 50′ E.
Barawa.—1° 5′ N., 44° 5′ E.
Barclay, see Barkly West.
Barkly West.—28° 5′ S., 24° E.
Barotse Country.—15° S., 26° E.
Barumbu.—1° 10′ N., 23° 20′ E.
Basongo, Kasai.—4° 25′ S., 20° 30′ E.
Bass River, see Bass Narok.
Bassalam, Abyssinia.
Bass Narok, Lake Rudolf
Batama.—1° N., 26° 40′ E.
Bavia.—7° 15′ N., 10° 15′ W.
Bengamisa.—1° N., 25° 10′ E.
Bengo (R.).—9° S., 13° 25′ to 15° 30′ E.
Bengu, Niger Territory.
Benguela.—12° 30′ S., 13° 20′ E.
Betu, on Ubangi (R.).
Bipindi.—3° 5′ N., 10° 25′ E.
Birket Kura, Sennar.
Black River, near Maitland.
Blue Nile.—15° 40′ to 11° 15′ N., 32° 25′ to 35° E.
Boksberg, see Boksburg.
Boksburg.—26° 15′ S., 28° 15′ E.
Bombo, on Dande River.
Bomokandi (R.).—3° 45′ to 2° 50′ N., 26° 10′ to 29° 45′ E.
Bono, on Lake Tanganyika.
Boran, see Boran Galla.
Boran Galla.—4° 30′ N., 39° 30′ E.
Boshof, Orange Free State.—28° 30′ S., 25° 10′ E.
Boteke.—0° 10′ S., 18° 55′ E.
Botletle (R.).—20° 5′ to 21° S., 23° 20′ to 24° 30′ E.
Bougouman, see Buguman.
Bounji, on the Alima River.
Brack Kloof (R.), near Grahamstown.
Brakna.—17° N., 14° W.
Brava, see Barawa.
Brickfields, near Grahamstown.
Bubu (R.).—4° 50′ S., 35° 50′ E.
Bugala (I.), see Bugalla (I.).
Bugalla (I.).—0° 30′ S., 32° 15′ E.
Buguman.—11° 25′ N., 15° 10′ E.
Bukome.—2° 55′ S., 31° 50′ E.
Bulungu, Kwango.—4° 40′ S., 18° 40′ E.
Bumbo (R.), Benguela.
Butiaba.—1° 50′ N., 31° 30′ E.

Cabo Negro.—15° 40′ S., 11° 50′ E.
Cairo.—30° 10′ N., 31° 10′ E.
Calumbo.—9° S., 13° 25′ E.
Camama, near Calumbo.
Cameroon (R.).—3° 55′ N., 9° 35′ E.
Camp's Bay, near Cape Town.
Canal de Joseph, Lower Egypt.
Cania (R.), Assinie.
Cape Flats, near Cape Town.
Cape Lopez.—0° 40′ S., 8° 45′ E.
Cape Mount.—6° 45′ N., 11° 25′ W.
Cape of Good Hope.—34° 15′ S., 18° 30′ E.
Cape Peninsula, near Cape Town.
Cape Town.—33° 55′ S., 18° 25′ E.
Caranxa (R.), Pungo Andongo.
Caroca (R.).—15° 40′ to 16° 25′ S., 11° 45′ to 13° 35′ E.
Cato's Creek, near Durban.
Chad (L.).—12° 25′ to 14° 25′ N., 13° to 15° E.
Chakaballa. ()I, near outlet of Lukuga.

Challa (L.), Abyssinia.
Chanler Falls.—0° 50′ N., 38° 5′ E.
Chari (R.).—8° 40′ to 13° N., 14° 25′ to 19° 10′ E.
Chienje.—8° 40′ S., 29° 5′ E.
Chimaou (R.), see Chimau (R.).
Chimau (R.), affluent of Lake Victoria.
Chisambo.— 5° S , 12° 10′ E.
Choa.—10° N., 39° 30′ E.
Chrissie (L.).—26° 20′ S., 30° 15′ E.
Christiana.—27° 55′ S., 25° 10′ E.
Cimbisi, Choa.
Colle (R.).—9° 20′ S., 16° 20′ E.
Como (R.).—0° 20′ to 1° 5′ N., 10° 35′ E.
Comoe (R.).—8° 30′ N., 3° 50′ W.
Crystal Mountains, Gaboon.
Cuando (R.).—12° 45′ to 17° 50′ S., 19° to 25° 5′ E.
Cunene (R.).—12° 40′ to 17° 30′ S., 11° 40′ to 15° 50′ E.

Dahlak (I.).—15° 45′ N., 40° E.
Daka.—18° 40′ S., 26° 10′ E.
Damiette.—31° 25′ N., 31° 50′ E.
Dande (R.).—8° 25′ S., 13° 15′ to 15° 10′ E.
Daressalaam.—6° 50′ S., 39° 15′ E.
Darmancoutz, Senegal.
Debaroa.—15° 5′ N., 38° 50′ E.
Debra-Braham, Choa, Abyssinia.
Debra-Brehan, see Debra-Braham.
Deea (R.), Liberia.
Dembea (L.), see Tsana (L.).
Denoq (R.), near Brava.
Diamouko (R.), see Diamuko (R.).
Diamuko (R.), affluent of the Senegal.
Dima.—3° 20′ S., 17° 20′ E.
Dioubeba, see Diubeba.
Dirk Filander's Region, southern Kalahari.
Diubeba, Senegal.
Djali, near Banalia.—1° 20′ N., 25° 10′ E.
Dolo.—4° 25′ S., 15° 25′ E.
Doume (R.), see Dume (R.).
Dufile.—3° 35′ N., 32° 20′ E.
Dume (R.).—4° 10′ N., 14° E.
Dungo, Pungo Andongo.
Duque de Bragança.—8° 55′ S., 15° 5′ E.
Duque de Braganza, see Duque de Bragança.
Durban.—29° 50′ S., 31° E.
Duru (R.).—3° N., 28° 30′ E.

Ebb en Vloed, near Port Elizabeth.
Ebrie (L.), near Grand Bassam.
Edward (L.), same as Albert Edward (L.).
Efulen.—2° 40′ N., 10° 45′ E.
Eguei District, east of Lake Chad.
Ekongu West, near Alberta.
Ekumbi, Cameroon.
Elizabetha.—1° 10′ N., 23° 40′ E.
Elmeteita (L.), see Elmenteita (L.).
Elmenteita (L.).—0° 10′ S., 36° 10′ E.
Enkeldoorn.—19° S., 30° 50′ E.
Ennerea (Mts.), Abyssinia.
Equeefa (R.), Natal.
Eroug.—18° 30′ N., 1° 20′ W.
Essoi (R.), Assinie.
Eusso Mara (R.), Kenya Colony; probably Mara (R.).
Eusso Nyiro (R.), see Uaso Nyiro (R.).

Fajum, see Fayûm.
Faleme (R.).—13° 45′ to 14° 35′ N., 10° W.
Faraba.—11° 50′ N., 8° 10′ W.
Faya (R.), affluent of Lufuko River.
Fayûm.—29° 15′ N., 30° 50′ E.
Felu (R.).—14° 25′ N., 11° 10′ W.
Finboni, on the coast of East Africa.
Fort Archambault.—9° 5′ N., 18° 35′ E.
Fort Lamy.—12° 10′ N., 14° 55′ E.
Fouladougou, see Fuladugu.
Fuladugu.—13° 10′ N., 14° 40′ W.

Galam, Senegal.
Gambaroo (R.), see Komadugu Yobe.
Gammaroo, probably Gambaroo (R.).
Gancini, see Nganchu.
Ganda Sundi.—4° 50′ S., 12° 50′ E.
Garamba (R.).—4° 10′ N., 29° 40′ E.
Gauritz (R.), Swellendam district.
Gazellenfluss, see Bahr del Ghazal.
Gazi.—4° 25′ S., 39° 30′ E.
Gebel Ahmad Agha.—11° N., 33° E.

Gharbiya Province, Lower Egypt.
Ghinda.—15° 35′ N., 39° E.
Gnédé, Senegal.
Gobabis.—22° 25′ S., 18° 55′ E.
Gongwe Pond, near Toa.
Gongwe, Marungu, Belgian Congo.
Gordon Falls.—29° 35′ S., 30° 15′ E.
Gorée (I.).—14° 40′ N., 17° 30′ W.
Gottorp.—5° 10′ S., 30° 25′ E.
Grahamstown.—33° 15′ S., 26° 35′ E.
Grand Bassam.—5° 10′ N., 3° 50′ W.
Guardafui (Cape).—11° 50′ N., 51° 25′ E.
Guebe (R.), affluent of Oromo River.
Gueledi, see Guelidi.
Guelidi.—2° 10′ N., 45° 5′ E.
Guidimouni, see Guidimuni.
Guidimuni, near Lake Chad.
Gumba, Angola.

Hamasen.—15° 20′ N., 38° 40′ E.
Hamaszen, see Hamasen.
Hangara, Eguei district.
Haouach (R.), see Hauash (R.).
Haoussa (L.), see Haussa (L.).
Harasa.—13° 40′ N., 36° 10′ E.
Hauash (R.).—8° 25′ to 11° 40′ N., 38° 25′ to 41° 30′ E.
Haussa (L.), Abyssinia.
Hawash (R.), see Hauash (R.).
Hemptinne-Saint Benoît, see Luluabourg.

Iboro (I.).—1° 10′ N., 23° 55′ E.
Ilindi, Ugogo.
Impfondo.—1° 35′ N., 18° E.
Inhambane.—23° 55′ S., 35° 35′ E.
Inkongu.—4° 55′ S., 23° 15′ E.
Ipamu, Belgian Congo.
Irangi.—5° S., 35° 50′ E.
Itole, Lake Victoria.
Ituha, Marungu, Belgian Congo.
Izezala (R.), Zululand.

Jipe (L.).—3° 30′ to 3° 40′ S., 37° 45′ E.
Johnston Falls.—10° 40′ S., 28° 40′ E.
Jonje, coast of Cameroon.
Jordan's Nullah, southern end of Lake Victoria.

Kabala (I.), near Kigoma.
Kabambaie, between Luebo and Makumbi.
Kabeba, Marungu, Belgian Congo.
Kabimbi. Luapula. 10° S., 28° 40′ E.
Kabogo (Cape).—6 ° 30′ S., 30 ° E.
Kabole, Marungu, Belgian Congo.
Kabwiri, eastern shore of Lake Moero.
Kachiobwe.—9° 50′ S., 28° 45′ E.
Kadec (R.), see Kadei (R.).
Kadei (R.).—3° 50′ N., 15° 30′ E.
Kafubo (R.).—11° 30′ to 12° S., 27° 30′ to 28° 30′ E.
Kafubu (R.), see Kafubo (R.).
Kafukala (R.), affluent of Lulufia (R.).
Kaha-ekjo, see Koha-ekjo.
Kai Bumba, near Ganda Sundi.
Kakurwe, west of Kilewa.
Kalaba, Marungu, Belgian Congo.
Kalamba.—8° 35′ S., 31° 15′ E.
Kalembwe.—8° 5′ S., 30° 35′ E.
Kalidje Canal, near Alexandria.
Kalingwisi (R.), see Kalungwesi (R.).
Kamamba, Lake Tanganyika.
Kamangu Bay, Lake Tanganyika.
Kamba, Lake Chad.
Kampemba (R ).—9° 30′ S., 28° E.
Kampenzey (I.), probably Mateba (I.).
Kampinda (R.), affluent of the Lobozi.
Kanassarom, Lake Chad.
Kanguba, Niger.
Kanisa.—6° 50′ N., 31° E.
Kansigania (R.), Marungu, Belgian Congo
Kapakwe, on Bay of Kilewa.
Kapampa.—7° 30′ S., 30° 25′ E.
Kapopo.—13° 20′ S., 27° 40′ E.
Karavia (R.).—11° 45′ S., 27° 40′ E.
Karimi, Lake Edward, see Kirima.
Karkloof (R.).—29° 25′ S., 30° 10′ E.
Karonga.—9° 55′ S., 33° 55′ E.
Kasa (R.), Marungu, Belgian Congo.
Kasakaku Bay, Lake Tanganyika.
Kasakalawe.—8° 50′ S., 31° 10′ E.
Kasarala (R.), affluent of the Lufuko.
Kasenge (R.), near Mpala.
Kasengeneke, near Pweto.

Kashiobwe, see Kachiobwe.
Kasokota, between Kilewa and Kapampa.
Kassarasi (I.), see Kassarosi (I.).
Katala —6° S., 12° 45′ E.
Katemberi (R.), Lake Tanganyika.
Katenga, Lake Tanganyika.
Kayou, see Kayu.
Kayu.—12° 40′ N., 7° 30′ W.
Kelekorarom, Lake Chad.
Khartum.—15° 40′ N., 32° 35′ E.
Kiandu, on Kasa (R.).
Kibawa, see Kiabwa.
Kibimbi (Cape), Lake Tanganyika.
Kibondwe (R.), affluent of the Lufuko.
Kibosa, near Lukonzolwa.
Kibwezi.—2° 25′ S., 37° 55′ E.
Kidada, near Kitobola.
Kigoma.—4° 50′ S., 29° 35′ E.
Kikango, Marungu, Belgian Congo.
Kikungu, near Kasenga, Luapula.
Kilewa, southwestern shore of Tanganyika.
Kilira Chakabala (I.), see Chakaballa (I.).
Killarney Lake, near Pietermaritzburg.
Kimilana (R.), Marungu, Belgian Congo.
Kimilolo (R.).—11° 45′ S., 27° 40′ E.
Kinsha, Marungu, Belgian Congo.
Kirando.—7° 25′ S., 30° 35′ E.
Kirungu, on Lobozi (R.).
Kisanga (R.), affluent of Kafubo (R.)
Kisanzi, on Lake Moero.
Kisasa, Marungu, Belgian Congo.
Kise (R.), near Mpala.
Kisebu (R.), Marungu, Belgian Congo.
Kisi, between Kilewa and Kapampa.
Kissakka, see Kishakka.
Kisuka, eastern shore of Lake Tanganyika.
Kisumi, see Kisumu.
Kisumu.—0° 5′ S., 34° 45′ E.
Kitida, Lake Tanganyika.
Kitobola.—5° 20′ S., 14° 40′ E.
Kitombe (Creek), near Banana.
Kitompo (Creek), see Kitombe.
Kitta.—5° 55′ N., 0° 55′ E.
Kituta.—8° 40′ S., 31° 10′ E.
Kitutu (R.), Marungu, Belgian Congo.
Kiunda, between Kilewa and Kapampa.
Knysna.—34° S., 23° 5′ E.
Kobo (R.), near Moliro.
Kokongo, Lake Tanganyika.
Kolangui, French Guinea.
Komadugu Yobe (R.).—10° to 13° 40′ N., 8° 45′ to 13° E.
Komati (R.).—25° to 26° 15′ S., 30° to 33° E.
Kombe, eastern shore of Tanganyika.
Konakry.—9° 25′ N., 13° 45′ W.
Kora, Senegal.
Kordofan.—12° 25′ N., 31° 15′ E.
Koulikoro, see Kulikoro.
Kouloa, see Kuloa.
Kouri (I.), see Kuri (I.).
Kuka.—12° 55′ N., 13° 35′ E.
Kulikoro.—13° N., 7° 25′ W.
Kuloa.—14° 15′ N., 13° 55′ E.
Kulua, see Kuloa.
Kumafubu, on Lake Moero.
Kunene (R.), see Cunene (R.).
Kuri (I.), Lake Chad.
Kwale (R.), Marungu, Belgian Congo.
Kwiro.—8° 40′ S., 36° 45′ E.
Kyngani (R.), see Kingani (R.).

Lagos.—6° 30′ N., 3° 25′ E.
Laikipia Plateau.—0° 25′ N., 36° 25′ E.
Lakeside, Cape Peninsula.
Lealui.—15° 10′ S., 23° 15′ E.
Lepenula (R.), a corruption of the native name of the Olifants River.
Letter Tree.—20° 30′ S., 24° 25′ E.
Leverville.—5° 10′ S., 18° 40′ E.
Libamba (R.), affluent of Lulufia (R.).
Libongo, Angola.
Lie.—2° N., 21° 20′ E.
Likasi.—10° 55′ S., 26° 55′ E.
Lilongwe.—14° S., 33° 45′ E.
Limpopo (R.).—22° 20′ to 26° S., 26° 40′ to 33° 15′ E.
Liwumbu (R.), northeast shore of Lake Victoria.
Lobo (R.), Cameroon.
Lobozi (R.), Marungu, Belgian Congo.
Lofu (R.), see Luvu (R.).
Los (I.).—9° 30′ N., 13° 50′ E.
Louandazi (R.), see Luandazi (R.).

Loukouga (R.), see Lukuga (R.).
Lourenzo Marques.—26° S., 32° 35′ E.
Luandazi (R.), west coast of Tanganyika.
Luanza.—8° 45′ S., 28° 45′ E.
Lubutu.—0° 40′ S., 26° 40′ E.
Lucala (R.).—9° 13′ S., 15° 40′ E.
Luebo.—5° 25′ S., 21° 25′ E.
Lufuko (R.).—6° 50′ to 7° 45′ S., 29° 20′ E.
Lufukwe (R.).—9° 15′ to 9° 40′ S., 27° 50′ to 28° 50′ E.
Lugufu, Lake Tanganyika.
Luhua (R.), misspelling of Lulua (R.).
Luinha, Angola.
Lukinda (R.), between Moero and Tanganyika.
Lukonje (R.), near Bipindi.
Lukulu (R.), affluent of the Luapula.
Lukunga (R.), see Lukungu (R.).
Lulua (R.).—4° 25′ to 11° S, 20° 30′ to 23° 20′ E.
Luluabourg.—5° 55′ S., 22° 20′ E.
Lulufia (R.), Marungu, Belgian Congo.
Lumbesi (R.), near Kapampa.
Lumono (R.), Marungu, Belgian Congo.
Lunangwa (R.).—7° 55′ S., 30° 10′ E.
Lungatshimo (R.).
Lusaka.—7° 20′ S., 29° 25′ E.
Lusalala (R.), affluent of Lake Moero
Lusambo.—4° 55′ S., 23° 15′ E.
Luvu (R.).—8° 40′ to 9° 25′ S., 30° 20′ to 31° E.

Magila.—5° 10′ S., 38° 45′ E.
Magogo (R.), in Ugogo.
Mahagi.—2° 20′ N., 31° 20′ E.
Mahenge.—8° 40′ S., 36° 45′ E.
Mahmoudieh Canal.—31° 10′ N., 30° to 30° 30′ E.
Mahongolo (R.), near Kibanga, Tanganyika.
Maitengue (R.).—20° 15′ S., 27° 10′ E.
Maitland.—33° 55′ S., 18° 30′ E.
Mai Wahiz, Tigre, Abyssinia.
Makarakari (L.), see Makarikari (L.).
Makarikari (L.).—20° 25′ S., 25° to 27° E.
Makata (R.).—6° 35′ to 7° 25′ S., 37° 5′ to 37° 25′ E.
Makdischu.—2° N., 45° 30′ E.
Makote. (R.), affluent of the Lufuko.
Makumbi, Kasai.—5° 40′ S., 20° 15′ E.
Malvern.—29° 50′ S., 31° E.
Mamoun Country, see Mamun.
Mamun Country.—19° 10′ N., 1° 20′ W.
Managembi.—0° 35′ S., 27° E.
Manjara (L.), see Manyara (L.).
Manuan Creek, Zululand.
Manyara (L.).—3° 25′ to 3° 50′ S., 35° 45′ to 35° 55′ E.
Mara (R.).—0° 30′ to 1° 35′ S., 34° to 35° 30′ E.
Maringa (R.).—0° 15′ N., 21° 10′ E.
Maringo (R.), perhaps Maringa (R.).
Mariout (L.).—31° 10′ N., 29° 50′ E.
Masai-Nyika Country.—About 4° 30′ S., 36° 50′ E.
Masindi.—1° 50′ N., 31° 50′ E.
Masran (I.).—12° 45′ N., 33° E.
Massabi.—5° S., 12° E.
Massansa.—2° 10′ S., 33° 55′ E.
Massanza (R.), near Kapampa.
Massanze, northwest of Ubuari.
Massassa, Speke Gulf, see Massansa.
Massaua.—15° 40′ N., 39° 25′ E.
Masswa, Lake Tanganyika.
Matarieh.—30° 5′ N., 31° 20′ E.
Mateba (I.).—5° 55′ S., 12° 45′ to 13° E.
Matjambo, on Kwango (R.).—6° S., 17° E
Mayombe.—5° S., 13° E.
Mazonde, between Kilewa and Lusaka.
Mbampa Bay.—12° 10′ S., 34° 40′ E.
Mbete, probably Pambete.
Mbiki.—6° 35′ S., 38° 20′ E.
Mbwe, eastern shore of Tanganyika.
Medine.—14° 25′ N., 11° 30′ W.
Mekerka, on Toquor (R.), Abyssinia.
Melut.—10° 27′ N., 33° E.
Mengo.—0° 20′ N., 32° 35′ E.
Merca.—1° 45′ N., 44° 55′ E.
Meschera, see Meshra-el-Req.
Meshra-el-Req.—8° 25′ N., 29° 15′ E.
Meurka, see Merca.
Miangoulou, see Miangulu.
Miangulu (R.), affluent of the Bangoran.
Middelburg.—25° 50′ S., 29° 30′ E.

Misembe, between Kilewa and Lusaka.
Mkulungulu (R.), Ugoma, west coast of Tanganyika.
Mkunga (R.), near Ruasa, Ruanda.
Mleroes, probably corruption of Moliro.
Mlilo, probably Moliro.
Mlonde (R.), Marungu, Belgian Congo.
Moba (R.), Marungu, Belgian Congo.
Mobanga.—9° 5′ S., 28° 25′ E.
Mogadiscio, see Makdischu.
Mokaka, French Congo.
Moliro.—8° 15′ S., 30° 35′ E.
Mombitili.—1° 30′ N., 27° 25′ E.
Mongu Sealu.—15° 15′ S., 23° 20′ E.
Monlo-Sakissagan Brook, Masai Nyika Country.
Mono, Dahomey.
Mooi (R.).—26° 10′ to 26° 55′ S., 27° 5′ E.
Mopopo, Pungo Andongo.
Mossamedes.—15° 15′ S., 12° 15′ E.
Moto.—3° N., 29° 30′ E.
Mpakassa (R.), between Vivi and Isangila.
Mpala.—6° 45′ S., 29° 20° E.
Mrondwe Bay, southern end of Tanganyika.
Mrumbi.—7° 5′ S., 29° 45′ E.
Mshale, northeast shore of Tanganyika.
Mtala Swamp, northwest of Uvira.
Mtembo, Marungu, Belgian Congo.
Mterize (R.).—14° 20′ S., 30° 45′ E.
Mtambala, Marungu, Belgian Congo.
Mtowa, see Toa.
Mtutula, Marungu, Belgian Congo.
Mufumbi, on Lake Tanganyika.
Mulumbwa, on Luapula (R.).
Mungo (R.).—4° to 4° 50′ N., 9° 30′ E.
Muria Brook, see Murie Brook.
Murie Brook, affluent of Quanza (R.).
Musengele (R.), Marungu, Belgian Congo.
Mutalala, on Lake Moero.
Mvuano, see Mwano.
Mwano, 9 miles from Kigoma.
Mwerasi (R.), near Kapampa.

Nala.—2° 50′ N., 27° 50′ E.
Namirembe.—2° 30′ S., 31° 40′ E.
Nausib (R.), probably the same as Nossob (R.).
Ndanvie, northeastern shore of Tanganyika.
Ndukali, on Bumbide (I.).
Nepongi (R.).—1° 45′ N., 26° 15′ E.
Nfuko, see Nefuku.
Nganchu.—3° 18′ S., 16° 5′ E.
Ngandu.—3° 15′ S., 18° 15′ E.
Nganza (R.), affluent of Lufuko (R.).
Ngombe, Kasai.—6° 45′ S., 20° 25′ E.
Ngoroine, east of Lake Victoria.
N'Guigmi.—14° 20′ N., 13° 5′ E.
Niamkolo.—8° 45′ S., 31° 10′ E.
Niam Niam Country.—4° 30′ to 7° N., 27° 30′ to 29° 30′ E.
Niapu.—2° 15′ N., 26° 50′ E.
Niari (R.).—3° 10′ to 4° S., 14° 15′ to 14° 40′ E.
Niebuhr (R.).—Affluent of Nile, in 8° N.
Niembakunda.—(On Lake Moero) 8° 35′ S., 28° 45′ E.
Niger (R.).—17° to 4° 20′ N., 4° W. to 6° E.
Nimule.—3° 40′ N., 32° 10′ E.
Ningo, Gold Coast.
Nkole.—2° 20′ S., 28° 30′ E.
Nkomati, see Komati.
Nola.—3° 30′ N., 16° 5′ E.
Nossob (R.).—22° to 27° S., 19° to 21° E.
Nuer (Land of the).—About 9° N., 30° E.
Nwambukoto, near Rikatla.
Nyang (R.), Cameroon.
Nyasa (L.).—9° 30′ to 14° 30′ S., 33° 50′ to 35° 25′ E.
Nyaua, Wembere Steppe.
Nyemirembe, see Namirembe.

Ocean Cliff, near mouth of Umlaas (R.).
Okaputa Pan.—20° 5′ S., 17° E.
Okosongoho.—20° 50′ S., 17° 30′ E.
Okosongolo, see Okosongoho.
Okavango (R.), see Okovango (R.).
Okovango (R.).—12° 30′ to 20° S., 16° 15′ to 22° 30′ E.
Olifants River.—26° to 24° S., 29° to 32° 30′ E.

Omambonde.—20° S., 17° 50′ E.
Ompolunyie, a branch of the Ogowe (R.).
Omvambonde, see Omambonde.
Ondonga.—17° 55′ S., 16° E.
Onono, at outlet of Lukuga (R.).
Oromo (R.), Abyssinia.
Ouani, see Uani.
Ouassoulou, see Uassulu.
Oudjiji, see Ujiji.
Ouesso.—1° 40′ N., 16° E.
Ovamboland, see Ovampoland.
Ovampoland.—18° to 18° 30′ S., 15° to 16° 30′ E.

Padrão Point.—6° 5′ S., 12° 15′ E.
Padron Point, see Padrão Point.
Pakalulwa, 8 kilom. south of Kilwa, Lake Moero.
Pala, see Mpala.
Pamolombue (L.), on Shire (R.).
Panda (R.).—11° S., 26° 50′ E.
Panda ma Tinka, middle of Zambezi district.
Pangalla, on Bakoy (R.).
Pangani.—5° 25′ S., 39° E.
Pata, northwest of Kapampa.
Pêcheurs (I. des), near Banana.
Pienaars Poort.—25° 45′ S., 28° 25′ E.
Pietermaritzburg.—29° 35′ S., 30° 25′ E.
Podor.—16° 40′ N., 15° W.
Poko.—3° 10′ N., 26° 50′ E.
Port Elizabeth.—34° S., 25° 35′ E.
Port Natal, see Durban.
Pota.—8° S., 30° 30′ E.
Potchefstroom.—26° 45′ S., 27° 5′ E.
Pretoria.—25° 40′ S., 28° 15′ E.
Pungo (R.), near Loanda.
Pyramids (The).—30° N., 31° E.

Quiapose (R.), see Quiaposa (R.).
Quicuje, Angola.
Quifangondo (L.).—8° 45′ S., 13° 20′ E.
Quilunda (L.), Angola.
Quitta, see Kitta.

Ramleh.—31° 15′ N., 30° E.
Ramses.—30° 50′ N., 30° 35′ E.
Ranjesfontein, Pretoria district.
Ras Hafoun.—10° 25′ N., 51° 15′ E.
Rikatla.—25° 45′ S., 32° 35′ E.
Roseires.—11° 50′ N., 34° 30′ E.
Rosette.—31° 25′ N., 30° 25 ′E.
Ruasa, Ruanda.
Rufiji.—7° 50′ S., 38° 25′ E.
Rugufu (R.).—5° 20′ S., 29° 50′ E.
Rumruti.—0° 5′ N., 36° 50′ E.
Rungu.—3° N., 28° E.
Russugi (R.), East Africa.
Rutschugi.—5° 5′ S., 30° 25′ E.
Rutuku, —6°10′ S., 29° 20′ E.

Sadani.—6° 5′ S., 38° 45′ E.
Saganeiti.—15° 5′ N., 39° 10′ E.
Salala (R.), Marungu, Belgian Congo.
Sambala (R.), Marungu, Belgian Congo.
San.—13° 20′ N., 5° W.
Sangam Compenzi,' see Kampanzey (I.).
Sange, on Quiaposa (R.).
San Thomé.—0° 20′ N., 6° 40′ E.
Schoa, see Choa.
Scimenzana (R.), near Senafe.
Senaar, see Sennar.
Senafe.—14° 40′ N., 39° 25′ E.
Senegal (R.).—16° 35′ to 14° 45′ N., 12° 10′ to 16° 35′ W.
Sennar.—12° 30′ N., 33° E.
Senoussi Country, see Senussi.
Senussi, near Lake Chad.
Shambe (L.).—7° N., 31° E.
Shari (R.), French Equatorial Africa, see Chari (R.).
Shark Point.—6° S., 12° 20′ E.
Shimba, on Kilwa (I.), Lake Moero.
Shire (R.).—15° 40′ to 17° S., 35° E.
Sibayi (L.).—27° 20′ S., 32° 45′ E.
Silongwe, probably misspelling for Lilongwe.
Simin (R.), near Massansa.
Sirwa (I.), Lake Victoria.
Smyth Sund, Lake Victoria.
Soba.—15° 32′ N., 33° E.
Sokotra.—12° 20′ N., 53° 45′ to55° 20′ E.
Songwe.—7° 15′ S., 30° 10′ E.
Soukoutaly, see Sukutaly.

Soutenthal Valley, see Zoetendal Valley.
South Coast Junction, Natal.
Speke (Gulf).—2° 5′ to 2° 35′ S., 33° to 33° 50′ E.
St. Louis, Senegal.—16° N., 16° 35′ W.
St. Louis de Mrumbi, Tanganyika.—6° 55′ S., 29° 45′ E.
St. Paul's (R.).—8° 55′ to 6° 20′ N., 8° 50′ to 10° 50′ W.
Stephanie (L.).—4° 40′ N., 36° 50′ E.
Suez.—29° 50′ N., 32° 30′ E.
Sukutaly, Senegal.
Sumbu.—8° 25′ S., 30° 30′ E.
Sumbua, east shore of Tanganyika.
Swellendam.—34° 5′ S., 20° 30′ E.

Tabora.—5° 10′ S., 32° 50′ E.
Tamara (I.), one of the Los (I.).
Tango.—4° 40′ S., 18° 35′ E.
Tawila.—13° 16′ N., 33° E.
Tchis, Dahomey.
Tembo, between Kilewa and Kapampa.
Tembwe.—6° 35′ S., 29° 25′ E.
Temma, Gold Coast.
Tempwe, Tanganyika (?Tembwe).
Terra de Bambu, mouth of the Congo.
Tigre.—14° 30′ N., 38° E.
Timbuktu.—16° 50′ N., 2° 35′ W.
Toa.—5° 40′ S., 29° 20′ E.
Tohen, Somaliland.
Tombuctu, see Timbuktu.
Tondj (R.), see Tonji (R.).
Tonj (R.), see Tonji (R.).
Tonji (R.).—5° N., 29° E.
Toquor (R.), Hamasen, Abyssinia.
Toukoto, see Tukoto.
Tourah.—29° 55′ N., 31° 15′ E.
Towalio, west shore of Lake Victoria.
Tristan da Cunha.—37° S., 12° 15′ W.
Trombeta, Golungo Alto.
Tsana (L.).—About 12° N., 37° 40′ E.
Tshikapa.—6° 30′ S.. 20° 25′ E.
Tshisika.—7° S., 20° 25′ E.
Tshopo (R.).—0° 55′ to 0° 5′ N., 25° 5′ to 28° E.
Tuabo, Senegambia.
Tukoto.—13° 30′ N., 9° 50′ W.
Tulo, west shore of Tanganyika.
Tumpa, near the Lobozi (R.).
Tzazega, see Zazega.

Ualamo, Abyssinia.
Uani, Eguei district.
Uaso Nyiro (R.).—0° to 1° 20′ N., 37° to 38° 30′ E.
Uassulu, French Sudan.
Ubwari, see Ubuari.
Udjiji, see Ujiji.
Ufipa.—7° to 8° 40′ S., 31° to 32° E.
Ugoi.—4° 55′ S., 29° 40′ E.
Uha, on Russugi (R.).
Ukuere.—6° 35′ S., 38° 25′ E.
Ulanga, Rufiji Region.
Umbugwe.—4° 5′ S., 35° 45′ E.
Umgeni (R.).—29° 25′ to 29° 50′ S., 29° 50′ to 31° E.
Umkomaas (R.).—30° S., 30° 15′ E.
Umhlatuzani (R.), Malvern, Natal.
Umlaas (R.), see Umlazi (R.).
Umlazi (R.).—29° 40′ to 29° 55′ S., 30° 10′ to 31° E.
Umpingave (R.), Natal.
Unyamwezi.—About 4° 40′ S., 33° 20′ E.
Unyanguira, on Magogo (R.), Ugogo.
Usige, East Africa.

Vaal (R.).—27° to 29° S., 24° to 30° E.
Vankerckhovenville.—3° 20′ N., 29° 20′ E.
Van Staaden's (R.).—34° S., 25° 20′ E.
Victoria.—4° N., 9° 15′ E.
Vouami (R.), see Vuami (R.).
Vua.—8° 5′ S., 30° 35′ E.
Vuami (R.).—6° to 6° 40′ S., 37° to 38° 45′ E.

Wami (R.), see Vuami (R.).
Watsa.—3° N., 29° 40′ E.
Webi (R.).—4 10′ to 7° 15′ N., 39° 35′ to 42° E.
Webi-Doboi.—2° N., 44° 30′ E.
White Nile.—15° 40′ to 9° 20′ N., 31° 30′ to 32° 25′ E.
Witkop.—27° 30′ S., 20° 10′ E.
Yakasa.—1° 35′ N., 23° 20′ E.
Yakusu.—0° 35′ N., 25° E.
Yaou (R.), see Komadugu Yobe (R.).

## Review of Bibliography

The first fresh-water mollusks reported from the Congo basin were obtained a century ago by the ill-fated expedition of Captain J. K. Tuckey, who was despatched in 1816 by the British Admiralty to ascend the River Congo, or Zaire, from its mouth. The expedition tried in vain to overcome the many obstacles to navigation offered by the region of the Cataracts, between Matadi and Leopoldville. Pernicious fevers decimated the crew and caused the loss of the Commander of the Expedition and of its two naturalists, John Cranch and Christian Smith. In an appendix to Captain Tuckey's 'Narrative'[1] there is a fragmentary account of the invertebrates collected by Cranch. In the 'Narrative' itself (p. 93), Tuckey mentions for the first time the peculiar fresh-water mussels of the genus *Egeria*, which are such a characteristic feature of the Congo estuary: "A great quantity of shell fish, of the *Mya* genus, are taken out of the mud round Kampenzey island[2] by the natives; and the fish, stuck on wooden skewers, as the French do frogs, and half dried, are an object of traffic; their state of half putrefaction being entirely to the taste of the Negroes. In a raw state they are uneatable, having no flavor of the oyster."[3]

It is probable that some of the shells described by Reeve and Sowerby from the Congo, between 1820 and 1870, had been obtained by Tuckey's expedition, for no fresh-water mollusks appear to have been collected in our territory during that half-century. Curiously enough, the next aquatic mollusks brought back from our territory came from Lake Tanganyika, giving to the scientific world the first inkling of the remarkable fauna of that lake. Richard Burton and J. H. Speke reached its eastern shores, February 13, 1858, and the shells which they picked up on the beach and brought back to England were described by Woodward in 1859.[4] They included representatives of the typically Tanganyikan species *Iridina spekii* Woodward, *Grandidieria burtoni* (Woodward),

[1]1818. 'Narrative of an Expedition to explore the River Zaire, in 1816, under Captain J. K. Tuckey.' (London).
[2]This is one of the low, sandy islands near Malela, where Mr. Lang and the junior author also found the natives fishing *Egeria* in 1915.
[3]See also Chr. Smith's account in the same 'Narrative,' p. 291. Smith calls the island Sangam Compenzi or Monkey's Island.
[4]1859, Proc. Zoöl. Soc. London, pp. 348–350, Pl. XLVII.

*Spekia zonata* (Woodward), and *Edgaria nassa* (Woodward). Between 1850 and 1880 a few species were obtained in some of the affluents of the Congo by Schweinfurth, Capello and Ivens, and Wissmann. Since then additions to the fresh-water mollusk fauna of the Congo have been made by a small number of collectors who were mentioned in the introduction to the report on land mollusks. On the whole, however, the aquatic species appear to have been somewhat neglected, with the exception of those of the Great Lakes where a great number of travellers and missionaries have gathered quantities of shells and where several expeditions have formally investigated the fauna.

## Suggestions to Collectors

Challenging the available data, we find that our present knowledge of the fresh-water mollusks of the Belgian Congo is even less complete than that of the terrestrial species. The main river, Congo-Lualaba, has only been somewhat satisfactorily investigated at its estuary (between Boma and Banana), at Stanley Pool, near the Stanley Falls, and between that locality and Kasongo. Of its many tributaries none can be said to have been more than superficially touched; thus, we have a few records from the Ubangi, Uele, Dungu, Ituri-Aruwimi, Tshopo, Luvua, Luapula, and some of their smaller affluents. Not more than a dozen species are listed for the extensive drainage of the Kasai. Although much attention has been paid to the fauna of the Great Lakes, additional discoveries will undoubtedly still be made there. Lakes Bangweolo, Kivu, and Albert especially need to be more fully investigated. Nothing is known as yet of the molluscan fauna of the Semliki.

The possibilities for making malacological discoveries in the waters of the Belgian Congo are therefore excellent in every respect. There are, it is true, but few places where water shells are at all abundant and conspicuous, yet a thorough search will reveal a fair number of species in almost any locality. The neighborhood of Stanleyville, for instance, has yielded 31 forms of aquatic mollusks, although there is no apparent reason why that locality should be favored.

Many species may often be picked up by hand from the rocks in the rapids, from floating pieces of wood, and from the muddy or sandy shores of rivers. Certain of the smaller snails, such as *Ancylus*, can be obtained only by carefully examining the stalks of water plants, and especially the under side of floating leaves, also stones and shells. The bottom layer of ponds and pools or shallow streams can be scooped out or scraped up from the shore or from a canoe with a net made of a strong wire bent into a ring to which is attached a sack-net of loose burlap or of fine-mesh copper screen. The dirt thus gathered is washed in the net to remove the mud and fine sand, the coarser material thrown out, and the remaining finer material which contains the mollusks kept for more thorough examination at home. Water plants should be pulled out and the mud adhering to their roots washed in the net. A crow-foot dredge trailed on the bottom conveniently secures many of the large and medium-sized fresh-water mussels. In deeper water dredging is the only means for collecting. A solid, rectangular frame, with a very loose burlap sack attached, or for the larger mussels a strong net of half-inch mesh, can be dragged from a boat or dropped some distance out and then hauled to the shore. Certain species live in rather coarse gravel at the bottom of creeks and it is necessary to stir up the heavy material before gathering it in the net.

Advantage should be taken of the season of the year when the level of the stream is at its lowest to visit the sandbanks and rapids and also to enter swamps which at other times are hardly accessible. The bottom of dried-out ponds should then be excavated to secure certain species that are able to estivate in the baked mud. With the beginning of the rainy season the first heavy rains often swell the streams rapidly and carry débris which is deposited along the banks of more quiet stretches. Such fine drift almost always contains dead shells, land-snails as well as small aquatic species. Many of the Congo species of *Cleopatra* have been obtained only in this fashion.

A modern taxonomy of aquatic mollusks must be primarily based on characters furnished by the animal and its anatomy. Since these have been examined in but very few of the African species, it cannot be too strongly urged that notes be made on the appearance of the living animal and that material be suitably preserved in alcohol. Indications for this purpose were given in the report on land mollusks. The system of African fresh-water mussels, Unionidæ and Mutelidæ, is now merely tentative for want of alcoholic material.

## Medical Importance of Fresh-water Mollusks[1]

The study of the ecology and distribution of aquatic mollusks in tropical and subtropical regions has acquired in late years considerable importance from a medical and veterinary point of view through

[1]The literature bearing on helminth parasites of mollusks and their relations to parasitic worms in vertebrates has grown to almost fantastic proportions. Only some of the salient points which have a direct bearing upon preventive medicine could here be considered. Much of the information has been taken from the Tropical Diseases Bulletin.

the discovery that certain water-snails act as intermediate hosts of helminth diseases. Recent researches seem to indicate that most, if not all, trematode parasites of vertebrates spend part of their life-cycle in some mollusk or crustacean. Although we are here primarily concerned with the rôle of fresh-water mollusks in the transmission of parasitic worms, it may not be amiss to mention that many terrestrial snails and slugs, as also some marine mollusks, may act as intermediate hosts to certain of these parasites. A well-known example is that of *Leucochloridium paradoxum* Carus, a frequent parasite in the tentacles of *Succinea putris* (Linnæus), in Europe, which upon entering song- and water-birds develops into the trematode parasite of the cloaca known as "*Distomum macrostomum*" Rudolphi.[1] Grassi and Rovelli[2] have shown that one of the tapeworms of chickens, *Davainea proglottina* (Davaine), in Europe has as intermediate hosts the slugs *Limax cinereus* Lister, *L. agrestis* Linnæus, and *L. variegatus* Draparnaud.

All flukes, or parasitic trematode worms, pass in the course of their ontogeny through a number of distinct phases, accompanied by migrations to different hosts and intervening free-living stages. The development of the common liver fluke, *Fasciola hepatica* Linnæus, a cosmopolitan parasite of sheep, goats, and other ruminants, and accidentally of man, may be taken as a classic illustration. In this case the adult parasite lives in the bile passages and liver tissue of the vertebrate host; its eggs are carried by the bile to the intestine and thence out of the body with the fæces. The eggs hatch upon reaching water at a favorable temperature, producing minute, ciliated embryos known as "miracidia," which swim about in search of a suitable intermediate host. In Europe this is the common pond snail, *Lymnæa truncatula* (Müller), as discovered by Leuckart in 1882.[3] Upon meeting the snail, the miracidium bores, into its body by means of a small, papillary projection of the anterior end and transforms within the tissues of the mollusk into a sporocyst. This produces a large number of parthenogenetic eggs, each developing into a larva of a second type known as a "redia." The wall of the sporocyst eventually bursts and the rediæ invade the tissues of the snail to develop, at least under certain conditions, into a new generation of rediæ. The second, or sometimes a third, generation of rediæ produce by partheno-

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[1]Zeller, E. 1874. 'Ueber *Leucochloridium paradoxum* Carus und die weitere Entwickelung seiner Distomenbrut.' Zeitschr. Wiss. Zool., XXIV, pp. 564–578, 1 Pl.

[2]Grassi, B. and Rovelli, G. 1889. 'Embryologische Forschungen an Cestoden.' Centralbl. f. Bakt. u. Parasitenk., V, pp. 370–377, 401–410.

[3]See Leuckart, R. 1886–1901. 'Die Parasiten des Menschen,' 2d Ed., I, Abt. 2, pp. 258–264. The essentials of the life-history of *Fasciola hepatica* were also worked out independently by A. P. Thomas in 1881. See Thomas, A. P. 1883. 'The life-history of the liver-fluke (*Fasciola hepatica*).' Quart. Journ. Microsc. Sci., N. S., XXIII, pp. 99–133, Pls. II–III.

genesis a third type of larvæ, the so-called "cercariæ," which are furnished with a sucker and an actively moving tail. The cercariæ leave the body of the snail and swim about in the water, finally attaching themselves to aquatic plants, where they lose their tails and encyst. Frequently, too, the cercariæ encyst free in the water. When eaten or drunk by a sheep or goat, the cyst is dissolved in the stomach and the little parasite penetrates the intestinal wall, then from the peritoneal cavity into the ducts of the liver, where it develops into the adult fluke.

In South America the intermediate host of *Fasciola hepatica* is, according to Ad. Lutz, a species of *Lymnæa*, while in the Hawaiian Islands *Lymnæa oahuensis* Souleyet is regarded as such. Iturbe and Gonzalez,[1] however, incriminate *Pomacea luteostoma* (Swainson) in Venezuela, while in the United States Boyd[2] suspects a snail which he calls *Physa "fontinalis acuta."* In South Africa the host is not known with certainty.

Though *Fasciola hepatica* has been recorded from various localities in Africa, it is usually replaced there by a much larger species, *Fasciola gigantica* (Cobbold) (= *Fasciola angusta* Railliet). This parasite affects cattle and sheep, and has also been reported from certain big game, such as giraffes, zebras, and buffaloes, and very rarely from man. Its life history, recently worked out by Annie Porter,[3] is similar to that of *Fasciola hepatica.* In South Africa the intermediate host is a common pond snail, *Lymnæa natalensis* (Krauss).

Other liver flukes are especially adapted for parasitizing carnivorous vertebrates and in some countries they are frequently found in domestic cats and dogs, and consequently occur also in man. One of these, the Chinese fluke, *Clonorchis sinensis* (Cobbold) (= *endemicus* Bälz), occurs throughout southern Asia, from India to Korea, and in the East Indies and Japan. This parasite migrates through three hosts: the adult is found in vertebrates; the encysted cercariæ occur in fresh-water fish; while the host in which the miracidia develop into cercariæ is a fresh-water snail. At first several species of Thiaridæ (*Melania* in the old, broad sense), especially "*Melania*" *libertina* Gould, were suspected, but Muto[4] implicated *Bulimus striatulus* var. *japonicus* (Pilsbry)

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[1]Iturbe, J. and Gonzalez, E. 1919. 'Quelques Observations sur les cercaires de la vallée de Caracas. (Première Partie).' (Caracas), 20 pp., 7 Pls.

[2]Boyd, M. F. 1920. 'A possible intermediate host of *Fasciola hepatica* L., 1758, in North America.' Journ. of Parasitology, VII, pp. 39–42.

[3]Porter, Annie. 1920. 'The life history of the African sheep and cattle fluke, *Fasciola gigantica.*' South African Jl. of Sci., XVII, 1, pp. 126–130. See also Annie Porter, 1920, Med. Jl. of South Africa, XV, pp. 128–133. Leiper (1922, Tropical Diseases Bull., XIX, p. 364) erroneously refers Miss Porter's experiments to *Fasciola hepatica.*

[4]Muto, M. 1918. 'Ueber den ersten Zwischenwirt von *Clonorchis sinensis.*' Verhandl. Japan. Path. Ges. Tokyo, VIII, p. 151. The snail is here called *Bythinia striatula* var. *japonica.*

More recently, Faust and Barlow[1] showed that in Chekiang Province, China, the cercariæ of *C. sinensis* occur in "*Melania*" *hongkongensis* Deshayes. They later encyst in many different species of fresh-water fish, either in the subcutaneous and connective tissues, or on the under side of the scales. Moreover, Faust is inclined to believe that the mollusk most commonly harboring the cercariæ of *C. sinensis* in the greater part of China will ultimately be found to be a species of *Bulimus* (=*Bythinia*). There are other allied species of liver flukes in Europe, India, and North America whose life-history is still unknown.

Among the intestinal flukes, the most important is the human parasite *Fasciolopsis buskii* (Lankester), which is rather frequent in the Far East. The life-history has been traced by Nakagawa[2] in Formosa and by C. H. Barlow[3] in China. The intermediate hosts, in Formosa, are *Planorbis cœnosus* Benson and *Segmentina largillierti* (Dunker), and the development and later encystment are very similar to those of *Fasciola hepatica*, to which *Fasciolopsis* is nearly related. Man becomes infected by eating raw vegetables on which the cercariæ are encysted, in China especially the nuts of water-caltrop (*Trapa natans*), and the tubers of *Eleocharis tuberosa*. Every detail of the life-cycle of *F. buskii* was recently elucidated by Barlow.[4] He found that, in China, the miracidia enter *Planorbis schmackeri* Clessin and *Segmentina nitidellus* E. v. Martens, where they develop into cercariæ that eventually leave the snail, encyst, and are able to infect man. *Loxotrema ovatum* Kobayashi (=*Metagonimus yokagawai* Katsurada) is another frequent, but apparently innocuous, trematode parasite in the small intestine of man in Formosa, Japan, and Korea, also commonly found in dogs. The cercarial stages are found in fresh-water fish. Muto described as the developmental stages a redia and cercaria found in up to fifty per cent of "*Melania* "*libertina* and various other "*Melaniæ*" in the endemic region of Kaishu, Korea, and successfully infected gold fish and carp, later infecting cats from these.[5] Faust found the cercariæ of *L. ovatum* in "*Melania*" *ebenina* Brot, in China. Similar intestinal flukes are often

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[1]Faust, E. C. and Barlow, C. H. 1924. 'A preliminary note on the life history of *Clonorchis sinensis*, in Chekiang Province, China.' Amer. Jl. Hyg., IV, pp. 69–71.
Faust, E. C. 1924. 'Notes on larval flukes from China. II. Studies on some larval flukes from the central and south coast provinces.' Amer. Jl. Hyg., IV, pp. 241–301, Pls. I–II.
1925. 'Some recent aspects of the epidemiology of *Clonorchis* infection in China.' China Med. Jl., XXXIX, pp. 287–296.

[2]Nakagawa, Koan. 1921. 'On the life cycle of *Fasciolopsis buski*, Lankester.' Kitasato Arch. Exper. Med., IV, pp. 159–167, 1 Pl.

[3]Barlow, C. H. 1923. 'Life cycle of *Fasciolopsis buski* (human) in China.' China Med. Jl., XXXVII, pp. 453–472, 1 Pl.

[4]Barlow, C. H. 1925. 'The life cycle of the human intestinal fluke *Fasciolopsis buski* (Lankester).' Amer. Journ. Hyg., Monogr. Ser., No. 4, pp. 1–96, 10 Pls.

[5]Muto, M., 1917, quoted in Tropical Diseases Bulletin, XII, 1918, p. 176.

found in considerable numbers in the intestine or stomach of wild and domestic vertebrates. Species of *Paramphistomum* are especially common in African herbivores. But little is known thus far of their life-cycle.[1] According to Cawston, the usual *Paramphistomum* of South African cattle and sheep has the snail *Bulinus schackoi* (Jickeli) as intermediate host.[2]

In Japan, China, and other Oriental countries a very serious disease is caused in man by a lung fluke, *Paragonimus ringeri* (Cobbold) (= *pulmonale* Bälz; *westermanii* Kerbert), which, moreover, also infects dogs and pigs. In this case it was shown experimentally that the miracidia enter certain water snails, particularly a species referred to as "*Melania*" *libertina* Gould, where they produce sporocysts.[3] Ando's[4] later experiments, though not eliminating all possible sources of error, render it probable that the cercariæ eventually migrate from "*Melania*" to fresh-water crabs (*Potamon* and *Eriocheir*), where they encyst, and that they finally reach their vertebrate host, mostly following the consumption of uncooked crustaceans.[5]

In Africa the most important parasitic trematodes are the blood flukes, species of the genus *Schistosoma*[6] that live in the large blood-vessels of the abdominal cavity of man, producing a disease known as bilharziosis or schistosomatosis. In *Schistosoma* the two sexes are separate, the adult male worm carrying the adult female in a ventral groove. Two species of the genus are restricted to man, at least as natural infections. Of these, *Schistosoma hæmatobium* (Bilharz) [= *S. capense* (Harley)] is common in Lower Egypt, Asia Minor, southern Asia, and the eastern half of Africa and has also been found in Morocco and Portugal.[7] The

[1] J. D. F. Gilchrist (1918, Parasitology, X, pp. 311–319) has shown that the cercariæ of *Distoma luteum* Gilchrist, a common intestinal fluke of South African frogs (*Rana* and *Xenopus*), develop in *Bulinus tropicus* (Krauss); the cercariæ emitted by infested *Bulinus*, after swimming about for some time, reenter the body of the same species of snail by the nephridial opening and encyst in the pericardium; snails thus infested with cysts are later eaten by the frogs. Another interesting case is that of certain trematode larvæ that have on several occasions been found in mosquito larvæ, whence they may pass into the adult insect. In the case of an Indian species, M. B. Soparkar (1918, Indian Jl. Med. Res., V, pp. 512–515) was able to show that cercariæ derived from *Planorbis exustus* infect larvæ of *Anopheles rossi* and *Culex fatigans*; the next stage of the fluke, which is related to *Clinostomum*, is found in certain fresh-water fish; but it is possible that the fully mature form of the worm develops in a fourth host, namely some aquatic bird.

[2] Cawston, F. G. 1923. 'South African larval trematodes and their intermediary hosts.' Trans. Roy. Soc. South Africa, XI, 2, pp. 119–130.

[3] Nakagawa, Koan. 1919. 'Further notes on the study of the human lung distome, *Paragonimus westermani*.' Journ. of Parasitology, VI, pp. 39–43. It is not clear from this paper that the life-history is as yet completely elucidated.

[4] Ando, R. 1920. ('The first intermediate host of *Paragonimus westermani*.') Tokyo Iji Shinshi, Nos. 2175–78, 21 pp., 1 Pl. (in Japanese; reviewed in Tropical Diseases Bull., XVII, 1921, p. 51).

[5] According to Iturbe and Gonzalez (1919. 'Quelques obsevations sur les cercaires de la vallée de Caracas.' (Caracas), 20 pp., 7 Pls., *P. ringeri* occurs also in Venezuela, where its intermediate hosts are, they claim, the snail *Pomacea luteostoma* (Swainson) and the fresh-water crab *Pseudothelphusa iturbei* Rathbun.

[6] *Schistosoma* Weinland, 1858 = *Bilharzia* Cobbold, 1859; *Gynæcophorus* Diesing, 1858; *Thecosoma* Moquin-Tandon, 1860.

[7] C. C. Chesterman (1923, 'Note sur la bilharziose dans la région de Stanleyville.' Ann. Soc. Belge Méd. Tropic., III, pp. 73–75, Pl.) has recently reported cases of intestinal bilharziosis from the region of Stanleyville, Belgian Congo. They appear to be due to *S. hæmatobium*, although the eggs found in the fæces are larger and narrower at the ends than in the Egyptian *S. hæmatobium*. The few adults examined seemed identical in every respect with *S. hæmatobium*. The intermediate host of this parasite was found to be near Stanleyville *Physopsis africana* (erroneously called *Bulinus contortus* in Chesterman's paper).

adult flukes, about one-half inch long, live in the abdominal veins, especially in the portal vein and its branches. The eggs are characteristicaly oval, with a stout, terminal spine by means of which they penetrate the wall of the bladder, being then voided with the urine; more rarely they invade the intestine and are eliminated with the fæces. While gaining their exit from the body, these eggs erode the mucous membrane, causing a certain amount of bleeding, which, mixed with the urine, produces the symptom known as "parasitic hæmaturia." Leiper (1915–1918) has worked out the life-history of this parasite. Upon reaching the water, the eggs hatch ciliated embryos or miracidia which enter the body of aquatic snails of the subfamily Bulininæ. In Egypt the usual host is *Bulinus contortus* (Michaud), although Leiper incriminates also *B. dybowskii* Fischer and *B. innesi* (Pallary).[1] Within the body of the snail, the miracidia develop into sporocysts, from which daughter sporocysts bud off. These migrate to the liver of the snail where they may become so numerous that the infection can easily be detected with the naked eye. Such infected snails later discharge through the pulmonary orifice every day for weeks free-swimming cercariæ with a characteristically forked tail. The cercariæ swarm on the surface of the water and die within forty-eight hours unless they are able to reach the body of their next, vertebrate host. They may enter a human being either by the mouth through the mucous membranes, or through the sound skin, and then migrate through the body to the abdominal veins. In South Africa the usual intermediate host is *Physopsis africana* Krauss, as first shown by Becker.[2] Annie Porter[3] also found the cercariæ in *Lymnæa natalensis* (Krauss), but this is probably not of frequent occurrence. The probable source of an outbreak of bilharziosis in Portugal was traced by C. França[4] and by A. Bettencourt and J. Borges[5] to *Planorbis dufourii* Graells (=*P. metidgensis* Forbes; *P. corneus* var. *metidjensis* Bourguignat), since it was shown that this snail attracts the miracidia of *S.*

[1]Leiper, R. T. 1915–1918. 'Report on the results of the Bilharzia Mission in Egypt.' Journ. Roy Army Med. Corps, XXV, 1915, pp. 1–55, 147–192, and 253–267, 3 Pls.; XXVII, 1916, pp. 171–190; XXX, 1918, pp. 235–260.

[2]Becker, 1916, Med. Journ. South Africa, XI, p. 156 and XII, p. 42. F. G. Cawston, 1918, 'Bilharziasis in Natal.' Parasitology, XI, pp. 83–93; 1922, 'The experimental infestation of fresh-water snails, with special reference to the Bilharzia parasite.' South African Jl. of Sci., XVIII, pp. 396–399. In Nyasaland the intermediate host is, according to W. H. Dye's experiments, a species of *Physopsis* allied to *globosa* (Morelet) (See J. B. Christopherson, 1923, Nature, CXII, p. 436). In Sierra Leone Blacklock and Thompson (1924) infected experimentally a *Physopsis* (related to *globosa* Morelet) with *S. hæmatobium*. See also Ingram, A. 1924. 'Note on a possible intermediate host of *Schistosoma haematobium*, in the Gold Coast.' Ann. Trop. Med. Paras., XVIII, pp. 265–266.

[3]Porter, Annie. 1920. 'The experimental determination of the vertebrate hosts of some South African cercariæ from the molluscs *Physopsis africana* and *Limnæa natalensis*.' Med. Journ. South Africa, XV, pp. 128–133. An echinostome (*Echinostomum xenopi*) was found in both *P. africana* and *L. natalensis* and successfully reared in a frog of the genue *Xenopus*. A monostome has also been reared in *Xenopus* from cercariæ in *P. africana*.

[4]1922, Bull. Soc. Path. Exot. Paris, XV, pp. 805–809.

[5]1922, Arq. Inst. Bact. Camera Pestana, V, pp. 133–135 and 189–230, Pls. VII–XII.

*hæmatobium* and could be experimentally infected with the parasite. Furthermore, in Portuguese localities where the outbreaks occur in man, specimens of this snail were found infected with cercariæ agreeing in every respect with those of *S. hæmatobium.*

A second species of *Schistosoma, S. mansoni* Sambon, differs from the foregoing in the shape of the eggs, which bear a lateral instead of a terminal spine, and in the fact that the eggs are voided in the digestive tract and are eliminated with the fæces instead of with the urine. The disease it produces is therefore usually designated as intestinal bilharziosis. *S. mansoni* occurs together with *S. hæmatobium* in many parts of Africa and was formerly thought to be but a form of that species.[1] In the Belgian Congo it appears to be the most frequent agent of bilharziosis, being common in certain parts of the Katanga district and elsewhere outside of the rain forest belt. It is the only species of *Schistosoma* known from tropical America, where it was probably introduced from Africa. The life-cycle is similar to that of *S. hæmatobium,* but the intermediate hosts are species of *Planorbis: P. boissyi* Potiez and Michaud, in Egypt, according to Leiper; *P. guadelupensis* Sowerby, in Venezuela, according to Iturbe and Gonzalez[2]; *P. olivaceus* Spix and *P. centrimetralis* Ad. Lutz, in Brazil. according to Ad. Lutz; and *P. antiguensis* Gould, in the West Indies, according to S. B. Jones. In Central Africa the intermediate host is but imperfectly known. Recent experiments by W. H. Dye[3] have shown that, in Nyasaland at least, a species of *Planorbis* related to *P. sudanicus* must be incriminated. In South Africa Annie Porter[4] found that *S. mansoni* produces cercariæ in at least three mollusks, namely *Planorbis pfeifferi* Krauss, *Physopsis africana* Krauss, and *Bulinus tropicus* Krauss.[5]

*Schistosoma japonicum* (Katsurada) is an endemic blood fluke of the Orient (Japan, China, Philippine Islands, etc.), where it is most common in cats and dogs, but also frequently infects man. The life-history is similar to that of *S. mansoni.* Miyairi and Suzuki,[6] in 1913, first succeeded

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[1]*Schistosoma hæmatobium* (Bilharz) originally included both forms. In 1864, Harley described the form with eggs having a terminal spine as *Distomum capense* and in 1907 Sambon named the form in which the egg has a lateral spine *Schistosoma mansoni.* If one wishes to adhere strictly to the rules of nomenclature, *S. mansoni* is a synonym of *S. hæmatobium,* but we have followed the general usage in calling *S. hæmatobium* the form in which the egg has a terminal spine (Harley's *D. capense*).

[2]Iturbe, J. and Gonzalez, E. 1917. 'The intermediate host of *Schistosomum mansoni* in Venezuela.' (Caracas), 10 pp., 2 Pls.

[3]Reported by J. B. Christopherson, 1923, Nature, CXII, p. 436.

[4]1921, Med. Journ. South Africa, XVI, pp. 75–76. See also Porter, Annie. 1922. 'Some modern developments in animal parasitology.' South African Jl. of Sci., XIX, pp. 64–94.

[5]A comprehensive account of *Schistosoma mansoni* is given by Ad. Lutz. 1919. 'O *Schistosomum mansoni* e Schistosomatose segundo observações feitas no Brazil.' Mem. Inst. Osw. Cruz, XI, 1, pp. 121–155, Pls. XXXVII–XLIII (English translation, pp. 109–140). Iturbe and Gonzalez' experiments have been doubted by Faust (1918, Journ. of Parasitology, IV, p. 109). See also S. Kemp and F. H. Gravely. 1919. 'On the possible spread of schistosomiases in India.' Indian Jl. Med. Research, VII, 1, pp. 251–264.

[6]1913, Tokio Med. Journ. (in Japanese); see 1914, Tropical Disease Bull., III, p. 289.

in tracing the development of the parasite through a small amnicolid snail. Leiper and Atkinson,[1] using eggs derived from a dog infected in China, were successful in rearing cercariæ in the Japanese amnicolid *Blanfordia nosophora* (Robson),[2] a common snail in the ditches of the rice-growing regions and probably the same species as used by Miyairi and Suzuki. In 1922 Suyemori found that *Blanfordia formosana* Pilsbry and Hirase acted as the intermediate host in Formosa,[3] and later Meleney and Faust sh *Hemibia hupensis* (Gredler) to be the carrier in the Yangtze Valley, China.[4]

Of the other blood flukes that occur in vertebrates the life-history has been studied in a few cases only. *Schistosoma spindale* Montgomery, a parasite of cattle in India and Sumatra, undergoes its life-cycle in *Planorbis exustus* Deshayes.[5] In North America, Bunshiro Tanabe recently succeeded in infecting mice with a blood fluke, *Schistosomatium pathlocopticum* Tanabe, starting from cercariæ found in the digestive gland of *Lymnæa palustris* Müller found near Boston.[6]

Several different types of cercariæ are of rather frequent occurrence in terrestrial, fluviatile, and even marine mollusks, but in the majority of cases their further history is unknown.[7] It is, however, evident that many species of mollusks, by no means closely related taxonomically, may act as intermediate hosts for trematode parasites of vertebrates. As far as strictly human parasites are concerned, the hosts at present known with certainty belong to the families Lymnæidæ, Planorbidæ and Amnicolidæ. Some of the Melaniidæ have also been incriminated, but on less conclusive evidence. The mollusks of medical importance belong to but few genera and species, although they have been referred to under many names. Since there appears to be much confusion with

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[1] 1915, Brit. Med. Journ., I, p. 201.

[2] *Katayama nosophora* Robson, January, 1915, Brit. Med. Journ., I, p. 203; *Blanfordia nosophora* Pilsbry, May, 1915, The Nautilus, XXIX, p. 1. It has been claimed that the species is synonymous with *Hemibia japonica*.

[3] Suyemori, S. 1922, Jl. Med. Assoc. of Formosa, No. 220, pp. 1–24 (in Japanese, with English résumé, pp. 1–3).

[4] Meleney, H. E. and Faust, E. C. 1923. 'The intermediate host of *Schistosoma japonicum* in China.' Proc. Soc. Experim. Biol. and Med., XX, pp. 216–218.

1924. 'Studies on schistosomiasis japonica.' Americ. Journ. Hyg., Monogr. Ser., No. 3, pp. 1–339, 36 Pls. With extensive bibliography and an account of the molluscan intermediate hosts by N. Annandale (pp. 269–294). Annandale refers all the species of mollusks here called *Blanfordia* and *Hemibia* to the genus *Oncomelania*.

[5] Linston, W. G. and Soparkar, M. B. 1918. 'Bilharziosis among animals in India. The life-cycle of *Schistosomum spindalis*.' Indian Jl. Med. Research, V, pp. 567–569.

[6] Tanabe, B. 1923. 'The life history of a new schistosome, *Schistosomatium pathlocopticum* Tanabe, found in experimentally infected mice.' Journ. of Parasitology, IX, pp. 183–198, Pls. XIV–XX.

[7] The following papers deal with cercariæ found in African fluviatile mollusks:

Sonsino, P. 1892. 'Studi sui parassiti di molluschi di acqua dolce nei dintorni di Cairo in Egitto. Festschr. 70. Geburtst. R. Leuckart's, (Leipzig), pp. 134–146, Pl. XVIII.

Leiper, R. T. 1916. 'Report on the results of the Bilharzia Mission in Egypt.' Journ. Roy. Army Med. Corps, XXVII, pp. 171–190.

Faust, E. C. 1920. 'A survey of Cawston's species of South African cercariæ.' Parasitology, XII, pp. 212–216.

Cawston, F. G. 1923. 'South African larval trematodes and their intermediary hosts.' Trans. Roy. Soc. South Africa, XI, 2, pp. 119–130.

## Intermediate Molluscan Hosts of Human Trematodes[1]

| HUMAN PARASITE | MOLLUSCAN HOST | COUNTRY | AUTHORITY |
|---|---|---|---|
| *Fasciola hepatica* (accidental in man) | *Lymnæa truncatula* | Europe | R. Leuckart and R. P. Thomas |
| | " sp. | South America | Ad. Lutz |
| | " *oahuensis* | Hawaii | ? |
| *Fasciola gigantica* (accidental in man) | *Lymnæa natalensis* | South Africa | Annie Porter |
| *Clonorchis sinensis* | *Bulimus striatulus* var. *japonicus* | Japan | M. Muto |
| | "*Melania*" *hongkongensis* | China | E. C. Faust and C. H. Barlow |
| *Fasciolopsis buskii* | *Planorbis cœnosus* | Formosa | K. Nakagawa |
| | *Segmentina largillierti* | " | " |
| | *Planorbis schmackeri* | China | C. H. Barlow |
| | *Segmentina nitidellus* | " | " |
| *Loxotrema ovatum* | (?"*Melania*" *libertina*) | Korea | M. Muto |
| | "*Melania*" *ebenina* | China | E. C. Faust |
| *Paragonimus ringeri* | "*Melania*" (? *libertina*) | Japan | K. Nakagawa and R. Ando |
| *Schistosoma hæmatobium* | *Bulinus contortus* | Egypt | R. T. Leiper |
| | " *dybowskii* | " | " |
| | " *innesi* | " | " |
| | *Physopsis africana* | South Africa | Becker and Annie Porter |
| | " " | Belgian Congo | C. C. Chesterman |
| | *Planorbis dufourii* | Portugal | C. França, A. Bettencourt and J. Borges |
| | *Lymnæa natalensis* | South Africa | Annie Porter |
| *Schistosoma mansoni* | *Planorbis boissyi* | Egypt | R. T. Leiper |
| | " *guadelupensis* | Venezuela | Iturbe and Gonzalez |
| | " *olivaceus* | Brazil | Ad. Lutz |
| | " *centimetralis* | " | " |
| | " *antiguensis* | West Indies | S. B. Jones |
| | " *pfeifferi* | South Africa | Annie Porter |
| | " sp. (near *sudanicus*) | Nyasaland | W. H. Dye |
| | *Physopsis africana* | South Africa | Annie Porter |
| | *Bulinus tropicus* | " " | " |
| *Schistosoma japonicum* | *Blanfordia nosophora* | Japan | Leiper and Atkinson |
| | " *formosana* | Formosa | Suyemori |
| | *Hemibia hupensis* | China | Meleney and Faust |

[1] A recent paper by P. Bartsch (1925, 'Some new intermediate hosts of the Asiatic human blood fluke.' Journ. Washington Ac. Sci., XV, pp. 71–73) contains no additional information with regard to the mollusks positively known as intermediate hosts of *Schistosoma japonicum*.

regard to their correct naming in medical publications, we present a summary in table form (p. 95) of the known host relationships.[1] A point of interest brought out by this table is that the molluscan host is not, as a rule, specific, but that even diffierent genera may be involved in the history of the same parasite. Of the genera listed, *Blanfordia, Hemibia*, and *Bulimus* (=*Bithynia*) belong in the family Amnicolidæ; *Bulinus, Physopsis, Planorbis*, and *Segmentina* in the Planorbidæ; and *Lymnæa* in the Lymnæidæ. The specific identity of the snails referred to "*Melania*" *libertina* by Japanese workers is still open to question, since they have apparently not yet been studied by a malacologist. The common Japanese *Melania libertina* belongs to the genus *Semisulcospira*.

In tropical and South Africa, where blood flukes are by far the most important trematode parasites from a sanitary point of view, the Planorbidæ (*Planorbis, Bulinus*, and *Physopsis*) which chiefly act as intermediate hosts are, fortunately, but seldom abundant. Furthermore, as these snails prefer stagnant to running water, their control, resulting in the eradication of bilharziosis, may be comparatively easy in densely populated regions.[2] Copper sulphate, where it may be used without danger, is very effective in clearing ditches of snails. In many cases, too, domestic ducks have been found of great value in keeping down the snail population of ponds in the neighborhood of human habitations. Wild ducks, on the other hand, contribute rather to the dispersal of dangerous fresh-water mollusks from pond to pond.[3]

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[1]See Milton, F. 1923. 'Note on the molluscan hosts of the human schistosomes.' Journ. Trop. Med. Hyg., XXVI, pp. 211–213. Although this paper is a praiseworthy attempt to elucidate molluscan nomenclature as applied to medical problems, it still contains a number of misleading statements.

[2]Chandler, A. C. 1920. 'Control of fluke diseases by destruction of the intermediate host.' Journ. Agric. Research, XX, pp. 193–208.

Baker, F. C. 1922. 'Fluke infections and the destruction of the intermediate host.' Journ. of Parasitology, VIII, pp. 145–147.

Cawston, F. G. 1923. 'Some practical means of dealing with the menace of fresh-water snails in Natal.' South African Med. Rec., XXI, pp. 514–515.

[3]Cawston, F G. 1920. 'The value of domesticated ducks in preventing diseases.' The Natal Poultry Journ.

1921. 'Wild birds a cause of the spread of *Bilharzia* infection.' Journ. Trop. Med. Hyg., XXIV, pp. 109–110.

## SYSTEMATIC ACCOUNT OF CONGO FRESH-WATER MOLLUSKS

### GASTROPODA

Aquatic or terrestrial mollusks, with a distinct head, bearing one or two pairs of tentacles and, with few exceptions, a pair of eyes. Radula usually present. The body is asymmetrical; the ventral side forms a broad and flat foot; the dorsal side is covered by the mantle which, as a rule, secretes a univalve shell, usually more or less coiled. The mantle contains an open, respiratory cavity serving as a lung or containing gills. In some marine forms (Nudibranchiata) the mantle is absent and the gills are outgrowths of the integument of the back.

The fresh-water gastropods are polyphyletic. They have evolved in two different ways and in each case from several stocks and at different times.

In the Streptoneura, the fluviatile types have been derived directly from marine forms which gradually became adapted to brackish and fresh-water conditions. These forms have retained the ancestral gills, but in some cases they have later become more or less terrestrial and have acquired an additional lung (Ampullariidæ). The purely terrestrial, lung-breathing Cyclophoridæ and Pomatiasidæ have undoubtedly originated in some such fashion from a pectinibranchiate stock. The adaptation from marine to fresh-water or even terrestrial life is still going on at present in the Neritidæ, Cerithiidæ, Littorinidæ and others.[1]

The Ethiopian fresh-water gastropods belong to the following seventeen families:

| | ORDERS | SUBORDERS | FAMILIES |
|---|---|---|---|
| | | | Auriculidæ |
| | | | Lymnæidæ |
| Euthyneura | Pulmonata | Basommatophora | Planorbidæ |
| | | | Physidæ |
| | | | Ancylidæ |
| Streptoneura | Scutibranchiata | Rhipidoglossa | Neritidæ |
| | | | Hydrocenidæ |
| | Pectinibranchiata | Tænioglossa | Ampullariidæ |
| | | | Viviparidæ |
| | | | Amnicolidæ |
| | | | Syrnolopsidæ |
| | | | Truncatellidæ |
| | | | Synceridæ |
| | | | Valvatidæ |
| | | | Littorinidæ |
| | | | Cerithiidæ |
| | | | Melaniidæ |

[1]See Pelseneer, P. 1895. 'Prosobranches aériens et Pulmonés branchifères.' Arch. de Biologie, XIV, 2, pp. 351–393, Pls. xiv–xviii.

The Basommatophora, or fresh-water pulmonates, have originated from terrestrial snails which reverted to aquatic conditions. In most cases they have retained the ancestral lung and breathe air. Some forms, however, have secondarily acquired gills, which may exist together with the lung (Planorbidæ) or may have replaced the latter almost completely (Ancylidæ). The passage from terrestrial to aquatic habits is well exemplified in the living fauna by the Auriculidæ.

### Key to Ethiopian Fresh-water Families

1. Snails not provided with an operculum; with few exceptions the shells are quite thin or fragile. Mainly air-breathing. PULMONATA .................2.
   Snails provided with an operculum; the shells mainly rather strong. Mainly breathing with gills. PROSOBRANCHIATA ...........................6.
2. Fresh-water limpets, the shell not spiral, simply conic, or with the apex recurved. Ancylidæ.
   Snails with spiral shell...................................................3.
3. Shell wider than long, coiled in a plane.......................Planorbidæ.
   Shell decidedly longer than wide, the spire projecting....................4.
4. Shell sinistral, oval or oblong..............................Planorbidæ.
   Shell dextral..........................................................5.
5. Rather solid; aperture with folds or teeth on the columella and often within the outer lip. In brackish water..........................Auriculidæ.
   Thin; aperture ample, without distinct folds or teeth on the columella. In fresh water.........................................Lymnæidæ.
6. Columella with a spirally entering fold. Small, slender snails of Lake Tanganyika.......................................Syrnolopsidæ.
   Columella without such a fold.............................................7.
7. Operculum having projecting processes within on the columellar side......8.
   Operculum without processes...............................................9.
8. Shell subglobose or hemispherical, solid, with extremely short spire and large aperture.............................................Neritidæ.
   Shell ovate, with conic spire and moderate aperture. Quite small..Hydrocenidæ.
9. Operculum wholly concentric, with the nucleus near the middle of its length. Shells of moderate or large size.................................10.
   Operculum corneous, rarely calcareous within, spiral or with a spiral center, or subspiral with the nucleus basal.................................11.
10. Last whorl and aperture very ample.......................Ampullariidæ.
    Last whorl less ample; aperture about half the length of the shell or less; spire conic, acute when unworn..............................Viviparidæ.
11. Operculum circular, of many narrow whorls..........................12
    Operculum with rapidly enlarging whorls............................13.
    Operculum concentric around a paucispiral, central portion or nucleus.... 16
12. Quite small, umbilicate shells of fresh waters..................Valvatidæ.
    Rather large, turrited, imperforate, sculptured shells of brackish water. Cerithiidæ.

13. Shells of moderate or rather large size, generally sculptured but sometimes smooth........................................ ......Melaniidæ.
Quite small or minute shells........................................14.
14. Cylindric, the summit broadly truncate; generally costate axially. Truncatellidæ.
Ovate-conic or elongate-conic; generally not sculptured..................15.
15. Generally perforate or rimate, not conspicuously solid nor very glossy. Amnicolidæ and Synceridæ.
Imperforate, very solid and glossy.............Melaniidæ (*Reymondia*, etc.).
16. Operculum calcareous within.......................Amnicolidæ( Buliminæ).
Operculum wholly corneous..................................Melaniidæ.

## PULMONATA BASOMMATOPHORA

### Auriculidæ

(ELLOBIDÆ of some authors)

Shell ovate or oblong, with the internal partitions absorbed above the penult whorl (except in *Pedipes*); aperture plicate or toothed within.

Animal hermaphroditic. Integument rugose. Jaw consisting of conglomerated fibres. Radula with fairly horizontal rows of teeth; the central small and narrow; the laterals tricuspid; the marginals short, serrulate along the margin. Respiration pulmonary only.

This family is of nearly world-wide distribution in warm and temperate latitudes. It contains amphibious snails which live on the seashore at the upper limit of the tide and also in salt-marshes which are regularly covered and uncovered by the sea.

### MELAMPUS Denys de Montfort

*Melampus* DENYS DE MONTFORT, 1810, 'Conchyl. Systém.,' II, p. 319. Monotype: *Bulimus coniformis* Bruguière = *Voluta coffea* Linnæus.

*Conovulus* LAMARCK, 1816, 'Encyclop. Méthod., Vers,' I, Pl. CCCCLIX. Type by designation of Gray (1847, Proc. Zoöl. Soc. London, p. 179): *Bulimus coniformis* Bruguière = *Voluta coffea* Linnæus.[1]

Shell of the shape of an inverted cone with shortly conic, wide spire composed of numerous whorls; the last whorl forming most of the shell, elongate and narrowed below. Aperture long and narrow; outer lip straight, sharp, inside with horizontal, short folds or teeth; columella with one or more stronger folds.

The following species have been recorded from the Ethiopian Region.

*Melampus acinoides* MORELET, 1889, Journ. de Conchyl., XXXVII, p. 14, Pl. I, fig. 9. Port Elizabeth, Cape Colony. According to Pallary this species belongs in his subgenus *Pseudomelampus* (1900, Journ. de Conchyl., XLVIII, p. 240).

*Melampus caffer* (Küster) = *Auricula caffra* KÜSTER, 1844, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 36, Pl. V (1843; without

[1]The name *Conovulus* has been sometimes dated from Lamarck, 1812, 'Extrait du Cours de Zoologie,' p. 116; but in that work only the French vernacular "Conovule" is used and no species are mentioned.

name), fig. 7 (only). *Melampus ater* H. AND A. ADAMS, 1854, Proc. Zoöl. Soc. London, p. 10. Natal; also elsewhere on the coasts of the Indian Ocean.

*Melampus monile* (Bruguière) = *Bulimus monile* BRUGUIÈRE, 1789, 'Encyclop. Méthod., Vers,' I, p. 338. *Voluta flava* GMELIN, 1791, in Linnæus, 'Syst. Nat.,' Ed. XIII, I, 6, p. 3436. *Auricula monile* KÜSTER, 1844, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 30, Pl. IV (1843), figs. 7–9. This species of the Antilles has been recorded by Dohrn from Prince's Island and by d'Ailly from Cameroon.

*Melampus hypoleucus* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 263, Pl. VI, fig. 44. Pangani on the coast of Tanganyika Territory and Zanzibar.

*Melampus küsteri* (Küster) = *Auricula küsteri* "Krauss," KÜSTER, 1844, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 34, Pl. IV, (1843; without name), figs. 10–11. Natal. According to Pfeiffer this is *Auricula monile* REEVE, 1842, 'Conchol. System.,' II, Pl. CLXXXVII, fig. 8 (not of Bruguière).

*Melampus küsteri* var. *oblongus* (Küster) = *Auricula küsteri* var. *oblonga* KÜSTER, 1844, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 35, Pl. IV, figs. 12–13. Natal.

*Melampus liberianus* H. and A. Adams. See p. 101.

*Melampus lividus* (Deshayes) = *Auricula livida* DESHAYES, 1830, 'Encyclop. Méthod., Vers,' II, p. 91. KÜSTER, 1844, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 44, Pl. VI, fig. 21. Natal, and elsewhere on the coasts of the Indian Ocean.

*Melampus lividus* var. *cæruleus* (Küster) = *Auricula livida* var. *cærulea* KÜSTER, 1844, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 45, Pl. VI, figs. 22–23. Natal.

*Melampus lividus* var. *fasciatus* (Küster) = *Auricula livida* var. *fasciata* KÜSTER, 1844, *op. cit.*, p. 45, Pl. VI, figs. 26. Natal.

*Melampus lividus* var. *ovatus* (Küster) = *Auricula livida* var. *ovata* KÜSTER, 1844, *op. cit.*, p. 45, Pl. VI, figs. 24–25. Natal.

*Melampus massauensis* "Ehrenberg" PFEIFFER, 1858, Malakoz. Blätter, V, p. 240. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 173, Pl. VII, fig. 1. *Melampus massanensis* PÆTEL, 1869, 'Moll. Syst. et Catal.,' p. 90. *Melampus mass ensis* PÆTEL, 1873, 'Catal. Conch. Samml.,' p. 114. *Melampus erythræus* MORELET, 1872, Ann. Mus. Civ. Genova, III, p. 204, Pl. IX, fig. 12. Massaua, Eritrea.

**Melampus moreleti,** new name = *Melampus granum* MORELET, 1872, Ann. Mus. Civ. Genova, III, p. 205, Pl. IX, fig. 14 (not *Melampus granum* Gassies, 1869). Island near Massaua, Eritrea. This is perhaps a species of *Pedipes*.

*Melampus ordinarius* MELVILL AND PONSONBY, 1901, Ann. Mag. Nat. Hist., (7) VIII, 1901, p. 321, Pl. II, fig. 14. Mouth of the Umlazi River, Natal.

*Melampus parvulus* "Nuttall" PFEIFFER, 1856, 'Monogr. Auriculac.,' p. 24. This species of the Sandwich Islands has been reported from the coast of Natal, but according to Connolly its occurrence there is very doubtful.

*Melampus semiaratus* CONNOLLY, 1912, Ann. South African Mus., XI, 3, p. 228, Pl. II, fig. 8. Coast of Natal. This is the species recorded as *Melampus granifer* "Mousson" by Melvill and Ponsonby, 1898, Proc. Malacol. Soc. London, III, p. 180.

*Melampus semiplicatus* Pease = *Melampus* (*Tralia*) *semiplicata* PEASE, 1860, Proc. Zoöl. Soc. London, p. 146. Sandwich Islands. E. v. Martens has recorded this species from Zanzibar.

*Melampus siamensis* E. v. MARTENS, 1865, Monatsber. Ak. Wiss. Berlin, p. 54. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 176, Pl. VII, fig. 2. *Melampus ehrenbergianus* MORELET, 1872, Ann. Mus. Civ. Genova, III, p. 203, Pl. IX, fig. 13. Originally described from Siam; it occurs on the coast of Eritrea. According to E. v. Martens this is also the species reported by Morelet (1872, *op. cit.*, p. 203) as *Melampus fasciatus* "Deshayes."

*Melampus umlaasianus* (Küster) = *Auricula umlaasiana* "Krauss" KÜSTER, 1844, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 43, Pl. VI (1843, without name), figs. 16–18. Mouth of the Umlazi River, Natal.

*Melampus umlaasianus* var. *obscurus* (Küster) = *Auricula umlaasiana* var. *obscura* KÜSTER, 1844, *op. cit.*, p. 44, Pl. VI, figs. 19–20. Mouth of the Umlazi River, Natal.

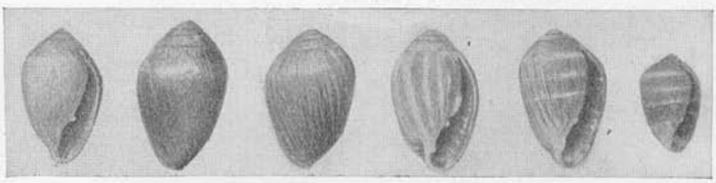
?*Melampus uniplicatus* (Mittre) = *Auricula uniplicata* MITTRE, 1841, Rev. Zoolog. Soc. Cuviér., p. 67. St. Louis, Senegal. This appears to be a *Melampus* from the description.

*Melampus wilkei* DOHRN, 1860, Malakoz. Blätter, VI, p. 204. Coasts of the Red Sea.

### **Melampus liberianus** H. and A. Adams

Text Figure 1

*Melampus liberianus* H. AND A. ADAMS, 1854, Proc. Zoöl. Soc. London, p. 12 (type locality: Liberia). PFEIFFER, 1854–1860, 'Novit. Conchol.,' I, p. 21, Pl. VI, figs. 13–14; 1856, 'Monogr. Auriculac.,' p. 23. H. DOHRN, 1878, Jahrb. Deutsch.



a b c d e f

Fig. 1. *Melampus liberianus* H. and A. Adams. Banana.

Malakoz. Ges., V, p. 151. A. D'AILLY, 1896, Bihang Svenska Vet. Ak. Handl., XXII, Afd. 4, No. 2, p. 117. KOBELT, 1901, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' II, p. 194, Pl. XXII, figs. 10–11. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 97.

*Melampus obovatus* H. AND A. ADAMS, 1854, Proc. Zoöl. Soc. London, p. 12 (type locality: Liberia). PFEIFFER, 1854–1860, 'Novit. Conchol.,' I, p. 21, Pl. VI, figs. 10–12.

Banana (P. Hesse Coll.).

Banana, in the brackish area, under heaps of débris, chiefly leaves and sticks, washed out upon the marsh grass at the high tide line (H. Lang and (J. Bequaert Coll.).

The color is usually bister or sepia, nearly uniform or varied with whitish lines and some whitish or deep olive-buff streaks. Occasionally there is a pale band at the shoulder, and sometimes four pale bands. A few examples are uniform deep olive-buff. The proportions in a lot taken at random are: bister to sepia, more or less streaked, shoulder band distinct, weak or wanting, 83; bister to sepia with four pale bands, 11; deep olive-buff, 4.

Length, 14.0 mm.; diameter, 8.3 mm.
" 13.0 " 8.0

According to Dohrn (1878, Jahrb. Deutsch. Malakoz. Ges., V, p. 151), *M. obovatus* H. and A. Adams was based on the young stage of *M. liberianus.* The species is known from Liberia, Gold Coast, San Thomé, Cameroon, and the mouth of the Congo.

"These tiny brownish shells (*Melampus liberianus*) are common at Banana on the shore about the strongly brackish part of the bay near the entrance to the creek. Dr. Bequaert first called my attention to the great numbers that were generally lying below the slight amount of drift washed up on the fine sand by the tide in front of the patches of marsh grass. Rarely were they imbedded in sand. I saw them only at night crawling about the dead leaves and grasses, since during the daytime they remain hidden." (H. L.)

### **Tralia** Gray

*Tralia* Gray, 1840, in Turton, 'Manual Shells Brit. Isl.,' 2d Ed., p. 21. Monotype: *Voluta pusilla* Gmelin = *Bulimus ovulus* Bruguière.

One species has been recorded from West Africa:

*Tralia ovulus* (Bruguière) = *Bulimus ovulus* Bruguière, 1789, 'Encyclop. Méthod., Vers,' I, p. 339. *Voluta pusilla* Gmelin, 1791, in Linnæus, 'Syst. Nat.,' Ed. xiii, I, 6, p. 3436. *Auricula nitens* Küster, 1841, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' p. 18, Pl. ii, figs. 11–13. Dohrn records this species of the Antilles from Prince's Island and d'Ailly from Cameroon. According to Connolly the Natal records are probably due to misidentification.

### **Pedipes** Férussac

*Pedipes* "Adanson" Férussac, 1821, 'Tabl. Systém. An. Moll.,' pt. 1, p. xxxiii; 1821 (?), *op. cit.*, 'Tabl. Systém. Limaçons,' pp. 99 and 109. Type by tautonomy: *Bulimus pedipes* Bruguière = Adanson's "Le Piétin, *Pedipes.*"

Three species have been thus far reported from the Ethiopian Region:

*Pedipes pedipes* (Bruguière) = *Bulimus pedipes* BRUGUIÈRE, 1789, 'Encyclop. Méthod., Vers,' I, p. 340.[1] *Helix afra* GMELIN, 1791, in Linnæus, 'Syst. Nat.,' Ed. XIII, I, 6, p. 3651. *Pedipes adansonii* DE BLAINVILLE, 1825, 'Manuel Malacol. Conchyl.,' p. 452. All these are based upon Adanson's "Le Piétin, *Pedipes*" (1757, 'Hist. Nat. Sénégal, Hist. des Coquillages,' p. 11, Pl. I, fig. 4). The type locality is Gorée Island; the species has been found on the coast of West Africa from Senegal to Mossamedes. It should be looked for at the mouth of the Congo.

*Pedipes affinis* FÉRUSSAC, 1821 (?), 'Tabl. Systém. An. Moll., Tabl. Systém. Limaçons,' p. 109. DESHAYES, 1863, 'Cat. Moll. Réunion,' p. 83, Pl. X, figs. 5–6. Réunion. Jickeli (1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 181, Pl. VII, fig. 6) has recorded it from the coast of Eritrea, and Connolly (1912, Ann. South African Mus., XI, p. 230) from Durban, Natal.

*Pedipes crassidens* BAVAY, 1920, Bull. Mus. Hist. Nat. Paris, p. 638, fig. (on p. 639). Tamara Island, one of the Los Islands, French Guinea.

*Pedipes dohrni* D'AILLY, 1896, Bihang Svenska Vet. Ak. Handl., XXII, Afd. 4, No. 2, p. 118. Jonje, on the coast of Cameroon.

### MARINULA King

*Marinula* KING, July, 1832, Zool. Journ., V, p. 343. Monotype: *Marinula pepita* King.

One species is known from South Africa:

*Marinula tristanensis* CONNOLLY, 1915, Ann. South African Mus., XIII, 4, p. 108, fig. (on p. 109). Tristan da Cunha and Cape of Good Hope.

### PLECOTREMA H. and A. Adams

*Plecotrema* H. AND A. ADAMS, 1853, Proc. Zoöl. Soc. London, p. 120. Type: *Plecotrema typica* H. and A. Adams.

One species has been found on the coast of the Red Sea:

*Plecotrema rapax* DOHRN, 1860, Malakoz. Blätter, VI, p. 204. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 182, Pl. VII, fig. 7. Coast of the Red Sea.

### BLAUNERIA Shuttleworth

*Blauneria* SHUTTLEWORTH, 1854, Mitth. Naturf. Ges. Bern, Nos. 314–316, p. 56. Monotype: *Tornatellina cubensis* Pfeiffer.

One species of East Africa has been referred to this genus:

*Blauneria exsilium* PRESTON, 1912, Proc. Zoöl. Soc. London, p. 189, Pl. XXXI, fig. 8. Gazi, coast of Kenya Colony.

### PHYTIA Gray

*Phytia* GRAY, 1821, London Medical Repository, XV, p. 231. Monotype: *Voluta denticulata* Montagu = *Auricula myosotis* Draparnaud.

[1] Though the title page of Vol. I of the 'Encyclop. Méthod., Vers,' is dated 1792, according to Sherborn and Woodward [1906, Ann. Mag. Nat. Hist., (7) XVII, p. 579], pp. 1–344 of this volume were published in 1789. Bruguière's *Bulimus pedipes* therefore antedates Gmelin's *Helix afra*. The same is true for *Bulimus ovulus* Bruguière and *Voluta pusilla* Gmelin.

*Alexia* "Leach" GRAY, 1847, Proc. Zoöl. Soc. London, p. 179. Monotype: *Voluta denticulata* Montagu (not *Alexia* Stephens, 1835).

*Alexia* section *Kochia* PALLARY, 1900, Journ. de Conchyl., XLVIII, p. 239. Type by designation of di Monterosato (1906, Il Naturalista Siciliano, XVIII, p. 125): *Kochia oranica* Pallary (not *Kochia* Frech, 1888).

*Myosotella* DI MONTEROSATO, 1906, Il Naturalista Siciliano, XVIII, p. 126. Type by original designation: *Alexia payraudeaui* "Shuttleworth" Pfeiffer.

*Nealexia* WENZ, December, 1920, Senckenbergiana, II, 6, p. 190. Substitute for *Alexia* Gray, with same type.

One South African species has been described:

*Phytia acuminata* (Morelet) = *Alexia acuminata* MORELET, 1889, Journ. de Conchyl., XXXVII, p. 15, Pl. I, fig. 11. *Alexia pulchella* MORELET, 1889, *op. cit.*, p. 15, Pl. I, fig. 10. Port Elizabeth, Cape Colony.

## AURICULASTRA E. v. Martens

*Marinula* subgenus *Auriculastra* E. v. MARTENS, 1880, in K. Möbius, 'Beiträge z. Meeresfauna Mauritius,' p. 207. Monotype: *Marinula elongata* Küster.

Most of the Ethiopian species described as *Auriculæ* appear to belong to *Auriculastra*.

*Auriculastra acuta* CONNOLLY, 1922, Ann. Mag. Nat. Hist., (9) X, p. 121. Estuary of Komati River, Rikatla, Portuguese East Africa.

*Auriculastra amplicata* (Jickeli) = *Læmodonta amplicata* JICKELI, 1874, Nova Acta. Ac. Nat. Cur. Dresden, XXXVII, 1, p. 180, Pl. VII, fig. 5. Dahlak Island in the Red Sea

*Auriculastra bronnii* (Philippi) = *Auricula bronnii* PHILIPPI, 1846, Zeitschr. f. Malakoz., III, p. 98. *Læmodonta bronii* JICKELI, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 178, Pl. VII, fig. 3. Described from the Sandwich Islands; this species has been reported by Jickeli from the Red Sea.

*Auriculastra catonis* (Melvill and Ponsonby) = *Auricula catonis* MELVILL AND PONSONBY, 1899, Ann. Mag. Nat. Hist., (7) IV, p. 199, Pl. III, fig. 13. Cato's Creek near Durban, Natal.

*Auriculastra gaziensis* (Preston) = *Auricula gaziense* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 54, Pl. V, fig. 13. Gazi, on the coast of Kenya Colony.

*Auriculastra oblonga* (Jickeli) = *Læmodonta oblonga* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, I, p. 179, Pl. VII, fig. 4. *Melampus jickelii* PFEIFFER, 1876, 'Monogr. Pneumonop. Viv.,' IV, p. 424. Coast of Eritrea.

*Auriculastra radiolata* (Morelet) = *Melampus radiolatus* MORELET, 1860, 'Séries Conchyl.,' II, p. 93, Pl. VI, fig. 11. *Auricula durbanica* MELVILL AND PONSONBY, 1899, Ann. Mag. Nat. Hist., (7) IV, p. 199, Pl. III, fig. 14. Zanzibar and the Coast of Natal. This is the species recorded from Natal by Krauss (1848, 'Südafrik. Mollusk.,' p. 82) as *Auricula pellucens* "Menke."

*Auriculastra socotrensis* (E. A. Smith) = *Auricula socotrensis* E. A. SMITH, 1897, Journ. of Malacol., VI, p. 37, Pl. V, figs. 8–8*a*. Sokotra.

*Auriculastra subula* (Quoy and Gaimard) = *Auricula subula* QUOY AND GAIMARD, 1830, 'Voyage de l'Astrolabe, Zool.,' II, p. 171, Pl. XIII, figs. 39–40. New Ireland. Jickeli has recorded this species from the Red Sea.

### CASSIDULA Férussac

*Auricula* subgenus *Cassidula* FÉRUSSAC, 1821 (?), 'Tabl. Systém. An. Moll., Tabl. Systém. Limaçons,' p. 105. Type by designation of Gray (1847, Proc. Zoöl. Soc. London, p. 179): *Auricula felis* Lamarck = *Bulimus auris-felis* Bruguière.

*Sidula* GRAY, 1840, in Turton's 'Manual Shells Brit. Isl.,' 2d Ed., p. 21. Monotype: *Sidula felis Catti* = *Bulimus auris-felis* Bruguière.

One species is found on the coast of South Africa:

*Cassidula labrella* (Deshayes) = *Auricula labrella* DESHAYES, 1830, 'Encyclop. Méthod., Vers,' II, p. 92. *Cassidula lutescens* PFEIFFER, 1856, 'Monogr. Auriculac.,' p. 113. *Auricula kraussi* KÜSTER, 1841, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 16, Auriculacea,' 1, p. 24, Pl. III, figs. 6–8. Described from Mauritius; has been found on the coast of Natal.

## Lymnæidæ[1]

Shell elongate, generally dextral, thin, with prominent or short, tapering spire and ovate or rotund aperture; the columellar axis is covered with a shelly deposit and generally gyrate or twisted; peristome thin, sometimes expanded or with a thin internal varix. The thin periostracum is usually pale and uniform, rarely banded, and sometimes showing dark underlying streaks.

The broad head bears triangular, flattened tentacles with the eyes at their inner bases. Foot rather short, rounded posteriorly. Radula with narrow, unicuspid central teeth, bicuspid or tricuspid laterals, serrate marginals. Jaw with accessory lateral pieces. Kidney wide and pear-shaped, with direct ureter. Male organ is divided into a slender and a wide section, both provided with retractor muscles. Oviparous. Air-breathing, not provided with a pseudobranch.

This family is of world-wide distribution in fresh water.

### LYMNÆA Lamarck

*Lymnæa* LAMARCK, 1799, Mém. Soc. Hist. Nat. Paris, p. 75. Monotype: *Helix stagnalis* Linnæus.

*Lymnus* DENYS DE MONTFORT, 1810, 'Conchyl. Systém.,' II, p. 262. Monotype: *Lymnæa stagnalis* Linnæus.

*Lymnula* RAFINESQUE, 1819, Journ. de Physique, LXXXVIII, p. 423. Substitute for *Lymnæa*. Type: *Helix stagnalis* Linnæus, as fixed by Pilsbry, 1917, The Nautilus, XXX, p. 113.

*Limneus* DRAPARNAUD, 1805, 'Hist. Nat. Moll. Terr. Fluv. France,' pp. 25, 28, and 48. Different spelling of *Lymnæa*.

*Lymnaeus* CUVIER, 1817, 'Règne Animal,' II, p. 412. Different spelling of *Lymnæa*.

*Leachia* "Risso" JEFFREYS, 1833, Trans. Linn. Soc. London, XVI, 3, p. 519. Type: *Limneus major* Jeffreys = *Helix stagnalis* Linnæus.

*Limnea* FLEMING, 1828, 'Hist. British Anim.,' p. 273. Different spelling of *Lymnæa*.

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[1]In drawing up the characters of this family and its subdivisions we have made use of the results of F. C. Baker's investigations as contained in his excellent monograph, 'Lymnæidæ of North and Middle America' (1911, Chicago Ac. Sci., Special Publ. No. 3, xvi + 539 pp., 58 Pls.).

*Limneus* subgenus *Eulimneus* SANDBERGER, 1875, 'Land- u. Süsswasser-Conch. Vorwelt,' pp. 787 and 844. Monotype: *Helix stagnalis* Linnæus.

*Lymneus* BRARD, 1815, 'Hist. Coq. Terr. Fluv. Env. Paris,' p. 133. Different spelling of *Lymnæa.*

*Limnæa* DE BLAINVILLE, 1825, 'Manuel Malacol. Conchyl.,' p. 448. Different spelling of *Lymnæa.*

In the Ethiopian Region the *Lymnææ* seem to avoid the rain forest belt and have not yet been recorded from Upper Guinea, though one species has been found in Senegal. In the Belgian Congo they prefer ponds of quiet or semi-stagnant water, which may disappear during seasons of drought, the animals then burying themselves in the mud. Being provided with a lung, many species can survive droughts for considerable periods and some of them even leave the water voluntarily, remaining a time on reeds or stones. On the other hand, they may stay under water a long while, either breathing through the skin, which is abundantly provided with blood vessels, or filling their pulmonary cavity with water, or absorbing the air present as bubbles at the surface of aquatic plants.[1] These facts are of importance in a consideration of these snails as intermediate hosts of certain fluke diseases.

Most species of *Lymnæa* normally are vegetarians, but all of them seem to take at times to a carnivorous diet and certain forms appear to prefer flesh to vegetable food. They are hermaphoditic and are believed to be capable of self-fertilization. Many eggs are laid together in irregular, gelatinous masses, on stones, sticks, leaves of water plants, etc.

Excepting two or three forms referable to the subgenus *Galba,* all known lymnæids of the Ethiopian Region and Madagascar are fragile, *Succinea*-like forms belonging to *Radix.*[2] This group inhabits nearly all of Europe and Africa, and a large part of Asia.[3]

### Subgenus **GALBA** Schrank

*Galba* SCHRANK, 1803, 'Fauna Boica,' III, 2, pp. 262 and 285. Monotype: *Galba pusilla* Schrank.[4]

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[1]Pauly, A. 1877. 'Ueber die Wasserathmung der Limnæiden.' (Munich), 47 pp.
Willem, V. 1896. 'Observations sur la respiration cutanée des Limnées et son influence sur leur croissance.' Bull. Ac. Sci. Belgique, (3) XXXII, pp. 563–577.

[2]This relationship has already been recognized by many authors. It is now confirmed by examination of the soft parts.

[3]In contour the shells of some African forms appear close to the Indian series of *L. acuminata* Lamarck; but the latter differ conspicuously in texture, being more solid and polished, and probably are not closely related to the Africans. We consider them a separate subgenus, to which the name *Cerasina* Kobelt may be applied, the type being *Lymnæa bulla* Benson.

[4]P. Hesse (1923, Archiv. f. Molluskenk, LV, p. 195) has rejected *Galba* on the ground of insufficient definition. Its type and only species was not originally stated to be *Buccinum truncatulum* O. F. Müller, which Schrank has on a succeeding page, but *Galba pusilla* Schrank, said to be smaller than a grain of millet, of three whorls, etc. It was evidently a quite young shell, which has been somewhat optimistically identified as *Lymnæa truncatula* (Müller). It was not figured, and this identification cannot well be either proved or refuted. If *Galba* be rejected, *L. truncatula* and its allies will form the section *Fossaria* Westerlund, in the subgenus *Stagnicola* "Leach" Jeffreys.

*Fossaria* WESTERLUND, 1885, 'Fauna Paläarct. Binnenconchylien,' V, p. 49. Type: *Buccinum truncatulum* O. F. Müller.

Shell in the African forms small, turreted; with a conic spire and an ovate or roundly ovate aperture of about half the total length of the shell; the columella not twisted. Lateral teeth of radula bi- or tricuspid (in *L. truncatula* bicuspid; the African forms have not been examined in this respect). Genitalia with a very large, oblong-ovate or elongate-pyriform prostate; upper section of the penis always shorter than the lower, which is usually very thick.

The following Ethiopian species appear to belong in this group.

*Lymnæa (Galba) subtruncatula* (O. Bœttger) = *Limnæa subtruncatula* O. BŒTTGER, 1910, Abh. Senckenberg. Naturf. Ges., XXXII, p. 451, Pl. XXVIII, figs. 17*a-b*. Gobabis, Damaraland (subfossil).

*Lymnæa (Galba) truncatula* (O. F. Müller) = *Buccinum truncatulum* O. F. MÜLLER, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 130. *Limnæa peregra* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 193, Pl. VII, fig. 9 (not of O. F. Müller). This common European species appears to occur in Abyssinia and Eritrea. Bourguignat (1889, 'Moll. Afrique Equator.,' p. 157) records it from the Vuami River, Tanganyika Territory but its occurrence there needs to be confirmed.

*Lymnæa (Galba) umlaasiana* (Küster) = *Limnæus umlaasianus* KÜSTER, 1862, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 1, *Limnæus*,' p. 32, Pl. VI, figs. 4-5. Umlazi River, Natal. Bourguignat, Connolly, and others regard this as a synonym of *L. truncatula*.

The occurrence of the true European *Lymnæa truncatula* in South Africa appears beyond doubt and is of some practical importance, since this species is a regular intermediate host of the common sheep liver fluke (see p. 88). Gilchrist[1] believes that this snail was introduced from Europe by man. "It may be objected," he says, "that it is very unlikely that a fresh-water snail could have been imported from Europe to South Africa, as the animal itself will not live long out of fresh water, and its eggs are readily dried up. A possible explanation may, however, be found in the fact that European carp were known to have been introduced into South Africa at an early time, and it is not improbable that fresh water plants and snails were introduced with them, to keep the water fresh and to supply food. There is certainly no doubt that the snails could have been introduced at a later date, as even the South African Governments have introduced, not only fresh-water fish, but also plants and snails from Europe and may thus be unwittingly keeping up a supply of the dreaded liver fluke."

[1]1918, Parasitology, X, pp. 313–314.

## Subgenus **Radix** Denys de Montfort

*Radix* Denys de Montfort, 1810, 'Conchyl. Systém.,' II, p. 266. Monotype: *Radix auriculatus* Denys de Montfort = *Helix auricularia* Linnæus.

*Gulnaria* "Leach" Turton, 1831, 'Manual Land Fresh-Water Shells Brit. Isl.,' p. 117 (in the synonymy of *L. auricularia*). Type: *Helix auricularia* Linnæus, as designated by Gray (1847, Proc. Zoöl. Soc. London, p. 180; as a synonym of *Radix*).

*Neritostoma* H. and A. Adams, 1855, 'Genera Rec. Moll.,' II, p. 253. Type: *Helix auricularia* Linnæus.

Shell thin or fragile, broadly ovate or rounded, with a generally short spire of few whorls; the last whorl very large, the peristome more or less expanded or even campanulate. Columella somewhat twisted. Radula with the laterals either all tricuspid or partly bicuspid. In the genitalia this group differs from all other *Lymnææ* in the very long and slender upper sac of the penis which can scarcely be differentiated from the vas deferens[1] and not differing much from the lower sac in length.

The group is indigenous in the Palæarctic, Oriental, and Ethiopian Regions.

It is doubtful whether the following list of names of Ethiopian forms represents more than one or very few species. Germain[2] has lately done good work in reducing the number of species and figuring many of the forms described by Bourguignat. Unfortunately, he fails to point out how the six species he retains are to be distinguished. Yet, for the purpose of listing the forms, we are accepting most of his conclusions, except in the case of *L. undussumæ* v. Martens, which is undoubtedly a form of *natalensis* Krauss.

*Limnæa ægyptiaca, L. amygdalina, L. astilba, L. cleopatræ, L. expansilabris, L. forskali, L. lessepsiana,* and *L. letourneuxi* of Bourguignat (1899, 'Moll. Afrique Equator.,' p. 155–156) are *nomina nuda*, the forms in question having never been described nor figured.

*Lymnæa* (*Radix*) *anceyana* (Preston). See p. 113.

*Lymnæa* (*Radix*) *caillaudi* (Bourguignat). See p. 113.

*Lymnæa* (*Radix*) *caillaudi* var. *succinoides* (Morelet) = *Limnæus succinoides* Morelet, 1866, Journ. de Conchyl., XIV, p. 161. *Limnæa bocageana* Morelet, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 86, Pl. vii, fig. 3. *Limnæa benguellensis* Morelet, 1868, *op. cit.*, p. 86, Pl. vi, fig. 4. *Limnæa orophila* Morelet, 1868, *op. cit.*, p. 87, Pl. vii, fig. 4. *Limnæa sordulenta* Morelet, 1868, *op. cit.*, p. 87, Pl. vii, fig. 5. *Limnæa cameroni* Bourguignat, 1889, 'Moll. Afrique Equator.,' p. 157. *Limnæa* (*Radix*) *africana* var. *bocagei* Germain, 1919, Bull. Mus. Hist. Nat. Paris, pp. 183 and 186. Portuguese West Africa (type locality of *succinoides:* Caroca River near Cabo Negro, Benguela).

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[1]Figures of the genitalia of *Radix* may be found in L. Soós, 1917, Annales Mus. Nat. Hungarici, XV, pp. 21–23. F. C. Baker, 1911, 'The Lymnæidæ of North and Middle America,' Chicago Ac. Sci., Special Publ. No. 3. Annandale and Prashad, 1919, Rec. Indian Mus., XVIII, p. 40, figs. A, B.

[2]L. Germain. 1919. 'Sur les Limnées africaines appartenant au groupe du *Limnæa* (*Radix*) *natalensis* Krauss.' Bull. Mus. Hist. Nat. Paris., pp. 179–186.

1920. 'Voyage dans l'Afrique Orientale Anglaise (1912–1913) par G. Babault. Moll. Terr. Fluv.,' pp. 129–188.

*Lymnæa* (*Radix*) *caillaudi* var. *azaouadensis* (Germain) = *Limnæa africana* var. *azaouadensis* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 372. Azaouad, French Sudan (subfossil).

*Lymnæa* (*Radix*) *caillaudi* var. *guidimouniensis* (Germain) = *Limnæa africana* var. *guidimouniensis* GERMAIN, 1916, 'Doc. Scientif. Miss. Tilho,' III, p. 294. Guidimuni, near Lake Chad.

*Lymnæa* (*Radix*) *caillaudi* var. *courteti* (Germain) = *Limnæa undussumæ* var. *courteti* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 467; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 492, Pl. v, fig. 2. Mamun country, French Territory of Lake Chad.

*Lymnæa* (*Radix*) *caillaudi* var. *jouberti* (Bourguignat). See p. 114.

*Lymnæa* (*Radix*) *caillaudi* var. *kambaensis* (Germain) = *Limnæa african* avar. *kambaensis* GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 176, Pl. I, figs. 11-12. Eight kilometers east of Kamba, in Lake Chad.

*Lymnæa* (*Radix*) *caillaudi* var. *kouloaensis* (Germain) = *Limnæa africana* var. *kouloaensis* GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 177, Pl. I, figs. 13-14. North of Kuloa, in Lake Chad.

*Lymnæa* (*Radix*) *caillaudi* var. *minor* (Germain) = *Limnæa africana* var. *minor* GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 177, Pl. I. fig. 15. Kelekorarom in Lake Chad.

*Lymnæa* (*Radix*) *caillaudi* var. *raffrayi* (Bourguignat) = *Limnæa raffrayi* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 93, Pl. x, figs. 97–98. *Limnæa æthiopica* BOURGUIGNAT, 1883, *op. cit.*, p. 94, Pl. x, figs. 92–93. *Limnæa africana* var. *raffrayi* GERMAIN, 1919, Bull. Mus. Nat. Hist. Paris, p. 186. Anseba valley, Abyssinia.

*Lymnæa* (*Radix*) *chudeaui* (Germain) = *Limnæa chudeaui* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 272, fig. 21. Lake Chad at Kuloa.

*Lymnæa* (*Radix*) *dakaënsis* (Sturany) = *Limnæus dakaënsis* STURANY, 1898, Anz. Ak. Wiss. Wien, Math. Naturw. Kl., XXX, p. 160; 1898, Denkschr. Math. Naturw. Kl. Ak. Wiss. Wien, LXVII, p. 610, Pl. III, figs. 55–56. Daka, Rhodesia.

*Lymnæa* (*Radix*) *damarana* (O. Bœttger) = *Limnæa damarana* O. BŒTTGER, 1910, Abh. Senckenberg. Naturf. Ges., XXXII, p. 450, Pl. XXVIII, figs. 16*a*-*b*. Gobabis, Damaraland (subfossil).

*Lymnæa* (*Radix*) *elmeteitensis* (E. A. Smith) = *Limnæa elmeteitensis* E. A. SMITH, 1894, Proc. Malacol. Soc. London, I, p. 167, fig. 5 (on p. 166). Lakes Elmenteita and Baringo, Kenya Colony. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–1908),' III, p. 208, records this species with some doubt from Lake Luhondo in Ruanda (Schubotz Coll.).

*Lymnæa* (*Radix*) *gravieri* (Bourguignat). See p. 114.

*Lymnæa* (*Radix*) *kempi* (Preston) = *Limnæa kempi* PRESTON, 1912, Proc. Zoöl. Soc. London, p. 190, Pl. XXXII, fig. 1. Kisumu, Lake Victoria.

*Lymnæa* (*Radix*) *natalensis* (Krauss). See p. 110.

*Lymnæa* (*Radix*) *natalensis exserta* (E. v. Martens). See p. 112.

*Lymnæa* (*Radix*) *natalensis* var. *humerosa* (E. v. Martens) = *Limnæa humerosa* E. v. MARTENS, 1897, 'Deutsch. Ost Afr., IV, Beschalte Weichth.,' p. 135, Pl. VI, fig. 1. Described from Mengo, Uganda; Itole, Lake Victoria; Umbugwe; Irangi; and Bubu River near Irangi (south of Lake Manyara).

*Lymnæa* (*Radix*) *natalensis* var. *perrieri* (Bourguignat) = *Limnæa perrieri* BOURGUIGNAT, 1881, 'Moll. Terr. Fluv. Pays Çomalis,' p. 11; 1882, 'Moll. Terr.

Fluv. Miss. Revoil,' p. 53, Pl. IV, figs. 77-78. *Limnæa poirieri* BOURGUIGNAT, 1881, 'Moll. Terr. Fluv. Pays Çomalis,' p. 12; 1882, 'Moll. Terr. Fluv. Miss. Revoil,' p. 55, Pl. IV, figs. 79-80. *Limnæa revoili* Bourguignat, 1881, 'Moll. Terr. Fluv. Pays Çomalis,' p. 14; 1882, 'Moll. Terr. Fluv. Miss. Revoil,' p. 56, Pl. IV, figs. 81-82. Lagoon of Tohen, Somaliland (type locality of *perrieri*, *poirieri*, and *revoili*).

*Lymnæa (Radix) natalensis undussumæ* (E. v. Martens). See p. 111.

*Lymnæa (Radix) nimoulensis* (A. T. de Rochebrune and Germain) = *Limnæa nimoulensis* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 141; 1904, Mém. Soc. Zool. France, XVII, p. 8, Pl. I, fig. 1. White Nile at Nimule, Uganda.

*Lymnæa (Radix) nyansæ* (E. v. Martens) = *Limnæa nyansæ* E. v. MARTENS, 1892, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 16; 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 134, Pl. VI, figs. 3, 4, and 6. Western shore of Lake Victoria, near Bukoba and Towalio.

*Lymnæa (Radix) tchadiensis* (Germain) = *Limnæa tchadiensis* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 484; 1908, in A. Čhevalier, 'L'Afrique Centrale Française,' p. 493, Pl. v, fig. 3. Southeastern part of Lake Chad.

*Lymnæa (Radix) vignoni* (Germain) = *Limnæa vignoni* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 474; 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 178, Pl. I, figs. 3-10. Lake Chad.

*Lymnæa (Radix) vignoni* var. *minor* (Germain) = *Limnæa vignoni* var. *minor* GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 179, Pl. I, fig. 16. Lake Chad.

### **Lymnæa (Radix) natalensis** (Krauss)

Plate XI, Figure 3

*Limnæus natalensis* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 85, Pl. v, fig. 15 (type locality: Natal).

*Limnæa natalensis* Krauss. E. A. SMITH, Proc. Zoöl. Soc. London, 1881, p. 295; 1906, *op. cit.*, I, p. 184; 1904, Proc. Malacol. Soc. London, VI, 2, p. 98; 1909, Trans. Zool. Soc. London, XIX, 1, p. 47.

Mt. Ruwenzori: (Woosnam Coll.). Lake Tanganyika: swamp near Mbete, at the southern end of the lake (W. A. Cunnington Coll.).

*Lymnæa natalensis* (Krauss) is typically a South African form having strongly convex whorls and generally about 15 mm. long. A specimen from Port Elizabeth is figured, Pl. XI, fig. 3. It is said to range northward into Rhodesia or farther. North of its typical area, from Angola to East Africa, the shells generally are larger, about 20 mm. long, though small ones also occur. Many names have been given to these snails, based on variations in the length of spire and degree of amplitude of the last whorl and aperture. Few examples of nomenclature so futile and inane can be found, since the variations are far less marked than in any good series of *L. stagnalis* or *auricularia*.

The prior name for the large, tropical African *Lymnæa* appears to be *L. caillaudi* Bourguignat. We are using the name *L. n. undussumæ*

(E. v. Martens) because it was based upon shells from within our territory agreeing fully with those prevalent in the regions covered by our Congo collections.

**Lymnæa (Radix) natalensis exserta** (E. v. Martens)

*Limnæus natalensis* Krauss var. *exsertus* E. von Martens, 1866, Malakoz. Blätter, XIII, p. 101, Pl. III, figs. 8 and 9 (var. *erectus* on Plate). (Type locality: Ain Zaba near Zazega, 6,000 ft., Eritrea).

*Limnæa* (*Radix*) *exserta* E. v. Martens. Bourguignat, 1883, Ann. Sc. Nat. Zool., (6) XV, pp. 90 and 125. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 136, Pl. VI, fig. 7. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 40.

*Limnæa* (*Radix*) *natalensis* var. *exserta* E. v. Martens. Germain, 1919, Bull. Mus. Nat. Hist. Paris, p. 185; 1920, 'Voyage dans l'Afrique Orientale Anglaise (1912-1913) par G. Babault, Moll. Terr. Fluv.,' pp. 131 and 185.

*Limnæa exerta* E. v. Martens. Pollonera, 1898, Boll. Mus. Zool. Anat. Comp. Torino, XIII, No. 313, p. 10.

Dautzenberg and Germain record this form from Lukonzolwa (in Lake Moero), the Lubumbashi River, and the Luvua River (J. Bequaert Coll.). We have examined a specimen from the lot of the Lubumbashi River and cannot separate it from the other Katanga specimens which are recorded below as *L. n. undussumæ* (E. v. Martens).

**Lymnæa (Radix) natalensis undussumæ** (E. v. Martens)

Plate XI, Figures 1-1*f*, 2-2*c*, 4, and 5-5*b*

*Limnæa* (*Radix*) *undussumæ* E. v. Martens, 1897 'Deutsch Ost Afr., IV, Beschalte Weichth., p. 135, Pl. I, fig. 18 and Pl. VI, figs. 1 and 5. J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-1908),' III, p. 208. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 39. Germain, 1916, Bull. Mus. Hist. Nat. Paris, p. 194.

Undussuma, in a brook beyond the Tararo (type locality); smaller specimens from Rumande on the western shore of Lake Edward; somewhat different specimens from Kigogo (district of the chief Karungo), east of the Semliki, in 0° 20′ N. (all Stuhlmann Coll.); Lake Edward (Gromier Coll.); Kisantu; Bukama; Lualaba River at Kibondo (between Kikondja and Bukama) (J. Bequaert Coll.). Lake Mohasi in Ruanda (Schubotz Coll.).

Irumu, in a brook of the savanna[1] (J. Bequaert Coll.). Faradje (Lang and Chapin Coll.). Tshikapa; Lukungu River at Kidada and between Kidada and Kitobola; Luebo (H. Schouteden Coll.). Ipamu (Vanderijst Coll.). Hemptinne-St.-Benoît (Callewaert Coll). Lubumbashi River near Elisabethville (Michael Bequaert Coll.). We have also

[1]These specimens come practically from the type locality of *undussumæ* as may be seen from the map published in the 'Report on Congo Land Mollusks' (1919, Bull. American Mus. Nat. Hist., XL, p. 17).

seen numerous specimens from Kibwezi, Kenya Colony (Dammer Coll.) Specimens from the Lubumbashi River (J. Bequaert Coll.), referred by Dautzenberg and Germain to *exserta* (v. Martens), are also in our opinion *undussumæ*.

Very fragile shells, olive-buff to cream-buff in color, or rarely vinaceous-cinnamon, the axis closed or very narrowly open. Shape variable, but typically ovate with full outline. The degree of inflation of the upper part of the last whorl is individually variable in every lot of several specimens, the angle formed by the outer lip at its insertion, and the shape of

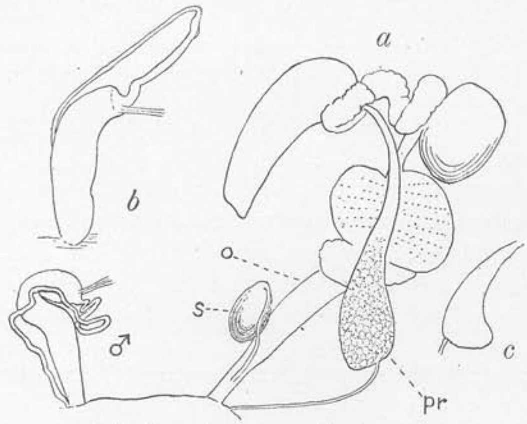



Fig. 2. *Lymnæa natalensis undussumæ* v. Martens.

*a*, genitalia of specimen from Kidada: o, oviduct; pr, prostate gland; s, spermatheca; ♂, penis. *b*, penis, pulled nearly straight. *c*, outline of prostate gland in profile.

the aperture consequently variable individually in most lots. The inflation of the last whorl increases with age, but varies widely in degree at all ages, as in the selected series of Pl. XI, figs. 1 to 1*f*, from a large lot taken in the Lubumbashi River, and consisting largely of specimens intermediate in shape. It will be seen that this series runs from the typical *undussumæ* shape to that of *L. natalensis exserta* (v. Martens). Less variation was noted in specimens from Irumu, Pl. XI, figs. 2-2*c*, and in those from Faradje, Pl. XI, figs. 5 to 5*b*.

E. v. Martens based his *L. humerosa* on a more shouldered example, such as Pl. XI, fig. 4, from Moto (Burgeon Coll.).

Length, 20.0 mm.; diameter, 12.0 mm.; length of aperture, 15.5 mm.; Faradje.
" 18.0 " " 12.0 " " " " 14.5 " "

The mantle is black with white specks or spots. In some of the specimens from Kidada the black is reduced, forming partially connected spots in the region over the lung. The foot is varying shades of slate.

The genitalia (Fig. 2*a-c*) are mainly characterized by the very slender upper sac of the penis, which is scarcely differentiated from the vas deferens. The prostate gland is club-shaped. These are characters of the subgenus *Radix*. Other characters are sufficiently shown in the figures.

The radula (Fig. 3) has about nine lateral teeth, having a bifid inner cusp (entocone and mesocone) and a small outer cusp. The marginals are oblique, with either three or four denticles.

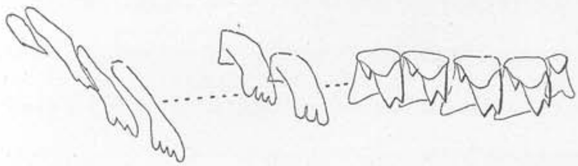


Fig. 3. *Lymnæa natalensis undussumæ*. Teeth of a Kidada specimen.

## Other Forms of *Lymnæa* Recorded from the Belgian Congo

### *Lymnæa* (*Radix*) *anceyana* (Preston)

*Limnæa anceyana* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 59, Pl. IV, fig. 4.

Type locality: Maringo River, Belgian Congo. No river of that name is known to us in the Belgian Congo.

This appears to be a synonym of *L. natalensis undussumæ* (E. v. Martens).

### *Lymnæa* (*Radix*) *caillaudi* (Bourguignat)

*Limnæa caillaudi* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 89, Pl. x, figs. 100-101 (type locality: Lake Dembea [Tsana], Abyssinia).

*Limnæa acroxa* BOURGUIGNAT, 1883, Ann. Sc. Nat Zool., (6) XV, p. 90, Pl. x, fig. 94 (type locality: Blue Nilė below Lake Dembea, Abyssinia).

*Limnæa africana* "Ruppell" BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, pp. 95 and 126, Pl. x, fig. 99 (type locality: Lake Dembea, Abyssinia); 1890, *op. cit.*, (7) X, p. 10. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249. GERMAIN, 1919, Bull. Mus. Hist. Nat. Paris, p. 185; 1920, 'Voyage dans l'Afrique Orientale Anglaise (1912-1913) par G. Babault, Moll. Terr. Fluv.,' pp. 141 and 185, figs. 31-49, 56-59, Pl. IV, figs. 6-11.

*Limnæa alexandrina* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 92, Pl. x, figs. 95-96 (type locality: Blue Nile, Abyssinia); 1890, *op. cit.*, (7) X, p. 8. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

*Limnæa kynganica* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 158 (type locality: valley of the Kingani River, south of Bagamoyo, Tanganyika Territory).

*Limnæa laurenti* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 88 (*nomen nudum*); 1888, 'Iconogr. Malacol. Tanganika,' Pl. I, figs. 21-22; 1980, Ann. Sc. Nat.

Zool., (7) X, p. 7, Pl. I, figs. 21-22 (originally described from Lake Tanganyika, near the outlet of the Lukuga and the mouth of the Malagarazi Rivers). ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

*Limnæa lavigeriana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. I, figs. 18-19; 1890, Ann. Sc. Nat. Zool., (7) X, p. 9, Pl. I, figs.18-19 (type locality: west coast of Lake Tanganyika between Kibanga and the outlet of the Lukuga River). ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

*Limnæa zanzibarica* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 158 (type locality: Kingani River, Tanganyika Territory).

Lake Tanganyika: between Kibanga and Karema; beach of Kibanga; outlet of the Lukuga River; mouth of the Malagarazi River; between Kibanga and the outlet of the Lukuga River.

It is probable that all these specimens from Tanganika belonged to v. Martens' *L. undussumæ*, if indeed that form is distinct from *caillaudi*.

Notwithstanding Germain's statement to the contrary, the name *caillaudi* has page priority over *africana*. On p. 85 of his 1883 paper, Bourguignat mentions, it is true, *africana*, but without description, so that it is there a *nomen nudum*.

### *Lymnæa (Radix) caillaudi* var. *jouberti* (Bourguignat)

*Limnæa jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. I, fig. 23; 1890, Ann. Sc. Nat. Zool., (7) X, p. 7, Pl. I, fig. 23. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

Lake Tanganyika: on the western coast, chiefly near the Ubuari Peninsula (type locality).

### *Lymnæa (Radix) gravieri* (Bourguignat)

*Limnæa gravieri* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 23, Pl., fig. 6 (type locality: Lake Haussa, Abyssinia). GERMAIN, 1919, Bull. Mus. Hist. Nat. Paris, pp. 183 and 186; 1920, 'Voyage dans l'Afrique Orientale Anglaise (1912-1913) de G. Babault, Moll. Terr. Fluv.,' pp. 181 and 185, figs. 82-87 (figs. 84-87 as *L. debaizei*).

*Limnæa debaizei* BOURGUIGNAT, 1887, Bull. Soc. Malacol. France, IV, p. 268 (type locality: Lake Victoria); 1888, 'Iconogr. Malacol. Tanganika,' Pl. I, fig. 20; 1890, Ann. Sc. Nat. Zool., (7) X, p. 11, Pl. I, fig. 20. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 136. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

?*Limnæa soleilleti* BOURGUIGNAT, 1883, 'Moll. Choa,' p. 24, Pl., fig. 7 (type locality: Hauash River, Abyssinia).

Lake Tanganyika: Ujiji; Kibanga; Mpala; Pambete.

## Planorbidæ

Sinistral snails in which the shell may be either coiled in a plane or somewhat lengthened and ultrasinistral (that is, to all appearance dextral), or it may be oblong, *Physa*-shaped, and sinistral.

Usually a large respiratory lobe or pseudobranch emerges from below the orifice of the lung on the left side of the animal; some species appear to have given up lung-breathing altogether.[1] The foot is rounded behind; the tentacles are

[1]Willem, V. 1895. 'Prosobranches aériens et Pulmoné aquatique.' Bull. Ac. Sci. Belgique, (3) XXIX, pp. 73-83.

slender and circular in section, acute. The blood is red. The radula has a bicuspid central tooth; the laterals are tricuspid and the marginals serrulate.

This family differs from the Lymnæidæ in the sinistral organization, the slender, subulate tentacles, the bicuspid central teeth of the radula, the development of a secondary branchia or "pseudobranch," and also in details of kidney and genitalia. The shape of the foot and the very different teeth of the radula, as well as the red blood and other features separate Planorbidæ from Physidæ.

They avoid the larger and swifter streams. In the forest region they occasionally are found in muddy ponds among decaying humus. In the savanna country they prefer pools of stagnant water that are densely filled with aquatic plants and algæ, being then found usually in company with *Lymnæa.* They are oviparous and, at least in the case of the Bulininæ, the egg-masses are often attached to shells of living snails of the same species.

This family of water snails has acquired considerable practical importance, from a medical point of view, through the discovery that many of them are intermediate hosts of certain fluke diseases, especially of bilharziosis (See p. 92).

### Planorbinæ

Shell flat, coiled in a plane or disk; sometimes more or less ovate and *Physa*-like when young.

### PLANORBIS O. F. Müller

*Planorbis* O. F. MÜLLER, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 152. Genotype: *Helix cornea* Linnæus = *Planorbis purpura* O. F. Muller, as designated by Denys de Montfort, 1810.

*Coretus* "Adanson" J. E. GRAY, 1847, Proc. Zoöl. Soc. London, p. 180. As an equivalent of *Planorbis* Müller with *Helix cornea* Linnæus as type. This is apparently the first use of Adanson's *Coretus* in binomial nomenclature and, since its type was correctly designated by Gray (by monotypy), it must become a synonym of *Planorbis*, proper, notwithstanding the fact that Adanson's *Coretus* was based upon a species of *Gyraulus*.

*Planorbia* J. E. S. MOORE, 1901, 'To the Mountains of the Moon,' p. 260. Monotype: *Planorbia albertensis* J. E. S. Moore.

*Biomphalaria* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 535. Monotype: *Biomphalaria smithi* Preston.

The shell is usually discoidal, the whorls coiled nearly or quite in a plane, visible on both sides, or the last whorl deviating obliquely toward the left. Cavity of the whorls not obstructed by teeth or laminæ. Right margin of the aperture advancing beyond the left.

The shell of *Planorbis* has been regarded as sinistral by some authors, dextral by others. The unpaired organs show the animal to be sinistral, and the shell in its early stage (and in some adults) is obviously sinistral. The shell is sometimes carried with its disk approaching a vertical position; but in the flatter forms it is carried horizontally, the left side below, in which case the spire (speaking morphologically) is beneath.

The genus is cosmopolitan in its distribution. Of the many subgenera into which it has been divided, only three, namely *Planorbis*, proper, *Gyraulus* J. de Charpentier, and *Hippeutis* J. de Charpentier, appear to be represented in the Ethiopian Region, at least on the continent.[1] In the Island of Sokotra, however, the two following species represent two other subgenera which have not yet been recorded from Africa proper.

*Planorbis exustus* Deshayes var. *maculatus* Godwin-Austen, 1883, Proc. Zoöl. Soc. London, p. 3, Pl. I, figs. 1 and 1*a-b*. Both Crosse (1884) and E. A. Smith (1903) unite this variety with the typical form of *Planorbis exustus* Deshayes, an Indian species for which Annandale and Prashad have recently erected the genus *Indoplanorbis* (1920, Indian Jl. Med. Res., VIII, p. 113 and 1921, Rec. Indian Mus., XXII, p. 573).

*Planorbis socotrensis* Godwin-Austen, 1883, Proc. Zoöl. Soc. London, p. 3, Pl. I, figs. 3 and 3*a-c*. This appears to belong in the subgenus *Tropidiscus* Stein.

No doubt several genera will soon be generally accepted in place of the heterogenous *Planorbis*, but at present we have only conchological data on the African forms.

The species of tropical and southern Africa are of moderate or small size, never reaching the dimensions of some of the American or European forms.

### Subgenus **Planorbis**, proper

Shell relatively large and thick, regularly discoidal; equally umbilicate on both sides, with relatively few whorls which are convex above and below; aperture oval or rounded.

This subgenus is found in Europe, Asia, Africa, and Madagascar. The subgenotype is the same as the genotype, *Planorbis corneus* (Linnæus).

The following Ethiopian species have generally been referred to *Planorbis* proper.

*Planorbis adowensis* Bourguignat. See p. 118.

*Planorbis adowensis* var. *major* Germain, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 508. Mamun country.

*Planorbis adowensis* var. *problematicus* Germain, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 508. Gribingui River, Chad Territory.

[1]In the following lists of Ethiopian species we have disregarded the numerous forms which have been named from Lower Egypt. *Planorbis caffer* "Krauss" Morelet, 1889, Journ. de Conchyl., XXXVII, p. 19, listed from Port Elizabeth, Cape Colony, is a *nomen nudum* and probably due to a clerical error.

*Planorbis boissyi* Potiez and Michaud, 1838, 'Galerie Moll. Douai,' I, p. 208, Pl. xxi, figs. 4-6. Nile River, Egypt. According to Ancey (1905, Journ. de Conchyl., LIII, p. 321) and Pallary (1921, Proc. Malacol. Soc. London, XIV, p. 146), *P. subsalinarum* Innès (1884, Bull. Soc. Malacol. France, I, p. 331; type locality: Gharbiya Province, Lower Egypt) is a synonym. Potiez and Michaud's name, however, is not preoccupied by *Planorbis boissyi* Deshayes, as stated by Pallary, since Deshayes name dates not from 1837 but from 1864 ('Descr. Anim. sans Vertèbres Bass. Paris,' II, p. 741, Pl. xlv, figs. 20-21). This species is said to extend to Eritrea.

*Planorbis bozasi* A. T. de Rochebrune and Germain, 1904, Bull. Mus. Hist. Nat. Paris, p. 141; 1904, Mém. Soc. Zool. France, III, p. 9, Pl. i, figs. 2-4. Lake Challa, Ualamo Country, Abyssinia.

*Planorbis bridouxianus* Bourguignat. See p. 119.

*Planorbis bridouxianus* var. *foai* Germain. See p. 119.

*Planorbis bridouxianus* var. *major* Germain = *Planorbis bridouxi* var. *major* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 253. Kuka, Lake Chad (dead specimens).

*Planorbis bridouxianus* var. *occidentalis* Germain = *Planorbis bridouxi* var. *occidentalis* Germain, 1904, Bull. Mus. Hist. Nat. Paris, pp. 349 and 351. Lake Chad.

*Planorbis cecchii* Pollonera, 1887, Boll. Mus. Zool. Anat. Comp. Torino, II, No. 34, p. [2]; 1888, Bull. Soc. Malacol. Italiana, XIII, p. 79, Pl. iii, figs. 11-13. Cimbisi near Debra-Braham, Choa, Eritrea.

*Planorbis choanomphalus* E. v. Martens. See p. 119.

*Planorbis choanomphalus* var. *basisulcatus* E. v. Martens. See p. 120.

*Planorbis choanomphalus* var. *victoriæ* (E. A. Smith) E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 149 = *Planorbis victoriæ* E. A. Smith, 1892, Ann. Mag. Nat. Hist., (6) X, p. 383. Northern shore of Lake Victoria.

*Planorbis hermanni* O. Bœttger, 1910, Abh. Senckenberg. Naturf. Ges., XXXII, p. 452, Pl. xxviii, figs. 18*a*-*c*. Okaputa Pan, Damaraland.

*Planorbis lavigerianus* Bourguignat. See p. 123.

*Planorbis monceti* Bourguignat. See p. 123.

*Planorbis nairobensis* Dautzenberg, 1908, Journ. de Conchyl., LVI, p. 16, Pl. ii, figs. 1-3. Nairobi, Kenya Colony. J. Thiele (1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 209) refers doubtfully to this species specimens from Lake Luhondo in Ruanda (Schubotz Coll.).

*Planorbis pæteli* Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 212, Pl. vii, figs. 19*a*-*c*. Nile.

*Planorbis pfeifferi* Krauss, 1848, 'Südafrik. Mollusk.,' p. 83, Pl. v, fig. 7; Umgeni River, Natal = *Planorbis bowkeri* Melvill and Ponsonby, 1893, Ann. Mag. Nat. Hist., (6) XII, p. 111, Pl. iii, fig. 19; Northern Transvaal. This species has been transferred to *Planorbula* by Connolly, 1925.

*Planorbis ruppellii* Dunker, 1848, Proc. Zoöl. Soc. London, p. 42. Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 211, Pl. vii, figs. 17*a*-*c* and 18*a*-*c* = *Planorbis herbini* Bourguignat, 1883, Ann. Sc. Nat. Zool., (6) XV, pp. 101 and 127. Abyssinia.

*Planorbis salinarum* Morelet, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 85, Pl. v, fig. 4. Near Dungo, Pungo Andongo district, Angola.

*Planorbis smithi* (Preston). See p. 120.

*Planorbis stanleyi* E. A. Smith. See p. 124.

*Planorbis sudanicus* E. v. Martens. See p. 121.

*Planorbis sudanicus tanganikanus* Bourguignat. See p. 122.

*Planorbis sudanicus* var. *globosus* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 505. Lake Chad.

*Planorbis sudanicus* var. *subsudanicus* GERMAIN, 1908, in A. Chevalier, 'L' Afrique Centrale Française,' p. 505. Lake Chad.

*Planorbis tetragonostoma* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 467; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 506, Pl. v, figs. 10-11. Kuri Archipelago, Lake Chad.

### **Planorbis adowensis** Bourguignat

Text Figure 4

*Planorbis adowensis* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 11 (type locality: Adua, Abyssinia); 1888, 'Iconogr. Malacol. Tanganika,' Pl. I, figs. 1-4; 1883, Ann. Sc. Nat. Zool., (6) XV, p. 101; 1890, *op. cit.*, (7) X, p. 17, Pl. I, figs. 1-4. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 147. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 98. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

*a* *b* *c*

Fig. 4. *Planorbis adowensis* Bourguignat. × 1½.

*Planorbis adowensis* var. *minor* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 351 (type locality: Kibanga, Lake Tanganyika).

*Planorbis* (*Coretus*) *adowensis* Bourguignat. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 42.

*Planorbis* (*Planorbis*) *adowensis* Bourguignat. GERMAIN, 1921, Rec. Indian Mus., XXI, p. 24.

Undussuma (Stuhlmann Coll.). Lubumbashi River near Elisabethville; Lukete (between Kiambi and Sampwe); Lake Moero at Lukonzolwa (J. Bequaert Coll.). Lake Tanganyika: Kibanga; on the western coast between Ubuari Peninsula and the outlet of the Lukuga.

Beni (Borgerhoff Coll.). Penge; Irumu (J. Bequaert Coll.). Lubumbashi River near Elisabethville (Michael Bequaert Coll.).

This species has more rapidly increasing whorls than *P. sudanicus tanganikanus*, the spiral of the left side being narrower, the last whorl relatively wider. On the right side *sudanicus tanganikanus* shows one whorl more than large *adowensis*. The left side of *adowensis* generally shows minute spirals decussating the fine striæ as in *P. sudanicus tanganikanus*.

Height, 5.0 mm.; diameter, 12.0 mm.
" 6.0 " 16.2. Irumu.

Germain has discussed the relationship of this species to *P. bridouxianus*, stating that some specimens approach it rather closely. On the other hand, some large *adowensis* resemble *P. sudanicus tanganikanus*.

**Planorbis bridouxianus** Bourguignat

*Planorbis bridouxianus* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. I, figs. 9-12; 1890, Ann. Sc. Nat. Zool., (7) 2, p. 20, Pl. I, figs. 9-12. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 149. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 98; 1909, Trans. Zoöl. Soc. London, XIX, 1, p. 47. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249. J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-1908),' III, p. 209.

*Planorbis bridouxi* form *orientalis* Germain, 1904, Bull. Mus. Hist. Nat. Paris, p. 350, footnote (Lake Tanganyika).

*Planorbis bridouxi* Bourguignat. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 256; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 636.

*Planorbis (Planorbis) bridouxi* Bourguignat. Germain, 1921, Rec. Indian Mus., XXI, p. 25.

Lake Tanganyika: mouth of the Mahongolo River near Kibanga, on the western shore (type locality). Mt. Ruwenzori (Woosnam Coll.). Also recorded by Thiele with some doubt from Lake Mohasi in Ruanda (Schubotz Coll.).

Aruwimi River in the rapids of Mombitili, above Bomili, 27-XII-1913; Lake Edward at Kabare (J. Bequaert Coll.).

Near *P. adowensis*, but smaller, the whorls increasing more rapidly, the last one wider. Microscopic spirals are visible on the left side, as in related forms. A specimen from the Aruwimi measures: diameter, 7.5 mm.; altitude, 3.2 mm.

A series from Lake Edward consists of specimens with the aperture a little smaller. One of the largest measures: diameter, 8 mm.; altitude, 3.1 mm.

*Planorbis bridouxianus* var. *foai* (Germain)

*Planorbis bridouxi* var. *foai* Germain, 1904, Bull. Mus. Hist. Nat. Paris, p. 351, footnote; 1905, *op. cit.*, p. 256; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 637.

Lake Tanganyika: at the southern end (Foà Coll.).

**Planorbis choanomphalus** E. v. Martens

Text Figure 5

*Planorbis choanomphalus* E. v. Martens, 1879, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 103 (type locality: southwestern shore of Lake Victoria); 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 148, Pl. VI, figs. 14 and 15. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 256; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 637. J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 209.

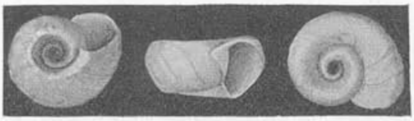
*Planorbis (Coretus) choanomphalus* E. v. Martens. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, p. 196.

Lake Edward: Vichumbi, living and subfossil (Stuhlmann Coll.; Schubotz Coll.; Gromier Coll.). Lake Kivu: (Schubotz Coll.).

Lake Kivu: near Kisenje (R. Van Saceghem Coll.).

This shell has much the appearance of the American *Planorbis bicarinatus* Say, type of the subgenus *Helisoma*, being angular on the left side around the deeply sunken spire, while the right side has a narrow umbilicus, the whorl narrowly rounded but scarcely angular. The periphery is broadly rounded.

Diameter, 11.5 mm.; height, 6 mm.; 4½ whorls.



*a* *b* *c*

Fig. 5. *Planorbis choanomphalus* E. v. Martens. Kisenje, Lake Kivu. ×1½.

### *Planorbis choanomphalus* var. *basisulcatus* E. v. Martens

*Planorbis choanomphalus* var. *basisulcatus* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 149, Pl. VI, fig. 16. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, p. 197.

Originally described from Kassarosi Island and Bukoba Bay in Lake Victoria, and subfossil on the shores of Lake Edward near Vichumbi (Stuhlmann Coll.).

### **Planorbis smithi** (Preston)

Text Figure 6

*Biomphalaria smithi* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 535, Pl. IX, figs. 26 and 26*a*.

Lake Edward: (type locality, without more definite information; J. E. S. Moore Coll.).

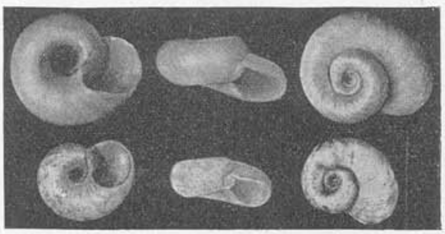
Lake Edward at Kabare (J. Bequaert Coll.).

The prominent character of this species is the deviation towards the left of the last half-whorl. The left side is bluntly angular. A specimen from Kabare measures: diameter, 13 mm.; altitude, 6.5 mm. Another from the original lot: diameter, 9.6 mm.; altitude, 5 mm. Both are figured.

While the unusual shape suggests various planorbid groups of remote places, such as the Andean *Taphius*, this species appears to be merely a modification of the *adowensis* type, perhaps to be placed in the same section of the genus.

*Planorbia albertensis* was very briefly and quite insufficiently described by Moore in 1901 ('To the Mountains of the Moon,' p. 260) as follows: "A very planorboid-looking shell, which, when examined, was found to be much more solid and heavy than any other *Planorbis* that is known. It subsequently turned out not to be a *Planorbis* at all, but an entirely new form, to which I have given the generic and specific name of *Planorbia albertensis*." In the Proc. Zoöl. Soc. London for 1901 (II, p. 468), however, Moore says that the small shell from Lake Edward which he at first took to be a heavily-built *Planorbis* "is in reality a modified *Melania*." There is some probability that it is the same species as

*a* *b* *c*



*d* *e* *f*

Fig. 6. *Planorbis smithi* Preston: Upper figures, specimen from Kabare, Lake Edward; lower figures, paratype. × 1½.

Preston's *Biomphalaria smithi*, which was also described from specimens obtained by J. E. S. Moore in Lake Edward and of which we have a paratype before us.

Germain synonymizes *P. smithi* with *P. choanomphalus*, but comparison with a specimen of that species from Lake Kivu shows it to be amply distinct.

### **Planorbis sudanicus** E. v. Martens

Text Figure 7

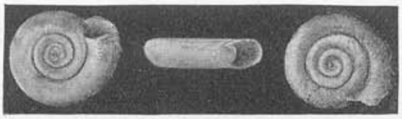
*Planorbis sudanicus* E. v. Martens, 1870, Malakoz. Blätter, XVII, p. 35 (type locality: region of the Bahr-el-Ghazal[1]); 1870-76, in Pfeiffer, 'Novit. Conchol.,' IV, p. 23, Pl. cxiv, figs. 6-9. E. A. Smith, 1880, Proc. Zoöl. Soc. London, p. 349; 1881, *op. cit.*, p. 294. Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 104. Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. i, figs. 13-15; 1890, Ann. Sc. Nat. Zool., (7) X, p. 15, Pl. i, figs. 13-15. R. Sturany, 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 299. E. v. Martens, 1897, 'Deutsch Ost Afr.,

[1]In 1873 (Malakoz. Blätter, XXI, p. 41) E. v. Martens defines the type locality more accurately as "bei der Meschera des Gazellenfluss, März 1869." This is Meshra-el-Req, in 8° 25′ N. and 29° 15′ E., of recent maps.

IV, Beschalte Weichth.,' p. 146, Pl. I, fig. 17. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 98; 1906, Proc. Zoöl. Soc. London, I, p. 184. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 249 and 261. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 209. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 40. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris. p. 195.

*Planorbis (Planorbis) sudanicensis* E. v. Martens. GERMAIN, 1921, Rec. Indian Mus., XXI, p. 23.

*Planorbis sudanicus minor* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 146. This was based upon the typical form of the species.



*a* *b* *c*

Fig. 7. *Planorbis sudanicus* E. v. Martens. Bahr-el-Ghazal. × 1½.

The typical form has been recorded from Lake Tanganyika: swamp at Mbete on the southern shore (W. A. Cunnington Coll.); at the northern end (O. Baumann Coll.); on the eastern shore (Storms Coll.); Ufina (Lechaptois Coll.); Kibanga; Kokongo; Mpala. Lake Edward: on the shore near Kiruwe; young specimens at Vichumbi; subfossil near Katarenge (Stuhlmann Coll.). Lualaba River at Kibondo (between Kikondja and Bukama) (J. Bequaert Coll.). Lake Mohasi in Ruanda (Schubotz Coll.).

We have not seen the typical form from within the limits of the Belgian Congo. It is before us from the Bahr-el-Ghazal, collected by Mearns (U. S. N. M., No. 215381), and is photographed in Fig. 7, for comparison with the following subspecies. The specimen figured measures: diameter, 11 mm.; altitude, 3 mm.; of 5⅓ whorls.

It appears to us doubtful whether the above-listed Congo records really applied to the typical form. The numerous specimens which we have seen, partly from the same localities, all belong to the subspecies *tanganikanus* Bourguignat. E. v. Martens refers Bourguignat's figures to the subspecies *major*.

### **Planorbis sudanicus tanganikanus** Bourguignat

Plate XI, Figures 10–10*b*

*Planorbis tanganikanus* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. I, figs. 16-17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 16, Pl. I, figs. 16-17. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 256. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

*Planorbis tanganicanus* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., V, Beschalte Weichth.,' p. 147.

*Planorbis tanganyikanus* Bourguignat. Germain, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 636.

*Planorbis sudanicus* var. *magna* R. Sturany, 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 310, Pl. xxiv, figs. 10, 14, and 29 (type locality: Lake Manyara, Tanganyika Territory).

*Planorbis sudanicus major* E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 146 (described from several localities in East Africa, from Tanganyika, Lake Edward and Lake Albert).

Lake Tanganyika: originally described from near the outlet of the Lukuga River, and near the mouth of several streams on the western coast, such as the Mkulungulu, Luandazi, and Mahongolo. Lake Edward: Kiruwe; Vichumbi; subfossil at Katarenge (Stuhlmann Coll.). Lake Albert: (Stuhlmann Coll.).

Lake Tanganyika: swamp in the plain of St. Louis de Mrumbi, on the western shore (Stappers Coll.). Lake Edward: on the shore at Kabare (J. Bequaert Coll.). Ngombe River, an affluent of the Lungatshimo (H. Schouteden Coll.).

This form resembles the type except in size. The specimens all show more or less minute spiral striation, either on both sides or on the left side of the spire only, a character we have not seen mentioned for the species. Some of the specimens from Lake Edward have numerous opaque rays on the last whorl. The concavity of the left side is sometimes so deep that the right side is flat with a very small central cavity. Usually the depth of the concavity is nearly equal on the two sides.

Diameter, 17. mm.; altitude, 4.9 mm.; 5¾ whorls.
,, 15.5 ,, 5 5 ,,

## Other Species of *Planorbis*, proper, Recorded from the Belgian Congo

### *Planorbis lavigerianus* Bourguignat

*Planorbis lavigerianus* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. i, figs. 5-8; 1890, Ann. Sc. Nat. Zool., (7) X, p. 19, Pl. i, figs. 5-8. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 148. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 98. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

Lake Tanganyika: southern coast of the Ubuari Peninsula near Kibanga (type locality).

### *Planorbis monceti* Bourguignat

*Planorbis monceti* Bourguignat, 1890, Ann. Sc. Nat. Zool., (7) X, p. 18. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 99. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

Lake Tanganyika: originally described from the western coast of the lake, without more definite locality. J. Thiele (1911,'Wiss. Ergebn. D.Z. Afr. Exp. (1907-08),' III, p. 209) states that a specimen from the falls between Lakes Bolero and Luhondo in Ruanda (Schubotz Coll.) was shaped somewhat like *P. monceti*.

## *Planorbis stanleyi* E. A. Smith

*Planorbis stanleyi* E. A. Smith, 1888, Proc. Zoöl. Soc. London, p. 55. J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 209.

Lake Albert: originally described from that lake without more definite locality; Kassenje (Schubotz Coll.).

This is perhaps a synonym of *P. adowensis* Bourguignat.

## Subgenus **Gyraulus** J. de Charpentier

*Planorbis* subgenus *Gyraulus* "Agassiz" J. de Charpentier, 1837, Neue Denkschr. Allg. Schweiz. Ges. Naturw., I, 'Cat. Moll. Terr. Fluv. Suisse,' p. 21. Type by designation of Clessin (1886): *Planorbis hispidus* Draparnaud = *P. albus* O. F. Müller, one of the species originally included.

*Caillaudia* Bourguignat, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 99. Monotype: *Caillaudia angulata* Bourguignat = *Planorbis costulatus* Krauss. This is the only species mentioned in establishing the genus and as it is correctly defined by reference to Jickeli's figure it must be taken as the type. *C. letourneuxi* Bourguignat, of Lower Egypt, was not described until p. 129 of Bourguignat's paper and was not mentioned on p. 99; moreover, that species appears to be also a *Gyraulus* and not a *Segmentina* as claimed by Pallary (1909, Mém. Inst. Egyptien, VI, 1, p. 58).

*Planorbis* subgenus *Nautilina* Stein, 1850, 'Leb. Schnecken u. Muscheln Umg. Berlins,' p. 80. Type as fixed by Clessin (1886): *Planorbis albus* Müller (as a synonym of *Gyraulus*).

Shell thin, as a rule small, always less than 1 cm. in diameter; flattened as a whole and usually more or less angular at the periphery; the whorls few, rapidly or very rapidly enlarging, convex above and below.

According to Annandale and Prashad the radula is as in *Planorbis*, proper. Branchial process simple. Penis relatively long, with a horny stylet; preputium of complicated structure; a single retractor muscle present.

This subgenus or genus is distributed over most of the world.

The following Ethiopian species appear to belong to *Gyraulus*.

*Planorbis* (*Gyraulus*) *abyssinicus* Jickeli = *Planorbis abyssinicus* Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 215, Pl. vii, figs. 21*a-c*. Toquor River near Mekerka, Abyssinia. *Planorbis* (*Gyraulus*) *abyssinicensis* Germain, 1922, Rec. Indian Mus., XXI, p. 116.

*Planorbis abyssinicus* var. *gravieri* Germain, 1904, Bull. Mus. Hist. Nat. Paris, p. 353. Andobed River, Abyssinia.

*Planorbis* (*Gyraulus*) *adansonii* J. E. Gray = *Planorbis adansonii* J. E. Gray, 1850, in M. E. Gray, 'Figures of Moll. Animals,' IV, p. 119; based upon Adanson's "le Coret, *Coretus*," 1757, 'Hist. Nat. Sénégal, Hist. des Coquillages,' p. 7, Pl. i, fig. 3. Podor, Sénégal.

*Planorbis* (*Gyraulus*) *æthiopicus* Bourguignat = *Planorbis æthiopicus* Bourguignat, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 99. *Planorbis costulatus* Jickeli (in part), 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 219, Pl. vii, figs. 23*a-c* (not of Krauss). Toquor River near Mekerka, Abyssinia.

*Planorbis* (*Gyraulus*) *anderssoni* Ancey = *Planorbis anderssoni* Ancey, 1890, Bull. Soc. Malacol. France, VII, p. 161. Omambonde, Ovampoland. J. Thiele, 1921, 'Wiss. Ergebn. Deutsch. Südpolar Exp.,' XVI, p. 100, fig. 2.

*Planorbis* (*Gyraulus ?*) *apertus* E. v. Martens. See p. 128.

*Planorbis* (*Gyraulus*) *avakubiensis* Pilsbry and Bequaert. See p. 127.

*Planorbis* (*Gyraulus*) *chudeaui* Germain = *Planorbis chudeaui* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 274, fig. 23. Lake Chad at N'Guigmi.

*Planorbis* (*Gyraulus*) *cockburni* Godwin-Austen = *Planorbis cockburni* GODWIN-AUSTEN, 1883, Proc. Zoöl. Soc. London, p. 4, Pl. I, figs. 2 and 2*a-b*. Sokotra.

*Planorbis* (*Gyraulus*) *coretus* Dautzenberg = *Planorbis coretus* "Adanson" DAUTZENBERG, 1890, Mém. Soc. Zool. France, III, p. 132, Pl. I, figs. 9*a-c*. Bakel, Sénégal. This was described as being Adanson's "le Coret, *Coretus*"; however, Adanson says that "les spires sont arrondies, renflées dans leur contour," whereas the whorls are subangular in Dautzenberg's species. The identity of the two seems therefore somewhat dubious; if they can be shown to be the same, Gray's prior name *P. adansonii* will have to be used for this species.

*Planorbis* (*Gyraulus*) *costulatus* Krauss. See p. 127

*Planorbis* (*Gyraulus*) *crawfordi* Melvill and Ponsonby = *Planorbis crawfordi* MELVILL AND PONSONBY, 1893, Ann. Mag. Nat. Hist., (6) XII, p. 111, Pl. III, fig. 20. Van Staaden's River, South Africa.

*Planorbis* (*Gyraulus*) *fouladougouensis* Germain. See p. 126.

*Planorbis* (*Gyraulus*) *gardei* Germain = *Planorbis gardei* GERMAIN, 1909, Bull. Mus. Nat. Hist. Paris, p. 475; 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 192, Pl. I, figs. 33-35. Lake Chad.

*Planorbis* (*Gyraulus*) *gibbonsi* Nelson. See p. 126.

*Planorbis* (*Gyraulus*) *kigeziensis* Preston = *Planorbis kigeziensis* PRESTON, 1912, Proc. Zoöl. Soc. London, I, p. 190, Pl. XXXII, figs. 5, 5*a-b*. Kigezi, 6,000 ft., in extreme southwestern Uganda, close to the border of the Belgian Congo.

*Planorbis* (*Gyraulus*) *kisumiensis* Preston = *Planorbis kisumiensis* PRESTON, 1912, Rev. Zool. Afric., I, 3, p. 327, Pl. XVII, fig. 10. Kisumu, Lake Victoria.

*Planorbis* (*Gyraulus*) *lamyi* Germain. See p. 128.

*Planorbis* (*Gyraulus*) *leucochilus* Melvill and Ponsonby = *Planorbis leucochilus* MELVILL AND PONSONBY, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 607, Pl. XXXI, fig. 3. Killarney Lake, Pietermaritzburg, Natal.

*Planorbis* (*Gyraulus*) *misellus* Morelet = *Planorbis misellus* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 85, Pl. V, fig. 5. Lake Quilunda, Angola.

*Planorbis* (*Gyraulus*) *natalensis* Krauss = *Planorbis natalensis* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 83, Pl. V, fig. 9. *Planorbis natalis* SOWERBY, 1877, 'Conchol. Iconica,' XX, *Planorbis*, Pl. IV, fig. 32. Umgeni River, Natal.

*Planorbis* (*Gyraulus*) *sperabilis* Preston = *Planorbis sperabilis* PRESTON, 1912, Proc. Zoöl. Soc. London, I, p. 190, Pl. XXXII, figs. 4 and 4*a-b*. Gazi, Kenya Colony.

*Planorbis* (*Gyraulus*) *tilhoi* Germain = *Planorbis* (*Diplodiscus*) *tilhoi* GERMAIN, 1911, Bull. Mus. Hist. Nat. Paris, p. 134; 1916, 'Doc. Scientif. Miss. Tilho,' III, p. 299, Pl. I, figs. 1, 2, and 9. Lake Chad and surrounding country.

*Planorbis* (*Gyraulus*) *toukotoensis* Germain = *Planorbis* (*Paraspira*) *toukotoensis* GERMAIN, 1917, Bull. Mus. Hist. Nat. Paris, p. 526, Pl. VII, figs. 9-11. Tukoto, in the Bakoy River, Senegambia.

### **Planorbis (Gyraulus) gibbonsi** Nelson

Text Figure 8

*Planorbis (Gyraulus) gibbonsi* NELSON, 1878, Quart. Journ. of Conch., I, p. 379, Pl. IV, fig. 3 (type locality: Zanzibar Island).

*Planorbis gibbonsi* Nelson. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 150.

*Planorbis (Tropidiscus) gibbonsi* Nelson. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 42.

Lake Albert: Kassenje (Stuhlmann Coll.). Lake Kisale at Kikondja (J. Bequaert Coll.).

Dautzenberg and Germain synonymize with this *Planorbis mutandaensis* Preston, but we have been unable to find the description of that species.

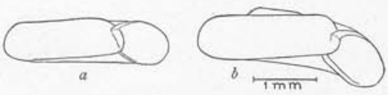



Fig. 8. *Planorbis gibbonsi* Nelson. Kabare, Lake Edward.

Lake Edward: Kabare (J. Bequaert Coll.).

Specimens which we refer to this species were found with *P. fouladougouensis*, from which they are readily distinguishable by the wider spire and the smoother surface, which is merely striatulate. The width of aperture is a little less than one-third of the total diameter. These examples are somewhat smaller than the typical *P. gibbonsi* compared, but do not seem to differ otherwise. Two figured measure:

Diameter, 2.80 mm.; altitude, 0.8 mm.; 3½ whorls.
" 3.15 " 1.2 4 "

### **Planorbis (Gyraulus) fouladougouensis** Germain

*Planorbis (Paraspira) fouladougouensis* GERMAIN, 1917, Bull. Mus. Hist. Nat. Paris, p. 523, Pl. VII, figs. 6-8 (type locality: Tukoto, in the Bakoy River, Senegambia).

Lake Edward at Kabare (J. Bequaert Coll.).

A prominent feature of this species is the sculpture of close rib-striæ. The spire is narrower than in *P. gibbonsi*, and the last whorl on the right side is decidedly wider than in *P. misellus* Morelet. The width of the aperture exceeds one-third of the total diameter. Diameter, 3.1 mm.; altitude, 0.9 mm.; 3½ whorls.

*Planorbis kisumiensis* Preston, from Lake Victoria, must be a good deal like these specimens, but the description and figure are insufficient for decision. *P. sperabilis* Preston also seems to be related.

### **Planorbis (Gyraulus) Avakubiensis,** new species

Text Figure 9

Avakubi, in a woodland pool (J. Bequaert Coll.).

The shell is about equally concave on both sides, thin, olivaceous, minutely, closely but not strongly striate, rather glossy. The whorls increase very rapidly. On the right side the concavity is rather funnel- or vortex-shaped, the whorls broadly rounded. The periphery is rounded, but a very little nearer the left side. The left side has a saucer-shaped concavity and rounded whorls. The aperture is large, its width more than one-third the total diameter of the shell, extremely oblique, cordate in front view. The peristome is thin; left margin curving strongly forward.

Diameter, 2.7 mm.; altitude, 1 mm.; barely 3 whorls.

The rapid increase of the whorls to the large, strongly oblique aperture and the nearly symmetrical curvature of the periphery characterize this species. It appears related to *P. lamyi* Germain, of Lake Tanganyika, but that is a larger shell, said to be quite solid, and "avec une angulosité inférieure assez marquée."

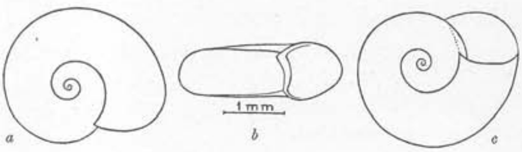



Fig. 9.

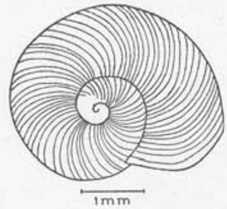



Fig. 10.

Fig. 9. *Planorbis avakubiensis* Pilsbry and Bequaert. Type. Avakubi.
Fig. 10. *Planorbis costulatus* Krauss. Elisabethville.

### **Planorbis (Gyraulus) costulatus** Krauss

Text Figure 10

*Planorbis costulatus* Krauss, 1848, 'Südafrik. Mollusk.,' p. 83, Pl. v, fig. 8 (type locality: Umgeni River, Natal). Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 219, Pl. vii, figs. 22*a-c* (Abyssinia).

*Planorbis stelzneri* E. v. Martens, 1869, Malakoz. Blätter, XVI, p. 213 (Ailet, Eritrea) (not of Dohrn).

*Caillaudia angulata* Bourguignat, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 129 (based upon Jickeli's Pl. vii, figs. 22*a-c* of 1874).

Kisanga River, an affluent of the Kafubo, near Elisabethville (Michael Bequaert Coll.).

The very wide last whorl as seen from the right side, and the sculpture of fine, curved, radially retractive costulæ, with faint traces of spiral striæ, are characteristic. The specimen agrees well with those from Abyssinia compared and also with Krauss' figures and description.

We have not been able to compare directly South African specimens with the Abyssinian, but from the information at hand we fail to see the necessity of Bourguignat's specific separation of the Abyssinian form.

### Other Species of *Gyraulus* Recorded from the Belgian Congo

### *Planorbis* (*Gyraulus*) *apertus* E. v. Martens

*Planorbis apertus* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 149, Pl. VI, fig. 17. GERMAIN, 1912, Bull. Mus. Hist. Nat. Paris, p. 80; 1916, *op. cit.*, p. 198.

Lake Edward: near Kirima on the northwestern shore (type locality; Stuhlmann Coll.); near Kasindi (Gromier Coll.).

It is possible that this species, of which we have seen no specimens, should be placed in the subgenus *Hippeutis*.

### *Planorbis* (*Gyraulus*) *lamyi* Germain

*Planorbis lamyi* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 256; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 638, figs. 4 and 5.

Lake Tanganyika: at the southern end (type locality; Foà Coll.).

### Subgenus **HIPPEUTIS** J. de Charpentier

*Planorbis* subgenus *Hippeutis* "Agassiz" J. DE CHARPENTIER, 1837, Neue Denkschr. Allg. Schweiz. Ges. Naturw., I, 'Cat. Moll. Terr. Fluv. Suisse,' p. 22. Type by designation of Clessin (1886): *Planorbis complanatus* Draparnaud = *P. fontanus* Lightfoot, one of the two species originally included.

Shell small or of moderate size, lenticular, convex above and narrowly and deeply umbilicate below. Spire of very few whorls, the last very broad, deeply embracing the foregoing, angular or subcarinate. Aperture lunate or subtriangular. The anatomy of the genotype has apparently not been worked out. In appearance *Hippeutis* is like *Segmentina*, but it lacks the internal lamellæ.

According to Germain this subgenus is strictly Palæarctic, yet the two following Ethiopian species appear to be true *Hippeutis*.

*Planorbis* (*Hippeutis*) *benguelensis* Dunker = *Planorbis benguelensis* DUNKER, 1845, Zeitschr. f. Malakoz., II, p. 164; 1853, 'Ind. Mollusc. Guin. Infer.,' p. 8, Pl. II, figs. 1-4. *Planorbis bengalensis* SOWERBY, 1877, 'Conchol. Iconica,' XX, *Planorbis*, Pl. IV, fig. 27. Benguela.

*Planorbis* (*Hippeutis*) *junodi* (Connolly) = *Hippeutis junodi* CONNOLLY, 1922, Ann. Mag. Nat. Hist., (9) X, p. 121. Nwambukoto, Rikatla, Portuguese East Africa.

It is possible that *Planorbis apertus* E. v. Martens should also be referred to this subgenus.

### **SEGMENTINA** Fleming

*Segmentina* FLEMING, 1817, 'Edinburgh Encyclopedia, Conchology,' ed. VII, vol. XII[1]. Monotype: *Nautilus lacustris* (Lightfoot) Montagu = *Planorbis nitidus* O. F. Müller.

[1]We have been unable to consult the original account of *Segmentina*.

*Hemithalamus* "Leach" TURTON, 1831, 'Manual Land Fresh-water Shells Brit. Isl.,' p. 116. As a synonym of *Segmentina nitida.*

*Planorbis* subgenus *Segmentaria* SWAINSON, 1840, 'Treatise on Malacology,' p. 337. Monotype: *S. lacustris* Fleming = *Planrobis nitidus* O. F. Müller. Evidently a clerical error for *Segmentina.*

Shell small or minute, planorboid, glossy; the whorls deeply embracing, the last very large and carinate or angular; aperture lunate or subtriangular. Cavity of the last whorl divided by several barriers, each typically composed of three transverse laminæ, on parietal, upper, and basal margins, leaving a triramose passage. In some forms these laminæ are more numerous, or they may be much reduced, or the parietal, or parietal and upper ones may be wanting.

This genus differs from *Planorbula* by having the spire very narrow on both sides, especially on the left, where the whorl is broadly rounded, the angulation or zone of greatest convexity of the whorl being peripheral, while in *Planorbula* the periphery is rounded. In addition, the internal barriers are all transverse to the cavity and more than one set is usually present. The embryonic whorl has spiral lines of punctures, as in the subgenus *Hippeutis,* which *Segmentina,* moreover, resembles in general shape and from which stock it may have been derived.

*Segmentina* is restricted to the Old World. The following Ethiopian species have been described.

*Segmentina angusta* Jickeli. See below.

*Segmentina emicans* (Melvill and Ponsonby) = *Planorbis* (*Segmentina*) *emicans* MELVILL AND PONSONBY, 1892, Ann. Mag. Nat. Hist., (6) X, p. 241, Pl. XIII, figs. 13-13*a*. Zwartkop, Cape Colony.

*Segmentina eussoensis* PRESTON, 1912, Proc. Zoöl. Soc. London, I, p. 191, Pl. XXXII, figs. 6 and 6*a*-*b*. Chanler Falls, Eusso Nyiro, Kenya Colony.

*Segmentina kanisaënsis* PRESTON, 1914, Journ. Linn. Soc. London, Zool., XXXII, p. 265, Pl. XVIII, figs. 17-19. In the Nile at Kanisa.

*Segmentina kempi* Preston. See p. 130.

*Segmentina planodiscus* (Melvill and Ponsonby) = *Planorbis* (*Segmentina*) *planodiscus* MELVILL AND PONSONBY, 1897, Ann. Mag. Nat. Hist., (6) XIX, p. 638, Pl. XVII, fig. 10. Umgeni River, Natal.

### **Segmentina angusta** "E. v. Martens" Jickeli

Text Figure 11*a*, *b*, *c*

*Segmentina angusta* E. v. MARTENS, 1873, Malakoz. Blätter, XXI, p. 42 (*nomen nudum*). JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 220, Pl. VII, figs. 24*a*-*c* (type locality: Toquor River at Mekerka, Abyssinia). DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 43.

*Segmentina chevalieri* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 468; 1905, *op. cit.*, p. 256; 1908, 'Rés. Scientif. Voy. Afrique, Foà,' p. 639, figs. 6-7 (type locality: Lake Chad).

Lake Kisale at Kikondja (J. Bequaert Coll.). Lake Tanganyika: at the southern end (Foà Coll.; recorded as *S. chevalieri*).

A single example from Kikondja (J. Bequaert Coll.) agrees well with Jickeli's description and figures. He says nothing about internal teeth, but his figure 24*c* appears to show traces of one or two. In the Katanga specimen four long radial teeth may be seen through the base; beyond the distal end of each one a very short tooth is seen above the periphery.

Diameter, 3.0 mm.; altitude, 1.25 mm.; 4 whorls.

### **Segmentina kempi** Preston

Text Figure 11*d, e, f*

*Segmentina kempi* PRESTON, 1912, Proc. Zoöl. Soc. London, I, p. 191, Pl. XXXII, figs. 7 and 7*a-b* (type locality: Kigezi, extreme southwestern Uganda, near the border of the Belgian Congo).

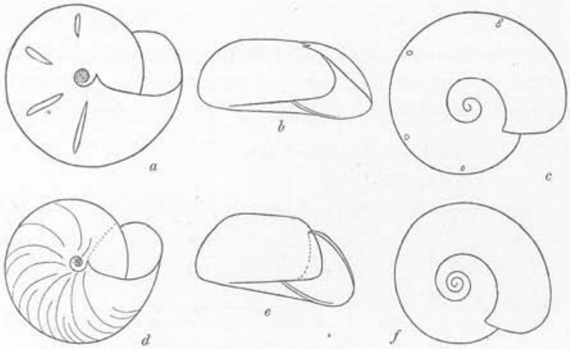



Fig. 11. *a-c, Segmentina angusta* Jickeli. Kikondja. *d-f, S. kempi* Preston. Near Elisabethville.

Kisanga River, an affluent of the Kafubo, near Elisabethville (Michael Bequaert Coll.).

This form is distinguished from *S. angusta* Jickeli by the relatively high form, the abrupt angulation of the periphery close to the left side, the latter being broadly concave, and the narrower aperture. A set of three teeth, placed as in *S. nitida*, is seen at the last third of the last whorl.

| | | | | | | |
|---|---|---|---|---|---|---|
| Diameter, | 3.25 mm.; | altitude, | 1.4 mm.; | $4\frac{1}{2}$ | whorls. |
| " | 2.7 | " | 1.35 | 4 | " |

Dautzenberg and Germain (1914, Rev. Zool. Afric., IV, 1, p. 43) synonymize this with *S. angusta*, but we cannot accept that view.

### PLANORBULA Haldeman

*Discus* HALDEMAN, July, 1840, 'Monograph of Limniades of North America,' pt. 1, p. 4 of cover (not *Discus* of Fitzinger, 1833). Monotype: *Planorbis armigerus* Say.

*Planorbula* HALDEMAN, October, 1840, *op. cit.*, Suppl. to part 1, p. 2 (new name for *Discus* Haldeman); 1842, *op. cit.*, IV, Physadæ, p. 14. Monotype: *Planorbis armigerus* Say.

*Coretus* subgenus *Dentatus* "Beck" GRAY, 1847, Proc. Zoöl. Soc. London, p. 181. Monotype: *Planorbis armatus* Gray, supposed to be *Planorbis armigerus* Say.

*Haldemanina* DALL, 1905, 'Alaska,' XIII, p. 97. Monotype: *Planorbis wheatleyi* Lea.

*Planorbulina* E. v. MARTENS, 1899, 'Biologia Centrali-Americana, Land and Fresh-water Mollusca,' p. 400. For the group of *Planorbis armigerus* Say; evidently a clerical error for *Planorbula*.

Shell small, planorboid, biconcave, showing the spiral broadly on both sides, deeply concave on the left side, nearly level on the right; whorls broadly rounded peripherally, angular or rounded on the left side. There is at some time in life an internal barrier in the throat composed of five or six transverse and entering teeth; these may, however, be resorbed in the course of growth so that in adult specimens there is often only one lamella and in some specimens the throat is unarmed. In the adult the aperture is margined internally with a thickened, whitish rib.

The genus is only known from America and the Ethiopian Region. It is especially numerous in tropical America. The African species appear to be very closely related.

*Planorbula alexandrina* (Ehrenberg) = *Planorbis alexandrinus* Ehrenberg, 1831, 'Symbolæ Physicæ, Evertebrata, I, Mollusca,' p. [18]. *Planorbula jickelii* BOURGUIGNAT, 1876, Bull Soc. Sc. Phys. Nat. Bordeaux, p. 80. *Planorbula alexandrinensis* GERMAIN, 1923, Rec. Indian Mus., XXI, p. 182. Type locality: between Alexandria and Rosette, Lower Egypt. The species is known from Egypt to Eritrea, and we have seen specimens from the Bahr-el-Ghazal, Lake Abaja in Abyssinia, and Lake Rudolf.

*Planorbula boccardi* POLLONERA, 1898, Boll. Lab. Zool. Anat. Comp. Torino, XIII, No. 313, p. 11, Pl., figs. 22-25. Adi-Ugri, Eritrea.

*Planorbula tanganyicensis* (E. A. Smith). See below.

*Planorbula tchadiensis* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 468; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 510, Pl. v, figs. 8-9. Kuri Archipelago, Lake Chad.

*Planorbula tchadiensis* var. *inermis* GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 193. Pl. I, fig. 19. Am Raya, Bahr el Ghazal.

## Species of *Planorbula* Recorded from the Belgian Congo

### *Planorbula tanganyicensis* (E. A. Smith)

*Segmentina* (*Planorbula*) *alexandrina* var. *tanganyicensis* E. A. SMITH, 1881, Proc. Zoöl. Soc. London, p. 294, Pl. XXXIV, figs. 30-30*b*.

*Planorbis alexandrinus* var. *tanganyicensis* E. A. Smith. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 150.

*Planorbula tanganikana* BOURGUIGNAT, 1890, Ann. Sc. Nat. Zool., (7) X, p. 23.

*Planorbis alexandrina* var. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 98.

*Planorbula tanganyicensis* E. A. Smith. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 249 and 261.

Lake Tanganyika: originally described from the lake without more definite locality (J. Thomson Coll.).

### Bulininæ

Shell ovate or oblong, sinistral, *Physa*-shaped or narrowly elongate, turreted, frequently scalariform.

This subfamily includes practically all Ethiopian species that were formerly regarded as *Physæ*. They differ from the true Physidæ, however, in the structure of the radula, which is as in *Planorbis*. In addition, the animal lacks the digitations of the mantle possessed by the Holarctic *Physæ*, and has a pseudobranch.

The subfamily Bulininæ appears to be restricted at present to Australia, Oceania, New Guinea, Celebes, Japan, India, the Ethiopian and Malagasy Regions, the Mediterranean Subregion as far east as Mesopotamia, and the Antilles. *Platyphysa* Fischer (1883, 'Manuel de Conchyl.,' p. 510) was proposed as a group of *Bulinus* for *Physa prinsepii* Sowerby, a large-sized form from the Eocene of India; its correct place in classification is uncertain, but it may equally well be one of the Physidæ.

The following are the genera and subgenera at present recognized among the Bulininæ.

*Bulinus* O. F. Müller. With *Pyrgophysa* Crosse, *Ameria* H. Adams, *Glyptophysa* Crosse, *Physastra* Tapparone-Canefri, and *Isidorella* Tate as subgenera, some of which may prove untenable upon further study. The African species appear all to belong to *Bulinus* proper and to *Pyrgophysa*. See p. 135.

*Physopsis* Krauss. See p. 142.

*Plesiophysa* FISCHER, 1883, 'Manuel de Conchyl.,' p. 509. Monotype: *Physa striata* d'Orbigny. Antilles.

*Miratesta* P. AND F. SARASIN, 1897, Zool. Anzeiger, XX, p. 242; 1898, 'Materialien z. Naturg. Insel Celebes, Die Süsswasser-Moll.,' p. 73. Monotype: *M. celebensis* P. and F. Sarasin. Celebes.

*Protancylus* P. AND F. SARASIN, 1897, Zool. Anzeiger, XX, p. 280; 1898, 'Materialien z. Naturg. Insel Celebes, Die Süsswasser-Moll.,' p. 84. Type by present designation: *P. adhærens* P. and F. Sarasin. Celebes.

*Camptoceras* BENSON, 1843, Calcutta Journ. Nat. Hist., III, p. 465. Monotype: *C. terebra* Benson. India and Japan.

### BULINUS O. F. Müller

*Bulinus* "Adanson" O. F. MÜLLER, 1781, Der Naturforscher, XV, pp. 5 and 6. For four species: *Bulinus perla* [=*Physa fontinalis* (Linnæus)], *B. turritus*, *B. gela-*

*tinus*, and *B. senegalensis* (this based upon Adanson's "le bulin, *Bulinus*"). Type by tautonymy: *Bulinus senegalensis* O. F. Müller = "le bulin" of Adanson.

*Bullinus* OKEN, 1815, 'Lehrb. d. Naturgesch.,' III, 1, p. 303 (emendation of *Bulinus* Müller). Type by present designation: *Bulinus senegalensis* O. F. Müller.

*Isidora* EHRENBERG, 1831, 'Symbolæ Physicæ, Evertebrata, I, Mollusca,' p. [19]. For three species: *I. hemprichii* Ehrenberg, *I. brocchii* Ehrenberg, and *I. forskali* Ehrenberg. Type by designation of Gray (1847, Proc. Zoöl. Soc. London, p. 180): *I. hemprichii* Ehrenberg = *Physa truncata* Audouin var.

*Diastropha* GRAY, 1840, in 'Turton's Manual Shells Brit. Isl.,' 2d Ed., p. 16. Monotype: *Physa contorta* Michaud.

*Isodora* A. MOUSSON, 1874, Journ. de Conchyl., XXII, p. 43. Misspelling of *Isidora*.

*Scævola* "Megerle" [v. Mühlfeld] SCUDDER, 1882, 'Nomencl. Zoolog., Suppl. List,' p. 300. Substitute for *Bulinus*.

*Pulmobranchia* PELSENEER, 1894, C. R. Ac. Sci. Paris, CXIX, p. 355; 1895, Arch. de Biologie, XIV, 2, p. 372. Monotype: *Physa lamellata* E. A. Smith, of Madagascar.

Shell ovate, or elongate, or turreted. Columella straight, rarely feebly sinuate, never truncate below.

H. M. Perry (1922, Trans. Roy. Soc. Trop. Med. Hyg. London, XVI, p. 272), who has kept *Bulinus contortus* of Egypt in an aquarium, writes of this species: "The eggs are deposited in little jelly-like sacs, which are firmly fixed on stones, reeds, or the shells of other mollusks by an extraordinarily tenacious cement material. Each sac contains from 20 to 30 ova. The rapidity of development of the ovum is dependent on temperature and has been found to be complete in about 12 days at 22° C. It is much delayed when the ova are kept at lower temperatures. The minute mollusk emerging from the egg-sac is fully formed, and attains a fair size in four or five months." Brumpt (1922, Bull. Soc. Path. Exot. Paris, XV, p. 635) also observed the oviposition of that species and figured the egg-masses which he describes as orbicular, flattened, and of a single layer of eggs.

The name *Bulinus* was introduced into binomial nomenclature by O. F. Müller. He states that his intention was to provide genera for the fresh-water snails with two bristle-shaped tentacles with eyes at their inner bases. He suggests that the "Tellerschnecken" keep the name *Planorbis*, while Adanson's name *Bulinus* could be accepted for the "Eyförmigen."[1] Of the latter, four species were known to him. The first, *Bulinus perla*, was fully described and figured, and is recognized to be *Physa fontinalis* (Linnæus). This species was designated type of

[1] "So kann doch bis dahin, den Schneckenliebhabern zu Gefallen, die den Begriff einer Tellerschnecke bey dem Eyförmigen nicht ausstehen können, der Name Tellerschnecke denen mit platter Schaale verbleiben, und die mit länglichen Schaalen den Adansonischen Namen *Bulinus* annehmen." (1781, Der Naturforscher, Halle, XV, p. 6).

*Bulinus* by Herrmansen (1846, 'Index Gen. Malac.,' I, p. 140). Müller's fourth species was *Bulinus senegalensis* defined by a reference to Adanson, 1757, 'Hist. Nat. Sénégal, Hist. des Coquillages,' p. 5, Pl. I. He also states that "*Adanson erfand ihr einen neuen Geschlechtsnamen* (*Bulinus*)." Obviously, therefore, Adanson's *Bulinus* becomes type of *Bulinus* by absolute tautonymy.[1] Otherwise the name *Bulinus* Müller, 1781, would supersede *Physa* Draparnaud, 1801.

The status of *Bulinus* Müller has been discussed by von Martens,[2] who accepted *Physa fontinalis* as its type, but refused to substitute *Bulinus* for *Physa*. Later, Dall[3] went over the ground, reaching a conclusion which we accept without reserve. Finally, Kennard and Woodward[4] considered the question, concluding that Müller's "adoption of Adanson's name (*Bulinus*) involves the acceptance of his shell as the type of the genus. Since, however, that is indeterminate, this post-Linnean revival of the name is rendered nugatory. But for that, *Bulinus* Müller would have precedence of *Physa* Draparnaud, 1801."

This conclusion seems to us incorrect in at least two statements. Adanson's species has been determined. It was defined very well, and, with specimens from the type locality, no competent zoölogist would go astray in its identification. Its acceptance does not displace *Physa*, but, on the contrary, if it were to be thrown out as indeterminate, then *Bulinus* would take the place of *Physa* having *Physa fontinalis* as type. The International Rules expressly exclude indeterminate species from consideration in the selection of genotypes.

*Bulinus* came into general use for the group under consideration and is to be found in the most widely used systematic works on general conchology, such as H. and A. Adams, 'Genera of Recent Mollusca'; Tryon, 'Structural and Systematic Conchology'; Fischer, 'Manuel de Conchyliologie' and others.

The new name (or amended spelling) *Bullinus* originated with Oken, 1815, and in recent years has been taken up by several authors. Oken's work was a mere compilation from Müller; only the same species were mentioned. The revival of Oken's name for the group was apparently due to the fact that Adanson, being pre-Linnean, could not properly be quoted for the genus, and to ignorance of the prior work of Müller. *Bullinus* Oken has no status in nomenclature according to the Rules of

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[1]This conclusion is based upon the International Code of zoölogical nomenclature, Art. 30*d*, and Opinions 16 and 18.

[2]1898, in P. and F. Sarasin, 'Materialien z. Naturg. Insel Celebes, Die Süsswasser-Moll.,' p. 83.

[3]1905, 'Harriman Alaska Exped., Land and Fresh-water Moll.,' p. 105.

[4]1920, Proc. Malacol. Soc. London, XIV, pp. 86–88.

the International Commission, being an absolute synonym of *Bulinus* Müller.[1]

### Subgenus BULINUS, proper

Shell ovate, elongate-ovate, or globular, not turreted. In some species the spire flattened above.

The following species are to be noted.

*Bulinus alluaudi* (Dautzenberg) = *Physa alluaudi* DAUTZENBERG, 1908, Journ. de Conchyl., LVI, p. 17, Pl. II, figs. 11-12. Nairobi, Kenya Colony.

*Bulinus angolensis* (Morelet) = *Physa angolensis* MORELET, 1866, Journ. de Conchyl., XIV, p. 162; 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 88, Pl. IX, fig. 8. *Physa algoensis* G. B. SOWERBY, 1873, 'Conchol. Iconica,' XIX, *Physa*, Pl. VII, fig. 53. Duque de Bragança, Angola.

*Bulinus benguelensis* (Sowerby) = *Physa benguelensis* G B. SOWERBY, 1873, 'Conchol. Iconica,' XIX, *Physa*, Pl. IX, fig. 77. Benguela. This species is, according to the figure, much like *B. canescens* (Morelet), with which it should perhaps be united.

*Bulinus brocchii* (Ehrenberg) = *Isidora brocchii* EHRENBERG, 1831, 'Symbolæ Physicæ, Evertebrata, I, Mollusca,' p. [20]. Syria and Lower Egypt. This is frequently regarded as a synonym of *B. truncatus* (Audouin).

*Bulinus comptus* (Melvill and Ponsonby) = *Isidora compta* MELVILL AND PONSONBY, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 606, Pl. XXXII, fig. 14. Boksburg, Transvaal.

*Bulinus contortus* (Michaud) = *Physa contorta* MICHAUD, 1829, Bull. Soc. Linn Bordeaux, III, p. 268, Pl., figs. 15-16. Type locality: Eastern Pyrénées, France; also said by Michaud to occur in Sicily. This is a common species in the Mediterranean Subregion apparently entering the Sudan and extending into Abyssinia.[2] Connolly even lists it from South Africa. According to certain authors it is the same as Ehrenberg's *Isidora hemprichii* and *I. brocchii*, which are posterior, notwithstanding Annandale's statement to the contrary (1922, Indian Jl. Med. Research, X, 2, p. 485). Moreover, *B. contortus* may ultimately prove to be the same as *B. truncatus* (Audouin), in which case the latter name will have precedence.

The following names appear to be plain synonyms of *B. contortus*: *Physa harpula* FÉRUSSAC, 1823, Mém. Soc. Hist. Nat. Paris, I, p. 365 (*nomen nudum*); *Physa mareotica* "Parreyss" SOWERBY, 1873, 'Conchol. Iconica,' XIX, *Physa*, Pl. X, fig. 78; *Physa rivularis* PHILIPPI, 1836, 'Enum. Moll. Sicil.,' I, p. 146, Pl. IX, fig. 1; *Physa scalata* MERIAN, 1847, Ber. Naturf. Ges. Basel, p. 91; and *Physa spiracea* "Parreyss" JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 204.

*Bulinus contortus* var. *rugosus* (Pallary) = *Bullinus contortus* var. *rugosa* PALLARY, 1909, Mém. Inst. Egyptien, VI, 1, p. 53. Tourah, Lower Egypt.

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[1]The combination "*Bullinus* Adanson," used by some authors is ruled out because it is false—Adanson never used "*Bullinus*"—and because a pre-Linnean author is not quotable as authority for generic or specific names.

[2]See Dollfus, R. P. 1922.' Sur la présence en France et en Corse du *Bullinus contortus* (Michaud), hôte intermédiaire de *Schistosoma hæmatobium* (Bilharz).' Bull. Soc. Path. Exot. Paris, XV, pp. 208–212.

Brumpt, E. 1922. 'La bilharziose au Maroc. Répartition du *Bullinus contortus* et du *Planorbis metidjensis*.' *Op. cit.*, XV, pp. 632–641.

*Bulinus contortus* var. *saulcyi* (Bourguignat) = *Physa saulcyi* BOURGUIGNAT, 1856, Rev. Mag. Zool., (2) VIII, p. 230, Pl. XV, figs. 14-16; 1856, 'Aménités Malacologiques,' I, p. 168, Pl. XXI, figs. 14-16. Alexandria, Lower Egypt.

*Bulinus corneus* (Morelet) = *Physa cornea* MORELET, 1889, Journ. de Conchyl., XXXVII, p. 16, Pl. I, fig. 8. Port Elizabeth, Cape Colony. According to v. Martens this is a synonym of *B. zanzebaricus* (Clessin).

*Bulinus coulboisi* (Bourguignat). See p. 139.

*Bulinus craveni* (Sturany) = *Physa lirata* CRAVEN, 1880, Proc. Zoöl. Soc. London, p. 617, Pl. LVII, fig. 10 (not *Physa lirata* Tristram, 1863). *Physa craveni* ANCEY, 1886, Le Naturaliste, VIII, p. 358; STURANY, 1898, Denkschr. Math. Naturw. Kl. Ak. Wiss. Wien, LXVII, p. 76. Mooi River, Transvaal. According to Dupuis (1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 81), this is the same as *B. tropicus* (Krauss).

*Bulinus crystallinus* (Morelet) = *Physa crystallina* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 89, Pl. IX, fig. 1. Quiaposa River near Sange, Angola.

*Bulinus diaphanus* (Krauss) = *Physa diaphana* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 84, Pl. V, fig. 11. Umgeni Valley, Natal.

*Bulinus dybowskii* FISCHER, 1891, Nouv. Arch. Miss. Scientif., I, p. 365, Pl. III, figs. 4-4*a*. Southern Algeria (subfossil), and alive in Tunis, according to Pallary.

*Bulinus dybowskii* var. *alexandrinus* (Pallary) = *Bullinus dybowskii* var. *alexandrina* PALLARY, 1909, Mém. Inst. Egyptien, VI, 1, p. 53. Alexandria and Matarieh, Lower Egypt.

*Bulinus guerinii* (Mittre) = *Physa guerinii* MITTRE, 1841, Rev. Zoolog. Soc. Cuviér., p. 68. This species was described from the Orient ("Levant"); according to Bourguignat, it probably came from Egypt.

*Bulinus guernei* (Dautzenberg) = *Isidora guernei* DAUTZENBERG, 1890, Mém. Soc. Zool. France, III, p. 133, Pl. I, figs. 11*a*-*b*. Tuabo, Senegambia.

*Bulinus hemprichii* (Ehrenberg) = *Isidora hemprichii* EHRENBERG, 1831, 'Symbolæ Physicæ, Evertebrata, I, Mollusca,' p. [19]. Lower Egypt.

*Bulinus innesi* (Pallary) = *Bullinus innesi* "Bourguignat" PALLARY, 1909, Mém. Inst. Egyptien, VI, 1, p. 53, Pl. III, figs. 41-42. Cairo, Lower Egypt.

*Bulinus innesi* var. *distortus* (Pallary) = *Bullinus innesi* var. *distorta* PALLARY, 1909, Mém. Inst. Egyptien, VI, 1, p. 53, Pl. III, figs. 44-46. Tourah, Lower Egypt.

*Bulinus joubini* (Germain) = *Physa* (*Isodora*) *joubini* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 273, fig. 22. Lake Chad at Kuloa.

*Bulinus jousseaumi* (Dautzenberg) = *Isidora jousseaumi* DAUTZENBERG, 1890, Mém. Soc. Zool. France, III, p. 132, Pl. I, figs. 10*a*-*b*. Falls of the Felu River, near Medine, Senegambia.

*Bulinus laikipiaensis* (Preston) = *Physa laikipiaensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 56, Pl. V, fig. 14. Laikipia Plateau, at 7,000 ft., Kenya Colony.

*Bulinus masakaensis* (Preston) = *Physa masakaensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 57, Pl. V, fig. 7. Masaka, southwestern Uganda.

*Bulinus mutandaensis* (Preston) = *Physa mutandaensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 57, Pl. V, fig. 8. Lake Mutanda, southwestern Uganda.

*Bulinus nyassanus* (E. A. Smith) = *Physa nyassana* E. A. SMITH, 1877, Proc. Zoöl. Soc. London, p. 717, Pl. LXXV, figs. 16-17. Lake Nyasa.

*Bulinus parietalis* (Mousson) = *Physa parietalis* MOUSSON, 1887, Journ. de Conchyl., XXXV, p. 298, Pl. XII, figs. 8-8*a*. Ondonga, Southwestern Africa.

*Bulinus permembranaceus* (Preston) = *Physa permembranacea* PRESTON, 1912, Rev. Zool. Afric., I, 3, p. 327, Pl. XVII, fig. 8. Aberdare Range, Kenya Colony.

*Bulinus randabeli* (Bourguignat). See p. 139.

*Bulinus rohlfsi* (Clessin) = *Physa rohlfsi* CLESSIN, 1886, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 17, Limnæiden,' p. 349, Pl. XLIX, fig. 7. Kuka, Lake Chad.

*Bulinus rumrutiensis* (Preston) = *Physa rumrutiensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 57. Between Rumruti and Mt. Kenya, Kenya Colony.

*Bulinus schackoi* (Jickeli) = *Isidora schackoi* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 197, Pl. VII, fig. 12. Toquor River at Mekerka, Abyssinia.

*Bulinus schackoi* mut. *minimus* (Pollonera) = *Isidora schackoi* mut. *minima* POLLONERA, 1898, Boll. Mus. Zool. Anat. Comp. Torino, XIII, No. 313, p. 12. Adi-Cani near Saganeiti, Eritrea.

*Bulinus senegalensis* O. F. Müller. See p. 138.

*Bulinus sericinus* (Jickeli) = *Isidora sericina* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 194, Pl. III, fig. 2 and Pl. VII, fig. 11. Province of Hamasen, near Mekerka on the Toquor River, Abyssinia.

Pollonera (1898, Boll. Mus. Zool. Anat. Comp. Torino, XIII, No. 313, p. 11, Pl., figs. 26-27) has described a doubtful variety *harpula* of this species, from between Asmara and Debaroa, Eritrea.

*Bulinus strigosus* (E. v. Martens) = *Isidora strigosa* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 139, Pl. VI, fig. 11. Lake Victoria, near Bukoba. J. Thiele (1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 209) records this species from Lakes Mohasi and Bolero in Ruanda (Schubotz Coll.).

*Bulinus succinoides* (E. A. Smith) = *Physa succinoides* E. A. SMITH, 1877, Proc. Zoöl. Soc. London, p. 718, Pl. LXXV, figs. 19-20. Lake Nyasa.

*Bulinus syngenes* (Preston) = *Physa syngenes* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 56, Pl. V, fig. 10. Lake Naivasha, Kenya Colony.

*Bulinus tchadiensis* (Germain) = *Physa* (*Isidora*) *tchadiensis* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 485; 1906, Mém. Soc. Zool. France, XIX, p. 225, Pl. IV, figs. 5-6. Lake Chad. Germain (1905, *op. cit.*, pp. 485-486) has named of this species the following varieties, all from Lake Chad: *albida, brevispirata, castanea, disjuncta, elata, regularis, translucida,* and *ventricosa.* Of these, the var. *regularis* has been figured in 1906, Mém. Soc. Zool. France, XIX, p. 226, Pl. IV, figs. 3-4, and 1908, in A. Chevalier, 'L'Afrique Centrale Francaise,' p. 498, Pl. V, fig. 6.

*Bulinus transversalis* (E. v. Martens) = *Isidora transversalis* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 139, Pl. VI, fig. 9. Ndukali in Bumbide Island, Lake Victoria.

*Bulinus trigonus* (E. v. Martens) = *Physa trigona* E. v. MARTENS, 1892, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 17 *Isidora trigona* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 138, Pl. VI, fig. 8. Near Bukome, Lake Victoria, J. Thiele (1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 209) records this species from Lake Mohasi in Ruanda (Schubotz Coll ).

*Bulinus trigonus* var. *altus* (Germain) = *Physa trigona* var. *alta* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 495. Lake Chad.

*Bulinus trigonus* var. *columellaris* (Germain) = *Physa trigona* var. *columellaris* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 496. Lake Chad.

*Bulinus trigonus* var. *solidus* (Germain) = *Physa trigona* var. *solida* GERMAIN 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 496. Lake Chad.

*Bulinus tropicus* (Krauss) = *Physa tropica* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 84, Pl. v, fig. 12. *Physa cyrtonota* BOURGUIGNAT, 1856, Rev. Mag. Zool., (2) VIII, p. 238, Pl. xv, figs. 1-2; 1856, 'Aménités Malacologiques,' I, p. 177, Pl. xxi, figs. 1-2. Lepenula River (between 25° and 26° S.), Transvaal (type locality of *tropica*); Olifants River (type locality of *cyrtonota*). Lepenula is a corruption of the native name of the Olifants River.

*Bulinus vaneyi* (Germain) = *Physa* (*Isodora*) *vaneyi* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 65; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 499, Pl. v, fig. 5. Kuri Islands in Lake Chad.

*Bulinus verreauxii* (Bourguignat) = *Physa verreauxii* BOURGUIGNAT, 1856, Rev. Mag. Zool., (2) VIII, p. 237, Pl. xv, figs. 3-4; 1856, 'Aménités Malacologiques,' I, p. 176, Pl. xxi, figs. 3-4. Olifants River, Transvaal.

*Bulinus welwitschi* (Morelet) = *Physa welwitschi* MORELET, 1866, Journ. de Conchyl., XIV, p. 162; 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 88, Pl. ix, fig. 9. Bumbo River, Benguela.

*Bulinus zanzebaricus* (Clessin) = *Physa zanzebarica* CLESSIN, 1886, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 17, Limnæiden,' p. 362, Pl. li, fig. 5. Zanzibar. J. Thiele (1911, 'Wiss. Ergebn. D. Z .Afr. Exp. (1907-08), III,' p. 209) reports this species from Lake Karago and the falls between the Lakes Bolero and Luhondo, in Ruanda (Schubotz Coll.).

## *Bulinus senegalensis* O. F. Müller

Text Figure 12*a-c*

"Le Bulin, *Bulinus*" ADANSON, 1857, 'Hist. Nat. Sénégal, Hist. des Coquillages,' p. 5, Pl. i. Type locality: Podor, Senegambia.

*Bulinus senegalensis* O. F. MÜLLER, 1781, Der Naturforscher, Halle, XV, p. 6.

*Bullinus senegalensis* OKEN, 1815, 'Lehrb. d. Naturgesch.,' III, 1, p. 303.

*Bulinus adansonii* J. E. GRAY, 1850, in M. E. Gray, 'Figures of Moll. Animals,' IV, p. 119 (based on Adanson's Bulin).

*Physa senegalensis* BOURGUIGNAT, 1856, Rev. Mag. Zool., (2) VIII, p. 238; 1856, 'Aménités Malacologiques,' I, p. 177.

*Bullinus bullin* "Adanson" PALLARY, 1909, Mém. Inst. Egyptien, VI, 1, p. 51. New name for *Bulinus adansoni* Gray.

Marécages de Podor, Senegal (H. Vignou Coll., 1872); No. 64128, A. N. S. P.

As the genotype of *Bulinus* is not well known, we venture to give some details of specimens from Adanson's type locality. They agree fully with Adanson's excellent account of this species.

The shell is perforate, the whorls rounded, with sculpture of nearly regularly spaced low axial threads, more or less fine striation between them. The suture is well impressed. Aperture ovate, the outer lip regularly arcuate. Columella slightly concave, reflected over, but not closing the perforation.

Length, 2.85 mm.; diameter, 1.7 mm.; aperture, 1.55 mm.; 3⅝ whorls.

Some larger specimens in the same lot (Figs. 12*b*, *c*) differ somewhat in contour, are more strongly sculptured, and have the aperture narrower. These may possibly represent a different species—a point to be determined by further collecting and observation in the original locality. Figure 12*c* measures:

Length, 4.4 mm.; diameter, 2.3 mm.; aperture, 2.3 mm.; 4⅛ whorls.

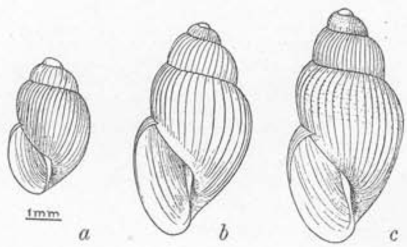


Fig. 12. *Bulinus senegalensis* O. F. Müller. *a*, typical. *b-c*, larger form· Marsh of Podor, Senegal.

## Species of *Bulinus*, proper, Recorded from the Belgian Congo

### *Bulinus coulboisi* (Bourguignat)

*Physa coulboisi* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. i, figs. 24 and 25; 1890, Ann. Sc. Nat. Zool., (7) X, p. 14, Pl. i, figs. 24 and 25.

*Isidora coulboisi* Bourguignat. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 139. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 99. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

*Physa* (*Isodora*) *coulboisi* Bourguignat. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 255; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 640.

Lake Tanganyika: originally described from the western shore of the lake, without more definite locality.

### *Bulinus randabeli* (Bourguignat)

*Physa randabeli* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. i, figs. 26 and 27; 1890, Ann. Sc. Nat. Zool., (7) X, p. 12, Pl. i, figs. 26 and 27.

*Isidora randabeli* Bourguignat. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 140. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 99. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

Lake Tanganyika: Ubuari Peninsula (type locality).

### Subgenus **Pyrgophysa** Crosse

*Pyrgophysa* Crosse, 1879, Journ. de Conchyl., XXVII, p. 208. Monotype: *Pyrgophysa mariei* Crosse, of Nossi Bé.

*Pyrgobullinus* PALLARY, 1923, Archives Inst. Pasteur Afr. du Nord, III, p. 31. Emendation of *Pyrgophysa.*

Shell narrowly oval and slender, turreted, sometimes scalariform; the early whorls frequently carinate and flattened near the suture.

There is no clear-cut division between the two subgenera of *Bulinus*, since certain forms, such as *B. canescens* (Morelet), can equally well be placed in either of them.

Most of the species listed below are by certain authors regarded as mere synonyms, neanic stages, or variations of one extremely variable species. But, as in the case of *Bulinus*, proper, we do not attempt a full synonymy.

*Bulinus (Pyrgophysa) apiculatus* (Morelet) = *Physa apiculata* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 90, Pl. VIII, fig. 3. Loanda district (on the road between Camama and Calumbo), Angola.

*Bulinus (Pyrgophysa) beccarii* (Paladilhe) = *Physa beccarii* PALADILHE, 1872, Ann. Mus. Civ. Genova, III, p. 23, Pl. I, figs. 7-8. Aden, southern Arabia.

*Bulinus (Pyrgophysa) capillaceus* (Morelet) = *Physa capillacea* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 89, Pl. VIII, fig. 1. District of Libongo, and Lake of Quifangondo near Bengo, Angola.

*Bulinus (Pyrgophysa) canescens* (Morelet) = *Physa canescens* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 90, Pl. IX, fig. 3. Swamps of the Bengo River and of Quicuje, Angola.

*Bulinus (Pyrgophysa) clavulatus* (Morelet) = *Physa clavulata* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 93, Pl. IX, fig. 6. Swamps of the Dande River, near Bombo, Angola.

*Bulinus (Pyrgophysa) dautzenbergi* (Germain) = *Physa (Pyrgophysa) dautzenbergi* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 486; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 501, Pl. V, fig. 7. Lake Chad.

*Bulinus (Pyrgophysa) fischerianus* (Bourguignat) = *Physa fischeriana* BOURGUIGNAT, 1856, Rev. Mag. Zool., (2) VIII, p. 18, Pl. II, figs. 1-3; 1856, 'Aménités Malacologiques,' I, pp. 146 and 179, Pl. XI, figs. 1-3. *Physa fischeri* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Mém. Soc. Zool. France, XVII, p. 11. Abyssinia.

*Bulinus (Pyrgophysa) forskalii* (Ehrenberg). E. v. Martens (1866, Malakoz. Blätter, XIII, p. 100) has listed a var. *elatior*, from southern Abyssinia, which does not seem to have been described. See p. 142.

*Bulinus forskalii* var. *pulchellus* (Pallary) = *Bullinus forskali* var. *pulchella* PALLARY, 1924, Mém. Inst. d'Egypte, VII, 1, p 25. Alexandria, Lower Egypt.

*Bulinus (Pyrgophysa) gradatus* (Melvill and Ponsonby) = *Physa gradata* MELVILL AND PONSONBY, 1898, Ann. Mag. Nat. Hist., (7) II, p. 129, Pl. VII, fig. 8. Brickfields near Grahamstown, Cape Colony.

*Bulinus (Pyrgophysa) lamellosus* (Roth). See p. 142.

*Bulinus (? Pyrgophysa) ludovicianus* (Mittre) = *Physa ludoviciana* MITTRE, 1841, Rev. Zoolog. Soc. Cuviér., p. 68. Saint Louis, Senegambia. The generic reference of this species is doubtful; it possibly is a *Physopsis*. Certain authors synonymize it with *Bulinus senegalensis*, but the description does not fit that species.

*Bulinus (Pyrgophysa) moreleti* (A. Nobre) = *Physa moreleti* A. NOBRE, 1905, Annaes Sc. Naturaes, Porto, IX, p. 15 (of separate), Pl. I, figs. 29-30. Luinha, Angola.

*Bulinus (Pyrgophysa) osorioi* (A. Nobre) = *Physa osarioi* A. NOBRE, 1905, Annaes Sc. Naturaes, Porto, IX, p. 15 (of separate), Pl. I, figs. 31-32. Gumba, Angola.

*Bulinus (Pyrgophysa) scalaris* (Dunker). See p. 142.

*Bulinus (Pyrgophysa) schmidtii* Dunker = *Bulinus schmidtii* DUNKER, 1853, 'Ind. Mollusc. Guin. Infer.,' p. 9, Pl. II, figs. 7-8. Benguela.

*Bulinus (Pyrgophysa) semiplicatus* (Morelet) = *Physa semiplicata* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 91. District of Pungo Andongo (near Mopopo and the Caranxa River) and also in the territory of Ambriz, Angola. This name is preoccupied by *Physa semiplicata* Küster (1841-43), but as Morelet's species is probably a synonym of *B. forskalii*, it seems unnecessary to rename it.

*Bulinus (Pyrgophysa) turriculatus* (Morelet) = *Physa turriculata* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 92, Pl. IX, fig. 7 Near the Lucala River, Angola.

*Bulinus (Pyrgophysa) wahlbergi* (Krauss) = *Physa wahlbergi* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 84, Pl. V, fig. 13. Limpopo River, Transvaal. This is frequently regarded as a synonym of *B. forskalii.*

### **Bulinus (Pyrgophysa) forskalii** (Ehrenberg)

Plate XI, Figures 9, 9*a*

*Isidora forskalii* EHRENBERG, 1831, 'Symbolæ Physicæ, Evertebrata, I, Mollusca,' p. [20] (type locality: Damiette, Lower Egypt).

*Isidora forskali* Ehrenberg. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 141, Pl. I, fig. 15.

*Bullinus (Pyrgophysa) forskali* Ehrenberg. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 43.

*Pyrgophysa forskhali* Ehrenberg. PALLARY, 1923, Archives Inst. Pasteur Afr. du Nord, III, p. 31.

*Pyrgophysa nyangweensis* PUTZEYS, 1898, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. vi, fig. 6.

*Physa jickelii* "Krauss" JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 199 (as a synonym of *P. forskalii*).

*Physa vitrea* "Parreyss" JICKELI, 1874, *op. cit.*, p. 199 (as a synonym of *P. forskalii*).

*Physa spiralis* FÉRUSSAC, 1827, Bull. Univ. Sc. Nat., X, p. 408 (*nomen nudum*). GERMAIN, 1921, 'Faune Malacol. Terr. Fluv. Iles Mascareignes,' p. 235, Pl. VI, figs. 6-14 (as a synonym of *P. forskalii*).

Karungo, east of the Semliki River (Stuhlmann Coll.). Lake Kisale at Kikondja (J. Bequaert Coll.). Nyangwe (Dupuis Coll.; type locality of *P. nyangweensis*).

Bambili (J. Rodhain Coll.).

The specimens are perforate, slender, with a fine keel and spaced axial laminæ on some early whorls, and agree with specimens and figures passing under this name.[1]

The largest example from Bambili measures:

Length, 12 mm.; diameter, 3.6 mm.; aperture, 4.5 mm.; 6 whorls.

[1]Ehrenberg's type was a very young shell, relatively wider, the diameter about half the length. Jickeli has figured a series showing changes of contour with age.

Specimens from Dupuis, labelled *forskalii*, and evidently what he described as *Pyrgophysa nyangweensis*, agree with those from Bambili.

Numerous forms close to *forskalii* in contour have been described, and in the series seen there appear to be several forms of at least subspecific rank in south and northeastern Africa.

## Other Species of *Pyrgophysa* Recorded from the Belgian Congo

### *Bulinus* (*Pyrgophysa*) *lamellosus* (Roth)

*Isidora lamellosa* ROTH, 1855, Malakoz. Blätter, II, p. 49, Pl. II, figs. 14 and 15 (type locality: Nile River).

*Bullinus forskali* var. *lamellosa* Roth. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, 1914, p. 44.

According to E. v. Martens (1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 141), this was based upon a young stage of *B. forskalii*. Dautzenberg and Germain (*op. cit.*) have recorded this form from Lake Kisale at Kikondja and the Lualaba River at Muyumbwe (in 9° S.) (both J. Bequaert Coll.).

### *Bulinus* (*Pyrgophysa*) *scalaris* (Dunker)

*Physa scalaris* DUNKER, 1845, Zeitschr. f. Malakoz., II, p. 164 (type locality: Benguela).

*Bulinus scalaris* DUNKER, 1853, 'Ind. Mollusc. Guin. Infer.,' p. 8, Pl. II, figs. 5-6.

*Pyrgophysa scalaris* Dunker. DAUTZENBERG, 1890, Mém. Soc. Zool. France, III, p. 131, Pl. I, figs. 12*a* and 12*b*.

*Physa* (*Pyrgophysa*) *scalaris* Dunker. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 255.

*Physa* (*Pyrgophysa*) *dunkeri* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 486, footnote (new name); 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 640.

Dunker's *Physa scalaris* did not need to be renamed since it is not preoccupied by "*Physa scalaris* Jay." That species was described as *Paludina scalaris* and is not now placed in *Physa*, but in *Planorbis*.

Lake Tanganyika: at the southern end (Foà Coll.).

### PHYSOPSIS Krauss

*Physopsis* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 85. Monotype: *Physopsis africana* Krauss.

Shell short or broadly ovate, with short and often flattened spire and elongate-ovate aperture. The columella bearing a spiral cord, obliquely or abruptly truncate below.

This genus is only known from Africa and Madagascar. The species are few and mostly ill-defined. Connolly (1925, Trans. Roy. Soc. South Africa, XII, 3, p. 190) treats *Physopsis* as a subgenus of *Isidora*, stating that H. Watson did not find sufficient ground for generic distinction in the anatomy.

*Physopsis abyssinica* (E. v. Martens) JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 210, Pl. VII, figs. 15-16 = *Physa (Physopsis) abyssinica* E. v. MARTENS, 1866, Malakoz. Blätter, XIII, p. 100. *Physopsis eximia* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 13. Southern Abyssinia.

*Physopsis africana* Krauss. See p. 144.

*Physopsis africana globosa* (Morelet). See p. 146.

*Physopsis africana* var. *ovoidea* (Bourguignat). See p. 146.

*Physopsis africana* var. *stanleyana* (Bourguignat). See p. 147.

*Physopsis choziensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 55, Pl. v, fig. 12. Chozi River, a tributary of the Chambezi River, Northeastern Rhodesia. Dupuis and Putzeys [1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 75] refer this as a variety to *P. africana* and claim to have specimens from Leopoldville.

*Physopsis didieri* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 142; 1904, Mém. Soc. Zool. France, XVII, p. 10, Pl. I, figs. 6 and 7. Dufile on the White Nile, Anglo-Egyptian Sudan. Dupuis and Putzeys [1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 75] refer this as a variety to *P. africana* and claim to have specimens rom Elisabethville and Kasongo.

In a recent paper, M. Leriche[1] refers to *Physopsis africana* var. *didieri* specimens of a fossil snail from a silicified limestone of the valley of the Kampemba, an affluent of the Lufukwe River, Katanga. The published figures (Pl. v, figs. 1 1*a-c*, and 5) appear to represent a species of *Bulinus* rather than of *Physopsis*. The alluvial deposit in which they cccur contains also remains of two species of *Lymnæa* and one species of *Planorbis*, and oögones of Characeæ (Algæ). It is found at the foot of the eastern escarpment of the Kundelungu Plateau, to the southwest of Lake Moero, and is probably of Pleistocene or possibly Upper Pliocene age.

*Physopsis exserta* (Preston) = *Physa exserta* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 56, Pl. v, fig. 9. Lake Baringo, Kenya Colony. This appears from the figure to possess a feebly truncate columella and is therefore better placed in *Physopsis*.

*Physopsis karongana* (E. A. Smith) = *Physa karongana* E. A. SMITH, 1893, Proc. Zoöl. Soc. London, p. 640, Pl. LIX, fig. 15. Karonga on Lake Nyasa. *Physopsis karongensis* DUPUIS AND PUTZEYS, 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 75, as a synonym of *P. africana globosa* (Morelet).

*Physopsis meneliki* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 25. Hauash River, Abyssinia.

*Physopsis nasuta* E. v. MARTENS, 1879, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 102; 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 144, Pl. VI, fig. 10 = *Physopsis bloyeti* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 160. Bagamoyo, Tanganyika Territory (type locality of *nasuta*); near Kondoa, Tanganyika Territory (type locality of *bloyeti*).

*Physopsis natalensis* (Küster) = *Physa natalensis* "Krauss" KÜSTER, 1841-43, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 17, Limnæiden,' p. 8, Pl. I, figs. 12-14. KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 84, Pl. v, fig. 10. *Physa natalica* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 98. *Physa zuluensis* MELVILL AND PONSONBY, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 606, Pl. XXXII, fig. 4. Umgeni River, Natal (type-locality of *natalensis*); eastern Zululand (type locality of *zuluensis*).

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[1] Leriche, M. 1925. 'Les fossiles du calcaire lacustre observé récemment sur le plateau du Kundelungu (Katanga).' Rev. Zool. Afric., XIII, pp. 150–155, Pl. v.

This South African species has generally been placed in *Bulinus*, but the specimens we have seen show an oblique truncation of the columella.

*Physopsis præclara* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 14. Kingani River near Bagamoyo, Tanganyika Territory.

*Physopsis rekwaensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 55, Pl. v, fig. 11. Lake Rikwa, Tanganyika Territory.

*Physopsis soleilleti* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 25, Pl. I, fig. 11. Lake Haussa and Hauash River, Abyssinia.

*Physopsis tanganyicæ* E. v. Martens. See p. 147.

### **Physopsis africana** Krauss

Plate XI, Figures 6, 6*a*

*Physopsis africana* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 85, Pl. v, fig. 14 (type locality: Port Natal, Natal). E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 142. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 45. DUPUIS AND PUTZEYS, 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 74, figs. 8-10.

*Physa werneana* "Troschel" JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 209 (as a synonym of *Physopsis africana*).

E. v. Martens records typical *africana* from Undussuma (Stuhlmann Coll.) and from the Nabambisso River and other brooks in the Niam-Niam Country (Schweinfurth Coll.). The last-named localities are from the region north of Faradje, from where we have seen numerous specimens of the subspecies *globosa* (Morelet), so that v. Martens' material might perhaps also have belonged to that form. Of the localities recorded by Dautzenberg and Germain for the typical form we have seen specimens of all, except those from Kibondo (between Bukama and Kikondja) and Lake Kisale at Kikondja (both J. Bequaert Coll.), and those we have examined we refer to the subspecies *globosa* (Morelet). We agree with Dupuis and Putzeys in attaching very little importance to the numerous varieties of *P. africana*.

In the typical form of this species from Natal, Pl. XI, figs. 6, 6*a*, the spire is very obtuse, rounded, though variable in degree of depression, and the individual whorls are evenly rounded. The suture is rather shallow, the whorl rising steeply to it. The outer lip makes a small angle with the whorl at its posterior insertion. The columella proper is very short, its truncation deep and relatively abrupt. It is often larger than Krauss' type—up to 17 mm. long.

We find no typical *africana* in the Congo material examined, but a form abundant at Stanleyville is intermediate between typical *africana* and the subspecies *globosa* (Morelet). We hesitate to attach a special name to it. Specimens from Stanleyville are photographed in Pl. XI, figs. 7 to 7*d*. We have seen this form from the following localities:

Stanleyville, brook near the Falls of the Congo, February, 1915 (Lang and Chapin Coll.).[1] Barumbu (J. Bequaert Coll.). Dolo, in the Stanley Pool, one young specimen (Maurice Bequaert Coll.).

The shell is almost imperforate, thin, semi-transparent olive-buff. Summit obtuse, but the first whorl less flattened than in *globosa* The last whorl descends rapidly, causing the penult to appear prominent on the left, and the suture to appear deep. The last whorl is rather swollen at the shoulder; the outer lip therefore joining the whorl *nearly at a right angle.* The point of greatest excavation of the inner lip is about mid-way of the whole right margin of the aperture (while in typical *P. africana* and *P. a. globosa* this point is far below the middle). The columella terminates obliquely and rather abruptly.

Length, 13.0 mm.; diameter, 9.0 mm.; aperture, 9.3 mm.; 4½ whorls.

The size and color vary but little. There is the usual variation in degree of descent of the last whorl, though far the greater number agree with that shown in Pl. XI, figure 7. Plate XI, figs. 7*a*, 7*b*, 7*c* show extreme forms.

Pl. XI, fig. 7*d* is an example selected to show fading out of the columellar truncation. Even in an oblique view in the aperture it is weak and strongly oblique. This character, often used in the discrimination of species in this genus, varies widely in every large lot we have seen. We conclude that its average development in a long series is probably as reliable as any of the characters of these forms, but its shape in an individual specimen has little significance.

"These tiny shells (*Physopsis africana*) are so well covered with the dirt at the bottom of small brooks or swampy places that they might be easily overlooked. They are common about Stanleyville and often are found where there is just enough moisture to keep their surroundings damp." (H. L.).

As pointed out by Blacklock and Thompson (1924, Ann. Trop. Med. Paras., XVIII, p. 227), *Physopsis* prefers water that stagnates or runs slowly on a muddy bottom, where weed or grass grows in the water, and under high or low shade. These three factors—mud, weed, and shade—appear to be essential for a favorable environment. The snail is not found in streams with a clean sandy bottom or with only a thin layer of mud over sand.

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[1]The snail figured by C. C. Chesterman (1923, Ann. Soc. Belge Méd. Trop., III, p. 75, Pl., fig. 2) from Yakusu near Stanleyville as "*Bullinus contortus*" is *Physopsis africana*, as shown by specimens kindly sent to us by the author. According to Dr. Chesterman it is in that region the probable intermediate host of what appears to be an intestinal form of *Schistosoma hæmatobium* (Compare p. 91).

**Physopsis africana globosa** (Morelet)

Plate XI, Figures 8–8*g*

*Physa globosa* MORELET, 1866, Journ. de Conchyl., XIV, p. 162 (type locality: Dande River, Angola).

*Physopsis globosa* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 93, Pl. IX, fig. 4.

*Physopsis ovoidea* E. V. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 142, Pl. VI, fig. 13 (not of Bourguignat, 1879).

*Physopsis martensi* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 65 (new name for *P. ovoidea* v. Martens).

Yakuluku; Faradje (Lang and Chapin Coll.). Lubumbashi River near Elisabethville (Stappers Coll.; Michael Bequaert Coll.). Lake Moero at Kilwa and Lukonzolwa; Luvua River; Bulongo near Bukama; Lesse; Bukama (J. Bequaert Coll.). Watsa; Moto (L. Burgeon Coll.).

Larger, more elongate than typical *P. africana; summit very obtuse* (but very exceptionally individuals with an exserted spire occur, as shown in Pl. XI, fig. 8, 8*f*). The penult whorl is either regularly rounded or somewhat flattened on both sides of a more strongly curved median zone. The outer lip at its insertion makes a *much larger angle* with the whorl than in *africana*, but this angle varies somewhat. The highly polished surface often shows traces of minute axial wrinkles cut by spiral impressions. The columella is generally rather abruptly truncate, but in other examples in the same lots, rather weakly and more obliquely terminated. Specimens from Lubumbashi measure:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length, | 20.0 mm.; | diameter, | 13.5 mm.; | aperture, | 15.0 mm.; | 4¾ whorls. |
| " | 18.0 | " | 13.0 | " | 13.3 | 4½ " |
| " | 18.5 | " | 12.0 | " | 12.0 | Spire abnormally elevated. |
| " | 15.3 | " | 10.0 | " | 11.2 | |

The series figured is from the Lubumbashi River near Elisabethville.

## Other Species of *Physopsis* Recorded from the Belgian Congo

### *Physopsis africana* var. *ovoidea* (Bourguignat)

*Physopsis ovoidea* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 16 (type locality: Kingani River at Bagamoyo, Tanganyika Territory). GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 503, Pl. V, fig. 4.

*Physopsis leroyi* GRANDIDIER, 1887, Bull. Soc. Malacol. France, IV, p. 189 (type locality: Usagara, Tanganyika Territory).

*Physopsis africana* var. *ovoidea* Bourguignat. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 46.

Dautzenberg and Germain have recorded this form from Shinsenda and the Luvua River (J. Bequaert Coll.). The Luvua River specimens we have referred to

*P. africana globosa* (Morelet) and it is probable that those from Shinsenda belonged to the same subspecies.

### *Physopsis africana* var. *stanleyana* (Bourguignat)

*Physopsis stanleyana* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 14 (type locality: Kingani River near Bagamoyo, Tanganyika Territory).

*Physopsis stanleyi* Bourguignat. A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Mém. Soc. Zool. France, XVII, p. 10.

*Physopsis africana* var. *stanleyi* Bourguignat. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 47.

Dautzenberg and Germain have recorded this form from Stanleyville, Kindu, and Lake Moero at Lukonzolwa (J. Bequaert Coll.). The specimens from Stanleyville we have examined and find that they agree with what is treated above as *P. africana* var.; those from Lukonzolwa are *P. a. globosa* (Morelet).

### *Physopsis tanganyicæ* E. v. Martens

*Physopsis tanganyicæ* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 144, Pl. VI, fig. 12. E. A. SMITH, Proc. Malacol. Soc. London, VI, 2, p. 99. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 249.

Lake Tanganyika: originally described from the lake without more definite locality (Reichard Coll.).

## Physidæ

Shell sinistral, ovate or oblong, usually glossy, similar to *Bulinus*.

Animal without a pseudobranch; the foot tapering to a point behind; tentacles long and slender. Radula having rastriform teeth in V-shaped rows, the side teeth all alike.

### PHYSA Draparnaud

*Physa* DRAPARNAUD, 1801, Tableau, pp. 31, 32.

True *Physæ* exist in northwestern Africa and also in Lower Egypt. According to Pallary (1909, Mém. Inst. Egyptien, VI, 1, p. 54), Bourguignat's *Physopsis letourneuxi* (1879, 'Descript. Moll. Egypte,' p. 16) and *Physopsis lhotellerii* (1879, *op. cit.*, p. 17) were based on young specimens of *Physa acuta* Draparnaud and *Physa subopaca* Lamarck respectively.[1] Pallary (1903, Bull. Inst. Egyptien, (4) III, (1902), p. 89, Pl. II, fig. 1) has also described a *Physa subopaca* var. *nilotica* from Gebelein, White Nile.

*Physa (Aplecta) waterloti* GERMAIN, 1911, Bull. Mus. Hist. Nat. Paris, p. 322, fig. 57 (on p. 323), of Porto-Novo, Dahomey, has much the shell-characters of true European *Physæ*. Its soft parts and radula are unknown, any surmises as to its relationships would be unwarranted.

*Physa mosambiquensis* CLESSIN, 1886, in Martini and Chemitz, 'Syst. Conch.

[1]According to P. Manson-Bahr and N. H. Fairley (1920, Parasitology, XII, p. 49), *Physa subopaca* is common in the Canal Zone, Lower Egypt.

Cab.,.I, 17, Limnæiden,' p. 366, Pl. LIV, fig. 1. Mozambique. Connolly, 1925, Trans. Roy. Soc. South Africa, XII, 3, p. 189, fig. 23. Lorenzo Marques.

Connolly states that Thiele has confirmed the generic reference by examination of the radula. He mentions also that he possesses another *Physa* from Lake Naivasha

## Ancylidæ

*Basommatophora in which the shell is simply conic, patelliform, or with the* apex recurved, capuliform or crepiduliform; rarely planorboid.

The mantle cavity is broadly open below, a well developed gill (pseudobranch) hanging from its deepest part. The jaw is composed of numerous narrow plates arranged in a semicircle. Radula with 1-to asymmetrically 4-cuspid centrals, laterals with 2, 3 or sometimes more cusps.

Fresh-water limpets are found abundantly in Africa wherever search has been made for small aquatic shells. Though Pulmonata, it is doubtful whether they ever breathe free air. Species living on submerged stones and shells certainly breathe water exclusively. Those living on plants near the top have often been observed to crawl to or above the surface of the water. Different species are found in these ecologically diverse stations.

While a number of species of Ancylidæ had been described from Africa, the first comprehensive work on the group was that of Bryant Walker, who has published[1] several papers on the species of south and of northern Africa, and who has recently issued an illustrated monograph of the South African species.[2] Dr. Bryant Walker has kindly examined several of the species described herein. Our definitions of subfamilies and in part of genera were kindly supplied by him.

The European genus *Pseudancylus* occurs in northern Africa, south to Abyssinia. The nearly world-wide *Ferrissia* and *Gundlachia* are found from the north to Cape Colony, while *Burnupia* is an exclusively African genus, ranging from the Cape to the equatorial region. It appears to be related to South American forms.[3]

The generic nomenclature of Ancylidæ has been somewhat fully discussed by Walker, but so far as we know, genotypes have not been designated for two names introduced by Westerlund:

"*Helicon* Montf. 1810, " WESTERLUND, 1885, 'Fauna Paläarct. Binnenconch.,' V, p. 88, as a synonym of *Ancylus*.

"*Calytra* Klein, 1763," WESTERLUND, 1885, *loc. cit.*, as a synonym of *Ancylus*."

"*Helicon*" may be supposed to be an error for *Helcion* Denys de Montfort, a genus of Patellidæ. If, however, it is considered a new name

[1] 1914, The Nautilus, XXVII, pp. 113–117 and 124–131.

[2] B. Walker. 1924. 'The Ancylidæ of South Africa.' Privately printed. 82 pp., 2 Pls. Although the cover bears the date 1923, the paper was not distributed until the early part of 1924.

[3] Pilsbry, 1920, Proc. Ac. Nat. Sci. Philadelphia, (1920), p. 8.

dating from Westerlund, it may take as type *A. lacustris* (Linnæus), since this is the type of *Ancylus*,[1] of which genus Westerlund considered "*Helicon*" to be a synonym.

"*Calytra*" was likely an error for *Calyptra* Klein, 1753 ('Tentamen Methodi Ostracologicæ,' II, p. 118). Klein's work was prior to the foundation of the binominal system of nomenclature (1758). It may be disregarded in the selection of a type for the new name *Calytra* Westerlund. As the latter was introduced as a synonym of *Ancylus, A. lacustris* (Linnæus) is to be taken as the type.

Both of these names will thus become synonyms of *Ancylus* O. F. Müller, having the same genotype.

### **Ferrissiinæ** Walker

Shell patelliform, the apex more or less turned to the right, and finely radially striate, punctate or smooth.

Radula with a bicuspid central, the base more or less wider below; laterals and marginals obliquely reflected above, with from three to five cusps owing to the splitting up of the mesocone and ectocone, which do not usually extend below the basal.

### **Ferrissia** Walker

*Ferrissia* Walker, 1903, The Nautilus, XVII, p. 15, as a section of *Ancylus*. Type by original designation: *Ancylus rivularis* Say.

Apex minutely radially striate, the rest of the shell smooth or radially striate; the aperture not contracted by a partition or deck at any stage.

Bryant Walker gives the distribution as "world-wide, but lacking in Europe and apparently in Siberia, Syria, and the south shore of the Mediterranean (excepting in the Nile Valley, and a single, possibly adventitious species in Algeria), Madeira and the Canary Islands; apparently also wanting in Mexico, Central and South America."

The following species of *Ferrissia* are known from the Ethiopian Region.

*Ferrissia burnupi* B. Walker, 1924, 'Ancylidæ of South Africa,' p. 67, fig. 28 (on p. 69); Pl. II, fig. 23 = *Ancylus* (*Ferrissia*) *burnupi* B. Walker, 1912, The Nautilus, XXV, p. 142. Equeefa River, Natal. Elsewhere in Natal and Transvaal.

*Ferrissia cawstoni* B. Walker, 1924, 'Ancylidæ of South Africa,' p. 70, Pl. II, figs. 25-26. Mooi River, Potchefstroom, Transvaal. Elsewhere in Transvaal. This species was mentioned as *Ancylus cawstoni* "Burnup" by Cawston (1918, Parasitology, XI, p. 94).

*Ferrissia chudeaui* Germain, 1917, Bull. Mus. Hist. Nat. Paris, p. 526, figs. 12-14 (on p. 526) and 15-17 (on p. 527). Bakoy River at Tukoto, Senegambia.

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[1] *Patella lacustris* Linnæus was designated as the type of *Ancylus* Müller by Children, 1823, 'Lamarck's Genera of Shells,' p. 95.

*Ferrissia connollyi* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 69, Pl. II, fig. 24 = *Ancylus* (*Ferrissia*) *connollyi* B. WALKER, 1912, The Nautilus, XXV, p. 143. Black River, Maitland, Cape Colony. Elsewhere in Cape Colony and Natal.

*Ferrissia fontinalis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 73, Pl. II, fig. 27 = *Ancylus* (*Ferrissia*) *fontinalis* B. WALKER, 1912, The Nautilus, XXV, p. 144. Ranjesfontein, Pretoria District, Transvaal. Elsewhere in Transvaal, Orange Free State, and Natal.

*Ferrissia junodi* CONNOLLY, 1925, Trans. Roy. Soc. South Africa, XII, 3, p. 200, fig. 26 Nwambukoto Pool near Rikatla, Portuguese East Africa.

*Ferrissia lacustris* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 71, Pl. I, fig. 20. Lake Chrissie, Transvaal.

*Ferrissia natalensis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 74, Pl. I, fig. 21. South Coast Junction, Natal. Eleswhere in Natal.

*Ferrissia victoriensis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 75, Pl. II, fig. 28 = *Ancylus* (*Ferrissia*) *victoriensis* B. WALKER, 1912, The Nautilus, XXV, p. 144. Victoria Falls, Zambezi River, Rhodesia.

*Ferrissia zambesiensis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 75, Pl. II, fig. 29 = *Ancylus* (*Ferrissia*) *zambesiensis* B. WALKER, 1912, The Nautilus, XXV, p. 144. Victoria Falls, Zambezi River, Rhodesia.

According to B. Walker (1914, The Nautilus, XXVII, p. 116) the species recorded by Blanford (1870, 'Observations on the Geology and Zoology of Abyssinia,' p. 472) from a small stream near Mai Wahiz, Tigre, Abyssinia, as "*Ancylus verruca* Benson," is also a *Ferrissia*. Its specific identity, however, is uncertain.

### KINCAIDILLA Hannibal

*Kincaidilla* HANNIBAL, 1912, Proc. Malacol. Soc. London, X, p. 148. Type by original designation: *Ancylus fragilis* Tryon.

Shell patelliform, similar to *Ferrissia* except that at a resting stage a septum is formed over the posterior part of the aperture. The shell sometimes attains full size without forming the septum.

Three African species formerly referred to *Gundlachia* are now known to belong to this genus.

*Kincaidilla equeefensis* (Walker) = *Gundlachia equeefensis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 79, fig. 29; Pl. II, fig. 33 = *Ancylus* (*Ferrissia*) *equeefensis* B. WALKER, 1912, The Nautilus, XXV, p. 143. Equeefa River, Natal.

*Kincaidilla farguhari* (Walker) = *Gundlachia farquhari* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 78, Pl. II, figs. 30–32 = *Gundlachia* sp. B. WALKER, 1914, The Nautilus, XXVII, p. 129, footnote. Brack Kloof River near Grahamstown, Cape Colony.

*Kincaidilla l'hotelleriei* (Walker) = *Gundlachia l'hotelleriei* "Bourguignat" B. WALKER, 1914, The Nautilus, XXVII, p. 128, Pl. VII, figs. 15–21. Alexandria, Egypt.

### BURNUPIA Walker

*Burnupia* B. WALKER, 1912, The Nautilus, XXV, p. 139; as a section of *Ancylus*. Type by original designation: *Ancylus caffer* Krauss.

Shell with radially punctate apex; more or less elevated, patelliform or approaching the capuliform shape of *Pseudancylus*.

"Radula with a bicuspid central tooth, the base wider below; laterals with three major cusps, the endocone and mesocone more or less united, and frequently entirely concrescent; additional small cusps are frequently developed on either side of the ectocone; the laterals gradually pass into the marginals by a progressive splitting up of the cusps, until in the perfect marginals the cusps are all substantially of the same size and practically the same as those of *Ferrissia*" (Walker).

Distribution: South Africa, north to British East Africa and the eastern Congo drainage.

The following Ethiopian species have been described:

*Burnupia alta* Pilsbry and Bequaert. See p. 153.

*Burnupia brunnea* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 38, fig. 21; Pl. I, fig. 4. Zoutpansberg, Transvaal. Elsewhere in Transvaal and Natal.

*Burnupia caffer* (Krauss). See p. 152.

*Burnupia capensis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 43, Pl. I, fig. 7 = *Ancylus* (*Burnupia*) *caffer* var. *capensis* B. WALKER, 1912, The Nautilus, XXV, p. 141. Lakeside, Cape Peninsula, Cape Colony. Elsewhere in Cape Colony.

*Burnupia capensis* var. *natalensis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 45, fig. 23 (on p. 46); Pl. I, fig. 8. Umhlatuzani River, Malvern, Natal. Elsewhere in Natal.

*Burnupia crassistriata* (Preston) = *Ancylus crassistriatus* PRESTON, 1911, Ann. Mag. Nat. Hist., (8) VII, p. 475, Pl. XII, fig. 35. Between Rumruti and Mt. Kenia, Kenia Colony.

*Burnupia edwardiana* Pilsbry and Bequaert. See p. 154.

*Burnupia farquhari* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 41, fig. 22 (on p. 42); Pl. I, fig. 6 = *Ancylus* (*Burnupia*) *caffer* var. *farquhari* B. WALKER, 1912, The Nautilus, XXV, p. 140. York, East Griqualand. Elsewhere in Cape Colony.

*Burnupia gordonensis* (Melvill and Ponsonby) B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 34, fig. 20 (on p. 36); Pl. I, fig. 3 = *Ancylus* (*Ferrissia*) *gordonensis* MELVILL AND PONSONBY, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 606, Pl. XXXI, fig. 2. Gordon Falls, Natal. Elsewhere in Natal and Cape Colony.

*Burnupia kempi* (Preston) = *Ancylus kempi* PRESTON, 1912, Proc. Zoöl. Soc. London, II, p. 190, Pl. XXXI, fig. 2 and 2*a*. Kigezi, southwestern Uganda, 5,000 ft.

*Burnupia kimiloloensis* Pilsbry and Bequaert. See p. 153.

*Burnupia mooiensis* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 47, fig. 24; Pl. I, fig. 9 = *Ancylus* (*Burnupia*) *mooiensis* B. WALKER, 1912, The Nautilus, XXV, p. 141. Mooi River, Potchefstroom, Transvaal.

*Burnupia mooiensis* var. *dubiosa* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 49, Pl. I, fig. 10 = *Ancylus* (*Burnupia*) *mooiensis* var. *dubiosus* B. WALKER, 1912, The Nautilus, XXV, p. 142. Pienaars Poort near Pretoria, Transvaal. Elsewhere in Transvaal.

*Burnupia nana* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 39, Pl. I, fig. 5 = *Ancylus* (*Burnupia*) *caffer* var. *nanus* B. WALKER, 1912, The Nautilus, XXV, p. 139. Karkloof Stream, Natal. Elsewhere in Natal and Transvaal.

*Burnupia obliqua* (Küster) = *Ancylus obliquus* "Krauss" KÜSTER, 1853, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 6, Ancylinen,' Pl. I, figs. 18-20 (without description); CLESSIN, 1882, *op. cit.*, p. 36 (as a synonym of *A. caffer*). No locality mentioned; not *A. obliquus* Broderip and Sowerby, 1832. B. Walker lists this as a dubious synonym of *Burnupia stenochorias* (Melvill and Ponsonby).

*Burnupia ponsonbyi* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 51, Pl. I, fig. 12. Umgeni River, Natal. Elsewhere in Natal.

*Burnupia ponsonbyi* var. *diminutiva* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 53, Pl. I, fig. 13. Vaal River, Christiana, Transvaal.

*Burnupia stenochorias* (Melvill and Ponsonby) B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 53, fig. 25 (on p. 55); Pl. I, figs. 14 and 15 = *Ancylus* (*Ferrissia*) *stenochorias* MELVILL AND PONSONBY, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 607, Pl. XXXI, fig. 1. Ebb en Vloed, Port Elizabeth, Cape Colony. Elsewhere in Cape Colony and Natal.

*Burnupia stuhlmanni* (E. v. Martens) = *Ancylus stuhlmanni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 151, Pl. I, figs. 19 and 19*b*. Busisi, Lake Victoria. It is said to be in large part flat, but with a steeply raised, blunt apex; concentrically striate; the apex with radial rows of impressed punctures.[1] Length, 2.3 mm.; width, fully two-thirds of the length; height, two-fifths of the length. Dautzenberg and Germain (1914, Rev. Zool. Afric., IV, 1, p. 47) have recorded this species from the Lualaba River at Kalengwe and Lake Moero at Lukonzolwa (both J. Bequaert Coll.). The specimens from Kalengwe, which we have seen, are in our opinion not *stuhlmanni* and we describe them below as *Burnupia walkeri*. We have not seen specimens from Lake Moero.

*Burnupia transvaalensis* Craven. See p. 154.

*Burnupia transvaalensis* var. *apicata* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 64, fig. 26; Pl. I, fig. 19. Vaal River, Boshof, Orange Free State. Elsewhere in Transvaal and Cape Colony.

*Burnupia trapezoidea* (O. Bœttger). See p. 155.

*Burnupia verreauxii* (Bourguignat) B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 50, Pl. I, fig. 11 = *Ancylus* (*Ancylastrum*) *verreauxii* BOURGUIGNAT, 1853, Rev. Mag. Zool., (2) V, p. 351; 1854, *op. cit.*, (2) VI, Pl. I, figs. 1-8. Cape of Good Hope. Elsewhere in Cape Colony and Transvaal.

*Burnupia vulcanus* B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 66, Pl. II, fig. 22. Mooi River, Potchefstroom, Transvaal.

*Burnupia walkeri* Pilsbry and Bequaert. See p. 154.

### **Burnupia caffer** (Krauss)

Plate XII, Figures 3 and 3*a*

*Ancylus caffer* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 70, Pl. IV, fig. 13 (type locality: Pietermaritzburg, Natal). BOURGUIGNAT, 1862, 'Spicilège Malacol.,' p. 193. CLESSIN, 1882, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 6, Ancylinen,' p. 36, Pl. IV, fig. 11.

*Ancylus caffra* Krauss. SOWERBY, 1872, 'Conchol. Iconica,' XX, *Ancylus*, Pl. I, fig. 5.

*Ancylus gaulus* GOULD, 1859, Proc. Boston Soc. Nat. Hist., VII, p. 40 (type locality: Cape of Good Hope); 1862, 'Otia Conchol.,' p. 106.

[1]According to J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 209, who examined the type.

*Ancylus* (*Burnupia*) *caffer* Krauss. B. Walker, 1912, The Nautilus, XXV, p. 139. Connolly, 1912, Ann. South African Mus., XI, p. 239.

*Burnupia caffra* Krauss. B. Walker, 1924, 'Ancylidæ of South Africa,' p. 31, figs. 7 (on p. 16), 18 (on p. 30), and 19 (on p. 33); Pl. i, figs. 1 and 2.

Lubumbashi River, on dead *Etheria* shells; Panda River, an affluent of the Lufira, at Likasi (both Michael Bequaert Coll.).

The elevated shell has the somewhat hooked apex at the posterior fourth, and, viewed from above, much nearer to the right margin than to the median line. Anterior and left slopes are quite convex. The apex is dented near the top, and marked with radial series of punctures; the rest of the shell has fine, close, radial striæ.

| | | | |
|---|---|---|---|
| Length, 4.8 mm.; | width, 3.2 mm.; | height, 2.0 mm. | Panda River. |
| " 5.3 | " 4.0 | " 2.3 | Lubumbashi River. |

The specimens have been compared with South African material, and the identification of those from the Panda River has been confirmed by Bryant Walker.

### **Burnupia kimiloloensis**, new species

Plate XII, Figures 2 and 2*a*

Kimilolo River near Elisabethville (Michael Bequaert Coll.).

The shell is regularly elliptical, rather strongly elevated, moderately solid, pale cinnamon buff. The apex is at the posterior fourth of the length and left fourth of the width, and is somewhat recurved, blunt, with a distinct apical pit and radial series of punctures. The later growth is finely but very distinctly striate radially, the striæ slightly rippled. The anterior slope is very strongly convex, posterior slope concave above, then straight. The right slope is nearly straight, the left somewhat convex.

Length 6.4 mm.; width, 4.5 mm.; height, 2.4 mm.

This is more strongly sculptured than other species of the region we have examined, but is similar in this character to the specimens of *B. stenochorias* which we have seen. It differs from the large form of *B. stenochorias* by the blunter summit, which in a dorsal view is decidedly farther from the left margin of the shell. *B. caffer* has a much more recurved apex than the present species.

### **Burnupia alta**, new species

Plate XII, Figures 5 and 5*a*

Kisanga River near Elisabethville (Michael Bequaert Coll.).

The shell is thin, oval, the left outline a little more convex than the right, anterior end broadly rounded, posterior a little more narrowly so. The summit is blunt, with the apical pit conspicuous, having radially punctate sculpture, situated well towards the left side and slightly behind the posterior fourth of the length. The posterior slope is strongly concave, the anterior convex; right slope straight and steep, the left convex. Sculpture of weak but distinct radial striæ.

Length, 3.5 mm.; width, 2.45 mm.; height, 1.5 mm. Type.
" 4.6 " 2.1 Paratype.

Smaller and relatively higher than the related *B. caffer*.

**Burnupia transvaalensis** (Craven)

Plate XII, Figures 1 and 1*a*

*Ancylus transvaalensis* CRAVEN, 1880, Proc. Zoöl. Soc. London, p. 617, Pl. LVII, fig. 11 (type locality: Mooi River Transvaal).

*Ancylus* (*Burnupia*) *transvaalensis* Craven. B. WALKER, 1912, The Nautilus, XXV, p. 142.

*Burnupia transvaalensis* Craven. B. WALKER, 1924, 'Ancylidæ of South Africa,' p. 62, Pl. I, fig. 18.

Lubumbashi River, on dead *Etheria* shells; Panda River at Likasi (both Michael Bequaert Coll.).

The apex is less recurved and the radial sculpture weaker than in *B. caffer*, with which the specimens were found associated. The figured specimen from the Panda River measures:

Length, 5.8 mm.; width, 4.0 mm.; height, 2.25 mm.

**Burnupia edwardiana**, new species

Plate XII, Figures 4 and 4*a*

Kabare, Lake Edward (J. Bequaert Coll.).

The shell is thin, small, oval, the left outline more convex than the right, the apex glossy, blunt, a little in front of the posterior fourth of the length, having a well-impressed apical pit; weakly radially punctate; the rest of the shell dull, finely and delicately striate radially, brownish. The anterior and left slopes are convex, posterior slope concave, right slope concave near the summit, then straight.

Length, 3.15 mm.; width, 2.2 mm.; height, 1.25 mm.

This form differs from any described African species, according to Bryant Walker.

**Burnupia walkeri**, new species

Plate XII, Figures 7 and 7*a*

*Ancylus stuhlmanni* "E. v. Martens" DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 47 (in part; specimens from Kalengwe).

Kalengwe, in the Lualaba River (type locality; J. Bequaert Coll.).

The shell is thin, elliptical, the sides equally curved, greatest width at about the anterior third. The anterior slope is convex, the posterior concave; both lateral slopes straight. The summit is obtuse, distinctly flattened; apex with the usual *Burnupia* punctation but no apical pit, situated at the posterior third and much nearer the median line than the right side. Sculpture of fine radial striæ.

Length, 2.4 mm.; width, 1.75 mm.; height, 0.9 mm.

The symmetrical basal outline and the position and form of the apex distinguish this species, which has been examined by Bryant Walker and pronounced distinct. It is named in his honor.

### Other Species of *Burnupia* Recorded from the Belgian Congo

### *Burnupia trapezoidea* (O. Bœttger)

*Ancylus trapezoideus* O. Bœttger, 1907, in Schulze, 'Aus Namaland und Kalahari,' p. 708 (without description); 1910, Abh. Senckenberg. Naturf. Ges., XXXII, p. 450, Pl. xxviii, figs. 15*a*-*b* (type locality: subfossil at Witkop, British Bechuanaland).

*Ancylus* (*Burnupia*) *trapezoideus* O. Bœttger. B. Walker, 1912, The Nautilus, XXV, p. 141. Connolly, 1912, Ann. South African Mus., XI, p. 240.

*Ancylus caffer* "Krauss" E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 151, Pl. i, figs. 19*a*-*d*.

*Burnupia trapezoidea* (O. Bœttger) B. Walker, 1924, 'Ancylidæ of South Africa,' p. 57, Pl. i, figs. 16 and 17.

B. Walker refers to this South African species the specimens from Undussuma in the Tararo brook (Stuhlmann Coll.) which E. v. Martens recorded as *A. caffer*, but he does not appear to have seen them.

### **Pseudancylinæ** Walker

Shell capuliform; apex posterior, slightly turned to the right, surface coarsely, radiately striate.

Animal sinistral. Radula having the teeth arranged in horizontal rows, with a narrow, unicuspid central tooth, the base slightly wider and rounded below; the laterals and marginals with long, narrow bases in close juxtaposition; endocones lacking; the laterals with a long unicuspid mesocone and a small ectocone; the laterals gradually pass into the marginals, the cusp of the mesocone diminishing in size toward the margin, and two cusps are developed representing the ectocone on the marginals. The jaw is described by Moquin-Tandon and Lehmann as composed of a central fixed portion and two movable side parts, but Gwatkin states that the jaw is "segmented in plates like that of *Punctum pygmæum*."

### **Pseudancylus** Walker

*Ancylus* of authors generally, but not of O. F. Müller as limited by Children's type selection.

*Pseudancylus* B. Walker, 1921, The Nautilus, XXXV, p. 58. Type by original designation: *Ancylus fluviatilis* O. F. Müller.

Shell without spiral apical whorls; other characters those of the subfamily.

The following two Abyssinian species apparently are true *Pseudancylus:*

*Pseudancylus abyssinicus* (Jickeli) = *Ancylus* (*Ancylastrum*) *abyssinicus* Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 223, Pl. iii, figs. 5-6, and Pl. vii, figs. 27-28. From various localities in Eritrea: on the road between Ghinda and Asmara; near Mekerka on the Toquor River; affluents of the Anseba River; Zazega.

*Pseudancylus hamacenicus* (Bourguignat) = *Ancylus hamacenicus* Bourguignat, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 84. *Ancylus* (*Ancylastrum*) *compressus* Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 223, Pl. vii, fig. 26 (not *Ancylus compressus* Nyst, 1843). Near Mekerka on the Toquor River, Eritrea.

## Unclassified Ancylidæ

### "*Ancylus*" *ruandensis* J. Thiele

*Ancylus ruandensis* J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 208, Pl. v, figs. 48 and 48*a*.

Lake Luhondo in Ruanda (type locality; Schubotz Coll.).

### "*Ancylus*" *vicinus* J. Thiele

*Ancylus vicinus* T. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 208, Pl. v, fig. 49.

Falls between Lakes Bolero and Luhondo, in Ruanda (type locality; Schubotz Coll.).

### **"Ancylus" tanganyicensis** (E. A. Smith)

Plate XII, Figures 6 and 6*a*

*Ancylus tanganyicensis* E. A. Smith, 1906, Proc. Zoöl. Soc. London, I, p. 184, Pl x, figs. 17 and 18. B. Walker, 1924, 'Ancylidæ of South Africa,' p. 80 (note on dentition).

*Ferrissia tanganyicensis* E. A. Smith. B. Walker, 1914, The Nautilus, XXVII, p. 116.

Lake Tanganyika: Niamkolo, at the southern end of the Lake (type locality; W. A. Cunnington Coll.).

Kasakaku Bay, Lake Tanganyika (Stappers Coll.).

A small, regularly elliptical species with nearly central apex, which shows no trace of apical pit. It has a rather indistinct sculpture of radial striæ crossed by concentric striæ, giving a somewhat cancellated appearance. The anterior slope is nearly straight, the posterior slightly concave near the summit, which is quite obtuse; side slopes straight. Sculpture of very fine, irregular but distinct radial striæ.

Length, 2.0 mm.; width, 1.55 mm.; altitude, 0.7 mm.

The apical sculpture differs from that of *Ferrissia* by the presence of concentric striæ; the radials are rather coarse and low. In some lights a cancellation reminiscent of *Burnupia* is seen. Walker states that the radula is very similar to that of *Gundlachia equeefensis,* and he believes that it belongs to that genus.

## **Scutibranchiata Rhipidoglossa**

### **Neritidæ**

Shell imperforate, globose or hemispherical, with short spire, or non-spiral somewhat limpet-like with marginal apex. Internal partitions of the shell resorbed. Aperture semi-ovate, entire, with acute outer lip; columellar region expanded, flat.

tened, usually thickened and frequently toothed at the aperture. Operculum calcareous, paucispiral with excentric nucleus; its inner edge as a rule with projecting processes (apophyses) articulating with the columella.

Animal living in fresh, brackish, or salt water. Head large; rostrum divided and lobed in front. Tentacles long and slender; the eyes sessile or pedunculate, placed at the external bases of the tentacles. Foot short and broad, truncate before and obtuse behind, the sides simple. Respiration branchial; the gill large, triangular, pointed, free at its extremity. Branchial and excretory orifices on the right side. No external male organ. Radula of the rhipidoglossate type: a single small central which is sometimes absent; normally 5 laterals of which the inner ones are sometimes vestigial and the two outer ones are frequently fused into a capituliform or umbrella-shaped plate; numerous marginals (uncini) which are narrow, ligulate.

Of the three subfamilies into which H. Burrington Baker[1] has recently divided this family, the Smaragdinæ are not known to occur in Africa.

### Neritinæ

Eyes pedunculate. Radula: unpaired central present; inner lateral large, transverse, not inclined more than 45 degrees; the two middle laterals vestigial; the two outer laterals united into a capituliform complex which bears on its inner side a well-marked, Y-shaped thickening; the marginals with elongate blades. Operculum in most cases with marginal projections and a curved rib and a peg on the inner side.

This subfamily is represented in the Ethiopian Region by the genera *Neritina* Lamarck, *Theodoxus* Denys de Montfort, and *Nerita* Linnæus. *Nerita* is truly marine and easily distinguished by its heavy, calcareous shell, without epidermis. One species, *Nerita senegalensis* Gmelin, is found on the coast of the Atlantic near the mouth of the Congo (San Antonio, Banana, Moanda).

### NERITINA Lamarck

*Neritina* LAMARCK, 1816, 'Encyclop. Méthod., Vers,' II, Pl. CCCCLV; 1822, 'Hist. Nat. Anim. sans Vertèbres,' VI, 2, p. 182. Type by designation of Children (1823): *Nerita pulligera* Linnæus.

*Laphrostoma* RAFINESQUE, 1815, 'Analyse de la Nature,' p. 144.[2]

*Clypeolum* RÉCLUZ, 1850, Journ. de Conchyl., I, p. 144. Type by designation of H. B. Baker (1923): *Nerita pulligera* Linnæus. Not *Clypeolum* Récluz, 1842.

Shell solid, hemispherical or subglobose, with short spire. Columella flattened and straight, smooth or finely denticulate. Lip acute, smooth within. Operculum semi-circular, large enough to close the aperture completely, with well-developed apophyses on its inner surface; usually both an inwardly projecting peg and a subspiral or arched rib.

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[1]H. Burrington Baker, 1923. 'Notes on the radula of the Neritidæ.' Proc. Ac. Nat. Sci. Philadelphia, LXXV, pp. 117–178, Pls. IX–XVI.

[2]*Laphrostoma* was based upon "*Neritina* Lamarck," which was not introduced into binomial nomenclature until 1816, though Lamarck had used the vernacular "Néritine" without mentioning a species in 1809 ('Philosoph. Zoolog.,' I, p. 321) and 1812 ('Extrait du Cours de Zoologie,' p. 117). As Rafinesque referred to a genus which had not been named at the time, his substitute may well be considered a *nomen nudum*.

This genus is estuarine and fluviatile and found throughout the tropics of the world.

Baker's recent arrangement of the *Neritinæ* into subgenera and sections is almost entirely based upon characters taken from the radula. Since only a few of the African species have been examined in this respect, it is not possible to arrange them all according to Baker's system. The following is a list of the species which have been reported from the Ethiopian Region.

*Neritina adansoniana* (Récluz). See p. 161.

*Neritina arctilineata* "Récluz" SOWERBY, 1849, 'Thesaurus Conchol.,' II, p. 531, Pl. CXVI, figs. 223 and 224 = *Neritina africana* "Parreyss" REEVE, 1856, 'Conchol. Iconica,' IX, *Neritina*, Pl. XXX, figs. 138*a-b*. *Neritina nilotica* REEVE, 1856, *op. cit.*, Pl. XXXIV, fig. 157. *Neritina dongolensis* "Ehrenberg" E. v. MARTENS, 1865, Malakoz. Blätter, XII, p. 206 (as a synonym of *N. africana*). Nile River (originally described from an unknown locality).

*Neritina atra* GRAY, 1831, 'Zoolog. Miscellany,' p. 11. Fernando Po.

*Neritina crepidularia* LAMARCK, 1822, 'Hist. Nat. Anim. sans Vertèbres,' VI, 2, p. 186. This is an East Indian species which has been recorded by Krauss (1848, 'Südafrik. Mollusk.,' p. 88) from Natal; but its occurrence there is doubtful.

*Neritina cristata* MORELET, 1864, Journ. de Conchyl., XII, p. 288. Como River, Gaboon. Appears to be very close to *N. oweniana* (Wood).

*Neritina fraseri* REEVE, 1855, 'Conchol. Iconica,' IX, *Neritina*, Pl. XXV, figs. 113*a-b*. West Africa. Closely related to *N. afra* Sowerby.

*Neritina glabrata* Sowerby. See p. 159.

*Neritina knorri* (Récluz) SOWERBY, 1849, 'Thesaurus Conchol.,' II, p. 511, Pl. CXI, fig. 78 and Pl. CXIII, fig. 150 = *Nerita knorri* RÉCLUZ, 1841, Rev. Zoolog. Soc. Cuviér., p. 274. *Neritina beckii* Sowerby, 1849, 'Thesaurus Conchol.,' II, p. 512, Pl. CIX, fig. 13 (not of Récluz). *Neritina* (*Neritæa*) *cryptospira* E. v. MARTENS, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab., II, 10, *Neritina*,' p. 61, Pl. VIII, figs. 10-12. Originally described from Madagascar; this species is also known from the East Indies, Zanzibar, and Lourenzo Marques.

*Neritina natalensis* REEVE, 1855, 'Conchol. Iconica,' IX, *Neritina*, Pl. XVI, figs. 75*a-b* = *Neritina zebra* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 88 (not of Lamarck). Coast of Natal and as far north as the Pangani River.

*Neritina oweniana* (Wood). See p. 162.

*Neritina rubricata* MORELET, 1858, 'Séries Conchyl.,' I, p. 30, Pl. III, fig. 2 = *Neritina gouldi* E. v. MARTENS, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab., II, 10, *Neritina*,' p. 81, and *Neritina calabarica* "Mousson" E. v. MARTENS, 1879, *op. cit.*, p. 81 (as synonyms of *N. rubricata*). Senegambia and Assinie.

*Neritina souverbiana* MONTROUZIER, 1863, Journ. de Conchyl., XI, pp. 75 and 175, Pl. V, fig. 5 = *Neritina* (*Vitta*) *pulcherrima* ANGAS, 1871, Proc. Zool. Soc. London, pp. 19 and 96, Pl. I, fig. 25. This species of New Caledonia and the coast of Australia has been found on the coast of Natal.

Three species of *Neritina* occur at the mouth and in the estuary of the Congo River. They may be separated by shell characters as follows:

1. Columella toothless. Shell strongly compressed dorsoventrally, the lip more or less expanding and winged above and below in the fully developed form. Length 13 to 28 mm........................*Neritina oweniana* (Wood).
   Columella having an inwardly directed tooth above the middle, visible in an oblique view in the mouth. Shell small, subglobose....................2.
2. Spire extremely low; about 1½ whorls visible. Suture in form of a semicircle ending in an apical pit. Greatest length about 7 mm. *Neritina glabrata* Sowerby.
   Spire slightly raised; about 2 whorls visible. Suture in form of a spiral around the apical pit. Greatest length about 9 mm. *Neritina adansoniana* (Récluz).

## Subgenus VITTA Mœrch

*Neritina* subgenus *Vitta* "Klein" MŒRCH, 1852, 'Cat. Conchyl. Yoldi,' I, p. 166. Type by designation of H. B. Baker (1923): *Nerita virginea* Linnæus.

*Scapha* "Klein" MŒRCH, 1852, 'Cat. Conchyl. Yoldi,' I, p. 166. As a synonym of *Vitta*. Type: *Nerita virginea* Linnæus.

Shell with prominent spire, the aperture not enlarged; in the African species known to us the columellar margin of the aperture toothed or serrulate.

Radula: unpaired central with a thickened rim; inner lateral roughly triangular, not especially large or broad, with well-marked indentation at outer edge for articulation with the innermost of the two small, middle laterals; of the two fused outer laterals, the inner one is well developed, while the outer one has shallow reflections and well-marked, heavy major and minor cusps; all marginals with prominent serrations on outer side and at the tip.

### **Neritina (Vitta) glabrata** Sowerby

Plate X, Figures 1–40

*Neritina glabrata* SOWERBY, 1849, 'Thesaurus Conchol.,' II, p. 535, Pl. CXVI, figs. 256-263 (described from an unknown locality). TRYON, 1888, 'Manual of Conchol.,' X, p. 56, Pl. XVIII, figs. 2-5. DAUTZENBERG, 1812, Ann. Inst. Océanogr. Monaco, V, 3, p. 74.

*Neritina (Smaragdia) glabrata* Sowerby. E. v. MARTENS, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab., II, 10, *Neritina*,' p. 253, Pl. XXIII, figs. 32-34.

*Neritina (Vitta) glabrata* Sowerby. H. B. BAKER, 1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, p. 137, Pl. x, fig. 4 (radula).

*Neritina webbei* RÉCLUZ, 1850, Journ. de Conchyl., I, p. 151 (as a synonym of *glabrata* Sowerby).

*Neritina glabrata* var. *senegalensis* "Duclos" H. B. BAKER, 1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, p. 137 (as a synonym of *glabrata* Sowerby).

Creek of Kitompo [=Kitombe] and entrance to the harbor of Banana (Gruvel Coll.).

The species is known along the coast of West Africa from Gambia to Angola.

San Antonio: collected in very large numbers at Pt. Padrão upon sand banks, also on the shore where it is only slightly exposed to the waves (H. Lang Coll.).

Plate X represents a selection of the numerous color forms which this species presents in the San Antonio colonies. It is very difficult to find two specimens colored exactly alike.

The ground color is almost always some tint of yellow. The markings are usually either black, deep brown, or red. The pattern of obliquely axial stripes, as in Pl. X, figs. 11 to 14, is one of the most frequent. This seems to be an ancestral pattern in the *Neritinæ*, appearing in many otherwise diverse species, especially of the section *Vitta*. Probably it was the original pattern of *N. glabrata*.

By weakening of the stripes in zones above and below the middle, a banded pattern is formed, as in figures 15 and 18. Further reduction of the bands results in a uniform yellow form, as in the series formed by figures 18, 17, and 16.

When the stripes composing the bands become confluent, we have such forms as the series figures 20, 25, and 30.

Splitting and other modifications of the bands are seen in the series leading from figures 10 to 6 and 10 to 5.

When the primitive stripes anastomose, netted and spotted patterns result, as in the series figures 14, 19, 24, 29 and 28, characterized by increasing predominance of markings over ground color.

Similar series are formed among the specimens with red markings, as indicated by connecting lines on the Plate.

Rare examples have both red and blackish-brown markings, as in figure 35. Figures 1, 2, 3, 39, and 40 are anomalous patterns, relatively rare and not readily connecting with the others.

The San Antonio colony appears to be a hybrid complex of several or many factors. It is contrasted with such colonies as that of *Neritina virginea*, figured by M. M. Metcalf,[1] in which the variation seems to be in degree of development of a single pattern.

The size does not vary much, the usual length being about 7 mm.

"The smallest of the three species of this group—*Neritina* (*Vitta*) *glabrata*—are the most easily gathered, being fairly abundant in their favorite places, the sheltered sandy coves with highly brackish water. Here, as well as on sand banks, during the slight wash of the waves at outgoing tide, they generally form a more or less continuous line of drift on the beach. Yellowish tints predominate on their shells, harmonizing fairly well with the fine, pale buff sand, but on some the red, brown, and

[1]Metcalf, M. M. 1904. '*Neritina virginea* variety *minor*.' American Naturalist, XXXVIII, pp. 565–569, Col. Pl.
1904. 'An outline of organic evolution.' (New York). Pl. I.

black tones render them rather conspicuous. It is only on closer investigation that one notices their extremely delicate and diversified patterns." (H. L.).

### **Neritina (Vitta) adansoniana** (Récluz)

Plate XIII, Figures 1–15

*Nerita adansoniana* RÉCLUZ, 1841, Rev. Zoolog. Soc. Cuviér., p. 313 (type locality: estuary of the Senegal).

*Neritina adansoniana* Récluz. REEVE, 1856, 'Conchol. Iconica,' IX, *Neritina*, Pl. XXXII, figs. 145*a-b*. TRYON, 1888, 'Manual of Conchol.,' X, p. 40, Pl. XIII, figs. 50-51.

*Neritina (Neritæa) adansoniana* Récluz. E. v. MARTENS, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab., II, 10, *Neritina*,' p. 129, Pl. XIV, figs. 22-23. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 108.

*Neritina (Vitta) adansoniana* Récluz. H. B. BAKER, 1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, p. 137.

*Neritina sangara* MORELET, 1848, Rev. Zoolog. Soc. Cuviér., p. 355 (type locality: rivers of the coast of Senegal).

Banana (P. Hesse Coll.).

The species is known along the West Coast of Africa from Senegal to Angola.

Banana: these snails were found in abundance crawling on algæ-covered banks of the creek of Banana toward Moanda, near the "Ile des Pêcheurs" (H. Lang Coll.).

This species is far less variable in color pattern than *N. glabrata*. The ground color is either light mineral gray or light pinkish cinnamon, the markings black. Most of the specimens seen may be assorted thus:

(a) Ground tint light mineral gray
   1. Fine axial lineolation strewn with black-shaded spots of the ground. Pl. XIII, figs. 1-3, 6.
   2. Spots coalescent into oblique stripes. Pl. XIII, figs. 4, 5.

(b) Ground tint light pinkish cinnamon; usually no lineolation.
   3. Spots and bands of the light ground at periphery and base, elsewhere black markings. Pl. XIII, figs. 7-11.
   4. Black reduced to bands above and below periphery. Pl. XIII, figs. 13, 14.

Sometimes pattern No. 1 has pinkish ground color. There are also a few transitions between each contiguous pair of color forms.

The usual length is 9 mm.

"The much darker and more inconspicuous *Neritina (Vitta) adansoniana* is found only on the right, or Belgian, shore of the Congo, just as the slightly smaller and brighter *N. (V.) glabrata* occurs apparently on the left, or Portuguese, bank. *N. (V.) adansoniana* is evidently more adaptable to different degrees of salinity, as well as to the more or less strong action of the waves. It seems remarkable that it should thrive equally well on the muddy shores of the Ile des Pêcheurs at the very mouth of the Congo opposite Banana point, on the algæ covered sand-banks of the creeks toward Moanda, and on the shallow flats near the shore farther up river. The latter are formed chiefly by the fine rootlets of mangroves over which exceptionally strong tides wash. At low tide they were literally covered by these tiny mollusks that gave them a particularly dark appearance." (H. L.).

### Subgenus **Neripteron** Lesson

*Neritina* subgenus *Neripteron* Lesson, 1831, 'Voyage de la Coquille, Zool.,' II, 1, p. 384. Type by designation of H. B. Baker (1923): *Neritina taitensis* Lesson.

*Neropterum* Agassiz, 1846, 'Nomencl. Zool. Index Univ.,' p. 249; emendation of *Neripteron*.

*Neritina* subgenus *Neritopteron* Fischer, 1885, 'Manuel de Conchyl.,' p. 802. Emendation of *Neripteron* Lesson.

Shell with reduced spire, the aperture enlarged and often produced into wings.

Radula: unpaired central with a rectangular, plane, upper surface or area; inner lateral roughly triangular, but transversely elongate so as to be as large or larger than lateral complex; of the two fused outer laterals, the inner one is well developed, while the outer one has shallow reflections and moderately developed, though distinct major and minor cusps.

H. B. Baker places *N. oweniana* (Wood) in the section *Alina* Récluz of this subgenus. Unfortunately, it seems to have been overlooked that *Clypeolum* was used by Récluz in 1842 (Rev. Zoolog. Soc. Cuviér., p. 235) for the group of auriculate *Neritinæ* which are globular and have the labrum laterally expanded. Below, on the same page, Récluz uses the name *Alina* for exactly the same group! *Clypeolum* Récluz, 1842 (type: *Neritina latissima* Broderip) must therefore be used in place of *Alina* Récluz, 1842. *Clypeolum* Récluz, 1850 (Journ. de Conchyl., I, p. 144), on the other hand, is a plain synonym of *Neritina* Lamarck, having the same genotype.

### **Neritina (Neripteron) oweniana** (Wood)

Plate XIII, Figures 16–27

*Nerita oweniana* Wood, 1828, 'Index Test., Suppl.,' p. 25, Pl. viii, fig. 8 (Africa, without more definite locality).

*Neritina* (*Neritæa*) *oweniana* "Gray" E. v. Martens, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab., II, 10, *Neritina*,' p. 75, Pl. ix, figs. 14-17. Tryon, 1888, 'Manual of Conchol.,' X, p. 76, Pl. xxii, fig. 90.

*Neritina owenii* Gray, 1831, 'Zoolog. Miscellany,' p. 11.

*Neritina oweni* Gray. Germain, 1908, Journ de Conchyl., LVI, p. 111.

*Neritina* (*Neritæa*) *hessei* O. Bœttger, 1885, 24. u. 25. Bericht Offenbacher Ver. f. Naturk., p. 194. C R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 108, Pl. ii, figs. 4*a*-*b*.

*Neritina (Alina) oweniana* "Gray" DAUTZENBERG, 1921, Rev. Zool. Afric., IX, p. 158.

*Neritina (Neripteron) oweniana* Wood. H. B. BAKER, 1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, p. 142, Pl. x, fig. 8 (radula).

Nefuku on the creek of Banana, at the mouth of the Congo (type locality of *N. hessei;* P. Hesse Coll.).

This species is known on the west coast of Africa from Cape Palmas to Angola.

Zambi and Malela, in the estuary of the Congo (H. Lang and J. Bequaert Coll.). Several hundreds of specimens.

This depressed, auriculate neritine has a network of black on an ecru-olive or rarely isabella-colored ground. The network varies in coarseness of mesh, and is often interrupted by one to three light bands. The ventral callus varies in color from iron gray to orange cinnamon or light pinkish cinnamon with some gray stains or suffusion; the smooth, toothless columellar edge is pale or white. The apex is sometimes eroded into a deep pit. The outline is variable, especially in degree of development of the posterior lobe of the lip. The convexity of the whole shell varies widely. The spire is normally very small, but in rare individuals in which the juvenile form is continued into the adult stage it is rather prominent.

Several of the specimens from Zambi bear the lower valves of hatched eggs and also a few unhatched eggs. These are elliptical or subcircular in outline and their greatest diameter varies from 1 to 2.3 mm. Moquin-Tandon[1] noted that the eggs of *Theodoxus fluviatilis* are enclosed in a thick, coriaceous, resistant shell; the egg itself, he says, is globular, opaque, and white. The young mollusk would have difficulty in hatching, were it not that about that time the shell divides into two valves after the fashion of a dehiscent fruit, one of the valves dropping off while the other remains on the support. The egg-shells of *N. oweniana* apparently have a similar structure. Moquin-Tandon states that the egg-shell of *T. fluviatilis* is more or less calcareous, but in the case of *N. oweniana* the dehiscent valves seem to be chitinous, since they do not effervesce with oxalic acid.

The young stages have a more normal *Neritina*-shape and coloration. There is a black lineolation with numerous clear spots outlined with black, and two spiral series of opaque, light spots near the periphery.

The operculum is peculiar by having a semicircular ridge at the base, concentric around the peg.

*N. oweniana* attains its fullest development in nearly fresh water, above the mangrove belt, as at Zambi.

[1] 1852, Journ. de Conchyl., III, p. 26.

| | | |
|---|---|---|
| Length, 28.0 mm.; | width, 23.5 mm.; | convexity, 11.5 mm. |
| " 24.3 | " 22.0 | " 11.5 |

In brackish water, at Malela, the size is much reduced, and the features of youth persist. The auriculate stage appears to be well developed in few individuals.

| | | |
|---|---|---|
| Length, 14.0 mm.; | width, 13.3 mm.; | convexity, 6.7 mm. |
| " 14.0 | " 12.5 | " 7.0 |
| " 13.5 | " 12.0 | " 6.5 |

"When we stepped ashore at Zambi Dr. Bequaert at once pulled a few of these beautiful large *Neritina* (*Neripteron*) *oweniana* from the limestones just below the surface of the water. Our host, Dr. René van Saceghem, called our attention to others that had fastened themselves to a nearby cement wall. Later on, when criss-crossing the Congo in the neighborhood, I found a much greater number on submerged, dead, anchored or floating branches or sticks generally no more than two feet below the surface. They showed themselves very susceptible to disturbances and instantly let go their hold when a branch or any other object upon which they were sitting was lifted quickly out of the water. When the receding tide might leave them stranded they let themselves drop before they were even completely uncovered. Though most of them sank like stones they can swim with ease. Perhaps their strongly flattened shell and large, expanded, winged lip help offer additional support to the mantle. In avoiding exposure they certainly behave differently from their two smaller relatives *N. glabrata* and *adansoniana*, found near or at the mouth of the Congo, which do not seem to be affected by being left dry during low tide. *N. oweniana* were common about and below Zambi but scarce farther up-river. Undoubtedly the salinity of the water is enough different there to be an important factor, since two crabs, *Sesarma* (*Holometopus*) *büttikoferi* and *angolense*, also begin to be common about Zambi and farther downstream. Some of the largest specimens of *oweniana* were taken in the neighborhood of Zambi (about 27 miles from the mouth), always in places with a fairly strong current. They were scarcer at Malela (about 12 miles from the mouth) and practically absent from Banana where I looked especially for them. Only once, a few miles up Banana creek, did I find two on a floating branch." (H. L.).

### THEODOXUS Denys de Montfort

*Theodoxus* DENYS DE MONTFORT, 1810, 'Conchyl. Systém.,' II, p. 351 (*Theodoxis* on p. 350, under the figure). Monotype: *Theodoxus lutetianus* Denys de Montfort = *Nerita fluviatilis* Linnæus.

*Theodoxia* BOURGUIGNAT, 1877, Bull. Soc. Sci. Phys. Nat. Toulouse, III, (1875–76), p. 92. Emendation of *Theodoxus*.

*Neritina* section *Theodorus* PALLARY, 1923, Archives Inst. Pasteur Afr. du Nord, III, p. 44. Misspelling of *Theodoxus*.

Agrees with *Neritina* in characters of shell and operculum.

Radula: inner lateral less than twice as broad as long, its posterior lobe large, usually rounded, with convex outer slope; reflection of the outermost lateral well developed, heavy, and with a tendency to increase the inner point so as to be broadly lanceolate in shape; blades of inner marginals with serrations on outer side.

The species are estuarine or fluviatile and found over much of the Old World, not in America.

Baker's examination of the radula of *Neritina afra* Sowerby has shown that this species is a *Theodoxus*. It has been placed in the section *Vittoclithon* H. B. Baker (1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, pp. 134 and 156; type: *Neritina meleagris* Lamarck) of the subgenus *Clithon* Denys de Montfort (1810, 'Conchyl. Systémat.,' II, pp. 326 and 327; type: *Nerita corona* Linnæus).

*Theodoxus afer* (Sowerby) H. B. BAKER, 1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, p. 158, Pl. XIV, fig. 26 (radula) = *Neritina afra* SOWERBY, 1843, 'Conchol. Illustrat.,' *Neritina*, fig. 13 (p. 3 of explanation). *Neritina æquinoxialis* MORELET, 1848, Rev. Zoolog. Soc. Cuviér., p. 355, and 1858, 'Séries Conchyl.,' I, p. 29, Pl. III, fig. 6. Fernando Po and Prince's Island.

### Neritiliinæ

Operculum without peg, but with an erect, marginal projection representing the rib. Shell globose.

Eyes pedunculate. Radula: unpaired central absent; inner laterals with long axes almost parallel to that of the radula, the inner ends alternating on opposite sides; of the two middle laterals the outermost is rather elongate; of the outer laterals the innermost is vestigial, the outermost is very oblique, with crescentic disk and well-marked cusps; marginals with large, crescentic, cusp-bearing disks and with prominent notch on the inner side near the distal end of the body.

This subfamily contains only one genus, the few species of which are fluviatile and are found in the tropics of America, Africa, and the Pacific Islands.

#### NERITILIA E. v. Martens

*Neritilia* E. v. MARTENS, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab., II, 10, *Neritina*,' p. 19. Type: *Neritina rubida* Pease.

The following Ethiopian species is apparently a true *Neritilia*. Its radula has, however, not yet been studied.

*Neritilia manoëli* (H. Dohrn) = *Neritina manoëli* H. DOHRN, 1866, Malakoz. Blätter, XIII, p. 135. E. v. MARTENS, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab., II, 10, *Neritina*,' p. 244, Pl. XXIII, figs. 21-22. TRYON, 1888, 'Manual of Conchol.,' X, p. 54, Pl. VIII, fig. 87. Prince's Island.

## Hydrocenidæ

Shell small, imperforate, globose-conic, with thickened columella. Operculum corneous, with concentric striæ, with a projecting process articulating with the columella.

Animal amphibious, with short, broad tentacles; the eyes placed at their external bases. Respiration by means of a lung. Radula with the teeth of the central field very small or absent; outer laterals not capitulate; the marginals extremely numerous and closely imbricate, in strongly oblique rows.

These minute snails are mainly found in the littoral zone. Only one species is known thus far from the Ethiopian Region.

### HYDROCENA Pfeiffer

*Hydrocena* "Parreyss" PFEIFFER, July, 1847, Zeitschr. f. Malakoz., IV, p. 112. Type by original designation: *Cyclostoma cattaroensis* Pfeiffer. The name was published as a *nomen nudum* by Herrmannsen (May, 1847, 'Ind. Gen. Malac.,' I, p. 546).

Ethiopion species:

*Hydrocena* N, 1856 *noticola* BENSO, Ann. Mag. Nat. Hist., (2) XVIII, p. 439 = *Assiminea tyttha* MELVILL AND PONSONBY, 1897, *op. cit.*, (6) XIX, p. 639, Pl. XVII, fig. 11. Near Cape Town (ravine overlooking Camp's Bay), Cape .Colony (type locality).

## PECTINIBRANCHIATA TÆNIOGLOSSA

## Ampullariidæ

Medium-sized, large or very large, dextral or (apparently) sinistral snails, the shell moderately thick to very thin; ovate, globose-conic or subspherical, rarely much depressed or planorboid; usually perforate or broadly umbilicate, or rarely the umbilicus is closed. The surface is usually smoothish, sculpture if present being microscopic; sometimes it is malleate, or with prominent growth wrinkles, more rarely with spiral grooves or carinæ. Operculum completely closing the aperture, with nucleus submedian near the columellar margin, and concentric increment. It is either thin, flexible and wholly corneous, capable of retraction some distance within the mouth; or rigid, thickened by an internal calcareous layer,[1] in which case it lodges at the peristome. The scar attachment is within the columellar half of its width.

The animal is dextral. The head has long, tapering tentacles and prominently stalked eyes at their exterior bases. Muzzle stout and conspicuous, terminating in two long, tapering labial processes. Anterior edge of the foot doubled. Epipodial lobes, adjacent to the eye-stalks, form left (inhalent) and right (exhalent) conduits. The penis arises from the right side of the thick mantle-edge and is carried folded back in the cavity Mantle cavity containing a monopectinate gill adnate throughout; it is divided by a partition attached to the mantle, perforated subcentrally or on the left side, and segregating an upper-left chamber which functions as a lung. The mouth is provided with a pair of large jaw plates and a relatively large radula. The

[1]The operculum of *Pila* has been erroneously described as "externally calcareous" (1904, Journ. of Conchology, XI, p. 52). The external layer is always corneous, the calcareous layer being within.

central teeth are wider than long; laterals with a long rhomboidal body and several cusps, of which the second is much the largest. The two marginal teeth are bicuspid or rarely tricuspid.

The animal is amphibious. When it is completely immersed, respiration may be wholly branchial; when out of the water, directly pulmonary. Ordinarily it obtains air by occasional visits to the surface, exactly like a lymnæid snail.[1]

The globular eggs have a calcareous shell, and are deposited in clusters on reeds some inches above the surface of the water.

The family inhabits the fresh waters of the tropics of both hemispheres. It is entirely absent from the Palæarctic Region (except Lower Egypt). In North America it extends from Central Mexico to the La Plata system; a few species occur in Florida and Georgia, and some others are found in the West Indies. Most of the species prefer marshy low banks of rivers, swamps, ponds, or lakes to running water. Some of them are able to stand prolonged desiccation.

The classification is based chiefly upon characters of the shell and operculum, since the soft parts are still unknown in a majority of the species, among them all those belonging to the groups *Saulea, Afropomus,* and *Limnopomus.* The interrelations and, to some extent, the limits of genera are not well understood. The major divisions of the following key to genera are artificial, for want of knowledge of the three groups mentioned above.

By external characters these snails may be grouped primarily into longisiphonate forms, including the American groups *Pomacea* and *Ceratodes*, and brevisiphonate, comprising the American *Asolene* and *Pomella*, and the Old World genera *Pila* and *Lanistes* with its subgenera *Meladomus* and *Leroya.*

The radula (Fig. 13) is singularly uniform throughout the family, and at present it appears doubtful whether it differs in any constant features in the three main genera, *Pomacea, Lanistes,* and *Pila.*[2] A few of the smaller groups or species have certain peculiarities, such as the wide marginal tooth and the produced lower angles of the central in *Lanistes (Leroya) graueri*, and the reduction of all but the main cusps in the teeth of *Pila (Turbinicola) nux.*[3]

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[1]This is the case with *Pomacea paludosa* (Say), which we have had under observation in the aquarium. When obtaining air, the animal is always partially supported by floating vegetation and remains wholly immersed, only the left siphon protruding above water. *A. genesensis* (Deshayes) in an aquarium was seen to take air only twice in over six months. A review of the mechanism of respiration in Ampullariidæ is given by F. Babák, 1921, in H. Winterstein, 'Handbuch der Vergleichenden Physiologie,' I, 2, pp. 540–542.

[2]Troschel, 1856–1863, 'Das Gebiss der Schnecken,' I, pp. 86–90, has made practically the same observations.

[3]H. Burrington Baker (1922, Occas. Pap. Mus. Zool. Univ. Michigan, No. 106, p. 38) found a tendency to double the cusps by division in *Ampullarius flagellatus.* In a few cases the central tooth had as many as 11 cusps, the normal number being 7.

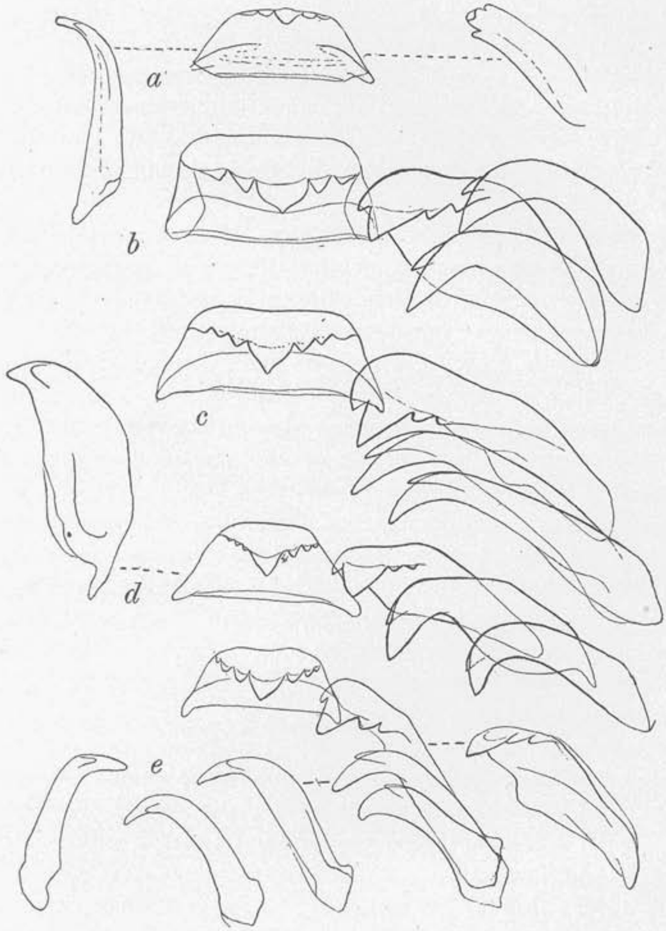


Fig. 13. Teeth of Ampullariidæ. *a*, *Saulea vitrea* (Born); inner marginal, central, and outer marginal, the last two lying prone, the cusps foreshortened. *b*, *Pila congoensis* Pilsbry and Bequaert. *c*, *Lanistes procerus langi* Pilsbry and Bequaert. *d*, *Lanistes graueri* Thiele. *e*, *Lanistes nsendweensis* (Dupuis and Putzeys), with two outer marginals, an inner marginal, and a lateral drawn separately from detached teeth.

A discussion of the nomenclature and a synopsis of the classification of Ampullariidæ has been published by Dall.[1] Some revision of his conclusions appear called for. He argues that by "*Ampullaria ampullacea*, le cordon bleu," Lamarck intended to indicate *Nerita urceus* Müller,

[1]1904, Journ. of Conchology, XI, pp. 50–55.

because two years later he added the words "muni d'un opercule corné." This is a pure assumption; in many cases an author has subsequently amplified his generic diagnosis by adding characters from additional species, and this is obviously what Lamarck did. So far as we have been able to learn, *N. urceus* was never known as "*le cordon bleu.*"[1] We believe that, in cases where an author bases a genus upon a described species and there is nothing in the original diagnosis to show that he meant something else, neither he nor any other author has the right to shift the generic name to any other genotype. *Ampullaria* Lamarck will therefore become *Pila* Röding, both having the same type.

## Key to the Known Genera and Subgenera of Ampullariidæ

1. Shell dextral.......................................................2.
   Shell sinistral. Operculum corneous, very thin. Africa. *Lanistes* Denys de Montfort.......................................................9.
2. Operculum thick and internally calcareous. Old World tropics. *Pila* Röding.3.
   Operculum thin and wholly corneous....................................4.
3. Umbilicus closed; the columella with a narrow, flat callus. Radula with the lateral cusps of the teeth reduced or vestigial. India.
   Subgenus *Turbinicola* Annandale and Prashad.[2]
   Umbilicus perforate or broadly open, rarely vestigial; the columella not calloused.
   Subgenus *Pila*, proper.
4. New World forms.......................................................5.
   Old World forms.......................................................8.
5. Left epipodial lobe (respiratory siphon) very long. *Pomacea* Perry[3]........6.
   Left epipodial lobe very short.........................................7.
6. Form elevated, the umbilicus narrow or sometimes closed.
   Subgenus *Pomacea*, proper.
   Form depressed, the umbilicus broadly open...Subgenus *Marisa* J. E. Gray.[4]
   Form planorboid.............................Subgenus *Ceratodes* Guilding.
7. Shell globose, compact, solid, and smoothish.............*Asolene* d'Orbigny.
   Shell hemispherical, of few, very rapidly increasing whorls, the last roughly sculptured, very capacious..........................*Pomella* Gray.[5]

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[1]*Nerita urceus* was known as "*l'idole*" in old French works using the vernacular names. Prior to Lamarck's use of the term in 1799, "*le cordon bleu*" was the name given to snails identified by Chemnitz and others with *Helix ampullacea* Linnæus. See Martini and Chemnitz, 1786, 'Syst. Conch. Cab.,' IX, pp. 105–109. At the time Lamarck mentioned "*Ampullaria ampullacea*, le cordon bleu," that was one of the best known species of the Ampullariidæ, from its appearance in Chemnitz's widely used iconography. See also Lamarck, 1822, 'Hist. Nat. Anim. sans Vertèbres,' VI, 2, p. 177.

[2]1921, Rec. Indian Mus., XXII, p. 9. Monotype: *Ampullaria nux* Reeve = *Ampullaria saxea* Reeve. See Prashad, 1923, Journ. Proc. Asiat. Soc. Bengal, N. S., XVIII, (1922), p. 591.

[3]The group *Limnopomus* Dall, proposed as a subgenus of *Ampullaria* Lamarck, and characterized by the imperforate axis and heavily calloused columella, cannot be exactly placed until the form of its siphon is known. We therefore leave it where originally placed, though we strongly suspect that it will prove to be brevisiphonate, and a subordinate group of *Asolene*.

[4]*Marisa* J. E. Gray, 1824, Philos. Mag. and Journ., LXIII, p. 276. Monotype: *Marisa intermedia* J. E. Gray, of Brazil, probably the same as *Ampullaria intermedia* Férussac, 1824 (?), 'Voy. Uranie, Zool.,' p. 489; Atlas, Pl. LXVIII, figs. 1–3.

[5]The type of *Pomella*, *Ampullaria megastoma* Sowerby, was found to have a very short siphon by Doello-Jurado (1915, Physis, II, p. 39).

8. Shell very thin, almost wholly corneous, with wavy spots; the early whorls angular or subcarinate. Umbilicus perforate or vestigial; columella not calloused.............................................*Saulea* Gray.
   Shell heavy, thick, not spotted; the early whorls not subcarinate; the periostracum densely rippled-lineolate. Axis imperforate; columella heavily calloused............................*Afropomus* Pilsbry and Bequaert.
9. Shell heavy, globosely conic, imperforate; the columella strongly calloused; surface often spirally lirate. Operculum narrow. Subgenus *Leroya* Bourguignat.
   Shell thinner, lighter; the umbilicus either broadly open, perforate or closed; but the columella thin, not calloused. Operculum broad..............10.
10. Shell longer than wide; the umbilicus very narrow, perforate or closed, without a bordering angle; all of the whorls convex, not angular. Subgenus *Meladomus* Swainson.
   Shell usually as wide as long or wider; umbilicus open, often bounded by an angle; whorls of the spire often angular.....Subgenus *Lanistes*, proper.

### POMACEA Perry

*Ampullarius* DENYS DE MONTFORT, 1810, 'Conchyl. Systém.,' II, p. 242. Monotype: *Nerita urceus* O. F. Müller. Not *Ampullaria* Lamarck.

*Pomacea* PERRY, 1811, 'Conchology,' letter-press to Pl. XXVIII. Type: *Pomacea maculata* Perry = *Nerita urceus* O. F. Müller.

*Conchylium* CUVIER, 1816, 'Le Règne Animal.,' II, p. 426, comprising four subgenera: *Ampullaria, Melania, Phasianella*, and *Janthina*. Type by present designation: *Bulimus urceus* Bruguière.

*Pomus* H. and A. Adams, 1856, 'Genera of Recent Mollusca,' p. 346. Type *P. urceus* (O. F. Muller).

*Pomacea* is the prevalent type found in the New World, but it is not represented in the Old World, unless by the groups *Saulea* and *Afropomus*. These we are provisionally treating as genera; but if they prove to be longisiphonate, when the animals are examined, they may more justly be ranked as subgenera of *Pomacea*, with which they agree in character of the operculum.

### SAULEA Gray

*Saulea* GRAY, 1867, Proc. Zool. Soc. London, p. 1000. Monotype: *Helix vitrea* Born.

This group, which Dall ranks as a section of *Pila*, has a thin, wholly corneous operculum as in American Ampullariidæ. When the soft parts are known, it may very likely prove generically distinct and we provisionally give it generic rank. The operculum and shell of the type species are figured on Pl. XIV, figs. 2 and 3.

The dry remains of a rotten animal washed out of a shell of *S. vitrea* furnished a few isolated teeth (Fig. 13*a*). The central has strongly sloping lateral margins as in *Lanistes*. It has five cusps, seen much foreshortened in the figure. The lateral tooth has four cusps, the second largest, as usual; only broken teeth were found. The marginal teeth preserved have two forms: a shorter tooth, evidently the outer marginal, with tricuspid apex (Fig. 13*a*, right, lying prone), and a longer, the inner marginal, with it bicuspid (Fig. 13*a*, left, drawn in profile).

A tricuspid marginal tooth is unusual in this family, where as a general rule both marginals are bicuspid; but *Pila nevilliana* (Annandale and Prashad)[1] has a tricuspid outer marginal, and in *Pila maura* (Reeve)[2] both marginals have three cusps.

The only species of this group is *Saulea vitrea* (Born) = *Helix vitrea* Born, 1780, 'Test. Mus. Vindobon.,' p. 383, Pl. xv, figs. 15-16, originally described from an unknown locality, but now known to occur in Liberia.

### **Afropomus**, new genus

The shell is globose with short conic spire, very solid, imperforate, microscopically, densely, spirally lineolate, the lines clearly rippled. The short, concave columella is heavily calloused, the callus spreading upward over the parietal wall. The operculum is very thin, with no calcareous layer, strongly concave outside; the very large scar of attachment to the foot is rippled concentrically.

Type: *Ampullaria balanoidea* Gould (1850, Proc. Boston Soc. Nat. Hist., III, p. 196; Morelet, 1851, Journ. de Conchyl., II, p. 267, Pl. vii, fig. 8), from Cape Mount, Liberia (Pl. XIV, Figs. 4, 5).

This group may resemble the section *Limnopomus* Dall (1904, Journ. of Conchology, XI, pp. 53 and 54) based on a Peruvian species, *A. columellaris* Gould, which we have not seen and which has not been figured. Gould's description appears to indicate a different structure of the columella. Dall describes it as having the "umbilicus filled with callus." In *A. balanoideus* there is no umbilicus at any stage of growth, its absence being due to closeness of the coil, not to a callous filling.

The possibility that *A. balanoideus* is a reversed, that is, secondarily dextral, species of *Lanistes* of the subgenus *Leroya* is suggested by its form, solidity, and sculpture. A definite decision can hardly be made until the animal can be fully studied; but such a relationship appears highly improbable.

If *Saulea* and *Afropomus* turn out to be brevisiphonate forms, they will be dissociated from *Pomacea* and brought near *Lanistes*. As they differ a good deal from one another and cannot be assimilated to any other Old World genera, it will probably be best to give both generic rank for the present.

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[1]Annandale and Prashad, 1921, Rec. Indian Mus., XXII, p. 8, fig. 1, B.
[2]Annandale and Amin-ud-Din, 1921, Rec. Indian Mus., XXII, p. 558, fig. 8.

## PILA Röding

*Pila* RÖDING, 1798, 'Museum Boltenianum,' II, p. 145. Type: *Helix ampullacea* Linnæus, as fixed by Dall, 1904, Journ. of Conchology, XI, p. 53.

*Ampullaria* LAMARCK, 1799, Mém. Soc. Hist. Nat. Paris, p. 76. Monotype: *Helix ampullacea* Linnæus.

*Pachystoma* GUILDING, 1828, Zool. Journ., III, p. 536. Type: *Ampullaria globosa* Swainson, designated by Guilding, *op. cit.*, p. 539, footnote. (Not *Pachystoma* Latreille, 1809).

*Ampullaria* subgenus *Pachylabra* SWAINSON, 1840, 'Treatise on Malacology,' p. 39. Type: *Ampullaria globosa* Swainson. Substitute for *Pachystoma* Guilding.

*Pachycheilus*[1] . . . 1840, 'Penny Cyclopedia,' XVII, p. 454, footnote. Substitute for *Pachylabra* Swainson.

*Pomus* GRAY, 1847, Proc. Zool. Soc. London, p. 148: Monotype: *Helix ampullacea* Linnæus.

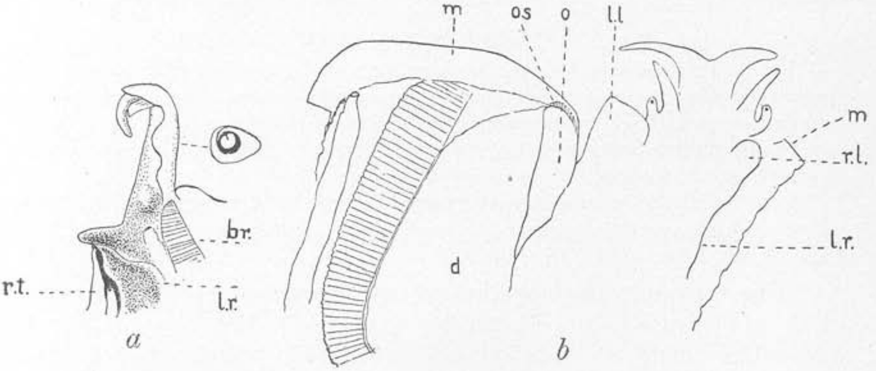


Fig. 14. *Pila congoensis* Pilsbry and Bequaert. *a*, penis with adjacent parts and section. *b*, dorsal view, the mantle thrown to the left.

br, end of the gill; ll, left epipodial lobe (respiratory siphon); lr, longitudinal ridge; m, mantle; os, osphradium; rl, right or exhalent epipodial lobe; d, diaphragm; o, lung orifice; rt, right tentacle.

*Pachychilus* PHILIPPI, 1851, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 20, p. 7. Emendation of *Pachylabra*.

Ampullariidæ with a dextral, ovate to globosely conic shell and a rigid operculum having a strong calcareous layer inside. Left epipodial lobe short, capable of forming a very short, broad respiratory siphon.

This genus is confined to the Oriental and Ethiopian Regions. In Africa it extends along the Nile into Lower Egypt, and is most abundant in the eastern and central portions of the continent. In West Africa it does not appear to have been found alive north of Lake Chad and the Niger, though subfossil specimens have been obtained in the dunes of Arezzal (Eroug, northern Sudan). In South Africa the southernmost

[1]We have been unable to discover the author of the malacological articles in the 'Penny Cyclopedia.'

records are from the Cunene River, Damaraland (Okosongoho), and northern Bechuanaland (Nausib River; Okovango; Lake Ngami; Botletle District), in the west; the mouth of the Zambezi in the east. A number of species occur in Madagascar, but the genus is unknown in the Mascarenes.

In deference to the decision of the Intenational Commission on Nomenclature we are admitting *Pila* and a few other Bolten-Röding names. It is hoped that this decision will be reversed. There seems little advantage to science in overthrowing nomenclature current for a century by the introduction of names from a sale catalogue of which only three or four copies were known to exist prior to the recent reprint.

In *Pila congoensis* the respiratory siphon appears in the preserved specimens as a flat, subtriangular lobe adjacent to the left eye-pedicel, about 7 mm. long, 9 mm. wide at the base, in an individual with shell 36 mm. long.[1] Inward, immediately adjacent to its base, is the large, oblong opening of the lung, which is 13 mm. long in the same specimen.

This differs conspicuously from the condition found in Sumatran specimens of *Pila ampullacea sumatrensis* (Philippi) and in the American *Pomacea paludosa* Say (*A. depressa* Say), in which the opening of the lung is small, rounded, and near the middle of the pallial diaphragm or partition, thus well removed from the base of the siphon.

The longitudinal ridge on the right side of the floor of the gill chamber is small. It unites anteriorly with the right or excurrent epipodial lobe. The relations of these parts are shown in Fig. 14*b*.

In a Madagascar species identified as *Pila madagascariensis* (Smith) the orifice of the lung is oblong, 10 mm. long, and situated rather nearer to the middle than to the right margin of the diaphragm.

The penis of *P. congoensis* (Fig. 14*a*) is about 10 mm. long in an individual with shell 29 mm. long; situated on the right side of the mantle-margin near its termination. It consists of a slender cylindric organ, the penis proper, which is deeply furrowed by the spermatic groove throughout its length. There is a rather prominent tubercle, the hypobranchial gland, at its base. It is enclosed in a fleshy sheath,

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[1]Annandale and Prashad (1921, Rec. Indian Mus., XXII, p. 9) describe the animal of the Indian *Pila globosa* (Swainson) as follows: "The right epipodial lobe is prominent and well developed. The inhalent siphon, which is formed by the left epipodial lobe, has, when contracted, the form of a prominent fold, forming part of a circle, but with its extremities widely separated. When expanded it is funnel-shaped and much broader than long." The gross anatomy of another Indian species, identified as *Pila cinerea* (Reeve), has been recently studied by K. Hägler (1923, 'Anatomie von *Pachylabra* (*Ampullaria*) *cinerea* Reeve, I. Teil.' Acta Zoologica, IV, pp. 313–410). A more recent and detailed account of the anatomy of *Pila globosa* is that by B. Prashad (1925, 'Anatomy of the common Indian apple-snail, *Pila globosa*.' Mem. Indian Mus., VIII, 3, pp. 91–152, Pls. XVI–XVIII). See also K. Kägler, 1923, Anatomie von *Pachylabra cinerea* Reeve,' Acta Zoologica, IV, 2–3, pp. 313–394.

an outgrowth of the mantle, which is slit along its lower side or, in other words, folded around the slender penis, which projects from its summit.

Unfortunately, no specimens of full size were preserved in alcohol, the largest being 41 mm. long. Several of 38 to 41 mm. opened, were females. Of nine specimens with shells from 26 to 30 mm. long opened, eight were males. Further examination should be made of shells 50 to 70 mm. long, to ascertain whether the male is smaller than the female.

The penis agrees with that of *Pila celebensis* (Quoy and Gaimard), as figured by those authors,[1] *Pila globosa*, figured by Bouvier,[2] and *Pila cinerea* (Reeve), examined by Hägler.[3] It is also similar in structure to the penis of several species of *Lanistes* which we have examined. In America the same type of penis was found in *Pomacea gigas* (Spix) by Sachwatkin,[4] in *Pomacea patula catemacensis* H. B. Baker and

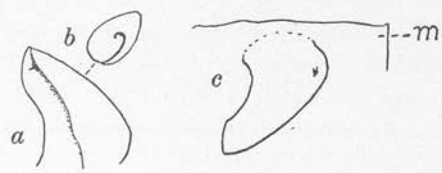


Fig. 15. Penis of *Pomacea paludosa* (Say). *a*, seen from below; *b*, in section; and *c*, turned back under the mantle.

*Pomacea* (*Ceratodes*) *cornuarietis* (Linnæus), by us. In an undetermined species of *Pomacea* from Lake Nicaragua the general structure is the same, but the penis is small, less than half the length of its sheath. In *Pomacea paludosa* (Say), of Florida (Fig. 15), there is no inclosed penis even at the base. The coiled sheath appears to have taken over its function. We found the same structure in *Pomacea gevesensis* (Deshayes) from Georgetown, British Guiana, collected by H. Lang.

Radula.—In *Pila congoensis* (Fig. 13*b*, page 168) the central tooth is squarish, having steep lateral margins, the upper margin therefore long. The lateral tooth has a very wide body, the second cusp from inside very large. The two marginals are nearly alike, both having an upper long and lower short cusp. The formula of cusps is 2-2-4-5-4-2-2.

[1]1833, 'Voyage de l'Astrolabe, Atlas, Mollusques,' Pl. LVII.
[2]E. L. Bouvier. 1888. 'Étude sur l'organisation des Ampullaires.' Mém. Soc. Philomath, Paris, pp. 63*–85*, Pl. IX.
[3]1923, Acta Zoologica, IV, pp. 371–373, figs. 17–19.
[4]Viktor Sachwatkin. 1920. 'Das Urogenitalsystem von *Ampullaria gigas* Spix.' Acta Zoologica, I, pp. 67–130.

Width of the central tooth, 0.5 mm. It is much like the teeth of American species figured by H. Burrington Baker.[1]

The determination of African *Pilæ* is difficult because of the similarity of the species. The minute sculpture, the width of the aperture, and the length of the adnate portion of the inner lip relative to that of the aperture, have been found to be among the most useful differential characters. In some cases the relative width of the operculum and its scar is highly characteristic. The sculpture of the scar is rather variable individually, and it changes somewhat with age.

The following is a list of continental African forms which appear to be specifically distinct. Most of them have been insufficiently described.

*Pila africana* (E. von Martens) = *Ampullaria africana* E. von Martens, 1886, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 114. Gold Coast (Abetifi and Akra).

*Pila chariensis* (Germain) = *Ampullaria chariensis* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 486; 1906, Mém. Soc. Zool. France, XIX, p. 232, Pl. iv, fig. 10. Lower Chari between Buguman and Fort Lamy; also Lake Chad.

*Pila charmesiana* (Billotte) = *Ampullaria charmesiana* Billotte, 1885, Bull. Soc. Malacol. France, II, p. 106. *Ampullaria wernei* Philippi (in part), 1851, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 20, Pl. v, fig. 4. Nile, above Gondokoro.

*Pila chevalieri* (Germain) = *Ampullaria chevalieri* Germain, 1904, Bull. Mus. Hist. Nat. Paris, p. 469; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 525, fig. 89 (on p. 526). Krebedje, French Equatorial Africa; this was apparently found in the Congo drainage.

*Pila congoensis* Pilsbry and Bequaert. See p. 177.

*Pila congoensis amplior* Pilsbry and Bequaert. See p. 179.

*Pila gordoni* (E. A. Smith) = *Ampullaria gordoni* E. A. Smith, 1892, Ann. Mag. Nat. Hist., (6) X, p. 382. Lake Victoria.

*Pila gordoni* var. *bukobæ* (E. v. Martens) = *Ampullaria gordoni* var. *bukobæ* E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 156, Pl. i, fig. 22. Lake Victoria at Bukoba.

*Pila gordoni* var. *volkensi* (E. v. Martens) = *Ampullaria gordoni* var. *volkensi* E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 157. Lake Jipe near Mt. Kilimanjaro.

*Pila gradata* (E. A. Smith) = *Ampullaria gradata* E. A. Smith, 1881, Proc. Zoöl. Soc. London, p. 289, Pl. xxxiii, figs. 22 and 22*a*. Lake Nyasa and between Lake Nyasa and the east coast. Germain (1905, Bull. Mus. Hist. Nat. Paris, p. 256; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 670) records this species from the southern end of Lake Tanganyika (Foà Coll.).

*Pila kordofana* (Philippi) = *Ampullaria kordofana* Philippi, 1851, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 20, p 44, Pl. xiii, fig. 1. Kordofan. This does not seem to differ very materially from *Pila wernei* (Philippi).

*Pila leopoldvillensis* (Putzeys). See p. 180.

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[1] 1922, Occas. Pap. Mus. Zool. Univ. Michigan, No. 106, Pl. xv, figs. 6, 7.

*Pila letourneuxi* (Bourguignat) = *Ampullaria letourneuxi* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 29. Kingani River near Bagamoyo, Tanganyika Territory.

*Pila microglypta* Pilsbry and Bequaert. See below.

*Pila nigricans* (G. B. Sowerby) = *Ampullaria nigricans* G. B. SOWERBY, 1910, Proc. Malacol. Soc. London, IX, 1, p. 63, fig. Buddu, Uganda, at 4,000 feet.

*Pila nyanzæ* (E. A. Smith) = *Ampullaria nyanzæ* E. A. SMITH, 1892, Ann. Mag. Nat. Hist., (6) X, p. 382. Jordan's Nullah, at the southern end of Lake Victoria.

*Pila occidentalis* (Mousson) = *Ampullaria occidentalis* MOUSSON, 1887, Journ. de Conchyl., XXXV, p. 299, Pl. XII, fig. 9. Cunene River.

*Pila ovata* (Olivier). See p. 181.

*Pila revoili* (Billotte) = *Ampullaria revoili* BILLOTTE, 1885, Bull. Soc. Malacol. France, II, p. 103. Between Merca and Makdischu, Somaliland.

*Pila ruchetiana* (Billotte) = *Ampullaria ruchetiana* BILLOTTE, 1885, Bull. Soc. Malacol. France, II, p. 105, Pl. VI, fig. 1. Webi River, above Guelidi, Somaliland.

*Pila speciosa* (Philippi) = *Ampullaria speciosa* PHILIPPI, 1849, Zeitschr. f. Malakoz., VI, p. 18; 1851, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 20, p. 40, Pl. XI, fig. 2. East Africa.

This species has been recorded from the Uele River by Germain and de Rochebrune (1904, Mém. Soc. Zool. France, XVII, p. 5); from the Lobay River, an affluent of the Congo in French territory, by Germain (1913, Bull. Mus. Hist. Nat. Paris, p. 289); and from the Upper Congo by C. R. Bœttger [1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 102]. The occurrence of true *P. speciosa* within the Congo basin appears to us very doubtful.

*Pila stuhlmanni* (E. v. Martens). See p. 182.

*Pila welwitschi* (Bourguignat) = *Ampullaria welwitschi* BOURGUIGNAT, 1879, 'Descript. Moll. Egypt.,' p. 31. *Ampullaria ovata* MORELET, 1868, 'Voy. Welwitsch. Moll. Terr. Fluv.,' p. 94, Pl. IX, fig. 10 (not of Olivier). Niger River. This appears to be a distinct species, not a variety of *ovata* as stated by Germain (1908, Journ. de Conchyl., LVI, p. 108).

*Pila wernei* (Philippi). See p. 183.

Certain authors list as African species a number of forms which were originally described as of doubtful provenance. Such are: *Ampullaria adusta* Reeve (= *A. sordida* Reeve), *A. canaliculata* Lamarck, *A. exigua* Philippi, *A. filosa* Reeve, and *A. pilula* Reeve. It is extremely doubtful whether any of these names apply to species of the African continent.

## **Pila microglypta**, new species

Plate XV, Figures 5 and 6

Stanleyville (type locality), 21 specimens (H. Lang Coll.).

The shell is moderately umbilicate, rather solid. The spire is moderately raised, more or less deeply corroded in all specimens seen. The suture is deep; following it the whorl is horizontal and flattened, then rather abruptly curved, convex peripherally, then convexly tapering toward the base. Color ecru-olive to buffy olive, with numerous unequal bands and lines of brownish olive. Surface showing under the lens unequal, *very minute, spiral threads and striæ and far finer, closer, axial striæ which renulate the spirals.* The aperture is oblong, rather wide, nearly as wide in the upper part as in the lower; chestnut colored within, becoming whitish and showing bands toward the lip. The columellar margin is but slightly expanded. Adnate portion of the inner lip rather short.

| | | | | | |
|---|---|---|---|---|---|
| Length, 37.0 mm.; | diameter, 32.0 mm.; | length of aperture, 26.0 mm. | | | Type. |
| " 27.5 | " 23.0 | " | " | " 18.4 | Paratype |

The operculum has a silvery sheen inside. The scar is large, occupying about half the total width, the smooth area in it narrow or very narrow. The sculptured area toward the columellar side is finely marked with irregular, concentric ridges; that outside of the smooth area has at first some intricate areoles, then a few weak concentric ridges. The length of the scar is two-thirds that of the operculum or somewhat more.

The minute sculpture of the shell is characteristic. It resembles that of *Saulea vitrea* (Born), and is far finer than that of *Afropomus balanoideus* (Gould). By size and sculpture it appears most nearly related to *Pila africana* (v. Martens), from Abetifi and Akra, on the Gold Coast. The chief difference noticed from the description is the diverse color and the presence of bands in all specimens of the Stanleyville shell. This, too, is umbilicate rather than perforate, as *africana* was described.

The shell is much more solid than in young specimens of *P. congoensis;* it is more distinctly sculptured, and the scar of the operculum is relatively much larger.

### **Pila congoensis,** new species

Plate XV, Figures 3 and 4

Stanleyville (type locality), about 60 specimens; Niangara, 15 specimens (Lang and Chapin Coll.). Avakubi, 2 young specimens (J. Bequaert Coll.).

The shell is rather large, inflated, with a large, open umbilicus. Spire moderately produced, corroded. The whorls are strongly convex, narrowly flattened below the deep suture, the last whorl evenly convex, not tapering downward. The surface is glossy, under a strong lens showing very weak, microscopically granular, spiral striæ in some places, marked with slight growth striæ. Isabella color with some darker brownish streaks and rather indistinct narrow olive bands. The aperture is ovate, wide, showing many chestnut bands on a light ground tinged with pink or yellowish; becoming suffused with chestnut in the throat. On the slightly expanding peristome the bands are more vivid. The columella is little thickened and very little expanded, yellowish or orange colored. *The adnate portion of the inner lip is very short,* contained 2½ times in length of aperture.

| | | | |
|---|---|---|---|
| Length, 63.0 mm.; | diameter, 58.0 mm.; | aperture, 45.0×31.0 mm. | Type. |
| " 67.0 | " 59.0 | " 46.0×33.0 | |

The operculum (Plate XIX, figs. 8 and 9) is moderately concave externally, its cuticle finely laminate. The columellar margin is somewhat concave in its apical half. The apex is rectangular, pointed. Inside it has a more or less pinkish gray color in the young stages, but in the old it is largely buff. The scar is relatively small, occupying much less than half the total width; it encloses a smooth area rather large in the young, but which narrows more or less with age; around it there is quite irregularly developed rugosity concentric to the nucleus. Length, 39 mm.; width, 26.5 mm.

This species appears to be related to *Pila wernei*. It differs by the far wider umbilicus and the conspicuously shorter adnate portion of the inner lip. It needs comparison with *P. kordofana*, which we have not seen.

Young shells, 25 or 30 mm. long, show a minute spiral sculpture like that of *P. microglypta*, but not so well developed. This gradually disappears with age and becomes faint or only visible in places in adult shells. The narrower scar of the operculum readily separates such young adults from *microglypta*.

In some of the examples of the type lot a horizontal ledge below the suture scarcely exists, the whorl sloping there as in Pl. XV, fig. 3, yet there seem to be transitional examples. The same two forms occur at Niangara, in the Uele drainage. The Stanleyville specimens appear to be usually free from malleation, but sometimes show small traces. Part of those from Niangara are similar, but others are profusely malleate in an intermediate stage of growth, generally smooth before and after this stage.

Some account of the soft parts is given under the generic head (Fig. 14).

"These large snails (*Pila congoensis*) do not occur in places subject to desiccation by seasonal droughts, nor in rivers with strong current, their principal habitats being muddy, practically stagnant swamps largely overgrown with aquatic plants and connected with the larger streams. Most of these mollusks stay but a few inches and seldom more than a foot below water level, and are often imbedded in the softer surface mud.

"At certain seasons the natives collect them in great quantities for food purposes. But among all the tribes of the northeastern Congo only the older people partake of this dish, the younger ones being afraid of even using the utensil they have been boiled in. The snails are cooked in water with wood ashes, taken from the shell, cleaned, cut to pieces, stewed again, seasoned, and served with palm oil.

"Among the riverine Bakongo tribe along the Uele River one often sees one of these shells fastened to a child's belt, as a protection against drowning, so I was assured by the superstitious. The photograph (Pl. XVI) shows a Bangba native near Niangara, Uele district, wearing a hat completely covered with these shells and surmounted with a tuft of feathers of the African crowned eagle (*Spizaetus coronatus*). Thus worn during certain ceremonies, the shells are supposed to counteract infecundity, considered by the natives a particular affliction and believed to befall those who, when still in reproductive age, have been careless enough to eat these mollusks." (H. L.)

**Pila congoensis amplior**, new subspecies

Plate XV, Figures 1 and 2

Nouvelle Anvers (type locality), one specimen; near Bumba, one specimen; Medje, 2 specimens (Lang and Chapin Coll.).

The shell agrees with *P. congoensis* in the short last whorl, the short adnate portion on the inner lip, and the ample umbilicus; by the same characters differing from *P. leopoldvillensis*. It attains a size much greater than *P. congoensis*. Microscopic sculpture is nearly effaced, but where visible it appears to be like that of *congoensis*. The surface is usually, but not always malleate in some part of the last whorl. The aperture shows various shades from cinnamon to walnut brown within, with more or less orange or yellow toward the lip, which may have a border of some shade of yellow or sometimes vinaceous-pink. There is more color inside than in the *P. leopoldvillensis* seen.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length, | 91.0 mm.; | diameter, | 83.0 mm.; | aperture, | 67.0×45.0 mm. | Nouvelle Anvers; type. Pl. XV, Fig. 2. |
| " | 90.0 | " | 84.0 | " | 67.0×42.0 | Near Bumba. |
| " | 91.0 | " | 81.0 | " | 66.0×44.0 | Medje. |
| " | 72.0 | " | 66.0 | " | 53.0×34.0 | Medje. Pl. XV, Fig. 1. |

Shells of this race are used as saltcellars by the Medje.

The operculum (Pl. XIX, fig. 10) is buff, mottled irregularly with dirty whitish patches and some reddish and olivaceous suffusion, the scar isabella colored, finely rugose concentrically and with local whorls. In the type specimen there is no distinct smooth area in the scar, but in one from Bumba it is distinct, large and raised. The scar is less than half the width of the operculum. Length, 62 mm.; width, 41 mm.; width of scar, 18 mm.

**Pila leopoldvillensis** (Putzeys)

Plate XIV, Figures 1 and 9

*Ampullaria leopoldvillensis* Putzeys, 1898, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. xcviii, fig. 23. Germain, 1907, Bull. Mus. Hist. Nat. Paris, p. 427. G. B. Sowerby, 1910, Proc. Malacol. Soc. London, IX, 1, p. 59. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 50.

*Ampullaria speciosa* var. *globosa* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 328 (type locality: shores of the Congo, near Stanley Pool); 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 531, fig. 90.

Stanley Pool, near Leopoldville (type locality). Stanley Pool near Brazzaville (E. Roubaud Coll.; F. Foureau Coll.). Ukaturaka (J. Bequaert Coll.).

Leopoldville, 3 specimens (J. Bequaert Coll.). Lie, 1 specimen (Lang and Chapin Coll.).

In this species the aperture is narrower than in *P. congoensis*, much as in *P. charmesiana;* the last whorl is long, as seen in front, and the adnate part of the inner lip is relatively long, thereby differing from *P. congoensis amplior*, which attains dimensions nearly as great. The umbilicus, while rather large, is not as open as in *P. congoensis*. Bands are faintly or not visible externally, but more or less apparent in the mouth. The character of the surface varies somewhat, but only one of the examples seen is "*obsolete cingulata*" as the type was described. The lip is whitish with brown spots in some examples, the mouth more or less suffused with pinkish cinnamon within.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length, | 111.5 mm.; | diameter, | 111.0 mm.; | aperture, | 83.0×48.0 mm. | Leopoldville. |
| " | 97.0 | " | 85.0 | " | 73.0×42.0 | Leopoldville. |
| " | 90.0 | " | 82.0 | " | 68.0×42.5 | Lie. |

A half grown specimen (length, 82.5 mm.; diameter, 68.0 mm.; aperture, 60.0×33.0 mm.) was taken somewhere on the middle Congo (the label destroyed). The shell is moderately umbilicate with a rather high spire and recalls *P. ovata* (Olivier) in contour. It is isabella color with light brownish-olive streaks, becoming brussels-brown on the last part. Some duskier bands are faintly visible in the lower half. Surface glossy, showing faint microscopic spirals on the earlier whorls. The whorls are not flattened below the suture. The aperture is narrow, as in *P. charmesiana*, suffused with pink inside. Columella and submargin of the lip nearly white. The adnate portion of the inner lip is very thin, transparent, and long, being half the length of the aperture.

The operculum is long, *narrow*, the columellar margin strongly sigmoid, being decidedly concave in the upper part. Interior pink, fading toward the outer edge. Scar much less than half the total width, with a large smooth area; between that and the columellar side irregularly rugose concentrically. Length, 55.0 mm.; width, 31.0 mm.

In *P. ovata* the operculum is relatively wider, with a larger scar. *P. congoensis amplior* has a much wider operculum, its columellar margin less sigmoid.

"According to Dr. J. Rodhain, common in the papyrus and other swamps of this region." (H. L.)

### Other Species of *Pila* Recorded from the Belgian Congo

### *Pila ovata* (Olivier)

*Ampullaria ovata* OLIVIER, 1804, 'Voyage dans l'Empire Othoman,' II, p. 39, footnote; (an XII), Atlas, Pl. XXXI, fig. 1 (type locality: Alexandria, Egypt). E. A. SMITH, 1880, Proc. Zoöl. Soc. London, p. 348. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 110. PELSENEER, 1886, Bull. Mus Hist. Nat. Belgique, IV, p. 104. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VI, fig. 1; 1890, Ann. Sc. Nat. Zool., (7) X, p. 74, Pl. VI, fig. 1. R. STURANY 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 299. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 158. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 256 (var. *major*); 1913, *op. cit.*, p. 356; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 668, fig. 23 (on p. 669) (var. *major*). E. A. SMITH, 1906, Proc. Zoöl. Soc. London, I, p. 184. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 250 and 262. G. B. SOWERBY, 1910, Proc. Malacol. Soc. London, IX, 1, p. 60. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 101. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 48.

*Pachylabra ovata* Olivier. KOBELT, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 46, Pl. XXXI, fig. 3. (PHILIPPI, 1851, *op. cit.*, Pl. XIV, fig. 5).

Lake Tanganyika: near Ujiji (J. C. Hore Coll.); at the southern end (W. A. Cunnington Coll.); at the northern end (O. Baumann Coll.); near the outlet of the Lukuga River; Kibanga; Karema, Ufipa; Mbwe. The var. *major* was described by Germain from the southern end of Tanganyika (Foà Coll.).

The occurrence of typical *P. ovata* in Lake Tanganika seems beyond doubt. C. R. Bœttger has also recorded this species from the "Upper Congo" (O. Baumann Coll.); and Dautzenberg and Germain list it from Lake Kisale at Kikondja; the Congo at Ukaturaka; and the Lualaba at Nyangwe (all J. Bequaert Coll.). These identifications appear to us dubious since we have been unable to recognize *ovata* among the many specimens brought back by the Congo Expedition.

### *Pila ovata* var. *bridouxi* (Bourguignat)

*Ampullaria bridouxi* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. V, fig. 22; 1890, Ann. Sc. Nat. Zool., (7) X, p. 72, Pl. V, fig. 22. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 156. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 250 and 262.

*Ampullaria ovata* var. *bridouxi* Bourguignat. GERMAIN, 1911, Bull. Mus. Hist. Nat. Paris, p. 439.

*Pachylabra bridouxi* Bourguignat. KOBELT, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 50, Pl. XXXI, fig. 4.

Lake Tanganyika at the mouth of the Malagarazi River and near the outlet of the Lukuga, below the Chakabala Islands (type locality not designated).

This is evidently a large variety of *P. ovata*.

## *Pila ovata* var. *emini* (E. v. Martens)

*Ampullaria ovata* var. *emini* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 160, fig. (type locality: Nyemirembe on Lake Victoria). GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, p. 202.

*Pachylabra ovata* var. *emini* E. v. Martens. KOBELT, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 52, Pl. XXXII, fig. 2.

Lake Edward: near Rumande (Stuhlmann Coll.).

We have seen a young specimen from Kabare, Lake Edward (J. Bequaert Coll.), which evidently belongs to a form of *P. ovata*.

The following forms have been regarded by certain authors as synonyms or variations of *P. ovata*. We mention them here to complete our list of described forms from continental Africa.

*Ampullaria bourguignati* BILLOTTE, 1885, Bull. Soc. Malacol. France, II, p. 107, Pl. VI, fig. 3. Lake Ballat, Lower Egypt.

*Ampullaria dumesniliana* BILLOTTE, 1885, Bull. Soc. Malacol. France, II, p. 104, Pl. VI, fig. 2. Webi-Doboi, near Merca, Somaliland.

*Ampullaria lucida*, PHILIPPI, 1851, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 20, p. 45, Pl. XIII, fig. 2 and Pl. XIV, fig. 4. Egypt.

*Ampullaria raymondi* BOURGUIGNAT, 1863, 'Moll. Nouv.,' I, 3e décade, p. 76, Pl. IX, fig. 4. Lake Ballat, Lower Egypt.

*Ampullaria ovata* var. *deckeni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 159. Zanzibar. We are inclined to accept this as a good race.

*Ampullaria ovata* var. *lamellosa* GERMAIN, 1912, Bull. Mus. Hist. Nat. Paris, p. 323, fig. 61 (on p. 324). River Niger. This appears to be a distinct species; the shaoe is not like that of *Pila ovata*.

## *Pila stuhlmanni* (E. v. Martens)

*Ampullaria erythrostoma* var. *stuhlmanni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 155, fig. J. THIELE. 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 210. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, p. 201.

*Pachylabra erythrostoma* var. *stuhlmanni* E. v. Martens. KOBELT, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 54, Pl. XXXII, fig. 1.

Lake Albert: near Kassenje (type locality; Stuhlmann Coll.; Schubotz Coll.). Lake Edward (?): Katarenge (one doubtful specimen, Stuhlmann Coll.; Germain merely copies v. Martens' record, making the identification definite, without, however, giving his reasons for doing so).

*Ampullaria erythrostoma* REEVE, 1856, 'Conchol. Iconica,' X, *Ampullaria*, Pl. XIII, fig. 59, was described as from Zanzibar. According to Sowerby (1909, Proc. Malacol. Soc. London, VIII, p. 363), this was, however, an erroneous locality, since

Reeve's specimen cannot be distinguished from the South American *Ampullarius guyanensis* (Lamarck). E. v. Martens' var. *stuhlmanni* should therefore be given specific rank.

### *Pila wernei* (Philippi)

*Ampullaria wernei* PHILIPPI, 1851, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 20, p. 19, Pl. XVII, fig. 2 (not Pl. v, fig. 4, which is *P. charmesiana*) (type locality: White Nile). E. A. SMITH, 1888, Proc. Zoöl. Soc. London, p. 53. DAUTZENBERG, 1891, Bull. Ac. Sc. Belgique, (3) XX, (1890), p. 569. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 328; 1908, A. Chevalier, 'L'Afrique Centrale Française,' p. 530. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 102.

It seems doubtful whether *P. wernei* actually occurs within our territory. Smith (1888) says that two young shells collected in Lake Albert by S. Baker (1864) "appear to be the early stages of this species."[1] Dautzenberg (1891) records it from the islands below Fort de Possel in the Ubangi River (Foureau Coll.) and C. R. Bœttger (1913) from the Kasai River (Wissmann Coll.). We are inclined to believe that these Congo records are all based on erroneous identifications.

### LANISTES Denys de Montfort

*Lanistes* DENYS DE MONTFORT, 1810, 'Conchyl. Systém.,' II, p. 122. Monotype: *Lanistes oliverii* Denys de Montfort = *Cyclostoma carinata* Olivier.

*Ampullaria* subgenus *Lanites* SWAINSON, 1840, 'Treatise on Malacology,' p. 339. Misspelling of *Lanistes*.

*Meladomus* section *Libyciana* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 176. Type by present designation: *Ampullaria libyca* Morelet.

*Meladomus* section *Bolteniana* BOURGUIGNAT, 1889, *op. cit.*, p. 178. Type by present designation: *Helix bolteniana* Chemnitz = *Cyclostoma carinata* Olivier.

*Meladomus* section *Nyassana* BOURGUIGNAT, 1889, *op. cit.*, p. 179. Monotype: *Lanistes nyassanus* Dohrn.

Ampullariidæ with the shell sinistral, the operculum wholly corneous.

The soft parts are dextral as in *Pila*, and the left epipodial lobe is rather short.

Bouvier [1891, Le Naturaliste, (2), No. 103, pp. 143-147] has figured living *Lanistes carinatus* which he kept in an aquarium. The very short siphon is incapable of extension materially beyond the edge of the shell.

*Lanistes purpureus* was said by O. Neumann to be viviparous (E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 163). A. d'Ailly (1896, Bihang Svenska Vet. Ak. Handl., Stockholm, XXII, Afd. 4, No. 2, p. 126), however, described the eggs of *L. lybicus*, of Cameroon, which, he says, are agglomerated on aquatic plants; one of the masses contained fifteen spherical eggs, 3.5 mm. to 4 mm. in diameter, with a rather strong, transparent membrane. We found no embryos in the specimens we have opened, four of *L. procerus langi*, about twenty of *L. nsendweensis*, and nine of *L. graueri*, though the majority were females.

[1]These specimens had been referred to *Lanistes* by H. Adams (1866, Proc. Zool. Soc. London, p. 376).

This genus is strictly Ethiopian and Malagassan. On the African continent it appears to have much the same distribution as *Pila*, extending northward to the delta of the Nile in the east, to Lake Chad and Senegal in the west; in South Africa it is found in Angola, Lake Ngami, the Zambezi Basin, Portuguese East Africa, and eastern Transvaal. The southernmost record appears to be Delagoa Bay. In the west the genus is unknown south of the Cunene.

It is of considerable interest that a number of fossil species of *Lanistes* have been found in the Tertiary of Lower Egypt. The oldest of these is *Lanistes antiquus* Blanckenhorn from the Middle Eocene or Lutetian of Fayûm. It is regarded as an ancestor of the *L. carinatus* group. *Lanistes bartonianus* Blanckenhorn of the Upper Eocene (Bartonian) appears to be still more closely related to the recent *L. carinatus* (Olivier). The other species, *Lanistes irregularis* (Blanckenhorn) (=*transiens* Mayer-Eymar) and *L. sandbergeri* (Mayer-Eymar), appear to be much more depressed than any of the living forms All four species, however, seem to belong to the subgenus *Lanistes* proper.[1]

While the shell of *Lanistes* is ordinarily spoken of as "sinistral," it is well known to be really ultradextral or hyperstrophic; the unpaired organs of the soft parts, as first noticed by Troschel for *L. ovum*,[2] are not reversed, but occupy the same positions they have in dextral Ampullariidæ. A planorboid ancestor of *Lanistes*, similar to the American *Ceratodes*, is therefore to be sought in early Tertiary or Mesozoic deposits. *Lanistes irregularis* and *L. sandbergeri* appear to be transitional forms approaching this hypothetical ancestor. *Ceratodes* is disqualified as a group ancestral to *Lanistes* by being longisiphonate, a more evolved condition than the brevisiphonate *Lanistes*. Since *Lanistes* had a planorboid ancestor, the openly coiled forms of the *carinatus* group, or *Lanistes* proper, are relatively primitive in structure of the shell, *Meladomus* being further evolved, and *Leroya* the final stage.

The soft parts of *Lanistes procerus langi* are very similar externally to those of *Pila congoënsis*. Both epipodial lobes are somewhat larger (in the alcoholic examples). The orifice of the lung is close to the left border, 8 mm. long, placed substantially as figured for *Pila*, the osphradium immediately anterior to it. The gill is on the right side, running back from the penis, as in *Pila*. The longitudinal ridge of the floor of the gill chamber is well developed, thin, and about 2 mm. high. The

[1]See C. Mayer-Eymar, 1901, Vierteljahrschr. Naturf. Ges. Zürich, XLVI, pp. 22–34, Pls. I–II. M. Blanckenhorn, 1901, Centralbl. Mineral., Geol. u. Paläont., pp. 270–275. R. B. Newton, 1912, Proc. Malacol. Soc. London, X, 2, pp. 74–75.

[2]1845 Archiv f. Naturgesch., XI, 1, p. 213.

penis is substantially as described for *Pila congoensis*. These parts are drawn in Fig. 16*b*, from an individual of average size.

*Lanistes (Leroya) graueri* has the lung orifice as described above but smaller—a slit 4 mm. long, at the left border of the lung, immediately behind the prominent osphradium, which is about 2 mm. from the edge of the mantle.

*Lanistes nsendweensis* also has the lung orifice situated as in *L. p. langi*, at the left border of the lung, about 7 mm. long in a shell of 24 mm. diameter. The penis (seen turned into the mantle cavity in Fig. 16*a*) is slender and grooved, as described for *Pila congoensis* and *L. p. langi*, with a fleshy sheath perforated at the end, but the folded edges are concrescent. It is 4 mm. long (as preserved in alcohol) in a shell of 21 mm. diameter.

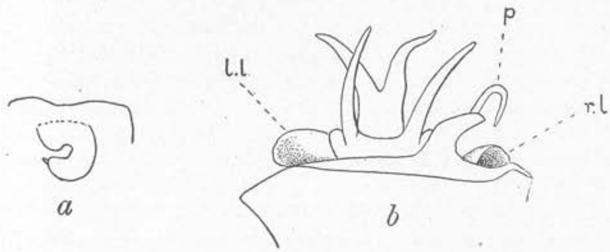


Fig. 16. *a*, *Lanistes nsendweensis* Dupuis and Putzeys, penis turned into the mantle cavity. *b*, *Lanistes procerus langi* Pilsbry and Bequaert, head and front of mantle.

ll, rl, left and right epipodial lobes; p, penis.

The radular teeth of *Lanistes* do not appear to differ materially from those of *Pila*, though in the three species we have examined the central teeth differ in outline, having narrower upper margin and more sloping side margins than in *Pila congoensis*. *L. graueri* is peculiar by the broad body of the inner marginal tooth. The teeth of both genera are drawn in Fig. 13, on p. 168.

*Lanistes (Lanistes) nsendweensis* (Fig. 13*e*) has the upper margin of the central tooth shorter, the lateral margins sloping less steeply. The body of the lateral tooth is narrower; even when the tooth is lying free, the cusps foreshortened, it is not so wide as in *Pila*. Formula of cusps as in *Pila*, except that the central has seven denticles instead of five. Width of the central tooth, 0.377 mm.

*Lanistes (Meladomus) procerus langi* (Fig. 13*c*) differs from *L. nsendweensis* by having the side teeth decidedly longer. Width of the central tooth, 0.525 mm.

*Lanistes* (*Leroya*) *graueri* (Fig. 13*d*), has the upper margin of the central tooth shorter than in any other species seen, the basi-lateral angles more produced. The cusps of the side teeth are short. The inner marginal has a very wide body, unlike the other species. Width of the central tooth, 0.445 mm.

The identification of species in this genus is often extremely difficult and sometimes uncertain. This is due in part to the intrinsic difficulty of dealing with a group of closely related forms, but also to the large number of species described without adequate comparisons with other forms.

Subgenus **Lanistes** proper

The following species belong to this group:

*Lanistes alexandri* (Bourguignat) = *Meladomus alexandri* Bourguignat, 1889, 'Moll. Afrique Equator.,' p. 177. Affluents of the Vuami River, above Sadani, East Africa. This is perhaps based on an immature example of another species.

*Lanistes assiniensis* (Kobelt) = *Meladomus libycus assiniensis* Kobelt, 1912, Nachrichtsbl. Deutsch. Malakoz. Ges., XLIV, p. 7; 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 30, Pl. xxvi, figs. 6-7. Assinie.

*Lanistes bernardianus* (Morelet) = *Ampullaria bernardiana* Morelet, 1860, Journ. de Conchyl., VIII, p. 190. Guinea. Perhaps a variety of *L. libycus* (Morelet).

*Lanistes bicarinatus* Germain. See p. 193.

*Lanistes carinatus* (Olivier) = *Ampullaria carinata* Olivier, 1804, 'Voyage dans l'Empire Othoman,' II, p. 39, footnote; (an xii), Atlas, Pl. xxxi, figs. 2*A*-*B* (type locality: Kalidje Canal near Alexandria, Egypt). *Helix bolteniana* Chemnitz, 1786, 'Syst. Conch. Cab.,' IX, 1, p. 89, Pl. civ, figs. 921-922 (not used as a binomial). *Lanistes oliverii* Denys de Montfort, 1810, 'Conchyl. Systém.,' II, p. 123, fig. (on p. 122). *Ampullaria ægyptiaca* "Ehrenberg" Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, p: 227. *Lanistes duveyrierianus* Revoil, 1885, Bull. Soc. Malacol. France, II, p. 99, Pl. vi, fig. 5. *Lanistes bolteni* Pallary, 1909, Mém. Inst. Egyptien, VI, 1, p. 61, Pl. iv, fig. 14 (with var. *perfecta* Pallary, p. 62, from Egypt, without more definite locality).

Nevill (1884, 'Hand List Moll. Indian Mus.,' II, p. 14) has listed, without describing them, a var. *bicarinatus* and a var. *depressus* of *Lanistes carinatus*, both from Egypt.

*Lanistes chaperi* (Kobelt) = *Meladomus libycus chaperi* Kobelt, 1912, Nachrichtsbl. Deutsch. Malakoz. Ges., XLIV, p. 7; 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 30, Pl. xxvii, figs. 3-6. Dahomey.

*Lanistes ciliatus* E. v. Martens, 1878, Monatsber. Ak. Wiss. Berlin, p. 296, Pl. ii, figs. 8-10. Finboni, East Africa.

*Lanistes congicus* O. Bœttger. See p. 188.

*Lanistes congicus fraternus* Pilsbry and Bequaert. See p. 189.

*Lanistes congicus schepmani* C. R. Bœttger. See p. 190.

*Lanistes fultoni* (Kobelt) = *Meladomus* (*Lanistes*) *fultoni* Kobelt, 1912, Nachrichtsbl. Deutsch. Malakoz. Ges., XLIV, p. 6; 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 28, Pl. xxvii, figs. 1-2. Lake Victoria. This species appears to be extremely close to *L. bicarinatus* Germain.

*Lanistes holostoma* (Morelet) = *Ampullaria holostoma* MORELET, 1860, Journ. de Conchyl., VIII, p. 191. Guinea.

*Lanistes intortus* (Lamarck). See p. 192.

*Lanistes letourneuxi* (Bourguignat) = *Meladomus letourneuxi* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 41. BERTHIER, 1885, Bull. Soc. Malacol. France, II, p. 101, Pl. VI, fig. 4. Nile, near Damiette. This species would perhaps be more correctly placed in the subgenus *Meladomus*.

*Lanistes libycus* (Morelet) = *Ampullaria libyca* MORELET, 1848, Rev. Zool. Soc. Cuviér., p. 354; 1858, 'Séries Conchyl.,' I, p. 28, Pl. III, fig. 9, Gaboon.

*Lanistes millestriatus* Pilsbry and Bequaert. See p. 188.

*Lanistes neavei* MELVILL AND STANDEN, 1907, Mem. Manchester Litt. Phil. Soc., LI, No. 4, p. 6, Pl., fig. 1. Kapopo, Northern Rhodesia. A var. *unicolor* Melvill and Standen together with the typical form.

*Lanistes nsendweensis* (Dupuis and Putzeys). See p. 190.

*Lanistes nsendweensis katanganus* Pilsbry and Bequaert. See p. 191.

*Lanistes nyassanus* DOHRN, 1865, Proc. Zoöl. Soc. London, p. 233. E. A. SMITH, 1877, *op. cit.*, p. 715, Pl. LXXIV, figs. 8-9. Southern end of Lake Nyasa and near the small lake Pamolombue of the Shire River. On account of its very flattened spire, this species seemingly belongs in a distinct group, for which Bourguignat's name *Nyassana* would be available.

*Lanistes palustris* (Morelet) = *Ampullaria palustris* MORELET, 1864, Journ. de Conchyl., XII, p. 158. Lake Ebrie, Grand Bassam, Ivory Coast.

*Lanistes pfeifferi* (Bourguignat) = *Meladomus pfeifferi* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 173. *Lanistes libycus* var. E. v. MARTENS, 1866, in Pfeiffer, 'Novit. Conchol.,' II, p. 286, Pl. LXX, figs. 5-6 (not of Morelet). Gaboon.

*Lanistes schweinfurthi* (Ancey) = *Meladomus schweinfurthi* ANCEY, 1894, Mém. Soc. Zool. France, VII, p. 223, footnote. Lake Victoria.

*Lanistes senegalensis* (Kobelt) = *Meladomus* (*Lanistes*) *senegalensis* KOBELT, 1912, Nachrichtsbl. Deutsch. Malakoz. Ges., XLIV, p. 6; 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 31, Pl. XXVIII, figs. 13-14. Senegal.

*Lanistes solidus* E. A. SMITH, 1877, Proc. Zoöl. Soc. London, p. 716, Pl. LXXIV, figs. 10-11. Lake Nyasa. This may belong to the same group as *Lanistes nyassanus* Dohrn.

*Lanistes subcarinatus* (J. Sowerby) = *Ampullaria subcarinata* JAMES SOWERBY, 1822, 'Genera of Shells,' No. 4 *Ampullaria*, fig. 4 of Plate (with short description on third page of accompanying letter-press). River Congo. This shell was apparently obtained in the Congo estuary by Cranch, the naturalist of the Tuckey Expedition (1816). See our remarks upon this species under the treatment of *L. intortus* (Lamarck).

*Lanistes varicus* (O. F. Müller) = *Helix varica* O. F. MÜLLER, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 70 (no locality mentioned). *Ampullaria guinaica* LAMARCK, 1822, 'Hist. Nat. Anim. sans Vertèbres,' VI, 2, p. 178 (figured without name in 1816, 'Encyclop. Méthod., Vers,' Pl. CCCCLVII, figs. 1*a*-*b*. Rivers of Guinea). *Ampullaria olivacea* BORY DE ST. VINCENT, 1827, 'Encyclop. Méthod., Vers,' Explanation of Plates, p. 177.

Germain (1917, Bull. Mus. Hist. Nat. Paris, p. 514) has described *Lanistes guinaicus* mut. *depressa* from Dahomey.

*Lanistes guinaicus* has generally been credited to Lamarck or to Chemnitz. Philippi pointed out that "die Priorität hat unstreitig der Müller'sche Name," but he did not adopt it. Müller described his *Helix varica* from a specimen in the Spengler collection which Chemnitz subsequently described and figured in 1786, 'Systematisches Conchylien Cabinet,' IX, p. 80, Pl. CVIII, figs. 913, 914.

*Helix lusitanica* Linnæus (1767, 'Syst. Nat.,' 12th Ed., I, 2, p. 1245), which Philippi quotes with doubt under *Ampullaria guinaica* Lamarck, was based upon a specimen of *Zonites algirus*, according to Hanley, although Linnæus referred to a figure of *Lanistes carinatus* (Olivier) in Gualtieri as illustrating his species.

*Lanistes vignoni* (Bourguignat) = *Meladomus vignoni* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 177. *Lanistes bernardianus* E. v. MARTENS, 1866, in Pfeiffer, 'Novit. Conchol.,' II, p. 286, Pl. LXX, figs. 1-4 (not of Morelet). Lagos.

### **Lanistes millestriatus**, new species

Plate XVIII, Figure 5

West Africa (Wheatley collection, No. 120,396, A. N. S. P.).

The shell is rather thin and light and resembles *L. varicus* (Müller) closely in shape and character of the umbilicus, but it differs by the sculpture of extremely fine, close and regular striæ in the direction of lines of growth. The color is lavender under a thin citrine-drab cuticle, which has scaled off in places. The striation is as distinct in such denuded patches as where the cuticle is preserved. The penult and next earlier whorls show no angulation and there is none around the umbilicus. The aperture is shaped much as in *L. varicus* but is a little narrower.

Length, 28.5 mm.; diameter, 32.5 mm.; aperture, 21.3×15.5 mm.

### **Lanistes congicus** O. Bœttger

Plate XVIII, Figures 12–15

*Lanistes congicus* O. BŒTTGER, 1891, Notes Leyden Mus., XIII, p. 111 (type locality: village of Elau near San Salvador, Angola). C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 103.

*Meladomus congicus* O. Bœttger. KOBELT, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 39, Pl. XX, figs. 2 and 3 (not the other figure).

*Lanistes bourguignoni* PUTZEYS, 1898, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. xxvi, figs. 9-11.

*Lanistes congicus* var. *bourguignoni* Putzeys. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 103.

Mouth of the Luima River (between Isangila and Manyanga in the Lower Congo; type locality of *L. bourguignoni*). In the region of brackish water at the estuary of the Congo and in the district of the Cataracts (P. Hesse Coll.).

Dautzenberg and Germain (1914, Rev. Zool. Afric., IV, 1, p. 51) record *L. bourguignoni* from Basoko; Kibombo; the Lualaba River in the Katanga district; between Kikondja and Ankoro; and the Little Lubembe River (all J. Bequaert Coll.). We are inclined to believe that none of these specimens were true *L. bourguignoni* Putzeys, which in our opinion cannot be separated as a race from *L. congicus* O. Bœttger. The specimens from the three first named localities we have not seen;

those from between Kikondja and Ankoro we refer to *L. nsendweensis* (Dupuis and Putzeys), while those from the Little Lubembe River are described in this paper as a new subspecies of *nsendweensis.*

Kidada, in the Lukungu River (H. Schouteden Coll.).

This is a much more depressed shell than *L. lybicus* (Morelet), characterized by the flat, horizontal zone below the suture, rectangularly bounded by a shoulder angle, which in old specimens becomes rounded on the latter part of the last whorl. This shoulder angle causes the spire to rise by abrupt stages. The first three-quarters of a whorl are strongly convex, the keel then beginning. The surface shows fine, irregular growth-striæ and very weak, minute and close spirals. In unrubbed, young examples, the fine axial striæ bear delicate cuticular threads, which also unite at intervals into spirals. In one specimen there are several inconspicuous and irregularly developed spiral ridges, like those produced by malleation, on the last whorl. A blunt keel bounds the rather large, well-like umbilicus.

Length, 21.5 mm.; diameter, 23 mm.; 4½ whorls, the apex perfect.

These specimens are not so large as O. Bœttger's type, but they agree with that in the contour of the spire.

In a lot of small, but apparently adult, shells from Boma (Lang and Chapin Coll.), Pl. XVIII, figs. 13-15, the spire is more elevated than in typical *congicus*, not so high as in the var. *schepmani*. The carina above is decidedly nearer the suture, and weakens on the last whorl. The narrow umbilicus has a rather strong bounding cord, and the dull reddish bands cover most of the surface. These specimens do not appear referable to either of the forms assembled under *L. congicus*, but in the present condition of the subject we hesitate to segregate them by another name.

Length, 15.0 mm.; diameter, 17.0 mm.
" 15.0 " 16.0 ; 4¼ whorls.

**Lanistes congicus fraternus,** new subspecies

Plate XVIII, Figure 16

Congo River, 2 to 3 kilometers below Kinshasa, on the Belgian side (type locality); also bank of the Congo at Dolo (near Kinshasa). On floating plants (Maurice Bequaert Coll.).

The shell resembles *L. congicus* in being depressed, with a well-like umbilicus. The penult whorl is strongly angular above (earlier whorls eroded). The last whorl is flattened below the suture, but not in the least angular; it is bluntly angular around the umbilicus. It is glossy, with sculpture of growth-lines only. Color ecru-olive with blackish-brown bands.

Length, 16.0 mm.; diameter, 19.0 mm.; aperture, 12.7×9.5 mm.

In the immature stage (diameter, 10 to 13 mm.), the form is more globose, nearly as high as wide (length, 12.5 mm.; diameter, 13.5 mm.). There is a strong angle, or even for part of its length, a carina above, on the second and third whorls, then becoming rounded. This angle is much nearer the suture than in typical *congicus*. There is also a distinct umbilical cord. The surface below the angle has six or eight spiral cuticular threads. On the last whorl, when not rubbed, such spaced threads continue over the whole surface, though smaller and disappearing with growth. This structure of the cuticle is not seen in equally young, well-preserved *L. nsendweensis*.

In the fully adult stage this form resembles *L. nsendweensis* by the loss of its superior carina. The immature stages, however, show relationship to *L. congicus* which occurs farther down the river.

### *Lanistes congicus* var. *schepmani* C. R. Bœttger

*Lanistes congicus* var. *schepmani* C. R. Bœttger, 1913. Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 104.

*Lanistes congicus* var. Schepman, 1891, Notes Leyden Mus., XIII, p. 111, Pl. viii, figs. 1*a-c* and 2*a-c*.

*Meladomus congicus* W. Kobelt, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' Pl. xxx, fig. 1 (not the other figures).

Type locality: Landana (Petit Coll.).

### **Lanistes nsendweensis** (Dupuis and Putzeys)

Plate XVIII, Figures 6–10

*Lanistes libycus* var. *nsendweensis* Dupuis and Putzeys, 1901, Ann. Soc. Malacol. Belgique, XXXVI, Bull. Séances, p. lvi, fig. 27. C. R. Bœttger, 1913, *op. cit.*, XLVII, (1912), p . 104.

*Meladomus nsendweensis* Dupuis and Putzeys. Kobelt, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 41, Pl. xxviii, figs. 11 and 12.

*Lanistes foai* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 256; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 671, figs. 24 and 25; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 536.

In the Lualaba at Nsendwe, Nyangwe, and Kasongo (Dupuis Coll.; type locality not designated). *L. foai* was described from the "Upper Congo" (Foà Coll.).

Tshikapa (H. Schouteden Coll.). Medje, 1 specimen; Stanleyville, several hundred specimens (Lang and Chapin Coll.). Aruwimi River at Djali (below Banalia) and at Panga; between Ankoro and Kikondja (J. Bequaert Coll.). Hemptinne St. Benoît (Callewaert Coll.).

The shell is rather solid, decidedly wider than high, openly umbilicate, generally not angular around the umbilicus, but sometimes distinctly so; flattened and slightly excavated below the suture, the depressed zone bounded by a distinct angle in the upper whorls, but this is obsolete on the last. The glossy surface is smoothish except for lines of growth, but sometimes faint spiral striæ are traceable in places. The color is chamois or more olivaceous, with chestnut-brown or olive bands. The quite oblique aperture is rather wide. Columella moderately white-calloused. Adnate part of the inner lip rather short. The upper whorls are always eroded, more or less.

| | | | | | |
|---|---|---|---|---|---|
| Length, | 24.0 mm., | diameter, | 29.0 mm.; | aperture, 19×13.5 mm. | Stanleyville |
| " | 25.0 | " | 26.5 | Stanleyville. | |
| " | 19.0 | " | 20.0 | Between Ankoro and Kikondja. | |

The spire is never so deeply eroded as in *L. graueri*, which lives associated with *nsendweensis* in some places. In some young examples, 8 to 10 mm. in diameter, the strongly convex initial whorl is seen to be very minutely pitted.

The form is always more depressed than in *L. libycus* (Morelet), from which the absence or very slight development of spiral sculpture also separates it. In quite young shells, of about 12 mm. diameter, the length and diameter are equal, but in later stages the diameter increases faster than the length. The flat zone along the suture is narrower than in *L. congicus*, and its bounding angle is far less strongly developed, being sharp only in the earlier stages of growth.

*L. nsendweensis* appears to be a common and generally distributed species of its region.

"These snails were numerous in the Congo River near Stanleyville about the rocky portions below the falls (Pl. LXIV, fig. 1), where in the many quiet stretches they are sheltered from the direct influence of the current. Also found in some of the smaller forest affluents and a few swampy places near the river." (H. L.)

**Lanistes nsendweensis katanganus**, new subspecies

Plate XVIII, Figure 11

Little Lubembe River in Upper Katanga (J. Bequaert Coll.). These specimens were recorded under the name "*Lanistes bourguignoni* Putzeys" by Dautzenberg and Germain (1914, Rev. Zool. Afric., IV, 1, p. 51).

The shell resembles *L. nsendweensis* in miniature. There is an angle on the second whorl, weakening on the third, and absent on the last whorl, in which the subsutural flattening is rather indistinct toward the end. The narrow umbilicus has no trace of a bordering angulation. The first whorl is strongly convex, with a beautiful, close, pitted sculpture.

Length, 15.3 mm.; diameter, 17 mm.; 4¼ whorls.

The apex is perfectly preserved, owing to the thick coat of iron hydroxide.

*L. neavei* Melvill and Standen, from Kapopo, northern Rhodesia, appears to be close to this form. The locality is not far away, but in the Zambezi drainage. It differs by the wider umbilicus as shown in the figures, and nothing is said of angulation of the upper whorls.

**Lanistes intortus** (Lamarck)

Plate XVIII, Figures 2, 3, 4

*Ampullaria intorta* Lamarck, 1822, 'Hist. Nat. Anim. sans Vertèbres,' VI, 2, p. 179 (without locality); figured without name in 1816, 'Encyclop. Méthod., Vers,' Pl. cccclvii, figs. 4*a-b*. Bory de St. Vincent, 1827, 'Encyclop. Méthod., Vers,' Explanation of Plates, p. 177. O. Bœttger, 1885, 24. u. 25. Bericht. Offenbacher Ver. f. Naturk., p. 193.

*Lanistes intortus* Lamarck. E. v. Martens, 1870, in Pfeiffer, 'Novit. Conchol.,' V, p. 191, Pl. clvii, figs. 1-3; 1882, Jahrb. Deutsch. Malakoz. Ges., IX, p. 248. Dupuis and Putzeys, 1901, Ann. Soc. Malacol. Belgique, XXXVI, Bull. Séances, p. lx. C. R. Bœttger, 1913, *op. cit.*, XLVII, (1912), p. 102.

*Meladomus intortus* Lamarck. Kobelt, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 27, Pl. xxix, figs. 4-6.

*Meladomus intortus* var. *hessei* Kobelt, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 43, Pl. xxx*a*, figs. 6-8.

Near Banana (German Expedition of the "Gazelle" and P. Hesse Coll.); in brackish water at San Antonio (P. Hesse Coll.). Zambi (Dupuis Coll.). Boma (Pohl Coll.). Dupuis and Putzeys also refer to this species, two specimens from Stanley Falls (Dupuis Coll.). We have not recognized *intortus* among the numerous specimens of *Lanistes* we have seen from that locality. Also recorded from the coast of Loango.

Zambi (Lang and Chapin and J. Bequaert Coll.). Malela (J. Bequaert Coll.). Banana (Lang and Chapin Coll.).

The history of this species has been discussed by von Martens, Kobelt, and C. R. Bœttger. The origin of Lamarck's specimen was not known, and his figure shows a narrower aperture than specimens from the Congo mouth treated of by the authors mentioned; yet this may have been due to faulty drawing, and, on the whole, we agree with von Martens and Bœttger that *A. intorta* of Lamarck applies to the form under consideration.

The shell is turbinate with small umbilicus, which rapidly widens at the opening, funnel-like, and is bounded by an angle varying from distinct to weak. There is a very inconspicuous shoulder angle on the upper whorls when these are well preserved. Later whorls remain flattened below the suture, but are not in the least angular. The last whorl is strongly convex. The glossy surface is lightly marked with growth-lines, but no spiral sculpture. The color is chamois with chestnut-brown bands variously arranged, and either few or many. In some old examples these are almost lost in a general darkening of the whorl. The aperture is broadly oval, wide in the upper part. The columella is long, whitish, thin. Adnate portion of the inner lip is quite short

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length, | 31.0 mm.; | diameter, | 28.5 mm.; | aperture, | 19.0×15.0 mm. | Zambi. |
| " | 28.0 | " | 28.0 | " | 19.5×15.5 | " |
| " | 30.0 | " | 29.0 | " | 19.0×15.0 | " |
| " | 30.0 | " | 30.5 | " | 21.0×17.0 | Malela. |

The operculum has a large, very distinctly defined scar, irregularly and rather strongly roughened with traces of concentric wrinkles near the nucleus. Color very dark brown, the scar and border black. It measured 19.0×14.0 mm. in a shell of 30.5 mm. diameter.

*L. nsendweensis* is a more depressed shell, with the spire less broadened, the umbilicus wider in large shells, and the subsutural flattening is more pronounced; it is also more solid.

*Ampullaria subcarinata* Sowerby, was described from the Congo, believed to have been collected by Cranch on the Tuckey Expedition; if so, it was taken in the Congo mouth region where *L. intortus* is found. It is therefore probably, as von Martens thought, a form of this species; yet the shorter spire and larger aperture shown in the figures of both Sowerby and Swainson cast a little doubt on this identification.

"At Zambi, Malela, and Banana *Lanistes intortus* was found always near the shore of the river on the edges of sandbanks, frequently where, due to the shallowness of the water, there are muddy, algæ-covered sites." (H. L.).

**Lanistes bicarinatus** Germain

Plate XVIII, Figure 1

*Lanistes bicarinatus* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 428, fig. 27 (type locality: in the Congo River at Brazzaville).

Leopoldville (J. Bequaert Coll.).

Germain has given a good account of this handsome species, but from a small, probably quite immature example of 25 mm. diameter.

A fine specimen from Leopoldville shows the adult form. There is a strong carina at the shoulder, which almost disappears before reaching the lip. Above it the surface slopes up to the suture. The second or peripheral angle is well developed on the face of the last whorl, but disappears on its last half. A strong angle bounds the deep, well-like umbilicus. The glossy surface shows very slight traces of fine spiral striæ in places. The color is brownish-olive above, chamois beneath, with chestnut-brown bands.

Length, 39.0 mm.; diameter, 39.0 mm.; 5½ whorls, the apex being slightly eroded.

This species differs conspicuously from *L. congicus* by the decidedly sloping zone between the shoulder keel and the suture. *L. fultoni* (Kobelt), thought to be from Lake Victoria, does not seem to differ materially from *bicarinatus*, to judge from Kobelt's description and figures. The collector was not stated and perhaps the locality assigned may prove incorrect.

## Subgenus **Meladomus** Swainson

*Meladomus* Swainson, 1840, 'Treatise on Malacology,' p. 340. Monotype: *Meladomus bulimoides* Swainson = *Ampullaria purpurea* Jonas.

This group contains the following species:

*Lanistes adansoni* Kobelt. See p. 196.

*Lanistes affinis* E. A. Smith, 1877, Proc. Zool. Soc. London, p. 716, Pl. lxxiv, fig. 7. Lake Nyasa.

*Lanistes affinis* var. *manyaranus* R. Sturany, 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 310, Pl. xxiv, fig. 32. Lake Manyara, Tanganyika Territory.

*Lanistes ambiguus* (E. v. Martens) = *Lanistes olivaceus* var. *ambiguus* E. v. Martens, 1866, in Pfeiffer, 'Novit. Conchol.,' II, p. 292, Pl. lxxi, figs. 3-4. Mozambique.

*Lanistes bloyeti* (Bourguignat) = *Meladomus bloyeti* Bourguignat, 1889, 'Moll. Afrique Equator.,' p. 171. Near Kondoa, Tanganyika Territory.

*Lanistes bœttgeri* (Kobelt) = *Meladomus libycus* var. *bœttgeri* Kobelt, 1912, Nachrichtsbl. Deutsch. Malakoz. Ges., XLIV, p. 7; 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 41, Pl. xxx, figs. 9-10. Gaboon.

*Lanistes deguerryanus* (Bourguignat) = *Meladomus deguerryanus* Bourguignat, 1889, 'Moll. Afrique Equator.,' p. 175. Kingani River (near Mbiki, Ukuere) and Makata River (an affluent of the Vuami), Tanganyika Territory.

*Lanistes ellipticus* E. v. Martens. See p. 198.

*Lanistes ellipticus luapulensis* Furtado. See p. 199.

*Lanistes ellipticus* var. *trapeziformis* Furtado, 1886, Journ. de Conchyl., XXXIV, p. 150. Zambezi River (below Tete) and Cuando River.

*Lanistes grasseti* (Morelet) = *Ampullaria grasseti* Morelet, 1863, Journ. de Conchyl., XI, p. 267, Pl. x, fig. 2. *Lanistes plicosus* E. v. Martens, 1870, in Pfeiffer, 'Novit. Conchol.,' V, p. 191, Pl. clvi, figs. 3-5 (from an unknown locality). *Lanistes martensianus* "Maltzan" E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth., p. 167 (as a synonym of *L. grasseti*). Madagascar. We have seen several specimens said to have come from that island and also one labeled Mozambique. There can be little doubt that *L. plicosus* v. Martens, 1879, is *L. grasseti*, as v. Martens seems to have recognized himself. But *L. ovum* var. *plicosus* v. Martens, 1897, is an entirely different form.

*Lanistes gribinguiensis* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 487; in A. Chevalier, 'L'Afrique Centrale Française,' p. 534, Pl. v, fig. 15. Gribingui River, an affluent of the Chari, French Equatorial Africa.

*Lanistes innesi* PALLARY, 1903, Bull. Inst. Egyptien, (4) III, (1902), p. 91, Pl. I, fig. 2. White Nile.

*Lanistes jouberti* (Bourguignat). See p. 199.

*Lanistes niloticus* (Swainson) = *Ampullaria nilotica* SWAINSON, 1831, 'Zool. Illustrations,' (2) I, Pl. XXXVIII, fig. 2 (the two central figures); with description in accompanying letter-press. No locality mentioned. The species is not determinable.

*Lanistes nitidissimus* (Bourguignat) = *Meladomus nitidissimus* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 171. Affluent of Kingani River near Bagamoyo; Vuami River near Kondoa; plain of Uha on the shores of the Russugi River; all in Tanganyika Territory.

*Lanistes olivaceus* (J. Sowerby) = *Paludina olivacea* JAMES SOWERBY, 1825, 'Catalogue of the shells of Earl Tankerville,' Appendix, p. ix; 1834, 'Genera of Shells,' No. 41, *Paludina*, fig. 3. No locality mentioned. Undeterminable; this may be either *L. ovum* (Peters) or *L. purpureus* (Jonas).

*Lanistes ovum* (Peters). See p. 196.

*Lanistes ovum elatior* E. v. Martens. See p. 196.

*Lanistes ovum ingens* (Ancey) = *Meladomus ovum* var. *ingens* ANCEY, 1894, Mém. Soc. Zool. France, VII, p. 223. Lake Nyasa, at Karonga.

*Lanistes ovum* var. *lacoini* GERMAIN, 1906, Mém. Soc. Zool. France, XIX, p. 324; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 533, Pl. v, fig. 16. Lower Chari River (between Buguman and Fort Lamy), French Equatorial Africa.

*Lanistes ovum* var. *major* Germain. See p. 196.

*Lanistes ovum* var. *plicatus* E. v. MARTENS, in Kobelt, 1909, Abh. Senckenb. Naturf. Ges., XXII, p. 79 = *Lanistes ovum* var. *plicosus* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 167 (not *L. plicosus* E. v. Martens, 1879). Ilindi in Ugogo; between Tabora and Lake Tanganyika; both localities in Tanganyika Territory.

*Lanistes procerus* (E. v. Martens). See p. 197.

*Lanistes procerus langi* Pilsbry and Bequaert. See p. 197.

*Lanistes procerus magnus* (Furtado). See p.198.

*Lanistes purpureus* (Jonas) = *Ampullaria purpurea* JONAS, 1839 Archiv f. Naturgesch., V, 1, p. 342, Pl. x, fig. 1. *Bulimus tristis* JAY, 1839, 'Cat. of Shells,' 3d Ed,. p. 121, Pl. VII fig. 1. *Meladomus bulimoides* SWAINSON, 1840, 'Treatise on Malacology,' p. 340, footnote. Originally described by error from the Swan River, Australia. We have seen specimens from Zanzibar and from Tete, Portuguese East Africa.

*Lanistes pyramidalis* (Bourguignat). See p. 199.

*Lanistes sinistrorsus* (I. Lea) = *Paludina sinistrosa* I. LEA, 1839, Trans. American Phil. Soc., N. S., VI, p. 90, Pl. XXIII, fig. 78. Described by error from the East Indies. We have seen specimens labeled Gaboon and Mozambique. The species has been recorded from Tanganyika Territory (Unyamwezi). Bourguignat (1890, Ann. Sc. Nat. Zool., (7) X, p. 78) mentions it from the Malagarazi River, an affluent of Lake Tanganyika on the eastern shore, but we are inclined to believe that the Tanganyika forms are not true *sinistrorsus*.

*Lanistes zambesianus* FURTADO, 1886, Journ. de Conchyl., XXXIV, p. 148, Pl. VII, figs. 1 and 1*a*-*b*. Zambezi River, below Tete, Portuguese East Africa.

### **Lanistes (Meladomus) ovum** Peters

*Lanistes ovum* Peters. 1845, in Troschel, Archiv f. Naturgesch., XI, 1, p. 215 (type locality: Mozambique; according to E. v. Martens, more exactly Tete). E. A. Smith, 1893, Proc. Zool. Soc. London, p. 635. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 166.

*Meladomus ovum* Peters. Kobelt, 1911, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 11 (Philippi, 1851, *op. cit.*, Pl. vi, fig. 2 and Pl. vii, fig. 7).

Lake Moero: Kabwiri on the eastern shore (R. Crawshay Coll.).

Lake Moero off Lukonzolwa (Stappers Coll.); two specimens which agree well with the typical form of the species.

### *Lanistes (Meladomus) ovum* var. *major* Germain

*Lanistes ovum* var. *major* Germain, 1907, Bull. Mus. Hist. Nat. Paris, p. 427; 1920, 'Voyage dans l'Afrique Orientale Anglaise, (1912-1913) par G. Babault, Moll. Terr. Fluv.,' p. 237, figs. 112-113.

Bamu Island in the Stanley Pool (type locality; Roubaud Coll.).

### *Lanistes (Meladomus) ovum* var. *elatior* E. v. Martens

*Lanistes ovum* var. *elatior* E. v. Martens, 1866, Malakoz. Blätter, XIII, p. 99 (without description; type locality: Niebuhr River, an affluent of the Nile, in 8° N.); 1866, in Pfeiffer, 'Novit. Conchol.,' II, p. 291, Pl. lxx, figs. 7 and 8; 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 167.

Dautzenberg and Germain (1914, Rev. Zool. Afric., IV, 1, p. 51) have recorded this form from Lake Kisale at Kikondja; Stanleyville; Lake Kabamba; and swamps of Lake Kaziba-ziba near Bukama (all J. Bequaert Coll.). One of the specimens from Kikondja, examined by us, belongs to *L. procerus langi*. It is likely that the other specimens were also misindentified and possibly they all belong to *procerus langi*.

### **Lanistes (Meladomus) adansoni** Kobelt

Plate XVII, Figures 5, 6, 7

*Lanistes adansoni* Kobelt, 1911, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 18, Pl. xxiv, fig. 6 (type locality: Senegambia).

*Lanistes* (*Meladomus*) *ovum* var. *adansoni* Kobelt. C. R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 106.

In brackish water at San Antonio; in fresh-water at Boma (P. Hesse Coll.).

San Antonio near Pt. Padrão; Banana, on the beach at low tide, living specimens together with marine mollusks (Lang and Chapin Coll.). Zambi (J. Bequaert Coll.).

The specimens which we refer to Kobelt's species differ from his figures by the smaller umbilicus. This shows an unusually wide range of variation among the Congo shells before us, as shown in our figures; but none have it so open as in typical *L. adansoni*. The color varies from olive to a lighter tint, with dark spire, the lighter examples often having the base chamois. There are sometimes brown streaks, though these are less conspicuous than in Kobelt's figure. In one of the examples from Zambi (Pl. XVII, fig. 5) the color is almost black. The surface is very glossy, without microscopic sculpture.

| | | | |
|---|---|---|---|
| Length, | 38.0 mm.; | diameter, | 31.0 mm. |
| " | 33.0 | " | 26.5 |

This is probably what was recorded from the Congo (v. Mechow Coll.) as *L. ovum* by E. v. Martens, 1882, Jahrb. Deutsch. Malakoz. Ges., IX, p. 248.

### **Lanistes (Meladomus) procerus** (E. v. Martens)

*Lanistes olivaceus* var. *procerus* E. v. Martens, 1866, in Pfeiffer, 'Novit. Conchol.,' II, p. 292, Pl. LXXI, figs. 1 and 2 (described from an unknown locality); 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 164.

*Celadomus olivaceus* var. *procerus* E. v. Martens. Kobelt, 1911, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 6, Pl. XXII, figs. 1 and 2.

Dupuis and Putzeys (1901, Ann. Soc. Malacol. Belgique, XXXVI, Bull. Séances, p. lviii, fig. 29) refer to *procerus* specimens from Nsendwe (Dupuis Coll.). It is extremely probable that these examples belonged to the race described below as *L. procerus langi*.

### **Lanistes (Meladomus) procerus langi**, new subspecies

Plate XVII, Figures 1–4

Stanleyville (type locality), common in quiet brooks near the Congo River; often covered with algæ; about 170 adult specimens (Lang and Chapin Coll.). Luapula River at Kachiobwe (Stappers Coll.). Lake Kisale at Kikondja (J. Bequaert Coll.).

The specimen from Kikondja was recorded by Dautzenberg and Germain (1914, Rev. Zool. Afric., IV, 1, p. 51) under the name *Lanistes ovum* var. *elatior* E. v. Martens.

The shell is narrowly umbilicate, buffy-olive to ecru-olive, glossy, without microscopic lines, smooth or malleate, and in old shells having coarse, low wrinkles along lines of growth. The spire varies individually in length, and is always eroded above, leaving 3 to 3½ perfect whorls. The broadly ovate aperture is bay, darker or lighter, within, with a white or pale yellow band bordering the lip and spreading inward at the base. The narrow columella is pale yellow to light pinkish cinnamon.

| | | | | | | |
|---|---|---|---|---|---|---|
| Length, | 65.0 mm.; | diameter, | 52.0 mm.; | aperture, | 40.0×29.5 mm. | |
| " | 64.0 | " | 47.0 | " | 35.0×26.0 | Type. |
| " | 60.0 | " | 50.0 | " | 36.0×28.0 | |

We have felt much uncertainty about the identification of this form. Dupuis submitted specimens from Nsendwe (which appear from his remarks to agree with ours from Stanleyville) to von Martens, who pronounced them his *L. olivaceus* var. *procerus;* but in these shells, as in our very large series from Stanleyville, the oldest shells fall far short of the size of that form. *L. ovum* var. *elatior* v. Martens is smaller with a relatively smaller aperture than our shells, and a more closed umbilicus. We conclude that in proposing a new name for this common race of the Upper Congo, we run less risk of error than would be involved in referring to it under a name not fully applicable.

When the thin epidermis is peeled off, the underlying shell is seen to have a beautiful Dutch blue to madder blue color, toward the base becoming pale lilac and then ivory yellow; a whitish line at the suture.

The specimens from the Luapula and Lake Kisale, in the Katanga, are somewhat darker than most of those from Stanleyville—brownish-olive to bister. Otherwise they are similar.

### *Lanistes (Meladomus) procerus magnus* (Furtado)

*Lanistes magnus* Furtado, 1886, Journ. de Conchyl., XXXIV, p. 147, Pl. vi, fig. 5. E. A. Smith, 1908, Proc. Malacol. Soc. London, VIII, 2, p. 118. G. B. Sowerby, 1916, Proc. Malacol. Soc. London, XII, 2-3, p. 67.

*Meladomus magnus* Furtado. Kobelt, 1911, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 14, Pl. xxiv, fig. 1.

Luapula River (type locality; Capello and Ivens and R. L. Harger Coll.). Harger noted that these mollusks constitute the main food of *Anastomus lamelligerus* Temminck, the open-bill stork.

This appears to be but a giant form of *Lanistes procerus.*

### **Lanistes (Meladomus) ellipticus** E. v. Martens

Plate XVII, Figure 8

*Lanistes (Meladomus) ellipticus* E. v. Martens, 1866, in Pfeiffer, 'Novit. Conchol.,' II, p. 224, Pl. lxx, figs. 9 and 10 (type locality: Tete, on the Zambezi River, Portuguese East Africa); 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 168. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 256; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 670.

Lake Tanganyika (Foà Coll.).

Near Elisabethville in the Kimilolo River, a small affluent of the Kisanga, itself a tributary of the Kafubo (Luapula drainage); abundant in clear water of the river and of its sources, at a depth of about 0.75 m. and less, on the fine gravel of the bed; 20 specimens (Michael Bequaert Coll.; July 3, 1920).

This species appears to be quite distinct from the *L. ovum* group by the inflation of the upper part of the last whorl, the narrow, somewhat *straightened* columella and the microscopic sculpture of very fine, nearly regular striæ in the direction of growth lines. The umbilicus is narrow.

Our specimens are light brownish olive, paler, often buff around the umbilicus and often in a line at the suture. The interior of the aperture is bay or somewhat darker. The apex is generally perfect.

| | | | | |
|---|---|---|---|---|
| Length, 44.5 mm.; | diameter, 38.5 mm.; | aperture, 30.0×20.0 mm.; | 5½ whorls. |
| " 40.0 | " 35.0 | " 27.0×19.0 | 5½ " |

### *Lanistes (Meladomus) ellipticus* var. *luapulensis* Furtado

*Lanistes ellipticus* var. *luapulensis* FURTADO, 1886, Journ. de Conchyl., XXXIV, p. 151.

*Meladomus ellipticus* var. *luapulensis* Furtado. KOBELT, 1911, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 10.

Luapula River (type locality; Capello and Ivens Coll.).

## Other Species of *Meladomus* Recorded from the Belgian Congo

### *Lanistes (Meladomus) pyramidalis* Bourguignat

*Meladomus pyramidalis* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 36 (type locality: Kingani River, near Bagamoyo). KOBELT, 1911, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 7, Pl. XXV, figs. 4 and 5.

Katanga (according to Kobelt).

### *Lanistes (Meladomus) jouberti* (Bourguignat)

*Meladomus jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VI, fig. 6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 78, Pl. VI, fig. 6. KOBELT, 1911, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 15, Pl. XXV, figs. 1-3.

*Lanistes (Meladomus) jouberti* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 165.

*Lanistes jouberti* Bourguignat. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

Lake Tanganyika: on the eastern shore at the mouth of the Malagarazi River (type locality).

### Subgenus LEROYA Grandidier

*Leroya* GRANDIDIER, 1887, Bull. Soc. Malacol. France, IV, p. 191. For two species: *L. bourguignati* Grandidier and *L. charmetanti* Grandidier. Type: *Leroya bourguignati* Grandidier, here designated.

E. v. Martens considered the two original species of *Leroya*, *L. bourguignati* and *L. charmetanti* to be varieties of *Lanistes farleri* Craven. Germain directly united *bourguignati* with *farleri*, and considered *charmetanti* a variety. These conclusions were apparently not based upon the actual comparison of specimens.

Both of Bourguignat's species are described and figured as having the columella "robust, thick." It passes by an even curve into the basal margin, exactly as in *L. graueri*. *L. farleri* has the columella only quite moderately thickened, and it is distinctly, though rather inconspicuously subtruncate at the base. The notch corresponds with the termination of a curved cord bordering the columella outside, and evidently homologous with the circum-umbilical carina of some *Lanistes.*

The operculum of *L. farleri* is somewhat similar to that of *L. graueri,* but the concentric wrinkles of the scar are coarser and fewer. We believe *L. farleri* to be specifically distinct.

The following is a list of the species which have been described in this group. Some of these have been regarded as synonyms by E. v. Martens and by Germain[1]; but, having only seen specimens of *L. farleri* and *L. graueri,* we are not inclined to adopt their conclusions at present.

*Lanistes bourguignati* (Grandidier). See p. 202.

*Lanistes charmetanti* (Grandidier) = *Leroya charmetanti* GRANDIDIER, 1887, Bull. Soc. Malacol. France, IV, p. 193. BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 180, Pl. VII, figs. 21-22. East Africa, without more definite locality (probably Vuami or Kingani River).

*Lanistes farleri* CRAVEN, 1880, Proc. Zoöl. Soc. London, p. 219, Pl. XXII, fig. 7. Magila (Usambara), Tanganyika Territory.

*Lanistes farleri* var. *olivata* GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, pp. 323-326. Kwiro (Mahenge), Tanganyika Territory.

*Lanistes graueri* J. Thiele. See below.

*Lanistes recki* DIETRICH, 1923, Centralbl. Mineral., Geol. u. Paläont., p. 317, fig. 2. Fossil in the Pleistocene (?), region of the saline Gottorp, near Rutschugi (Malagarazi River), Tanganyika Territory.

*Lanistes sculptus* E. v. MARTENS, 1887, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 97. Usambara, Tanganyika Territory. The typical specimens were united by E. v. Martens (1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 171) with *L. farleri* Craven, and this was probably right. Kobelt (1912, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 34, Pl. XXX, figs. 5-6), however, figures as *Meladomus farleri* a specimen from Umbugwe, received from the Berlin Museum, which is evidently not Craven's species.

*Lanistes stuhlmanni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 171, Pl. VI, fig. 37. Daressalaam, Tanganyika Territory.

### Lanistes (Leroya) graueri J. Thiele

Plate XIV, Figures 6, 7, 8

*Lanistes graueri* J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907-08),' III, p. 210, Pl. V, fig. 50.

*Meladomus graueri* Thiele. KOBELT, 1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' p. 38, Pl. XXVI, figs. 8-9.

*Lanistes (Leroya) graueri* Thiele. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, pp. 323 and 328.

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[1]Germain, L. 1916. 'Sur le genre *Leroya* Bourguignat.' Bull. Mus. Hist. Nat. Paris, pp. 317–329.

*Lanistes (Leroya) stuhlmanni* DUPUIS AND PUTZEYS, 1901, Ann. Soc. Malacol. Belgique, XXXVI, Bull. Séances, p. lx; 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 78 (with var. *unicolor* Dupuis and Putzeys, p. 79, from Stanleyville).

Type locality: between Uvira and Kasongo (Grauer Coll.); Germain (1916) makes this two localities instead of one as it was originally intended for. Lualaba River at Nsendwe and at Stanley Falls (Dupuis Coll.).

Stanleyville, in forest brooks, several hundred specimens, together with *L. procerus langi*, *L. nsendweensis*, and *Pila congoensis* (Lang and Chapin Coll.).

This species is well distinguished from all others of the region by the solid compact shell, wholly imperforate at all stages of growth seen, and more or less strongly angular at the shoulder.

Immediately below the suture there is at first a short, steep descent, a slight furrow, then a subhorizontal flattening bounded by an angle or slight keel. This is strongest on the penult whorl, generally weaker and sometimes almost rounded near the mouth. The surface has but little gloss, and under a lens often shows faint, close spiral striæ, wanting on many examples. The color is light brownish-olive or isabella, nearly uniform or having deep chestnut-brown bands. The columella is heavily calloused, white. It is bounded outwardly by a narrow, flattened, blackish, crescentic area defined outwardly by an angle. The width of this area varies individually. Interior whitish, sometimes banded. The early whorls are very deeply eroded, even in the youngest seen, 13.5 mm. long.

Length, 24.0 mm.; diameter, 24.0 mm.

The operculum is rather narrow, the width from 57 to 60 per cent of the length, the columellar outline weakly sigmoid, the outer regularly arched. It is strongly concave externally, the greatest concavity near the columellar side. The scar is shaped like the operculum and occupies about half the total width. It is concentrically plicate, with some irregular radial rugosity.

The distinction between *L. graueri* and *L. stuhlmanni* is certainly not very conspicuous, and Thiele, who had both before him, subsequently considered them as doubtfully distinct. In the absence of specimens of *stuhlmanni* for comparison, we prefer to use the name *graueri* for the form of the Belgian Congo. Dupuis and Putzeys in a recent paper [1923, Ann. Soc. Zool. Belgique, LIII, (1922), pp. 78-79], having examined a long series from Stanleyville, consider *graueri* to be synonymous with *stuhlmanni* and doubtfully distinct from *farleri*. They propose callin bandless specimens var. *unicolor*.

Kobelt (1912, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., I, Ampullariidæ,' Pl. xxviii, figs 15-16) figures under the name "*Lanistes congicus*" a shell from the Crystal Mountains in Gaboon (Lamothe Coll.) which certainly belongs to the subgenus *Leroya*. Whether this really belongs to *L. stuhlmanni*, as has been claimed by C. R. Bœttger [1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 105] or to some undescribed form could only be established from a study of specimens.

## Other Species of *Leroya* Recorded from the Belgian Congo

### *Lanistes* (*Leroya*) *bourguignati* (Grandidier)

*Leroya bourguignati* Grandidier, 1887, Bull. Soc. Malacol. France, IV, p. 191. Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. vi, figs. 2-5; 1889, 'Moll. Afrique Equator.,' p. 180; 1890, Ann. Sc. Nat. Zool., (7) X, p. 79, Pl. vi, figs. 2-5. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 96.

*Lanistes* (*Leroya*) *farleri* var. *bourguignati* Grandidier. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 172, Pl. vi, fig. 34.

*Lanistes* (*Leroya*) *bourguignati* Grandidier. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

Originally described from East Africa, without more definite locality. Bourguignat, however, records it from the Vuami River, the Malagarazi River, and the eastern shore of Lake Tanganyika.

## Viviparidæ

Shell turbinate, smooth, tuberculate or carinate, perforate or with solid axis, covered with an olivaceous or dark, often banded, periostracum; aperture shortly ovate or rounded, with simple lip. Operculum corneous, concentric throughout or with a paucispiral center.

Tentacles acute, equal in the female, the right one often truncate or recurved in the male, where it serves as a penis; eyes on low swellings at the posterior bases of tentacles; there are two cervical lobes, of which the right is larger and serves as a siphon. The foot is ample, truncate in front, rounded behind. Radula with a wide central tooth without basal denticles; lateral teeth rhomboid, marginals narrow; cusps of all the teeth are finely denticulate (Viviparinæ) or smooth (Lioplacinæ).

Viviparidæ occur in fresh waters of all the continents except South America. The greatest differentiation of the family is in the Holarctic Realm, where they are known to have existed since Mesozoic times.

In the Ethiopian Region this family comprises the genera *Viviparus* and *Neothauma*.

*Neothauma* differs primarily from *Viviparus* in the shape of the outer lip, which is distinctly expanded in the middle and sinuate above, near the suture, and below, near the columella In *Viviparus*, the outer margin of the aperture is in a plane and shows no upper and lower sinuosity in the full-grown shell. This is true even in the thick-shelled species, such as *V. mweruensis*, which approach *Neothauma* somewhat in shape. Various anatomical distinctions have also been indicated.

## VIVIPARUS Denys de Montfort[1]

*Viviparus* DENYS DE MONTFORT, 1810, 'Conchyl. Systém.,' II, p. 246. Monotype: *Viviparus fluviorum* Denys de Montfort = *Helix vivipara* Linnæus.

*Paludina* LAMARCK, 1816, 'Encyclop. Méthod., Vers,' Pl. CCCCLVIII, figs. 1*a-c*, with explanation [according to Sherborn and Woodward, 1906, Ann. Mag. Nat. Hist., (7) XVII, p. 581, Livr. 84, containing Pls. CCCXCI to CCCCLXXXVIII with 16 pages of explanation written by Lamarck, was issued in 1816]; 1817, in Cuvier, 'Règne Animal,' II, p. 421; 1822, 'Hist. Nat. Anim. sans Vertèbres,' VI, 2, p. 172. Type: *Paludina achatina* Lamarck = *Nerita fasciata* O. F. Müller.

*Vivipara* J. SOWERBY, 1813, 'Mineral Conch.,' I, p. 75. Type: *Helix vivipara* Linnæus.

*Viviparella* RAFINESQUE, 1815, 'Analyse de la Nature,' p. 144. New name for *Vivipara*.

*Bellamya* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 478. Type by original designation and tautonomy: *Bellamya bellamya* Jousseaume = *Vivipara duponti* de Rochebrune.

*Viviparus* subgenus *Callina* HANNIBAL, 1912, Proc. Malacol. Soc. London, X, p. 193. Monotype: *Paludina intertexta* Say. Not *Callina* Lowe, 1854.

The shell is of medium size, ovate-conic or globosely conic, with convex or more or less carinate whorls, which may be smooth or variously sculptured; olivaceous, dark brown, or banded. Aperture very shortly ovate, approaching circular, the margins of the lip in a plane. Operculum corneous, shortly ovate, not retracted deeply, concentric, the nucleus near the columellar margin.

This genus is found in all of the continents except South America, and on most continental islands. In America it extends southward into northern Mexico and also reaches Cuba. The distribution of the genus on the African continent (Map 1) is similar to that of *Lanistes* and *Pila*. In the west it extends to about 18° N. to include the basins of the Senegal, Niger, and Lake Chad. In the east it follows the valley of the Nile to the Mediterranean. Its southern limits cannot yet be traced with certainty. It exists in the basin of the Zambezi and extends along the east coast to Lourenzo Marques and Lake Sibayi in Zululand (27° 20′ S.). In the western half of South Africa *Viviparus* does not appear to live at present south of the estuary of the Congo River, though E. v. Martens has described a species found subfossil at the Letter Tree on the Botletle River in northern Bechuanaland (in 20° 30′ S., 24° 25′ E.). The genus is unknown from South Africa proper, Madagascar,[2] the Comoros, and

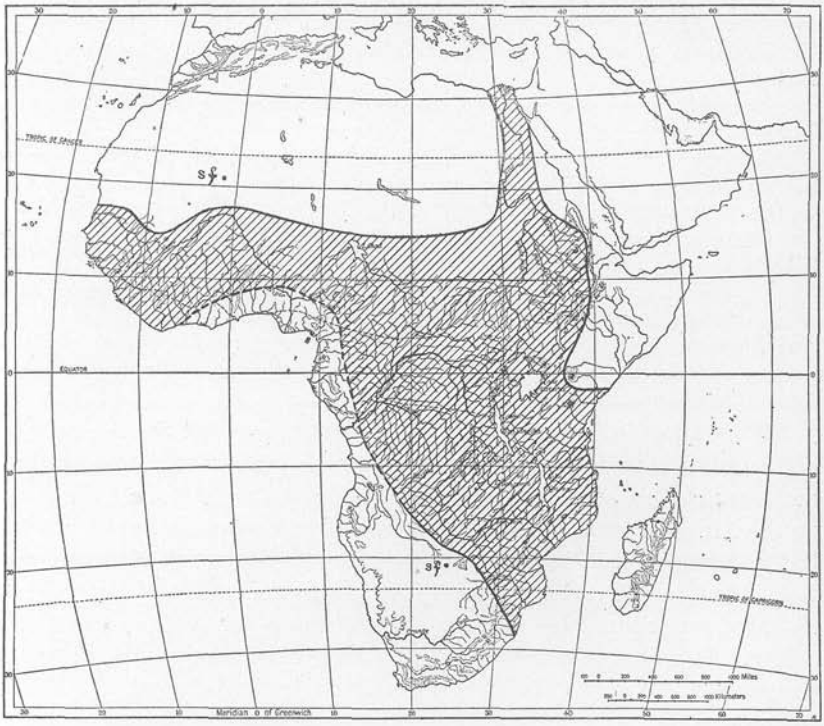
[1]Germain (1920, 'Voyage dans l'Afrique Orientale Anglaise (1912–1913) par G. Babault, Moll. Terr. Fluv.,' p. 195, footnote) dates *Vivipara* from Lamarck, 1809, 'Philosoph. Zoolog.,' I, p. 320; but in that work the name is only used in the French vernacular "Vivipare," and has therefore no standing in nomenclature.

[2]Kobelt (1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 91) lists a "*Vivipara madagascariensis* E. A. Smith" from Madagascar. We have been unable to find another reference to that species which is not mentioned in Kobelt's revision of *Vivipara* in Martini and Chemnitz, 'Syst. Conch. Cab.,' (1909). The reference is probably due to a confusion with *Paludina madagascariensis* Crosse and Fischer, which belongs in the genus *Cleopatra*, or with *Ampullaria madagascariensis* E. A. Smith.

Mascarenes. No species have as yet been found in Cameroon and Gaboon.

The following is a list of the species described from the Ethiopian Region.

*Viviparus abyssinicus* (E. v. Martens) = *Vivipara abyssinica* E. v. MARTENS, 1866, Malakoz. Blätter, XIII, p. 97, Pl. III, fig. 7. Southern Abyssinia.



Map 1. Distribution of the genus *Viviparus* in Africa.

*Viviparus* (?) *brincatianus* (Bourguignat). See p. 209.

*Viviparus* (?) *brincatianus* var. *bridouxianus* (Bourguignat). See p. 209.

*Viviparus capillatus* (Frauenfeld) = *Vivipara capillata* FRAUENFELD, 1865, Verh. Zool. Bot. Ges. Wien, XV, p. 533, Pl. XXII, figs. 11 and 12. *Viviparus capillaceus* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 637. *Vivipara unicolor* form *minor* PALLARY, 1924, Mém. Inst., d'Egypte, VII, 1, p. 32. Lake Nyasa.

*Viviparus capillatus* var. *sambesiensis* (Sturany) = *Vivipara unicolor* var. *sambesiensis* STURANY, 1898, Anz. Ak. Wiss. Wien, Math. Naturw. Kl., XXXV, p. 161; 1898, Denkschr. Ak. Wiss. Wien, LXVII, p. 621, Pl. III, figs. 57-61. *Vivipara densestriata* PRESTON, 1905, Proc. Malacol. Soc. London, VI, 2, p. 300, fig. 2. *Vivipara* *zambesiensis* GERMAIN, 1919, Bull. Mus. Hist. Nat. Paris, p. 116. Victoria Falls Zambezi River.

*Viviparus cepoides* E. A. SMITH, 1892, Ann. Mag .Nat. Hist., (6) X, p. 125, Pl. XII, fig. 4. Either from Lake Victoria or from the Nile between 3° and 14° N.

*Viviparus constrictus* (E. v. Martens) = *Paludina constricta* E. v. MARTENS, 1886, 'Conchol. Mitth.,' III, 1, p. 16, Pl. XLI, fig. 7. *Vivipara trochlearis* E. v. MARTENS, 1892, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 18. *Viviparus victoriæ* var. *a* E. A. SMITH, 1892, Ann. Mag. Nat. Hist., (6) X, p. 124, Pl. XII, fig. 10. Lake Victoria.

*Viviparus constrictus* var. *pagodella* (E. v. Martens) = *Vivipara constricta* var. *pagodella* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 182, Pl. VI., fig. 18. Bukoba, in Lake Victoria.

*Viviparus constrictus* var. *phthinotropis* (E. v. Martens) = *Vivipara phthinotropis* E. v. MARTENS, February, 1892, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 17. *Viviparus victoriæ* E. A. SMITH, August, 1892, Ann. Mag. Nat. Hist., (6) X, p. 124, Pl. XII, fig. 9 (typical form). *Vivipara constricta* var. *pectinotropis* KOBELT, 1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 79. Lake Victoria.

*Viviparus costulatus* (E. v. Martens). See p. 208.

*Viviparus costulatus* var. *altus* (Germain) = *Vivipara costulata* var. *alta* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 299. Entebbe, Lake Victoria.

*Viviparus costulatus* var. *globosus* (Germain) = *Vivipara costulata* var. *globosa* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 299. Entebbe, Lake Victoria.

*Viviparus costulatus* var. *triliratus* (E. v. Martens) = *Vivipara costulata* var. *trilirata* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 183, Pl. VI, figs. 23–24. Ndukali, Bumbide Island, Lake Victoria.

*Viviparus crawshayi* E. A. Smith. See p. 208.

*Viviparus duponti* (de Rochebrune) = *Vivipara duponti* A. T. DE ROCHEBRUNE, 1882, Bull. Soc. Philomath. Paris, (7) VI, p. 34. *Bellamya bellamya* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 479, Pl. XII, fig. 3. *Vivipara unicolor* var. *bellamyi* DAUTZENBERG, 1890, Mém. Soc. Zool. France, III, pp. 125 and 134. *Vivipara lenoiri* "Mabille" GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française, p. 517, footnote. *Vivipara colini* "de Rochebrune" GERMAIN, *op. cit.*, p. 517, footnote. Pangalla, on the Bakoy River, an affluent of the Senegal. Germain (1920, 'Voyage dans l'Afrique Orientale Anglaise (1912–1913) par G. Babault, Moll. Terr. Fluv.,' p. 209, figs. 95–106) regards this as a variety of *V. unicolor* (Olivier); but, on account of the shape of the peristome, which is notably angular below, it appears to be specifically distinct.

*Viviparus foai* (Germain). See p. 208.

*Viviparus gracilior* (E. v. Martens) = *Vivipara gracilior* E. v. MARTENS, 1903, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 7. Southern shore of Lake Chad (the type locality is not Kuka on the western shore, as stated by Germain).

*Viviparus jeffreysii* (Frauenfeld) = *Vivipara jeffreysii* FRAUENFELD, 1865, Verh. Zool. Bot. Ges. Wien, XV, p. 532, Pl. XXII, figs. 3–4. *Vivipara simonsi* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 35. *Vivipara smithi* BOURGUIGNAT, 1889, *op. cit.*, p. 35. Lake Nyasa.

*Viviparus kalingwisiensis* (E. A. Smith) = *Vivipara kalingwisiensis* E. A. SMITH, 1908, Proc. Malacol. Soc. London, VIII, 1, p. 12, fig. (on p. 13). Kalungwesi River, Northeast Rhodesia.

*Viviparus leopoldvillensis* Putzeys). See p. 207.

*Viviparus liberianus* (Schepman) = *Paludina liberiana* SCHEPMAN, 1888, Notes Leyden Mus., X, p. 247, Pl. x, figs. 1*a*-*b*. St. Paul's River, near Bavia, Liberia.

*Viviparus meta* (E. v. Martens) = *Vivipara meta* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 179, Pl. VI, fig. 27. Kassarosi Island, near the southwestern shore of Lake Victoria.

*Viviparus mweruensis* E . A. Smith. See p. 208.

*Viviparus mweruensis* var. *pagodiformis* E. A. Smith. See p. 209.

*Viviparus passargei* (E. v. Martens) = *Vivipara passargei* E. v. MARTENS, 1904, in Passarge, 'Die Kalahari,' p. 757, fig. 3 (on p. 755). Subfossil in calcareous sandstone at the Letter Tree, along the Botletle River, Northern Bechuanaland.

*Viviparus punctatus* (Frauenfeld) = *Vivipara punctata* FRAUENFELD, 1865, Verh. Zool. Bot. Ges. Wien, XV, p. 532. This is an obscure species described from "West Africa."

*Viviparus robertsonii* (Frauenfeld) = *Vivipara robertsonii* FRAUENFELD, 1865, Verh. Zool. Bot. Ges. Wien, XV, p. 533, Pl. XXII, figs. 13–14. Lake Nyasa. This appears to be closely allied to *V. unicolor* (Olivier).

*Viviparus rubicundus* (E. v. Martens). See p. 209.

*Viviparus rubicundus* var. *kisumiensis* (Preston) = *Vivipara rubicunda* var. *kisumiensis* PRESTON, 1912, Proc. Zool. Soc. London, p. 191, Pl. XXXII, fig. 9. Kisumu, Lake Victoria.

*Viviparus rubicundus* var. *subturritus* (E. v. Martens) = *Vivipara rubicunda* var. *subturrita* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 179, Pl. VI, fig. 26. Busisi, on the southern shore of Lake Victoria.

*Viviparus unicolor* (Olivier). See p. 207.

*Viviparus unicolor* mut. *biangulatus* (Küster) = *Paludina biangulata* KÜSTER, 1852, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 21, *Paludina*,' p. 25, Pl. v, figs. 11–12. *Paludina nilotica* "Benson" FRAUENFELD, 1864, Verh. Zool. Bot. Ges. Wien, XIV, p. 629. *Paludina dimidiata* "Ziegler" FRAUENFELD, 1864, *op. cit.*, p. 599. Originally described from an unknown locality; it occurs on the Nile together with the typical form and appears to be a mutation in which the juvenile carinulation of the whorls persists in the adult.

*Viviparus unicolor* var. *conoideus* (E. v. Martens). See p. 208.

*Viviparus unicolor* var. *elatior* (E. v. Martens) = *Vivipara unicolor* var. *elatior* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 177, Pl. VI, fig. 25. Busisi and Nyemirembe, Lake Victoria.

*Viviparus unicolor* var. *fasciatus* (Frauenfeld) = *Vivipara unicolor* var. *fasciata* FRAUENFELD, 1865, Verh. Zool. Bot. Ges. Wien, XV, p. 1164, "Africa."

*Viviparus unicolor* var. *lenfanti* (Germain) = *Vivipara unicolor* var. *lenfanti* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 53; 1906, Mém. Soc. Zool. France, XIX, p. 228, Pl. IV, figs. 7 and 8. Lake Chad.

*Viviparus unicolor* var. *obesus* (Germain) = *Vivipara unicolor* var. *obesa* GERMAIN, 1906, Mém. Soc. Zool. France, XIX, p. 228. Lake Chad.

*Viviparus unicolor* var. *spekei* (E. A. Smith) = *Paludina spekei* E. A. SMITH, 1880, Proc. Zool. Soc. London, p. 484, Pl. XLVIII, fig. 11. Lowlands near the east coast of Africa, between 6° and 7° S.

*Viviparus unicolor* var. *subimperforatus* (Nevill) = *Paludina unicolor* var. *subimperforata* NEVILL, 1884, 'Hand List Moll. Indian Mus.,' II, p. 30. Nile.

In addition, Germain has named a large number of forms and variations of *V. unicolor: major, minor, globosa, elata, pervius, microporus, normalis, unicarinata, bicarinata, tricarinata, viridis, fusca, pallescens,* and *rubra* (1920, 'Voyage dans l'Afrique Orientale Anglaise (1912–1913) par G. Babault, Moll. Terr. Fluv.,' pp. 200–203).

*Vivipara heliciformis* Frauenfeld, originally described as from Africa, is an Indian species.

### **Viviparus leopoldvillensis** (Putzeys)

*Paludina leopoldvillensis* PUTZEYS, 1898, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. xxv, figs. 7 and 8.

*Vivipara leopoldvillensis* Putzeys. KOBELT, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 380, Pl. LXXV, figs. 10–11.

In the Stanley Pool, near Leopoldville (type locality).

In the Stanley Pool at Dolo near Kinshasa (Maurice Bequaert Coll.).

A half-grown specimen, 13 mm. long, from the last-named locality, shows a series of short bristles on the blunt angle below the suture and another midway between that and the periphery, which also bears a few very short bristles.

### **Viviparus unicolor** (Olivier)

Plate XIX, Figure 1

*Cyclostoma unicolor* OLIVIER, 1804, 'Voyage dans l'Empire Othoman,' II, p. 39; (an XII) Atlas, II, Pl. XXXI, figs. 9*a* and 9*b* (type locality: Alexandria, Egypt).

*Vivipara unicolor* Olivier. H. ADAMS, 1866, Proc. Zool. Soc. London, p. 375. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 175. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 327; 1906, *op. cit.*, pp. 52 and 59; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 662. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 52. KOBELT, 1907, in Martini and Chemnitz, 'Syst. Conch. Cab., n.F., II, 21*a*, *Paludina*,' p. 162, Pl. IV, figs. 12–13 and Pl. V, figs. 11–12.

*Paludina unicolor* Olivier, var. STURANY, 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 305, Pl. XXIV, figs. 16 and 27.

*Vivipara polita* FRAUENFELD, 1862, Verh. Zool. Bot. Ges. Wien, XII, p. 1163 (type locality: South Africa).

*Paludina polita* Frauenfeld. REEVE, 1863, 'Conchol. Iconica,' XIV, *Paludina*, Pl. XI, fig. 73.

*Paludina æthiops* REEVE, 1863, 'Conchol. Iconica,' XIV, *Paludina*, Pl. X, fig. 60 (type locality: Central Africa).

*Vivipara alhiensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 58, Pl. IV, fig. 4 (type locality: Alli[=Athi] Plains, British East Africa).

In the Lualaba River at Kindu and Kibombo; in the Luvua River between Kiambi and Ankoro; channel from Lake Kabamba to the Lualaba at Mulongo (J. Bequaert Coll.). Lake Tanganyika: at the southern end (Foà Coll.). Region of the sources of the Kagera River in Ruanda (O. Baumann Coll.).

**Viviparus unicolor var. conoideus** (E. v. Martens)

*Vivipara unicolor* var. *conoidea* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 175. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, p. 198.

Lake Edward: subfossil at the southern end of the lake (District Iwinsa; type locality; Stühlmann Coll.).

One dead specimen on the beach at Kabare, at the southern end of the lake (J. Bequaert Coll.). This species has not yet been found alive in Lake Edward.

## Other Species of *Viviparus* Recorded from the Belgian Congo

*Viviparus costulatus* (E. v. Martens)

*Vivipara costulata* E. v. MARTENS, February, 1892, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 18 (type locality: Kassarosi Island in Lake Victoria); 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 182, Pl. VI, fig. 22. GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 298; 1908, 'Rés. Scientif. Voy Afrique Foà,' p. 663.

*Viviparus jucundus* E. A. SMITH, August, 1892, Ann. Mag. Nat. Hist., (6) X, p. 124, Pl. XII, fig. 6 (type locality: Lake Victoria).

*Vivipara jucunda* E. A. Smith. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 257.

*Viviparus victoriæ*, var. *b* E. A. SMITH, August, 1892, Ann. Mag. Nat. Hist., (6) X, p. 124, Pl. XII, fig. 8.

*Vivipara jucunda* E. A. Smith. KOBELT, 1907, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 169, Pl. XXXIII, fig. 10.

Lake Tanganyika: at the southern end (Foà Coll.).

*Viviparus crawshayi* E. A. Smith

*Viviparus crawshayi* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 637, Pl. LIX, fig. 8.

*Vivipara crawshayi* E. A. Smith. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 53. KOBELT, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*, p. 377, Pl. LXXV, fig. 5.

Lake Moero: originally described from that lake without more definite locality (R. Crawshay Coll.); Kilwa (J. Bequaert Coll.). Stappers obtained specimens at Lukonzolwa, Pweto, between Kilwa and Mobanga, and between Kilwa and Kilwa Island.

*Viviparus foai* (Germain)

*Vivipara foai* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 257; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 664, figs. 17 and 18. KOBELT, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 416.

Type locality: Lake Tanganyika (Foà Coll.).

*Viviparus mweruensis* E. A. Smith

Plate XIX, Figure 6

*Viviparus mweruensis* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 636, Pl. LIX, figs. 5 and 6.

*Neothauma mweruensis* E. A. Smith. KOBELT, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 374, Pl. LXXV, figs. 1–3.

Type locality: Lake Moero (R. Crawshay Coll.). Stappers obtained the typical form off Pweto (Pl. XIX, fig. 6).

This species we take to be the type of a new section **Rectiviviparus.**

## *Viviparus mweruensis* var. *pagodiformis* E. A. Smith

Plate XIX, Figure 7

*Viviparus mweruensis* var. *pagodiformis* E. A. SMITH, 1893, Proc. Zool. Soc. London, 1893, p. 536, Pl. LIX, fig. 7. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 54.

Lake Moero: (type locality; R. Craswhay Coll.); Kilwa (J. Bequaert Coll.). Stappers collected this variety at a number of places: off Kilwa; off Mobanga; off Lukonzolwa; and on the beach at Pweto. This is one of the commonest shells of Lake Moero, though living specimens are very rarely met with.

## *Viviparus rubicundus* (E. v. Martens)

*Paludina rubicunda* E. v. MARTENS, 1879, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 104 (type locality: southwestern shore of Lake Victoria).

*Paludina unicolor* var. E. A. SMITH, 1888, Proc. Zool. Soc. London, p . 53.

*Vivipara rubicunda* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 179. KOBELT, 1907, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 169, Pl. XXXIII, fig. 8.

*Viviparus rubicundus* E. v. Martens. E. A. SMITH, 1892, Ann. Mag. Nat. Hist., (6) X, p. 123, Pl. XII, fig. 3. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 210.

Lake Albert: (Gordon Coll.; S. Baker Coll.; Emin Pasha Coll.); at Kassenje on the southwestern shore (Stuhlmann Coll.; Schubotz Coll.).

## *Viviparus* (?) *brincatianus* (Bourguignat)

*Vivipara brincatiana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. IV, fig. 1· 1890, Ann. Sc. Nat. Zool., (7) X, p. 41, Pl. IV, fig. 1. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 183. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 99. KOBELT, 1907, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 170, Pl. XXXIII, fig. 11. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

Type locality: eastern shore of Lake Tanganyika near the mouth of the Malagarazi River.

According to E. v. Martens (1897), the generic position of this species is doubtful; it possibly belongs to *Cleopatra*.

## *Viviparus* (?) *brincatianus* var. *bridouxianus* (Bourguignat)

*Vivipara bridouxiana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. IV, fig. 2; 1890, Ann. Sc. Nat. Zool., (7) X, p. 42, Pl. IV, fig. 2. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

*Vivipara bridouxi* Bourguignat. GERMAIN, 1095, Bull. Mus. Hist. Nat. Paris, p. 257; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 665.

*Vivipara brincatiana* var. *bridouxiana* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth., p. 183. KOBELT, 1907, in Martini and Chemnitz, 'Syst. Conch. Cab., N.F., II, 21*a*, *Paludina*,' p. 171, Pl. XXXIII, fig. 12.

Type locality: eastern shore of Lake Tanganyika near the mouth of the Malagarazi River.

### NEOTHAUMA E. A. Smith

*Neothauma* E. A. SMITH, 1880, Proc. Zool. Soc. London, p. 349. Monotype: *Neothauma tanganyicense* E. A. Smith.

According to Moore (1901, Proc. Zool. Soc. London, II, p. 466), the anatomical structure of *Neothauma* is similar to that of *Viviparus*, but the nervous system is less concentrated.

The genus is restricted to Lake Tanganyika.

Germain (1908, Rés. Scientif. Voy. Afrique Foà,' pp. 658–662) admits three species of this genus, which he believes are distributed in different regions of Lake Tanganyika. This opinion is evidently based upon Moore's contentions, but it is hardly borne out by the extensive collections made by Stappers in 1912–13, now at the Congo Museum, Tervueren. From a study of this material Dautzenberg concludes that there is only one very variable species of *Neothauma*, a point of view also advocated by E. A. Smith in 1904. The typical form and the varieties *bicarinatum* and *euryomphalum* have, for instance, all been dredged off Moliro, at the southern end of the Lake.

Charles Hedley (1925, The Nautilus, XXXVIII, p. 110) found *Neothauma* abundant on the strand at Albertville. Forms represented are similar to Bourguiguat's figures of *tanganikanum*, *bicarinatum* (both short and elongate), *bridouxianum*, either with narrow perforation or similarly shaped but with an umbilicus like *euryomphalum;* also various annectant examples. The color under the periostracum may be either white or purplish.

#### *Neothauma tanganyicense* E. A. Smith

Plate XIX, Figures 2, 3, 5

*Neothauma tanganyicense* E. A. SMITH, 1880, Proc. Zool. Soc. London, p. 349, Pl. XXXI, figs. 7–7*c*, 1881, *op. cit.*, p. 293; 1889, Ann. Mag. Nat. Hist., (6) IV, p. 173. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 112. E. v. MARTENS, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, pp. 71 and 72. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 2. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 203. J. E. S. MOORE, 1901, Proc. Zool. Soc. London, II, p. 466 (anatomy), Pl. XXV, figs. 1, 2, and 4 and Pl. XXVI, figs. 1, 3, and 4–6; 1903, 'The Tanganyika Problem,' p. 264, figs. 44–46. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 99; 1906, Proc. Zool. Soc. London, I, p. 184. KOBELT, 1907, in Martini and Chemnitz, 'Syst. Conch. Cab., N.F., II, 21*a*, *Paludina*,' p. 154, Pl. XXXI, figs. 1–6 and Pl. XXXII, figs. 3–5. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 249 and 261.

*Viviparus tanganyicensis* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 635.

*Neothauma tanganyikanum* GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 658.

*Neothauma bridouxianum* GRANDIDIER, 1885, Bull. Soc. Malacol. France, II, p. 163. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 26; 1888, 'Iconogr. Malacol. Tanganika,' Pl. II, figs. 2 and 3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 27, Pl. II, figs. 2 and 3.

*Neothauma servainianum* GRANDIDIER, 1885, Bull. Soc. Malacol. France, II, p. 164. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 27; 1888, 'Iconogr. Malacol. Tanganika,' Pl. III, figs. 2 and 3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 31, Pl. III, figs. 2 and 3.

*Neothauma tanganikanum* GRANDIDIER, 1885, Bull. Soc. Malacol. France, II, p. 163. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 26; 1888, 'Iconogr. Malacol. Tanganika,' Pl. II, fig. 1; 1890, Ann. Sc. Nat. Zool., (7) X, p. 26, Pl. II, fig. 1. R. STURANY, 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 299. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 257.

*Neothauma giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 27; 1888, 'Iconogr. Malacol. Tanganika,' Pl. II, figs. 5 and 6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 29, Pl. II, figs. 5 and 6.

Lake Tanganyika: originally described from specimens obtained at Ujiji, on the eastern shore, by E. C. Hore; Kituta; Kala; Moliro; Sumbu; Kalamba (W. A. Cunnington Coll.); northern end (O. Baumann Coll.); Ufipa; Mbwe (Lechaptois Coll.).

Germain, following Moore, believes that the typical form of the species is restricted to the central portion of the Lake. But in Stappers' collection it is represented by specimens collected all along the western shore: Uvira; at the mouth of the little Ruzizi; Tulo; off Tumpa; Baraka; bay of Tempwe; off Songwe; off the mouth of the Sambala; bay of the Luvu; pond of Gongwe near Toa; Toa; bay of Kilewa; bay of Kasakalawe; off the shore between Moba and the Lobozi; between Vua and Moliro; off Moliro. It lives in the littoral zone between the shore and a depth of 20 meters. W. A. Cunnington also found keeled and non-carinate specimens together at the southern end of the lake, so that E. A. Smith concludes "that Mr. Moore's idea of the local distribution of this species appears to be, in a measure, incorrect."

## *Neothauma tanganyicense* var. *bicarinatum* (Bourguignat)

Plate XIX, Figure 4

*Neothauma bicarinatum* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 28; 1888, 'Iconogr. Malacol. Tanganika,' Pl. III, fig. 1; 1890, Ann. Sc. Nat. Zool., (7) X, p. 32, Pl. III, fig. 1. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 661, fig. 16 (on p. 662); 1905, Bull. Mus. Hist. Nat. Paris, p. 258 ; 1911, *op. cit.*, p. 438. KOBELT, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 158, Pl. XXXI, fig. 9.

*Neothauma pelseneeri* BOURGUIGNAT, 1890, Ann. Sc. Nat. Zool., (7) X, p. 33.

*Paludina tanganyicensis* PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 104, fig. 1 (on p. 105).

Type locality: on the western shore of Lake Tanganyika between Pambete and Kibanga.

According to Germain, this is the form of the southern region of the Lake. In Stappers' collection it is represented by specimens from the bay of Sumbu; bay of the Luvu; and off the Kalembwe.

### *Neothauma tanganyicense* var. *euryomphalum* (Bourguignat)

*Neothauma euryomphalum* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. II, figs. 7 and 8; 1890, Ann. Sc. Nat. Zool., (7) X, p. 35, Pl. II, figs. 7 and 8. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 258; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 660.

*Neothauma jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. III, figs. 4 and 5; 1890, Ann. Sc. Nat. Zool., (7) X, p. 34, Pl. III, figs. 4 and 5. KOBELT, 1907, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 160, Pl. XXXI, fig. 7.

*Neothauma vysseri* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. III, fig. 6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 37, Pl. III, fig. 6.

Lake Tanganyika: beach of Kibanga (type locality); beach of the peninsula Ubuari; mouth of the Luandazi River. All these on the western shore.

According to Germain, this is the form of the northern region of the Lake. Stappers obtained it off Toa and in the pond of Gongwe near Toa.

### *Neothauma tanganyicense* var. *major* Germain

*Neothauma euryomphalum* var. *major* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 258; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 660, figs. 14 and 15.

Type locality: northern region of Lake Tanganyika.

## Amnicolidæ

### (HYDROBIIDÆ, PALUDESTRINIDÆ of authors)

The shell is small or minute, usually ovate-conic, but varying from turreted to depressed and umbilicate, covered with a thin, translucent or olivaceous periostracum; aperture ovate or rounded. Operculum spiral or with a spiral nucleus, corneous or with a calcareous layer.

Tentacles slender, with the eyes sessile at their external bases. Male organ long, inserted on the back some distance behind the tentacles; its form characteristic for the several genera. Foot truncate and with projecting angles in front, rounded behind; in locomotion not extending in front of the rostrum. Radula with 3.1.3 teeth, all with denticulate cusps. Central tooth having basal denticles on the face of the tooth, the basal margin trilobed.. Lateral (or admedian) teeth with trapezoidal body, tapering shank and unequal denticles. Marginal teeth with numerous equal denticles. The insertions of the lateral and marginal teeth are near together and remote from the central tooth. The fæces are in the form of small oblong pellets.

This very large family is found almost all over the world, in temperate and tropical latitudes. It is but poorly represented in Africa as now known and is unknown in Madagascar and the Mascarenes. A few genera, such as *Peringia*, are truly marine; others (*Paludestrina* and

*Littoridina*) inhabit both brackish and fresh water; but most of the genera are confined to fresh water. The family is closely related to the marine group Rissoidæ.

Nearly all the genera are oviparous, depositing the eggs in chitinous capsules, which adhere strongly to shells, stones, and like objects. The New Zealand and American species of *Potamopyrgus* are viviparous, but whether this is also true for the African form referred to that genus, is unknown.

Two subfamilies, Buliminæ and Amnicolinæ, are represented in the Ethiopian Region.

**Buliminæ**

Operculum solid, mainly calcareous, largely concentric, lodging at the edge of the peristome. Shell ovate-conic, rather thin, the peristome continuous.

Sides of the foot smooth, continuous. A right cervical, epipodial lobe serves as a water conduit. The central tooth of the radula has basal denticles.

This subfamily comprises all known genera having the operculum calcareous. It occurs on all the continents of the Old World and one European species has been introduced locally in America.

Authors are conspicuously at variance as to the number of genera of Buliminæ and their limits. The type species of *Bulimus* (*Bithynia* Leach) is known to have a concentric operculum with a small spiral nucleus, but this nuclear character is often overlooked, being visible only in young or quite unworn examples. In *Gabbia* Tryon and *Digyrcidum* Locard the spiral portion is larger, but the shell and soft parts are not otherwise different so far as known. Annandale and Prashad[1] separate *Hydrobioides* Nevill and *Paranerita* Annandale as genera on account of the thickened peristome; *Digoniostoma* Annandale on the same ground, and because of the basally angular peristome. All of these appear to have the operculum initially spiral, later concentric, with an inner calcareous layer. When these groups are better known, further distinctive characters may be found in the penes or other organs, but for the present we are disposed to rank all as subgenera of *Bulimus*.

*Mysorella* Godwin-Austen, which has an operculum of the ordinary bulimine type, differs by its dentition.

*Alocinma* Annandale and Prashad[2] is certainly not related to *Amnicola*. The operculum is thick and calcareous, too large for retraction into the shell, characters of *Bulimus;* in *Amnicola* it is thin and corneous retracting well into the shell. Though mainly spiral, the operculum of

[1]Annandale and Prashad, 1921, Rec. Indian Mus., XXII, p. 4.
[2]1919, Rec. Indian Mus., XVIII, 1, p. 23. Type: *Amnicola sistanica* Annandale and Prashad. Seistan, eastern Persia.

*Alocinma* is said to be provided around the margin with concentric lines. The penial structure also agrees with that of *Bulimus tentaculatus*. It appears therefore to be a bulimid snail, with the operculum less evolved than the type species of *Digyrcidum*, but of the same nature. It has the most primitive operculum of the bulimid series, as *B. tentaculatus* has the most evolved. It is therefore to be ranked as a subgenus of *Bulimus*, or as a very closely related genus.

### BULIMUS Scopoli

*Bulimus* SCOPOLI, 1777, 'Introductio ad Historiam Naturalem,' p. 392. For *Helix putris, fragilis, stagnalis*, and *tentaculata* of Linnæus. Type by present designation: *Helix tentaculata* Linnæus.

*Bithynia* LEACH, 1818, in Abel, 'Narrative of a Journey in the Interior of China,' p. 362. Type by original designation: *Helix tentaculata* Linnæus.

*Bithinia* GRAY, 1824, Philos. Mag. and Journ., LXIII, p. 277. Monotype: *Helix tentaculata* Linnæus. The generic name *Bithinia* was first published in 1821, London Medical Repository, XV, p. 239; but the only species cited there, *P. ventricosa*, without description, was at that time a manuscript name.

*Bythinia* W. MACGILLIVRAY, 1843, 'Hist. Moll. Aberdeen,' p. 51. Monotype: *Helix tentaculata* Linnæus.

*Elona* MOQUIN-TANDON, 1855, 'Moll. France,' II, pp. 516 and 527. Type by present designation: *Helix tentaculata* Linnæus.

Shell imperforate, ovate-conic, thin, glossy; aperture ovate, slightly oblique, not contracted, the lip not thickened, sharp, the columellar margin narrow and ridge-like. Operculum solid, lodged at the edge of the peristome, calcareous within; the outer layer thin, cuticular, concentrically striate; the nucleus spiral, a little below and to the left of the middle.

The animal has a well-developed right cervical lobe and the male organ, in the type species, is conspicuously bifid. Radula having a broad central tooth with weakly trilobed basal margin and numerous basal denticles.

The genus *Bulimus* of Scopoli was proposed for four species which had previously been included in *Helix*, and one of these must necessarily be selected as the type, barring all surmises as to what Scopoli's unex-expressed intentions might have been at the time. Of the four species cited, *putris* was subsequently placed in *Succinea*, *fragilis* and *stagnalis* in *Lymnæa*, and *tentaculata* in *Bithynia*. The name *Bulimus* was afterwards improperly used for an extensive series of land shells. While it was clearly derived from the pre-Linnæan *Bulinus* of Adanson (1757, 'Hist. Nat. Sénégal, Hist. des Coquillages,' p. 5), the term had not before been used in Linnæan nomenclature and cannot properly be restricted to the Adansonian species, which was specifically nameless at the time *Bulimus* was proposed. Moreover, it is a matter of conjecture whether Scopoli's change of spelling was due to an oversight or an intentional correction, and as the first binomial author to utilize Adanson's pre-Linnæan term, Scopoli's right to modify the spelling and the scope of the genus cannot be questioned. Since *Succinea* and *Lymnæa* are the oldest and most widely used of the three above mentioned names, we propose to take *Helix tentaculata* Linnæus as the type of Scopoli's *Bulimus* which consequently replaces *Bithynia* Leach.

This genus is abundantly developed in the Old World, especially in its warmer portions. One European form has been introduced into North America. But few species are thus far known from the Ethiopian Region and none from Madagascar.

### Subgenus GABBIA Tryon

*Gabbia* TRYON, 1865, American Journ. Conch., I, p. 220. Monotype: *Gabbia australis* Tryon.

*Digyrcidum* LOCARD, 1882, 'Prodr. Malacol. Franç., Moll. Terr. Eaux Douces,' p. 224. Monotype; *Bythinia bourguignati* Paladilhe.

*Digyreidum* LOCARD, 1893, 'Coq. Eaux Douces et Saum. France,' p. 75. Monotype: *Bythinia bourguignati* Paladilhe.

*Diggreidum* PÆTEL, 1887, 'Catal. Conch. Samml.,' I, p. 428. Misspelling of *Digyreidum*.

The form is like *Bulimus*; the outer lip may be a trifle thickened outwardly at the edge, but not expanded. The operculum lodges at the edge of the aperture, and has a larger spiral portion than in *Bulimus* proper.

*Gabbia* is here understood to include *Digyreidum* (=*Digyrcidum*), in which the spiral part of the operculum is typically larger than in *B. tentaculatus*, occupying the greater part of the whole. In African species the size varies; *B. senaariensis* sometimes has the spiral part as small as in the type of *Gabbia*, while *B. kisalensis* has it as large as in that of *Digyreidum*.

It appears that the operculum of *Bulimus*, in the embryonic stage, is spiral. The spiral mode of increase may continue in the neanic stage for a time, varying in different species, after which the operculum ceases to revolve with growth, the increment becoming concentric, nearly equal on all sides. In *B. tentaculatus* the spiral portion is very small, yet distinctly visible in unworn opercula. In the species upon which *Gabbia* and *Digyreidum* were founded, the spiral portion is larger and therefore more readily seen. The concentric stage is a highly specialized structure, superposed upon the earlier, more primitive spiral type, common to other genera of the family.

The following known Ethiopian species appear to belong to the subgenus *Gabbia* as here defined.

*Bulimus africanus* (Frauenfeld) = *Bithynia africana* FRAUENFELD, 1862, Verh. Zool. Bot. Ges. Wien, XII, p. 1155. West Africa.

*Bulimus kisalensis* Pilsbry and Bequaert. See below.

*Bulimus martreti* (Germain) = *Bithynia (Gabbia) martreti* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 469; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 522, Pl. v, figs. 12-12*a*. Mamun country, near Lake Chad.

*Bulimus martreti* var. *major* (Germain) = *Bythinia martreti* var. *major* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 522. Mamun country, near Lake Chad.

*Bulimus neothaumæformis* (Germain) = *Bythinia (Gabbia) neothaumæformis* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 65; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 523, Pl. v, figs. 13–13*a*. Southeast of Lake Chad.

*Bulimus neumanni* (E. v. Martens) = *Bithynia (Gabbia) neumanni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 191 (fig. of radula), Pl. vi, fig. 33. In the Monlo-Sakissagan brook, Masai -Nyika country, East Africa.

*Bulimus neumanni* var. *elatus* (Germain) = *Bythinia neumanni* var. *elata* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 522. Lake Chad.

*Bulimus neumanni* var. *globosus* (Germain) = *Bythinia neumanni* var. *globosa* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 522. Lake Chad.

*Bulimus nyassanus* (Bourguignat) = *Amnicola nyassana* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 36. *Bythinia stanleyi* E. A. SMITH (*pro parte*), 1877, Proc. Zool. Soc. London, Pl., LXXV, fig. 22. Lake Nyasa.

*Bulimus senaariensis* (Küster) = *Paludina senaariensis* "Parreyss" KÜSTER, 1852, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 21, *Paludina*,' p. 44, Pl. IX, figs. 10–11. *Digyreidum sennaaricum* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 130. Sennar, Anglo-Egyptian Sudan.

*Bulimus senaariensis* var. *adspersus* (Jickeli) = *Bithynia sennariensis* var. *adspersa* JICKELI, 1874, Nov. Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 246, Pl. VII, fig. 32. Anseba, Abyssinia.

*Bulimus stanleyi* (E. A. Smith) = *Bythinia stanleyi* E. A. SMITH, 1877, Proc. Zool. Soc. London, p. 717, Pl. LXXV, fig. 21 (only). Lake Nyasa.

*Bulimus subbadiellus* (Bourguignat) = *Bythinia subbadiella* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 30. Lake Haussa, Abyssinia.

*Bulimus tilhoi* (Germain) = *Bythinia tilhoi* GERMAIN, 1912, Bull. Mus. Hist. Nat. Paris, p. 322; 1916, 'Doc. Scientif. Miss. Tilho,' III, p. 306, Pl. I, figs. 5–6. Bengu, Niger Territory.

*Bulimus walleri* (E. A. Smith). See p. 217.

### **Bulimus (Gabbia) kisalensis**, new species

Text Figure 17

Lake Kisale at Kikondja (type locality; J. Bequaert Coll.). Near the source of the Kimilolo River, Elisabethville, on the gravelly bottom (Michael Bequaert Coll.).

The shell is minutely perforate, *Ampullaria*-shaped, pale translucent gray, glossy and smooth, the growth lines very faint. The whorls are strongly convex, the last somewhat flattened below the suture, everywhere well rounded. The aperture is slightly oblique, very broadly oval, the peristome dark-edged, in a plane. The operculum lodges at its edge, and is slightly concave in the middle. It is composed of about 2½ spiral whorls. The nucleus central; surrounding this is a band of concentric increment about one-fourth the width of the operculum.

Length, 2.2 mm.; diameter, 2.3 mm.; aperture, 1.4 mm.; 3 whorls.

One of the most globose species. It has some resemblance in contour to the figure of the undescribed *B. nyassanus* (Bourguignat), from Lake Nyasa, but that is far larger. It has not the rapidly enlarging last whorl and expansion at the aperture of *B. alberti*, but it is like that species in having the operculum mainly spiral. Four small specimens, apparently of the same species, were found among *Lobogenes michaelis* near the source of the Kimilolo River, here a brook.

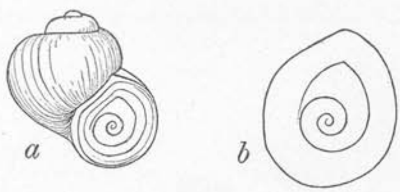



Fig. 17. *Bulimus kisalensis* Pilsbry and Bequaert, shell and operculum of type. Kikondja.

## Other Species of *Gabbia* Recorded from the Belgian Congo

### *Bulimus (Gabbia) walleri* (E. A. Smith)

*Bythinia walleri* E. A. Smith, 1888, Proc. Zool. Soc. London, p. 54, fig. 3 (on p. 55).

*Bithynia (Gabbia) walleri* E. A. Smith. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 191.

Lake Albert: (type locality, without more definite indication; Emin Pasha Coll.).

### Subgenus **Paranerita** Annandale

*Hydrobioides* subgenus *Paranerita* Annandale, 1920, Rec. Indian Mus., XIX, p. 45. Monotype: *Hydrobioides physcus* Annandale.

The last whorl expands and is thickened outwardly at the aperture. The spiral part of the operculum occupies fully half of its width.

The following African forms agree technically with Annandale's Indian group, but we feel somewhat doubtful about the actual relationship.

*Bulimus alberti* (E. A. Smith). See p. 218.
*Bulimus humerosus* (E. v. Martens). See p. 219.

*?Bulimus puteanus* (E. v. Martens) = *Bithynia (Gabbia) puteana* E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 191. Zanzibar. This species has not been figured, so that we feel very doubtful as to its proper subgeneric position.

### **Bulimus (Paranerita) alberti** (E. A. Smith)

Text Figure 18

*Bythinia alberti* E. A. Smith, 1888, Proc. Zool. Soc. London, p. 54.

*Bithynia (Gabbia) alberti* E. A. Smith. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 190, Pl. vi, fig. 32. J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 210.

*Bythinia (Gabbia) alberti* E. A. Smith. Germain, 1912, Bull. Mus. Hist. Nat. Paris, p. 81; 1916, *op. cit.*, p. 199, figs. 1 and 2 (on p. 200).

Lake Albert: (type locality, without more definite indication; Emin Pasha Coll.; Schubotz Coll.); near Kassenje (Stuhlmann and Emin Pasha Coll.). Lake Edward: near Kirima, on the northwestern shore (Stuhlmann Coll.); in the lake, without more definite indication (Schubotz Coll.); near Kasindi and fossil in sediments 5 meters above the present level of the lake at Vichumbi (Gromier Coll.).

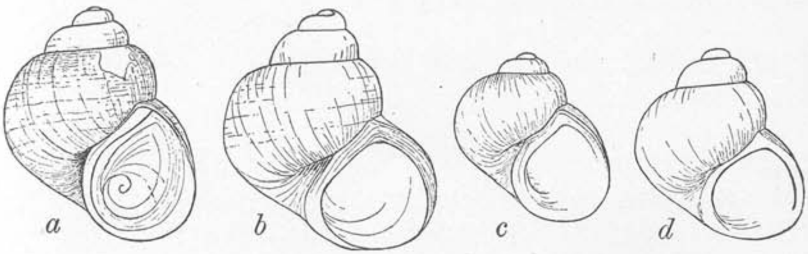



Fig. 18. *Bulimus alberti* (E. A. Smith). Kabare, Lake Edward.

Kabare, at the southern end of Lake Edward (J. Bequaert Coll.).

A globose species with short, conic spire and obtuse apex, quite solid, perforate, covered with a thin, isabella colored or pale olive-buff periostracum. The initial whorl is very little raised. All of the whorls are strongly convex, the last one a little flattened below the deep suture, and rather rapidly curving below the flattening, in the most strongly characterized examples appearing very bluntly subangular there. It expands rather strongly near the mouth. The surface has fine, slight growth lines and very minute, spiral striæ, most conspicuous in the region of the shoulder and not visible in slightly worn examples. The aperture is quite large, very oblique to the axis, broadly ovate, flattened by the contact with preceding whorl. The peristome is expanded, in old specimens thickened on the face, continuous; the outer margin, in a profile view, is seen to arch forward somewhat. The concave columella is moderately thickened within. Two fully adult shells measure:

Length, 4.4 mm.; diameter, 4.0 mm.; length of aperture with peristome, 3.0 mm.; 4 whorls.

Length, 2.9 mm.; diameter, 2.8 mm.; length of aperture with peristome, 2.3 mm.; 3¼ whorls.

The thin operculum lodges in a vertical position, with the lower margin just within the lip-edge, the upper much farther in. The nucleus is near the lower third of the length. There are 1½ spiral whorls, the last half-whorl enlarging very rapidly. This is surrounded by a band of concentric increment, the width of which is from somewhat less than one-fourth the width of the operculum to, in the largest examples, nearly a third its width. Internally it has an extremely thin calcareous layer, a little roughened and slightly concave in the middle, thin toward the edges.

The small number of whorls and their rapid increase, the last one expanding, somewhat campanulate at the mouth, and the large, rather strongly oblique aperture, are diagnostic of this species.

The very superficial spiral striæ are present only on the best preserved examples. Smith did not mention them. The size of fully adult shells with thick, expanded lip varies considerably.

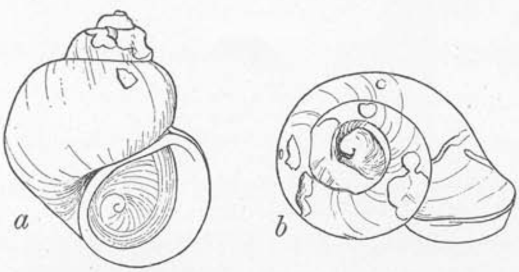



Fig. 19. *Bulimus humerosus* (E. v. Martens). Kisumu, Lake Victoria.

## Other Species of *Paranerita* (?) Recorded from the Belgian Congo

### *Bulimus* (*Paranerita*) *humerosus* (E. v. Martens)

Text Figure 19

*Bithynia stanleyi* var. *humerosa* E. von Martens, 1879, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 104 (type locality: southwestern shore of Lake Victoria).

*Bithynia* (*Gabbia*) *humerosa* E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 190 (fig. of radula ), Pl. vi, fig. 31.

*Bythinia* (*Gabbia*) *humerosa* E. v Martens. Germain, 1916, Bull. Mus. Hist. Nat. Paris, p. 200.

Lake Edward: E. v. Martens in 1897 refers to this species, with some doubt, subfossil specimens obtained at Vichumbi by Stuhlmann. All *Bulimus* collected by

Schubotz, Gromier, and Bequaert, either alive in the lake or subfossil on its southern shores, have proved to be *B. alberti*.

Dautzenberg and Germain (1914, Rev. Zool. Afric., IV, 1, p. 61) have recorded *B. humerosus* from the Katanga District of the Belgian Congo: in the Lovoi River near Kikondja; in Lake Kisale; and in the Luvua River (all Bequaert Coll.). A specimen of the Lake Kisale lot which we have examined, is quite distinct from *B. humerosus* of Lake Victoria and we have described it as *B.* (*Gabbia*) *kisalensis*. We therefore doubt that true *B. humerosus* occurs in the Katanga.

This species agrees with *B. alberti* in all characters except the form of the last whorl, which has a decidedly more conspicuous shoulder bounded by a rounded angulation. The operculum is similar.

Length, 4.5 mm.; diameter, 4.2 mm.

The example figured is from a lot collected by Sir Charles Eliot at Kisumu, on the eastern shore of Lake Victoria, a place near the original locality. It seems likely that *B. alberti* will eventually be ranked as a subspecies of *humerosus*.

Fig. 20. *Mysorella* (?) *multisulcata* (Bourguignat). Tanganyika.

### MYSORELLA Godwin-Austen

*Mysoria* GODWIN-AUSTEN, 1919, Rec. Indian Mus., XVI, 3, p. 211. Monotype: *Bithynia costigera* Küster var. *curta* Nevill. Not *Mysoria* Watson, 1893.

*Mysorella* GODWIN-AUSTEN, 1919, Rec. Indian Mus., XVI, 6, p. 431. New name for *Mysoria* Godwin-Austen, preoccupied.

The shell is umbilicate, spirally lirate with the peristome slightly expanded, thickened. Operculum calcareous, concentric, with a small spiral center.

Teeth of the radula as in *Bulimus* except that the central has only a single, short basal denticle on the thickening which borders the lateral margins on each side.

The single African species referred to this genus resembles the Indian *M. costigera* (Küster) in sculpture of the conspicuously umbilicate shell, but as it has no thickening or expansion of the peristome, and its operculum and radula are still unknown, the generic reference appears highly dubious. *Mysorella* is thus introduced into the African fauna simply for the reason that our species cannot be referred to any known African genus.

### **Mysorella (?) multisulcata** (Bourguignat)

Text Figure 20

*Bythinia multisulcata* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 11, Pl. III, figs. 7 and 8; 1890, Ann. Sc. Nat. Zool., (7) X, p. 52, Pl. III, figs. 7 and 8. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

Lake Tanganyika: shores of Ubuari Peninsula, on the western side (type locality).

Stappers dredged this curious, beautifully sculptured species off Uvira; in the bay of Tembwe; in the bay of Kilewa; in the bay of Sumbu; and in 100 meters off the western shore between the mouth of the Moba and Lobozi Rivers. We have examined three of the specimens obtained by this collector and have figured one.

### **Amnicolinæ**

Operculum thin, wholly corneous, retractile some distance within the aperture, spiral, composed of rapidly enlarging whorls, with decidedly eccentric nucleus. The shell varies from turreted or pupiform to globose or depressed.

There is no cervical lobe. The central tooth of the radula has one or several basal denticles on each side.

Two species of Amnicolinæ which we have seen from the south-eastern Belgian Congo appear to represent a new genus. *Amnicola ciliata* Gould, described from West Africa, must be placed in *Potamopyrgus*. In addition, a small number of Ethiopian species have been referred to *Hydrobia;* but in the absence of specimens, we are unable to decide whether they are true Amnicolinæ.

### PALUDESTRINA d'Orbigny

*Paludina* subgenus *Paludestrina* D'ORBIGNY, 1840 (or 1839), 'Voy. Amérique Mérid., Moll.,' p. 381. Type: *Helix acuta* Draparnaud, one of the species originally included, and designated as type by Bourguignat in 1887 ('Etudes Pet. Paludinidées,' p. 10).

*Hydrobia* HARTMANN, 1821, 'Syst. Erd u. Süsswasser Gasterop. Europa's,' in Sturm, 'Deutschland's Fauna,' VI, 5, pp. 47 and 58. Type: *Helix acuta* Draparnaud, as designated by Gray (1847, Proc. Zool. Soc. London, p. 151) (preoccupied by *Hydrobius* Leach, 1817).

*Paludestina* GRAY, 1847, Proc. Zool. Soc. London, p. 151. Misspelling of *Paludestrina*, as a synonym of *Hydrobia*. Type: *Helix acuta* Draparnaud.

The members of this genus live in fresh or brackish water. The following African species appear referable to it.

*Paludestrina alabastrina* (Morelet) = *Hydrobia alabastrina* MORELET, 1889 Journ. de Conchyl., XXXVII, p. 19, Pl. II, fig. 5. Port Elizabeth, Cape Colony.

*Paludestrina* (?) *balfouri* (Godwin-Austen) = *Hydrobia* (?) *balfouri* GODWIN-AUSTEN, 1883, Proc. Zool. Soc. London, p. 4, Pl. I, figs. 4–5. Sokotra.

*Paludestrina erythræa* (E. v. Martens) = *Hydrobia erythræa* E. v. MARTENS, 1858, Archiv f. Naturgesch., XXIV, 1, p. 186, Pl. v, fig. 11. Shores of the Red Sea.

*Paludestrina gabonensis* (Morelet) = *Hydrobia gabonensis* MORELET, 1885, Journ. de Conchyl., XXXIII, p. 30, Pl. II, fig. 12. Ogowe River, Gaboon. This was said to have a corneous operculum and must therefore be one of the Amnicolinæ.

*Paludestrina schweinfurthi* (Jickeli) = *Hydrobia schweinfurthi* JICKELI, 1874, Nov. Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 250, Pl. VII, fig. 35. White Nile. The generic reference of this is somewhat dubious.

*Paludestrina tristis* (Morelet) = *Hydrobia tristis* MORELET, 1889, Journ. de Conchyl., XXXVII, p. 18, Pl. II, fig. 4. Port Elizabeth, Cape Colony. We have examined specimens of this species and it appears not to be a typical *Paludestrina*, the central tooth of the radula having several basal denticles and the outer lip of the shell being slightly sinuous. The formula of denticles is $\frac{5}{8-8}$, 7, 10, many. The basal denticles stand in an oblique row on each side, the outer one lowest and extremely minute.

*Paludestrina zwellendamensis* (Küster) = *Paludina zwellendamensis* KÜSTER, 1852, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 21, *Paludina*,' p. 53, Pl. x, figs. 19–20. Zoetendal Valley, Swellendam District, Cape Colony.

*Eussoia* PRESTON, 1912, Proc. Zool. Soc. London, p. 192. This was described as a fluviatile snail, having the appearance of *Assiminea*, but without operculum. We have examined a cotype of the only species, *Eussoia inopina* Preston (1912, *op. cit.*, p. 192, Pl. XXXII, fig. 10. Banks of the Eusso Nyiro River, Kenya Colony) and can find but little difference with *Paludestrina*. We are inclined to believe that it belongs in Amnicolinæ. The specimens may have lost their thin, corneous operculum, after death, while the decayed animal remained in the shell.

## POTAMOPYRGUS Stimpson

*Potamopyrgus* STIMPSON, 1865, American Journ. Conch., I, p. 53. Monotype: *Amnicola corolla* Gould.

*Patamopyrgus* PÆTEL, 1887, 'Catal. Conch. Samml.,' I, p. 429. Misspelling of *Potamopyrgus*.

*Pyrgophorus* ANCEY, 1888, Bull. Soc. Malacol. France, V, pp. 188 and 192. Type by present designation: *Pyrgulopsis spinosa* Call and Pilsbry.

With the exception of the species mentioned below and the British *Hydrobia jenkinsi* Smith, which appears to be a *Potamopyrgus*, the genus is restricted to South and Central America (northward to Texas), New Zealand, Tasmania, and Australia. Unlike Amnicolidæ generally, the young are born alive.

*Potamopyrgus ciliatus* (Gould) = *Amnicola ciliata* GOULD, 1850, Proc. Boston Soc. Nat. Hist., III, p. 196.

"Shell small, elongate, imperforate, brownish-green; spire acutely conic; whorls 6, subangulate, armed with a series of recurved spines on the angle, the last whorl acutely carinate at the periphery; aperture circular; lip black.

"Length 14, width ⅛ inch. Hab. Deea River, Liberia, on the muddy margins. Dr. Perkins."

The specimens figured (Fig. 21) are from Cape Palmas (R. Swift collection). The aperture is broadly ovate rather than circular. They measure:

| | | | |
|---|---|---|---|
| Length, 5.5 mm.; | diameter, 3.20 mm.; | 7 whorls. | |
| " 5.8 | " 3.25 | 7 " | |

In the collection of the Academy of Natural Sciences of Philadelphia there are three lots of this species labelled "Cape Palmas," received from T. Bland, R. Swift and C. M. Wheatley; in all 37 specimens. Possibly all of these were from one source.

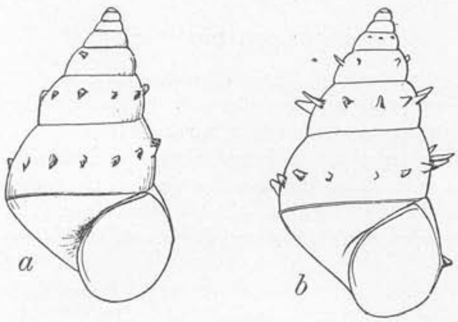


Fig. 21. *Potamopyrgus ciliatus* (Gould). Cape Palmas.

No subsequent record of this species or genus in Africa has been made. Dr. Gould remarked upon the resemblance of this species to *P. corolla* which he had previously described, and pointed out their differences. Frauenfeld examined specimens "in Cuming's Sammlung aus Liberia, als *alvata* Gld.[1] aus Afrika, und gleichfalls aus Neuseeland. Ich kann die aus Afrika stammenden nicht von den neuseeländischen trennen." Fischer's *Paludestrina salleana*[2] was said to be from New Zealand, on the authority of Sallé; it appears quite indistinguishable from *P. ciliata* (Gould). Suter[3] ranks *P. salleana* as a subspecies of *P. corolla* (Gould). He states that "the only specimens with a slight chordate carina below the series of spines are from Lake Manapouri." His figure shows a form which is only subangular below the spines.

On the whole, it appears likely that Gould's African locality was erroneous; but his well-known accuracy, as well as the circumstantially recorded locality and collector, cause us to suspend judgment until this locality can be searched again.

[1] "*Alvata*" was evidently Frauenfeld's misreading of a poorly written *ciliata*.
[2] 1860, Journ. de Conchyl., VIII, p. 208, Pl. IV, fig. 6.
[3] H. Suter, 1913, 'Man. New Zealand Moll.,' p. 233; 1915, *op. cit.*, Atlas, Pl. XIV, fig. 4.

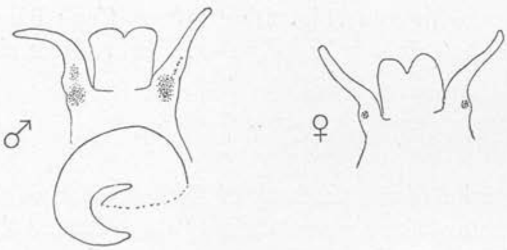



Fig. 22. *Lobogenes michaelis* Pilsbry and Bequaert. Head, both sexes.

## LOBOGENES, new genus

Shell with the general form of *Amnicola*; outer lip thin, produced forward in a broad, median lobe; columella heavily calloused. Operculum thin, wholly corneous, paucispiral with nucleus at about the lower fourth.

Penis (Fig. 22) very large, dagger-shaped, abruptly widened at the base of attachment. Radula about as in *Paludestrina* or *Bythinella viridis*, the central tooth with single basal denticles situated high on the margins. Formula of denticles $\frac{3 \cdot 1 \cdot 3}{1-1}$.

Type: *Lobogenes michaelis* Pilsbry and Bequaert.

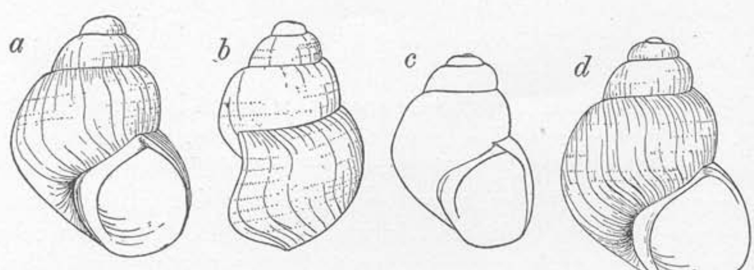



Fig. 23. *Lobogenes michaelis* Pilsbry and Bequaert: *a-b*, type; *c-d*, two paratypes. Kimilolo River.

This group has dentition entirely like the slender paludestrinids of Europe and America, the denticles being much more numerous on the outer than on the inner marginal, and the central tooth with single basal denticles. It differs from all the paludestrinids by the heavily calloused columella, like that of *Lithoglyphus*. The lobed outer lip reminds one of some of the species of the South American genus *Potamolithus*.

### **Lobogenes michaelis,** new species

Text Figure 23

At the source of the Kimilolo River near Elisabethville (Michael Bequaert Coll.).

The shell is imperforate, rather solid, ovate-conic with the apex obtuse; ecru-olive in color. The whorls are strongly convex below the suture, then rather weakly convex, the last whorl strongly convex also at the periphery. The surface is glossy, marked with low, forwardly-arched growth lines and having fine, very shallow spiral striation, which becomes subobsolete on the last whorl (and sometimes is nowhere noticeable). The aperture is about half the total length, ovate and slightly oblique. The outer lip is thin, its middle part produced forward in a conspicuous lobe. The columella is concave, very much thickened by a heavy white callus.

Length, 3.8 mm.; diameter, 2.9 mm.; length of aperture, 2.0 mm.; 4½ whorls. ♀.

Length, 3.0 mm.; diameter, 2.3 mm.; length of aperture, 1.8 mm.; 4 whorls. ♂. Type.

The male measured may not be adult. It was the only one found in 8 specimens opened.

The lobe of the lip is developed in the neanic stage, being distinct in a shell 1.8 mm. long. Columella and closed umbilicus are as in the adult stage.

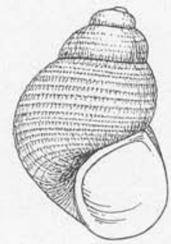


Fig. 24. *Lobogenes spiralis* Pilsbry and Bequaert. Type. Kimilolo River.

### **Lobogenes spiralis,** new species

Text Figure 24

At the source of the Kimilolo River near Elisabethville (Michael Bequaert Coll.).

The shell is more slender than *L. michaelis,* distinctly perforate, and very distinctly striate spirally, the striæ coarse. The aperture is smaller. The curvature of the lip is less pronounced, and the columella less heavily calloused.

Length, 2.8 mm.; diameter, 2.0 mm.; aperture, 1.40 mm.; 4 whorls. Type.
" 3.6 " " 2.2 " " 1.75 " 4½ whorls.

## Incertæ sedis

### **Tomichia** Benson

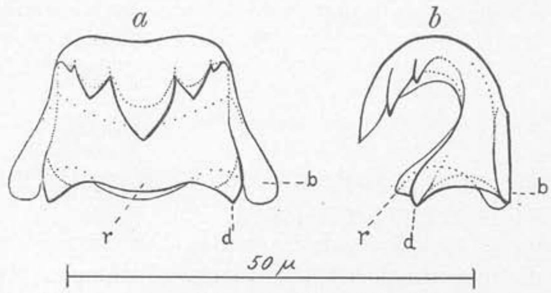
*Tomichia* Benson, 1851, Ann. Mag. Nat. Hist., (2) VII, p. 378. Monotype: *Truncatella ventricosa* Reeve.

This genus has been placed in the Truncatellidæ, but the external characters of the animal as described by Benson, and the radula, examined by Troschel, Thiele and ourselves, show this classification to be erroneous.

The teeth resemble those of Synceridæ and Amnicolidæ in general form. The central tooth (Fig. 25) has a long reflection with $\frac{2\text{-}1\text{-}2}{1\text{-}1}$

denticles, the basal denticles united by a ridge which rises higher than they in the middle. Between this ridge and the basal plate there is a hollow in which the anterior part of the next tooth fits.[1] The lateral tooth has 8 denticles and a body shaped as in *Amnicola*. The marginals have 6 and 12 denticles, those of the inner marginal larger, as usual in *Syncera*.

From the small number of denticles on the central tooth one would think this snail related to *Syncera*, were it not that Benson states that the eyes are at the bases of the tentacles. He was well acquainted with




25. *Tomichia ventricosa* (Reeve). Central tooth from above and in profile. .terior border of basal plate; d, basal denticle; r, ridge connecting basal denticles. The profile view is diagrammatic.

*Syncera*, mentioning its pedunculate eyes, so that his observation is evidently trustworthy. Under the circumstances, we place *Tomichia* in the Amnicolidæ, pending further study of the anatomy. If correctly referred to this family, it will require a new subfamily, Tomichiinæ.

Only one species is known, from South Africa:

*Tomichia ventricosa* (Reeve) = *Truncatella ventricosa* "Sowerby" REEVE, 1842, 'Conchol. System.,' II, p. 94, Pl. CLXXXII, fig. 2; PFEIFFER, 1846, Zeitschr. f. Malakoz., III, p. 189; J. THIELE, 1921, 'Deutsch. Südpolar Exped. 1901–3,' XVI, p. [99], fig. 1. *Truncatella capensis* "Krauss" PFEIFFER, 1846, Zeitschr. f. Malakoz., III, p. 189. *Hydrobia caledonensis* CHAPER, 1885, Bull. Soc. Zool. France, X, p. 484, Pl. XI, fig. 6. Cape Colony (type locality: Swellendam).

*Tomichia ventricosa* var. *brevis* (Krauss) = *Truncatella ventricosa* var. *brevis* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 87. Cape Flats and Zoetendal Valley, Cape Colony.

### Syrnolopsidæ

The shell is small, imperforate, long and slender, of numerous (7 to 18) whorls, which may be smooth or sculptured spirally or axially. Aperture small, the lip

[1]The figures and notes on the central tooth were supplied by Dr. H. Burrington Baker. The diagrammatic reconstruction of the profile view was made by readings of the scale of the fine adjustment, as no tooth was actually seen in this position.

sinuated above, retracted or effuse at base, often expanded; inner lip calloused or continuous. Columellar axis encircled with a spiral fold in the middle and later whorls, emerging more or less on the columella (but sometimes subobsolete). The operculum and soft parts are unknown.

Known from Lake Tanganyika only. From their abundance on beaches it is evident that these snails live in quite shallow water, and they have also been dredged from as deep as 80 m. So far as we know, only dead specimens have been taken.

While the shells of this group recall *Nematurella*, *Pyrgula*, and *Prososthenia* by their form, size and sculpture, and *Pterides* by the sinuous lip, they are unique among fresh-water prosobranchs for the pyramidelloid columellar fold and the palatal folds of some species. However, both of these structures are weak or even wanting in certain species and they are wanting in the early neanic stages of all those we have examined.

Pending examination of the soft parts, the taxonomic position of the group remains uncertain. Many and various are the opinions which have been advanced. We think it will turn out to be a member of the superfamily Rissoaceæ, and possibly a subfamily of the Amnicolidæ.

The genus *Fascinella* (Stache) of Sandberger[1] requires comparison with *Syrnolopsis*. It is from the Cosina Chara Beds, a Dalmatian freshwater deposit of Palæocene age, carrying a considerable fauna of special species, the genera of part of them uncertain. Until the characters of *Fascinella* are much better known, the evidence of identity with *Syrnolopsis* claimed by Tausch, who appears to have seen neither genus, remains inconclusive.

## Key to Genera and Species of Syrnolopsidæ

1. Shell smooth or having spiral sculpture. *Syrnolopsis* E. A. Smith............2.
   Shell having well-developed axial ribs. *Anceya* Bourguignat................3.

*Syrnolopsis*

2. Length 8 to 12 mm., with 9 to 12 whorls; lateral outlines of the spire straight or slightly convex; surface smooth; columellar fold small, weakly emerging. *S. lacustris* E. A. Smith.
   Smaller, of 7 to 9 whorls; lateral outlines rather strongly convex; surface smooth, spirally lirate or carinate; columellar fold strongly emerging. *S. minuta* Bourguignat.
   Length about 4 mm., of 8 to 9 convex whorls; slender, regularly tapering; surface smoothish or with weak spiral cords; columellar fold very weak. *S. gracilis* Pilsbry and Bequaert.

[1]1871, 'Land- und Süsswasser-Conch. der Vorwelt,' p. 186. See also Wenz, 1923, 'Fossilium Catalogus,' Pars 20, III, p. 8841 (in the family Cœliaxidæ).

*Anceya*

3. Last whorl roundly subangular, not keeled; whorls about 18 in a length of 12 mm. Subgenus *Burtonilla* E. A. Smith.......*A. terebriformis* (E. A. Smith).
Base encircled by a narrow keel........................................4.
4. With about 11 to 14 whorls in entire shells 4 to 12 mm. long. Subgenus *Anceya*, proper..........................................................5.
With about 6½ to 7½ whorls in specimens about 3 mm. long. *Martelia* Dautzenberg......................................................8.
5. Columellar fold wanting or extremely weak; about 12 ribs on the penult whorl. *A. bella* Pilsbry and Bequaert.
Columellar fold well developed.........................................6.
6. Last whorl with a deeply immersed median palatal fold, seen by transparence through the shell, or by breaking it back; ribs rather straight. *A. giraudi* Bourguignat.
No palatal fold within the last whorl..................................7.
7. Very slender; about 8 curved ribs on the penult whorl. *A. admirabilis* Bourguignat.
Stouter shells, with about 11 to 13 ribs on the penult whorl; banded with reddish on a pale ground..........................*A. rufocincta* E. A. Smith.

*Martelia*

8. Periphery prominent, but not keeled or spinose; axial ribs rather numerous. *M. tanganyicensis* Dautzenberg.
Periphery carinate; the axial ribs fewer and somewhat spinose. *M. dautzenbergi* Dupuis.

## **Syrnolopsis** E. A. Smith

*Syrnolopsis* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 426. Monotype: *Syrnolopsis lacustris* E. A. Smith.

*Stormsia* "Bourguignat" Germain, 1919, Bull. Mus. Hist. Nat. Paris, p. 356. As a synonym of *Syrnolopsis*, with *Syrnolopsis carinifera* E. A. Smith as type.

### **Syrnolopsis lacustris** E. A. Smith

Text Figures 26*a-g* and 27*a, b*

*Syrnolopsis lacustris* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 426; 1881, Proc. Zool. Soc. London, p. 288, Pl. xxxii, figs. 21 and 21*b*. Crosse, 1881, Journ. de Conchyl., XXIX, p. 119, Pl. iv, fig. 6. Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 107. Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 14–17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 142, Pl. x, figs. 14–17. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 210, Pl. vi, fig. 46. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 97. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 259; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 675. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

*Fascinella lacustris* E. A. Smith. Tausch, 1884, Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., XC, Abt. 1, p. 68, Pl. i, fig. 10.

*Syrnolopsis grandidieriana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 18; 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 22–24; 1890, Ann. Sc. Nat. Zool., (7) X, p. 144, Pl. x, figs. 22–24. Ancey, 1907, Bull. Scientif France et Belgique, (5) IX, (1906), pp. 255 and 266.

*Syrnolopsis anceyana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 20; 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 25–27; 1890, Ann. Sc. Nat. Zool., (7) X, p. 145, Pl. x, figs. 25–27. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

*Syrnolopsis hamyana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 17; 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 18–21; 1890, Ann. Sc. Nat. Zool., (7) X, p. 142, Pl. x, figs. 18–21. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

*Syrnolopsis foai* J. MABILLE, 1901, Bull. Soc. Philomath. Paris, (9) III, 2, p. 56. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 260; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 676, fig. 26 (young of *S. lacustris*).

Lake Tanganyika: originally described from the lake without more definite locality (J. Thomson Coll.); Pambete (type locality of *grandidieriana*, *anceyana*, and *hamyana*); Ufipa.

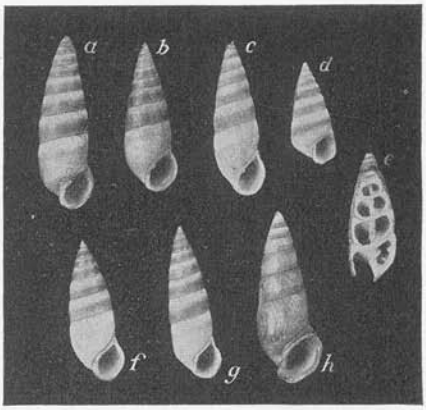



Fig. 26. *Syrnolopsis lacustris* E. A. Smith: *a*, one of the original lot; *b-g*, Sumbu Bay. *h*, *S. lacustris molirensis* Pilsbry and Bequaert.

Sumbu Bay (Stappers Coll.); Albertville (Charles Hedley Coll.).

The original specimens had the outer lip slightly thickened, widely sinuated above and below a prominent outer basal lobe, the "columella thickened, with a distinct plait at the upper part, and joined to the upper extremity of the labium by a thin callosity." Strong upper and weak lower palatal folds are so deeply immersed that they are not visible except by transparence or by breaking back the outer lip. Length, 11.5 mm.; diameter, 3 mm.; length of aperture, 3 mm. One of the original lot is represented in Figs. 26*a* and 27*b*. The lateral outlines of the spire are slightly convex, the individual whorls almost flat, the earliest convex. This specimen measures: length, 10.5 mm.; diameter, 3.3 mm.; aperture 3.0 mm. long; 10 whorls remain, apparently about one being lost.

In a series from Sumbu Bay (Figs. 26*b*-*g* and 27*a*) the size is smaller and the whorls slightly more convex. In some examples the outlines of the spire are about as in typical *lacustris*, while in others they are straight. The parietal callus is thicker, with raised edge.

Length, 9.0 mm.; diameter, 3.0 mm.; length of aperture, 2.7 mm.; 11 whorls, apex entire.

Length, 9.0 mm.; diameter, 2.80 mm.; length of aperture, 2.5 mm.; 8 whorls, apex lost.

Length, 8.5 mm.; diameter, 3.00 mm.; length of aperture, 2.4 mm.

Length, 9.2 mm.; diameter, 2.75 mm.; length of aperture, 2.5 mm.; 10 whorls, the tip lost.

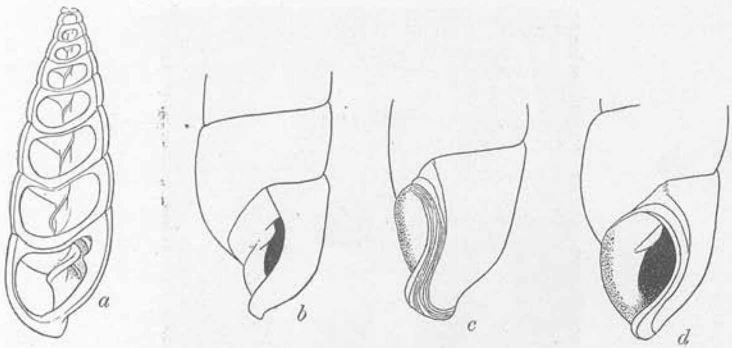



Fig. 27. *Syrnolopsis lacustris* E. A. Smith: *a*, Sumbu Bay; *b*, profile of one of the original lot. *c*-*d*, *Syrnolopsis lacustris molirensis*, last whorl.

In these specimens, which clearly are fully adult, the outer lip is obtuse and slightly expanded, the basal lip effuse and somewhat recurved. All of them are typical in the columellar fold. A specimen similar to Fig. 26*c* opened shows the columellar lamella distinctly in the lower four whorls, hardly a trace of it in the next earlier and none in those above. In the sixth from last whorl there is a shelly partition across the cavity (Fig. 27*a*). Another shell opened, similar to Fig. 26*b*, shows the columellar lamella in the last two whorls only (Fig. 26*e*). The section figured by Smith shows the columellar lamella ascending farther than in those we have opened, if the early whorls are drawn correctly, which is open to doubt.

Young examples of about six and eight whorls (Fig. 26*d*) have the columella straight and foldless.

Charles Hedley found this species more abundant than any other of the family on the sandy beach at Albertville.

**Syrnolopsis lacustris molirensis**, new subspecies

Text Figures 26*h* and 27*c*, *d*

Off Moliro, in 70 mm. (L. Stappers Coll.) and at Moliro (Pillette Coll.); in Lake Tanganyika.

The shell has a thin, cinnamon-buff periostracum, slightly paler below the suture and at the base. The peristome is entire, the outer lip moderately thickened, deeply sinuate above and at the base, which is conspicuously effuse. Inner lip strongly thickened. Columellar fold rather small and immersed, scarcely or not visible in a direct face view.

Length, 10.3 mm.; diameter, 3.6 mm.; length of aperture, 3.3 mm.; 9 whorls. Type.

Length, 11.8 mm.; diameter, 3.6 mm.; 10 whorls. Paratype.

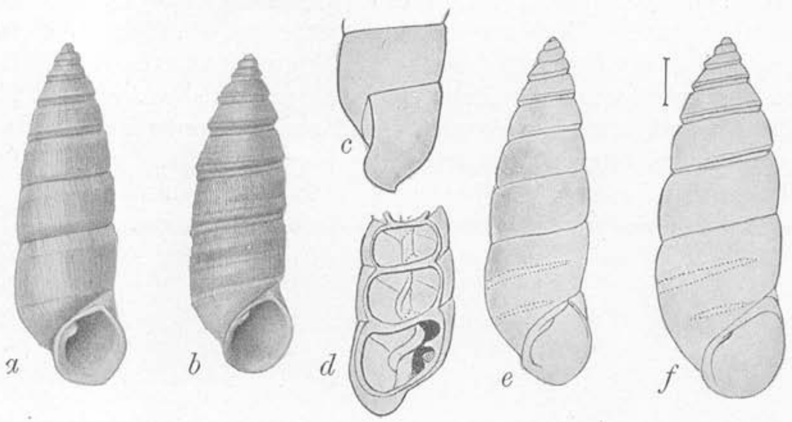



Fig. 28. *a-b*, *Syrnolopsis minuta* Bourguignat. Tanganyika.

**Syrnolopsis minuta** Bourguignat

Text Figure 28*a-f*

*Syrnolopsis minuta* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 21; 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 28–30; 1890, Ann. Sc. Nat. Zool., (7) X, p. 147, Pl. x, figs. 28–30. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 260; 1908, 'Rés. Scientif. Voy. Afrique, Foà,' p. 677. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 255 and 266.

?*Syrnolopsis giraudi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 20; 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 31–33; 1890, Ann. Sc. Nat. Zool., (7) X, p. 146, Pl. x, figs. 31–33. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

?*Syrnolopsis minuta* var. *major* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 260; 1909, *op. cit.*, p. 355, as equivalent to *S. giraudi*.

*Syrnolopsis minuta* var. *semilævis* ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 267.

*Syrnolopsis minuta* var. *multicarinata* ANCEY, 1907, *op. cit.*, p. 267.

*Syrnolopsis minuta* var. *unicarinata* ANCEY, 1907, *op. cit.*, p. 267.

Lake Tanganyika; Pambete (type locality of both *giraudi* and *minuta)*; Ufipa (Lechaptois Coll.).

Lake Tanganika: several lots collected by L. Stappers; Tembwe (Hubert Coll.); Albertville, on the sandy beach (Charles Hedley Coll.).

The shape is somewhat pupiform, the lateral outlines being decidedly more convex in the upper half than in *S. lacustris*, the last two whorls cylindric. Typically the whorls are smooth except for very fine axial striæ, clearly engraved in unworn shells, and sometimes a few minute spiral lines; but, in most examples seen, after the two strongly convex, smooth, embryonic whorls there are two angles or carinæ on each whorl, near the sutures. These may continue to the last whorl, but more frequently they disappear with growth. The outer lip is expanded a little and slightly sinuous in profile. The base is retracted and effuse. The calloused and continuous columellar and parietal border is raised as a distinct ledge, often with a groove between it and the whorl. The columellar fold is strong and emerges nearly to the edge. Two deeply immersed palatal folds are lateral and ventral in position.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Length, | 5.80 | mm.; | diameter, | 2.0 | mm.; | 8¼ | whorls. | (Fig. 28*f*). |
| " | 5.60 | " | " | 1.7 | " | 8½ | " | (Fig. 28*e*). |
| " | 5.40 | " | " | 1.9 | " | 8⅓ | " | |
| " | 5.00 | " | " | 1.7 | | | | |
| " | 3.75 | " | " | 1.5 | " | 7 | whorls. | |
| " | 4.50 | " | " | 1.4 | " | 8 | " | |

Variation in the carinæ is shown in the figures. As scarcely two specimens are alike, these variations do not denote races. There is also great variation in size and in ratio of diameter to length, as in the specimens drawn in Fig. 28*e*, *f*.

Germain believes *S. giraudi* Bourguignat to be a "var. *major*" of *S. minuta;* but in about a hundred specimens of the latter before us, none reaches the size of *giraudi* (7.5×3.0 mm., according to Bourguignat), and we are disposed to think them distinct. According to Bourguignat's figure, the contour is somewhat convex, as in *S. minuta*, but in size, especially in diameter, it agrees better with *S. lacustris*.

### **Syrnolopsis minuta carinifera** E. A. Smith

Text Figures 29*a*-*c* and 30*a*-*b*

*Syrnolopsis carinifera* E. A. SMITH, 1889, Ann. Mag. Nat. Hist., (6) IV, p. 174. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 15. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 210. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 97, fig. 6 (on p. 87). GERMAIN, 1919, Bull. Mus. Hist. Nat. Paris, p. 355, figs. 34 and 35 (on p. 356).

*Syrnolopsis minuta* var. *carinifera* E. A. Smith. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 255 and 267.

Lake Tanganyika: described from the lake, without more definite locality (C. Hore Coll.); Kigoma; Ufipa (Lechaptois Coll.).

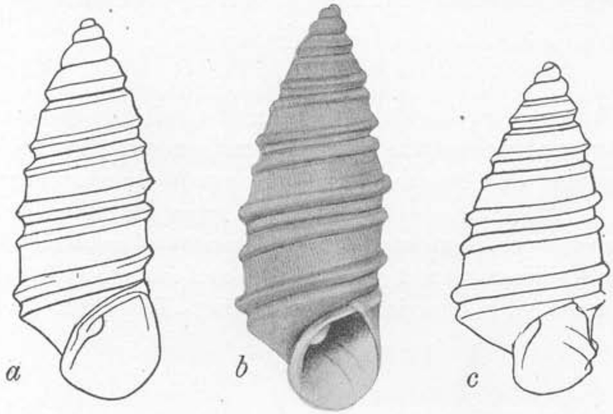



Fig. 29. *a-c*, *Syrnolopsis minuta carinifera* E. A. Smith. Tanganyika.

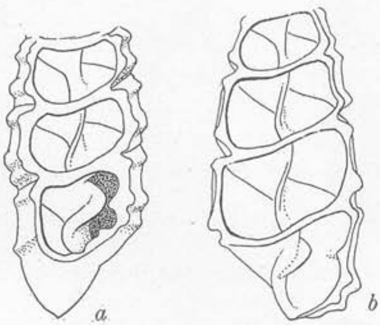



Fig. 30. *a-b*, *Syrnolopsis minuta carinifera* E. A. Smith, sections.

Lake Tanganyika: several lots collected by L. Stappers.

This is a *Pyrgula*-like form, with noticeably convex lateral outlines, the first two (or sometimes three) whorls smooth and strongly convex, the rest bicarinate, one keel below the suture, another above it, a small, low thread often visible immediately above the suture. There is a flat, axially striate space in the middle of each whorl. The last whorl has two carinæ at the periphery, the upper one more prominent. The ovate aperture is somewhat effuse below, the outer lip but little thickened, noticeably expanded, and somewhat sinuous in profile view. The columellar and parietal margins are calloused and continuous. Columellar fold is rather strong, emerging nearly to the edge. Inside it diminishes rapidly upward, and disappears in the third whorl from the last. There are two deeply immersed and rather strong palatal folds.

Length, 5.0 mm.; diameter, 1.9 mm.; 7½ whorls.
" 4.6 " " 1.7 " 7 "

This form differs from the sculptured specimens of *S. minuta* by the broader contour and the greater prominence of the carinæ, but it may be doubted whether any definite line can be drawn. There seem to be nearly intermediate specimens in the series examined, and Ancey, who was no lumper, thought it merely a variety of *minuta*.

In one specimen opened we find no palatal folds (Fig. 30*b*); possibly they were removed in filing it, as several others show them (Fig. 30*a*).

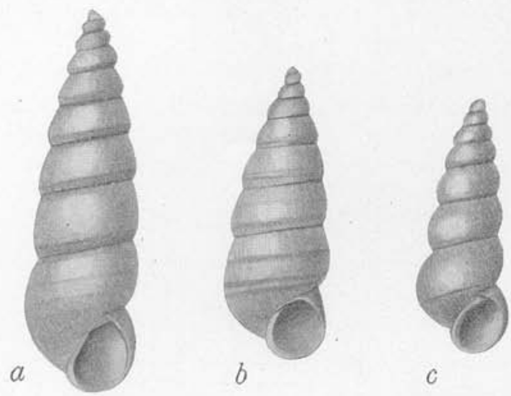



Fig. 31. *Syrnolopsis gracilis* Pilsbry and Bequaert. *a*, type; *b*, *c*, two smaller specimens. Tanganyika.

**Syrnolopsis gracilis**, new species

Text Figure 31*a-c*

Lake Tanganyika: without more definite locality (L. Stappers Coll.).

The shell is thin, very slender, resembling a *Turritella* in miniature; bluish under the thin, pale brown periostracum, somewhat glossy, with only very faint traces of growth-lines. The high initial 1½ whorls are strongly convex, smooth; then two spiral angles appear, the lower one continuing to the penult whorl in the type (but in other examples disappearing sooner, or continuing to the last whorl). The whorls are rather weakly convex, but with well-impressed suture. Aperture ovate, the outer lip thin. Columella but little calloused, weakly folded. Parietal callus thin. No palatal fold seen in a specimen opened.

Length, 4.3 mm.; diameter, 1.2 mm.; length of aperture, 0.8 mm.; 8½ whorls. Type; apex broken.

Length, 3.9 mm.; diameter, 1.0 mm.; 8 whorls. Paratype.

This form is quite distinct from those described by its slender shape and much weaker columellar fold. Though weaker, the system of sculpture is substantially as in *S. m. carinifera.*

Some smaller, immature examples, length about 3 mm., have three or four spiral threads and the whorls are more convex. In some others of similar size the threads are very small, and disappear on the later whorls, which are smooth and rounded.

A species from Kasakalawe, to be described, we believe, by M. Dautzenberg, is stouter in figure, the spiral cords are very strong, and the columellar fold even weaker than in *S. gracilis.*

### ANCEYA Bourguignat

*Anceya* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 14. Monotype: *Anceya giraudi* Bourguignat.

This group of beautiful little shells is distinguished from *Syrnolopsis* solely by the possession of axial sculpture. The columellar fold is usually shorter than in *Syrnolopsis*, only in the last two whorls, or weakly in one earlier. In *A. bella* it is often entirely wanting. The initial 1½ whorls have axial sculpture and also two spiral angles or cords, as in the sculptured species of *Syrnolopsis.* In adult shells, the first whorl or two are generally lost.

*Burtonilla* has the same early sculpture and later strong costation, leaving for that group only the differential characters of more numerous whorls and bluntly subangular rather than keeled last whorl—characters which can hardly be considered generic unless others are found in the soft anatomy.

### Subgenus ANCEYA, proper

#### **Anceya giraudi** Bourguignat

Text Figures 32*a-d*, 33*b*, and 34*a*

*Anceya giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 15; 1889, 'Moll. Afrique Equator.,' p. 118, Pl. VII, figs. 12–13. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 97. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 255 and 268. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 678.

Lake Tanganyika: near Mlilo on the western shore (type locality; Giraud Coll.); Mpala (Guillemé Coll.); Albertville (Charles Hedley Coll.); Kasakalawe (L. Stappers Coll.).

Bourguignat's types of *A. giraudi* and *A. admirabilis* were either young shells which had not formed a final peristome, or individuals in which the peristome had been broken, and was more or less restored in his figures. The measurements he gave make *A. giraudi* the more slender of the two, but this is contradicted by the text and figures.

*A. giraudi* is represented as broader than *A. admirabilis*, with closer, straighter, and more numerous ribs. There is a palatal fold. Length, 9.0 mm.; diameter, 2.0 mm.; 12 to 13 whorls. Bourguignat's figure is

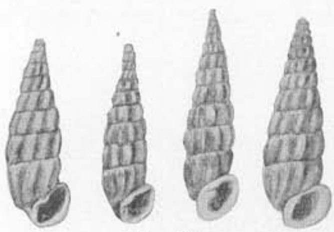


Fig. 32

a b c d

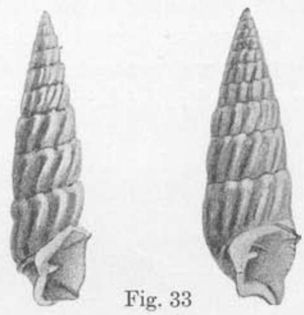


Fig. 33

a b

Fig. 32. *a-d, Anceya giraudi* Bourguignat. Kasakalawe.

Fig. 33. *a, Anceya admirabilis* Bourguignat. *b, A. giraudi* Bourguignat. Copies of original figures.

reproduced in our Fig. 33*b*. We imagine that his description was a composite of the two above-mentioned forms, which he discriminated later; and his measurements may have been from an *A. admirabilis*.

We refer to *A. giraudi* a long series from Kasakalawe (L. Stappers Coll.) in which there is a palatal fold within the last whorl, in a latero-ventral position. It is only weakly developed, but is visible by transparence in most specimens, and is readily seen by breaking back a half whorl. The shape is variable, but generally stouter than the specimens we refer to *A. admirabilis*. The color is from cinnamon-brown to vinaceous-drab in specimens quite unworn but which may have lost a thin periostracum. The columellar fold appears strongly in the aperture, and ascends three whorls.

The ribs are decidedly less curved than in *A. admirabilis*. They appear to be less numerous than in Bourguignat's figure.

Length, 8.8 mm.; diameter above aperture, 2.6 mm.; 11 whorls, the apex lost; 10 ribs on the penult whorl.

Length, 8.5 mm.; diameter above aperture, 2.1 mm.; 12 whorls, the apex entire; 10 ribs on the penult whorl.

Length, 7.3 mm.; diameter above aperture, 2.0 mm.; 10 whorls, the apex lost; 10 ribs on the penult whorl.

Length, 7.7 mm.; diameter above aperture, 2.4 mm.; diameter including outer lip, 2.7 mm.; 8½ whorls, the apex truncate; 10 ribs on the penult whorl.

### **Anceya admirabilis** Bourguignat

Text Figures 33*a*, 34*b*, and 35*a-c*

*Anceya admirabilis* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 119, Pl. VII, figs. 10–11. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 97. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 260. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 255 and 267.

Lake Tanganyika: between Mpala and Mlilo (type locality); Mpala (Guillemé Coll.).

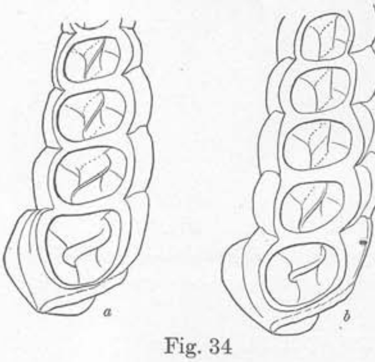



Fig. 34

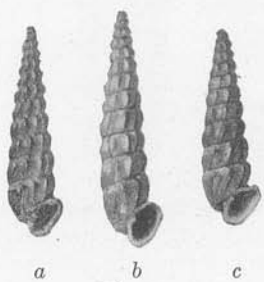



Fig. 35

Fig. 34. Sections of *a*, *Anceya giraudi* Bourguignat; *b*, *A. admirabilis* Bourguignat.

Fig. 35. *a-c, Anceya admirablis* Bourguignat. Tanganyika.

Bourguignat's type was said to have a single lamella, the columellar, and to measure 8 mm. long, 2 mm. wide, of 10–11 whorls. Our specimens from Tanganyika (L. Stappers Coll.) agree in sculpture with his figure which we reproduce in Fig. 33*a*.

This species is the most slender of the carinate *Anceyæ* now known, regularly tapering, the whorls quite convex, each with eight rather sharp, curved, noticeably protractive axial ribs, separated by regularly concave intervals; on the latter part of the last whorl they become obsolete. The base is bounded by a narrow, strongly expressed carina, and below that is flat and finely striate radially. The color is ecru-olive or somewhat darker, the periostracum thin and very glossy. The aperture is strongly diagonal, the lip expanded and thickened, deeply sinuated above and at the base. The inner lip is continuous and thickened. The columellar fold emerges; it continues inward into the antepenult whorl where it is very weak, the axis being plain above that.

Length, 10.4 mm.; diameter above aperture, 2.1 mm.; length of aperture, 2.1 mm.; 12½ whorls, the apex lost.

Length, 8.5 mm.; diameter above aperture, 2.0 mm.; length of aperture, 2.0 mm.; 11½ whorls, the apex lost.

Probably about one whorl has been lost in the specimens measured.

Fig. 36

Fig. 37

Fig. 36. *Anceya bella* Pilsbry and Bequaert. Type. Tanganyika.
Fig. 37. *Anceya bella* Pilsbry and Bequaert. Section of later whorls.

### **Anceya bella**, new species

Text Figures 36 and 37

Lake Tanganyika: without definite locality, numerous specimens; Kituta. Type No. 133,783 A. N. S. P. (All L. Stappers Coll.).

The shell is less slender than *A. admirabilis*, with more numerous ribs, which are usually less distinctly aligned from whorl to whorl, 12 on the penult whorl of the type, 11 in a paratype; on the last half whorl the ribs become smaller and closer (or some times irregular). The basal keel is strongly expressed, somewhat nodulous, but often weak or even disappearing on the front of the whorl. Color olive in varying shades. Surface glossy. The strongly diagonal aperture is sinuated deeply at both ends, the peristome thickened and expanded, as in *A. admirabilis*, but *the columellar lamella is represented by a mere trace, hardly noticeable;* in a cut specimen none is visible.

Length, 9.8 mm.; diameter above aperture, 2.6 mm.; length of aperture, 2.6 mm.; 11½ whorls, the apex lost. Type. Fig. 36.

Length, 10.8 mm.; diameter above aperture, 2.6 mm.; length of aperture, 2.7 mm.; 12½ whorls, the apex lost. Paratype.

Length, 9.0 mm.; 9⅓ whorls the summit lost. Paratype.

### **Anceya rufocincta** E. A. Smith

*Syrnolopsis* (*Anceya*) *giraudi* var. E. A. SMITH, 1890, Ann. Mag. Nat. Hist., (6) VI, p. 94.

*Anceya rufocincta* E. A. SMITH, 1906, Proc. Zool. Soc. London, I, p. 183, Pl. x, fig. 12.

Lake Tanganyika: in 10 fathoms at Kirando near the southeastern end of the lake (type locality; W. A. Cunnington Coll.).

The shell has about the size and contour of *A. giraudi* and *A. bella*, and is similar in sculpture. In the smallest and largest specimens before us there are eleven and thirteen ribs on the penult whorl. The specimens seen are "dead" shells, white with rufous bands below the suture and above the carina. In the form of aperture and the expanded, thickened peristome it is similar to the other *Anceyæ*. The columellar fold is well developed but perceptibly smaller than in *A. admirabilis*.

Length, 8.5 mm.; diameter, 2.5 mm.; length of aperture, 2.0 mm.; 13 whorls. Smith's type specimen.

Length, 12.2 mm.; 13 whorls, the apex lost.

Length, 9.0 mm.;. 9 whorls, the summit truncate.

The exact locality of our specimens (L. Stappers Coll.) was not given. The band above the basal keel was not mentioned in Smith's description.

### Subgenus BURTONILLA E. A. Smith

*Burtonilla* E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 97. Monotype: *Turbonilla* (?) *terebriformis* E. A. Smith.

### **Anceya (Burtonilla) terebriformis** (E. A. Smith)

*Turbonilla* (?) *terebriformis* E. A. SMITH, 1890, Ann. Mag. Nat. Hist., (6) VI, p. 95.

*Burtonilla terebriformis* E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 97, fig. 2 (on p. 87). ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

Lake Tanganyika: described from the lake without more definite locality.

We have not seen this species. It is an acuminate, strongly ribbed form, differing from the typical *Anceyæ* by having more whorls, and by the roundly subangular instead of carinate last whorl.

Length, 12.0 mm.; diameter, 2⅔ mm.; about 18 whorls.

### MARTELIA Dautzenberg

*Martelia* DAUTZENBERG, 1908 (March), Journ. de Conchyl., LV, (1907), p. 328. Monotypic for *M. tanganyicensis* Dautzenberg.

Similar to *Anceya* in being axially ribbed, but far more minute (about 3 mm. long) and more conic, of 6 to 7½ whorls. Columellar fold very strongly developed.

Distinguished from *Anceya* by the minute size, the less sinuous outer lip and the appearance of the basal cord at an early neanic stage. This cord remains small in the adult stage, not becoming a keel there as in *Anceya*.

### *Martelia tanganyicensis* Dautzenberg

*Martelia tanganyicensis* Dautzenberg, 1908 (March 30), Journ. de Conchyl., LV, (1907), p. 329, Pl. iv, figs. 11 and 12.

Lake Tanganyika: described from Mpala, on the western coast (Guillemé Coll.). Albertville (Charles Hedley Coll.).

Fig. 38. *Martelia tanganyicensis* Dautzenberg.

The specimens taken by Charles Hedley (Fig. 38) have the axial ribs prominent at the shoulder, more or less pointed, about eight on the face of the last whorl. The color is transparent brown or white, with a brown band below the suture, another just above the weak basal cord. The first two whorls are smooth and rounded, very fine axial riblets then appearing. The last three and a half whorls have coarse ribs.

Length, 2.3 mm : diameter, 1.2 mm.; 6 whorls.

### *Martelia dautzenbergi* Dupuis

*Martelia dautzenbergi* Dupuis, 1924 (May), Ann. Soc. Zool. Belgique, LIV, (1923), p. 20, fig. 1 (on p. 26).

Lake Tanganyika: described from the western coast, without more definite locality.

## Truncatellidæ

Shell imperforate, cylindric, of few whorls by loss of the tapering earlier portion, or if entire, elongate and many-whorled. Aperture oval; peristome blunt. Operculum thin, corneous, subspiral.

Animal with a very large, long rostrum and tapering tentacles with eyes sessile at their posterior bases. Foot short. Pallial cavity very large, containing a small gill of many triangular ciliated lamellæ. Radula (Fig. 39) with 3-1-3 teeth, the central triangular, unicuspid, with a mesially interrupted row of basal denticles; laterals transverse, with few large denticles; marginals having a long body and numerous denticles.

Locomotion is by looping, the oral disc and the foot being advanced alternately. Placed in water they are said to glide in the ordinary fashion of gastropods.

They are small snails, mainly of the tropics of both hemispheres. The typical genus, *Truncatella*, lives under trash at extreme high tide line, or under stones, wood, etc., somewhat higher, always in the neighborhood of the sea. This genus is remarkable for its peculiar looping gait and the unicuspid central tooth of the radula.

Vayssière,[1] who has published the best account we have of *Truncatella*, considered its respiration branchial. Though not living in the water, he believes that the moist station and occasional splashing of the waves supply sufficient water. He mentions keeping specimens alive for ten days in the moist air of a closed glass. We believe that, though provided with a gill, *Truncatella* respires free air as a rule. The senior author has collected living specimens in situations reached by the waves only at intervals of months. He has published drawings of specimens of *T. bilabiata*[2] which had lived in a loosely plugged vial without water for about six weeks. These snails promptly became active on dropping a slip of moistened blotting paper into their vial, and lived for several weeks longer.

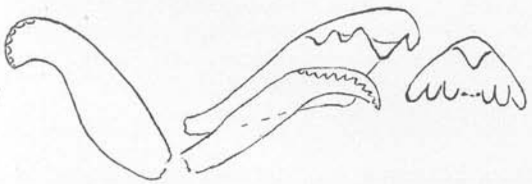


Fig. 39. Teeth of *Truncatella caribæensis* Reeve.

### TRUNCATELLA Risso

*Truncatella* RISSO, 1826, 'Hist. Nat. Europ. Mérid.,' IV, p. 124. Type: *Truncatella lævigata* Risso = *Helix subcylindrica* Linné.

The following species have been recorded from the Ethiopian Region:

*Truncatella pellucida* DOHRN, 1860, Malakoz. Blätter, VI, p. 203. Red Sea.

*Truncatella princeps* DOHRN, 1866, Malakoz. Blätter, XIII, p. 134. Prince's Island.

*Truncatella semicostulata* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 189, Pl. VII, fig. 8. Dahlak Island, off the coast of Eritrea.

*Truncatella teres* PFEIFFER, 1856, Proc. Zool. Soc. London, p. 336; 1856, 'Monogr. Auricul. Viv.,' p. 188. Originally described from Mauritius and Australia, this species has also been recorded from the Red Sea and from Port Elizabeth, Cape Colony.

## Synceridæ

### (ASSIMINEIDÆ of authors)

Shell ovate-conic, compact, the whorls flattened. Peristome simple, the margins connected by a closely adnate callus. Operculum corneous, paucispiral, with excentric nucleus.

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[1] 1885, Journ. de Conchyl., XXXIII, p. 253.

[2] Pilsbry and Brown, 1914, Proc. Ac. Nat. Sci. Philadelphia, LXVI, p. 426, Pl. XIV (illustrating locomotion).

Animal with tentacles concrescent with the ocular peduncles, the eyes at or near the apex. Muzzle emarginate anteriorly. Respiration by means of a lung which opens to the right side of the mantle. Radula with teeth amnicoloid in general form; central with few cusps and one or several basal denticles; inner marginals having much larger or longer cusps than the decidedly wider, multicuspid outer one.

These little snails are markedly amphibious and prefer brackish water, living as a rule near or at the seashore.

### SYNCERA Gray

*Nerita* subgenus *Syncera* GRAY, 1821, London Medical Repository, XV, p. 239. Monotype: *Nerita (Syncera) hepatica* Gray = *Assiminea grayana* Fleming. Not *Syncerus* Hodgson, 1847.

*Assiminea* "Leach" FLEMING, 1828, 'Hist. British Anim.,' p. 275. Monotype: *Assiminea grayana* Fleming = *Nerita (Syncera) hepatica* Gray.

*Assaminia* "Leach" GRAY, 1839, 'Beechey's Voy., Zool.,' p. 141. Misspelling of *Assiminea*.

*Assiminea* subgenus *Euassiminea* HEUDE, 1882, Mém. Hist. Nat. Empire Chinois, II, p. 82. Monotype: *Assiminea violacea* Heude.

*Assemania* KNIGHT, 1900, Journ. of Conchology, IX, p. 276. Emendation of *Assiminea*.

The following Ethiopian species have been referred to this genus:

*Syncera aurifera* (Preston) = *Assimania aurifera* PRESTON, 1912, Proc. Zool. Soc. London, p. 191, Pl. XXXI, fig. 9. Gazi, Kenya Colony.

*Syncera bifasciata* (Nevill) = *Assiminea bifasciata* NEVILL, 1880, Journ. Asiatic Soc. Bengal, XLIX, 2, p. 162. Port Natal, Natal.

*Syncera fasciata* (Krauss) = *Paludina fasciata* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 86, Pl. v, fig. 18. Knysna and Zoetendal Valleys, Cape Colony.

*Syncera hessei* (O. Bœttger). See p. 243.

*Syncera hidalgoi* (Gassies) = *Hydrocena hidalgoi* GASSIES, 1869, Journ. de Conchyl., XVII, p. 78. *Assiminea granum* MORELET, 1882, *op. cit.*, XXX, pp. 105 and 198, Pl. IV, fig. 8. Originally described from New Caledonia, this species has been reported from Mauritius and the coast of Natal.

*Syncera knysnaensis* (Krauss) = *Paludina knysnaensis* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 86, Pl. v, fig. 17. Knysna and Zoetendal Valleys, Cape Colony.

*Syncera leptodonta* (Connolly) = *Assiminia leptodonta* CONNOLLY, 1922, Ann. Mag. Nat. Hist., (9) X, p. 122. Estuary of the Komati River, Rikatla, Portuguese East Africa.

*Syncera ovata* (Krauss) = *Paludina ovata* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 85, Pl. v, fig. 16. Knysna and Zoetendal Valleys, Cape Colony.

*Syncera ponsonbyi* (Morelet) = *Assiminea ponsonbyi* MORELET, 1889, Journ. de Conchyl., XXXVII, p. 17, Pl. II, fig. 6. Port Elizabeth, Cape Colony.

*Syncera sinensis* (Nevill) = *Assiminea sinensis* NEVILL, 1880, Journ. Asiatic Soc. Bengal, XLIX, 2, p. 161. *Assiminea sinica* O. BŒTTGER, 1887, Jahrb. Deutsch. Malakoz. Ges., XIV, p. 203. Originally described from Hong Kong, this species has also been recorded from Natal.

*Syncera umlaasiana* (E. A. Smith) = *Assiminea umlaasiana* E. A. SMITH, 1902, Journ. of Conchology, X, p. 248, Pl. IV, fig. 3. From caves in the ocean cliff near the mouth of the Umlaas River, Natal.

## Species of *Syncera* Recorded from the Belgian Congo

### *Syncera hessei* (O. Bœttger)

*Assiminea* (*Euassiminea*) *hessei* O. Bœttger, 1887, Jahrb. Deutsch. Malakoz. Ges., XIV, p. 180, Pl. vi, fig. 7. C. R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 106.

Banana, abundant in swamps behind the English trade house (type locality; P. Hesse Coll.).

## Valvatidæ

Shell small, thin, turbinate to discoidal, openly umbilicate, composed of few, tubular whorls. Aperture circular, subvertical; peristome thin, continuous. Operculum very thin, corneous, orbicular, multispiral, composed of many narrow whorls; the nucleus central.

Animal said to be hermaphroditic. Foot lyre-shaped. Proboscis rather long. Eyes sessile at the inner bases of the slender tentacles, which are blunt at the tips. The gill is symmetrically bipinnate, attached at the base only, and capable of extension forward, out of the branchial cavity. There is a tentacle-shaped appendage on the mantle-edge and a long penis at the right side of the neck. The teeth of the radula have finely serrate cusps, the central tooth being broad, without basal tentacles. The nervous system is orthoneurous.

The only known genus, *Valvata* O. F. Müller (1774, 'Verm. Terr. Fluv. Hist.,' II, p. 198. Monotype: *Valvata cristata* O. F. Müller), is generally distributed in the northern hemisphere extending into Northern Africa and Egypt. We have not seen the following three species, described from the northern half of the Ethiopian Region; they appear to be true representatives of this genus.

*Valvata revoili* Bourguignat, 1889, 'Moll. Afrique Equator.,' p. 189, Pl. viii, figs. 5–6. Webi River, above Guelidi, Somaliland.

*Valvata scioana* (Pollonera) = *Valvata nilotica* var. *scioana* Pollonera, 1888, Bull. Soc. Malacol. Italiana, XIII, p. 82. Cimbisi near Debra-Braham, Choa District, Abyssinia.

*Valvata tilhoi* Germain, 1909, Bull. Mus. Hist. Nat. Paris, p. 376; 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 207, Pl. ii, figs. 26–31. Eguei district, east of Lake Chad.

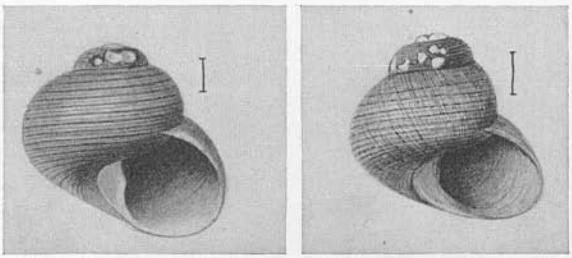
## Littorinidæ (?)

### Pseudogibbula Dautzenberg

*Pseudogibbula* Dautzenberg, 1891, Bull. Ac. Sci. Belgique, (3) XX, (1890), p. 570. Monotype: *Pseudogibbula duponti* Dautzenberg.

Shell imperforate, rather thin, conoidal, with obtuse summit, almost always eroded. Spire of three to four feebly convex whorls, with well-marked sutures; the whorls somewhat flattened above, the last bi-angulose and slightly concave at its base in the umbilical region. Surface covered with numerous spiral cords alternately heavy and feeble; on the penultimate whorl one counts about ten heavy ones. Fine and arcuate growth-striæ render the ribs somewhat granulose. Aperture rhomboidal. Outer lip simple, acute, smooth and shining; but not nacreous inside. Columella feebly arcuate, oblique, toward its base with a denticulation due to the termination of a spiral funiculus which enters the shell (or sometimes this is lacking). Callosity of the columella depressed, very shiny, distinctly limited and connected with the outer lip through a very thin, shiny deposit. Color uniformly dark chestnut-brown except for the white columella. Operculum corneous, thin, paucispiral, with lateral nucleus, pale yellowish brown.

According to Dautzenberg this curious snail belongs to the family Littorinidæ. The shell certainly resembles *Littorina* more than it does any amnicolid snail, but as the soft parts and radula are unknown, its place in classification is uncertain.



*a* *b*

Fig. 40. *a-b*, *Pseudogibbula duponti* Dautzenberg. Two of the original lot.

**Pseudogibbula duponti** Dautzenberg

Text Figure 40*a-b*

*Pseudogibbula duponti* DAUTZENBERG, 1891, Bull. Ac. Sci. Belgique, (3) XX, (1890), p. 570, Pl. I, figs. 2–6.

Type locality: this species was found in large numbers at Vivi (opposite Matadi), "sur des roches de gneiss amphibolique qui émergent sur le bords des rapides du Congo à l'époque des basses eaux, maisuiq sont constamment mouillées par les remous produits par les tourbillons." (E. Dupont Coll.). The locality is about 125 kilometers above the mouth of the Congo, at the upper edge of the estuary. It is therefore considerably removed from the influence of brackish water, since the tides are not much perceptible beyond Boma, some 50 kilometers farther downstream.

The specimens figured, which we owe to the kindness of Dr. H. Schouteden, are part of the original lot. They confirm Dautzenberg's characterization, translated above, except that one specimen lacks the prominence of the columella, which is simply concave.

**Cerithiidæ**

Shell usually turriculate, many-whorled, often very large; frequently varicose, tuberculate, spinose, or costulate. Aperture with the outer lip expanded, often considerably so; with a notch or sinus near the upper insertion and with a broad, more or less twisted channel below. Operculum corneous, spiral, with central or sublateral nucleus.

Animal with the rostrum broad, short, and contractile; tentacles wide apart, subulate. Eyes on short peduncles united to the outer side of the tentacles. Margin of the mantle with a rudimentary siphonal fold in front. Radula long.

This family is closely allied to the Melaniidæ, the above characterizaitons being framed more especially to discriminate the African forms of both families rather than to cover the Cerithiidæ generally. It consists mostly of marine forms. A number of genera, however, inhabit brackish waters and are often extremely abundant in tropical regions in the river estuaries and tidal flats.

Only one genus is represented at the mouth of the Congo and elsewhere along the West Coast of Africa. It belongs to the subfamily Potamidinæ, a group largely restricted to brackish water, in which the shell is usually covered with a brown epidermis and the early whorls of the very elongate spire are almost always corroded. The fore part of the aperture is more or less channelled, truncate, not produced into a beak. The operculum is orbicular, polygyrate, with central nucleus.

The Potamidinæ are more or less amphibious, being able to stand prolonged drought, although they breathe exclusively by gills. Of some of the species of *Cerithidia* of the Oriental Region it is said that during the dry season they close the aperture with the operculum and hang, suspended by glutinous threads, to small branches and mangrove-roots. Lang and Bequaert have never observed this with *Potamides fuscatus* of the Congo estuary; that species is found exclusively on the mud of the mangrove swamps and tidal flats and was not seen to crawl upon stones, roots, or leaves.

### POTAMIDES Brongniart

*Potamides* BRONGNIART, 1810, Ann. Mus. Hist. Nat. Paris, XV, p. 368. Monotype: *Potamides lamarki* Brongniart, of the Oligocene of France.

### Subgenus TYMPANOTONOS Schumacher

*Tympanotonos* SCHUMACHER, 1817, 'Essai Nouv. Syst. Test.,' p. 211. Monotype: *Tympanotonos fluviatilis* Schumacher = *Murex fuscatus* Linnæus.

*Tympanostoma* G. B. SOWERBY, 1839, 'Conchol. Man.,' p. 110. Misspelling of *Tympanotonos*.

*Potamis* or *Potamides* G. B. SOWERBY, 1839, *op. cit.*, p. 88. Monotype: *Cerithium muricatum* Bruguière = *Murex fuscatus* Linnæus.

*Tympanotomus* GRAY, 1842, 'Syn. Contents Brit. Mus.,' 44th Ed., p. 90. Misspelling of *Tympanotonos*.

*Tympanotonus* AGASSIZ, 1846, 'Nomencl. Zool. Index Univ.,' p. 382. Emendation of *Tympanotonos*.

In Africa this subgenus occurs on the western coast only, where it is represented by two species, but there are others in the Oriental Region.

*Potamides fuscatus* (Linnæus). See below.

*Potamides homologus* (Bayle) = *Cerithium homologum* BAYLE, 1880, Journ. of Conchyl., XXVIII, p. 248; new name for *Cerithium multigranum* SOWERBY, 1855, 'Thesaurus Conchol.,' II, p. 393, Pl. CLXXXIII, fig. 182 ("West Africa"). *Potamides multigranosus* "Sowerby" Tryon, 1887, 'Manual of Conchol.,' IX, p. 159 and p. 213 (as *Tympanotonos multigranosus*); E. v. MARTENS, 1903, 'Wiss. Ergebn. Deutsch. Tiefsee-Exped.,' VII, 1, p. 19 (Prince's Island). Not *Cerithium multigranum* DESHAYES, 1834, 'Descr. Coq. Foss. Env. Paris,' II, p. 393, Pl. LX, figs. 4–5.

### **Potamides (Tympanotonos) fuscatus** (Linnæus)

Plate XX, Figures 1–9

"Le Popel" ADANSON, 1757, 'Hist. Nat. Sénégal, Hist. des Coquillages,' p. 152, Pl. x, Gen. IV, fig. 1.

*Murex fuscatus* LINNÆUS, 1758, 'Syst. Nat.,' 10th Ed., p. 755.

*Potamides* (*Tympanotomus*) *fuscatus* Linnæus. DAUTZENBERG, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 42. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 99.

*Murex radula* LINNÆUS, 1758, 'Syst. Nat.,' 10th Ed., p. 756.

*Potamides* (*Tympanotomus*) *fuscatus* var. *radula* Linnæus. O. BŒTTGER, 1885, 24. u. 25. Ber. Offenbacher Ver. f. Naturk., p. 191. DAUTZENBERG, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 42. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 99.

*Nerita aculeata* O. F. MÜLLER, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 193.

*Murex fluviatilis* GMELIN, 1791, in Linnæus, 'Syst. Nat.,' 13th Ed., p. 3562. The figure of Lister's 'Conchology' (Pl. CXXII, fig. 20) cited by Gmelin shows that this is *Murex radula* Linnæus.

*Murex terebella* GMELIN, 1791, in Linnæus, 'Syst. Nat.,' 13th Ed., p. 3562. Fig. 1459 on Pl. CLV of Martini's 'Conch. Cab.,' IV, referred to by Gmelin, represents *Murex radula* Linnæus.

*Cerithium muricatum* BRUGUIÈRE, 1792, 'Enclyclop. Méthod., Vers.,' I, p. 490.

*Tympanotonos owenii* REEVE, 1866, 'Conchol. Iconica,' XV, *Tympanotonos*, Pl. I, fig. 5.

*Tympanotomus oweni* Férussac. H. DE CORT, 1899, Ann. Soc. Malacol. Belgique, XXXIV, Bull Séances, p. xl.

*Potamides* (*Tympanotomus*) *fuscatus* var *oweni* Reeve. DAUTZENBERG, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 42.

*Potamides fuscatus* var. *muricatus* Bruguière. E. v. MARTENS, 1903, 'Wiss. Ergebn. Deutsch. Tiefsee-Exped.,' VII, 1, p. 19 (Chisambo and Massabi in the Portuguese colony of Cabinda).

Banana (Buchholz Coll.; P. Hesse Coll.; Gruvel Coll.). Creek of Kitompo and Moanda and at the Ile des Pêcheurs near Banana (Gruvel Coll.).

The species is found along the western coast of Africa from Senegal to Mossamedes. Gruvel has recorded its occurrence in subfossil condition in the Bay of the Archimedes, Mauritania.[1] This discovery is of much interest as indicating that at some comparatively recent time rather large rivers flowed from the Sahara into the Atlantic.

[1]Gruvel, A. 1922. 'De l'origine fluviale de la Baie du Lévrier.' C. R. Ac. Sci. Paris, CLXXIV, pp. 1242–1243.

Mangrove swamps of the estuary of the Congo River: Malela; Kunga; Bulabemba Island; Banana; also at the mouth of the Moanda River. Several thousands of specimens collected by H. Lang. Landana, in the Portuguese colony of Cabinda, at the mouth of the Shiloango River (J. Bequaert Coll.).

As a rule, this species occurs together with *Pachymelania fusca* (Gmelin), from which it is, however, easily distinguished by the expanded lobe of the aperture and the distinct channel below the columella. The operculum is subcircular, with a regular, closely spiral figure starting from a central nucleus (Pl. XX, fig. 9).

A. d'Ailly (1896, Bihang Svenska Vet. Ak. Handl., Stockholm, XXII, Afd. 4, No. 2, p. 121) lists among the synonyms of *P. fuscatus* also *Murex cingulatus* Gmelin (1791, in Linnæus, 'Syst. Nat.,' 13th Ed., p. 3561). From Gmelin's reference to Pl. CLVII, fig. 1492 of Martini's 'Conch. Cab.,' IV, it appears that *cingulatus* is not an African snail, but the Oriental species usually called "*fluviatilis*." Gmelin's *Murex fluviatilis*, however, is a synonym of *Potamides fuscatus*, so that the Oriental species should be called *Potamides cingulatus* (Gmelin); it appears to belong in the subgenus *Tympanotonos*.

Dautzenberg and others have recognized the specific identity of the Linnæan species *fuscatus*, in which there is a posterior series of stout spines on each whorl, and *radula*, which has a nearly uniform tuberculation. Intergradation is fully exhibited in the extensive material of the Congo Expedition.

In some lots, such as that from the mangrove swamps at the mouth of the Moanda River, both of the forms are found in about equal number, together with a smaller number of transitional examples. A series from this place is illustrated in Plate XX, figures 1–6. Similar conditions are found in a lot from Malela, while another lot from the same locality, but from a different habitat, contains only the form *radula* and all the specimens are of small size. At Kunga and Banana, on the other hand, pure colonies of the form *fuscatus* were found.

An extensive and very remarkable series of large-sized specimens, all of the *radula* form, was obtained at Bulabemba Island, near the lighthouse (Pl. XX, figs. 7, 8). They commonly reach 65 to 70 mm. in length, in some cases even up to 80 mm. Two specimens measured had a length of 78 and 61 mm. by a diameter of 27 and 26.5 mm. respectively. The photographs on Plate LXXVII give an idea of the tremendous numbers of these snails in the mangrove swamps of the Congo estuary.

## Melaniidæ

(THIARIDÆ of some authors)

Shell spiral, varying widely in shape, but typically turrited or ovate and imperforate, covered with a distinct periostracum, the aperture ovate and entire or notched basally. Operculum spiral, at least in its early stage.

Muzzle wide, emarginate in front. Tentacles subulate, the eyes at their outer bases. Foot short. No external male organ. Respiration branchial. The radula has 3-1-3 teeth, their cusps with few or many denticles.

These mollusks inhabit fresh or rarely brackish water in tropical and temperate parts of the world.

The extensive and heterogeneous family of melanians or Thiaridæ can hardly be technically defined so as to exclude all Cerithiidæ, except by taking its usually fresh-water station into account. As Bouvier has remarked, the melanians are the fresh-water and the cerites the marine phase of a single large group. There has been extensive differentiation throughout both branches of this group, and there appears to be closer relationship between certain members of the fresh-water and marine branches than between divergent lines of the latter.

The first definite steps towards a natural classification of the melanians were taken by Troschel. The arrangement of Fischer and Crosse[1] is an expansion of Troschel's ideas, incorporating the results of later investigation. The subfamilies recognized by them appear to be natural groups, which will probably be admitted as families eventually. Three subfamilies or families occur in the Ethiopian Region.

1. Melaniinæ (or Melaniidæ proper), with fringed mantle border; the radula small, with plain central tooth; operculum paucispiral, with baso-columellar nucleus. Old World. African genera: *Melania Melanoides, Pachymelania.*

2. Potadominæ (or Potadomidæ),[2] in which the mantle margin is plain; the radula relatively large, with central tooth swollen mesially below the cusp; cusps of all teeth with few denticles. Operculum from paucispiral with basal nucleus to multispiral with central nucleus (though never with many whorls). Tropics of both hemispheres. African genera: *Potadoma* (and perhaps *Rhinomelania*).

3. Paludominæ (or Paludomidæ), with fringed mantle margin, plain central tooth of the radula, the operculum concentric with spiral nucleus about midway between its ends, or lamellar with external or

[1]1891–1892. 'Miss. Sci. au Mexique, Etudes Moll. Terr. et Fluv.,' II, pp. 311–313.

[2]We prefer to base this subfamily on *Potadoma*, the oldest genus, rather than on *Pachychilus*, a later genus, the name of which has to be changed on account of the earlier term *Pachycheilus* in Ampullariidæ. The term Melanoididæ or Melanoidinæ of H. von Ihering (1909, Journ. de Conchyl., LVII, pp. 296 and 298), though equivalent to Pachychilinæ Fischer and Crosse, is not applicable, since the genus *Melanoides* does not belong to this group.

externo-basal nucleus. Oriental and Ethiopian Regions. African genus: *Cleopatra.*

The reference of *Cleopatra* to the Paludominæ (*Paludomus*, *Tanalia*, *Philopotamis* and *Stomatodon*) is provisional; perhaps it should form another subfamily, Cleopatrinæ. In describing the animal Smith did not mention mantle processes, such as are said to exist in *Philopotamis.* The shell is usually perforate, unlike other melanians.

The following thalassoid genera of Lake Tanganyika appear from their anatomical structure to be Melaniidæ or closely related to that group: *Limnotrochus* E. A. Smith, *Chytra* J. E. S. Moore, *Bythoceras* J. E. S. Moore, *Paramelania* E. A. Smith, *Joubertia* Bourguignat, *Randabelia* Bourguignat, *Edgaria* Bourguignat, *Lechaptoisia* Ancey, *Spekia* Bourguignat, *Tanganyicia* Crosse, *Stanleya* Bourguignat, *Giraudia* Bourguignat, and *Reymondia* Bourguignat. *Lavigeria* Bourguignat (*Nassopsis*) is thought by J. E. S. Moore to represent a distinct family which he identifies with the Purpurinidæ. In part of this view he is followed by Thiele,[1] who segregates *Lavigeria* in a family Lavigeridæ, grouped with the Cyclophoridæ, Viviparidæ and Ampullariidæ. The other Tanganyikan genera form his subfamily Paramelaniinæ of the Tiaridæ (Melaniidæ).

*Melania tanganyicensis* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 427, from Lake Tanganyika, is unknown to us. It is the type of the genus *Horea* Bourguignat (1888, 'Iconogr. Malacol. Tanganika,' p. [27], Pl. VI, figs. 28–29) which antedates *Horea* E. A. Smith, 1889.

Madagascar possesses a number of additional genera of Melaniidæ which apparently have no close relatives on the African continent.

The African origin of the following species is extremely doubtful and consequently they have not been considered in the course of our studies:

*Melania decollata* Reeve, 1859, 'Conchol. Iconica,' XII, *Melania*, Pl. XII, fig. 78. "Guinea." This is, of course, very different from the East African *Cerithidea decollata* (Bruguière).

*Melania ferrea* Reeve, 1859, 'Conchol. Iconica,' XII, *Melania*, Pl. III, fig. 9. "Borneo; Grand Bassam, W. Africa." Brot in 1874 synonymizes this with *M. corporosa* Gould, of Tahiti.

*Melania maurula* Reeve, 1859, 'Conchol. Iconica,' XII, *Melania*, Pl. IV, fig. 15. "Southeast coast of Guinea."

*Melania pallidula* Reeve, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. XXI, fig. 153. "West Africa." The name is corrected into *M. pallens* in the Errata on the last page of the Index to the *Melania* part of Reeve's work.

*Melania phlebotomum* Reeve, 1859, 'Conchol. Iconica,' XII, *Melania*, Pl. XV, fig. 105. "West Africa." Brot in 1874 synonymizes this with *M. semicancellata* v. d. Busch, of Java.

[1] 1925, Handbuch der Zoologie, V, erste Lieferung, pp. 79, 83.

I

Various species of *Melanatria* were reported from West Africa by Reeve from specimens in Cuming's collection, but the genus is now generally admitted to be special to Madagascar.

### Key to Ethiopian Genera of Melaniidæ
### (Exclusive of Specially Tanganyikan Forms)

1. Lip sinuous, retracted basally and above, or with the base channelled distinctly . 2.
   Outer lip scarcely or not sinuous; base sometimes effuse but not channelled . . . 4.
2. Spire long; shell with both axial and spiral sculpture, at least in early stages; operculum with basal nucleus . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3.
   Spire short; form ovate; smoothish, with some basal spirals; aperture channelled basally . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Rhinomelania* E. v. Martens.
3. Solid, rather large forms of brackish water; operculum very narrow. *Pachymelania* E. A. Smith.
   Rather thin, moderate or rather small forms of fresh-water; operculum ovate. *Melanoides* Olivier.
4. Oblong-conic, spinose at the shoulder; operculum with basal nucleus. *Melania* Lamarck.
   Oblong-conic to turrited, the summit often eroded, solid, smoothish, or with spiral sculpture; operculum with well-developed spiral figure below the middle . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Potadoma* Swainson.
   Ovate or conic, of moderate or small size, often perforate; smooth, spirally sculptured, or nodulous; operculum mainly concentric, with a spiral nucleus at about half its length . . . . . . . . . . . . . . . . . . . . . . . . . . . . *Cleopatra* Troschel.

## Melaniinæ

### MELANIA Lamarck

*Thiara* RÖDING, 1798, 'Museum Boltenianum,' II, p. 109. Monotype: *Helix amarula* Linnæus, the other species mentioned by Röding being *nomina nuda*.

*Melania* LAMARCK, 1799, Mém. Soc. Hist. Nat. Paris, p. 75. Monotype: *Helix amarula* Linnæus.

*Melas* DENYS DE MONTFORT, 1810, 'Conchyl. Systém.,' II, p. 323. Monotype: *Melas melanus* Denys de Montfort = *Helix amarula* Linnæus.

*Melanidia* RAFINESQUE, 1815, 'Analyse de la Nature,' p. 144. Type: *Helix amarula* Linnæus, designated by Pilsbry, 1917, The Nautilus, XXX, p. 110.

*Melacantha* SWAINSON, 1840, 'Treatise on Malacology,' pp. 199 and 341. Type: *Helix amarula* Linnæus, designated by Hermannsen, 1847, 'Ind. Gen. Malac.,' II, p. 26.

*Amarula* G. B. SOWERBY, JR., 1842, 'Conchol. Man.,' 2d Ed., p. 61. Type: *Helix amarula* Linnæus, designated by Hermannsen, 1846, 'Ind. Gen. Malac.,' I, p. 81.

*Spirilla* "Humph. Mss.," in GRAY, 1847, Proc. Zool. Soc. London, p. 152. As a synonym of *Melania* Lamarck, with *Helix amarula* Linnæus given as type.

*Lithoparches* GISTEL, 1848, 'Naturgesch. Thierr. f. Höhere Schulen,' p. ix. Substitute for *Melania* Lamarck.

*Hydrognoma* GISTEL, 1848, 'Naturgesch. Thierr. f. Höhere Schulen,' p. 169. Substitute for *Melania* Lamarck.

*Tiara* HERMANNSEN, 1849, 'Ind. Gen. Malac.,' II, p. 576. Emendation of *Thiara* Type: *Melania amarula* Linnæus.

The typical species, *M. amarula* (Linnæus), of Madagascar, the Comoros, Mauritius, and Réunion, occurs in East Africa as a subspecies *coacta* (Meuschen), which according to Germain (1921, 'Faune Malacol. Iles Mascareignes,' p. 362) is but little different from the type. It is found along the coast from Ugogo to Lourenzo Marques and Zululand (at Izezela, Umkomaas, and Amanzimtoti River; Connolly, 1915, Ann. South African Mus., XIII, p. 100). *Tiara vouamica* Bourguignat (1889, 'Moll. Afrique Equator.,' p. 183) and *Melania crenularis* E. v. Martens (1860, Malakoz. Blätter, VI, p. 216) Germain lists as synonyms of *coacta.*

### MELANOIDES Olivier

*Melanoides* OLIVIER, 1804, 'Voyage dans l'Empire Othoman,' II, p. 40, footnote. Monotype: *Melanoides fasciolata* Olivier = *Nerita tuberculata* O. F. Müller.

*Melania* subgenus *Striatella* BROT, 1870, American Journ. Conch., VI, 2, Appendix, p. 290, for several species, including *M. tuberculata* (Müller); 1874, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 24, Melaniaceen, p. 7; divides it into two sections with *M. corporosa* Gould and *M. tuberculata* (Müller) as respective types. In 1885, Fischer ('Manuel de Conchyl.,' p. 701) gives *M. tuberculata* as example of *Striatella* and this species is here designated as the type.

*Melania* section *Eumelania* ROVERETO, 1899, Atti Soc. Ligustica Sc. Nat., X, p. 109. Substitute for *Striatella* Brot, 1870.[1]

*Pallarya* P. HESSE, 1916, Nachrichtsbl. Deutsch. Malakoz. Ges., XLVIII, p. 124. Substitute for *Striatella* Brot, 1870.[1]

*Nyassia* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 5. Type by present designation: *Melania nodicincta* Dohrn.

*Nyassella* BOURGUIGNAT, 1889, *op. cit.*, VI, p. 17. Type by present designation: *Nyassella smithi* Bourguignat.

*Micronyassia* BOURGUIGNAT, 1889, *op. cit.*, VI, p. 24. Type by present designation: *Melania turritispira* E. A. Smith.

*Nyassomelania* BOURGUIGNAT, 1889, *op. cit.*, VI, p. 30. Type by present designation: *Nyassomelania leia* Bourguignat.

Shell never very large or heavy; long and slender, with both axial and spiral sculpture, at least in the early neanic stage, sometimes spinose along the upper part of the whorls. Aperture ovate, the peristome somewhat sinuous, the inner lip not calloused. Operculum ovate, paucispiral, the nucleus near the baso-columellar margin, the spiral figure very small.

Mantle having a row of digitiform processes near its margin. Radula relatively very small. Central tooth short and wide, with numerous (usually 9 to 11) denticles and a plain body. Laterals with numerous denticles, the body with a median convex-

[1]This new name was unnecessary since *Striatella* Brot, 1870, is not preoccupied by *Striatella* Agardh, 1832, the latter being a genus of plants (Diatomaceæ).

ity and a projection below. Marginal teeth with numerous, long denticles and very long body.

L. Raymond[1] apparently first observed that *Melanoides tuberculata* is viviparous. He stated that the young, newly laid snails spend the night inside the shell of the mother snail within a pouch of the neck of the animal. Whether all the species included in *Melanoides* are viviparous remains uncertain. In opening about a dozen *M. wagenia* we found no embryos. This species has the denticle formula: C. 9, 10, or 11; L. 7; M. 8 and 9 (Fig. 41).

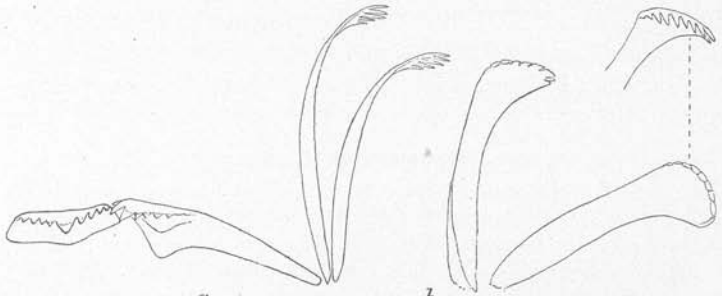



Fig. 41. Teeth of *Melanoides wagenia* Pilsbry and Bequaert. At *b* an inner marginal, and at *c* the outer, drawn in different positions.

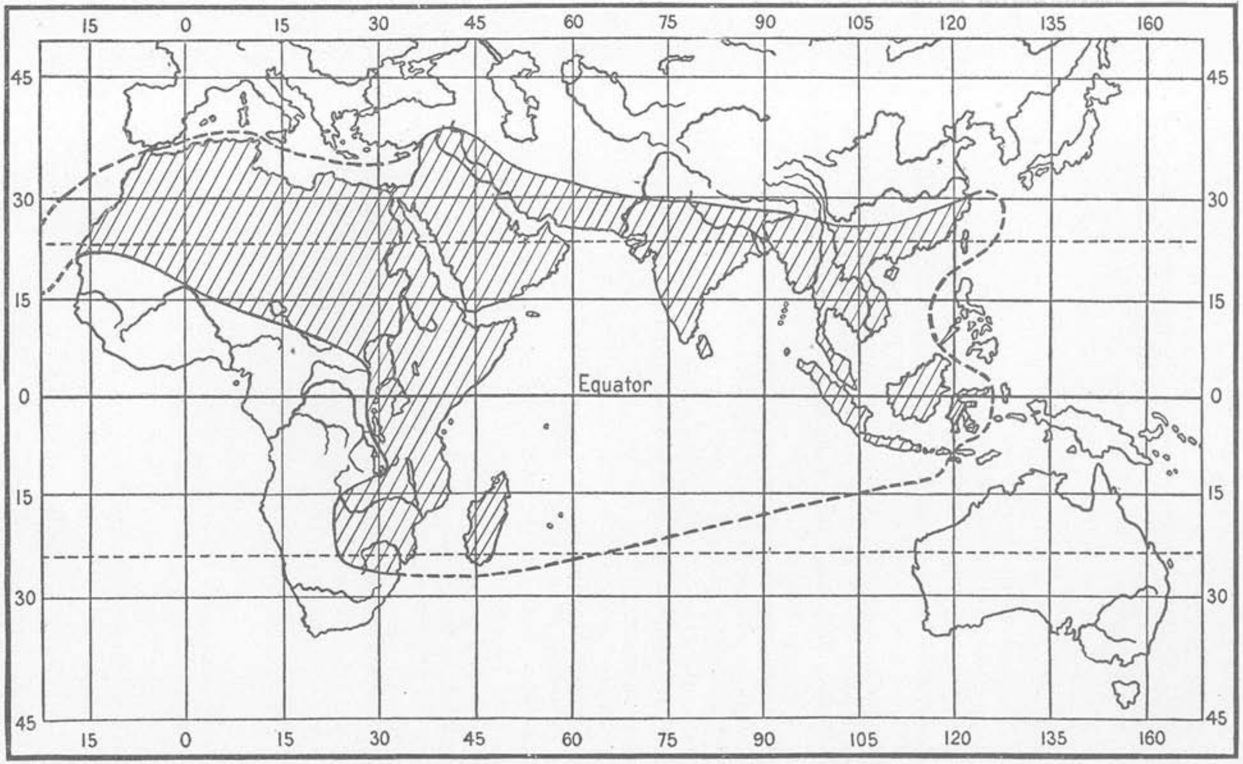
*Melanoides* is apparently restricted to the Old World tropics, but, as its limits have not yet been worked out, its distribution cannot be given at present. That of *M. tuberculata* is shown on Map 2.

The distribution of *Melanoides* in Africa is peculiar inasmuch as no species are as yet known to occur in Upper Guinea from Senegambia to the Gaboon, as also in South Africa proper (Cape Province, Orange Free State, and Natal); the genus is absent from the basins of the Senegal, Niger, and Orange Rivers. Lake Nyasa has a series of special species. The Congo basin seems to nourish many forms, a small part of which are probably known thus far; while but few, widely spread forms inhabit the river systems of the Nile and Zambezi.

The following species are at present known from the African continent outside of Lake Nyasa:

*Melanoides admirabilis* (E. A. Smith). See p. 264.
*Melanoides anomala* (Dautzenberg and Germain). See p. 258.
*Melanoides anomala bukamana* Pilsbry and Bequaert. See p. 258.

[1]Raymond, L. 1852. 'Recherches anatomo-physiologiques sur les Mollusques de l'Algérie., Journ. de Conchyl., III, pp. 325–329.




Map 2. Distribution of *Melanoides tuberculata* (O. F. Müller).

*Melanoides bavayi* (Dautzenberg and Germain). See p. 264.

*Melanoides crawfordi* (Brot) = *Melania crawfordi* Brot, 1894, Journ. de Conchyl., XLII, p. 473, Pl. IX, fig. 5. Type locality: Middelburg, Transvaal.

*Melanoides crawshayi* (E. A. Smith). See p. 264.

*Melanoides depravata* (Dupuis and Putzeys). See p. 264.

*Melanoides dupuisi* (Spence). See p. 265.

*Melanoides imitatrix* (E. A. Smith). See p. 265.

*Melanoides kinshassaensis* (Dupuis and Putzeys). See p. 259.

*Melanoides kisangani* Pilsbry and Bequaert. See p. 263.

*Melanoides kisangani congo* Pilsbry and Bequaert. See p. 263.

*Melanoides langi* Pilsbry and Bequaert. See p. 259.

*Melanoides langi zambiensis* Pilsbry and Bequaert. See p. 260.

*Melanoides liebrechtsi* (Dautzenberg). See p. 259.

*Melanoides maraensis* (Preston) = *Melania maraensis* Preston, 1913, Rev. Zool. Afric., III, 1, p. 58, Pl. VI, fig. 5. Type locality: Eusso Mara River, at 3,500 ft., Kenya Colony. Germain (1919, Bull. Mus. Hist. Nat. Paris, p. 264) synonymizes this with *M. tuberculata* (Müller).

*Melanoides mweruensis* (E. A. Smith). See p. 265.

*Melanoides nsendweensis* (Dupuis and Putzeys). See p. 260.

*Melanoides nsendweensis consobrina* (Dupuis and Putzeys). See p. 261.

*Melanoides nsendweensis megalobasis* Pilsbry and Bequaert. See p. 261.

*Melanoides nsendweensis soror* (Dupuis and Putzeys). See p. 261.

*Melanoides nyangweensis* (Dupuis and Putzeys). See p. 265.

*Melanoides recticosta* (E. v. Martens) = *Melania recticosta* E. v. Martens, 1882, Jahrb. Deutsch. Malakoz. Ges., IX, p. 248. Murie brook, an affluent of the Quanza River, Portuguese West Africa.

*Melanoides scabra* (O. F. Müller) = *Buccinum scabrum* O. F. Müller, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 136. Type locality: coast of Coromandel, India. This species is found at various places along the coast of East Africa. The following are regarded as synonyms: *Plotia bloyeti* Bourguignat, 1889, 'Moll. Afrique Equator.,' p. 186 (described from the Vuami and Kingani basins, Tanganyika Territory); *Plotia leroyi* Bourguignat, 1889, *op. cit.*, p. 185 (type locality: Vuami River, Tanganyika Territory); and *Melania subspinulosa* Brot, 1872, 'Matér. Et. Mélaniens,' III, p. 48, Pl. II, figs. 7–8 (type locality: Zanzibar).

*Melanoides tuberculata* (O. F. Müller). See p. 256.

*Melanoides tuberculata* var. *dautzenbergi* Pilsbry and Bequaert. See p. 257.

*Melanoides victoriæ* (Dohrn) = *Melania victoriæ* Dohrn, 1865, Proc. Zool. Soc. London, p. 234. Type locality: Victoria Falls, Zambezi River, Rhodesia.

*Melanoides wagenia* Pilsbry and Bequaert. See p. 262.

*Melanoides wagenia tshopoicola* Pilsbry and Bequaert. See p. 262.

*Melanoides zengana* (Morelet) = *Melania zengana* Morelet, 1860, 'Séries Conchyl.,' II, p. 115, Pl. VI, fig. 9. Type locality: Zanzibar.

To these are to be added the forms from Lake Nyasa distributed by Bourguignat in the supposed genera *Nyassia*, *Nyassella*, *Micronyassia*, and *Nyassomelania*. The essential characters of these groups, to be found in the mantle, radula, and operculum, remain unknown; until differential characters are pointed out, they may well be left in *Melan-*

*oides* in the wide sense. We do not care to add new name combinations for a host of merely mutational forms, and a consideration of the synonymy of Nyasan species does not come within the limits of this work. They are here listed separately, therefore, under the original names.

## List of *Melanoides* of Lake Nyasa

*Nyassella acuminata* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 22, Pl. I, figs. 21–22.

*Nyassia acutalis* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 10 = *Melania polymorpha* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 10 (only).

*Melania (Nyassella) arcuatula* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 201, Pl. VI, fig. 39.

*Nyassella arenaria* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 20, Pl. II, figs. 17–18.

*Nyassia callista* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 12, Pl. II, figs. 1–2.

*Nyassia edgari* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 13 = *Melania nyassana* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 2 (only).

*Micronyassia egregia* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 27 = *Melania turritispira* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 15 (only).

*Nyassia elegans* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 15, Pl. II, figs. 7–8.

*Nyassella episema* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 22, Pl. I, figs. 19–20.

*Micronyassia eximia* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 27, Pl. I, figs. 1–2.

*Nyassella formosa* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 21, Pl. I, figs. 23–24.

*Nyassia giraudi* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 15, Pl. II, figs. 9–10.

*Micronyassia giraudi* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 28, Pl. I, figs. 5–6.

*Nyassia hermosa* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 8 = *Melania polymorpha* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 5 (only).

*Nyassia idia* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 16, Pl. II, figs. 11–12.

*Nyassia lacunosa* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 9 = *Melania polymorpha* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 7 (only).

*Nyassia lacustris* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 11 = *Melania polymorpha* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 9 (only).

*Nyassomelania lævigata* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 32, Pl. I, figs. 13–14.

*Nyassomelania leia* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 31, Pl. I, figs. 9–10.

*Nyassia magnifica* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 16, Pl. II, figs. 5–6.

*Melania nodicincta* DOHRN, 1865, Proc. Zool. Soc. London, p. 234. E. A. SMITH, 1877, *op. cit.*, p. 715, Pl. LXXV, figs. 11–12. Also in the upper part of the Shire River, according to Dohrn.

*Nyassia nodulosa* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 10 = *Melania polymorpha* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 8 (only).

*Melania nyassana* E. A. SMITH, 1877, Proc. Zool. Soc. London, p. 715, Pl. LXXV, fig. 1 (only, according to Bourguignat).

*Nyassia paradoxa* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 14, Pl. II, figs. 3–4.

*Melania (Nyassia) pergracilis* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 199, Pl. VI, fig. 48.

*Melania polymorpha* E. A. SMITH, 1877, Proc. Zool. Soc. London, p. 714, Pl. LXXV, fig. 4 (only, according to Bourguignat).

*Nyassella pulchra* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 19, Pl. I, figs. 17–18.

*Melania pupiformis* E. A. SMITH, 1877, Proc. Zool. Soc. London, p. 713, Pl. LXXV, fig. 13.

*Nyassia rivularis* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 9 = *Melania polymorpha* E. A. SMITH, 1877, Proc. Zool. Soc. London, Pl. LXXV, fig. 6 (only).

*Melania simonsi* E. A. SMITH, 1877, Proc. Zool. Soc. London, p. 713, Pl. LXXV, fig. 3.

*Micronyassia singularis* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 29, Pl. I, figs. 7–8.

*Nyassella smithi* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 18, Pl. I, figs. 15–16.

*Micronyassia smithi* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 26, Pl. I, figs. 3–4.

*Nyassella tayloriana* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 23, Pl. I, figs. 25–26.

*Nyassia thaumasta* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 11.

*Nyassomelania truncatelliformis* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 31, Pl. I, figs. 11–12.

*Melania turritispira* E. A. SMITH, 1877, Proc. Zool. Soc. London, p. 713, Pl. LXXV, fig. 14 (only, according to Bourguignat).

*Melania woodwardi* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 638, Pl. LIX, fig. 11.

### **Melanoides tuberculata** (O. F. Müller)

Plate XXI, Figures 1–7

*Nerita tuberculata* O. F. MÜLLER, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 191 (type locality: Coast of Coromandel, India).

*Melanoides fasciolata* OLIVIER, 1804, 'Voyage dans l'Empire Othoman,' II, p. 40, footnote; (an XII) Atlas, II, Pl. XXXI, fig. 7 (type locality: Alexandria, Egypt).

*Melania tuberculata* O. F. Müller. BOURGUIGNAT, 1853, 'Cat. Moll. de Saulcy,' p. 65. H. ADAMS, 1866, Proc. Zool. Soc. London, p. 376. E. A. SMITH, 1881, *op. cit.*, p. 291. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, figs. 26 and 27; 1890, Ann. Sc. Nat. Zool., (7) X, p. 163, Pl. XI, figs. 26 and 27. E. A. SMITH, 1888, Proc. Zool. Soc. London, p. 52. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 193. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 257; 1912, *op. cit.*, p. 82; 1916, *op. cit.*, p. 202; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 649. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 211.

*Strombus vibex* GMELIN, 1791, in Linnæus, 'Syst. Nat.,' 13th Ed., I, 6, p. 3522.

Lake Tanganyika: at the southern end (Foà Coll.); bay of Karema; between the mouth of the Malagarazi and Cape Kabogo. Lake Kivu: (J. E. S. Moore Coll.; Schubotz Coll.). Lake Edward: Kiruwe and Katarenge near Vichumbi on the southwestern shore, where it is also found subfossil 1 meter above the level of the Lake; near Kishakka on the western shore (Stuhlmann Coll.); near Kasindi and Vichumbi, and subfossil in sediments 5 meters above the level of the Lake at Vichumbi (Gromier Coll.). Lake Albert: (S. Baker and Emin Pasha Coll.); near Kassenje on the western shore (Stuhlmann Coll.). Lake Mohasi in Ruanda (Schubotz Coll.).

Kabare, on the southern shore of Lake Edward (J. Bequaert Coll.). Kisenje on the northeastern shore of Lake Kivu (R. Van Saceghem Coll.).

A series from Kabare, Lake Edward, is figured, showing the variation in color—from white to uniform blackish brown—and in sculpture.

Length, 25.0 mm.; diameter, 7.5 mm.; 10 whorls remaining. Pl. XXI, Fig. 1.
" 19.6 " " 6.5 " 10 " " " " " 2.
" 20.0 " " 7.5 " 8½ " " " " " 3.

### **Melanoides tuberculata var. dautzenbergi,** new name

*Melania tuberculata* var. *victoriæ* DAUTZENBERG, 1908, Journ. de Conchyl., LVI, p. 23, Pl. II, figs. 3 and 5 (type locality: Kavirondo Bay, Lake Victoria). GERMAIN, 1912, Bull. Mus. Hist. Nat. Paris, p. 82; 1916, *op. cit.*, p. 203. (Not *Melania victoriæ* Dohrn, 1865).

Germain records this variety as having been found together with typical *tuberculata*, in Lake Edward at Vichumbi and Kasindi (Gromier Coll.). All of the numerous *Melanoides* which we have seen from Lake Edward belong to typical *tuberculata*.

The following African forms also appear to be variations of *M. tuberculata:*

*Melania dembea* REEVE, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. XXIII, fig. 161. Type locality: Lake Dembea [Tsana], Abyssinia.

*Melania inhambanica* E. v. MARTENS, 1860, Malakoz. Blätter, VI, (1859), p. 216, Pl. II, fig. 10. Type locality: Inhambane, Portuguese East Africa.

*Melania tamsii* DUNKER, 1845, Zeitschr. f. Malakoz., II, p. 165. Type locality: Island S. Anton, Cape Verde Archipelago.

E. v. Martens (1904, in Passarge, 'Die Kalahari,' p. 757) has recorded from Central South Africa (Lake Ngami and Makarikari) the varieties *plicifera* Mousson (described from Java) and *virgulata* (Quoy and Gaimard) (described from Mauritius). These identifications appear to us very questionable.

**Melanoides anomala** (Dautzenberg and Germain)

Plate XXI, Figures 8–12

*Melania tuberculata* var. *anomala* DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 62, Pl. III, figs. 3, 4, 7, 8, and Pl. IV, fig. 8.

Originally described from the Luvua River between Ankoro and Kiambi; Kabanza on the Lovoi River (near Kikondja); and Bukama, in the Lualaba River (J. Bequaert Coll.). No type locality was designated, but Kabanza, on the Lovoi River, is here selected as such.

Sankuru River (Ac. Nat. Sci. Philadelphia and U. S. Nat. Mus.; collector unknown). Near the source of the Kimilolo River (an affluent of the Lubumbashi); Kisanga River (an affluent of the Kafubo); Panda River, near *Likasi* (*Michael* Bequaert Coll.). Kidada near Kitobola (H. Schouteden Coll.).

It appears that several forms, probably local races, were included in the illustrations which originally defined *M. t.* var. *anomala.* The specimen represented in Plate III, fig. 4, of Dautzenberg and Germain's work, is here selected as the type. It is from Kabanza on the Lovoi River (J. Bequaert Coll., 22, x, 1911). A new figure of this specimen, now at the Congo Museum, Tervueren, is given in our Pl. XXI, fig. 8.

The upper half of the last whorl is rather coarsely ribbed (about 13 ribs on the last whorl); these ribs are interrupted by an impression which cuts off a subsutural series of tubercles; there is also a weakly impressed spiral line midway of the ribs, and another at the periphery. The ribs then terminate, the base showing three rather strong spiral cords. The pale olive-buff color is varied by a few scattered reddish-brown spots on the last whorl.

Length, 14.0 mm.; diameter, 5.0 mm.; 6 whorls remaining.

In a series (Pl. XXI, figs. 9, 10, 11) from near the sources of the Kimilolo River, an affluent of the Lubumbashi River, the earlier whorls are similar to typical *anomala*, being costate and more or less granose, but on the last whorl the ribs are usually obsolete.

Length, 22.7 mm.; diameter, 8.0 mm.; 6 whorls remaining.
" 23.7 " " 8.5 " 6 " "

A series from the Kisanga River, an affluent of the Kafubo, has similar shells but smaller, the largest of twenty being 15.5 mm. long, 6.0 mm. wide, with seven whorls (Pl. XXI, fig. 12).

A few from the Panda River are about like those of the Kimilolo.

**Melanoides anomala bukamana,** new subspecies

Plate XXI, Figure 13

The strongly subcylindric form represented by Dautzenberg and Germain's Pl. III, figs. 5, 6, and Pl. IV, figs. 7, 9, 10, appears to be a separable race of *anomala*, characterized by having the ribs, in the adult stage, deeply cut into tubercles by four spiral furrows (on the last three whorls), the upper furrow a little more emphatic; on the base there are 3 or 4 spiral cords.

Length, 8.5 mm.; diameter, 3.5 mm.; about 3½ whorls remaining.

The type in the Congo Museum, Tervueren, is the specimen illustrated in Dautzenberg and Germain's Plate III, fig. 5, and in our Pl. XXI, fig. 13, from the Lualaba River at Bukama.

**Melanoides kinshassaensis** (Dupuis and Putzeys)

Text Figure 42

*Melania kinshassaensis* DUPUIS AND PUTZEYS, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xix, figs. 33 and 34.

Type locality: Kinshasa.

Leopoldville, one immature example (J. Bequaert Coll.).

We copy the original figures of this species.

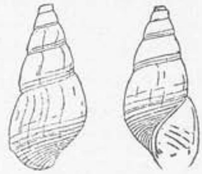


Fig. 42. *Melanoides kinshassaensis* (Dupuis and Putzeys). Copy of orginal figures.

**Melanoides liebrechtsi** (Dautzenberg)

Plate XXI, Figures 14–18

*Melania liebrechtsi* DAUTZENBERG, 1901, Ann. Soc. Malacol. Belgique, XXXVI, Mémoires, p. 4, Pl. I, figs. 5–8. G. C. SPENCE, 1923, Journ. of Conchology, XVII, p. 23.

Type locality: Upper Congo, without more definite indications (Collector unknown). Also found at Ngandu (F. M. Dyke Coll.) on the right bank of the Congo River.

Leopoldville, abundant on sand banks in the Congo River (H. Lang and J. Bequaert Coll.).

Many of the examples of this beautiful snail are wider than those figured by Dautzenberg. They measure:

Length, 26.5 mm.; diameter, 11.0 mm.; 4½ whorls remaining.
" 24.0 " " 10.8 " 4½ " "

Pl. XXI, fig. 17 represents a young individual, 13 mm. long. The length of the other specimens figured is respectively 26.4, 24.0, 24.0, and 17.7 mm.

**Melanoides langi**, new species

Plate XXII, Figures 1 and 2

Sand banks of the Tshopo River (type locality), near Stanleyville, March, 1915; abundant (H. Lang Coll.). Malela, abundant, and Barumbu, one specimen (J. Bequaert Coll.).

The shell is rather slender, turrited, thin, deep olive-buff, the early whorls lost. The upper whorls retained are convex with several spiral threads. The last two to three whorls have the spiral below the suture prominent, beaded, forming a narrow, horizontal ledge; it is separated from the following spiral by a space slightly wider than those separating subsequent spirals. On the penultimate whorl there are three tubercular spirals below the prominent sutural one (and sometimes a fourth spiral is visible just above the suture). The last whorl has about 7 spirals, of which three or four are tuberculate except in the largest shells, in which only the upper one remains so sculptured, the others becoming nearly smooth. Axial sculpture consists of fine striæ of growth, and sometimes weak ribs on the penultimate whorl. The aperture is ovate, biangular posteriorly.

Length, 13.5 mm.; diameter, 5.0 mm.; aperture, 5.0 mm.; about 5 whorls remaining. Type.

Length, 14.5 mm.; diameter, 6.0 mm.; aperture 5.0 mm.; about 3 whorls remaining.

A species of the group of *M. mweruensis*, resembling *M. crawshayi* (Smith) by the prominence of the subsutural cingulum, but distinguished by its small size, more slender shape, and more delicate sculpture.

A single specimen from Yakasa (J. Bequaert Coll.) appears to come near *langi;* but it is more slender, with no beaded spirals and weak subsutural cords.

**Melanoides langi zambiensis**, new subspecies

Plate XXII, Figure 3

Mud-banks of the Congo River about midway between Malela and Zambi, numerous specimens (H. Lang and J. Bequaert Coll.).

The shell differs from *M. langi* chiefly by its larger size and the numerous spiral threads of the base.

Length, 20.0 mm.; diameter, 7.0 mm.; length of aperture, 7.0 mm.; 5½ whorls remaining. Type.

Length, 19.5 mm.; diameter, 7.0 mm.
" 19.0 " 6.2

**Melanoides nsendweensis** (Dupuis and Putzeys)

Plate XXII, Figures 7 and 8

*Melania nsendweensis* Dupuis and Putzeys, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xvii, figs. 28 and 29. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 64.

In the Lualaba River at Nsendwe (type locality), Nyangwe, and Lokandu (Dupuis Coll.). In the same river at Kibombo and Nyangwe (J. Bequaert Coll.).

The species is strongly ribbed, the ribs prominent or sometimes tuberculiferous at the sutural or peripheral ends, the base having about four spiral cords, of which the second from below is often largest. The outer lip is markedly sinuous, advancing in the lower part. The length is given by Dupuis as 14 to 20 mm. Those before us from Nsendwe are 12.5 to 14.0 mm. long.

The shape and sculpture vary so much in the considerable series seen that we are compelled to include *M. soror* and *M. consobrina* Dupuis and Putzeys as forms of *nsendweensis*.

### **Melanoides nsendweensis consobrina** (Dupuis and Putzeys)

Plate XXII, Figures 9–11

*Melania consobrina* Dupuis and Putzeys, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xviii, figs. 31 and 32.

Lualaba River at Nsendwe (type locality; Dupuis Coll.). Kindu (J. Bequaert Coll.).

*Melanoides nsendweensis consobrina* differs by having the two series of tubercles more developed than in typical *nsendweensis*. Often the tubercles of the lower series are bifid. The specimens from Kindu on the Lualaba referred to *nsendweensis* by Dautzenberg and Germain belong to this race.

The specimens figured are respectively 13.5, 11.5, and 11.0 mm. long.

### **Melanoides nsendweensis soror** (Dupuis and Putzeys)

Plate XXII, Figure 13

*Melania soror* Dupuis and Putzeys, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xviii, fig. 30. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 65.

Lualaba River at Nsendwe (type locality; Dupuis Coll.). In the same river at Nyangwe (J. Bequaert Coll.).

*Melanoides nsendweensis soror* is a narrow, rather parallel-sided form in which the axial ribs of the later whorls tend to become obsolete except near the suture, where they remain as a series of oblong tubercles. In other examples the ribs persist, but the subsutural tubercles are more or less defined by a spiral impression.

### **Melanoides nsendweensis megalobasis,** new subspecies

Plate XXII, Figures 6 and 12

Sandbanks of the Tshopo River near Stanleyville (H. Lang Coll.).

This is a form having the narrow shape of *M. n. soror*. On the penultimate and next earlier whorls the ribs are deeply impressed below the subsutural tubercles, and bear two tubercles below the impression. On the last whorl they are more or less obsolete below the subsutural tubercles. The base has about four spirals, of which the second from below is very strongly developed, projecting well beyond the others, giving the last whorl an angular or carinate basal outline.

Length, 12.5 mm.; diameter, 4.0 mm.; length of aperture, 4.2 mm.; 4½ whorls remaining.

**Melanoides wagenia**, new species

Plate XXII, Figure 14

Stanleyville, from a brook near the falls of the Congo River; very abundant (H. Lang Coll.).

The shell is much like *M. admirabilis* (E. A. Smith) of Lake Tanganyika. The spire, of weakly convex whorls, tapers regularly. Color deep olive-buff when cleaned of the blackish coating. Sculpture of regular axial ribs (about 20 on the penult whorl), which curve back a little below the suture, then forward and fade out at the periphery, the base of the last whorl having about six low spiral cords wider than their intervals. Sometimes one of these cords appears above the suture on the spire. The aperture is ovate, the outer lip thin, sinuous, curving forward below. The columella is moderately thickened.

Length, 26.0 mm.; diameter, 8.5 mm.; length of aperture, 8.7 mm.; 6 whorls remaining. Type.

Length, 22.0 mm.; diameter, 8.0 mm.; length of aperture, 7.7 mm.; 5½ whorls remaining.

Length, 22.5 mm.; diameter, 8.0 mm.; length of aperture, 7.3 mm.; 6 whorls remaining.

This snail is extremely abundant and was collected by hundreds. It resembles *M. admirabilis* in sculpture-pattern, but is always smaller; the ribs much more numerous and they are not cut by a spiral impression a short distance below the suture, as in the Tanganyika shell.

Variation is often toward weakening or obsolescence of the ribs and the basal spirals on the last whorls in old individuals. Among hundreds looked over, none was found having the color markings of the following race.

*Melanoides recticosta* (v. Martens), from Angola, appears from the description somewhat related, but it is broader, with rather straight ribs and fewer basal spirals.

While this species and *M. admirabilis* have the sculpture of the subgenus *Sermyla*, they differ by the shape of the shell and aperture; we believe that there is no direct relationship. The sculpture of these African species is readily derivable from the *tuberculata* pattern, and in the neanic stage, described under *M. w. tshopoicola*, it resembles closely the pattern of *M. anomala* (Dautzenberg and Germain).

**Melanoides wagenia tshopoicola**, new subspecies

Plate XXII, Figures 15 and 16

Sandbanks of the Tshopo River, near Stanleyville, in company with *M. kisangani* (H. Lang Coll.).

The shell has the shape of *M. wagenia*, but differs in sculpture; the axial ribs are weaker and nearly straight; on the last whorl they are very weak or (in large speci mens such as the type) obsolete, but under the lens there are fine, sharp, axial ripples, irregularly cut by a few spiral lines. The earlier whorls have strong spiral cords. The basal spiral cords are weak, variable. The color is citrous-drab, with a series of vertical oblong chestnut spots below the suture and smaller spots around the columella.

Length, 20.5 mm.; diameter, 8.0 mm.; 5 whorls remaining. Type.
" 17.3 " 6.3 nearly 5 whorls remaining.

The smallest specimens preserved, 9–10 mm. long, with 6–7 whorls, have already lost the tip (Pl. XXII, fig. 16). The early neanic whorls preserved are moderately convex, with three or four spiral cords. This stage continues to within about four whorls from the base. Then axial riblets set in— cut by impressed spiral lines, of which six may be counted in some individuals, fewer in others. On the penult whorl of adults these spirals have nearly or wholly disappeared except for one above the suture.

**Melanoides kisangani**, new species

Plate XXI, Figures 19–22

Sandbanks of the Tshopo River, near Stanleyville, very abundant (H. Lang and J. Bequaert Coll.).

The shell is slender, rather thin, formed by flatsided whorls which are prominent below the suture. Surface very pale yellow, irregularly and sparsely strewn with chestnut spots; finely marked with lines of growth, not glossy. The earlier whorls are rather strongly convex, with three spiral cords, and weak, coarse, axial folds or waves. The last three whorls are flattened laterally, the upper spiral cord enlarges and becomes coarsely tubercular, and the axial folds weaken. The last whorl has lost axial folds, and the spirals are obsolete or wanting between the subsutural series of tubercles (which are somewhat lengthened in a spiral direction) and the periphery; on the lower half there are about five spiral cords. The aperture is small, rather narrowly ovate. The thin lip advances in the lower-outer part. The basal lip is deeply curved. Columella moderately calloused.

Length, 15.0 mm.; diameter, 5.2 mm.; length of aperture, 5.2 mm.; 4¾ whorls remaining. Type.

Length, 16.3 mm.; diameter, 4.7 mm.; length of aperture, 5.5 mm.; 5 whorls remaining.

Length, 17.0 mm.; diameter, 5.3 mm.; length of aperture, 6.3 mm.; 5 whorls remaining.

This form is very similar to *M. liebrechtsi* (Dautzenberg), a much larger shell, 28×10 mm., with 7 to 9 whorls remaining. We consider it distinct mainly on account of the far smaller size in several lots of hundreds of specimens.

**Melanoides kisangani congo,** new subspecies

Plate XXI, Figures 23 and 24

Stanleyville, near the falls of the Congo River (H. Lang Coll.).

This shell has the subcylindric shape and the coloration of *M. kisangani*. The axial folds are stronger, persisting more or less distinctly on the last whorl, at their upper ends enlarged, forming substantial tubercles which are somewhat lengthened in the direction of the folds (in *kisangani* proper, in a spiral direction). At and below the periphery there are about 7 spiral cords.

Length, 18.0 mm.; diameter, 5.5 mm.; about 5 whorls remaining. Type.
" 15.5 " 5.5 " 5 " "

## Other Species of *Melanoides* Recorded from the Belgian Congo[1]

### *Melanoides admirabilis* (E. A. Smith)

*Melania (Sermyla) admirabilis* E. A. SMITH, 1880, Ann. Mag. Nat. Hist., (5) VI p. 427; 1881, Proc. Zool. Soc. London, p. 291, Pl. XXXIV, fig. 24.

*Melania admirabilis* E. A. Smith. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 114. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, fig. 25; 1890, Ann. Sc. Nat. Zool., (7) X, p. 164, Pl. XI, fig. 25. E.v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 196. J. E. S. MOORE, 1903, 'The Tanganyika Problem,' p. 219, fig. 1 and p. 353, figs. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 257; 1900, 'Rés. Scientif. Voy. Afrique Foà,' p. 650.

Lake Tanganyika: originally described from the lake without more definite locality (E. C. Hore Coll.); at the southern end (Foà Coll.); Kibanga.

We have seen two specimens from Rugufu on the eastern shore (Hayes Perkins Coll.).

### **Melanoides bavayi* (Dautzenberg and Germain)

Plate XXII, Figures 17 and 18

*Melania bavayi* DAUTZENBERG AND GERMAIN, 1919, Rev. Zool. Afric., IV, 1, p. 65, Pl. I, figs. 3 and 4.

Type locality: Lualaba River at Kibombo (J. Bequaert Coll.).

We have no specimens of this species, and copy the original figures.

### *Melanoides crawshayi* (E. A. Smith)

Plate XXII, Figure 19

*Melania crawshayi* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 639, Pl. LIX, fig. 14.

Lake Moero: (R. Crawshay Coll).; without more definite type locality.

Numerous specimens have been obtained by Stappers in this lake at Lukonzolwa, Kilwa, Pweto, etc.; and also inthe Luapula River at Kachiobwe and Kasenga.

The specimen figured is 15.5 mm. long.

### *Melanoides depravata* (Dupuis and Putzeys)

Plate XXII, Figures 4 and 5

*Melania depravata* DUPUIS AND PUTZEYS, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xvi, figs. 26 and 27.

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[1]Names of species not seen by the authors are preceded by an asterisk (*).

*Melania nyangweensis* var. *depravata* DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 64.

In the Lualaba River at Nyangwe (type locality) and Nsendwe (Dupuis Coll.). In the same river at Kibombo (J. Bequaert Coll.).

The specimens figured are respectively 14.5 mm. (Kibombo) and 18.3 mm. (Nsendwe) long.

### *Melanoides dupuisi* (G. C. Spence)

*Cleopatra dupuisi* G. C. SPENCE, 1923, Journ. of Conchology, XVII, 1, p. 24, Pl. I, fig. 8.

*Tiara dupuisi* G. C. Spence. DUPUIS, 1924, Ann. Soc. Zool. Belgique, LIV, (1923), p. 22.

In wash of the Congo River on the beach at Ngandu, on the right bank (type locality; F. M. Dyke Coll.).

This appears to be related to *M. liebrechtsi* (Dautzenberg), as pointed out by Dupuis.

### **Melanoides imitatrix* (E. A. Smith)

Text Figure 43

*Melania imitatrix* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 639, Pl. LIX, fig. 13.

*Melania (Nyassia) imitatus* E. A. Smith. KOBELT, 1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 81.

Lake Moero: (R. Crawshay Coll.); without more definite type locality.

The original figure is reproduced.

Fig. 43. *Melanoides imitatrix* (E. A. Smith). Copy of original figure.

### *Melanoides mweruensis* (E. A. Smith)

Plate XXII, Figures 20, 21, and 22

*Melania mweruensis* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 639, Pl. LIX, fig. 12.

Lake Moero: (R. Crawshay Coll.); without more definite type locality.

Stappers obtained it in the same lake at Lukonzolwa, Kilwa, Pweto, Mobanga, etc., and also in the Luapula River at Kasenga and Kachiobwe.

The specimens figured are respectively 25.0, 24.0, and 15.0 mm. long.

### *Melanoides nyangweensis* (Dupuis and Putzeys)

Plate XXII, Figure 23

*Melania nyangweensis* DUPUIS AND PUTZEYS, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xvi, fig. 25. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 64.

In the Lualaba River at Nyangwe (type locality), Lokandu, and Nsendwe (Dupuis and Putzeys Coll.). In the same river at Kibombo and Nyangwe (J. Bequaert Coll.).

The specimen figured, from Nyangwe, is 17.8 mm. long.

### Incertæ sedis

### **Melania tanganyicensis* E. A. Smith

*Melania tanganyicensis* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 427; 1881, Proc. Zool. Soc. London, p. 291, Pl. xxxiv, fig. 25. H. Crosse, 1881, Journ. de Conchyl., XXIX, p. 115. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 197. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

*Horea tanganikana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xi, figs. 28 and 29; 1890, Ann. Sc. Nat. Zool., (7) X, p. 161, footnote, Pl. xi, figs. 28 and 29.

Lake Tanganyika (Thomson Coll.). Originally described without indication of a more definite locality.

This species does not appear to belong to either *Potadoma* or *Melanoides*. In case it should prove sufficiently distinct, the generic or subgeneric name *Horea* Bourguignat (1888, 'Iconogr. Malacol. Tanganika,' p. 28) might perhaps be retained for it.[1]

### Pachymelania E. A. Smith

*Claviger* Haldeman, 1842, Silliman's Am. Jl. Sci., XLII, p. 216. Monotype: *Nerita aurita* O. F. Müller. Not *Claviger* Preyssler, 1790.

*Vibex* Gray, 1847, Proc. Zool. Soc. London, p. 153. Monotype: *Nerita aurita* O. F. Müller. Not *Vibex* Rafinesque, 1815, nor of Oken, 1815.

*Pachymelania* E. A. Smith, 1893, The Conchologist, II, p. 142. Substitute for *Claviger* Haldeman. Not *Pachymelania* White, 1895.

*Hemipirena* Rovereto, 1899, Atti Soc. Ligustica Sc. Nat., X, p. 109. Substitute for *Claviger* Haldeman.

*Clavigerina* E. v. Martens, 1903, 'Wiss. Ergebn. Deutsch. Tiefsee-Exp.,' VII, 1, p. 14. Substitute for *Claviger* Haldeman.

*Itameta* H. v. Ihering, 1909, Journ. de Conchyl., LVII, p. 297. Substitute for *Claviger* Haldeman and *Vibex* Gray.

The shell is solid, turrited, with sculpture of axial folds sometimes obsolete in the adult stage, and spiral threads, carinæ, or series of tubercles or nodules. Aperture small, the outer lip sigmoid, retracted above and at the base; columella thickened. The operculum (Fig. 44) is narrow, with straight columellar margin, on which the nucleus is marginal near the base. Scar of attachment shaped like the operculum and occupying more than half its width.

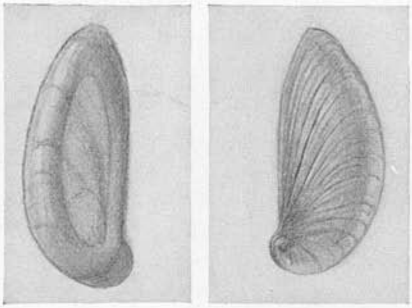
The radula resembles that of *Melanoides*.

The genus *Pachymelania* is strictly West African, being found along the coast and on the islands of Upper and Lower Guinea, from Senegal to Angola. It prefers brackish water of rather high salinity and is often extremely abundant in the mangrove swamps and on the mud-flats within reach of the tide, in the lagoons and river estuaries, in company with certain species of *Potamides*. There appear to be only three distinct

[1]Bourguignat's *Horea* (type: *Horea tanganikana* Bourguignat = *Melania tanganyicensis* E. A. Smith) has precedence over *Horea* E. A. Smith, 1889, which is a synonym of *Lechaptoisia* Ancey.

species: *P. aurita* (O. F. Müller), *P. fusca* (Gmelin), and *P. byronensis* (Wood).

*Pachymelania byronensis* (Wood) = *Strombus byronensis* Wood, 1828, 'Index Test.,' 2d Ed., Suppl., p. 14, Pl. iv, *Strombus*, fig. 23. *Melania owenii* Gray, 1831, 'Zoolog. Miscellany,' p. 10. *Melania tuberculosa* Rang, 1832, Mag. Zool., II, Classe v, Pl. xiii. *Melania rangii* Deshayes, 1838, in Lamarck, 'Hist. Nat. Anim. sans Vertèbres, 2d Ed., VIII, p. 442. *Pachymelania byroni* E. A. Smith, 1893, The Conchologist, II, p. 142. Coast of Upper Guinea. We have seen specimens from Assinie, but the species does not appear to extend south of Cameroon.



*a* *b*

Fig. 44. *Pachymelania fusca* (Gmelin). *a*, inner and *b*, outer side of operculum.

## **Pachymelania aurita** (O. F. Müller)

Plate XXIII, Figures 1–1*c* and 2–2*g*

*Nerita aurita* O. F. Müller, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 192. No locality mentioned.

*Melania aurita* O. F. Müller. Reeve, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. xii, figs. 190*a-c*.

*Claviger auritus* O. F. Müller. Brot, 1874, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 24, Melaniaceen,' p. 361, Pl. xxxvi, figs. 7, 7*a-c*, 11, and 11*a*; and Pl. xxxvii, figs. 2, 7, and 7*a*.

*Clavigerina aurita* O. F. Müller. E. v. Martens, 1903, 'Wiss. Ergebn. Deutsch. Tiefsee-Exp.,' VII, 1, p. 19 (Chinchoxo, Massabi, and Chisambo in the Portuguese colony of Cabinda).

*Melania zonata* Philippi, 1851, 'Abbild. Beschr. Conchyl.,' III, *Melania*, p. 57, Pl. v, fig. 5.

*Melania balteata* Philippi, 1851, 'Abbild. Beschr. Conchyl.,' III, *Melania*, 4th page of "Register"; new name for *M. zonata* Philippi.

*Melania histrionica* Reeve, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. xxix, fig. 192 ("Cap Colony").

*Strombus tympanorum africanus* Chemnitz, 1786, 'Syst. Conch. Cab.,' IX, p. 192, Pl. cxxxvi, figs. 1265–1266.

*Io rota* Reeve, 1860, 'Conchol. Iconica,' XII, *Io*, Pl. ii, fig. 13 ("United States").

*Melania subaurita* BROT, 1868, 'Matér. Et. Mélaniens,' II, p. 43, Pl. I, figs. 1–3.

*Melania soriculata* MORELET, 1864, Journ. de Conchyl., XII, p. 287 (Grand Bassam).

San Antonio, on the left bank of the Congo estuary, in Angola (H. Lang Coll.). Moanda, over one hundred specimens (H. Lang Coll.).

The neanic stage agrees with that of *P. fusca* in having somewhat protractive axial ribs, but they are smaller and more numerous, and are covered by a greater number of spiral cords and threads.

In the large form from Moanda (Pl. XXIII, figs. 1–1*c*) the spiral threads become weak or subobsolete on the later whorls. Five to seven whorls have the compressed peripheral tubercles characteristic of the species. These do not arise from enlargement of a single spiral, as in *P. fusca*, but are enlargements of the lower part of each axial rib. On the last whorl there are about ten (9–11) tubercles.

A series from San Antonio, on sandbanks at low tide, consists of smaller examples when apparently adult, mainly 35 to 40 mm. long; one 45, one 45.9, in several hundred collected. Tubercles 9 or 10 on last whorl. In this lot there are many relatively large individuals (up to 30 mm. long) retaining sculpture of the neanic stage (Pl. XXIII, figs. 2-2*g*).

### **Pachymelania fusca** (Gmelin)

Plate XXIII, Figures 3–3*h* and 4–4*a*; Plate XXIV

*Murex fuscus* GMELIN, 1791, in Linnæus, 'Syst. Nat.,' Ed. XIII, p. 3561 (without locality).

*Melania fusca* Gmelin. REEVE, 1860, 'Conch. Iconica,' XII, *Melania*, Pl. XXX, figs. 200*a-c* (Senegal).

*Murex fuscatus* MATON, 1804, Trans. Linn. Soc. London, VIII, p. 149, Pl. IV, fig. 6.

*Melania fuscata* HANLEY, 1854–58, 'Conchol. Miscellany,' Melaniadæ, Pl. I, fig. 1.

*Melania matoni* GRAY, 1831, 'Zoolog. Miscellany,' p. 10.

*Claviger matoni* Gray. BROT, 1874, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 24, Melaniaceen,' p. 366, Pl. XXXVII, figs. 3, 3*a-f*, and 4*a-b* [Senegal; Calabar; Victoria (Cameroon)]. DAUTZENBERG, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 45. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 100.

*Melania quadriseriata* GRAY, 1831, 'Zoolog. Miscellany,' p. 10 (coast of Africa). HANLEY, 1854–58, 'Conchol. Miscellany,' Melaniadæ, Pl. I, fig. 9. BROT, 1868, 'Matér. Et. Mélaniens,' II, p. 47 (as *typica*).

*Clavigerina fusca quadriseriata* Gray. E. v. MARTENS, 1903, 'Wiss. Ergebn. Deutsch. Tiefsee-Exp.,' VII, 1, p. 19.

*Melania mutans* GOULD, 1843, Proc. Boston Soc. Nat. Hist., I, p. 159 (Liberia); 1862, 'Otia Concholog.,' p. 193 (synonymizes it with *fusca* Gmelin). REEVE, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. XXXII, fig. 215.

*Melania loricata* REEVE, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. XXX, fig. 198 (without locality).

*Melania matoni* var. *loricata* Reeve. O. BŒTTGER, 1885, 24.u.25. Ber. Offenbacher Ver. f. Naturk., p. 191. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 100.

*Pirena granulosa* LAMARCK, 1822, 'Hist. Nat. Anim. sans Vertèbres,' VI, 2, p. 170. DELESSERT, 1841, 'Rec. Coq. Lamarck,' Pl. XXXI, figs. 1*a*-*b*.

*Melania tessellata* I. LEA, 1850, Proc. Zool. Soc. London, p. 192 (locality unknown). BROT, 1868, 'Matér. Et. Mélaniens,' II, p. 45, Pl. I, figs. 4 and 5 (Gaboon).

*Melania quadriseriata* var. *carinata* BROT, 1868, 'Matér. Et. Mélaniens,' II, p. 47 (new name for *M. mutans* Gould).

Banana (P. Hesse Coll.). Dredged at the mouth of the Congo between Point Padrão and Shark Point (Gruvel Coll.).

This species is found along the West Coast of Africa from Senegal to Angola.

Landana at the mouth of the Shiloango River (Portuguese colony of Cabinda) (J. Bequaert Coll.). San Antonio, on the southern shore of the Congo estuary, in Angola (H. Lang Coll.). Malela; Kunga; Banana; Moanda (H. Lang Coll.).

Although the remarkable polymorphism of this species has long been recognized, the series of thousands of specimens collected by the Congo Expedition gives occasion for further statement and illustration.

The embryonic stage and the beginning of the neanic are unknown. The sculpture in the earliest stages seen, and as far as a mid-neanic stage, consists of numerous axial ribs crossed by four low spiral cords which are strengthened on the ridges. Just above the suture a smooth cord revolves, or it may be covered. The base has many spiral cords, not tubercular. After this stage, the species may assume either of three forms, which we designate I, II, III.

I. In the form *granulosa* Lamarck[1] the sculpture just described continues to the adult stage, the ribs becoming somewhat curved or protractive in the last three or four whorls. In aged individuals they become irregular, and the spiral cords lose their tubercles to a great extent (Pl. XXIV, figs. 3-3*f*, and others).

This strain was doubtless the original form of the species.

Two forms of *granulosa* are distinguishable: the typical *granulosa* in which the axial ribs are strong (Pl. XXIV, figs. 3, 3*e*) and a form in which they are much smaller and more numerous (Pl. XXIV, fig. 6).

II. In the form *fusca* the length of the granose-costate stage varies individually. A keeled stage begins by gradual enlargement of the upper spiral cord and of the fifth or smooth one, in the suture; at the same time the second to fourth cords rapidly fade out. The three enlarged spirals

[1]*Melania loricata* Reeve appears to be an exact synonym.

form two smooth, thin and very prominent keels on the last two to five whorls, the upper keel being usually the more prominent. The base has numerous (usually 10 to 16) smooth spiral cords, as in the form *granulosa* (Pl. XXIII, figs. 3-3*b*; Pl. XXIV, figs. 1–1*g*).

The neanic stage of *fusca* seems to be always of the rather coarse-ribbed granular type.

III. In another form, which has been called *mutans* Gould,[1] the upper and, to a smaller extent, the fifth spirals are more or less extended to form carinæ, as in form *fusca*; but they diminish again, leaving the last whorl simply granose-costate, as in form *granulosa* (Pl. XXIV, figs. 2, 4).

This form, which appears to be a blend between *granulosa* and *fusca*, is extremely rare. No two examples are alike. The ribbing varies from coarse to rather fine. The carinæ may exceptionally become as strong as in *fusca*, but generally are much less developed, with the crest lobed at intersections with the ribs.

Banana. (Pl. XXIV, figs. 1–4). The specimens here are large.

| | | | | |
|---|---|---|---|---|
| Length, 41.5 mm.; | diameter, 27.5 mm.; | 7 | whorls; | form *fusca*. |
| " 34.5 | " 18.5 | 2½ | " | " " |
| " 45.0 | " 16.0 | 7 | " | " *granulosa*. |
| " 30.0 | " 17.5 | 2 | " | " " |

In this very large series the forms *granulosa* and *fusca* are represented by an equal number of individuals. The form *mutans*, however, is much rarer, as shown by the following figures:

| | Number of individuals | |
|---|---|---|
| Form *granulosa* | 1898 | together 3992 |
| " *fusca* | 1927 | |
| " *mutans* | 167 | |
| Young specimens | 253 | |
| Total | 4245 | |

Malela. (Pl. XXIII, figs. 3–3*h*). The form *granulosa* reaches about as great a size as at Banana, and shows similar coarser and finer ribbed forms.

Form *fusca* is constantly smaller than those of Banana, and often more slender.

| | | |
|---|---|---|
| Length, 34.5 mm.; | diameter, 13.0 mm.; | 6 whorls. |
| " 30.3 | " 15.3 | 5 " |

[1]The name is used as restricted by Reeve. Gould's description covered various other forms also.

More of the *mutans* form occurred at this place than elsewhere.

Lang's label states that it is "common on the shore of the Congo River at low tide both varieties together. At certain places one or the other predominates. July 4, 1915."

Malela, from another place, August, 1915. Several hundred specimens of the form *fusca* only, the size and other characteristics very uniform. An average specimen and the largest seen measure:

| | | | |
|---|---|---|---|
| Length, 19.5 mm.; | diameter, 10.0 mm.; | 5 whorls. |
| " 24.0 | " 11.0 | 6 " |

The special ecologic features of the station of this pigmy form were not noted.

Kunga. A small series of medium size, about: length, 32 mm.; diameter, 15 mm.; 4 whorls. Only the *fusca* form occurred. The carinate phase sets in early, and apparently consists of five or six whorls. It is therefore an extreme form of the *fusca* type.

San Antonio. The series of some hundreds of specimens is divided into living shells and dead ones containing hermit crabs. Barnacles are found on the shells of both lots. All of the shells taken alive are of the form *fusca*. All are small, about $21\times8$ to 9 mm., with about 7 whorls, of which 2 to 3 are carinate. They taper to a very small apical truncation. Many specimens have two dark bands, as figured by Hanley as *matoni* Gray. (Pl. XXIII figs. 4–4*a*).

The crab shells are larger, 25 to 32 mm. long, and include both *fusca* and *granulosa* forms, the latter rather finely ribbed. There are also a few of the *mutans* blends. These were probably brought by the hermit crabs from the mangrove swamps, where similar specimens are known to occur.

From the frequent presence of barnacles, the slight degree of erosion, and the absence of ferric incrustation, it may be presumed that the water in this place is decidedly salt, too saline for the optimum growth of the species.

San Antonio, in a mangrove swamp occasionally submerged (Pl. XXIV, figs. 5–5*b*). Several hundreds of specimens, of which many are of the form *granulosa* with numerous small axial ribs (Pl. XXIV, fig. 5). Others have the ribs more emphatic with prominent tubercles below the suture, like the stage immediately preceding the carinate stage in form *fusca* (Pl. XXIV, fig. 5*a*). Some have a brief *fusca* stage with the upper carina either lobed or rarely even for a short space, then becoming lobed and more or less fully returning to the *granulosa* type (Pl. XXIV, fig. 5*b*).

The *mutans* blend is more abundant in this station than in any other.

Moanda, from the mangrove swamps just below the mission, on the river. The form *fusca* is only rarely developed typically, and is always preceded by a long *granulosa* stage; generally the keels are relatively weak, or the lower one wanting.

Landana (Pl. XXIV, fig. 6). Only the form *granulosa*, specimens with numerous small axial ribs.

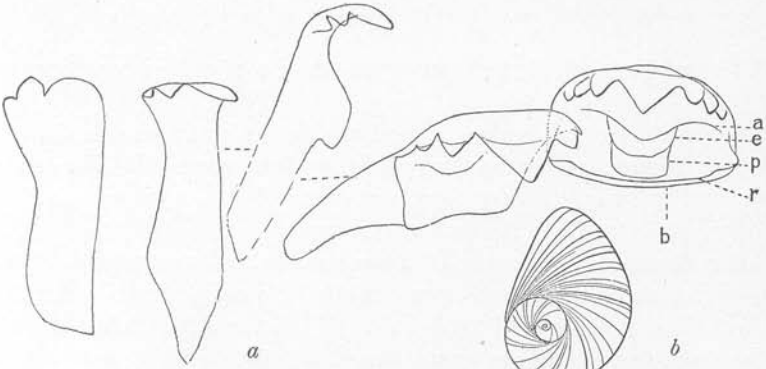



Fig. 45. *a*, teeth of *Potadoma ponthiervillensis* mut. *spoliata* (Putzeys), an outer marginal lying prone at left. *b*, operculum of *Potadoma liricincta walikalensis* Pilsbry and Bequaert.

**a, anterior margin, and b, posterior margin of basal plate; e, embayment line; p, platform line; r, rise line.**

## Potadominæ

### Potadoma Swainson

*Melania* subgenus *Potadoma* Swainson, 1840, 'Treatise on Malacology,' pp. 200 and 341. Includes two species: *M. freethii* Gray and *M. lævis* Gray.

*Melania* subgenus *Nigritella* Brot, 1870, American Journ. Conchol., VI, 2, Appendix, p. 277, for several species, among them *M. nigritina* Morelet, but no type designated; 1874, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 24, Melaniaceen,' p. 6, with *M. nigritina* Morelet designated as type. Not *Nigritella* E. v. Martens, 1860.

*Melania* section *Nigriculina* Rovereto, 1899, Atti Soc. Ligustica Sc. Nat., X, p. 109. Substitute for *Nigritella* Brot, 1870.

Type: *Melania freethii* Gray, as designated by Hermannsen, 1847, 'Ind. Gen. Malac.,' II, p. 329, and also by Gray, 1847, Proc. Zool. Soc. London, p. 152. According to Brot, 1874, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 24, Melaniaceen,' [p. 487], the British Museum specimen of *M. freethii* Gray, from Gray's collection, does not differ from *M. nigritina* Morelet, and E. A. Smith, 1887, Proc. Zool. Soc. London, p. 566, also admits that they are the same.

The shell is solid, either smoothish, spirally lirate, or carinate, never having axial ribs or folds; color uniform or but little variegated, brown, olivaceous, or yellowish. Aperture ovate, the basal lip more or less produced; outer lip straight or nearly so in profile; the callus of the inner lip thickened near the posterior angle. Operculum ovate, of about three whorls, of which the first two form a small spiral figure, and the last widens rapidly; the nucleus situated between the lower third and fourth, near the columellar side; scar of attachment narrow, less than half the total width (Fig. 45*b*, *P. liricincta walikalensis*).

Edge of the mantle smooth and even. Animal apparently oviparous; externally uniform black in species examined. The radula is relatively large and very long (8.5 mm. long and 0.5 mm. wide in a specimen of *P. p. spoliata* of 11 mm. diameter). The squarish central tooth has few denticles, 3 on each side of the very prominent central one; the body below it is mesially swollen, showing the usual Troschel lines, the platform line[1] continuous downward from the embayment line.[2] The lateral tooth has a distinct embayment line and supporting plate.[3] The marginal teeth have three denticles each (Fig. 45*a*, *Potadoma ponthiervillensis spoliata*).

Distribution: West and Central Africa, in streams draining into the Atlantic and Lake Albert (Map 3).

The early neanic whorls never show coarse spiral sculpture. When this is present, it arises in a mid-neanic stage and is generally most fully expressed in the adult stage. The only exception we have noticed is seen in *P. schoutedeni*, in which the acme of sculpture falls in a late neanic stage, and is nearly or wholly obliterated in the last whorl. The relatively late appearance of coarse spirals in ontogeny apparently denotes rather recent evolution of this character in the genus. This contrasts with *Melanoides*, in which such sculpture appears at the beginning of the neanic stage in all species of which young stages were examined.

*Potadoma* is related to the Indo-Chinese genus *Brotia*[4] and the Javan *Sulcospira*. Both of these differ from the African genus by the absence of callus on the parietal wall of the shell, by the nearly circular "palæomelanid" operculum with larger spiral figure and more slowly widening last whorl, and by the viviparous reproduction.

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[1] "Rampenlinie" in the Troschelian terminology.

[2] "Buchtlinie."

[3] "Stützplatte."

[4] *Brotia* H. Adams, 1866, Proc. Zool. Soc. London, p. 150. Monotype: *Melania pagodula* Gould.

*Melania* subgenus *Acrostoma* Brot, 1870, American Journ. Conchol., VI, 2, Appendix, p. 272, for two species, among them *M. hügelii* Philippi, but type not designated; 1874, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 24, Melaniaceen,' p. 6, with *M. hügelii* Philippi, of India, designated as type. Not *Acrostoma* Le Sauvage, 1826.

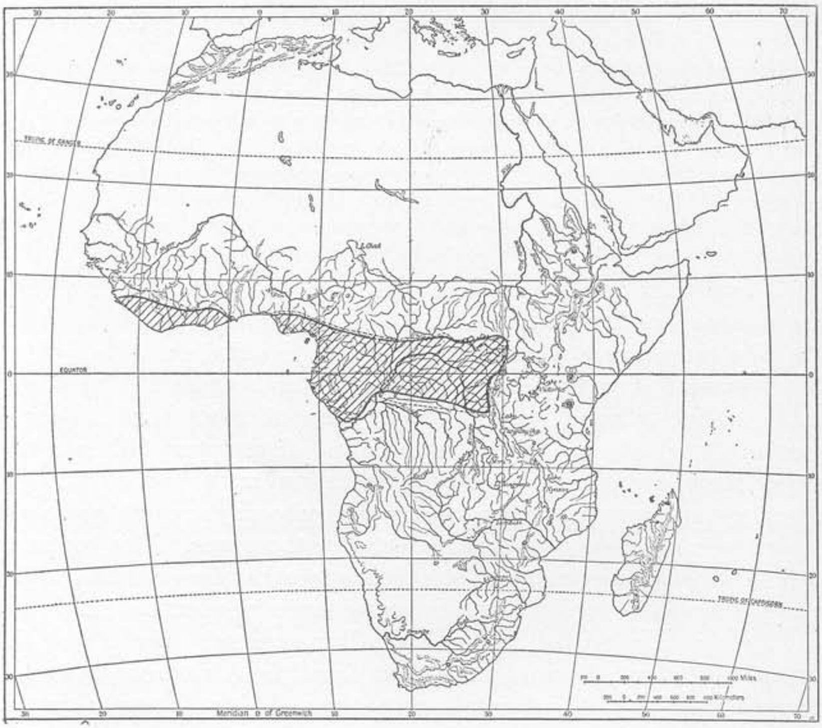
*Melania* section *Brotella* Rovereto, 1899, Atti Soc. Ligustica Sc. Nat., X, p. 109. Substitute for *Acrostoma* Brot, 1870. Not *Brotella* Kaup, 1858.

*Paracrostoma* Cossmann, 1900, Rev. de Paléozool., IV, p. 42. Substitute for *Brotella* Rovereto, 1899.

Annandale (1920, Rec. Indian Mus., XIX, p. 109; 1921, *op. cit.*, XXII, p. 559) is the chief authority on the characters of this genus. It comprises large melanians of the regions from southern China to India.

The name of this group appears to be as variable as the shells, and we are not yet wholly satisfied with it. *Sulcospira* Troschel (1857, 'Das Gebiss der Schnecken,' p. 114; monotype: *Melania sulcospira* Mousson), has similar operculum and dentition, and is also viviparous. The shell is somewhat different, and the mantle margin and terminal genital ducts need comparison. Yet it seems likely that no differential characters of importance exist between *Sulcospira* and *Brotia* (*Acrostoma*).

The Middle American genus *Pachychilus* also stands close to *Potadoma*. It agrees in being oviparous, with smooth mantle margin and similar teeth; but it differs by the less evolved, more closely spiral operculum. The shells are strikingly similar in some species.



Map 3. Distribution of the genus *Potadoma*.

The following is a list of the species known at present:

*Potadoma alutacea* Pilsbry and Bequaert. See p. 278.

*Potadoma büttikoferi* (Schepman) = *Melania büttikoferi* Schepman, 1888, Notes Leyden Mus., X, p. 249, Pl. x, figs. 5*a*-*c*. St. Paul's River, near Bavia, Liberia.

*Potadoma conulus* (I. and H. C. Lea) = *Melania conulus* I. and H. C. Lea, 1850, Proc. Zool. Soc. London, p. 190. Fernando Po.

*Potadoma freethii* (Gray) = *Melania freethii* Gray, 1831, 'Zoolog. Miscellany,' p. 11. *M. frethii* Gray, in Griffith, 'Cuvier's Anim. Kingdom,' XII, Moll., Pl. xiv, fig. 2 (not of Brot, 1874, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 24, Melaniaceen,' p. 67, Pl. vii, fig. 7). *M. nigritina* Morelet, 1848, Rev. Zoolog. Soc. Cuviér., p. 355; and 1858, 'Séries Conchyl.,' I, p. 31, Pl. iii, fig. 8 (type locality: Gaboon). *M. nigrita* Morelet, 1851, Journ. de Conchyl., II, p. 191, Pl. v, fig. 2.

*M. fœnaria* REEVE, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. XIX, fig. 134. Fernando Po (type locality), Gold Coast, Liberia, Calabar, Cameroon, Gaboon.[1]

*Potadoma freethii guineensis* (Reeve) = *Melania guineensis* REEVE, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. xx, fig. 142. Coast of Guinea. This appears to be at least sub-specifically distinct from *freethii* by the much finer sculpture (See E. A. Smith, 1887, Proc. Zool. Soc. London, p. 566).

*Potadoma funerea* (Preston) = *Melania funerea* PRESTON, 1908, Proc. Malacol. Soc. London, VIII, 1, p. 7, fig. (on p. 8). Gold Coast.

*Potadoma graptoconus* Pilsbry and Bequaert. See p. 276.

*Potadoma ignobilis* (J. Thiele). See p. 278.

*Potadoma liberiensis* (Schepman) = *Melania liberiensis* SCHEPMAN, 1888, Notes Leyden Mus., X, p. 248, Pl. x, figs. 3*a*-*b* and 4*a*-*b*. St. Paul's River, near Bavia, Liberia.

*Potadoma liricincta* (E. A. Smith). See p. 280.

*Potadoma liricincta dryas* Pilsbry and Bequaert. See p. 282.

*Potadoma liricincta latior* (J. Thiele). See p. 282.

*Potadoma liricincta major* (J. Thiele). See p. 281.

*Potadoma liricincta semperlirata* Pilsbry and Bequaert. See p. 282.

*Potadoma liricincta walikalensis* Pilsbry and Bequaert. See p. 281.

*Potadoma medjeorum* Pilsbry and Bequaert. See p. 283.

*Potadoma mörchii* (Reeve) = *Melania mörchii* REEVE, 1859, 'Conchol. Iconica,' XII, *Melania*, Pl. xv, fig. 108. Habitat not given originally. Brot in 1874 states that it came from "Guinea danica," which is what is now called the Gold Coast.[2]

*Potadoma mungwana* Pilsbry and Bequaert. See p. 287.

*Potadoma pokoensis* Pilsbry and Bequaert. See p. 279.

*Potadoma ponthiervillensis* (Dupuis and Putzeys). See p. 284.

*Potadoma ponthiervillensis* mut. *spoliata* (Dupuis and Putzeys). See p. 285.

*Potadoma sancti-pauli* (Schepman) = *Melania sancti-pauli* SCHEPMAN, 1888, Notes Leyden Mus., X, p. 248, Pl. x, figs. 2*a*-*c*. St. Paul's River, near Bavia, Liberia.

*Potadoma schoutedeni* Pilsbry and Bequaert. See p. 277.

*Potadoma superba* Pilsbry and Bequaert. See p. 286.

*Potadoma superba* mut. *inculta* Pilsbry and Bequaert. See p. 287.

*Potadoma tornata* (E. v. Martens). See p. 288.

## Key to the Species of *Potadoma* of the Belgian Congo

1. Shell appearing smooth to the eye, or having a few spiral cords around the columella; periphery rounded or angular ........................... 2.
   Shell having distinct spiral sculpture in the peripheral region or throughout. . 7.
2. Minute sculpture of distinct, very close spiral striæ; 3 or 4 low cords around the columella; periphery rounded ........................................ 3.
   Not so sculptured; no cords around the columella ........................ 4.
3. Spire rather long; aperture less than half the total length; young shells without peripheral cords .................... *P. graptoconus* Pilsbry and Bequaert.
   Spire quite short; aperture more than half the total length; young shells with cords at and below periphery ........ *P. schoutedeni* Pilsbry and Bequaert.

[1] E. v. Martens (1886, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 114) mentions, without description, a *Melania nigritina* var. *gracilior*, from Abetifi, Gold Coast.

[2] The Danes occupied for some time four trading stations at Christiansborg, Ningo, Temma, and Kitta (Quitta).

4. Minute sculpture of dense granulation, like pebbled leather, and faint, indistinct spiral lines; form biconic, the periphery angular.
*P. alutacea* Pilsbry and Bequaert.
Minute sculpture of fine axial wrinkles decussated or cut into oblong beads by impressed spirals; generally irregularly and locally developed..........5.
Minute sculpture of faint lines of growth only; a very slight peripheral angulation faintly visible..............................*P. ignobilis* (J. Thiele).
5. Periphery angular or marked by a low cord..............................6.
Periphery rounded........................*P. liricincta major* (J. Thiele).
6. Last whorl decidedly more swollen than those of the spire.
*P. ponthiervillensis* mut. *spoliata* (Dupuis and Putzeys).
*P. superba* mut. *inculta* Pilsbry and Bequaert.
Last whorl not swollen, the shell tapering slowly and regularly; periphery angular........................*P. mungwana* Pilsbry and Bequaert.
7. A few very weakly raised, mostly blunt spirals, none around the columella; last whorl rather swollen, strongly convex.
*P. ponthiervillensis* mut. *spoliata* (Dupuis and Putzeys).
*P. superba* mut. *inculta* Pilsbry and Bequaert.
7–9 smooth, clean cut spiral cords, or if fewer there are plain zones below suture and periphery..................................................8.
4–5 strong spiral cords or carinæ on last whorl..........................10.
8. Upper spiral forming a horizontal shoulder below the suture; in all 7–8 spirals on the last whorl; large shells of stout figure.
*P. medjeorum* Pilsbry and Bequaert.
Whorls regularly convex, the upper spiral not prominent; contour graceful..9.
9. Having spirals throughout, or with plain zones below suture and periphery.
*P. liricincta* (E. A. Smith).
Similar, but without spiral cords around the columella.
*P. pokoensis* Pilsbry and Bequaert.
10. Spiral cords squamose-tubercular....*P. ponthiervillensis* (Dupuis and Putzeys).
Spirals smooth, or only the basal tubercular............................11.
11. Two very strong and two or three weaker keels on last whorl; 35×15 mm.
*P. tornata* (E. v. Martens).
Four very strong keels on the last whorl, the lowest often waved, usually a weak fifth cord around the columella; size larger.
*P. superba* Pilsbry and Bequaert.

### **Potadoma graptoconus**, new species

Plate XX, Figures 10 and 11

Ganda Sundi (type locality) and Lukula (H. Schouteden Coll.) We have also seen specimens from the basin of the Niari, in the French Congo (Le Chatelier Coll.).

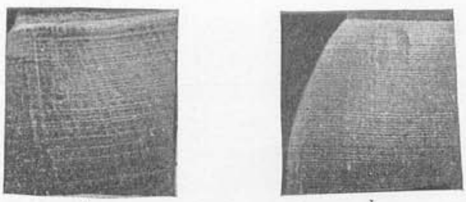
The shell is solid, resembling *P. freethii* (Gray) in shape. It is cinnamon-brown, lighter on the spire, or between that hue and honey-yellow, not glossy, with microscopic sculpture of fine, close, minutely rippled spiral striæ, and around the columella a group of about 4 small cords. The whorls are nearly flat, the penult becoming slightly convex, the last convex at and below the periphery. The aperture is ovate, a little expanded and effuse at the junction of columellar and basal margins. Columella concave, not heavily calloused. There is a thin, whitish or transparent callus on the penult whorl, slightly thickened near the posterior angle.

Length, 33.0 mm.; diameter, 15.0 mm.; length of aperture, 13.7 mm.; 5 whorls remaining.

Length, 33.7 mm.; diameter, 15.3 mm.; length of aperture, 15.0 mm.; about 4½ whorls remaining.

This species differs from *P. freethii* (Gray), generally known as *Melania nigritina* Morelet, from the Gaboon, by the microscopic sculpture. That species is beautifully granulose, while in this the spiral striæ, though waved a little, are not cut into granules (Fig. 46*a*). *P. guineensis* (Reeve) is stated by E. A. Smith to be "minutely granosely striated, but much more finely than in the type of *M. freethii*"; thus also differing from *P. graptoconus*.

In one of the specimens from the Niari there are two dusky bands, a wider but indistinct one at the periphery and a narrower, more distinct band between that and the suture.



*a* *b*

Fig. 46. *a*, *Potadoma graptoconus* Pilsbry and Bequaert, and *b*, *Potadoma schoutedeni* Pilsbry and Bequaert. Sculpture from suture to periphery of last whorl. × 3.

### **Potadoma schoutedeni**, new species

Plate XX, Figures 12 and 13

Lukula (H. Schouteden Coll.).

The shell is solid, with short, conic (truncate) spire, rounded periphery and tapering base; cinnamon-brown; not glossy; with very minute, close and distinct sculpture of spiral striæ, of which there are 9 or 10 in one millimeter on the face of the last whorl (Fig. 46*b*). Near the columella there is a group of spiral cords, about 6 in the type specimen. The whorls are but slightly convex up to the last, which is quite convex in the peripheral region, and becomes a little inflated approaching the lip. The aperture is broadly ovate. Outer lip is rather thick, sinuous, being retracted in the upper part, advancing below. The concave columellar margin is moderately calloused, and there is a rather strong parietal callus across the penult whorl, thickened into a callous pad near the posterior angle of the mouth.

Length, 24.0 mm.; diameter, 14.7 mm.; length of aperture, 12.8 mm.; about 2½ whorls remaining; type.

Length, 17.2 mm.; diameter, 10.3 mm.; length of aperture, 10.0 mm.; less than 2 whorls remaining.

Length, 24.7 mm.; diameter, 13.3 mm.; length of aperture, 15.0 mm.; about 2½ whorls remaining.

This form is related to *P. graptoconus* by its minute sculpture, but differs by the short contour, the more sinuous outer lip and the strong callus covering the inner lip and thickened to form a pad above.

A series of nine immature melanians from Kai Bumba near Ganda Sundi, collected by H. Schouteden, represent young stages of *P. schoutedeni*. The specimens measure from 5 to 15.8 mm. long. They have the minute sculpture as in adult *P. schoutedeni* and at and below the periphery there are rather strong spiral cords, four on the largest examples, two in the smallest. The larger ones have also a group of three cords around the columella, the smaller ones none there.

### **Potadoma alutacea,** new species

Plate XXVI, Figures 3 and 3*a*

Tshopo River near Stanleyville (H. Lang Coll.), March, 1915, in company with *P. superba* and other species.

The shell is solid, conic, sharply angular at periphery, the whorls almost flat. Surface smooth to the eye, but under a lens minutely, densely granulose, the granules not arranged in either spiral or vertical series; also showing indistinct and superficial traces of spiral lines. The color is carob-brown. Aperture ovate, somewhat produced, being shortly spout-like at base of the columellar margin. The outer lip is very slightly sinuous. Columella but little thickened. Parietal callus moderately thick.

Length, 26.0 mm.; diameter, 11.5 mm.; length of aperture, 12.0 mm.; 4½ whorls remaining.

Length, 19.5 mm.; diameter, 12.0 mm.; length of aperture, 11.0 mm.; 1½ whorls remaining.

This species was taken with *P. superba, P. superba* mut. *inculta* and *P. mungwana*. It differs from the latter by the more conic form and especially the minute sculpture. *P. alutacea* has a surface like pebbled leather, while in *P. mungwana* there are irregular axial striæ cut by incised spirals, producing a decussate appearance on parts of the shell where it is well developed. The peripheral angle of *P. alutacea* is somewhat more pronounced than in *mungwana.*

### **Potadoma ignobilis** (J. Thiele)

Plate XXVI, Figures 1 and 2–2*a*

*Melania ignobilis* J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 211, Pl. v, fig. 53.

Type locality: Ituri River near Mawambi (Schubotz Coll.).

Avakubi in the Ituri River (Lang and Chapin Coll.) and in one of its affluents at the same locality (J. Bequaert Coll.). Stanleyville; Batama (Lang and Chapin Coll.).

Specimens from Avakubi, farther down the Ituri River than the type locality, agree perfectly with Thiele's description and figure. When cleaned of their incrustation they are from bister to saccardo's umber in color, sometimes lighter, ecru-olive in young specimens, glossy, with practically no minute sculpture except faint growth-lines. This separates it from *P. mungwana*, which is otherwise very similar. The spire of almost flat whorls tapers rather rapidly. The last whorl shows a very faintly traced, scarcely noticeable, peripheral angulation in adult shells, but distinct in young stages. The parietal callus is moderately strong, thickened posteriorly.

Length, 22.0 mm.; diameter, 11.0 mm.; length of aperture, 10.4 mm.; 3½ whorls remaining.

Length, 22.0 mm.; diameter, 10.5 mm.; length of aperture, 10.7 mm.; 2½ whorls remaining.

Specimens from Stanleyville, where it was taken in abundance, are slightly more lengthened than those of the Ituri, generally showing a distinct angle on the penult whorl above the suture, and the spire tapers less rapidly. They have a black coat. The exact location was not noted, but they did not occur with any other large species.

Length, 23.0 mm.; diameter, 10.3 mm.; about 3 whorls remaining.
" 21.5 mm.; " 9.8 mm.; " 3 " "

Dupuis and Putzeys [1923, Ann. Soc. Zool. Belgique, LIII, (1922), pp. 77–78] have referred specimens from Stanleyville to *P. liricincta*, of which they claim *P. ignobilis* to be only a variety. Undoubtedly they examined the same species as here called *ignobilis*.

**Potadoma pokoensis,** new species

Plate XXVI, Figures 12 and 12*a*

Poko, from an affluent of the Bomokandi River (H. Lang Coll.); about 80 specimens.

The shell is rather slender, somewhat thin, chestnut brown when the black coat is removed, rather glossy. Sculpture of about three spiral cords in the peripheral region of the last whorl and above the suture of the penult whorl, or part of it, not ascending further. On the spire a few rather indistinct spiral impressed lines are seen under the lens, with some indistinct and interrupted axial rugosity. The whorls are weakly convex, and in specimens seen only a few earliest ones are removed. The suture has a dark border on the upper whorls. The aperture is ovate; outer lip thin, very slightly sinuous; columella and basal lip calloused within. Parietal wall covered with a thin, dark colored callus.

Length, 24.3 mm.; diameter, 9.3 mm.; length of aperture, 8.7 mm.; 7½ whorls remaining. Type.

This form is closely related to *M. liricincta* and may possibly prove to be a subspecies of that polymorphic species. It differs by the small size and slender form, by the absence of cords in the columellar region and by retaining most of the whorls. Its minute sculpture also differs. From a study of long series of both forms we believe them specifically distinct. Unlike *liricincta*, the sculpture seems quite constant in *pokoensis*; but as yet it is known from a single station.

### **Potadoma liricincta** (E. A. Smith)

Plate XXVI, Figures 4–4*b*, 6, and 8–8*c*

*Melania* (*Melanoides*) *liricincta* E. A. Smith, 1888, Proc. Zool. Soc. London, p. 53, fig. 1. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 195.

"Lake Albert" (type locality; Emin Pasha Coll.).

Medje, 44 specimens (Lang and Chapin Coll.). Panga, in the Nepongi River, an affluent of the Ituri (J. Bequaert Coll.).

This species is spread, in a great variety of mutations and local forms, in the upper Ituri and its tributaries, southward in some tributaries of the Lualaba, and eastward in tributaries of the Semliki. The type was supposed to be from Lake Albert, collected by Emin Pasha; but Stuhlmann and others have not found this species in the lake. Probably the type was picked up in some stream westward or southwest of the lake, in the area where we know that this river melanian occurs.

The type was described as having two or three cords around the lower part, and other specimens are said to have "four round the middle part of the body-whorl and four at the base, the two sets being separated by a smooth blank space." The dimensions are given as length, 26.0 mm.; diameter, 9.5 mm.; length of aperture, 9.5 mm.; 5 whorls remaining. The original figure is reproduced, Pl. XXVI, fig. 6.

The form from Medje (Pl. XXVI, figs. 4–4*b*) is practically typical in sculpture, but larger than Smith's type. There is a group of about four spiral cords at and above the periphery, followed by a plain space, then two or three small cords around the columella. Two or three of the spirals ascend on the lower half of the penult and antepenult whorls in some examples, not so far in most, leaving the earlier whorls plain except for a carina barely visible above the suture, and faint growth-lines.

The color is between honey-yellow and isabella, becoming lighter ecru-olive or old gold on the spire, and more brownish toward the base.

| | | |
|---|---|---|
| Length, 34.5 mm.; | diameter, 13.5 mm.; | 5½ whorls remaining. |
| " 31.0 | " 13.3 | nearly 4 whorls remaining. |

Many specimens from the Nepongi River, at Panga (Pl. XXVI, figs. 8–8*c*) are smaller than those of Medje, varying in spiral ribs from six to one on the last whorl as shown in the figures. The color is chestnut at the base, fading to ecru-olive on the early whorls.

| | | |
|---|---|---|
| Length, 32.7 mm.; | diameter, 12.0 mm.; | 6 whorls remaining. |
| " 31.0 | " 12.3 | 5 " " |

## **Potadoma liricincta major** (J. Thiele)

Plate XXVI, Figures 5 and 5*a*

*Melania liricincta* var. *major* J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 211, Pl. v, fig. 52.

Between Beni and Boga (type locality; Schubotz Coll.).

Among the forty-four specimens from Medje referred to *liricincta*, fifteen belong to a smooth form. In a few of these some extremely faint traces of spirals are discernable in the peripheral region. Under a strong lens a minute, wavy spiral lineolation is visible in places, chiefly on the upper whorls. In this it differs from lirate *liricincta*, which only occasionally shows very imperfect traces of such lines. These specimens appear to be referable to Thiele's var. *major*, which came from the western border of the Semliki watershed.

## **Potadoma liricincta walikalensis,** new subspecies

Plate XXVI, Figure 9

In a forest brook flowing to the Lubutu River, at Managembi, 30 miles east of Lubutu (J. Bequaert Coll.).

Stout specimens from this locality have strongly raised spirals, usually nine on the last whorl. A plain zone below the periphery is seen in one of the eleven examples. This place is in the Lowa drainage, and must be close to the type locality of var. *latior* Thiele, which has the spiral cords less developed. If varieties are definable in a mutation series so variable, these specimens may be considered fully sculptured *latior*. In old specimens the color is a little browner throughout than in Medje *liricincta*, when the black coat is removed.

| | | |
|---|---|---|
| Length, 31.0 mm.; | diameter, 15.3 mm.; | 3 whorls remaining. |
| " 27.4 | " 14.7 | 3 " " |
| " 28.4 | " 13.3 | about 4½ whorls remaining. |

### **Potadoma liricincta latior** (J. Thiele)

Plate XXVI, Figure 7

*Melania liricincta* var. *latior* J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 211, Pl. v, fig. 51.

Ninety kilometers west of the southern shore of Lake Edward (type locality; Grauer Coll.).

We have not definitely recognized this form among the several lots of *P. liricincta* examined. The nearest approach to it is our *P. l. walikalensis*. A copy of Thiele's figure is reproduced for the sake of comparison.

### **Potadoma liricincta semperlirata,** new subspecies

Plate XXVI, Figures 10 and 10*a*

Faradje (Lang and Chapin Coll.).

The shell is rather slender with very strong spiral cords, 7 to 9 on the last whorl, 3 on several preceding whorls, the lowest one close above the suture, the median cord ascending farther than the others (to the sixth whorl upward in specimens retaining so many). The spirals become somewhat smaller and closer on the base of the last whorl, but in the long series seen there is never a plain zone below the periphery, such as is seen in *liricincta*. The color is chestnut-brown on the last two whorls, fading to honey-yellow or a somewhat more olivaceous tint above. All were black-coated when collected. As in all the forms here referred to *P. liricincta*, there is a callous pad on the inner lip near the posterior angle of the aperture.

Length, 30.0 mm.; diameter, 11.3 mm.; length of aperture, 10.7 mm.; 6½ whorls remaining.

Length, 28.0 mm.; diameter, 11.5 mm.; length of aperture, 10.7 mm.; 4½ whorls remaining.

A series of over one hundred specimens shows the race of the upper Uele River to be quite constant, at least in the single station. The sculpture is decidedly stronger than in the typical form of that species. From one to three of the spiral cords ascend to the earliest whorls preserved.

### **Potadoma liricincta dryas,** new subspecies

Plate XXVI, Figures 11 and 11*a*

Stanleyville, in a forest brook (Lang and Chapin Coll.).

The shell is rather thin for this genus, deep olive, somewhat shiny. The rather long, tapering spire is composed of rather weakly convex whorls, the penult one sharply angular close above the suture. Sculpture of sharp but delicate spirals in low relief, one at the periphery, three around the columella (and in some specimens, several others on the base, and sometimes one above the periphery). Under the lens some weakly impressed spiral lines appear on the upper surface and spire, by their intersection of axial wrinkles forming irregular spiral rows of oblong granules, quite distinct in some places, weak or wanting elsewhere. The aperture is ovate. Outer lip thin, scarcely sinuous, columella and parietal wall moderately calloused, thickened to form a low tubercle or callous pad near the posterior angle of the aperture.

Length, 26.0 mm.; diameter, 10.0 mm.; length of aperture, 10.3 mm.; 5 whorls remaining.

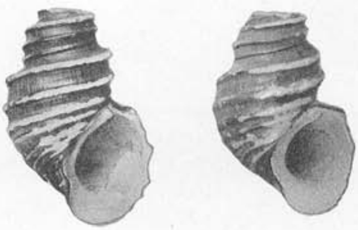
Length, 23.7 mm.; diameter, 9.5 mm.; about 4½ whorls remaining.

A small, very delicately sculptured and deep olive race of the protean *P. liricincta*, similar to that in the minute sculpture.

**Potadoma medjeorum,** new species

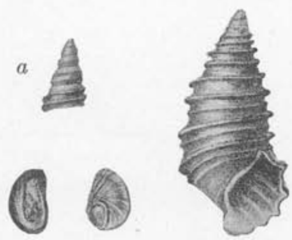
Text Figure 47*a*,-*b*

Medje, on anklets worn by children of the Medje tribe (Fig. 49); not found living. (Lang and Chapin Coll.).



*a* *b*

Fig. 47.



*a* *b* *c* *d*

Fig. 48.

Fig. 47. *Potadoma medjeorum* Pilsbry and Bequaert. *a*, type and *b*, paratype Medje.

Fig. 48. *a-d*, *Potadoma tornata* (v. Martens). Copy of original figures.

The shell is very solid, ovate-turrited, truncate, leaving about 2½ whorls in those seen, white under a glossy chestnut-brown epidermis. Spire rises in stages on account of the concave, partly horizontal shoulder formed by the upper carina, and the rather straight-sided whorls. Sculpture of three strong carinæ at and above the periphery, strong spiral cords below it, in all 7 (or sometimes 8) on the last whorl, three on the penult, the lower one partly concealed in the suture; on the next earlier whorl the lower carina is covered, leaving but two. The last whorl is relatively large. The aperture is broadly oval, the basal margin decidedly expanding. Columellar margin heavily calloused, with a thicker callus above, separated from the outer lip-termination by a shallow furrow.

Length, 29.0 mm.; diameter, 18.5 mm.; length of aperture, 16.0 mm.; 2½ whorls remaining; type.

Length, 29.5 mm.; diameter, 19.5 mm.; length of aperture, 16.5 mm.; 2 whorls remaining.

With some resemblance to *P. tornata* (von Martens), figured for comparison in Fig. 48*a-d*, and to the more heavily lirate forms of *P.*

*liricincta* (Smith), this species differs by the broad form, shouldered whorls and the ample aperture with a very heavy callus of the inner lip near the posterior angle.

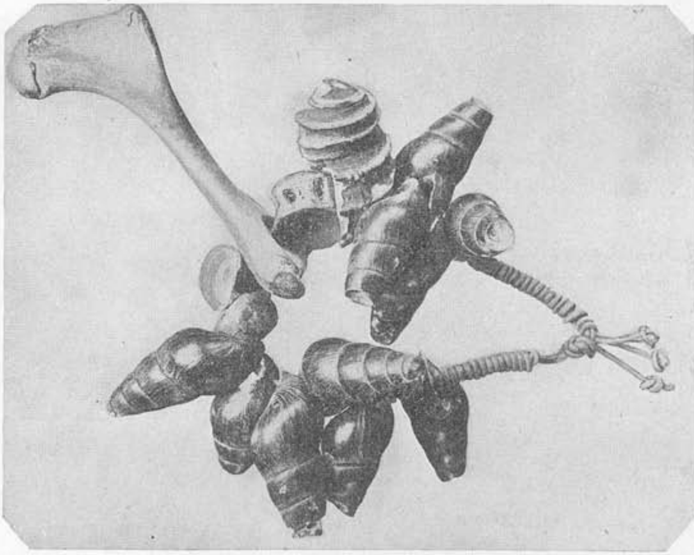


Fig. 49. Anklet worn by children of the Medje tribe, composed of *Potadoma medjeorum*, *P. ignobilis*, teleostean vertebræ and humerus of *Varanus niloticus*. ¾ natural size.

**Potadoma ponthiervillensis** (Dupuis and Putzeys)

Plate XXV, Figures 1–1*f*

*Melania ponthiervillensis* Dupuis and Putzeys, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xv, fig. 23.

Lualaba River at Ponthierville (type locality; Dupuis Coll.).

Stanleyville near the Falls of the Congo River; 105 specimens (H. Lang and J. Bequaert Coll.).

This beautiful melanian has been well described and figured by Dupuis, but further illustrations are now given to show its variation.

The form varies from ovate to elongate, the color from chestnut-brown to sayal-brown. On the well-rounded last whorl there are four strong, knotted spiral cords, the knots or tubercles often with a short scale; below these there is a fifth smaller spiral cord, and sometimes a sixth around the columella. Under the lens is seen a fine sculpture of axial wrinkles cut by impressed spiral lines, forming a rather coarse, unevenly developed texture, much as in *P. mungwana* and *superba.* The aperture is somewhat produced at base, and the inner lip is thickened posteriorly. Specimens apparently adult measure:

Length, 36.5 mm.; diameter, 18.0 mm.; length of aperture, 17.0 mm.; 3½ whorls remaining.

Length, 27.0 mm.; diameter, 15.7 mm.; length of aperture, 14.5 mm.; 2 whorls remaining.

Length, 32.0 mm.; diameter, 15.0 mm.; length of aperture, 15.0 mm.; 3 whorls remaining.

Length, 21.5 mm.; diameter, 15.0 mm.; length of aperture, 13.3 mm.; 2 whorls remaining.

The spiral cords are not present in the earlier part of the neanic stage, occupying from two to three whorls only. The earlier whorls are nearly flat, with the minute sculpture described above (Pl. XXV, fig. 1*f*; 14.5 mm. long).

### **Potadoma ponthiervillensis** mut. **spoliata** (Dupuis and Putzeys)

Plate XXV, Figures 2–2*f*

*Melania ponthiervillensis* var. *spoliata* Dupuis and Putzeys, 1900, Ann. Soc. Malacol. Belgique, XXXV, Bull. Séances, p. xv, fig. 24.

Lualaba River at Wanie-Rokula and Ponthierville (Dupuis Coll.; type locality not designated).

Stanleyville, in a brook near the Falls of the Congo River; also Stanleyville without more definite location; about 320 specimens (H. Lang Coll.)

This strain differs from *ponthiervillensis* by having only weak traces of spiral cords, and by the uniformly elongate shape; there are no short, broad individuals, and none attaining the size of the largest *ponthiervillensis.* In the minute sculpture and the color they are like *ponthiervillensis.* Specimens measure:

Length, 29.0 mm.; diameter, 13.5 mm.; aperture, 14.0 mm.; 2½ whorls remaining.

Length, 28.5 mm.; diameter, 13.0 mm.; aperture, 12.5 mm.; 3¼ whorls remaining.

Length, 26.0 mm.; diameter, 15.0 mm.; aperture, 15.0 mm.; 2⅓ whorls remaining.

Intergrading individuals connecting *spoliata* with *ponthiervillensis* are extremely rare and none seen is fully intermediate. Pl. XXV, figs. 2, 2*a*, 2*b* represent specimens which partially bridge the gap. The upper and peripheral cords are moderately strong, the former characteristically knotted. This form is what Dupuis and Putzeys figured for *spoliata,* but they state that the only constant spiral is that at the periphery. Their statement "Nous possédons toute la série des formes intermédiaires entre cette variété et le type de l'espèce," could not be made of the Stanleyville series, in which the two forms, if interbreeding as we suppose,[1] show remarkably complete segregation and remarkably few blends. This is true even of quite young specimens, which are decidedly more slender in *spoliata*, as will be seen by the measurements:

Fig. 1*f*, *ponthiervillensis*: length, 14.7 mm.; diameter, 9.3 mm.; aperture, 8.8 mm.; 3 whorls.

Fig. 2*d*, *spoliata*: length, 14.7 mm.; diameter, 7.3 mm.; aperture, 7.3 mm.; 4 whorls.

### **Potadoma superba,** new species

Plate XXV, Figures 3–3*e*

Stanleyville in an affluent of the Tshopo River; also in the Tshopo River (H. Lang and J. Bequaert Coll.).

The shell is large, solid, turrited, with the last whorl somewhat swollen, burnt umber. The upper whorls are smoothish, rather weakly convex (in well-preserved and young examples showing a sculpture of impressed spiral lines cutting fine, weak axial ripples, as in *P. mungwana*). On the third whorl from the base two spiral cords arise, rapidly becoming raised into spiral carinæ, of which there are four on the last whorl, with a small or indistinct fifth around the columella. The crest of the fourth carina is somewhat waved or lobed. The aperture is widely ovate, dirty whitish gray with some brown stains within. The outer lip is strongly notched by the external carinæ, and is more or less produced, spout-like at the base, but this feature varies in different individuals. Columella has a rather strong callus, thickened locally near the posterior angle of the mouth.

| | | | | | | |
|---|---|---|---|---|---|---|
| Length, | 46.0 mm.; | diameter, | 20.0 mm.; | about 4½ | whorls remaining. | Type. |
| " | 40.5 | " | 20.0 | 3 | " | " |

This fine species has some resemblance to *P. tornata* (v. Martens) of the Ituri head waters; but that has a less elongate spire and differs in details of sculpture. The most closely related species is *P. ponthiervillensis* (Dupuis and Putzeys), which differs by having shortly scaly nodés on the spiral keels, the upper keel being nearer to the suture. Usually the spire is relatively shorter in *ponthiervillensis*.

There is some variation in the sculpture. In some specimens the second or intermediate keel arises at the end of the penult whorl, those above showing two keels; but in others it may arise a whorl earlier,

[1]In one of the lots *spoliata* was preserved with *ponthiervillensis*. Whether taken together or in different colonies we do not know. The question whether the two forms occupy different ecologic stations should be taken up by an observer on the spot.

The lot from a brook near the Falls contained only *spoliata*, but included a specimen or two having a knotted upper spiral cord.

nearly as early as the two primary keels, so that three show on the whole penult whorl. In still other examples this intermediate keel is wanting throughout.

### **Potadoma superba** mut. **inculta**, new mutation

Plate XXV, Figures 5 and 5*a*

With the typical form in the Tshopo River at Stanleyville (H. Lang and J. Bequaert Coll.).

As in *P. ponthiervillensis*, there is also a nearly smooth form which may be designated mutation *inculta*. None of the specimens attain so large a size as some of the typical form. The early whorls are as described for the type; the last two become more convex, and show very weak traces of several spiral cords, of which that girding the periphery is most developed, and in some examples the only one.

| | | | | | | |
|---|---|---|---|---|---|---|
| Length, | 37.0 mm.; | diameter, | 16 mm.; | 3½ | whorls remaining. | Type. |
| " | 33.5 | " | 13 | 4½ | " | " |
| " | 28.0 | " | 13 | 2½ | " | " |
| " | 24.0 | " | 10 | 3½ | " | " |

This form differs from *P. mungwana* by the strongly convex last whorl, the more conic contour and larger size.

### **Potadoma mungwana,** new species

Plate XXV, Figure 4

Tshopo River near Stanleyville (H. Lang Coll.).

The shell is solid, slowly tapering, approaching a subcylindric contour, the last whorl having a peripheral angle (usually rather indistinct), the whorls but slightly convex. Surface somewhat glossy, smooth to the eye, but under a lens showing fine sculpture of irregular axial wrinkles cut by weakly incised spiral lines, forming where best developed a distinctly decussate pattern; over this there is more or less minute, irregularly developed rugosity or granulation. The color is carob brown or somewhat darker. The aperture is ovate, somewhat produced at the base. Outer lip thin, very slightly sinuous. Columella but little thickened. Parietal callus thin in the middle, thickened to form a low tubercle or callous pad near the upper insertion.

Length, 24.5 mm.; diameter, 9.8 mm.; length of aperture, 10.3 mm.; 3½ whorls remaining. Type.

This species differs from *P. alutacea* and *P. ignobilis* in the minute sculpture. In general appearance these three species are much alike. The minute sculpture of *P. mungwana* is the same as in immature *P. superba* and *P. superba inculta*; these species diverge in their later stages of growth.

## Other Species of *Potadoma* Recorded from the Belgian Congo

### *Potadoma tornata* (E. v. Martens)

Text Figure 48a-*d* (on page 283)

*Melania* (*Melanoides*) *tornata* E. v. MARTENS, 1892, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 181; 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 196, Pl. I, figs. 20 and 21, and Pl..VI, fig. 35.

Duki River (Shari R.) in the district of Buessa, 950 m., in 1° 20′ N., 30° E. (type locality) and Ituri River at the ferry [region of Kilo; in about 1° 35′ N., 29° 55′ E.] (Stuhlmann Coll.).

A photograph of v. Martens' figure is reproduced for comparison with our carinate species.

### RHINOMELANIA E. v. Martens

*Semisinus* subgenus *Rhinomelania* E. v. MARTENS, 1901, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 26. Monotypic for the following species:

*Rhinomelania zenkeri* (E. v. Martens) = *Semisinus* (*Rhinomelania*) *zenkeri* E. v. MARTENS, 1901, *op. cit.*, p. 26, fig. Lukonje River near Bipindi, Cameroon.

## SUBFAMILY UNCERTAIN

### CLEOPATRA Troschel

*Paludina* subgenus *Cleopatra* TROSCHEL, 1857 (?), 'Das Gebiss der Schnecken,' p. 100. Monotype: *Cyclostoma bulimoides* Olivier.

*Zanguebaria* FISCHER, 1881, 'Manuel de Conchyl.,' p. 224. Type by present designation: *Melania amæna* Morelet.

The shell is perforate or imperforate, ovate-conic or turrited, of few (4 to 6) whorls, either smooth, spirally lirate, keeled, or nodulose. Aperture ovate, the peristome in a plane, not sinuous. Operculum concave externally, corneous, mainly concentric, but having a small spiral nucleus of about 1½ whorls, situated near the columellar side, about midway of the length.

The radula is minute. Central tooth with numerous denticles and a plain body. Marginal teeth with very broad shafts, all the side teeth having a moderate number of denticles (about 7 to 9) (Fig. 50*a-c*, *C. bulimoides*).

E. A. Smith (1911, Proc. Malacol. Soc. London, IX, 4, p. 240) has described and figured the animals of *C. ferruginea* (Lea) and *C. exarata* (v. Martens) from live specimens which he received from the Shimbi Hills, Kenya Colony. The animals of both species are very much alike: "The proboscis in *C. ferruginea* is rather large, flattish, extensile and contractile, rather blunt at the end, and cleft longitudinally, streaked across with fine black lines. The tentacles, 7–8 mm. in length, are very slender and acutely pointed, transparent, but speckled with black. No neck-lappets, such as occur in *Vivipara*. The eyes are minute, slightly prominent, and situated on the outer side of the tentacles toward the base. Foot small, broad, widely curved in front, somewhat auriculate anteriorly at the sides, narrower and rounded behind. Above of a semi-transparent smoky appearance, mottled with yellowish specks, uniformly pale beneath. On removing the animal from its shell the mantle is seen to be of a bright-green tint, excepting the margin, which is yellowish. The liver also is of a similar verdigris-green colour." In *C. exarata* the foot is a little more pointed behind.

*Cleopatra* has an operculum similar to that of many Tanganyikan melanians. In character of the radula it is rather between the groups with short and those with long side teeth. It appears to be an unspecialized group related to the Tanganyikans.

*Cleopatra* has often been associated with the Viviparidæ, but the external form and coloration of the animal and the characters of the radula are purely melanid.

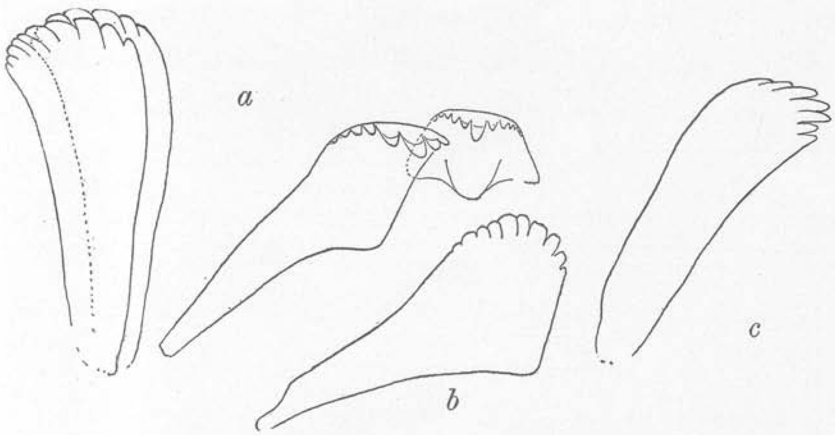
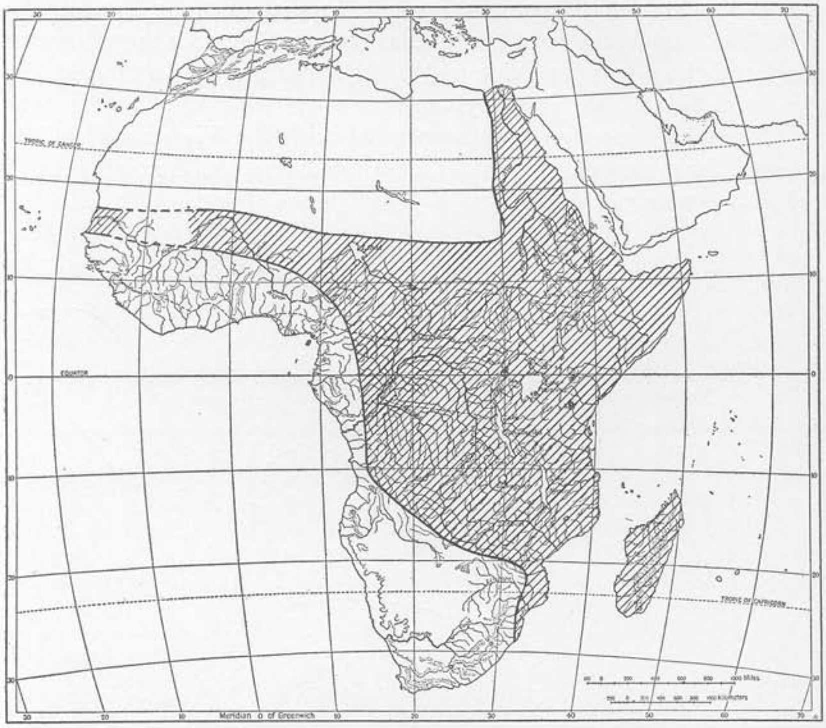



Fig. 50. *a-c*, Teeth of *Cleopatra bulimoides* (Olivier): *b*, detached lateral tooth; *c*, detached marginal.

This genus is peculiar to the Ethiopian and Malagasy Regions. It is especially abundant in species in the basins of the Nile, Lake Chad, and Congo, and in East Africa (Map 4). In West Africa only one species is recorded from Senegal (*C. senegalensis*) and, as it has not been figured and was not mentioned again since Morelet's time, it is a somewhat doubtful form. Apart from this, the westernmost record of any member of the genus is the region of Timbuktu, whence Germain reported *C. bulimoides* var. *tchadiensis* (1909, Bull. Mus. Hist. Nat. Paris, p. 470). The genus does not appear to go farther south than Angola[1] in the west,

[1]Kobelt (1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 80) lists a *Cleopatra moniliata* Morelet, of Angola. We have been unable to find where this species was described.

while on the east coast the southernmost record is from the Manuan Creek in Zululand. Several species have been described from Madagascar: *C. carinulata* Dautzenberg, *C. colbeaui* (Craven), *C. grandidieri* (Crosse and Fischer) and var. *submutica* (Crosse and Fischer), *C. madagascariensis* (Crosse and Fischer),[1] *C. mangaroensis* Ancey, *C. multilirata* Ancey, and *C. trabonjiensis* E. A. Smith.



Map 4. Distribution of the genus *Cleopatra*.

The following is a list of the species known from the African continent:

*Cleopatra africana* (E. v. Martens) = *Paludomus africanus* E. v. MARTENS, 1878, Monatsber. Ak. Wiss. Berlin, p. 297, Pl. II, figs. 11–13. Finboni, on the coast of Kenya Colony.[2]

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[1]This was described as a *Paludina* (1872, Journ. de Conchyl., XX, p. 210). In 1880 (in Martini and Chemnitz, 'Syst. Conch. Cab., I, 25, *Paludomus*,' p. 48, Pl. VIII, fig. 7), Brot described as new a *Paludomus madagascariensis*, which is evidently also a *Cleopatra*. There is a possibility that it is the same species as Crosse and Fischer's *Paludina madagascariensis*, so that it will not need be renamed.

[2]*C. ferruginea* (Lea), *C. zanguebarensis* (Petit), *C. amæna* (Morelet), *C. africana* (v. Martens), *C. kynganica* Bourguignat, and *C. cameroni* Bourguignat are closely allied species of the East Coast of Africa. Connolly (1912, Ann. South African Mus., XI, 3, p. 261) treats all these names as synonyms of *C. ferruginea*. Having no material for comparison, we prefer to list them separately.

*Cleopatra ajanensis* (Morelet) = *Paludomus ajanensis* MORELET, 1860, 'Séries Conchyl.,' II, p. 110, Pl. VI, fig. 10. Ras Hafoun, 30 miles south of Cape Guardafui, Somaliland. This species has also been recorded from Madagascar.

*Cleopatra amæna* (Morelet) = *Melania amæna* MORELET, 1851, Journ. de Conchyl., II, p. 192, Pl. V, fig. 9. This species was originally described from Madagascar; but Morelet stated later that it came from Zanzibar and the Seychelles (1860, Series Conchyl., II, p. 117).

*Cleopatra aurocincta* E. v. MARTENS, 1879, Sitz. Ber. Ges. Naturf. Fr. Berlin p. 103. Bagamoyo, Tanganyika Territory.

*Cleopatra bequaerti* Dautzenberg and Germain. See p. 296.

*Cleopatra broecki* Putzeys. See p. 296.

*Cleopatra broecki* var. *zonata* Putzeys. See p. 296.

*Cleopatra bulimoides* (Olivier) = *Cyclostoma bulimoides* OLIVIER, 1804, 'Voyage dans l'Empire Othoman,' II, p. 39, footnote; (an XII), Atlas, Pl. XXXI, fig. 6. *Melania ægyptiaca* REEVE, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. XXXIV, fig. 227. *Paludina nigra* "Caillaud" KOBELT, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., N.F., II, 21, *Paludina*,' p. 384. *Cyclostoma gaillardoti* BOURGUIGNAT, 1855, 'Aménités Malacologiques,' I, p. 104, Pl. VII, figs. 5-7. *Cleopatra mareotica* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 25. *Cleopatra lhotellerii* BOURGUIGNAT, 1879, *op. cit.*, p. 25. *Cleopatra laurenti* BOURGUIGNAT, 1879, *op. cit.*, p. 24. *Cleopatra raymondi* BOURGUIGNAT, 1879, *op. cit.*, p. 23. *Paludina trifasciata* "Parreyss" E. v. MARTENS, 1865, Malakoz. Blätter, XII, p. 203. *Paludina vexillata* E. v. MARTENS, 1865, *op. cit.*, p. 203. *Cleopatra bulimoides* var. *media* PALLARY, 1924, Mém. Inst. d'Egypte, VII, 1, p. 33 (states also that *Cleopatra pulchella* Bourguignat, apparently a *nomen nudum*, was based upon a young specimen of *C bulimoides*). Type locality: Kalidje canal, near Alexandria, Egypt. Common in Egypt and extending eastward into Syria.

*Cleopatra bulimoides* var. *bilirata* GERMAIN, 1918, Bull. Mus. Hist. Nat. Paris, p. 444. Roseires, on the Blue Nile, Anglo-Egyptian Sudan. *C. bulimoides* var. *bicarinata* PALLARY, 1924, Mém. Inst. d'Egypte, VII, 1, p. 33, appears to be the same.

*Cleopatra bulimoides* var. *richardi* GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 200, Pl. II, figs. 5 and 6. Lake Chad.

*Cleopatra bulimoides* var. *unilirata* GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 199, Pl. II, figs. 22–24. Lake Chad.

*Cleopatra bulimoides* var. *welwitschi* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 185. Dungo, Pungo Andongo district, Angola.

*Cleopatra cara* Pilsbry and Bequaert. See p. 294.

*Cleopatra cameroni* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 21. Kingani River near Bagamoyo, Tanganyika Territory.

*Cleopatra congener* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 59, Pl. IV, fig. 6. Lake Baringo, Kenya Colony. According to Germain (1919, Bull. Mus. Hist. Nat. Paris, p. 264), this is a synonym of *C. bulimoides* (Olivier).

*Cleopatra cyclostomoides* (Küster) = *Paludina cyclostomoides* KÜSTER, 1852, in Martini and Chemnitz, 'Syst. Conch. Cab., I, 21, *Paludina*,' p. 32, Pl. VII, figs. 6–10. Egypt.

*Cleopatra cyclostomoides* var. *tchadiensis* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 519. Lake Chad.

*Cleopatra dautzenbergi* Pilsbry and Bequaert. See p. 294.

*Cleopatra exarata* (E. v. Martens) = *Paludomus exarata* E. v. MARTENS, 1878 Monatsber. Ak. Wiss. Berlin, p. 297, Pl. II, figs. 14-16 (as *cingulata* on Plate). Finboni, on the coast of Kenya Colony.

*Cleopatra ferruginea* (I. and H. C. Lea) = *Melania ferruginea* I. AND H. C. LEA, 1850, Proc. Zool. Soc. London, p. 182. Zanzibar.

*Cleopatra guillemei* Bourguignat. See p. 297.

*Cleopatra hargeri* E. A. SMITH, 1908, Proc. Malacol. Soc. London, VIII, 1, p. 13, fig. Kalungwesi River, Northeast Rhodesia.

*Cleopatra hirta* Dautzenberg and Germain. See p. 297.

*Cleopatra johnstoni* E. A. Smith. See p. 297.

*Cleopatra johnstoni* var. *minor* Dautzenberg and Germain. See p. 297.

*Cleopatra jouberti* Bourguignat. See p. 297.

*Cleopatra kynganica* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 21. Kingani River near Bagamoyo, Tanganyika Territory.

*Cleopatra langi* Pilsbry and Bequaert. See p. 293.

*Cleopatra letourneuxi* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 19. Kingani River near Bagamoyo ,Tanganyika Territory.

*Cleopatra morrelli* PRESTON, 1905, Proc. Malacol. Soc. London, VI, 5, p. 300, fig. 3. Just above the Victoria Falls, in the Zambezi River, Rhodesia.

*Cleopatra morrelli* var. *costata* PRESTON, 1905, Proc. Malacol. Soc. London, VI, 5, p. 301, fig. 4 (on p. 300). Just above the Victoria Falls, in the Zambezi River, Rhodesia.

*Cleopatra mterizensis* MELVILL AND STANDEN, 1907, Mem. Manchester Litt. Phil. Soc., LI, No. 4, p. 5, Pl., fig. 2. Mterize River, a tributary of the Loangwa River, Rhodesia.

*Cleopatra mweruensis* E. A. Smith. See p. 297.

*Cleopatra nsendweensis* (Dupuis and Putzeys). See p. 295.

*Cleopatra nsendweensis katangana* Pilsbry and Bequaert. See p. 296.

*Cleopatra pauli* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 27, Pl., fig. 3. Hauash River, Abyssinia.

*Cleopatra percarinata* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 28, Pl., fig. 2. Lake Haussa, Abyssinia.

*Cleopatra pirothi* Jickeli. See. p. 298

*Cleopatra pirothi* var. *elata* Dautzenberg and Germain. See p. 298.

*Cleopatra pirothi* var. *unicarinata* E. v. MARTENS, 1886, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 126. Subfossil with the typical form in Fayum, Egypt.

*Cleopatra pirothi* var. *rufolirata* GERMAIN, 1919, Bull. Mus. Hist. Nat. Paris, p. 119. Lealui on the Upper Zambezi, Northwest Rhodesia.

*Cleopatra poutrini* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 376; *op. cit.*, p. 288, fig. 66. Eguei Region, east of Lake Chad.

*Cleopatra rugosa* CONNOLLY, 1925, Ann. Mag. Nat. Hist., (9) XVI, p. 424. Aggherrer, Italian Somaliland.

*Cleopatra schoutedeni* Dautzenberg and Germain. See p. 298.

*Cleopatra senegalensis* (Morelet) = *Paludina senegalensis* MORELET, 1860, Journ. de Conchyl., VIII, p. 190. Podor, Senegal River. Is this a true *Cleopatra?*

*Cleopatra smithi* ANCEY, 1906, The Nautilus, XX, p. 45. Chozi River, an affluent of the Chambezi River, Northeast Rhodesia.

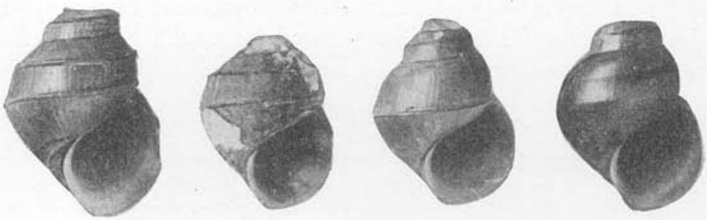
*Cleopatra soleilleti* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 28, Pl., fig. 1. Lake Haussa, Abyssinia.

*Cleopatra trisulcata* Germain. See p. 298.

*Cleopatra trisulcata* var. *foai* Germain. See p. 298.

*Cleopatra verreauxiana* BOURGUIGNAT, 1856, 'Aménités Malacologiques,' I, p. 181, Pl. XX, figs. 25–27. Nile.

*Cleopatra zanguebarensis* (Petit) = *Melania zanguebarensis* PETIT, 1851, Journ. de Conchyl., II, p. 263, Pl. VII, fig. 1. *Cleopatra zanguebarica* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 164. Zanzibar.



*a* *b* *c* *d*

Fig. 51. *a-d*, *Cleopatra langi* Pilsbry and Bequaert. Type (*c*) and paratypes (*a* and *d*). Stanleyville, × 3.

**Cleopatra langi,** new species

Text Figures 51*a-d* and 52

Stanleyville (Lang and Chapin Coll.; March, 1915).

The shell is imperforate, rather broad and short, the aperture more than half the total length; somewhat biconic, being typically carinate at the periphery; between old gold and primuline yellow, the earlier whorls narrowly banded with reddish brown next to the suture, above and below, and in the median keel; these bands not extending upon the last whorl. Nearly three moderately convex whorls remain in the type, less than two in some adult shells. The penult and earlier ones have a keel in the middle, another partly concealed in the suture. The surface is rather glossy, marked with light growth lines. The aperture is large, ovate; outer lip thin; the concave columella rather heavily calloused; parietal callus very thin, transparent. There is a slight basal projection at the junction of the columellar and external margins.

Length, 8.3 mm.; diameter, 6 mm.; length of aperture, 5.5 mm.; nearly three whorls remaining. Type. Fig. 51*c*.

While this species has some resemblance to *C. pirothi* Jickeli, *C. mweruensis* E. A. Smith, and other carinate species, it differs by the short but broad shape and the complete closure of the umbilicus.

A young shell, 4.7 mm. long, has 4½ whorls. The first two are strongly convex; a vertical ripple or two then mark the end of the embryonic stage, after which a median red-brown keel and one immediately above the suture begin, at first weakly, soon stronger. The spire has a staged appearance. The last whorl shows these colored keels and also a group of two or three spiral threads occupying a red-brown tract around the columella. The axis is imperforate (Fig. 52).

In one adult specimen, 9.2 mm. long, the keel midway between periphery and suture (as well as that on the periphery) remain strong to the end of the last whorl, and there are two distinct cords around the columellar region, but no colored tract there (Fig. 51*a*). This example retains early characters lost in what we select as typical *C. langi*.

In two examples the peripheral keel is reduced to a mere angle, which becomes obsolete on the last part of the whorl. The band of the upper surface extends upon the last whorl (Fig. 51*d*).

Fig. 52

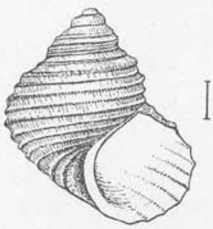


Fig. 53

Fig. 52. *Cleopatra langi* Pilsbry and Bequaert Young, 4.7 mm. long. Stanleyville

Fig. 53. *Cleopatra cara* Pilsbry and Bequaert. Type. Stanleyville.

**Cleopatra cara,** new species

Text Figure 53

Stanleyville (Lang and Chapin Coll.; March, 1915).

The shell is short, broad, narrowly umbilicate, the umbilicus bounded by a keel; rather solid, blackish-brown. The four whorls are strongly convex. Sculpture of strong, somewhat unequal spiral cords narrower than their intervals, one at the shoulder being slightly larger. On the last whorl there are 12 of these cords in the type; in the younger paratypes 10 is the usual number. The intervals have extremely close and fine axial striæ. The aperture is large, nearly circular except for a wide angle above. Outer lip crenulate, thin. Columella concave, with a rather heavy blackish-violet callus. Parietal callus short, rather strong.

Length, 5.0 mm.; diameter, 4.0 mm.; length of aperture, 3 mm.

A well-characterized species by its short, umbilicate shell.

**Cleopatra dautzenbergi,** new species

Text Figure 54

*Paludomus ferrugineus* Lea form *minor* Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 61 (without description, figure, or dimensions).

Lovoi River, near Kikondja (J. Bequaert Coll.).

This appears to be specifically distinct from *C. ferruginea* (Lea) (*?africana* E.v. Martens) by its more globose last whorl and the much shorter spire. The shell is quite solid, isabella color or slightly darker, shiny, faintly striate by lines of growth. The spire is eroded in all seen, but clearly would be short. The aperture is rather widely oval, angular above, vinaceous-brown within. Columellar callus soiled white. The axis is imperforate.

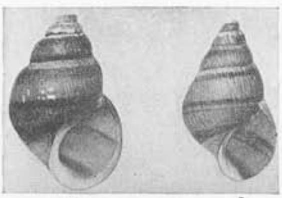
Length, 11.6 mm.; diameter, 8.6 mm.; length of aperture, 8.0 mm.

The operculum is strongly concave externally.

The species has a more globose last whorl and a wider aperture than *C. nsendweensis*, which also is more lengthened.

The true *Cleopatra ferruginea* (Lea) appears to be a species of East Africa and has not yet been detected within the territory of the Bel gian Congo.

Fig. 54



*a* *b*

Fig. 55

Fig. 54. *Cleopatra dautzenbergi* Pilsbry and Bequaert Type. × 3.

Fig. 55. *a, Cleopatra nsendweensis* Putzeys. Panda River. × 2. *b, Cleopatra nsendweensis katangana* Pilsbry and Bequaert. Type. × 2.

### **Cleopatra nsendweensis** (Dupuis and Putzeys)

Text Figure 55*a*

*Cleopatra bulimoides* var. *nsendweensis* Dupuis and Putzeys, 1901, Ann. Soc. Malacol. Belgique, XXXVI, Bull. Séances, p. lv. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 56.

Nsendwe (type locality); Nyangwe; Lokandu (Dupuis Coll.). Kindu; Kalilo (on the Luapula River); Kibombo (J. Bequaert Coll.).

Panda River near Likasi (Mich. Bequaert Coll.): Stanleyville, 1 specimen from the Tshopo River (J. Bequaert Coll.).

The specimens from Kibombo and the Panda River belong to Dautzenberg and Germain's form *major*.

Dupuis' var. *nsendweensis* appears specifically distinct from *C. bulimoides* by the characters already pointed out by Mr. Dupuis. Not only is the umbilicus reduced or closed, but the slope of the whorl around it is different. The early whorls show no trace of the angulation present in early stages of *C. bulimoides* when unworn. The length is 12 to 15 mm.

*Cleopatra hargeri* E. A. Smith, 1908, Proc. Malacol. Soc. London, VIII, 1, p. 13, fig., from the Kalungwesi River, an eastern affluent of Lake Moero, appears from the description and figure to be very closely related to *C. nsendweensis*.

### **Cleopatra nsendweensis katangana,** new subspecies

Text Figure 55*b*

*Cleopatra bulimoides* DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 56 (not of Olivier).

Specimens from the Luvua River, between Kiambi and Ankoro, recorded by Dautzenberg and Germain as *C. bulimoides,* are a form or race of *nsendweensis* which may be defined thus:

The margin of the very narrow umbilicus or perforation is noticeably angular. Narrow bands accompany those near the suture and the periphery, below the principal bands. Color as in *nsendweensis*, buffy olive with chestnut-brown bands.

Length, 11.0 mm. (apex eroded); diameter, 6.5 mm.

The true *C. bulimoides* (Olivier) has not yet been found in the Belgian Congo. Specimens from Dungo in the Pungo Andongo District, Angola, referred by Morelet to *C. bulimoides* (1868, 'Voy. Welwitsch, Moll. Terr. et Fluv.,' p. 96) are before us. They have been rightly named by v. Martens (1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 185) as a distinct variety *welwitschi*. They may even prove specifically distinct for the reasons given by v. Martens, to which we may add that they lack any trace of the spiral keel on the early whorls.

## Other Species of *Cleopatra* Recorded from the Belgian Congo

### *Cleopatra bequaerti* Dautzenberg and Germain

*Cleopatra bequaerti* DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 59, Pl. IV, figs. 1–6.

Lualaba River at Kindu (type locality; J. Bequaert Coll.).

### *Cleopatra broecki* Putzeys

*Cleopatra broecki* PUTZEYS, 1899, Ann. Soc. Malacol. Belgique, XXXIV, Bull. Séances, p. lx, fig. 16. KOBELT, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n.F., II, 21*a*, *Paludina*,' p. 398, Pl. LXXVI, fig. 18.

On valves of *Etheria* in the Aruwimi River (type locality).

### *Cleopatra broecki* var. *zonata* Putzeys

*Cleopatra broecki* var. *zonata* PUTZEYS, 1899, Ann. Soc. Malacol. Belgique, XXXIV, Bull. Séances, p. lx.

Aruwimi River (type locality).

### *Cleopatra guillemei* Bourguignat

*Cleopatra guillemei* Bourguignat, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 6 (type locality: southern shore of Lake Victoria). E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 186. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

*Cleopatra guillemeti* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. iv, fig. 4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 46, Pl. iv, fig. 4. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 99. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 257; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 668. Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n.F., II, 21*a*, *Paludina*,' p. 394, Pl. lxxvi, figs. 13 and 14.

Lake Tanganyika: near the mouth of the Malagarazi River, on the eastern shore.

### *Cleopatra hirta* Dautzenberg and Germain

*Cleopatra hirta* Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 59, Pl. iv, figs. 11–14.

Lualaba River at Nyangwe (type locality; J. Bequaert Coll.).

### *Cleopatra johnstoni* E. A. Smith

*Cleopatra johnstoni* E. A. Smith, 1893, Proc. Zool. Soc. London, p. 637, Pl. lix, fig. 9. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 186. Dautzenberg, 1901, Ann. Soc. Malacol. Belgique, XXXVI, Mémoires, p. 6, Pl. i, figs. 9–12. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 57. Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n. F., II, 21*a*, *Paludina*,' p. 398, Pl. lxxvi, fig. 19.

Originally described from Lake Moero without more definite locality (R. Crawshay Coll.).

Lake Moero: Pweto (Lemaire Coll.); Kilwa; Lukonzolwa (J. Bequaert Coll.). Also at Kalilo, 10° S., in the Luapala River near its mouth in Lake Moero (J. Bequaert Coll.), and at Kasenga in the same river (Stappers Coll.).

### *Cleopatra johnstoni* var. *minor* Dautzenberg and Germain

*Cleopatra johnstoni* var. *minor* Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 57.

Luvua River, between Ankoro and Kiambi (type locality; J. Bequaert Coll.).

### *Cleopatra jouberti* Bourguignat

*Cleopatra jouberti* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. iv, fig. 3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 48, Pl. iv, fig. 3. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250. Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n.F., II, 21*a*, *Paludina*,' p. 397, Pl. lxxvi, fig. 16.

Eastern shore of Lake Tanganyika near the mouth of the Malagarazi River (type locality).

### *Cleopatra mweruensis* E. A. Smith

*Cleopatra mweruensis* E. A. Smith, 1893, Proc. Zool. Soc. London, p. 637, Pl. lix, fig. 10. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 189. Germain, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 520.

Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 57. Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n.F., II, 21*a*, *Paludina*,' p. 399, Pl. lxxvi, fig. 20.

Originally described from Lake Moero (R. Crawshay Coll.) without more definite locality.

Lake Moero: Kilwa (J. Bequaert Coll.).

Germain (1908) records this species from the Chari River.

### *Cleopatra pirothi* Jickeli

*Cleopatra pirothi* Jickeli, 1881, Jahrb. Deutsch. Malakoz. Ges., VIII, p. 338 (type locality: Abyssinia, exact locality not indicated). E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 185. Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n.F., II, 21*a*, *Paludina*,' p. 407.

*Cleopatra emini* E. A . Smith, 1888, Proc. Zool. Soc. London, p. 54, fig. 2 (type locality: Lake Albert). J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 210. Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., N.F., II, 21*a*, *Paludina*,' p. 391, Pl. lxxvi, fig. 8.

Lake Albert: Kassenje on the southwestern shore (Stuhlmann Coll.).

### *Cleopatra pirothi* var. *elata* Dautzenberg and Germain

*Cleopatra pirothi* var. *elata* Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 57.

Lualaba River at Bulongo, 9° S. (near Bukama; type locality; J. Bequaert Coll.).

### *Cleopatra schoutedeni* Dautzenberg and Germain

*Cleopatra schoutedeni* Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV 1, p. 58, Pl. iv, figs. 15 and 16.

Lualaba River at Kindu (type locality), Nyangwe, and Kibombo; Luvua River between Ankoro and Kiambi; Lualaba River between Ankoro and Kikondja (J. Bequaert Coll.).

### *Cleopatra trisulcata* Germain

*Cleopatra trisulcata* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 257; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 665, figs. 19 and 20 (on page 666). Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., n.F., II, 21*a*, *Paludina*,' p. 407.

Southern end of Lake Tanganyika (type locality; Foà Coll.).

### *Cleopatra trisulcata* var. *foai* Germain

*Cleopatra trisulcata* var. *foai* Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 257; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 667, figs. 21 and 22. Kobelt, 1909, in Martini and Chemnitz, 'Syst. Conch. Cab., N.F., II, 21*a*, *Paludina*,' p. 407.

Southern end of Lake Tanganyika (type locality; Foà Coll.).

## Thalassoid Melaniidæ of Lake Tanganyika

The thalassoid or so-called "halolimnic"[1] mollusks of Tanganyika have been distributed by some authors in several families of marine

[1]As Pelseneer has pointed out, the term *thalassoid* merely refers to the resemblance of these forms to sea shells. *Halolimnic*, or sea-lake mollusks, denotes marine forms which have been transformed into lake dwellers, the hypothesis of J. E. S. Moore and others.

gastropods, or referred to Mesozoic genera of marine or fresh-water shells. E. A. Smith has referred part of the genera to the Melaniidæ (=Thiaridæ), leaving many others without family affiliations. Pelseneer[1] has placed *Spekia*, *Tanganyicia*, *Limnotrochus*, and *Chytra* in the family Hydrobiidæ (=Amnicolidæ), *Nassopsis* (=*Lavigeria*) and *Bythoceras* in the Melaniidæ, and *Tiphobia* and *Bathanalia* in the Tiphobiidæ. In a note written later[2] he concluded "that all the 'halolimnic' forms belong to the family Melaniidæ or to very closely related types." We agree with this conclusion. With the exception of the Syrnolopsidæ, the entire series, so far as their structure is known, appears to be melanid. Certainly none of them are hydrobiid and the characters assigned for the Tiphobiidæ do not distinguish that group from Melaniidæ. Thiele's view of *Lavigeria* was alluded to on p. 249.

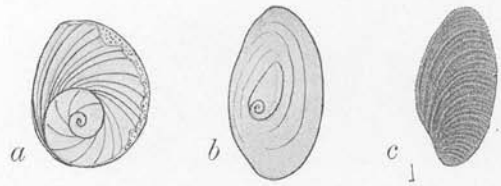


Fig. 56. Opercula of: *a*, *Limnotrochus thomsoni* E. A. Smith; *b*, *Paramelania damoni* (E. A Smith); *c*, *Lavigeria grandis* (E. A. Smith) (copy of Smith's figure).

The opercula of these shells are of three types, as follows:

1.—Paucispiral (Fig. 56*a*), with nucleus below the center or at about the lower third: *Bathanalia*, *Limnotrochus*, *Chytra*, and *Giraudia*. This is the well-known littorinoid or "palæomelanian" operculum, a primitive type found in many diverse thiarids.

2.—Subspiral (Fig. 56*c*). These genera have the extreme form of the "neomelanian" type, with marginal nucleus: *Lavigeria* and *Edgaria*. This type of operculum is found also in many branches of the family of melanians, doubtless evolved from the paucispiral type.

3.—Concentric around a Paucispiral Center (Fig. 56*b*): *Tanganyicia*, *Reymondia*, *Tiphobia*, *Paramelania*, *Bythoceras*, and *Spekia*. This relatively evolved form of operculum occurs also in *Cleopatra* and *Paludomus* among the melanians. Also in *Bulimus* (=*Bithynia*), *Lioplax*, and elsewhere. It has evidently arisen independently many times from the paucispiral type.

The radulæ are of two types:

[1] 1906 'A Treatise on Zoology, V, Mollusca,' p. 154.
[2] 1907, Rept. Brit. Asso. Adv. Sci., (1906), p.602.

1. Side teeth not more than usually elongate, the marginals being rather short: *Lavigeria*, *Spekia*, and perhaps *Giraudia* and *Reymondia*.

2. Side teeth much lengthened, the two marginals nearly alike; the radula very small and weak (2 mm. long, 0.4 mm. wide in the large *Paramelania damoni*, Fig. 57). This group comprises all of the other genera, so far as known.

Radulæ similar to these two types are found in various other Melaniidæ. The second type is somewhat individualized by the shape of the lateral tooth, but still is not greatly unlike *Melanoides*.

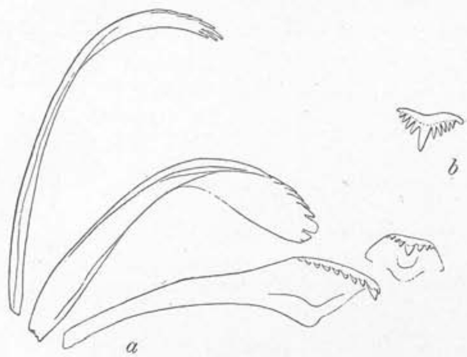



Fig. 57 *a-b*, Teeth of *Paramelania damoni* (E. A. Smith). At *b* a central tilted back to show full length of the cusps.

*Tiphobia*, *Bathanalia*, and *Lavigeria* are viviparous, having the last part of the oviduct enlarged to form a brood pouch in the mantle, as in *Melanoides* and *Viviparus*. *Tanganyicia* has a genital groove on the side of the foot leading across to a brood pouch on the left side of the head, and is also viviparous. This seems to be a structure special to this very divergent genus. It is entirely analogous to the brood pouch of the Oriental region genus *Antimelania* Fischer and Crosse,[1] but, from its different position, apparently evolved independently. So far as is known, *Limnotrochus*, *Paramelania* and *Spekia* are oviparous.

The series gives the impression that a few rather generalized types of Melaniidæ have been long isolated under highly favorable conditions, without much competition with gastropods of other families, and with ample time for adaptation into forms of shore and deep water and rock or mud bottoms. The shells of many genera show mature stages of

[1]Type by present designation: *Melania variabilis* Benson.

sculpture evolution; few, such as *Limnotrochus*, have characteristics of old age.

These conclusions are substantially those reached by Boulenger respecting the fishes, and by Calman in dealing with the macrurous Crustacea; also by Cunnington in his excellent résumé of the Tanganyikan fauna and flora.[1] They give no support to the hypothesis that the Tanganyikan fauna is directly traceable to the marine inhabitants of an arm of the Jurassic sea.

## Key to the Genera of Tanganyikan Melaniidæ

Many Tanganyikan shells have been collected without the operculum or soft parts. We have therefore framed the following key from the shells alone, as more widely useful than one employing characters more fundamental.

1. Shell smooth or nearly so . . . . . . . . . . 2.
   Shell very distinctly or strongly sculptured . . . . . . . . . . 5.
2. Shell semiglobose or oval, dark colored, with a very short spire. Aperture large and very oblique; a broad, concave columellar area bounded by a sharp ridge on the base giving it a circular appearance . . . . . . *Spekia* Bourguignat.
   Without the above-mentioned characters . . . . . . . . . . 3.
3. Spire very short; surface marked with fine, dark spiral lines . . . . . . . . . . 4.
   Spire produced, conic . . . . . . . . . . *Baizea* Bourguignat.
   *Reymondia* Bourguignat.
   *Bridouxia* Bourguignat.
4. Shell oval; neritinoid; inner lip covered with a very heavy callus, spreading forward and adnate . . . . . . . . . . *Stanleya* Bourguignat.
   Inner lip thickened, but without a forwardly spreading adnate callus; often rimate or umbilicate . . . . . . . . . . *Tanganyicia* Crosse.
5. Rather capacious, large shells, with the shoulder angular and bearing subhorizontal, radiating spines . . . . . . . . . . 6.
   Solid, umbilicate or perforate shells of trochiform or turbinate form, not shouldered. Nearly circular aperture with continuous peristome. Sculpture of granose spirals throughout . . . . . . . . . . 7.
   Imperforate, more or less lengthened, with spiral sculpture and oval or ovate aperture . . . . . . . . . . 8.
6. Imperforate, top-shaped, the spire short. Last whorl and aperture tapering downward to a channelled beak . . . . . . . . . . *Tiphobia* E. A. Smith.
   Umbilicate, the spire rather long, the aperture rounded basally.
   *Bathanalia* J. E. S. Moore.
7. Shell higher than wide, turbinate, perforate . . . . . . *Limnotrochus* E. A. Smith.
   Shell wider than high, trochiform with flat base, umbilicate.
   *Chytra* J. E. S. Moore.

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[1]W. A. Cunnington, 1920, Proc. Zool. Soc. London, p. 603.

8. Sculpture of close, even, spiral cords and weak axial ripples. Small (less than 8 mm. long), ovate-conic, with thick, simply concave columella.
*Lechaptoisia* Ancey.
Sculpture of spiral cords or threads and axial folds or ribs. Generally over 10 mm. long. Columella thick....................................9.
9. Peristome thickened or produced outside at both ends of the aperture....10.
Peristome not thickened outwardly at the ends..........................11.
10. Peristome thickened outside but not produced at the ends of the aperture.
*Paramelania* E. A. Smith.
Peristome produced into a horn at the upper or at both ends.
*Paramelania* subgenus *Bythoceras* J. E. S. Moore.
11. Columella having at its base a low, rounded prominence, or tapering to a point.
*Joubertia* Bourguignat.
*Lavigeria* Bourguignat.
*Randabelia* Bourguignat.
Columella simply concave...........*Hirthia* Ancey and *Edgaria* Bourguignat.

As the Congo Expedition did not visit the region of Tanganyika, we merely list the species to complete our Belgian Congo and African catalogue. The industry of Bourguignat, who did not distinguish between individual mutations and racial forms, has so overloaded the list of species that no proper revision can be made without access to his collection. In the treatment of species we mainly follow E. A. Smith.[1]

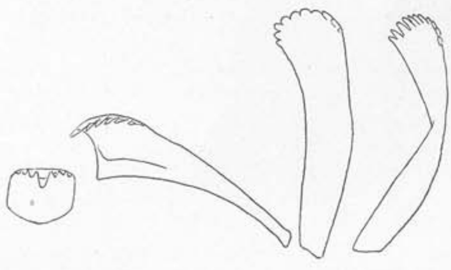

Fig. 58. Teeth of *Tanganyicia rufofilosa* (E. A. Smith)

## *Tanganyicia* Group

Solid, imperforate or rimate, smooth or spirally engraved shells, oval, with very short or conic spire. Operculum concentric around a paucispiral center, or wholly paucispiral. Radula (Fig. 58) with long side teeth. Viviparous; a brood pouch on the left of the head (in *Tanganyicia* and *Giraudia*).

Nothing is known of the anatomy or operculum of *Stanleya, Coulboisia, Baizea*, or *Bridouxia*.

*Tanganyicia* lives on stones in shallow water.

[1]1904, Proc. Malacol. Soc. London, VI, 2, pp. 77–104.

### Tanganyicia Crosse

*Tanganyicia* Crosse, 1881, Journ. de Conchyl., XXIX, p. 123. Monotype: *Lithoglyphus rufofilosus* E. A. Smith.

*Tanganikia* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' pp. 10 and 41; emendation of *Tanganyicia* Crosse. Type by present designation: *Tanganikia maunoiriana* Bourguignat = *Tanganyicia rufofilosa* (E. A. Smith).

*Cambieria* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 42. Monotype: *Lithoglyphus rufofilosus* E. A. Smith.

*Hauttecœuria* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 46. Type by designation of Germain (1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 644): *Hauttecœuria soluta* Bourguignat.

*Tanganyikia* Germain, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 642. Emendation of *Tanganyicia* Crosse.

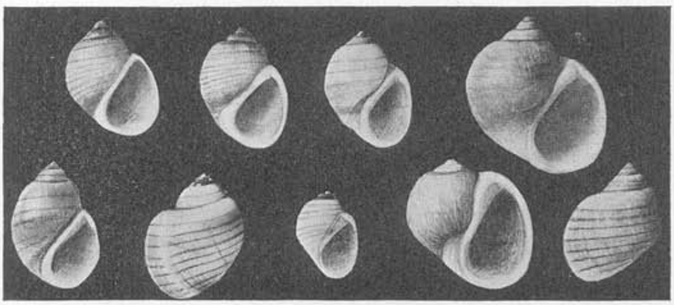


Fig. 59. *a-b, Tanganyicia*, an undertermined form from Tembwe *c-i, Tanganyicia rufofilosa* (E. A. Smith); *c, e-h*, from Moliro. × 1½.

E. A. Smith (1904) and Ancey (1907) accept only one species in the genus. Germain (1908), however, after studying some of Bourguignat's types, concludes that four species may be recognized, which he distributes among the two subgenera *Tanganyicia* and *Hauttecœuria*. In the material which we have examined there are, we believe, a number of forms which are at least racially or perhaps even specifically distinct. We therefore provisionally accept Germain's conclusions.

Our figures represent two forms, probably different species. Figs. 59*c* to *i* are varying forms of *T. rufofilosa*. This is imperforate in the young (Fig. 59*g*, length 7.4 mm.) but becomes rimate or quasiumbilicate with age. Fig. 59*c*, *e-h* are from Moliro (Pilette Coll.), *d* and *i* not definitely localized. Fig. 59*a*, *b* are apparently a different species, from

Tembwe (Hubert Coll.), imperforate or barely perforate in the fully adult stage. We are uncertain which of the many names belongs to this form.

In the typical species of *Tanganyicia* the aperture is entire and broadly rounded basally. In forms referred to *Hauttecœuria* the base of the shell is angular, the aperture somewhat angular basally, with a small sinus there.

### *Tanganyicia reymondi* (Bourguignat)

*Hauttecœuria duveyrieriana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 53; 1888, 'Iconogr. Malacol. Tanganika,' Pl. VIII, figs. 4–6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 108, Pl. VIII, figs. 4–6 (Pambete).

*Hauttecœuria burtoni* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 1–3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 93, Pl. VII, figs. 1–3 (Mpala, Kibanga).

*Hauttecœuria levesquiana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VIII, figs. 9–11; 1890, Ann. Sc. Nat. Zool., (7) X, p. 112, Pl. VIII, figs. 9–11 (Kibanga).

*Hauttecœuria locardiana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VIII, figs. 12–14; 1890, Ann. Sc. Nat. Zool., (7) X, p. 113, Pl. VIII, figs. 12–14 (Kibanga).

*Hauttecœuria maunoiriana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 55; 1888, 'Iconogr. Malacol. Tanganyika,' Pl. VIII, figs. 7–8; 1890, Ann. Sc. Nat. Zool., (7) X, p. 111, Pl. VIII, figs. 7–8 (Pambete).

*Hauttecœuria reymondi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 54; 1888, 'Iconogr. Malacol. Tanganika,' Pl. VIII, figs. 1–3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 109, Pl. VIII, figs. 1–3 (Pambete, Kibanga).

*Tanganyikia* (*Hauttecœuria*) *reymondi* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 645.

Lake Tanganyika: Pambete (type locality of both *duveyrieriana* and *maunoiriana*); Kibanga; Mpala.

### *Tanganyicia fagotiana* (Bourguignat)

*Tanganikia fagotiana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 43; 1888, 'Iconogr. Malacol. Tanganika,' Pl. V, figs. 20–21; 1890, Ann. Sc. Nat. Zool., (7) X, p. 81, Pl. V, figs. 20–21 (Ujiji, Toa, Pambete).

*Tanganyikia fagoti* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 643, footnote.

*Tanganikia giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 44; 1888, 'Iconogr. Malacol. Tanganika,' Pl. V, figs. 16–17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 84, Pl. V, figs. 16–17 (Kapampa).

*Tanganikia opalina* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. V, figs. 18–19; 1890, Ann. Sc. Nat. Zool., (7) X, p. 83, Pl. V, figs. 18–19 (Kibanga).

Lake Tanganyika: originally described from Ujiji, Toa, and Pambete, without definite indication of type locality; Kapampa; Kibanga.

## *Tanganyicia soluta* (Bourguignat)

*Hauttecœuria milne-edwardsiana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 50; 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 12–14; 1890, Ann. Sc. Nat. Zool., (7) X, p. 100, Pl. VII, figs. 12–14 (Pambete).

*Hauttecœuria brincatiana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 20–21; 1890, Ann. Sc. Nat. Zool., (7) X, p. 104, Pl. VII, figs. 20–21 (Kibanga).

*Hauttecœuria charmetanti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 15–17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 101, Pl. VII, figs. 15–17 (Pambete, Mpala, Kibanga).

*Hauttecœuria soluta* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 51; 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 18–19; 1890, Ann. Sc. Nat. Zool., (7) X, p. 103, Pl. VII, figs. 18–19 (Pambete).

*Tanganyikia (Hauttecœuria) soluta* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 644.

*Tanganyikia (Hauttecœuria) soluta* var. *milne-edwardsi* Bourguignat. GERMAIN, 1908, *op. cit.*, p. 645.

Lake Tanganyika: Pambete (type locality of *milne-edwardsiana* and *soluta*); Kibanga; Mpala.

The name *milne-edwardsiana* has page precedence over that of *soluta* employed by Germain, but, according to Opinion 40 of the International Commission, the first reviser can select either of several names of even date.

## *Tanganyicia rufofilosa* (E. A. Smith)

*Lithoglyphus rufofilosus* E. A. SMITH, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 426; 1881, Proc. Zool. Soc. London, p. 288, Pl. XXXIII, figs. 20–20*a*. PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 105. J. E. S. MOORE, 1898, Proc. Roy. Soc. London, LXII, p. 457, fig. 3.

*Tanganyicia rufofilosa* E. A. Smith. CROSSE, 1881, Journ. de Conchyl., XXIX, pp. 125 and 287, Pl. IV, fig. 5.[1] G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 14. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 204. J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 307; 1903, 'The Tanganyika Problem,' pp. 246–250, figs. 28–32. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 92; 1906, Proc. Zool. Soc. London, I, p. 183. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 253 and 265.

?*Cambieria rufofilosa* E. A. Smith. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VI, figs. 8–10; 1890, Ann. Sc. Nat. Zool., (7) X, p. 86, Pl. VI, figs. 8–10 (near Ujiji and Kigoma).

*Tanganyikia rufofilosa* E. A. Smith. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 643, footnote.

*Tanganikia maunoiriana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 44 (Mpala and Pambete).

*Tanganikia ovoidea* BOURGUIGNAT, 1885, *op. cit.*, p. 45 (Kapampa).

*Cambieria jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VI, figs. 15–16; 1890, Ann. Sc. Nat. Zool., (7) X, p. 89, Pl. VI, figs. 15–16 (Kibanga).

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[1] According to Bourguignat, Crosse's figure refers to his *T. fagotiana* and not to Smith's species.

*Cambieria maunoiriana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. vi, figs. 11–12; 1890, Ann. Sc. Nat. Zool., (7) X, p. 87, Pl. vi, figs. 11–12 (Mpala, Pambete).

*Cambieria ovoidea* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. vi, figs. 13–14; 1890, Ann. Sc. Nat. Zool., (7) X, p. 88, Pl. vi, figs. 13–14 (Kampampa).

Lake Tanganyika: originally described from the lake without more definite locality (J. Thomson Coll.); at the southern end (W. A. Cunnington Coll.); Ujiji; Kigoma; Pambete; Mapala; Kapampa; Kibanga; Albertville (C. Hedley Coll.).

### *Tanganyicia rufofilosa* var. *minuta* (Bourguignat)

*Hauttecœuria minuta* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 57; 1888, 'Iconogr. Malacol. Tanganika,' Pl. viii, figs. 29–31; 1890, Ann. Sc. Nat. Zool., (7) X, p. 124, Pl. viii, figs. 29–31 (Mpala, Kibanga).

*Tanganyicia rufofilosa* f. *minuta* Bourguignat. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 265.

Lake Tanganyika: originally described from Mpala and Kibanga, but type locality not definitely designated; Ufipa (Lechaptois Coll.).

We have given this form varietal rank on the authority of Ancey, who is even inclined to regard it as perhaps specifically distinct.

The types of the following forms, all described by Bourguignat, have not been studied thus far and some of them may be individual or local variations of one or other of the foregoing species.

*Hauttecœuria bridouxiana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. viii, figs. 26–28; 1890, Ann. Sc. Nat. Zool., (7) X, p. 122, Pl. viii, figs. 26–28. Kibanga, Mpala.

*Hauttecœuria cambieri* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 56; 1888, 'Iconogr. Malacol. Tanganika,' Pl. viii, figs. 23–25; 1890, Ann. Sc. Nat. Zool., (7) X, p. 121, Pl. viii, figs. 23–25. Mpala, Kibanga.

*Hauttecœuria cameroni* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. viii, figs. 15–17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 118, Pl. viii, figs. 15–17. Kibanga.

*Hauttecœuria eximia* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 55; 1888, 'Iconogr. Malacol. Tanganika,' Pl. viii, figs. 20–22; 1890, Ann. Sc. Nat. Zool., (7) X, p. 120, Pl. viii, figs. 20–22. Mpala, Kibanga.

*Hauttecœuria giraudi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 49; 1888, 'Iconogr. Malacol. Tanganika,' Pl. vii, figs. 8–9; 1890, Ann. Sc. Nat. Zool., (7) X, p. 99, Pl. vii, figs. 8–9 (with var. *minor*, p. 100, from Kibanga). On the western shore from the outlet of the Lukuga southward, especially near Pambete.

*Tanganikia globosa* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 46 = *Hauttecœuria minuta* var. *globosa* Bourguignat, 1890, Ann. Sc. Nat. Zool., (7) X, p. 125. Kapampa.

*Hauttecœuria hamyana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 48; 1888, 'Iconogr. Malacol. Tanganika,' Pl. vii, figs. 6–7; 1890, Ann. Sc. Nat. Zool., (7) X, p. 92, Pl. vii, figs. 6–7. Pambete.

*Hauttecœuria jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 24–25; 1890, Ann. Sc. Nat. Zool., (7) X, p. 107, Pl. VII, figs. 24–25. Kibanga.

*Hauttecœuria lavigeriana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 26–27; 1890, Ann. Sc. Nat. Zool., (7) X, p. 115, Pl. VII, figs. 26–27. Pambete.

*Hauttecœuria macrostoma* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 10–11; 1890, Ann. Sc. Nat. Zool., (7) X, p. 97, Pl. VII, figs. 10–11. Pambete.

*Hauttecœuria moineti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 4–5; 1890, Ann. Sc. Nat. Zool., (7) X, p. 95, Pl. VII, figs. 4–5. Kibanga.

*Hauttecœuria pusilla* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VIII, figs. 32–34; 1890, Ann. Sc. Nat. Zool., (7) X, p. 119, Pl. VIII, figs. 32–34. Mpala (typical) and a variety at Pambete.

*Hauttecœuria servainiana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. VIII, figs. 18–19; 1890, Ann. Sc. Nat. Zool., (7) X, p. 116, Pl. VIII, figs. 18–19. Kibanga and near the mouth of the Luandazi River.

*Hauttecœuria singularis* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 52; 1888, 'Iconogr. Malacol. Tanganika,' Pl. VII, figs. 22–23; 1890, Ann. Sc. Nat. Zool., (7) X, p. 106, Pl. VII, figs. 22–23. Pambete.

### STANLEYA Bourguignat

*Stanleya* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 86. Type by original designation: *Lithoglyphus neritoides* E. A. Smith (error for *neritinoides*) (not *Stanleya* of Bourguignat, 1888, nor of Smith, 1904).

*Rumella* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 89. For *Rumella giraudi* Bourguignat and *R. milne-edwardsiana* Bourguignat, both apparently synonyms of *Lithoglyphus neritinoides* E. A. Smith. Type by present designation: *Rumella giraudi* Bourguignat.

As pointed out by H. B. Baker (1923, Proc. Ac. Nat. Sc. Philadelphia, LXXV, p. 174) the fact that Bourguignat had apparently misidentified Smith's *Lithoglyphus neritinoides* in no way invalidates his designation of that species as the genotype of *Stanleya*, since he referred to Smith's species by page and figure, and it was later, in 1888, that he figured a different species as *Stanleya neritoides* and his error became manifest.

### *Stanleya neritinoides* (E. A. Smith)

Text Figure 60*a-b*

*Lithoglyphus neritinoides* E. A. SMITH, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 426; 1881, Proc. Zool. Soc. London, p. 287, Pl. XXXIII, fig. 19.

*Tanganyicia* (?) *neritinoides* E. A. Smith. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 126.

*Stanleya neritoides* E. A. Smith. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 87.

*Lithoglyphus neritoides* E. A. Smith. Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 106.

*Stanleya neritinoides* E. A. Smith. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 214. S. B. Baker, 1923, Proc. Ac. Nat. Sc. Philadelphia, LXXV, p. 174.

*Rumella neritinoides* E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, p. 93. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 254 and 265.

*Rumella giraudi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 90; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 35–37; 1890, Ann. Sc. Nat. Zool., (7) X, p. 253, Pl. xvii, figs. 35–37 (Mpala, Kibanga).

*Rumella milne-edwardsiana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 91; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 26–28; 1890, Ann. Sc. Nat. Zool., (7) X, p. 253, Pl. xvii, figs. 26–28 (Kapampa).

*Rumella globosa* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 20–22; 1890, Ann. Sc. Nat. Zool., (7) X, p. 250, Pl. xvii, figs. 20–22. (Mpala, Kapampa, Kibanga).

*Rumella callifera* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 23–25; 1890, Ann. Sc. Nat. Zool., (7) X, p. 251, Pl. xvii, figs. 23–25 (Kibanga).

*a* *b*

Fig. 60. *a-b*, *Stanleya neritinoides* (E. A. Smith). × 3. Tembwe Bay

*Rumella jouberti* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 29–31; 1890, Ann. Sc. Nat. Zool., (7) X, p. 255, Pl. xvii, figs. 29–31 (southern part of Ubuari Peninsula)

*Rumella lavigeriana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 32–34; 1890, Ann. Sc. Nat. Zool., (7) X, p. 256, Pl. xvii, figs. 32–34 (Kibanga).

*Neritina* (*Stanleya*) *neritoides* E. A. Smith. Tryon, 1888, 'Manual of Conchol.,' X, p. 56, Pl. xvii, fig. 80.

Lake Tanganyika: originally described from the lake without more definite locality (Thomson Coll.); Mpala; Kapampa; Kibanga; southern part of Ubuari Peninsula; Ufipa (Lechaptois Coll.).

## Baizea Bourguignat

*Baizea* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 33. Monotype: *Baizea giraudi* Bourguignat.

*Ponsonbya* Ancey, 1890, Bull. Soc. Malacol. France, VII, p. 346. Monotype: *P n onbya leucoraphe* Ancey.

Solid, ovate-conic, imperforate shells, usually brownish with light subsutural band, either smooth or having very fine and superficial spiral sculpture. The last whorl rising a little, then descending to the aperture. Peristome slightly expanded outwardly and more or less thickened. The inner lip thickened, regularly concave. Columella often bordered outwardly by a narrow, lunate, flattened or concave area.

The operculum (in *B.* (*Giraudia*) *præclara*) "consists of a single whorl, the nucleus being subcentral, but nearer the lower end; it is sub-ovate, being rather narrower below than above."[1]

According to Pelseneer, "the radula of *Giraudia* is clearly similar to that of the melaniid genus *Ancylotus* [=*Anculosa* Say]. The two species *G. præclara* Bourguignat and *G.* [*Reymondia*] *horei* (Smith) have radulæ so different in structure as to perhaps necessitate their allocation to two distinct genera."

*B.* (*Giraudia*) *præclara* lives on rocks in shallow water.

The conchological features are so similar in the supposed genera *Baizea, Coulboisia,* and *Giraudia* that it appears absurd to accept all as genera until distinctions are found to exist in opercula or soft parts. We leave them as subgenera for the moment.

The special character of *Baizea* proper is the possession of a narrow, flattened or concave, lunate area bordering the columella. This appears occasionally in old individuals of almost any species of *Baizea, Coulboisia,* or *Reymondia,* and a similar structure is often seen in various Amnicolidæ. It has very little systematic value.

### Subgenus **Baizea**, proper

### *Baizea giraudi* Bourguignat

*Baizea giraudi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 34; 1888, 'Iconogr. Malacol. Tanganika,' Pl. iv, figs. 17–19; 1890, Ann. Sc. Nat. Zool., (7) X, p. 60, Pl. iv, figs. 17–19. G. B. Sowerby, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 12. Ancey, 1894, Bull. Soc. Zool. France, XIX, p. 28. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 205. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 94. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

Lake Tanganyika: Kapampa (type locality).

### *Baizea leucoraphe* (Ancey)

Text Figure 61

*Ponsonbya leucoraphe* Ancey, 1890, Bull. Soc. Malacol. France, VII, p. 347. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 296.

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[1]E. A. Smith, 1906, Proc. Zool. Soc. London, I, p. 183. The figure given by Smith does not agree with his description.

*Baizea leucoraphe* Ancey. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 95.

*Baizea (Ponsonbya) leucoraphe* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

Lake Tanganyika: originally described from the lake without more definite locality (E. C. Hore Coll.).

Fig. 61. *Baizea leucoraphe* (Ancey). Length 4.8 mm.

### Subgenus Coulboisia Bourguignat

*Coulboisia* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' pp. 39 and 40 For two species: *Coulboisia giraudi* Bourguignat and *C. smithiana* Bourguignat. Type by designation of S. B. Baker (1923): *Stanleya*[ = *Coulboisia*] *giraudi* Bourguignat.

?*Stanleya* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' pp. 39 and 40 (not of Bourguignat, 1885). Monotype: *Stanleya neritoides* Bourguignat = *Stanleya rotundata* E. A. Smith.

*Stanleya* Bourguignat. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 93.

### *Baizea* (*Coulboisia*) *giraudi* (Bourguignat)[1]

*Stanleya giraudi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 88. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 94.

*Stanleya (Coulboisia) giraudi* Bourguignat. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

*Coulboisia giraudi* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 16–17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 247, Pl. xvii, figs. 16–17. S. B. Baker, 1923, Proc. Ac. Nat. Sc. Philadelphia, LXXV, p. 174.

Lake Tanganyika: Mlilo (type locality; Giraud Coll.).

### *Baizea*? (*Coulboisia*?) *rotundata* (E. A. Smith)

*Stanleya neritoides* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 13–15; 1890, Ann. Sc. Nat. Zool., (7) X, p. 246, Pl. xvii, figs. 13–15. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254. S. B. Baker, 1923, Proc. Ac. Nat. Sc. Philadelphia, LXXV, p. 174.

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[1] If *Coulboisia* is a subordinate group of *Baizea*, as we believe, the name of this form will have to be changed, at least in case it proves to be a valid species or subspecies.

*Stanleya rotundata* E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 93.
Lake Tanganyika: on the eastern shore between Ujiji and the mouth of the Malagarazi River (type locality).

### *Baizea (Coulboisia) smithiana* (Bourguignat)

*Stanleya smithiana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 88. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 94.

*Stanleya (Coulboisia) smithiana* Bourguignat. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

*Coulboisia smithiana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 18–19; 1890, Ann. Sc. Nat. Zool., (7) X, p. 248, Pl. xvii, figs. 18–19. H. B. Baker, 1923, Proc. Ac. Nat. Sc. Philadelphia, LXXV, p. 174.

Lake Tanganyika: Mlilo (type locality; Giraud Coll.).

## Subgenus Giraudia Bourguignat

*Giraudia* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 61. For two species: *Giraudia præclara* Bourguignat and *G. grandidieriana* Bourguignat. Type by present designation: *G. præclara.*

### *Baizea (Giraudia) minima* (E. A. Smith)

*Giraudia minima* E. A. Smith, 1908, Proc. Malacol. Soc. London, VIII, 1, p. 12, fig.

Lake Tanganyika: originally described from the lake without more definite locality (R. L. Harger Coll.).

### *Baizea (Giraudia) præclara* (Bourguignat)

*Giraudia præclara* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 62; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xi, figs. 16–18; 1890, Ann. Sc. Nat. Zool., (7) X, p. 149, Pl. xi, figs. 16–18. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 95; 1906, Proc. Zool. Soc. London, I, p. 183, Pl. x, fig. 14 (operculum). Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 254 and 265.

*Reymondia præclara* Bourguignat. Martel and Dautzenberg, 1899, Journ. de Conchyl., XLVII, p. 176.

*Giraudia grandidieriana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 63; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xi, figs. 19–21; Ann. Sc. Nat. Zool., (7) X, p. 150, Pl. xi, figs. 19–21. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 95. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

*Giraudia lavigeriana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xi, figs. 22–24; 1890, Ann. Sc. Nat. Zool., (7) X, p. 151, Pl. xi, figs. 22–24. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 95. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

Lake Tanganyika: Mlilo (type locality; Giraud Coll.); Moliro (W. A. Cunnington Coll.); near the mouth of the Mkulungulu River in Ugoma; Mpala (Guillemé Coll.).

### REYMONDIA Bourguignat

*Reymondia* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 64. For *Melania* (?) *horei* E. A. Smith and *Reymondia giraudi* Bourguignat.

The shell is smooth, similar to that of *Baizea*, except that it is somewhat more lengthened. The operculum (of *R. horei*) is concentric with paucispiral center.

Radula said to be similar to that of *Anculosa*, but differing from that of *Baizea* (*Giraudia*) *præclara;* neither has been described or figured. *R. horei* is said by J. E. S. Moore to have a brood pouch as in *Tanganyicia*.

Type by present designation: *Melania* (?) *horei* E. A. Smith (Fig. 62).

This generic name is not preoccupied by *Raymondia* Frauenfeld, 1855.

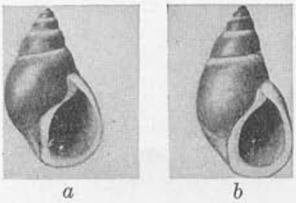


Fig. 62. *a-b*, *Reymondia horei* (E. A. Smith). × 1½.

### *Reymondia horei* (E. A. Smith)

Text Figure 62*a-b*

*Melania* (?) *horei* E. A. SMITH, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 427; 1881, Proc. Zool. Soc. London, p. 292, Pl. XXXIV, fig. 27.

*Melania horei* E. A. Smith. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 115. PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 108.

*Reymondia horei* E. A. Smith. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 65; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, figs. 1–2; 1890, Ann. Sc. Nat. Zool., (7) X, p. 153, Pl. XI, figs. 1–2. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 9. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 206. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 175, Pl. VIII, figs. 20–21.

*Giraudia horei* E. A. SMITH, Proc. Malacol. Soc. London, VI, 2, p. 95; 1906, Proc. Zool. Soc. London, I, p. 183, Pl. X, fig. 13 (operculum). GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 258; 1911, *op. cit.*, p. 440; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 646, figs. 8–9. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 254.

*Giraudia horei* form *minor* ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 254 and 265 (Ufipa).

*Reymondia jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, figs. 5–6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 155, Pl. XI, figs. 5–6 (mouth of Mkulungulu River).

*Reymondia monceti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, figs. 7–8; 1890, Ann. Sc. Nat. Zool., (7) X, p. 157, Pl. XI, figs. 7–8 (mouth of Mkulungulu River and Kilira Chakabala Islands).

*Reymondia bridouxiana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, figs. 14–15; 1890, Ann. Sc. Nat. Zool., (7) X, p. 157, Pl. XI, figs. 14–15 (Kibanga).

*Reymondia foai* J. MABILLÉ, 1901, Bull. Soc. Philomath. Paris, (9) III, 2, p. 57. (Tanganyika).

*Giraudia foai* J. Mabille. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259 (*Reymondia*).

Lake Tanganyika: originally described from the lake without more definite locality (E. C. Hore Coll.); in 10 fathoms, Mrondwe Bay at the southern end (W. A. Cunnington Coll.); Ufipa (Lechaptois Coll).; Mlilo; mouth of the Mkulungulu River; Kilira Chakabala Islands, north of the Lukuga; Kibanga. Taken by Charles Hedley at Albertville.

## *Reymondia horei* var. *giraudi* (Bourguignat)

*Reymondia giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 65; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, figs. 3–4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 154, Pl. XI, figs. 3–4.

*Giraudia horei* var. *giraudi* Bourguignat. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259; 1911, *op. cit.*, p. 440; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 647.

*Reymondia pyramidalis* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XI, figs. 9–13; 1890, Ann. Sc. Nat. Zool., (7) X, p. 159, Pl. XI, figs. 9–13 (mouth of Mkulungula River).

Lake Tanganyika: Mlilo (type locality); mouth of the Mkulungulu and vicinity in Ugoma.

## *Reymondia minor* E. A. Smith

*Reymondia minor* E. A. SMITH, 1889, Ann. Mag. Nat. Hist., (6) IV, p. 174. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 11.

*Giraudia minor* E. A. Smith. ANCEY, 1894, Bull. Soc. Zool. France, XIX, p. 28. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 96, fig. 4 (on p. 87). ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254. GERMAIN, 1908, 'Rés Scientif. Voy. Afrique Foà,' p. 648, figs. 10–11.

*Assiminea foas* J.MABILLE, 1901, Bull. Soc. Philomath. Paris (9) III, 2, p. 56 (Tanganyika).

*Giraudia foai* J. Mabille. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 95. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259 (*Assiminea*).

Lake Tanganyika: originally described from the lake without more definite locality (E. C. Hore Coll.).

## *Reymondia tanganyicensis* E. A. Smith

*Reymondia tanganyicensis* E. A. SMITH, 1889, Ann. Mag. Nat. Hist., (6) IV, p. 175. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 10.

*Giraudia tanganyicensis* E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 96, fig. 5 (on p. 87). ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 254 and 265. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 649, fig. 12 (on p. 648).

*Giraudia tanganyikana* E. A. Smith. ANCEY, 1894, Bull. Soc. Zool. France, XIX, p. 28.

*Assiminea quintana* J. MABILLE, 1901, Bull. Soc. Philomath. Paris, (9) III, 2, p. 56 (Tanganyika).

*Giraudia quintana* J. Mabille. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 95. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259.

Lake Tanganyika: originally described from the lake without more definite locality (E. C. Hore Coll.); Ufipa (Lechaptois Coll.).

### BRIDOUXIA Bourguignat

*Bridouxia* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 29. Type by present designation: *Bridouxia giraudi* Bourguignat.

This genus is unknown to us. It is by no means certain just where it belongs.

### *Bridouxia giraudi* Bourguignat

*Bridouxia giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 30; 1888, 'Iconogr. Malacol. Tanganika,' Pl. IV, figs. 5–7; 1890, Ann. Sc. Nat. Zool., (7) X, p. 54, Pl. IV, figs. 5–7. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

*Bridouxia villeserriana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 30 (type locality: beach of Kapampa, on the southeastern shore of Tanganyika); 1888, 'Iconogr. Malacol. Tanganika,' Pl. IV, figs. 8–10; 1890, Ann. Sc. Nat. Zool., (7) X, p. 55, Pl. IV, figs. 8–10. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

*Bridouxia costata* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 31 (type locality: beach of Kapampa, on the southeastern shore of Tanganyika); 1888, 'Iconogr. Malacol. Tanganika,' Pl. IV, figs. 11–13; 1890, Ann. Sc. Nat. Zool., (7) X, p. 56, Pl. IV, figs. 11–13. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

*Bridouxia reymondi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 32 (type locality: beach of Kapampa, on the southeastern shore of Tanganyika); 1888, 'Iconogr. Malacol. Tanganika,' Pl. IV, figs. 14–18; 1890, Ann. Sc. Nat. Zool., (7) X, p. 57, Pl. IV, figs. 14–18. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

Lake Tanganyika: Kapampa on the southeastern shore (type locality).

### *Spekia* GROUP

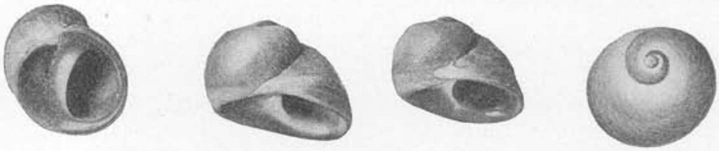
Shell imperforate, orbicular, irregularly hemispherical, with short spire of 4 or 5 convex, smooth whorls. The very large aperture is strongly oblique; columella calloused, bounded by a large, concave, lunate area with angular boundary. Operculum oblong, concentric with a paucispiral center. Radula with very wide central tooth, short side teeth, the two marginals similar, with numerous denticles.

### Spekia Bourguignat

*Spekia* Bourguignat, 1879, 'Descript. Moll. Egypte,' p. 27. Monotype: *Lithoglyphus zonatus* Woodward.

*Spekea* E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 205. Misspelling of *Spekia*.

The shape, a dome with large base, is apparently an adaptation to conditions of the shore, where the animal lives on rocks after the fashion of *Littorina*.



*a* *b* *c* *d*

Fig. 63 *a-d, Spekia zonata* (Woodward). × 1½.

### *Spekia zonata* (Woodward)

Text Figure 62*a-d*

*Lithoglyphus zonatus* Woodward, 1859, Proc. Zool. Soc. London, p. 349, Pl. xlvii, figs. 3-3*c*. E. A. Smith, 1880, *op. cit.*, p. 350; 1881, *op. cit.*, p. 287.

*Spekia zonata* Woodward. Bourguignat, 1879, 'Descript. Moll. Egypte,' p. 28; 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 37; 1888, 'Iconogr. Malacol. Tanganika,' Pl. iv, figs. 20–24; 1890, Ann. Sc. Nat. Zool., (7) X, p. 63, Pl. iv, figs. 20–24. E. A. Smith, 1889, Ann. Mag. Nat. Hist., (6) IV, p. 173. G. B. Sowerby, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 3. J. E. S. Moore, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 307, Pl. xxiii, fig. 4; 1903, 'The Tanganyika Problem,' pp. 256–264, figs. 39–43, and p. 351, fig. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 92. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 259; 1906, *op. cit.*, p. 580; 1911, *op. cit.*, p. 439; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 673. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 254 and 265. E. A. Smith, 1906, Proc. Zool. Soc. London, I, p. 183.

*Lacunopsis (Spekia) zonata* Woodward. Crosse, 1881, Journ. de Conchyl., XXIX, p. 122, Pl. iv, fig. 4, and p. 287.

*Lacunopsis zonata* Woodward. Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 106.

*Spekea zonata* Woodward. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 205, Pl. vi, fig. 41.

*Spekia cameroni* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. v, figs. 13–15. 1890, Ann. Sc. Nat. Zool., (7) X, p. 67, Pl. v, figs. 13–35 (Mpala; Zugue).

*Spekia duveyrieriana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 37; 1888, 'Iconogr. Malacol. Tanganika,' Pl. v, figs. 4–6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 65, Pl. v, figs. 4–6 (Mpala; Kibanga).

*Spekia giraudi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 36; 1888, 'Iconogr. Malacol. Tanganika,' Pl. iv, figs. 25–27; 1890, Ann. Sc. Nat. Zool., (7) X, p. 69, Pl. iv, figs. 25–27 (Kibanga; Mpala; Pambete).

*Spekia grandidieriana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 40; 1888, 'Iconogr. Malacol. Tanganika,' Pl. v, figs. 7–9; 1890, Ann. Sc. Nat. Zool., (7) X, p. 66, Pl. v, figs. 7–9 (southwestern shores of Marungu).

*Spekia hamyana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 38; 1888, 'Iconogr. Malacol. Tanganika,' Pl. v, figs. 1–3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 70, Pl. v, figs 1–3 (Mpala).

*Spekia reymondi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 39; 1888, 'Iconogr. Malacol. Tanganika,' Pl. v, figs. 10–12; 1890, Ann. Sc. Nat. Zool., (7) X, p. 71, Pl. v, figs. 10–12 (Mpala; Kibanga).

*Spekia zonata* var. *unisulcata* BOURGUIGNAT, 1890, Ann. Sc. Nat. Zool., (7) X, p. 64 (Pambete).

*Spekia zonata* var. *elongata* BOURGUIGNAT, 1890, Ann. Sc. Nat. Zool., (7) X, p. 65 (Mpala).

*Spekia zonata* var. *tanganikana* BOURGUIGNAT, 1890, Ann. Sc. Nat. Zool., (7) X, p. 65 (Kapampa).

Lake Tanganyika: eastern shore at Ujiji (type locality; Speke Coll.); Niamkolo (W. A. Cunnington Coll.); Ufipa (Lechaptois Coll.); Mpala; Pambete; Kapampa; Kibanga; Zugue (Marungu); Uvira; Karema; Mkulungulu (Ugoma); Ituha (Marungu).

### *Tiphobia* GROUP

Capacious, moderately large shells; the whorls flattened above the angular shoulder which bears radiating spines. Operculum concentric with paucispiral center (*Tiphobia*) or paucispiral (*Bathanalia*). Side teeth of radula very long. Viviparous, the latter part of the oviduct enlarged to form a brood pouch as in *Viviparus* and *Melanoides*.

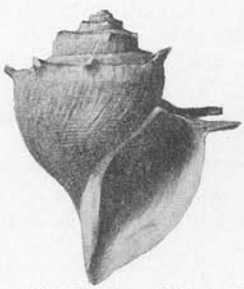


Fig. 64. *Tiphobia horei* E. A. Smith.

### TIPHOBIA E. A. Smith

*Tiphobia* E. A. SMITH, 1880, Proc. Zool. Soc. London, p. 348. Monotype: *Tiphobia horei* E. A. Smith.

*Hilacantha* C. F. ANCEY, 1886, Le Naturaliste, III, No. 37, p. 293. Substitute for *Tiphobia* E. A. Smith.

*Hylacantha* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 23; 1890, Ann. Sc. Nat. Zool., (5) X, p. 126. Emendation of *Hilacantha*.

*Typhobia* J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 181 (not *Typhobia* Pascoe, 1869).

## *Tiphobia horei* E. A. Smith

Text Figure 64

*Tiphobia horei* E. A. SMITH, 1880, Proc. Zool. Soc. London, p. 348, Pl. XXXI, figs. 6 and 6*b;* 1881, *op. cit.*, p. 293, Pl. XXXIV, fig. 28. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 117, Pl. IV, figs. 2-2*b*. E. v. MARTENS, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 72. BOURGUIGNAT, 1886, Bull. Soc. Malacol. France, III, p. 143, Pl. VI, figs. 1–4. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 1. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 203, Pl. VI, fig. 45. E. A. SMITH 1904, Proc. Malacol. Soc. London, VI, 2, p. 85; 1906, Proc. Zool. Soc. London, I, p. 181. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 258; 1911, *op. cit.*, p. 436; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 651.

*Tiphobia longirostris* BOURGUIGNAT, 1886, Bull. Soc. Malacol. France, III, p. 144, Pl. VI, figs. 8–10.

*Tiphobia jouberti* BOURGUIGNAT, 1886, Bull. Soc. Malacol. France, III, p. 146, Pl. VI, figs. 11–13.

*Tiphobia bourguignati* "Joubert" BOURGUIGNAT, 1886, Bull. Soc. Malacol. France, III, p. 148, Pl. VI, figs. 5–7.

*Hylacantha horei* E. A. Smith. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. IX, figs. 1–4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 128, Pl. IX, figs. 1–4, ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 250 and 262.

*Hylacantha longirostris* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. IX, figs. 11–13; 1890, Ann. Sc. Nat. Zool., (7) X, p. 131, Pl. IX, figs. 11–13.

*Hylacantha bourguignati* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. IX, figs. 5–7; 1890, Ann. Sc. Nat. Zool., (7) X, p. 132, Pl. IX, figs. 5–7.

*Hylacantha jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. IX, figs. 11–13; 1890, Ann. Sc. Nat. Zool., (7) X, p. 131, Pl. IX, figs. 11–13.

*Typhobia horei* E. A. Smith. J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, pp. 183 and 307 (anatomy), Pl. XI, figs. 1–11; Pl. XII, figs. 12–28; Pl. XIII, figs. 42–49 and 54; 1903, 'The Tanganyika Problem,' pp. 223–228, figs. 2–7.

Lake Tanganyika: Ujiji (type locality); Kala in the southern portion (W. A. Cunnington Coll.); Kibanga (type locality of *T. longirostris;* Guillemé Coll.); near the peninsula of Katenga, northwest of the islands Kilira Chakabala; Massanze, northwest of the peninsula of Ubuari (type locality of *T. jouberti*); bay of Kamangu, southwest of the islands Kilira Chakabala (type locality of *T. bourguignati*).

## BATHANALIA J. E. S. Moore

*Bathanalia* J. E. S. MOORE, 1898 (March), Proc. Roy. Soc. London, LXII, p. 451; 1898 (July), Proc. Malacol. Soc. London, III, 2, p. 92. Monotype: *Bathanalia howesi* J. E. S. Moore.

*Batanalia* J. E. S. MOORE, 1898 (March), Quart. Jl. Micr. Sci., N.S., XLI, p. 181. Misspelling of *Bathanalia.*

*Bathyanalia* and *Bathynalia* J. E. S. MOORE, 1898, *op. cit.*, pp. 170 and 171. Misspellings of *Bathanalia.*[1]

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[1]Moore invented a new spelling for this genus almost every time he mentioned it. He has also some remarkable spellings of other Tanganyikan genera.

### *Bathanalia howesi* J. E. S. Moore

*Bathanalia howesi* J. E. S. Moore, 1898 (March), Proc. Roy. Soc. London, LXII, p. 452, fig. 2; 1898 (March), Quart. Jl. Micr. Sci., N.S., XLI, pp. 192 and 307 (anatomy), Pl. xii, figs. 29–33 and Pl. xxiii, fig. 3; 1898 (July), Proc. Malacol. Soc. London, II, 2, p. 92, fig. ii (on p. 93); 1903, 'The Tanganyika Problem,' pp. 227–228, figs. 8–10. Nicolas, 1899, C. R. Assoc. Franç. Av. Sci., (1898), II, p. 525, fig. 8, E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 85. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

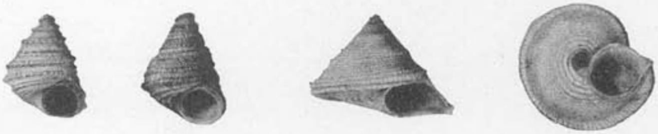
Lake Tanganyika: Mleroes, in the southern portion, alive at a depth of 800 ft. and more (type locality; J. E. S. Moore Coll.); Niamkolo, at the southern end (W. A. Cunnington Coll.).

### *Limnotrochus* Group

Solid, trochiform, perforate or umbilicate shells, without noticeable periostracum, spirally lirate-tuberculate, the aperture rounded. Operculum paucispiral. Radula as in *Tiphobia*. Probably oviparous.

### Limnotrochus E. A. Smith

*Limnotrochus* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 425; 1881 Proc. Zool. Soc. London, p. 285. Monotype: *Limnotrochus thomsoni* E. A. Smith.



*a* *b* *c* *d*

Fig. 65. *a-b, Limnotrochus thomsoni* E. A. Smith. *c-d, Chytra kirkii* (E. A. Smith).

### *Limnotrochus thomsoni* E. A. Smith

Text Figure 65*a-b*

*Limnotrochus thomsoni* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 425; 1881, Proc. Zool. Soc. London, p. 285, Pl. xxxiii, figs. 17–17*b*. Crosse, 1881, Journ. de Conchyl., XXIX, p. 127. Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 59. Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 105. Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 4–7; 1890, Ann. Sc. Nat. Zool., (7) X, p. 136, Pl. x, figs. 4–7. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 210. J. E. S. Moore, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 307, Pl. xxiii, fig. 5; 1903, 'The Tanganyika Problem,' pp. 233–237, figs. 17–20, and p. 349, figs. Digby, 1902, Journ. Linn. Soc. London, Zool., XXVIII, p. 437 (anatomy), Pl. xxxviii, figs. 1–9 and Pl. xl, fig. 24. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 85. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 258; 'Rés. Scientif. Voy. Afrique Foà,' p. 652. E. A. Smith, 1906, Proc. Zool. Soc. London, I, p. 181. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 250 and 262.

*Limnotrochus giraudi* Bourguignat, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 59; 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 8–10; 1890, Ann. Sc. Nat. Zool., (7) X, p. 137, Pl. x, figs. 8–10.

*Limnotrochus cyclostoma* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 60; 1888, 'Iconogr. Malacol. Tanganika,' Pl. X, figs. 11–13; 1890, Ann. Sc. Nat. Zool., (7) X, p. 138, Pl. x, figs. 11–13.

Lake Tanganyika: originally described from that lake without more definite locality (J. Thomson Coll.); Mpala (Storms Coll.); Ndanvie on the northeastern shore (W. A. Cunnington Coll.); Pambete (also type locality of *L. giraudi* and *L. cyclostoma*); Ufipa (Lechaptois Coll.).

Stappers obtained this species at a number of places: Moliro (at a depth of 20 meters); bay of Kasakalawe; between Moliro and Vua; bay of Tembwe; Uvira; bay of Sumbu; Baraka; bay of the Luvu; off Toa; at the mouth of the Ruzizi; and between Mwerasi and Kapampa. We have also seen specimens from Tembwe (Hubert Coll.).

## CHYTRA J. E. S. Moore

*Chytra* J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 307. Monotype: *Limnotrochus kirkii* E. A. Smith.

*Kytra* J. E. S. MOORE, 1901, Proc. Zool. Soc. London, II, p. 461. Misspelling of *Chytra.*

### *Chytra kirkii* (E. A. Smith)

Text Figure 65*c-d*

*Limnotrochus kirkii* E. A. SMITH, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 426; 1881, Proc. Zool. Soc. London, p. 286, Pl. XXXIII, figs. 18 and 18*b*. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 128. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. x, figs. 1–3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 135, Pl. x, figs. 1–3. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 4. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 209, Pl. VI, fig. 40.

*Chytra kirkii* E. A. Smith. J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 307, Pl. XXIII, fig. 6; 1903, 'The Tanganyika Problem,' pp. 228–234, figs. 11, 12, and 14–16, and p. 350, figs. DIGBY, 1902, Journ. Linn. Soc. London, Zool., XXVIII, p. 434 (anatomy), Pl. XXXVIII, figs. 10–11; Pl. XXXIX, figs. 12–21; Pl. XL, fig. 25. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 84; 1906, Proc. Zool. Soc. London, I, p. 181. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 260; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 672. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 250.

*Kytra kirki* E. A. Smith. J. E. S. MOORE, 1901, Proc. Zool. Soc. London, II, p. 470, Pl. XXVI, fig. 2.

Lake Tanganyika: originally described without more definite locality (Hore Coll.); Masswa, in 25 fathoms (J. E. S. Moore Coll.); Tembwe, in 20 fathoms (W. A. Cunnington Coll.); Ujiji; Karema.

Stappers obtained it off Uvira; near the mouth of the Ruzizi; near the mouth of the Sambala; and in the bay of Kilewa.

## *Paramelania* GROUP

Elongate shells, with spiral sculpture and tuberculate, axial folds; the aperture oval; the peristome thickened outwardly or produced at the ends. Operculum concentric, with paucispiral center. Side teeth much lengthened.

## PARAMELANIA E. A. Smith

*Tiphobia* subgenus *Paramelania* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 559. Type by present designation: *Tiphobia* (*Paramelania*) *damoni* E. A. Smith.

*Paramelania* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 67.

*Pyrgulifera* C. A. WHITE, 1881, Nature, XXV, p. 101. Not *Pyrgulifera* Meek, 1872.

*Bourguignatia* GIRAUD, 1885, Bull. Soc. Malacol. France, II, p. 193. Monotype: *Bourguignatia imperialis* Giraud = *Paramelania damoni* E. A. Smith.

The radula of *P. damoni* (Fig. 57, on page 300) is quite small (about 2 mm. long and 0.4 mm. wide in a specimen 30 mm. long). The central tooth is small, with long denticles, the body slightly swollen below the cusp, its posterior margin indistinct in our preparation. The laterals have the usual rhombic body and an extremely long peduncle. The marginals are also very long. The formula of denticles is: C. 4, 1, 5 or 4, 1, 4; L. 3, 1, 8; M. 7 and 7.

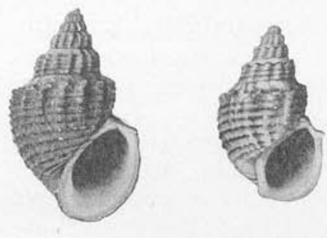


Fig. 66. *a–b*, *Paramelania damoni* (E. A. Smith). At *b* the form called *imperialis* Giraud.

### Subgenus PARAMELANIA, proper

### *Paramelania bridouxi* (Bourguignat)

*Bourguignatia bridouxi* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XII, figs. 1–4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 166, Pl. XII, figs. 1–4. NICOLAS, 1899, C. R. Assoc. Franç. Avanc. Sci., (1898), II p. 516, fig. 4.

*Paramelania* (*Bourguignatia*) *bridouxi* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 207.

*Paramelania bridouxi* Bourguignat. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 87. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: Kibanga and near the mouth of the Luandazi River, on the western shore (type locality not designated).

### *Paramelania bridouxi* var. *jouberti* (Bourguignat)

*Bourguignatia jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XII, figs. 1–4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 168, Pl. XII, figs. 1–4.

*Paramelania bridouxi* var. *jouberti* Bourguignat. E. A. SMITH, 1904, Proc Malacol. Soc. London, VI, 2, p. 87.

*Paramelania jouberti* Bourguignat. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: Kibanga (type locality).

## *Paramelania crassigranulata* (E. A. Smith)

*Tiphobia* (*Paramelania*) *crassigranulata* E. A. SMITH, 1881, Proc. Zool. Soc. London, I, p. 560, fig. 2.

*Melania* (*Paramelania*) *crassigranulata* E. A. Smith. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 284.

*Paramelania crassigranulata* E. A. Smith. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, fig. 18; 1890, Ann. Sc. Nat. Zool., (7) X, p. 202, Pl. XIV, fig. 18. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 209. J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 307. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 180, Pl. VIII, fig. 25. J. E. S. MOORE, 1903, 'The Tanganyika Problem,' p. 245, fig. 26 (radula). E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 87; 1906, Proc. Zool. Soc. London, I, p. 182, Pl. X, figs. 7 and 8. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

*Pyrgulifera crassigranulata* E. A. Smith. C. A. WHITE, 1881, Nature, XXV, p. 102; 1882, Proc. U. S. Nat. Mus., V, p. 98, Pl. III, fig. 14. TAUSCH, 1884, Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., XC, Abt. 1, p. 61.

Lake Tanganyika: originally described from the lake without more definite locality (Damon Coll.); southern end of the lake (W. A. Cunnington Coll.); Mpala (Guillemé Coll.).

Stappers obtained this species at Baraka, off Uvira, and in the Bay of Kilewa.

## *Paramelania damoni* (E. A. Smith)

Text Figure 66*a-b*

*Tiphobia* (*Paramelania*) *damoni* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 559, fig. 1.

*Melania* (*Paramelania*) *damoni* E. A. Smith. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 285.

*Paramelania damoni* E. A. Smith. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, fig. 17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 200, Pl. XIV, fig. 17. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 209. MARTEL AND DAUTZENBERG, 1899, Journ de Conchyl., XLVII, p. 177, Pl. VIII, fig. 22. J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, p. 307, Pl. XXIII, fig. 1; 1903, 'The Tanganyika Problem,' pp. 243–245, figs. 25 and 27, and p. 345, fig. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 87; 1906, Proc. Zool. Soc. London, I, p. 182, Pl. X, figs. 5, 6, and 9. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 251 and 262.

*Bourguignatia imperialis* GIRAUD, 1885, Bull. Soc. Malacol. France, II, p. 194, Pl. VII, figs. 5–7. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 67; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XII, figs. 8–10; 1890, Ann. Sc. Nat. Zool., (7) X, p. 169, Pl. XII, figs. 8–10 (Mpala).

*Melania damoni* E. A. Smith. PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 108.

*Paramelania (Bourguignatia) imperialis* Giraud. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 207.

*Paramelania imperialis* Giraud. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 178.

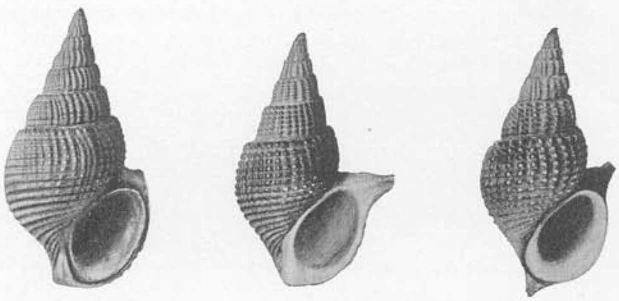
*Paramelania imperialis* var. *guillemei* MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 178, Pl. VIII, fig. 23 (Mpala).

*Paramelania imperialis* var. *mpalaensis* MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 180, Pl. VIII, fig. 24 (Mpala).

*Pyrgulifera damoni* E. A. Smith. C. A. WHITE, 1881, Nature, XXV, p. 102; 1882, Proc. U. S. Nat. Mus., V, p. 98, Pl. III, fig. 13. TAUSCH, 1884, Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., XC, Abt. 1, p. 61, Pl. I, fig. 4.

Lake Tanganyika: originally described from that lake without more definite locality (Damon Coll.); Mpala, on the southwestern shore (Giraud Coll.; Guillemé Coll.); Tembwe and Mrumbi on the western shore at a depth of 30 to 40 fathoms; Mshale, on the northeastern shore at a depth of 25 fathoms; also at the southern end (W. A. Cunnington Coll.); on the western coast (Guillemé Coll.).

Stappers dredged this species at a number of places: Bay of Kilewa; off Uvira; bay of Kasakalawe; delta of the Ruzizi River; near the mouth of the Sambala River; between the Moba and the Lobozi Rivers; and off Tulo. Hedley found it on the beach at Albertville.



*a* *b* *c*

Fig. 67. *a-c*, *Paramelania (Bythoceras) iridescens* (Moore). At *b*, a specimen from Kilewa.

## Subgenus **BYTHOCERAS** J. E. S. Moore

*Bythoceras* J. E. S. MOORE, 1898 (March), Proc. Roy. Soc. London, LXII, p. 452; 1898 (July), Proc. Malacol. Soc. London, III, 2, p. 93. Monotype: *Bythoceras iridescens* J. E. S. Moore.

According to E. A. Smith (1906, Proc. Zool. Soc. London, I, p. 182), there seems to be very little in the character of the shells, opercula, and radulæ to separate this from *Paramelania*. Moore states that the anatomy is practically identical. It differs from *Paramelania* only in the more produced ends of the peristome and this varies considerably in specimens seen.

### *Paramelania (Bythoceras) iridescens* (J. E. S. Moore)

Text Figure 67*a-c*

*Bythoceras iridescens* J. E. S. Moore, 1898 (March), Proc. Roy. Soc. London, LXII, p .452, fig. 1; 1898 (March), Quart. Jl. Micr. Sci., N.S., XLI, p. 307; 1898 (July), Proc. Malacol. Soc. London, III, 2, p. 93, fig. I; 1903, 'The Tanganyika Problem,' pp. 237–243, figs. 21–23. Nicolas, 1899, C. R. Assoc. Franç. Avanc. Sci., (1898), II, p. 525, fig. 9. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 86; 1906, Proc. Zool. Soc. London, I, p. 182, Pl. x, figs. 1–3. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: Sumbu, in the southern portion, alive at a depth of 600–700 ft. (type locality; J. E. S. Moore Coll.); Niamkolo, at the southern end (W. A. Cunnington Coll.).

Stappers obtained this species in the bay of Kilewa, bay of the Luvu, the region of Kituta, off Uvira, off Moliro, bay of Sumbu, and near the delta of the Ruzizi River.

### *Paramelania (Bythoceras) minor* (J. E. S. Moore)

*Bythoceras minor* J. E. S. Moore, 1903, 'The Tanganyika Problem,' p. 242, fig 24, and p. 244. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 86, fig. 1. (on p. 87); 1906, Proc. Zool. Soc. London, I, p. 182, Pl. x, fig. 4.

Lake Tanganyika: originally described from the lake without more definite locality (J. E. S. Moore Coll.); Tembwe, on the western coast (W. A. Cunnington Coll.).

In 1906, E. A. Smith was of opinion that *B. minor* would eventually prove to be a variety of *Paramelania crassigranulata* E. A. Smith.

### *Lavigeria* Group

Shell elongate or ovate, with spiral sculpture and axial folds. Operculum scarcely spiral, with subbasal, marginal nucleus. Side teeth of the radula short, the inner one with few cusps (3 in *L. grandis*), outer with numerous denticles.

Probably the genera *Joubertia*, *Lavigeria*, and *Randabelia* are not really separable. Their shell characters are much the same. According to Dautzenberg, *Hirthia* is to be added. We have seen only *Lavigeria* and *Joubertia*. *Lavigeria* has been dissected, but the anatomy and opercula of the other supposed genera are unknown.

*Edgaria* has an operculum of the same type as *Lavigeria*, but wider and oval. The shell differs chiefly by its rounded, evenly concave columella. The position of *Lechaptoisia* is doubtful, as only the shell is known.

These are mollusks of the littoral zone, often very abundant.

### JOUBERTIA Bourguignat

*Joubertia* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 32; 1890, Ann. Sc. Nat. Zool., (7) X, p. 174. Type by present designation: *Paramelania baizeana* Bourguignat.

### *Joubertia baizeana* (Bourguignat)

*Paramelania baizeana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 74.

*Joubertia baizeana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIII, figs. 5–7; 1890, Ann. Sc. Nat. Zool., (7) X, p. 174, Pl. XIII, figs. 5–7. E, A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 88. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: Kapampa on the southern shore (type locality).

### *Joubertia spinulosa* (Bourguignat)

*Paramelania spinulosa* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 75.

*Joubertia spinulosa* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIII, figs. 8–10; 1890, Ann. Sc. Nat. Zool., (7) X, p. 175, Pl. XIII, figs. 8–10. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 88. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

*Paramelania (Joubertia) spinulosa* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 207.

Lake Tanganyika: Mlilo, on the southern shore (type locality).

### *Joubertia stanleyana* (Bourguignat)

*Paramelania stanleyana* BOURGUIGNAT, 1885, 'Notice Prodom. Moll. Giraud Tanganika,' p. 75.

*Joubertia stanleyana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIII, figs. 11–12; 1890, Ann. Sc. Nat. Zool., (7) X, p. 176, Pl. XIII, figs. 11–12. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 88. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: Mlilo and Pambete, on the southern shore (type locality not designated).

### LAVIGERIA Bourguignat

*Lavigeria* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 33; 1890, Ann. Sc. Nat. Zool., (7) X, p. 178. Type by present designation: *Tiphobia nassa* var. *grandis* E. A. Smith.

*Nassopsis* E. A. SMITH, 1890, Ann. Mag. Nat. Hist., (6) VI, p. 93. Monotype· *Nassopsis nassa* var. *grandis* E. A. Smith.

This genus is characterized chiefly by the basal nucleus of the operculum (Fig. 56*c*) and the relative shortness of the side teeth of the radula, the inner marginal having but three cusps.

Our knowledge of the anatomy is due to Moore, who published an account with figures of *L. grandis*. Pelseneer [1907, Rept. Brit. Ass. Adv. Sci., (1906), p. 602], who also has examined but not published the anatomy, concludes that *Lavigeria* is a melanid; the female is viviparous.

### *Lavigeria callista* Bourguignat

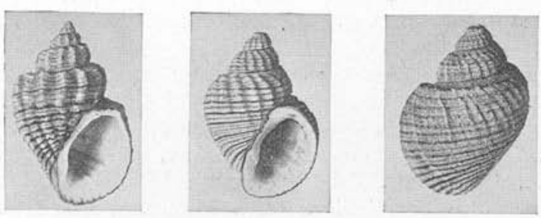
*Lavigeria callista* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xiv, fig. 2; 1890, Ann. Sc. Nat. Zool., (7) X, p. 183, Pl. xiv, fig. 2. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: Bono and at the mouth of the Mkulungulu in Ugoma (type locality not designated).

### *Lavigeria combsa* Bourguignat

*Lavigeria combsa* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xiv, fig. 7; 1890, Ann. Sc. Nat. Zool., (7) X, p. 189, Pl. xiv, fig. 7. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 251 and 263.

Lake Tanganyika: Mlilo, on the southern shore (type locality); Ufipa, on the eastern shore (Lechaptois Coll.).



*a* *b* *c*

Fig. 68. *a*, *Lavigeria coronata* Bourguignat. *b-c*, *Lavigeria grandis* (E. A. Smith)

### *Lavigeria coronata* Bourguignat

Text Figure 68*a*

*Lavigeria coronata* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xiii, figs. 13–14; 1890, Ann. Sc. Nat. Zool., (7) X, p. 180, Pl. xiii, figs. 13–14. Nicolas, 1899, C. R. Ass. Franç. Av. Sci., (1898), II, p. 517, fig. 6. E. A. Smith, Proc. Malacol. Soc. London, VI, 2, p. 89. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

*Paramelania tabulata* G. B. Sowerby, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 8 (Tanganyika).

*Paramelania* (*Lavigeria*) *coronata* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 207.

Lake Tanganyika: near the mouth of the Luandazi and the Mkulungulu Rivers on the western coast (type locality not designated).

## *Lavigeria diademata* Bourguignat

*Lavigeria diademata* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIII, figs. 15–17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 179, Pl. XIII, figs. 15–17. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

*Paramelania* (*Lavigeria*) *diademata* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 207.

*Nassopsis grandis* var. *diademata* Bourguignat. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 168, Pl. VIII, fig. 6.

Lake Tanganyika: Bono, on the western coast; near the mouth of the Mkulungulu and Luandazi Rivers in Ugoma (type locality not designated).

## *Lavigeria grandis* (E. A. Smith)

Text Figure 68*b*-*c*

*Melania* (*Melanella*) *nassa* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 292 (*pro parte*), Pl. XXXIV, figs. 26 and 26*a* (not of Woodward).

*Tiphobia* (*Paramelania*) *nassa* var. *grandis* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 561.

*Paramelania grandis* E. A. Smith. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 69. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 7.

*Lavigeria gr ndis* E. A. Smith. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, fig. 1; 1890, Ann. Sc. Nat. Zool., (7) X, p. 182, Pl. XIV, fig. 1. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 88; 1906, Proc. Zool. Soc. London, I, p. 182, Pl. X, figs. 10 and 11 (operculum). ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

*Nassopsis nassa* var. *grandis* E. A. SMITH, 1890, Ann. Mag. Nat. Hist., (6) VI, p. 93 (anatomy).

*Nassopsis grandis* E. A. Smith. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 167.

*Nassopsis nassa* J. E. S. MOORE, 1898, Quart. Jl. Micr. Sci., N.S., XLI, Pl. XXIII, fig. 2; 1903, 'The Tanganyika Problem,' pp. 250–256, figs. 33–38, and p. 347, lower figs. DIGBY, 1902, Journ. Linn. Soc. London, Zool., XXVIII, p. 442, Pl. XL, fig. 26.

Lake Tanganyika: originally described from the eastern shore of the lake, without more definite locality; on the eastern coast, from the bay of Kigoma to Kisuka in Usige; Mbete, at the southern end (W. A. Cunnington Coll.).

## *Lavigeria jouberti* Bourguignat

*Lavigeria jouberti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, fig. 4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 185, Pl. XIV, fig. 4. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259; 1911, *op. cit.*, p. 438; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 657. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 251 and 262.

*Nassopsis grandis* var. *jouberti* Bourguignat. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 169, Pl. VIII, fig. 7.

Lake Tanganyika: Mlilo (type locality); Ufipa on the eastern shore (Lechaptois Coll.).

### *Lavigeria pereximia* Bourguignat

*Lavigeria pereximia* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, fig. 3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 187, Pl. XIV, fig. 3. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: near the mouth of the Mkulungulu River (type locality).

### *Lavigeria ruellaniana* Bourguignat

*Lavigeria ruellaniana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, figs. 5–6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 190, Pl. XIV, figs. 5–6. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

Lake Tanganyika: Mlilo and Kapampa (type locality not designated).

## RANDABELIA Bourguignat

*Randabelia* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 31; 1890, Ann. Sc. Nat. Zool., (7) X, p. 170. Type by present designation: *Paramelania hamyana* Bourguignat.

Both E. A. Smith and Ancey are inclined to believe that this so-called genus represents the young stages of *Lavigeria*, an opinion which we share; but we have not seen specimens.

### *Randabelia catoxia* Bourguignat

*Randabelia catoxia* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIII, figs. 1–2; 1890, Ann. Sc. Nat. Zool., (7) X, p. 171, Pl. XIII, figs. 1–2. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. ANCEY, Bull. Scientif. France et Belgique, (5) X, (1906), pp. 251 and 262.

Lake Tanganyika: north of Mlilo, on the southern shore (type locality); Ufipa, on the eastern shore (Lechap ois Coll.).

This, Ancey believes, is the young stage of *Lavigeria jouberti*.

### *Randabelia hamyana* (Bourguignat)

*Paramelania hamyana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 71.

*Randabelia hamyana* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIII, figs. 3–4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 173, Pl. XIII, figs. 3–4. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 89. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 251.

*Paramelania* (*Randabelia*) *hamyana* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 207.

Lake Tanganyika: Pambete, on the southern shore (type locality).

### HIRTHIA Ancey

*Hirthia* ANCEY, 1898, Bull. Mus. Marseille, I, 1, p. 142. Type by present designation: *Hirthia littorina* Ancey.

*Hirtia* DAUTZENBERG, 1900, Journ. de Conchyl., XLVIII, p. 81. Misspelling of *Hirthia*.

According to Dautzenberg (1900, Journ. de Conchyl., XLVIII, p. 81) this genus does not differ from *Lavigeria* (*Nassopsis*).

### *Hirthia littorina* Ancey

*Hirthia littorina* ANCEY, 1898, Bull. Mus. Marseille, I, 1, p. 142, Pl. IX, fig. H (left). E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 91. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 265.

Lake Tanganyika: Ufipa on the southeastern shore (type locality; Lechaptois Coll.).

### *Hirthia globosa* Ancey

*Hirthia globosa* ANCEY, 1898, Bull. Mus. Marseille, I, 1, p. 144, Pl. IX, fig. H (right). E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 91. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 265.

Lake Tanganyika: Ufipa on the southeastern shore (type locality; Lechaptois Coll.).

### EDGARIA Bourguignat

*Edgaria* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 34; 1890, Ann. Sc. Nat. Zool., (7) X, p. 192.

*Paramelania* subgenus *Nassopsidia* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 208. Type by present designation: *Paramelania crassilabris* Bourguignat.

Type by present designation: *Paramelania nassa* var. *paucicostata* E. A. Smith = *Edgaria paucicostata* Bourguignat, the first of the four species originally included; the other three are probably only variations of this.

### *Edgaria arenarum* (Bourguignat)

*Paramelania arenarum* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XVII, figs. 3–4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 244, Pl. XVII, figs. 3–4. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 656.

*Edgaria livingstoniana* f. *arenarum* Bourguignat. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252.

Lake Tanganyika: Kabanga and Kapampa (type locality not designated).

We have followed Germain in listing this as a distinct species; according to E. A. Smith it is one of the many variations of *E. nassa*.

### *Edgaria crassilabris* (Bourguignat)

*Paramelania crassilabris* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 84; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XVI, figs. 15–16; 1890, Ann. Sc. Nat. Zool., (7) X, p. 241, Pl. XVI, figs. 15–16.

*Nassopsis crassilabris* Bourguignat. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 171, Pl. VIII, figs. 10–11.

*Edgaria crassilabris* Bourguignat. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 91. ANCEY, 1907, Bull. Scientf. France et Belgique, (5) IX, (1906), pp. 252 and 263.

*Nassopsis guillemei* MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 172, Pl. VIII, figs. 12–13 (Mpala).

*Edgaria guillemei* Martel and Dautzenberg. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252.

Lake Tanganyika: originally described from Mlilo and Pambete, on the southern shore, but no type locality designated; Ufipa; Mbwe; Mpala (Guillemé Coll.)

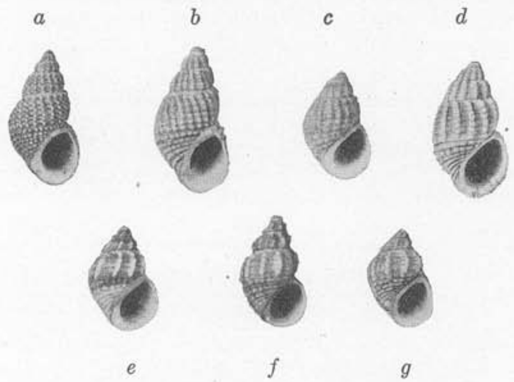



Fig. 69. *a-b*, *Edgaria giraudi* (Bourguignat) (=*locardiana* Bourguignat). *c-d*, *Edgaria nassa* (Woodward). *e-g*, *Edgaria paucicostata* (E. A. Smith).

### *Edgaria giraudi* (Bourguignat)

Text Figure 69*a-b*

*Paramelania giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 82; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XVI, figs. 19–20; 1890, Ann. Sc. Nat. Zool., (7) X, p. 239, Pl. XVI, figs. 19–20.

*Paramelania locardiana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 82; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XVI, figs. 23–24; 1890, Ann. Sc. Nat. Zool., (7) X, p. 240, Pl. XVI, figs. 23–24 (Pambete, Mlilo, Kapampa).

*Paramelania locardi* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259; 1911, *op. cit.*, p. 437; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 655.

*Edgaria giraudi* Bourguignat. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p 252.

*Edgaria locardiana* Bourguignat. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, pp. 252 and 263.

Lake Tanganyika: Mlilo (type locality; V. Giraud Coll.); Pambete; Kapampa; also on the eastern coast.

We have followed Germain in regarding this as specifically distinct, but synonymous with *locardiana.* E. A. Smith regards both as variations of *E. nassa.*

### *Edgaria lechaptoisi* (Ancey)

*Lavigeria (?) lechaptoisi* ANCEY, 1898, Bull. Mus. Marseille, I, 1, p. 145, Pl. IX, fig. I.

*Edgaria lechaptoisi* Ancey. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 91. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 264.

*Nassopsis nassa* Woodward var. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, Pl. VIII, fig. 4. DAUTZENBERG, 1900, *op. cit.*, XLVIII, p. 71.

*Paramelania nassa* var. *dautzenbergi* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 654 (Mpala).

Lake Tanganyika: Ufipa, on the southeastern shore (type locality; Lechaptois Coll.) Mpala (Guillemé Coll.).

### *Edgaria lechaptoisi* var. *obliqua* Ancey

*Edgaria lechaptoisi* var. *obliqua* ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 264, footnote.

Lake Tanganyika: Ufipa, on the southeastern shore (type locality; Lechaptois Coll.).

### *Edgaria nassa* (Woodward)

Text Figure 69*c*-*d*

*Melania (Melanella) nassa* WOODWARD, 1859, Proc. Zool. Soc. London, p. 349, Pl. XLVII, fig. 4. E. A. SMITH, 1880, *op. cit.*, p. 348.

*Melania nassa* Woodward. REEVE, 1860, 'Conchol. Iconica,' XII, *Melania*, Pl. XXXII, fig. 216. BROT, 1874, in Martini and Chemnitz, 'Syst. Conch. Cab.,' I, 24, Melaniaceen, p. 52, Pl. VI, fig. 7. PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 108.

*Tiphobia (Paramelania) nassa* Woodward. E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 561.

*Paramelania nassa* Woodward. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 76; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XVI, figs. 7–8; 1890, Ann. Sc. Nat. Zool., (7) X, p. 227, Pl. XVI, figs. 7–8. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 5. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 653.

*Paramelania (Nassopsis) nassa* Woodward. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 208.

*Nassopsis nassa* Woodward. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 165, Pl. VIII, figs. 1–3, and 5.

*Edgaria nassa* Woodward. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 90; 1906, Proc. Zool. Soc. London, I, p. 182, Pl. X, fig. 19 (operculum). ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252.

*Paramelania randabeli* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XVI, figs. 21–22; 1890, Ann. Sc. Nat. Zool., (7) X, p. 225, Pl. XVI, figs. 21–22.

*Edgaria nassa* f. *randabeli* Bourguignat. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263.

*Pyrgulifera nassa* Woodward. TAUSCH, 1884, Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., XC, Abt. 1, p. 62, Pl. I, figs. 5–6.

Lake Tanganyika: eastern shore at Ujiji (type locality; Speke Coll.); near the mouth of the Luandazi River (type locality of *P. randabeli*); Kirando, on the southeastern shore (W A. Cunnington Coll.); Pambete. Albertville, abundant and variable, appearing to merge into *paucicostata, giraudi* and *singularis* (Charles Hedley).

### *Edgaria nassa* var. *nassatiformis* Bourguignat

*Paramelania nassatiformis* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XVII, figs. 5–6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 234, Pl. XVII, figs. 5–6.

*Melania* (*Melanella*) *nassa* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 292 (in part), Pl. XXXIV, fig. 26. H. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 113, Pl. IV, figs. 3–3*a*.

*Paramelania nassa* var. *nassatiformis* Bourguignat. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 655.

*Edgaria livingstoniana* f. *nassatiformis* Bourguignat. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252.

Lake Tanganyika: Kapampa, Karema, and Ujiji (type locality not designated).

### *Edgaria paucicostata* (E. A. Smith)

Text Figure 69*e, f, g*

*Melania* (*Melanella*) *nassa* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 292 (in part), Pl. XXXIV, fig. 26*b* (not of Woodward).

*Tiphobia* (*Paramelania*) *nassa* var. *paucicostata* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 561.

*Melania* (*Paramelania*) *crassa* var. *paucicostata* E. A. Smith. CROSSE, 1881, Journ. de Conchyl., XXIX, p. 285.

*Paramelania paucicostata* E. A. Smith. BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 69. G. B SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 1, Pl., fig. 6. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 656; 1911, Bull. Mus. Hist. Nat. Paris, p. 437.

*Edgaria paucicostata* E. A. Smith. BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, figs. 8–9; 1890, Ann. Sc. Nat. Zool., (7) X, p. 193, Pl. XIV, figs. 8–9. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 90. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 259. E. A. SMITH, 1906, Proc. Zool. Soc. London, I, p. 82. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 251 and 263.

*Paramelania* (*Edgaria*) *paucicostata* E. A. Smith.. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 209.

*Nassopsis paucicostata* E. A. Smith. MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 170, Pl. VIII, figs. 8–9.

*Edgaria monceti* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XIV, figs. 12–13; 1890, Ann. Sc. Nat. Zool., (7) X, p. 195, Pl. XIV, figs. 12–13.

*Edgaria littoralis* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xiv, figs. 14–16; 1890, Ann. Sc. Nat. Zool., (7) X, p. 196, Pl. xiv, figs. 14–16.

*Paramelania (Edgaria) flexicosta* E. v. Martens, 1895, Nachrichtsbl. Deutsch. Malakoz. Ges., XXVII, p. 186; 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 209, Pl. vi, fig. 42 (Tanganyika).

*Nassopsis tiarella* Martel and Dautzenberg, 1899, Journ. de Conchyl., XLVII, p. 175, Pl. viii, figs. 18–19 (not of v. Martens).

Lake Tanganyika: originally described from that lake without more definite locality (Reichard Coll.); Ufipa (Lechaptois Coll.); at the southern end (W. A. Cunnington Coll.); Kibanga (type locality of *E. monceti*); Pambete (type locality of *E. littoralis*); Ujiji; Mpala (Guillemé Coll.).

## *Edgaria paucicostata* var. *callopleuros* (Bourguignat)

*Paramelania callopleuros* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 69.

*Edgaria callopleuros* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xiv, figs. 10–11; 1890, Ann. Sc. Nat. Zool., (7) X, p. 194, Pl. xiv, figs. 10–11.

*Edgaria paucicostata* var. *callopleuros* Bourguignat. Germain, 1905, Bull. Mus. Hist. Nat. Paris, p. 259.

*Paramelania paucicostata* var. *callopleuros* Bourguignat. Germain, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 657.

Lake Tanganyika: Pambete (type locality).

## *Edgaria reymondi* (Bourguignat)

*Paramelania reymondi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 72; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 20–21; 1890, Ann. Sc. Nat. Zool., (7) X, p. 214, Pl. xv, figs. 20–21.

*Paramelania bourguignati* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 73; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 18–19; 1890, Ann. Sc. Nat. Zool., (7) X, p. 213, Pl. xv, figs. 18–19.

*Edgaria bourguignati* Bourguignat. E. A. Smith, 1904, Proc. Malacol. Soc. London, IV, 2, p. 91. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 264.

*Edgaria reymondi* Bourguignat. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 91.

*Edgaria bourguignati* f. *reymondi* Bourguignat. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252.

Lake Tanganyika: Kapampa (type locality of both *reymondi* and *bourguignati*); Kigoma; Ufipa, on the eastern coast (Lechaptois Coll.).

## *Edgaria singularis* (Bourguignat)

*Paramelania singularis* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 16–17; 1890, Ann. Sc. Nat. Zool., (7) X, p. 211, Pl. xv, figs. 16–17.

*Edgaria singularis* Bourguignat. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 91. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252.

Lake Tanganyika: Kapampa (type locality).

## *Edgaria tiarella* (E. v. Martens)

*Paramelania* (*Edgaria*) *tiarella* E. v. MARTENS, 1895, Nachrichtsbl. Deutsch. Malakoz. Ges., XXVII, p. 187; 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 209, Pl. VI, fig. 43.

*Edgaria tiarella* E. v. Martens. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 90. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 251 and 263.

Lake Tanganyika: originally described from the lake, without more definite locality; Ufipa (Lechaptois Coll.).

## *Edgaria variabilis* (Martel and Dautzenberg)

*Nassopsis variabilis* MARTEL AND DAUTZENBERG, 1899, Journ. de Conchyl., XLVII, p. 174, Pl. VIII, figs. 16–17.

*Edgaria variabilis* Martel and Dautzenberg. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 90. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 251 and 263.

Lake Tanganyika: Mpala (type locality; Guillemé Coll.); Ufipa (Lechaptois Coll.).

The following forms, described by Bourguignat, are probably mere individual or local variations of some of the foregoing species:

*Edgaria alphonsi* (Bourguignat) = *Paramelania alphonsi* BOURGUIGNAT, 1890, Ann. Sc. Nat. Zool., (5) X, p. 218. *Edgaria milne-edwardsiana* f. *alphonsi* ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Mlilo (type locality).

*Edgaria bythiniformis* (Bourguignat) = *Paramelania bythiniformis* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XV, figs. 26–27; 1890, Ann. Sc. Nat. Zool., (7) X, p. 242, Pl. XV, figs. 26–27. *Edgaria elongata* f. *bythiniformis* ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263. Lake Tanganyika: at the outflow of the Lukuga River (type locality); Ufipa (Lechaptois Coll.).

*Edgaria cameroniana* (Bourguignat) = *Paramelania cameroniana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 80; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XV, figs. 22–23; 1890, Ann. Sc. Nat. Zool., (7) X, p. 210, Pl. XV, figs. 22–23. *Edgaria egregia* f. *cameroniana* ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Mlilo and Kapampa; type locality not designated.

*Edgaria duveyrieriana* (Bourguignat) = *Paramelania duveyrieriana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 79; 1888, 'Iconogr. Malacol, Tanganika,' Pl. XV, figs. 12–13; 1890, Ann. Sc. Nat. Zool., (7) X, p. 207, Pl. XV, figs. 12–13. *Edgaria egregia* f. *duveyrieriana* ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Mlilo (type locality); Pambete.

*Edgaria egregia* (Bourguignat) ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263 = *Paramelania egregia* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 81; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XV, figs. 1–3; 1890, Ann. Sc. Nat. Zool., (7) X, p. 205, Pl. XV, figs. 1–3. Lake Tanganyika: Kapampa (type locality); Ufipa (Lechaptois Coll.).

*Edgaria elongata* (Bourguignat) Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252 = *Paramelania elongata* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvi, figs. 9–10; 1890, Ann. Sc. Nat. Zool., (7) X, p 238, Pl. xvi, figs. 9–10. Lake Tanganyika; Mlilo and Pambete; type locality not designated.

*Edgaria formosa* (Bourguignat) = *Paramelania formosa* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 9–11; 1890, Ann. Sc. Nat. Zool., (7) X, p. 209, Pl. xv, figs. 9–11. *Edgaria egregia* f. *formosa* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263. Lake Tanganyika: Kapampa (type locality); Ufipa (Lechaptois Coll.).

*Edgaria grandidieriana* (Bourguignat) Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252 = *Paramelania grandidieriana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvi, figs. 1–2; 1890, Ann. Sc. Nat. Zool., (7) X, p. 221, Pl. xvi, figs. 1–2. Lake Tanganyika: Pambete (type locality).

*Edgaria infralirata* (Bourguignat) = *Paramelania infralirata* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 4–5; 1890, Ann. Sc. Nat. Zool., (7) X, p. 203, Pl. xv, figs. 4–5. *Edgaria egregia* f. *infralirata* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Mlilo (type locality).

*Edgaria lacunosa* (Bourguignat) = *Paramelania lacunosa* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika ' Pl. xvi, figs. 5–6; 1890, Ann. Sc. Nat. Zool., (7) X, p. 224, Pl. xvi, figs. 5–6. *Edgaria grandidieriana* f. *lacunosa* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Kapampa (type locality).

*Edgaria ledoulxiana* (Bourguignat) = *Paramelania ledoulxiana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 80; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 14–15; 1890, Ann. Sc. Nat. Zool., (7) X, p. 208, Pl. xv, figs. 14–15. *Edgaria egregia* f. *ledoulxiana* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263. Lake Tanganyika: Kapampa (type locality); Ufipa (Lechaptois Coll.).

*Edgaria lessepsiana* (Bourguignat) Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252 = *Paramelania lessepsiana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 78; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 28–29; 1890, Ann. Sc. Nat. Zool., (7) X, p. 218, Pl. xv, figs. 28–29. Lake Tanganyika: Mlilo (type locality).

*Edgaria limnæa* (Bourguignat) = *Paramelania limnæa* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 7–8; 1890, Ann. Sc. Nat. Zool., (7) X, p. 235, Pl. xvii, figs. 7–8. *Edgaria livingstoniana* f. *limnæa* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263. Lake Tanganyika: Pambete and Karema (type locality not designated); Ufipa (Lachaptois Coll.).

*Edgaria livingstoniana* (Bourguignat) Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252 = *Paramelania livingstoniana* Bourguignat, 1888, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 85; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 1–2; 1890, Ann. Sc. Nat. Zool., (7) X, p. 233, Pl. xvii, figs. 1–2. Lake Tanganyika: Pambete; Kapampa; Kibanga; type locality not designated.

*Edgaria mabilliana* (Bourguignat) = *Paramelania mabilliana* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvi, figs. 17–18; 1890, Ann. Sc. Nat Zool., (7) X, p. 232, Pl. xvi, figs. 17–18. *Edgaria egregia* f. *mabilliana* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Taganyika: Pambete (type locality).

*Edgaria milne-edwardsiana* (Bourguignat) Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263 = *Paramelania milne-edwardsiana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 77; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, fig. 30; 1890, Ann. Sc. Nat. Zool., (7) X, p. 216, Pl. xv, fig. 30. *Paramelania* (*Nassopsidia*) *milne-edwardsiana* E. v. Martens, 1897, 'Deutsch Ost Afr., IV , Beschalte Weichth.,' p. 208. Lake Tanganyika: Mlilo (type locality); Ufipa (Lechaptois Coll.).

*Edgaria nassatella* (Bourguignat) = *Paramelania nassatella* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvi, figs. 3–4; 1890, Ann. Sc. Nat. Zool., (7) X, p. 222, Pl. xvi, figs. 3–4. *Edgaria grandidieriana* f. *nassatella* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Kirando, south of Karema (type locality).

*Edgaria obtusa* (Bourguignat) = *Paramelania obtusa* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 6–8; 1890; Ann. Sc. Nat. Zool., (7) X, p. 206, Pl. xv, figs. 6–8. *Edgaria egregia* f. *obtusa* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 252 and 263. Lake Tanganyika: Kapampa (type locality); Ufipa (Lechaptois Coll.).

*Edgaria palustris* (Bourguignat) Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252 = *Paramelania palustris* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 31–32; 1890, Ann. Sc. Nat. Zool., (7) X, p. 219, Pl. xv, figs. 31–32. Lake Tanganyika: Mlilo (type locality).

*Edgaria pulchella* (Bourguignat) = *Paramelania pulchella* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 86; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 9–10; 1890, Ann. Sc. Nat. Zool., (7) X, p. 237, Pl. xvii, figs. 9–10. *Edgaria livingstoniana* f. *pulchella* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Kapampa (type locality).

*Edgaria servainiana* (Bourguignat) = *Paramelania servainiana* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 83; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvii, figs. 11–12; 1890, Ann. Sc. Nat. Zool., (7) X, p. 243, Pl. xvii, figs. 11–12. *Edgaria livingstoniana* f. *servainiana* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Pambete (type locality).

*Edgaria smithi* (Bourguignat) = *Paramelania smithi* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvi, figs. 11–12; 1890, Ann. Sc. Nat. Zool., (7) X, p. 228, Pl. xvi, figs. 11–12. *Edgaria nassa* f. *smithi* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Mlilo and coast of Ituha (type locality not designated).

*Edgaria timida* (Bourguignat) = *Paramelania timida* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xv, figs. 24–25; 1890, Ann. Sc. Nat. Zool., (7) X, p. 215, Pl. xv, figs. 24–25. Lake Tanganyika: Kigoma (type locality).

*Edgaria venusta* (Bourguignat) = *Paramelania venusta* Bourguigant, 1888, 'Iconogr. Malacol. Tanganika,' Pl. xvi, figs. 13–14; 1890, Ann. Sc. Nat. Zool., (7) X, p. 230, Pl. xvi, figs. 13–14. *Edgaria nassa* f. *venusta* Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 252. Lake Tanganyika: Pambete (type locality).

### Lechaptoisia Ancey

*Lechaptoisia* Ancey, 1894, Bull. Soc. Zool. France, XIX, p. 29. Substitute for *Horea* E. A. Smith, not of Bourguignat, 1888.

*Rissoa* subgenus *Horea* E. A. Smith, 1889, Ann. Mag. Nat. Hist., (6) IV, p. 175. Monotype: *Rissoa* (*Horea*) *ponsonbyi* E. A. Smith. Not *Horea* Bourguignat, 1888.

### *Lechaptoisia ponsonbyi* (E. A. Smith)

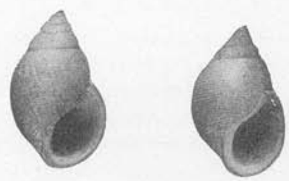
Text Figure 70*a-b*

*Rissoa* (*Horea*) *ponsonbyi* E. A. Smith, 1889, Ann. Mag. Nat. Hist., (6) IV, p. 175.

*Lechaptoisia ponsonbyi* E. A. Smith. Ancey, 1894, Bull. Soc. Zool. France, XIX, p. 29; 1901, Journ. de Conchyl., XLIX, p. 224. E. A. Smith, 1904, Proc. Malacol. Soc. London, VI, 2, p. 94. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 254.

*Horea ponsonbyi* E. A. Smith. G. B. Sowerby, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 13. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 211.

Lake Tanganyika: originally described from the eastern shore without more definite locality (E. C. Hore Coll.).



*a* *b*

Fig. 70. *a-b*, *Lechaptoisia ponsonbyi* (E. A. Smith). 6.5 and 6.7 mm. long.

## PELECYPODA

Aquatic mollusks without distinct head and without radula, protected by a bivalve shell, the two valves united by an elastic dorsal ligament and usually articulated together by hinge-processes or "teeth"; connected also by adductor muscles passing from one valve to the other and serving to pull them together. In the freshwater groups there are two (rarely one) pairs of leaf-like gills between mantle and foot, serving also as gatherers of food and often as marsupial pouches for the eggs and embryos.

In the Ethiopian Region this class is represented by eight families, classified thus[1]:

| | | |
|---|---|---|
| Order Teleodesmacea | Superfamily Cyrenacea | Cyrenidæ<br>Sphæriidæ |
| | Superfamily Tellinacea: | Donacidæ. |
| | Superfamily Lucinacea: | Cyrenoididæ |
| Order Prionodesmacea | Superfamily Naiadacea | Unionidæ<br>Mutelidæ<br>Etheriidæ |
| | Superfamily Mytilacea: | Dreissenidæ |

[1]The arrangement given is that of Dall. In the classification of Pelseneer the first six families are placed in the Order Eulamellibranchia, the last one in Filibranchia.

### Key to Ethiopian Families of Pelecypoda

1. Shell equivalve, wedge-shaped, the hinge without teeth, the beaks terminal at the smaller (anterior) end, a septum across them inside; posterior adductor muscle very large. Byssiferous. Estuarine mussels...........Dreissenidæ.
   Beaks not terminal, or if so, the adductor muscle scars are not greatly unequal..2.
2. Interior pearly..........................................................3.
   Interior porcellanous....................................................5.
3. Irregular, inequivalve, oyster-like; hinge without teeth; living attached to shells, stones, etc....................................Etheriidæ.
   Equivalve; free in the adult stage.........................................4.
4. Hinge having lamellar lateral teeth and shorter cardinals (in African species). Unionidæ.
   Hinge various; toothless, with a series of many short teeth, etc., but without lamellar laterals (in African species)..........................Mutelidæ.
5. No lateral teeth; a 7-shaped cardinal in each valve, another tooth below it in the right valve; shell subcircular, with very indistinct adductor and pallial impressions..........................................Cyrenoididæ.
   Anterior and posterior lateral teeth present, at least in the right valve (though often very small in *Egeria*, where the cardinal teeth are very large); cardinal teeth present; shell trigonal, oval or orbicular....................6.
6. Two or three moderately to very strong cardinal teeth, diverging from the beaks in both valves, on a distinctly or strongly developed hinge-plate..........7.
   Cardinal teeth minute and conspicuously unlike in the two valves, not more than two in each valve, the laterals far larger though lamellar; the hinge-plate extremely narrow; shell thin, rather small or minute..........Sphæriidæ.
7. No pallial sinus in African fresh-water genera....................Cyrenidæ.
   A pallial sinus present in African fresh-water genera..............Donacidæ.

## TELEODESMACEA

### Cyrenidæ

Shell trigonal to oval, moderately or very solid, porcellanous, covered with a yellow to olivaceous or brown periostracum; hinge-plate developed, bearing 2 or 3 cardinal teeth diverging from the beaks in each valve, and anterior and posterior lateral teeth. Ligament external; pallial line entire in the African genera. The mantle is free, except posteriorly where a partition divides off a siphonal cavity. Siphons quite short and separate or represented by mere orifices. Gills concrescent posteriorly. Labial palpi rather short, triangular. Oviparous so far as known.

A number of genera in nearly all tropical and subtropical regions of both hemispheres. *Corbicula*, generally spread in East Africa, appears to be in course of invading the West African fauna.

### Key to African Genera of Cyrenidæ

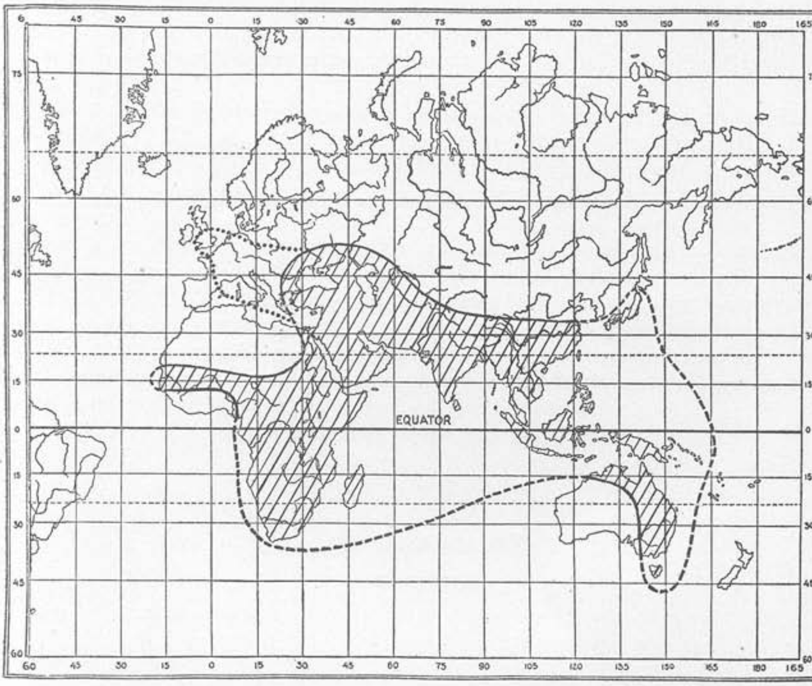
1. Lateral teeth absent in both valves. Shell thin and fragile. *Soleilletia* Bourguignat.
   Lateral teeth well developed in both valves, long and finely crenulate. Shell thick and solid..........................*Corbicula* Megerle v. Mühlfeld.

**Corbicula** Megerle v. Mühlfeld

*Corbicula* Megerle v. Mühlfeld, 1811, Mag. Ges. Naturf. Fr. Berlin, V, p. 56. Monotype: *Tellina fluminalis* O. F. Müller, "die Euphratische Korbmuschel." Dall, 1903, Trans. Wagner Free Inst. Sci. Philadelphia, III, p. 1448.

Trigonal to oval Cyrenidæ in which the lateral teeth are long and closely crenulate. Pallial sinus entire. Usually the exterior has concentric sculpture, and the interior more or less violaceous color.

Animal with two short siphons, both provided with papillæ at their apertures.[1]




Map 5. Present-day distribution of the genus *Corbicula*.

**The dotted line indicates the former distribution of *Corbicula fluminalis* in Europe.**

The genus *Corbicula* is at present distributed over the Ethiopian Region, Madagascar, southeastern Europe, southern and eastern Asia, the Indo-Malayan Region, eastern Australia, and Tasmania (See Map 5). During the late Pliocene and the Pleistocene, however, it extended over much of central and southern Europe, as far as western Great Britain.[2]

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[1]See Prashad, B. 1920. 'The gross-anatomy of *Corbicula fluminalis* (Müller).' Rec. Indian Mus., XVIII, pp. 209–211.

[2]O. v. Linstow. 1922. 'Beitrag zur Geschichte und Verbreitung von *Corbicula fluminalis*.' Archiv f. Molluskenk., LIV, pp. 113–144, Pls. IV–V.

See also L. Germain. 1922. 'Mollusques terrestres et fluviatiles recueillis en Syrie par M. H. Gadeau de Kerville,' II, pp. 92–109.

Closely allied forms (*Cyanocyclas*) are found living in South America.

We cordially endorse Connolly's sage remark that "It would require intimate acquaintance with the types and long sets of each variety to unravel the extraordinary tangle into which the African species of *Corbicula* have been woven."

The following species of *Corbicula* have been described from Africa.[1]

*Corbicula africana* (Krauss) = *Cyrena africana* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 8, Pl. I, fig. 8 (here restricted to the specimens from the Guaritz River, Swellendam Province). *Cyrena africana* var. *a olivacea* KRAUSS, 1848, *op. cit.*, p. 8 (the specimens from the Gauritz River). *Cyrena gauritziana* KRAUSS, 1848, *op. cit.*, p. 8 (as a synonym of *olivacea*).

*Corbicula artini* PALLARY, 1903, Bull. Inst. Egyptien, (4) III, (1902), p. 93, Pl. I, fig. 4 (White Nile; with var. ex colore *albina* Pallary). According to Pallary (1909, Mém. Inst. Egyptien, VI, p. 71), the following is a synonym of this: *Corbicula lavigeriana* "Bourguignat" GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 583. fig. 18*b* (type locality: Ugoi); *C. consobrina* var. *lavigeriei* GERMAIN, 1906, *op. cit.*, p. 584. We have seen a specimen referable to *C. artini* from the Nile in 10° N. (Pilette Coll.) and it appears to be quite a distinct species.

*Corbicula astartina* (v. MARTENS) = *Cyrena astartina* E. v. MARTENS, 1860, Malakoz. Blätter, VI, p. 219, Pl. III, figs. 6 and 7 (type locality: Tete in the Zambezi River). *Corbicula giraudi* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 38 (without description; from Lake Nyasa at Karonga; a synonym of *C. astartina*, according to Germain, 1906, Bull. Mus. Hist. Nat. Paris, p. 584).

*Corbicula audoini* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 476; 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 218, Pl. II, figs. 35–37. Several localities in the Eguei district, east of Lake Chad.

*Corbicula callipyga* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 37, Pl., figs. 13 and 13′. Hauash River, Abyssinia.

*Corbicula cunningtoni* E. A. SMITH, 1906, Proc. Zool. Soc. London, I, p. 186, Pl. X, fig. 15. Bukoba, in Lake Victoria.

*Corbicula delessertiana* PRIME, 1870, Ann. Lyc. Nat. Hist. New York, IX, p. 299. The Pyramids, Egypt and Smyrna. Clessin supposes that this is a synonym of *C. radiata* (Philippi).

*Corbicula difficilis* PRIME, 1864, Ann. Lyc. Nat. Hist. New York, VIII, p. 62, fig. 7. "African septentrionalis?"

*Corbicula doufilei* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 144; 1904, Mém. Soc. Zool. France, XVII, p. 22, Pl. II, figs. 3–5. Dufilé on the White Nile.

*Corbicula fischeri* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 68; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 580, Pl. V, figs. 18–19*a*. Mamun, Senussi Country, French Equatorial Africa.

*Corbicula fluminalis* (O. F. Müller). See p. 344.

*Corbicula foai* J. Mabille. See p. 345.

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[1] Servain (1890, Bull. Soc. Malacol. France, VII, p. 286) enumerated 46 alleged species of *Corbicula* from Egypt recognized by Bourguignat. As none of the new names were defined, they need not be listed here. See also Pallary, 1909, Mém. Inst. Egyptien, VI, p. 73; list of 39 supposed species of *Corbicula* in Bourguignat's collection, none of them defined. More recently Pallary (1924, Mém. Inst. d'Egypte, VII, 1, pp. 37–39) has named many additional forms from Egypt.

*Corbicula gabonensis* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) IV, p. 90, Pl. IV, fig. 8. Gaboon.

*Corbicula gravieriana* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 38, Pl., figs. 14 and 14′. Hauash River, Abyssinia.

*Corbicula heuglini* CLESSIN, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab.,' IX, 3, Cycladeen, p. 139, Pl. XXV, figs. 1 and 2. Lake Tsana, Abyssinia.

*Corbicula inæquilateralis* PRIME, 1864, Ann. Lyc. Nat. Hist. New York, VIII, p. 80, fig. 31. "Africa."

*Corbicula jickeli* CLESSIN, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab.,' IX, 3, Cycladeen, p. 163, Pl. XXIX, figs. 1 and 2. Based upon *C. pusilla* var. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 289, Pl. II, fig. 12. In a canal of the Nile, near Cairo.

*Corbicula kirkii* PRIME, 1864, Ann. Lyc. Nat. Hist. New York, VIII, p. 66, fig. 12. Mozambique.

*Corbicula lacoini* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 487; 1906, Mém. Soc. Zool. France, XIX, p. 241, Pl. IV, figs. 13 and 14; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 579; 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 215 (with var. ex colore *castanea* Germain). Numerous localities in the region of Lake Chad.

*Corbicula meridionalis* CLESSIN, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab.,' IX, 3, Cycladeen, p. 142, Pl. XXV, figs. 15–17. "Afrika im Senegal?"

*Corbicula natalensis* "Krauss" CLESSIN, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab.,' IX, 3, Cycladeen, p. 155, Pl. XXVII, figs. 19–21. Natal.

*Corbicula nilotica* CLESSIN, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab.,' IX, 3, Cycladeen, p. 177, Pl. XXXI, fig. 3. Near Bahr-el-Asrak, in the Blue Nile.

*Corbicula oliphantensis* CRAVEN, 1880, Proc. Zool. Soc. London, p. 618, Pl. LVII, fig. 12. Olifant's River, Transvaal.

*Corbicula pusilla* (Philippi) = *Cyrena pusilla* "Parreyss" PHILIPPI, 1846, 'Abbild. Beschr. Conchyl.,' II, p. 78, *Cyrena*, Pl. I, fig. 7 (type locality: Upper Nile). *Cyrena africana* var. β *albida* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 9 (specimens from the Upper Nile). *Corbicula alba* CLESSIN, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab.,' IX, 3, Cycladeen, p. 157, Pl. XXVII, figs. 27 and 28 (White Nile; specimens from Sennar, above Khartoum). H. Adams (1866, Proc. Zool. Soc. London, p. 376) has recorded *C. pusilla* from Lake Albert.

*Corbicula radiata* (Philippi). See p. 341.

*Corbicula radiata edwardi* Pilsbry and Bequaert. See p. 343.

*Corbicula senegalensis* CLESSIN, 1879, in Martini and Chemnitz, 'Syst. Conch. Cab.,' IX, 3, Cycladeen, p. 141, Pl. XXV, figs. 9 and 10. Senegal.

*Corbicula soleilleti* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 36, Pl., figs. 12 and 12′. Hauash River, Abyssinia.

*Corbicula subtruncata* "Bourguignat" GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 582, fig. 17*c* (type locality: Kingani River at Bagamayo) = *Corbicula subtruncatula* BOURGUIGNAT, 1889, 'Moll. Afr. Equator.,' p. 190 (without description). Germain makes this a synonym of *C. fluminalis;* but Pallary (1909, Mém. Inst. Egyptien, VI, p. 70) considers it a distinct species and records it from Mahmoudieh Canal, Egypt.

*Corbicula subtruncata* var. *ægyptiaca* "Bourguignat" PALLARY, 1909, Mém Inst. Egyptien, VI, p. 70 (from the Nile and the fresh-water canal of Suez; with var.

ex colore *cyanea* "Bourguignat," not described) = *Corbicula ægyptiaca* BOURGUIGNAT, 1889, 'Moll. Afr. Equator.,' p. 190 (without description). GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 582, fig. 17*b* (as a synonym of *C. consobrina* = *C. fluminalis*).

*Corbicula tanganyicensis* Crosse. See p. 343.

*Corbicula tsadiana* E. v. MARTENS, 1903, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 9 = *Corbicula tchadiensis* GERMAIN, 1916, 'Doc. Scientif. Miss. Tilho,' III, p. 318. Southern shore of Lake Chad.

*Corbicula zelebori* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 290, Pl. XI, fig. 13. Fresh-water canal near Suez, Egypt.

## **Corbicula radiata** (Philippi)

Text Figures 71*a-f* and 72*a-d*

*Cyrena radiata* "Parreyss" PHILIPPI, 1846, 'Abbild. Beschr. Conchyl.,' II, p 78, *Cyrena*, Pl. I, fig. 8 (type locality: Bahr-el-Abiad, White Nile).

*Corbicula radiata* Philippi. DESHAYES, 1854, 'Cat. Conchif. Brit. Mus.,' II, p. 222. H. ADAMS, 1866, Proc. Zool. Soc. London, p. 376. E. A. SMITH, 1877, *op. cit.*, p. 718; 1888, *op. cit.*, p. 55; 1890, Ann. Mag. Nat. Hist., (6) VI, p. 149; 1892, *op. cit.*,

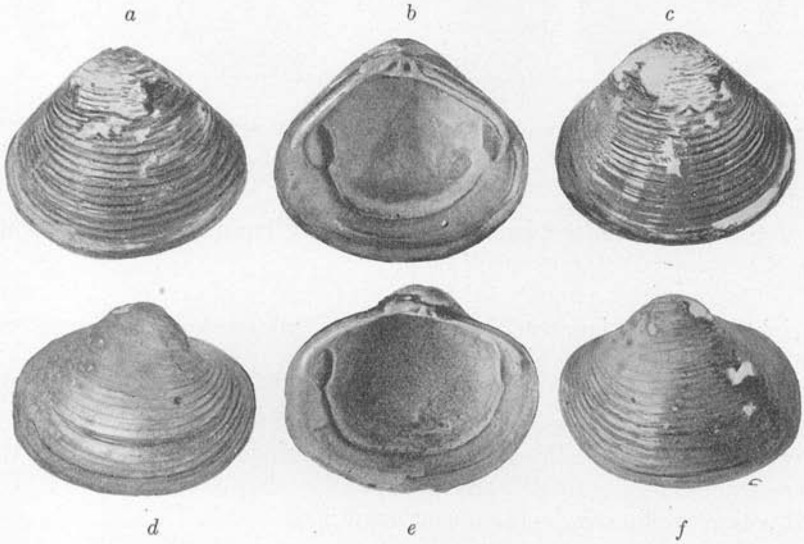



Fig. 71. *a-f*, *Corbicula radiata* (Philippi), Kachiobwe. Exterior of both valves and interior of left valve. *a-c*, triangular, and *d-f*, oval forms. ×2.

(6) X, p. 126. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 259. DAUTZENBERG, 1908, Journ. de Conchyl., LVI, p. 31. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 212. GERMAIN, 1912, Bull. Mus. Hist. Nat. Paris, p. 82. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 70. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, p. 205.

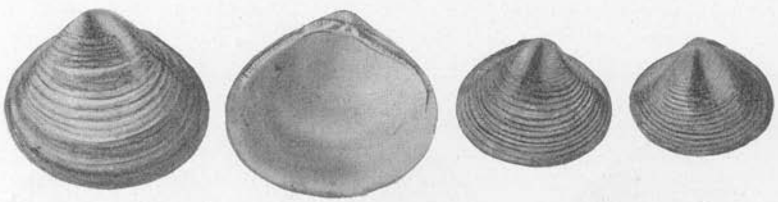
*Corbicula nyassana* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 37; based upon *C. radiata* E. A. Smith, 1877, Proc. Zool. Soc. London, p. 718, from Lake Nyasa; according to Germain, 1906, Bull. Mus. Hist. Nat. Paris, p. 307, this is not separable from *C. radiata*.

This species appears to extend from the mid-Nile throughout the region of the Great Lakes, southward to Potchefstroom, Transvaal, and westward to Stanleyville.

Lake Albert: (S. Baker Coll.; Schubotz Coll.); near Kassenje (Stuhlmann Coll.). Lualaba River at Kindu; Luapula River at Kasenga (J. Bequaert Coll.).

The species has been repeatedly recorded from Lake Edward: (Schubotz Coll.); near Kasindi and fossil near Vichumbi at 5 m. above the present level of the Lake (Gromier Coll.); near Kishakka on the northwestern coast and subfossil near Kataronge on the southwestern coast (Stuhlmann Coll.). We suspect that the specimens in question all belonged to our *C. radiata edwardi*.

The records from Lake Tanganyika probably all pertain to *C. tanganyicensis* Crosse



*a* *b* *c* *d*

Fig. 72. *a-d, Corbicula radiata* (Philippi). *a-b*, Nile, and *c-d*, White Nile. ×2.

Stanleyville in the Lualaba (Lang and Chapin Coll.). Kachiobwe in the Luapula (Stappers Coll.).

Two specimens from Stanleyville are rather small: length, 13.3 mm.: height, 11 mm.; diameter, 7.3 mm. They lack the violaceous beak-ray of the typical form. Epidermis dusky olive.

Nine specimens from the Luapula at Kachiobwe are separable into two forms. In the more triangular form (Fig. 71*a-c*) the strong ribs fade out on the posterior third of the shell, the hinge-line is wider and the lateral teeth lie at a smaller angle than in the other more oval form. The color is ecru-olive, in large part suffused with brown.

Length, 16.4 mm.; height, 14.3 mm.; diameter, 11.0 mm.

In the more oval form (Fig. 71*d-f*) the ribs occupy little more than half of the valves. The color is ecru-olive. Hinge-plate narrow.

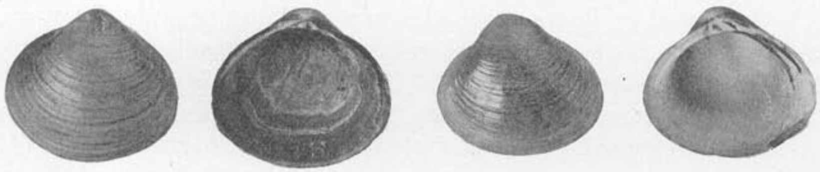
Length, 16.4 mm.; height, 13.4 mm.; diameter, 10.7 mm.

In both forms the whole posterior end is densely, very finely covered with epidermal laminæ, there is no trace of a violet beak-ray, the whole eroded beaks being violet, and the interior deep violaceous.

In one example there is no smoothish posterior area, and the shape is intermediate between the above described specimens.

Typical specimens of *C. radiata* from the White Nile are figured (Fig. 72*a-d*). They are costulate, the ribs giving place to fine striæ toward the dorsal margins. A rapidly widening violet ray runs downward from the beaks, and another, generally brownish one is on the posterior slope. The beaks are small and the hinge is narrow.

The name of this species must be changed on account of the prior *Cyrena radiata* Hanley (1844, Proc. Zool. Soc. London, p. 159); but the needed rectification will require a thorough study of African *Corbiculæ* for which we have not sufficient material.



*a* *b* *a* *b*
Figs. 73 Figs. 74

Fig. 73. *a-b*, *Corbicula radiata edwardi* Pilsbry and Bequaert. Type. ×2.
Fig. 74. *a-b*, *Corbicula tanganyicensis* Crosse. ×2.

### **Corbicula radiata edwardi**, new subspecies

Text Figure 73*a-b*

Lake Edward at Kabare (J. Bequaert Coll.).

The surface is nearly smooth, with only a few narrow concentric riblets on the anterior part, not extending upon the anterior-dorsal slope, and generally there are some irregular radial wrinkles on the posterior slope. The very large, finely striate lunule is defined by a weak raised line. Valves covered with an ecru-olive epidermis, fading to white at the beaks, which are marked with a median and a posterior violaceous ray, as in typical *radiata*. Some examples are marked with narrow darker rays. The hinge-plate and teeth are narrow, as in *radiata*. The interior is deep violaceous, varying in shade, often with a light or white zone below; teeth dark or light.

Length, 11.5 mm.; height, 10.0 mm.; diameter, 8.0 mm. Type.
" 13.3 mm.; largest example.

This form, which was taken in some abundance, differs from typical *C. radiata* by its nearly smooth surface. It is more oval than *C. tanganyicensis*, with lower beaks and a narrower hinge.

### **Corbicula tanganyicensis** Crosse

Text Figure 74*a-b*

*Corbicula radiata* var. *tanganyicensis* Crosse, 1881, Journ. de Conchyl., XXIX, p. 290 (based upon *C. radiata* var. E. A. Smith, from Tanganyika).

*Cyrena* (*Corbicula*) *radiata* var. E. A. Smith, 1881, Proc. Zool. Soc. London, p. 295.

*Corbicula tanganikana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 104; 1888, 'Iconogr. Malacol. Tanganika,' pp. 41 and 42, Pl. XVIII, figs. 8–10. Emendation of *tanganyicensis* Crosse.

*Corbicula radiata* "Parreyss" E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 100.

?*Corbicula radiata* GERMAIN, 1915, Bull. Mus. Hist. Nat. Paris, p. 261; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 696.

Lake Tanganyika: the original specimen on which Crosse's *tanganyicensis* was based, was obtained by J. Thomson. Bourguignat records *tanganikana* from the beach of Kapampa, on the southwestern shore and Germain lists *C. radiata* (possibly *tanganyicensis*) as obtained by Foà at the southern end.

As figured by Bourguignat, this form is almost or quite ribless and of a markedly triangular shape. Possibly this feature has been exaggerated by the draughtsman; if not, a quite distinct species is indicated.

A specimen collected by Stappers in Tanganyika is provisionally referred to this species. It is illustrated in Fig. 74. The surface is smooth except for low, narrow, spaced concentric riblets on the anterior half, not extending upon the anterior-dorsal slope. The color is sepia, becoming cinnamon along the ventral border and beaks, yellow at both ends. Interior is slate-purple in the cavity, with pale cinnamon lower border and white teeth. The hinge-plate is wider than in typical Nilotic *C. radiata*.

Length, 11.0 mm.; height, 9.9 mm.; diameter, 7.2 mm.

This form differs from *C. radiata edwardi* by the more prominent beaks, more triangular shape and the wider hinge-plate.

## Other Species of *Corbicula* Recorded from the Belgian Congo

### *Corbicula fluminalis* (O. F. Müller)

*Tellina fluminalis* O. F. MÜLLER, 1774, 'Verm. Terr. Fluv. Hist.,' II, p. 205 (type locality: Euphrates River).

*Cyrena* (*Corbicula*) *fluminalis* O. F. Müller. E. v. MARTENS, 1871, Malakoz. Blätte , XVIII pp. 61 and 66, Pl. I, figs. 12–14.

*Corbicula fluminalis* O. F. Müller. DESHAYES, 1854, 'Cat. Conchif. Brit. Mus.,' II, p. 222. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 283, Pl. XI, figs. 4–9. GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 216 (with full synonymy); 1922, 'Moll. Terr. Fluv. de Syrie,' II, p. 92.

*Cyrena fuscata* LAMARCK, 1818, 'Hist. Nat. Anim. sans Vertèbres,' V, p. 562 [552] (type locality: "fleuves de Chine et du Levant").

*Cyrena cor* LAMARCK, 1818, *op. cit.*, V, p. 562 [552] (type locality: not given).

*Cyrena orientalis* LAMARCK, 1818, *op. cit.*, V, p. 562 [552] (type locality: "ex Oriente").

*Cyrena consobrina* CAILLIAUD, 1827, 'Voyage à Meroé,' IV, p. 263; 1823, Atlas, II, Pl. LXI, figs. 10 and 11 (type locality: cana s of Lower Egypt).

*Corbicula consobrina* Cailliaud. PALLARY, 1904, Bull. Inst. Egyptien, (4) IV, p. 8; 1909, Mém. Inst. Egyptien, VI, p. 71, fig. 2 (with *C. laurenti*, *C. nilotica*, *C. bithydea*, *C. eucistæra*, and *C. chlora* as synonyms; all Ms. names of Bourguignat).

*Corbicula cameroni* "Bourguignat" GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 583, fig. 18*d* (type locality: Kingani River at Bagamoyo).

*Corbicula degousei* BOURGUIGNAT, 1889, 'Moll. Afr. Equator.,' p. 190 (without description). GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 583, fig. 17*d* (on p. 582) (type locality: Kingani River at Bagamoyo).

*Corbicula jouberti* "Bourguignat" GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 582, fig. 18*c* (on p. 583).

*Corbicula kynganica* "Bourguignat" GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 584, fig. 18*a* (on p. 583) (type locality: Kingani River at Bagamoyo).

Lake Tanganyika: Kibanga (type locality of *C. jouberti*).

We have accepted Germain's synonymy of *C. fluminalis*, except in the case of *C. ægyptiaca*, *C. lavigeriana*, and *C. subtruncatula*, which Pallary claims to be distinct. Whether the Tanganyika specimens called *C. jouberti* were true *C. fluminalis* or *C. tanganyicensis* Crosse we do not venture to decide. We have before us specimens of true *C. fluminalis* from the Nile in 10° N. (Pilette Coll.), which are quite distinct from *C. tanganyicensis.*

### *Corbicula foai* J. Mabille

*Corbicula foai* J. MABILLE, 1901, Bull. Soc. Philomath. Paris, (9) III, 2, p. 58. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 261; 1906, *op. cit.*, p. 585; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 696, figs. 52 and 53 (on p. 697).

Lake Tanganyika: (without more definite type locality; Foà Coll.).

Germain (1906, p. 585) states that this differs clearly from *C. astartina* by the serrulate lateral teeth; but von Martens has pointed out that his original ascription of smooth lateral teeth to *C. astartina* was an error, as crenulation may be distinctly seen. E. A. Smith (1904, Proc. Malacol. Soc. London, VI, 2, p. 100) considered *C. foai* to be probably a variety of *C. radiata.*

### SOLEILLETIA Bourguignat

*Soleilletia* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 32. Type by present designation: *Soleilletia abbadiana* Bourguignat.

To judge from Bourguignat's account and figures, this appears to be one of the Cyrenidæ or Donacidæ, somewhat resembling *Egeria*, from which it differs by the simple pallial line. The armature is described by Bourguignat as follows: "Sur la valve droite, 1 cardinale centrale et 2 renflements allongés; sur la gauche, 2 cardinales seulement, sans renflements. A l'endroit où, chez les Pisidies, les Sphéries et les Corbicules, s'élèvent les dents latérales, il n'y a, chez les Soleilleties, que le prolongement filiforme des renflements (valve dextre) ou renfoncements (valve sénestre) cardinaux." The shell is said to be small (6 to 9 mm. long), fragile and thin, with sharp and rather curved beaks.

Two species have been described:

*Soleilletia abbadiana* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 34, Pl., figs. 15–18. Hauash River, Abyssinia.

*Soleilletia hamyana* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 35, Pl., fig. 19. Hauash River, Abyssinia.

## Sphæriidæ

Shell oval, squarish, or subtriangular, of small or minute size, rather thin, porcelanous within, the adductor scars not impressed. Pallial line simple. Hinge curved, narrow, with anterior and posterior lateral teeth in both valves; cardinals very small, not more than two in each valve; those of the right valve united into an inverted V or a straight lamella; those of the left valve wholly separate, the posterior obliquely above the anterior (or sometimes wanting); ligament narrowly exposed or more or less completely immersed.

Mantle margins united posteriorly to form siphons. Viviparous and hermaphroditic.

R. J. Gilmore has contributed an interesting paper on the reproduction in this family, which also briefly reviews previous observations on the subject. These mussels incubate their embryos in a brood pouch. At a later stage the young are found in the gills where they may remain a long time.[1]

They inhabit ponds and small streams as well as the larger rivers and lakes; they often occur in ponds which become dry part of the year and seem to be well able to withstand drought. They can anchor or sometimes suspend themselves by a number of mucous threads attached to pebbles, plants, or the surface film of the water. The African *Euperæ* are usually found attached to the outer surface or within cavities in the shell of the Etheriidæ. The food consists mainly of diatoms. Owing to their small size, the living mussels are readily carried about by adventitious means. They have, for instance, been found attached to the legs of large water beetles. The family is of world-wide distribution.

### Key to Ethiopian Genera of Sphæriidæ

1. Beaks behind the middle, the almost wholly immersed ligament thus on the shorter end of the hinge.......................... *Pisidium* C. Pfeiffer.
   Beaks median or in front of the middle, the partly exposed ligament therefore on the longer end..............................................2.
2. Beaks decidedly in front of the middle. Valves fragile, with one minute, simple cardinal tooth in each valve, or none in the right......*Eupera* Bourguignat.
   Beaks nearly or quite median.............................................3.
3. Two cardinal teeth in each valve, but those of the right valve united to form a broad inverted V. Shell thin or very thin, not rayed....*Sphærium* Scopoli.
   One very weak cardinal in the right valve, two in the left. Shell *Corbicula*-like, rather solid, rayed......................*Pseudocorbicula* Dautzenberg.

[1]Gilmore, R. J. 1917. 'Notes on reproduction and growth in certain viviparous mussels of the family Sphæriidæ,' The Nautilus, XXXI, pp. 16–30, Pls. IV–VI.

### SPHÆRIUM Scopoli

*Sphærium* SCOPOLI, 1777, 'Introductio ad Historiam Naturalem,' p. 397. Monotype: *Tellina cornea* Linnæus.

*Cyclas* BRUGUIÈRE, 1792, 'Encyclop. Méthod., Vers,' II, Pls. CCCI and CCCIII (including species of *Cyrena*, *Corbicula*, and *Musculium*, as well as *Cyclas cornea*). LAMARCK, 1799, Mém. Soc. Hist. Nat. Paris, p. 84, monotypic for *Tellina cornea* Linnæus.

*Cornea* MEGERLE v. MÜHLFELD, 1811, Mag. Ges. Naturf. Fr. Berlin, V, p. 56. Monotype: *Cornea communis* Megerle v. Mühlfeld = *Tellina cornea* Linnæus.

*Corneola* CLESSIN, 1890, in Westerlund, 'Fauna Paläarct. Binnenconchylien,' VII, pp. 6 and 8. Type by present designation: *Tellina cornea* Linnæus. Not *Corneola* Held, 1837).

*Corneocyclas* FÉRUSSAC, 1818, 'Dict. Sci. Nat.,' XII, p. 278. Type by present designation: *Cyclas cornea* Draparnaud.[1]

*Sphæriastrum* BOURGUIGNAT, 1854, Rev. Mag. Zool., (2) VI, pp. 668, 669, and 674. Type by designation of Dall (1903, Proc. Biol. Soc. Washington, XVI, p. 7): *Cyclas rivicola* Leach = *Cyclas cornea* Draparnaud.

*Cyrenastrum* BOURGUIGNAT, 1854, Rev. Mag. Zool., (2) VI, pp. 668, 669 and 674. Monotype: *Sphærium solidum* Normand.

*Cornecyclas* P. HESSE, 1916, Nachrichtsbl. Deutsch. Malakoz. Ges., XLVIII, p. 123. Misspelling of *Corneocyclas*.

Shell oval, squarish or bluntly triangular, usually rather solid and concentrically striate, with nearly median, rounded beaks without projecting caps.

Siphons short and separate.

The genus is mostly Holarctic in distribution and is not known from the Oriental and Australian Regions, but a few species occur in Africa to the Cape.

Germain has proposed a subgenus *Serratisphærium* (1909, Arch. Zool. Expér. Gén., XLI, p. 114) for the African *Sphærium courteti* Germain, characterized by "les lamelles de sa charnière fortement et régulièrement serrulées." Cf. *Sphærium solidum* (Normand), type of *Cyrenastrum* Bourguignat.

The following African species have been described. Several of them, such as *S. abyssinicum* and *S. nyanzæ*, may belong to *Musculium*, but we have not seen them.

*Sphærium abyssinicum* POLLONERA, 1898, Boll. Mus. Zool. Anat. Comp. Torino, XIII, No. 313, p. 12, Pl., figs. 28 and 29. From the sources of the Addas River, near Adi Caie, Eritrea.

*Sphærium boccardi* POLLONERA, 1898, Boll. Mus. Zool. Anat. Comp. Torino, XIII, No. 313, p. 12, Pl., figs. 30 and 31. Senafe, in the Scimenzana River, Eritrea.

*Sphærium capense* (Krauss). See p. 349.

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[1]Dall (1903, Proc. Biol. Soc. Washington, XVI, p. 7) named *Tellina pusilla* Gmelin as the type of *Corneocyclas*, in which case that name would replace *Pisidium* C. Pfeiffer. But, as will be shown elsewhere, *Tellina pusilla* Gmelin was not originally included by Férussac in *Corneocyclas* and it cannot be shown to be positively identical with *Cyclas fontinalis* Draparnaud, one of the species mentioned by Férussac. Dall's fixation of type is therefore invalid.

*Sphærium congener* PRESTON, 1912, Rev. Zool. Afric., I, 3, p. 327, Pl. XVII, fig. 2. Between Entebbe and Mbarara, southwestern Uganda.

*Sphærium courteti* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 471; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 583, Pl. v, figs. 21 and 21*a*. Miangulu River, a tributary of the Bangoran, in the Mamun Country, French Territory of Lake Chad.

*Sphærium courteti* var. *unicolor* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 584. Mamun Country, with the typical form.

*Sphærium courteti* var. *marginatum* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 584. Mamun Country, with the typical form.

*Sphærium hartmanni* (Jickeli) = *Cyclas hartmanni* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 292, Pl. XI, fig. 15. Nubia.

*Sphærium iredalei* PRESTON, 1912, Rev. Zool. Afric., I, 3, p. 328, Pl. XVII, fig. 3. Lake Victoria at Kisumu.

*Sphærium kigeziense* PRESTON, 1912, Proc. Zool. Soc. London, p. 192, Pl. XXXI, figs. 1 and 1*a*. Kigezi, southwestern Uganda, 6,000 ft., close to the border of the Belgian Congo. This may prove to be a *Pisidium.*

*Sphærium mohasicum* J. Thiele. See p. 349.

*Sphærium naivashaense* PRESTON, 1912, Rev. Zool. Afric., I, 3, p. 328, Pl. XVII, fig. 1. Lake Naivasha, Kenya Colony. Dautzenberg and Germain synonymize this with *S. stuhlmanni* E. v. Martens.

*Sphærium nyanzæ* E. A. Smith. See p. 350.

*Sphærium pharaonum* "Bourguignat" PALLARY, 1909, Mém. Inst. Egyptien, VI, p. 74, Pl. IV, fig. 26. Alexandria, Lower Egypt.

*Sphærium stuhlmanni* E. v. Martens. See p. below.

*Sphærium subcapense* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 133 = *Cyclas capensis* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 291, Pl. XI, fig. 14. Toquor River near Mekerka, 6,000 ft., Abyssinia.

*Sphærium teilhardi* PALLARY, 1909, Mém. Inst. Egyptien, VI, p. 74, Pl. IV, fig. 27. Alexandria, Lower Egypt.

*Sphærium victoriæ* E. A. SMITH, 1906, Proc. Zool. Soc. London, I, p. 186, Pl. X, fig. 16. Lake Victoria, at Bukoba.

*Sphærium vinosum* DUPUIS, 1924, Ann. Soc. Zool. Belgique, LIV, (1923), p. 21 = *Sphærium capense* SOWERBY, 1878, 'Conchol. Iconica,' XX, Pl. v, figs. 45*a-b*. South Africa. Not of Krauss.

### **Sphærium stuhlmanni** E. v. Martens

Text Figure 75*a-d*

*Sphærium stuhlmanni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 261, Pl. VII, fig. 8 (type locality: Smyth Sund near Busisi, in Lake Victoria). DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 72.

Lualaba River near Kiabwa and Bulongo (J. Bequaert Coll.). E. v. Martens also referred to this species loose valves from Lake Albert and Lake Edward.

Dautzenberg and Germain also record a var. *mutandaensis* "Preston" of this species, from the Lualaba River at Nyangwe and the Luvua River (collected in both localities by J. Bequaert), but we have been unable to find a description of that form.

Luebo (H. Schouteden Coll.). Moto (L. Burgeon Coll.).

The examples which we have seen from Kiabwa on the Lualaba, Luebo on the Lulua, and Moto, are referred to this species with some doubt, as v. Martens' small and unsatisfactory figure of the interior shows far stronger lateral teeth. This figure, however, is probably incorrect, as v. Martens says: "Schlosszähne sehr schwach."

The largest specimen, a complete one from Moto, measures: length, 12.2 mm.; height, 10.3 mm.; diameter, 7.4 mm. The striation is very fine, and, in suitable light, extremely fine, very superficial, closely crowded radial lines are seen to impress the striæ slightly. The hinge-plate is very narrow; the cardinal teeth occupy its whole width. In the right valve the cardinal tooth is long, parallel to the hinge, its posterior limb abruptly deflexed and thickened. Lateral teeth are short, doubled; the anterior stronger than the posterior; the upper ones very small. In the left valve the anterior cardinal tooth is high, rather thick, oblong, the posterior slender and short.


Fig. 75. *Sphærium stuhlmanni* E. v. Martens Moto. *a-b*, left valve, *c-d*, right valve.

## Other Species of *Sphærium* Recorded from the Belgian Congo

### *Sphærium capense* (Krauss)

*Cyclas capensis* Krauss, 1848, 'Südafrik. Mollusk.,' p. 7, Pl. I, fig. 6 (type locality: Knysna River, Cape Colony). J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp (1907–08),' III, p. 212.

Lake Karago in Ruanda (Schubotz Coll.). Specimens from that locality were somewhat doubtfully referred to this species by J. Thiele.

### *Sphærium mohasicum* J. Thiele

*Sphærium mohasicum* J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 212, fig. xxv.

Lake Mohasi in Ruanda (type locality; Schubotz Coll.).

### *Sphærium nyanzæ* E. A. Smith

*Sphærium nyanzæ* E. A. SMITH, 1892, Ann. Mag. Nat. Hist., (6) X, p. 383 (type locality: northern end of Lake Victoria). E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 260, Pl. VII, fig. 10. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 212.

Lake Albert, Lake Edward, and Lake Luhondo in Ruanda (Schubotz Coll.).

## PISIDIUM C. Pfeiffer

*Pisidium* C. PFEIFFER, 1821, 'Syst. Anordn. u. Beschreib. Deutsch. Land- u. Wasser-Schnecken,' pp. 17 and 123. Type by designation of Herrmannsen (1847, 'Ind. Gen. Malac.,' II, p. 274): *Tellina amnica* O. F. Müller.

Shell small, inequilateral, globose or somewhat triangular, with the beaks nearer the posterior end. Ligament immersed. Lateral teeth double in the right, single in the left valve. Cardinals two in each valve, in the right concrescent into a single arcuate tooth, its posterior limb wider; in the left valve they are arched, or triangular.

Siphons separate at the ends. Self-fertilization appears to be common, if not the rule, in certain species.

The genus is almost cosmopolitan in distribution.

Africa will doubtless prove to have many *Pisidia* when the special methods of collecting aquatic minutiæ are employed. As the genus is intrinsically difficult and very few authors figure the teeth exactly, the group will probably become loaded with species which are not determinable except from the types, as is now the case in the older continents.

The classification of *Pisidia* will doubtless depend upon the gill structure, as Odhner[1] has shown. This is not known for any African species. By conchological characters most African species now known appear to belong to the Holarctic section *Galileja* Costa. Germain has erected for *Pisidium landeroini* Germain a subgenus *Pseudeupera* (1913, Bull. Mus. Hist. Nat. Paris, p. 295), which, he says, differs from *Pisidium* proper by the characters of the hinge "qui rappelle un peu celle des *Eupera*." The description and figures show no differences from *Galileja*.

The following species have been described from Africa.

*Pisidium giraudi* Bourguignat. See p. 354.

*Pisidium hermosum* Bourguignat. See p. 352.

*Pisidium katangense* Pilsbry and Bequaert. See p. 353.

*Pisidium kenianum* PRESTON, 1911, Ann. Mag. Nat. Hist., (8) VII, p. 475, Pl. XII, fig. 36. Between Rumruti and Mt. Kenya, Kenya Colony; also on Mt. Kenya, between 9,000 and 10,000 ft. (Fig. 76).

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[1]N. H. Odhner, 1921, Journ. of Conchology, XVI, pp. 218–223.

*Pisidium landeroini* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 476; 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 218, Pl. II, figs. 32 and 33. Between Uani and Hangara, in the Egueï District, east of Lake Chad.

*Pisidium langleyanum* MELVILL AND PONSONBY, 1891, Ann. Mag. Nat. Hist., (6) VIII, p. 237; 1892, *op. cit.*, (6) IX, p. 94, Pl. V, fig. 7. Port Elizabeth.

*Pisidium ovampicum* ANCEY, 1890, Bull. Soc. Malacol. France, VII, p. 162. Omambonde, Ovampoland. This is, according to Connolly, possibly the species recorded by Bœttger (1910, Abh. Senckenberg. Naturf. Ges., XXXII, p. 455, Pl. XXVIII, fig. 19) as related to *P. langleyanum* and found subfossil at Witkop, British Bechuanaland.

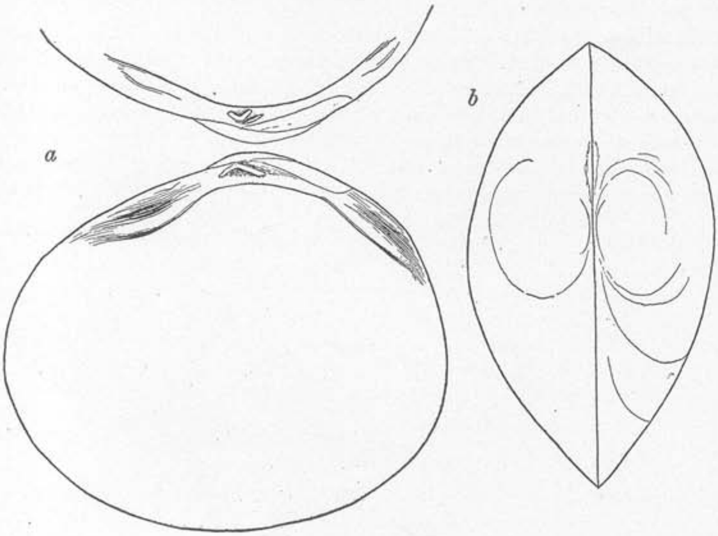


Fig. 76. *Pisidium kenianum* Preston.

*Pisidium pirothi* JICKELI, 1881, Jahrb. Deutsch. Malakoz. Ges., VIII, p. 340 Harasa, between Atbara and Bassalam, Abyssinia.

*Pisidium ruwenzoriense* GERMAIN, 1911, Bull. Mus. Hist. Nat. Paris, p. 135. On the eastern slopes of Mt. Ruwenzori in Uganda; in the lower zone in an affluent of the Wimi River and at the foot of the Kichuchu rock-shelter in about 3,000 m.; also on Mt. Kilimanjaro in 2,200 m. (all C. Alluaud Coll.). This will undoubtedly be found on the western slope of Mt. Ruwenzori, in Belgian territory. It is the largest African species yet known, measuring: length, 5.5 mm.; height, 4.5 mm.; diameter, 3 mm. The lateral teeth are said to be much lengthened.

Probably the clam described as *Sphærium kigeziense* Preston will turn out to be a *Pisidium*.

## Key to Ethiopian Species of *Pisidium*

1. Height of shell equal to the length; Tanganyikan species....................2.
   Height decidedly less than the length....................................3.
2. Beaks very broad; shell 2.4×2.4×1.6 mm.[1]....*P. hermosum* Bourguignat.
   Beaks rather narrow; shell 3×3×2 mm..............*P. giraudi* Bourguignat.
3. Lateral teeth much lengthened; shell large, 5×4.5×3 mm.
   *P. ruwenzoriense* Germain.
   Lateral teeth of normal length; shell smaller, not over 4.5 mm. long........4.
4. Diameter about half the length; shell thin, fragile, 2¼×2×1-1¼ mm.
   *P. landeroini* Germain.
   Diameter decidedly exceeding half the length............................5.
5. Abyssinian species; length, 3⅓; height, 2½ mm...............*P. pirothi* Jickeli.
   Central African species...................................................6.
   South African species.....................................................7.
6. Both lateral teeth of right valve heavy; posterior end of right cardinal wide and bifid; 3.8×3.2×2.3 mm...............*P. katangense* Pilsbry and Bequaert.
   Posterior lateral of right valve much more compressed than anterior; right cardinal tooth thin throughout; 4.2×3.5×2.3 mm.....*P. kenianum* Preston.
7. Umbones small, but little projecting; 2⅔×2⅐×1½ mm.....*P. ovampicum* Ancey.
   Umbones full and prominent; 3×2½ mm..*P. langleyanum* Melvill and Ponsonby.

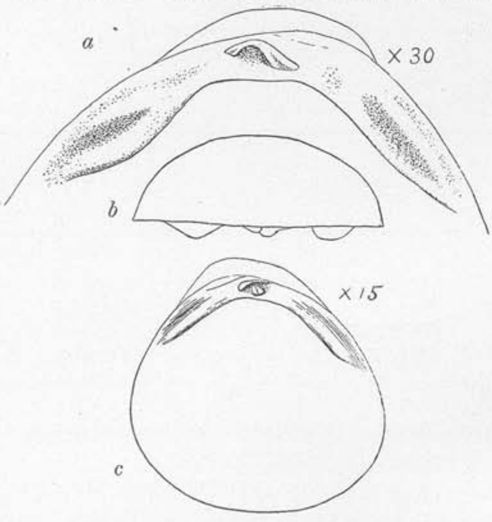


Fig. 77. *Pisidium hermosum* Bourguignat. Hinge of right valve and two views of left valve.

### **Pisidium hermosum** Bourguignat

Text Figure 77*a-c*

*Pisidium hermosum* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' pp. 41 and 42, Pl. XVIII, figs. 1–4. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

Lake Tanganyika: on the southwestern shores (type locality).

[1]Measurements are given in the order: length, height, diameter.

Lake Tanganyika: we have seen numerous, mostly wave-worn valves collected by Stappers, without more definite data. In the Congo Museum at Tervueren there are other specimens referred to this species by Dautzenberg and obtained by the same collector from the beach between Mwerasi and Kapampa; these we have not seen.

This species was figured but not described by Bourguignat. It is a quite small, ventricose clam, well distinguished by its short, high form, the height about equal to the length, and by the very wide, obtuse beaks. Externally it is distinctly striate, the striæ fine and not very close. The hinge-plate and teeth are unusually heavy. The right valve has an arched cardinal tooth, bifid posteriorly and slightly so anteriorly. Laterals heavy and rugose, especially the posterior. In the left valve there is a curved posterior cardinal, thick at the posterior end, and a somewhat bifid, short anterior cardinal; both laterals heavy and high.

Length, 2.4 mm.; height, 2.4 mm.; semi-diameter, 0.8 mm.

Another species having the general outline of *P. katangense* is represented by a single valve, 2 mm. long, 1.7 mm. high, found with the specimens of *P. hermosum*. As it is somewhat worn, a description need not now be given.

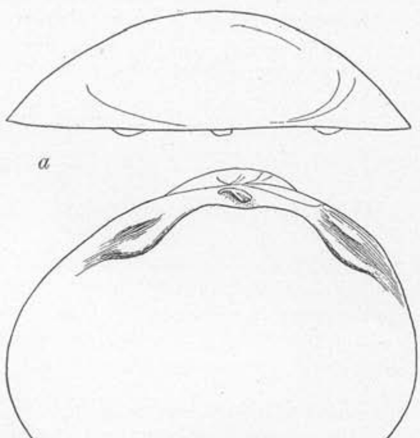


Fig. 78. *Pisidium katangense* Pilsbry and Bequaert. Right valve of type.

**Pisidium katangense**, new species

Text Figure 78

Kisanga River near Elisabethville, 5 valves, type locality; Lubumbashi River at Elisabethville, one specimen (Michael Bequaert Coll.).

The shell is oval, moderately convex, the anterior end moderately prolonged and narrowly rounded; posterior end broadly rounded. The beaks are rather low. The surface appears nearly smooth, but under the microscope fine, close striation is distinctly seen. Cardinal tooth of the right valve arcuate, bifid posteriorly. Two posterior laterals are well developed. The lower anterior lateral is decidedly heavier than the posterior, while the upper one is only weakly developed.

Length, 3.85 mm.; height, 3.25 mm.; semi-diameter, 1.15 mm.

This species resembles *P. kenianum* (Fig. 76) and *P. landeroini* in general outline, but it differs from both by the decidedly heavier lateral teeth. The right cardinal tooth is heavier than in *P. kenianum*, and strongly bifid, and the shell is relatively longer.

## Other Species of *Pisidium* Recorded from the Belgian Congo

### *Pisidium giraudi* Bourguignat

*Pisidium giraudi* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 105; 1888, 'Iconogr. Malacol. Tanganika,' pp. 41 and 42, Pl. xviii, figs. 5–7. Ancey, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

Lake Tanganyika: beach of Mpala (type locality; Giraud Coll.).

### Eupera Bourguignat

*Eupera* Bourguignat, 1854, Rev. Mag. Zool., (2) VI, pp. 84 and 675 (without mention of species). Monotype: *Pisidium moquinianum* Bourguignat = *Cyclas modioliformis* Anton, of South America. The species is described by Bourguignat, 1854, Rev. Mag. Zool., (2) VI, p. 663 and it is clearly stated that it belongs to the group previously called by him *Eupera*.[1]

*Limosina* Clessin, 1872, Malakoz. Blätter, XIX, p. 160. Type by present designation: *Cyclas modioliformis* Anton = *Pisidium moquinianum* Bourguignat.

*Sphærium* subgenus *Clessinella* L. Waagen, 1905, Sitz. Ber. Ak. Wis . Wien, Math. Naturw. Kl., CXIV, Abt. 1, p. 171. Monotype: *Sphærium* (*Clessinella*) *sturanyi* L. Waagen.

The shell is very small, very thin, oblong, inequilateral; the beaks prominent, placed in front of the middle. Hinge narrow, curved, with one minute, oblong cardinal tooth, parallel to the hinge, in each valve, or none in the right valve; lateral teeth as in *Sphærium*, single in the left valve, double in the right.

Siphons united near the base. Mantle generally spotted with black.

In the recent fauna this genus is known only from Middle and South America and Africa; *E. ferruginea* has been recorded also from Mauritius and Madagascar. In Africa the shells are usually found inhabiting the cavities of the spongy valves of Etheriidæ. Formerly the genus was more widely spread, as there are Eocene species in Europe and western North America, and one has recently been described from China.[2]

[1]The type is not *Pisum parasiticum* as stated by Germain, 1913, Bull. Mus. Hist. Nat. Paris, p. 295, footnote.

[2]*Eupera sinensis* Odhner, 1922, Bull. Geol. Surv. China, No. 4, p. 129, Pl. i, figs. 16–22. Eocene of Southern Shansi.

*Eupera* differs from *Sphærium* by the decidedly inequilateral shell and the reduced cardinal teeth, not more than one in each valve, and having the simple shape of a tubercle lengthened in the direction of the hinge.

The following African species have been described.

*Eupera bequaerti* Dautzenberg and Germain. See p. 358.

*Eupera ferruginea* (Krauss) = *Cyclas ferruginea* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 7, Pl. XI, fig. 7. Knysna River, Cape Colony.

*Eupera letourneuxi* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 134. Canals of Alexandria, Egypt.

*Eupera mediafricana* Pilsbry and Bequaert. See below.

*Eupera mediafricana etheriarum* Pilsbry and Bequaert. See p. 357.

*Eupera parasitica* (Deshayes) = *Pisum parasiticum* "Parreyss" DESHAYES, 1854, 'Cat. Conchif. Brit. Mus.,' II, p. 280 (Upper Nile). *Limosina ferruginea* "Krauss" JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 293, Pl. XI, figs. 16 and 17. *Eupera jickelii* BOURGUIGNAT, 1883, Ann. Sci. Nat. Zool., (6) XV, p. 134, based upon Jickeli's Pl. XI, fig. 17; *cf.* Germain (1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 585), who states that this is only a variation of *E. parasitica*. *Limosina parasitica* (Deshayes) E. A. SMITH, 1892, Ann. Mag. Nat. Hist., (6) X, p. 126. First Cataract at Assuan, Upper Nile (Parreyss), Lake Victoria (Bishop Hannington).

*Eupera sturanyi* (L. Waagen). See p. 358.

## **Eupera mediafricana,** new species

Text Figures 79*a-f* and 80*a*

Tshopo River near Stanleyville, in cavities of the shells of *Etheria* (Lang and Chapin, and J. Bequaert Coll.).

Shell relatively higher than *E. parasitica*, more inflated than *E. parasitica* or *E. ferruginea*. The subtrapezoidal shell is light brownish olive, rather profusely marked with black spots. The weakly, very finely striate surface has many cuticular laminæ. In the right valve there is no cardinal tooth; a rather strong ridge runs posteriorly, as far as the anterior end of the posterior laterals, which are short and double, the lower one stout, the upper one very slender. The anterior lower tooth is short and robust, the upper slender and much reduced. In the left valve there is a small, oblong cardinal, and the lateral teeth are rather slender.

| | | | | | |
|---|---|---|---|---|---|
| Length, | 5.30 mm.; | height, | 3.70 mm.; | diameter, | 2.90 mm. |
| " | 4.80 | " | 3.30 | " | 2.60 |
| " | 4.75 | " | 3.40 | | |
| " | 4.75 | " | 3.45 | " | 3.10 |
| " | 4.60 | " | 3.10 | " | 2.75 |
| " | 4.30 | " | 3.30 | " | 2.70 |
| " | 4.10 | " | 3.10 | " | 2.30 |

We have found the proportions of height to length highly variable in the series from Stanleyville, as may be seen by the measurements given above.

The height varies from about 68 per cent to about 76 per cent of the length.[1] A few measurements are intermediate between those of the longer and the broader shells, so that we have not thought it practicable to divide the lot into two species; though it is true that a majority of the specimens can be assorted into groups of broader and of narrower shells. The relative convexity of the valves is also quite variable, the diameter running from 54 per cent to 65 per cent of the length in specimens measured.

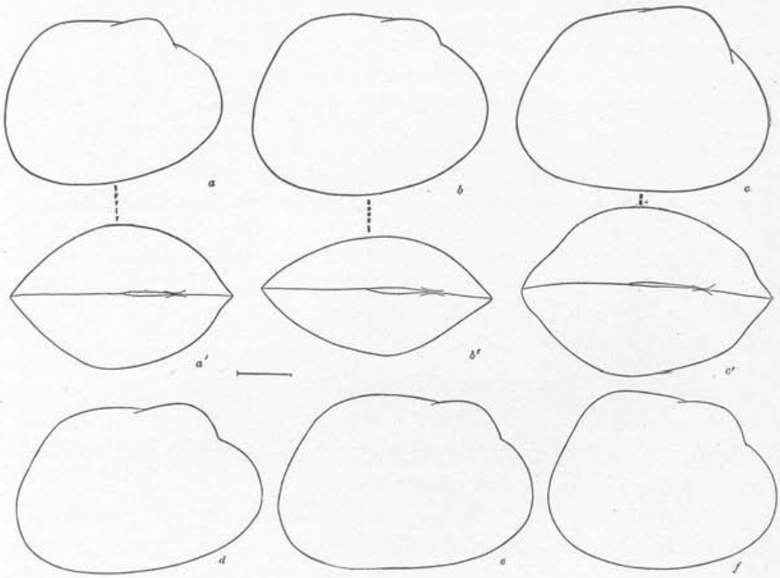


Fig. 79. *a-f*, *Eupera mediafricana* Pilsbry and Bequaert. Stanleyville. Series showing variation in contour. The line represents one mm. to the same enlargement as the shells.

Our Stanleyville *Eupera* agrees in most respects with the description and figures of *E. ferruginea* (Krauss). The type of that species was somewhat larger: length, 3.2; height, 2.4; diameter, 1.4 lines; the height thus being 75 per cent of the length. Krauss' figure shows it 70 per cent. In our shells the height is 68 to 76 per cent of the length. The anterior end is not quite so narrow in our shells as in his figures, but the latter were drawn free hand. There is a difference in the relative diameter. According to Krauss, the diameter of *ferruginea* is 44 per cent of the length. In our shells it runs from 54 to 76 per cent.

[1]The length represents the longest axis of the shell, which is somewhat oblique to the hinge-line.

According to E. A. Smith, who had before him the types of *E. parasitica* (Deshayes) and author's specimens of *E. ferruginea*, the former "is slightly longer and narrower and the concentric striæ are stronger and more lamellar" than in *E. ferruginea*. Unfortunately, the dimensions of the type of *parasitica* have not been published. Jickeli's measurements and figures show the relation of diameter to length to be about the same as in *ferruginea* in some examples, in others the diameter is half the length. Whether *ferruginea*, *parasitica*, and *letourneuxi* are really distinct remains still rather doubtful; but the Congo form seems to differ constantly by its relatively greater diameter.

**Eupera mediafricana etheriarum**, new subspecies

Text Figure 80 *b, c, d*

Dungu River at Faradje (H. Lang Coll.; December, 1912).

The shell is trapezoidal, broad (the height about 78 per cent of the length), rather plump (the diameter about 58 per cent of the length), fragile, uniform buff when the thick coating of iron hydroxid is removed, irregularly striate, the striæ bearing irregular epidermal laminæ, much closer than in *mediafricana* of the same size. The beaks are rather prominent, at the anterior two-ninths of the length. The anterior end is much smaller than the posterior, rounded; posterior end straightened and sloping back of the hinge, rounded below; basal margin gently curved.

Length, 3.45 mm.; height, 2.7 mm.; diameter, 2 mm.

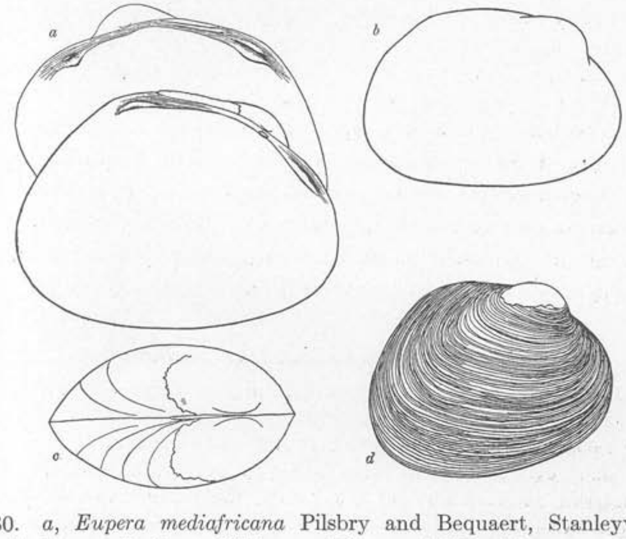


Fig. 80. *a*, *Eupera mediafricana* Pilsbry and Bequaert, Stanleyville. *b-d*, *Eupera mediafricana etheriarum* Pilsbry and Bequaert, Faradje.

This form appears to be constantly smaller than *E. mediafricana* with the epidermal laminæ more crowded.

As in *mediafricana*, there seems to be a wider (typical) and a narrower form. The latter (Fig. 80*b*) is like *etheriarum* in color, sculpture and general form, but is not so high, the height being about 70 per cent of the length. One opened has in the right valve a very small, tubercular cardinal tooth, a strong, short anterior lateral and a long, slender posterior lateral. The left valve has a much stronger, elongate cardinal tooth, forming a prominence over the beak cavity, and well developed anterior and posterior lateral teeth.

Length, 3.7 mm.; height, 2.6 mm.; diameter, 2.0 mm.

### Other Species of *Eupera* Recorded from the Belgian Congo

### *Eupera bequaerti* Dautzenberg and Germain

*Eupera bequaerti* Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 72, Pl. II, figs. 7 and 8.

Luapula River at Kasenga, living in the texture of the shell of *Etheria elliptica* (type locality; J. Bequaert Coll.).

This species, though known by the type specimen only, appears quite distinct from others by its broad, less inequilateral shape, more like that of some *Sphæria*, and by the less projecting beaks. It measures: length, 7.5 mm.; height, 6 mm.; diameter, 3 mm.

### *Eupera sturanyi* (L. Waagen)

*Sphærium* (*Clessinella*) *sturanyi* L. Waagen, 1905, Sitz. Ber. Ak. Wiss. Wien Math. Naturw. Kl., CXIV, Abt. 1, p. 171, fig. 1 (on p. 167).

Rapids of the Congo River in the District of the Cataracts (Lower Congo), in valves of *Etheria* (type locality; O. Baumann Coll.).

This species has not been figured. It is said to measure: length, 5 mm.; height, 4 mm.; diameter, 1.5 mm. The height is therefore 80 per cent, the diameter 30 per cent of the length; it is thus higher and much more compressed than *E. ferruginea*. While the ratio of height to length is about the same as in *E. mediafricana etheriarum*, the relative diameter is only about half as much if the dimensions given are correct.

### Pseudocorbicula Dautzenberg

*Pseudocorbicula* Dautzenberg, 1908, Journ. de Conchyl., LVI, p. 32. Monotype: *Pseudocorbicula alluaudi* Dautzenberg.

Shell rather solid, with the general form and sculpture of *Corbicula;* rayed. Ligament short, external. Right valve having one very weak cardinal and two strong, lamellar laterals, projecting at the distal ends; left valve with two very feeble cardinals and a lamellar lateral on each side. The lateral teeth have no trace of vertical striation or crenulation. The pallial line is entire.

We have not seen this interesting clam, which appears to belong to the Sphæriidæ by its diminutive cardinal teeth, but differs by the rather solid, *Corbicula*-like shell with colored rays. The cardinal teeth have not been described in sufficient detail to admit of the needed comparison with *Sphærium*, or to distinguish it from that genus.

Only one species is known:

*Pseudocorbicula alluaudi* DAUTZENBERG, 1908, Journ. de Conchyl., LVI, p. 32, Pl. II, figs. 8–10. Kavirondo Bay, in Lake Victoria. Length, 9.5 mm.; height, 8.5 mm.; diameter, 6 mm.

### Donacidæ

This family is introduced with some hesitation to provide a place for the genera *Egeria* and *Iphigenia.* The former genus and the small species of the latter have usually been referred to the Cyrenidæ, the typical *Iphigeniæ* to the Donacidæ.

The families Cyrenidæ and Donacidæ are placed in different super-families by Dall and in different suborders by Pelseneer. Unfortunately, the definitions given for these groups above family rank are nearly worthless in actual practice.

*Egeria* and *Iphigenia* differ from Cyrenidæ by their long siphons, by having the gills free throughout, not concrescent posteriorly as they are said to be in *Cyrena* and *Corbicula*, and by having longer labial palpi, In other external features the animals appear to be about as in Cyrenidæ. *Donax* (*denticulatus* Linnæus) has the siphons decidedly longer than in *Iphigenia.* In both *Egeria* and *Iphigenia*, there is a pallial sinus and the lateral teeth are developed in the right valve only and sometimes sub-obsolete. These two genera may be separated as follows:

1. Pallial sinus ample, extending past the middle; hinge-plate narrow. *Iphigenia* Schumacher.

   Pallial sinus small, not extending as far as the middle; hinge-plate broad. *Egeria* de Roissy.

### EGERIA de Roissy

*Galatea* BRUGUIÈRE, 1797, 'Encycl. Méthod, Vers,' II, Atlas, Pl. CCL (representing the species subsequently described as *Galathea radiata* Lamarck).

*Galathea* LAMARCK, 1804, Ann. Mus. Hist. Nat. Paris, V, p. 431. Monotype: *Galathea radiata* Lamarck, 1804 = *Venus paradoxa* Born, 1780. Not *Galathea* Fabricius, 1793.

*Egeria* DE ROISSY, 1805, 'Hist. Nat. Gén. Partic. Mollusques,' VI, pp. 324 and 327. Monotype: *Galathea radiata* Lamarck (Dall, 1903, Trans. Wagner Free Inst. Sci. Philadelphia, III, p. 1453).

*Potamophila* J. SOWERBY, 1821,[1] 'Gen. Rec. Foss. Shells,' I, Pl. LXVI, with accompanying letter-press. Substitute for *Galathea* Lamarck.

[1]The plate is dated "January 1821, published by Js. Sowerby."

*Megadesma* BOWDICH, 1822, 'Elem. of Conch.,' pt. 2, p. 8, fig. 21. Substitute for *Galathea* Lamarck.

*Galathæa* G. B. SOWERBY, 1839, 'Conchol. Man.,' 1st Ed., p. 88, as a synonym of *Potamophila*. Misspelling of *Galathea* Lamarck.

*Galateola* "Fleming" HERRMANNSEN, 1847, 'Ind. Gen. Malac.,' I, p. 458, as a synonym of *Galatea*. In Fleming, 1828, 'Hist. British Anim.,' p. 409, *Galateola* is used as a *nomen nudum*, without mention of species, so that the name properly dates from Herrmannsen.

*Galateia* F. DE BRITO CAPELLO, 1878, Mem. Ac. Sci. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description Esp. *Galateia*,' p. 2. Emendation of *Galathea*.

The shell is trigonal or oblong, solid, covered with a strong olivaceous, brownish or yellowish periostracum, under which it is white, violet or pink and sometimes rayed. Hinge-plate wide. Two or 3 diverging cardinal teeth, often irregularly sulcate radially, and with low, short anterior and posterior lateral teeth in the right, sockets in the left valve; but these teeth often become almost obsolete in adult shells. Nymphs strongly developed. Ligament short and prominent. Pallial sinus small, not reaching to the middle of the shell's length.

These large, handsome clams are usually characterized by an excessive development of the shell in thickness. The siphons and the pallial sinus are far shorter than in *Iphigenia*, which in teeth and other respects is a less evolved stock than *Egeria*.

West Africa, from Liberia to Angola, in estuaries.

The localities of nine of the seventeen species are unknown. No doubt the number of species and varieties from the Loanda district of Angola will be materially reduced when large quantities of the shells are studied.

*Egeria aguiarii* (Brito Capello) = *Galateia aguiarii* BRITO CAPELLO, 1878, Mem. Ac. Sci. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description Esp. *Galateia*,' p. 11. Quanza River, Angola.

*Egeria bengoensis* (Dunker) = *Galatea bengoensis* DUNKER, 1849, Zeitschr. f. Malakoz., V, (1848), p. 183; 1853, 'Ind. Mollusc. Guin. Infer.,' p. 51, Pl. IX, figs. 28–30. BERNARDI, 1860, 'Monogr. *Galatea*,' p. 25, Pl. VI, figs. 5 and 6 and Pl. IX, fig. 4. SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. V, fig. 11. *Galateia bengoensis* BRITO CAPELLO, 1878, Mem. Ac. Sci. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description Esp. *Galateia*,' p. 16 (which var. *versicolor*, *multiradiata*, and *tigrina*, all from the Bengo River). Angola: Bengo River, near Loanda.

*Egeria bengoensis bocagii* (Brito Capello) = *Galateia bocagii* BRITO CAPELLO, 1878, Mem. Ac. Sc. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description Esp. *Galateia*,' p. 9, Pl. I, figs. 8 and Pl. II, figs. 2–4. Quanza River, Angola.

*Egeria bengoensis læta* (Philippi) = *Galatea læta* PHILIPPI, 1849, Zeitsch. f. Malakoz., V, (1848), p. 190 (type locality unknown); 1851, 'Abbild. Beschr. Conchyl.,' III, p. 123, Pl. I, fig. 2. BERNARDI, 1860, 'Monogr. *Galatea*,' p. 27, Pl. I, figs. 3, 4, 7, and 8 and Pl. VIII, fig. 7; with var. *versicolor* "Morelet," p. 29, Pl. I, figs. 7–8, credited to H. and A. Adams (1856, Gen. Recent Moll.,' II, p. 408) where it is a *nomen nudum*. SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. VI, figs. 16*d*, *e*, *f*. *Galateia læta* BRITO CAPELLO, 1878, Mem. Ac. Sci. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description esp. *Galateia,*' p. 13 (with var. *triangularis*, p. 14). *Galatea rubicunda* PHILIPPI, 1849, Zeitschr. f. Malakoz., V, (1848), p. 190 (locality unknown); 1851, 'Abbild. Beschr. Conchyl.,' III, p. 123, Pl. I, fig. 1. BERNARDI, 1860, 'Monogr. *Galatea,*' p. 37, Pl. I, figs. 1 and 2 and Pl. VIII, fig. 2. SOWERBY, 868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. VI, figs. 14*a*, *b*. *Galatea philippiana* MORELET, 1858, 'Séries Conchyl.,' I, p. 32 (new name for *G. læta* and *G. rubicunda* Philippi). *Galathea philippiana* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 99. *Galatea versicolor* "Morelet" H. and A. ADAMS, 1856, 'Gen. Recent Moll.,' II, p. 408, name only; said by Morelet, in P. Fischer, 1856, Journ. de Conchyl., V, p. 344, to be an unpublished name for *G. læta* and *rubicunda* Philippi. This form has been several times collected in Angola (in a little river near Loanda; Quanza River; Dande River near Loanda; and Bengo River; all these are in close proximity). Morelet, who studied a large series taken by the corvette "Elan" in the Dande River, found that *læta* and *rubicunda* of Philippi are fully connected, and merely mutations of the same. Philippi's types of both, he states, were from the same "Elan" lot. A. Nobre (1909, Bull. Soc. Portugaise Sci. Nat., III, Suppl. 2, p. 108) added *Galatea bengoensis* Dunker to the synonymy and considered *Galateia bocagii* Brito Capello a robust variety of *læta*. We provisionally list *læta* and *bocagii* as subspecies of *bengoensis*, the last mentioned name having page priority.

*Egeria bernardii* (Dunker) = *Galatea bernardii* DUNKER, 1856, Journ. de Conchyl., V, p. 338, Pl. XII, fig. 3 ("Guinée près du Cap Lopez"). BERNARDI, 1860, 'Monogr. *Galatea,*' p. 32, Pl. V, figs. 1–5, and Pl. VIII, fig. 8 (with var. *versicolor* and var. *triangularis*, on p. 33). SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. III, fig. 4*a*, *b*, *c*. *Galathea bernardii* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 99 (Bengo River, Angola). *Galateia bernardii* DAUTZENBERG, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 93 (Ogowe River, Gaboon).

*Egeria biangulata* (Sowerby) = *Galatea biangulata* SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. V, fig. 12. Habitat unknown. We have seen specimens from Angola: Pungo River, in the district of Loanda, Mus. A. N. S. Phila. (collector unknown). This appears to be a valid species.

*Egeria cailliaudii* (Bernardi) = *Galatea cailliaudii* BERNARDI, 1860, 'Monogr. *Galatea,*' p. 43, Pl. IV, figs. 1 and 2 and Pl. IX, fig. 3. Africa.

*Egeria chemnitzii* (Philippi) = *Galatea chemnitzii* PHILIPPI, 1851, 'Abbild. Beschr. Conchyl.,' III, p. 124, based upon *Venus ægyptica* CHEMNITZ, 1795, 'Conchyl. Cab.,' XI, p. 231, Pl. CCII, figs. 1985 and 1986. *Galatea ægyptiaca* "Chemnitz" BERNARDI, 1860, 'Monogr. *Galatea,*' p. 39, Pl. VI, figs. 1 and 2 and Pl. IX, fig. 1. Probably not SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. V, figs. 9*a*, *b*. Habitat unknown. According to Chemnitz, "Vermuthlich beym Nilstrom." Bernardi refigured the unique valve in the Royal collection of Denmark.

*Egeria concamerata* (Duval) = *Gal.* [*athea*] *concamerata* DUVAL, 1840, Rev. Zoolog. Soc. Cuviér., p. 211. *Galatea concamerata* BERNARDI, 1860, 'Monogr. *Galatea,*' p. 20, Pl. II, fig. 1; Pl. III, figs. 1 and 2; and Pl. VIII, fig. 1 (with var. *rosea*). SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. II. figs. 2*a*, *b*. Africa.

*Egeria congica* (O. Bœttger). See p. 362.

*Egeria cumingii* (Bernardi) = *Galatea cumingii* "Dunker" BERNARDI, 1860, 'Monogr. *Galatea,*' p. 35, Pl. VI, figs. 7 and 8 and Pl. IX, fig. 8 ("Le Gabon"). *Galateia cumingii* BRITO CAPELLO, 1878, Mem. Ac. Sci. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description Esp. *Galateia,*' p. 14, Pl. I, figs. 1–4 and Pl. II, figs. 1

5–8 (Bengo River, Angola; with varieties *versicolor*, *rubra*, *nitida*, *multiradiata*, *longirostris*, on p. 15, and in the explanation of Plate I, fig. 3, var. *equilatera*).

*Egeria cumingiiquanzæ* (Brito Capello) = *Galateia quanzæ* Brito Capello, 1878, Mem. Ac. Sci. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description Esp. *Galateia*,' p. 12, Pl. I, figs. 5–7. Angola: Quanza River; also young specimens from the Bengo River. Nobre, (1909, Bull. Soc. Portugaise Sci. Nat., III, Suppl., 2, p. 107) considered *G. cumingii* a synonym of *G. bernardii*, and *G. quanzæ* a very robust variety of the same.

*Egeria heukelomii* (Bernardi) = *Galatea heukelomii* Bernardi, 1860, 'Monogr. *Galatea*,' p. 30, Pl. VI, figs. 3 and 4 and Pl. IX, fig. 2. Africa.

*Egeria kochii* (Bernardi) = *Galatea kochii* Bernardi, 1860, 'Monogr. *Galatea*,' p. 22, Pl. IV, figs. 3–8 and Pl. IX, figs. 6 and 7 (with var. *unicolor*, on p. 23). Central Africa.

*Egeria lubackii* (Bernardi) = *Galatea lubackii* Bernardi, 1860, 'Monogr. *Galatea*,' p. 24, Pl. I, figs. 5 and 6 and Pl. VIII, fig. 4. *Galatea lubakii* Sowerby, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. VI, fig. 13. Africa.

*Egeria nux* Pilsbry and Bequaert. See p. 367.

*Egeria paradoxa* (Born). See p. 368.

*Egeria pseudoradiata* (Brito Capello) = *Galateia pseudo-radiata* Brito Capello, 1878, Mem. Ac. Sci. Lisboa, Cl. Sci. Math. Phys. Nat., N.S., V, 2, 'Description Esp. *Galateia*,' p. 10. Quanza River, Angola.

*Egeria tenuicula* (Philippi). See p. 366.

*Egeria tenuicula langi* Pilsbry and Bequaert. See p. 366.

*Egeria triangularis* (Sowerby) = *Galatea triangularis* Sowerby, 1868, 'Conchol. Iconica,' XVI, *Galatea*, Pl. VI, fig. 14*c* (species 15 of text). Habitat unknown. The figured type is No. 55258, A. N. S. Philadelphia. It resembles *E. bernardii* except that the height is greater, the diameter somewhat less and the beaks more slender than in the topotypes of *bernardii* which we have compared. It appears to be quite distinct from other species. Length, 80 mm.; height, 69 mm.; diameter, 35 mm.

*Egeria truncata* (Dunker) = *Galatea truncata* Dunker, 1867, Malakoz. Blätter, XIV, p. 206, Pl. III, figs. 1–3. Guinea.

### **Egeria congica** (O. Bœttger)

Plate XXVII, Figures 1–2; Plate XXVIII, Figures 1–4

"Shellfish of the *Mya* genus," Tuckey, 1818, 'Narrative Exped. Zaire,' p. 93. Also mentioned in Chr. Smith's account on p. 291, and again on p. 358.

*Potamophila radiata* James Sowerby, 1821, 'Gen. Rec. Foss. Shells,' I, Pl. LXVI, with accompanying letter-press. (Not *Galathea radiata* Lamark).

*Galatea congica* O. Bœttger, 1885, 24. u. 25. Bericht Offenbacher Ver. f. Naturk., p. 196. C. R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 90.

*Galateia tuckeyi* Dautzenberg, 1891, Bull. Ac. Sci. Belgique, (3) XX, (1890), p. 573, Pl. II, figs. 1–6. H. de Cort, 1899, Ann. Soc. Malacol. Belgique, XXXIV, Bull. Séances, p. xl. Dautzenberg, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 93. Gruvel, 1912, *op. cit.*, p. 144, fig. 21.

*Galatea tuckeyi* Dautzenberg. C. R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 113.

*Galatea tuckeri* Dautzenberg. Kobelt, 1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 88.

*Galateia duponti* DAUTZENBERG, 1891, Bull. Ac. Sci. Belgique, (3) XX, (1890), p. 577, Pl. III, figs. 1 and 2. H. DE CORT, 1899, Ann. Soc. Malacol. Belgique, XXXIV, Bull. Séances, p. xxxix.

*Galatea duponti* Dautzenberg. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 114.

*Galatea rubrotincta* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) IV, p. 90, Pl. IV, fig. 9.

The type locality of *Potamophila radiata* J. Sowerby was "Congo River" and Sowerby states that his specimens were brought back by the survivors of Captain Tuckey's expedition. *Galatea congica* O. Bœttger was described from a left valve drifted up at Banana (P. Hesse Coll.). *Galateia tuckeyi* Dautzenberg was based upon dead shells found in heaps along the shore of the Congo estuary between the island of Melella at 35 kilometers from the sea (probably the same as Malela) and an islet opposite the village of Samboela near the confluence of the river Passikonde (= Pasokonde), at 67 kilometers from the sea (this is just above Zambi) (E. Dupont Coll.). Drifted valves referred to *G. tuckeyi* were also collected by P. Hesse and at Banana by A. Taquin. *Galateia duponti* Dautzenberg was described from specimens obtained by E. Dupont "dans une poche située dans l'alluvion ancienne du Congo à une quinzaine de mètres au dessus des hautes eaux du fleuve, au fond du port de Banana, près de la mission de Nemlao." H. de Cort noted that A. Taquin found near Banana dead specimens, but still fresh and covered with a periostracum, of *G. duponti*, and that Putzeys had seen young, live specimens of the same form. C. R. Bœttger also reports live *G. duponti* sent by P. Hesse from the Lower Congo. The type locality of *Galatea rubrotincta* Preston is merely given as Congo Delta. "Kampenzey Island," where Tuckey first observed the species, is probably what is now called Mateba.

We have seen more than a thousand examples from Malela; and a few specimens from near Katala, below Zambi (Lang and Chapin, and J. Bequaert Coll.).

The shell is large, very solid, triangular, with very prominent, somewhat slender beaks. The posterior ridge is strongly developed. It is white under a strong epidermis, varying from yellow toward the posterior end to olive-brown in the middle and anteriorly. In the most strongly characterized individuals there are on the median and anterior part about six low, rounded raised rays with concave, concentrically wrinkled intervals, extending over about half the valve or less, the earlier part being smooth; the posterior ridge has irregular, coarse lumps or concentric waves, also wanting in the earlier stages. In other specimens this sculpture may be inconspicuous or even wanting; and it very rarely appears until the shell is 40–50 mm. long. The interior is almost always white throughout in adult shells; rarely some violet stains appear near the posterior adductor scars. Young shells are often considerably stained with violet within, or rarely are largely jasper pink. The very strong cardinal teeth vary a good deal in details. The median cardinal of the right valve is strong and triangular, sometimes distinctly biramose, Λ-shaped, but usually the space between its sides is nearly or quite filled. The laterals are very weak. The nymphs are relatively small. The cavities of the beaks are very deep in large individuals, but quite shallow in the young.

| | | | | | | |
|---|---|---|---|---|---|---|
| Length, | 146 mm.; | height, | 116 mm.; | diameter, | 62 mm | |
| " | 120 | " | 91 | " | 54 | |
| " | 115 | " | 95 | " | 55 | |
| " | 94 | " | 83 | " | 49 | |
| " | 75 | " | 67 | " | 50 | |
| " | 73 | " | 68 | " | 47 | |
| " | 30 | " | 31 | " | 22 | (young) |
| " | 14 | " | 14 | " | 7.2 | " |

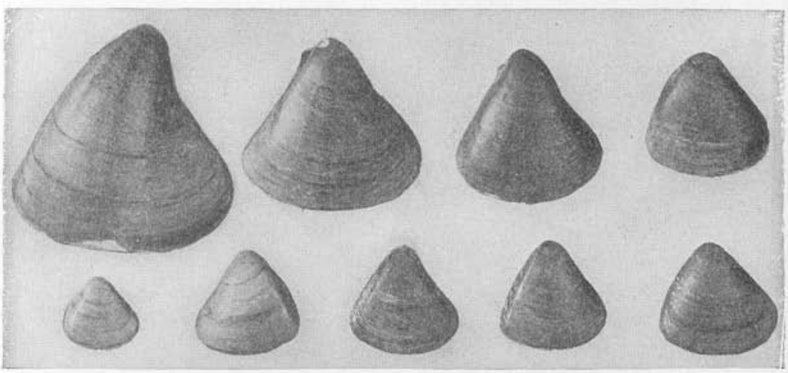

Fig. 81. *Egeria congica* (O. Bœttger). Series of young shells. Natural size.

In the earlier stages (Fig. 81) the height usually equals or sometimes exceeds the length; later the front and back ends grow faster than the middle, and the shell becomes relatively longer. The diameter is greatest in the earlier part of the mid-neanic stage, when it may exceed two-thirds of the length. In quite early neanic stages it is less inflated, the diameter little more than half the length; and again in adult shells it is about half. Very old shells, such as the first measurement above, become strongly rostrate posteriorly, as usual in this genus.

Young specimens sometimes have several green rays, as in Plate XXVIII, fig. 2, but we have seen no adults so marked.

In some very old individuals (length, 145 mm.) there is a sharp-edged ridge or incipient septum over the anterior end of the beak cavity, such as is seen in well-characterized adult shells of *E. concamerata*, but not so strongly developed as in old shells of that species.

The few specimens from Katala, below Zambi, (Pl. XXVII, fig. 2) are large, 100–110 mm. long,— with anteriorly glossy periostracum which in drying generally peels off in large part. The radial undulations of the typical form are wanting, or in some individuals weakly indicated. The usual dimensions and those of a long, compressed individual are:

| | | |
|---|---|---|
| Length, 109 mm.; | height, 85 mm.; | diameter, 52.0 mm. |
| " 105 | " 77 | " 45.5 |

*Egeria congica* was originally described from a left valve measuring: length, 25¾ mm.; height, 24 mm.; diameter (calculated for both valves), 17 mm. This could only be a young of Dautzenberg's *tuckeyi*, of which we have specimens of the same size and proportions. The description and the comparison with *G. truncata* Dunker fully supports this identification. C. R. Bœttger (1913, pp. 90–91) was of opinion that it was a young specimen of *G. duponti*, a form which we cannot separate from *tuckeyi*.

M. Dautzenberg appropriately named this fine clam after Captain J. R. Tuckey, R.N., leader of the first scientific expedition to the Congo. It is noticed, if somewhat obscurely, in Tuckey's narrative; moreover, some of Tuckey's specimens were figured by Sowerby a few years later. It appears to be, thus, the first shell from the Congo River to be figured or noticed in any scientific work. It is unfortunate that Dautzenberg's name must be relegated to the synonymy, since it would have reminded us of a brave man who lost his life in the exploration of the great river.

*Galateia duponti* Dautzenberg is a small, smooth form of *congica*. Possibly in the type locality it has been stunted by unfavorably saline conditions, as the place is at the river's mouth. At all events, the type figures can easily be matched exactly by many specimens found with typical *tuckeyi* and fully connected with that. One is illustrated in Plate XXVIII, figs. 1, 1*a*.

*Galatea rubrotincta* Preston is merely a young *E. congica* which has not yet become sculptured. It is in the stage when the height slightly exceeds the length.

*Egeria congica* is, we believe, a well-marked species, entirely distinct from *E. paradoxa* (Born).

Captain Tuckey,[1] H. de Cort, and others have noted the extensive use of this species for food by the natives and this is fully corroborated by Mr. Lang's observations. Professor Gruvel also states that the shells are burned for lime, which they furnish of excellent quality, in demand for whitewash and mortar. H. de Cort has given many interesting details as to the location of these clams in life; he mentions, moreover, that as a comestible they are insipid and unsubstantial.

### **Egeria tenuicula** (Philippi)

*Galatea tenuicula* PHILIPPI, 1849, Zeitschr. f. Malakoz., V, (1848) p. 191 (type locality unknown); 1851, 'Abbild. Beschr. Conchyl.,' III, p. 124 (?BERNARDI, 1860, 'Monogr. *Galatea*,' p. 41, Pl. II, fig. 2 and Pl. VIII, fig. 5).

### **Egeria tenuicula langi**, new subspecies

Plate XXIX, Figures 1–3

*Galatea tenuicula* Philippi. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 114.

"Terra de Bambu" (that is brackish water region) of the Congo estuary (P. Hesse Coll.).

Malela, with *E. congica* (Lang and Chapin Coll.).

The shell is triangular-elliptical (the height about 70 per cent of the length), compressed (the diameter about 42 per cent of the length), thin for this genus. Covered with a smooth epidermis of various nuances between naples yellow, cinnamon, and isabella color (in some examples having dusky green radial spots in the region of the beaks). The valves have an ill-defined, rounded posterior ridge and small submedian beaks projecting but little; the anterior end is rounded, the upper margin somewhat straightened; posterior end indistinctly truncate obliquely, upper margin somewhat convex; basal margin is evenly convex. The right valve has a strong submedian cardinal tooth which is very slightly emarginate, and a thin posterior; very small but distinct laterals are present. In the left valve there are two diverging cardinals with only the slightest trace of an intermediate tooth. Nymphs small. The interior is white, with violet stains on the lateral hinge-margins and in the pallial sinus. In other examples the whole interior may be either white, violaceous, or rarely light congo pink.

| | | | |
|---|---|---|---|
| Lenght, 51.0 mm.; | height, 36.4 mm.; | diameter, 21.5 mm. | Type; Pl. XXIX, Figs. 1–1c. |
| " 42.0 | " 29.0 | " 17.5 | Paratype. |
| " 38.0 | " 26.5 | " 17.7 | |

This is a form very close to *E. tenuicula* (Philippi), being similar in general form and in the teeth; but it differs by the less prominent, not at all swollen beaks. Philippi emphasizes the "apicibus prominentibus, tumidis" of *tenuicula*. It is also a little more compressed than *tenuicula*, the diameter 42–46 per cent of the length.

[1]Tuckey's remarks have been reproduced in our introduction, p. 85.

Young specimens of this species resemble the adult form closely in proportions. Two measure:

| | | |
|---|---|---|
| Length, 18.0 mm.; | height, 13.0 mm.; | diameter, 8.3 mm. |
| " 16.5 | " 12.0 | " 7.4 |

This species varies toward a higher, more trigonal shape, such as are shown in Pl. XXIX, figs. 2 and 3, theother characters remaining the same.

| | | |
|---|---|---|
| Length, 47.0 mm.; | height, 33.0 mm.; | diameter, 21.0 mm. |
| " 45.0 | " 32.0 | " 20.4 |
| " 40.0 | " 29.0 | " 19.0 |

### **Egeria nux,** new species

Plate XXIX, Figures 4–7

Malela (Lang and Chapin Coll.).

The shell is triangular, plump, very solid, covered with a smooth ecru-olive to buffy olive periostracum, often with small dusky spots, or rarely interrupted dark rays. The obliquely truncate posterior end is somewhat convex with a slightly concave, ill-defined escutcheon. No lunule. The anterior end is rounded, the outlines between ends and beaks slightly convex. The beaks are rather depressed, not very prominent.

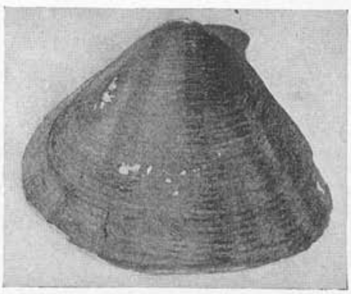

Fig. 82. *Egeria nux* Pilsbry and Bequaert. Radially corrugated individual.

The interior is white (or sometimes more or less extensively violet on the lateral margins, posterior region and basal margin). Hinge-plate strongly developed, the median cardinal tooth of the right valve narrowly triangular with bifid summit; in the left valve only the trace of a median tooth. Beak cavities moderately deep. Nymphs are very short and small.

| | | | |
|---|---|---|---|
| Length, 36.7 mm.; | height, 29.3 mm.; | diameter, 22.0 mm. | Type; Pl. XXIX, Fig. 4. |
| " 46.7 | " 34.5 | " 25.0 | Paratype. |
| " 32.0 | " 27.0 | " 21.2 | " |

In shape this small species is quite unlike the young of *E. congica*. It is much more nearly related to *E. tenuicula* (Philippi), but the outline is more triangular and the valves and teeth are much heavier. In *E. truncata* (Dunker) the beaks are narrower and the teeth are far heavier.

One specimen of the long series collected has, near the base, shallow radial depressions transversely striate much as in *E. congica,* otherwise having the characters of *E. nux* (Fig. 82).

### Other Species of *Egeria* Recorded from the Belgian Congo

### *Egeria paradoxa* (Born)

*Venusd paradoxa* BORN, 1780, 'Test. Mus. Vindobon.,' p. 66, Pl. IV, figs. 12 and 13 (habitat unknown).

*Galatea paradoxa* Born. GERMAIN, 1918, Bull. Mus. Hist. Nat. Paris, p. 133, figs. 20 and 21 and Pl. III, figs. 18 and 19. With var. *unicolor* "Bernardi" and var. *multiradiata* "Bernardi," p. 130; var. *olivacea* "Bernardi," p. 131, fig. 21; and var. *purpurea*, p. 131. See for full references to literature.

*Venus meretrix* var. β GMELIN, 1791, 'Syst. Nat.,' 13th Ed., I, 6, p. 3273; based upon *Venus paradoxa* Born ("In Oceano Indico").

*Venus hermaphrodita* GMELIN, 1791, *op. cit.*, I, 6, p. 3278 (Guinea); based upon *Venus reclusa*, etc., CHEMNITZ, 1782, 'Conchyl. Cab.,' VI, p. 326, Pl. XXXI, figs. 327–329.

*Venus subviridis* GMELIN, 1791, *op. cit.*, I, 6, p. 3280 (locality unknown).

*Galathea radiata* LAMARCK, 1804, Ann. Mus. Hist. Nat. Paris, V, p. 433, Pl. XXVIII (supposed to be from the rivers of Ceylon). RANG, 1832, Ann. Sc. Nat., XXV, p. 160, Pl. V, figs. 1–3 (anatomy).

*Galatea radiata* Lamarck. BERNARDI, 1860, 'Monogr. *Galatea*,' p. 18, Pl. VII, figs. 1–5 and Pl. VIII, fig. 3 (with varieties *unicolor, multiradiata,* and *olivacea,* on p. 19). E. v. MARTENS, 1877, Monatsber. Ak. Wiss. Berlin, (1876), p. 271. (?GERMAIN, 1916, Ann. Mus. Civ. Genova, (3) VII, [XLVII], p. 310, fig. 8).

*Donax variegata* PERRY, 1811, 'Conchology,' Pl. LVIII, fig. 1, with accompanying letter-press (no locality mentioned).

From an inspection of numerous specimens and of the published descriptions and figures, we think that probably two subspecies or possibly species are involved in the synonymy of *paradoxa* and *radiata* of authors. As most of our specimens are not definitely localized, and we have not the means of deciding what forms were actually before part of the many authors who have treated of these shells, a definite separation has not been carried out at this time.

Typical *E. paradoxa,* as figured by Born, has a relatively narrow hinge-plate, in which the middle cardinal tooth of the right valve is rather narrow, and bifid along the summit. The shell is rather light for an *Egeria* of its size; length, about 86 mm.; height, about 67 mm. The habitat of this race is unknown. It includes *G. radiata* Lamarck and *D. variegata* Perry.

*Egeria paradoxa hermaphrodita* (Gmelin) is a more solid shell with larger, prominent beaks. The dual nature of the middle right cardinal tooth is apparent, as it has the shape of an inverted V (Λ), and the hinge-plate is wider. This form is what Rang (1832) figured from the coastal rivers of Liberia (between Cape Palmas and Sierra Leone). We have before us specimens labelled Cape Palmas and Old Calabar (collector not recorded); and it is evidently what von Martens (1877) recorded from Mungo Creek, in the delta of the Cameroon River (Coll. Buchholz), since he noted that they agree with Chemnitz's type figures of *Venus reclusa*.[1] Most of the figures of "*G. radiata*" published by Bernardi, Sowerby, and some others appear to represent forms of *E. p. hermaphrodita*.

Germain (1916) reported *G. radiata* from the French Congo (Gaboon) coast in the Ompolunyé, one of the arms of the Ogowe (L. Fea Coll.). This place must be very near the type locality of *E. bernardii*. The outline figure given would serve equally well for a form of that species.

There are two records of *G. radiata* Lamarck from the Congo. But that of Sowerby, 1821, was certainly based upon specimens of *E. congica* (O. Bœttger), as the good figures demonstrate. A. Nobre's "Fleuve Zaire" record of *G. radiata* collected by Newton[2] we cannot control; but that species did not turn up in the collections made in the same region by Hesse, Dupont, Lang, and Bequaert. We conclude that what Newton got was probably *E. congica*, the common species of tidal waters of the Congo, and one which Nobre did not mention.

### IPHIGENIA Schumacher

*Iphigenia* SCHUMACHER, 1817, 'Essai Nouv. Syst. Test.,' p. 155. Monotype: *Donax lævigata* "Chemnitz" Gmelin.

?*Donacina* FÉRUSSAC, 1821, 'Tabl. Systém. An. Moll.,' pt. 1, p. xliii; listed as equivalent to *Capsa* Lamarck, *Donax* of Linnæus and Bruguière; no species mentioned.

*Procos* GISTEL, 1848, 'Naturgesch. Thierr. f. Höhere Schulen,' p. 172. Substitute for *Capsa* Lamarck and "*T. lævigata*" given as the only species.

*Fischeria* BERNARDI, 1860, 'Monogr. *Galatea* et *Fischeria*,' p. 45. Monotype: *F. delessertii* Bernardi. Not *Fischeria* Robineau-Desvoidy, 1830.

*Egeria* section *Profischeria* DALL, 1903, Proc. Biol. Soc. Washington, XVI, p. 7. Substitute for *Fischeria* Bernardi.

Shell thin, trigonal to elliptical with median beaks, covered with a thin yellowish to olive-brown periostracum. Interior violaceous, varied with white, or pure white. Right valve with a triangular, bifid median cardinal tooth and a much reduced anterior one, and low, rather long, narrow laterals forward and behind. Left valve with subequal anterior and posterior cardinals and no laterals or sockets. Nymphs well developed. Ligament short, external; a narrow resilium below it. Pallial sinus ample, extending past the middle of the shell's length.

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[1]Chemnitz gives an interesting history of this name.
[2]1886, O Instituto, Coimbra, XXXIV, p. 403 (not seen by us); 1909, Bull. Soc. Portugaise Sci. Nat., III, Suppl. 2, p. 108.

In *Iphigenia rostrata* a siphonal cavity within the mantle is partitioned off, as in Cyrenidæ and many other groups. The siphons are long (8 mm. in their contracted state), equal, wholly free, both papillose at the orifices, and externally they are marked with widely spaced longitudinal threads, as figured by Rang for *Egeria*,[1] but weaker. The mantle has a double line of papillæ just within the edge, the outer papillæ minute, the inner rather long; at a distance of about 2 mm. within the row of papillæ there is a narrow, smooth ridge parallel with it. It is nowhere concrescent except at the partition mentioned, which does not reach the edge. The gills are free throughout. The labial palpi are quite long. In dried specimens of *I. congo*, which were soaked, all of the same characters were observed, except that the mantle has a single row of papillæ.

As *I. congo* is closely related to *Fischeria delessertii* Bernardi, and *I. rostrata* stands very near *I. lævigata* (Gmelin), the type of *Iphigenia*, it appears that these two supposed genera are to be united. If *Profischeria* is retained at all, it could be used as a section for the small, strongly violaceous, more fluviatile forms; but in all structural characters of shell and animal they appear to agree fully with the large, more whitish *I. rostrata*.

While this group is similar to *Egeria* in essential characters, it differs by the thinner shell with narrow hinge-plate, longer lateral teeth and especially by the very much larger pallial sinus, extending beyond the middle of the valve. No species of intermediate character have been found; and we agree with most authors who have dealt with the group in ranking it as a genus distinct from *Egeria*.

*Iphigenia* is known from the coast and the rivers of West Africa and from the Pacific and Atlantic coast of Central and South America. In West Africa the fluviatile species occur from Senegal to the Congo estuary, but, curiously enough, have not been reported from Angola. They are found from far in the interior (*I. centralis* in the middle Niger) to strongly saline waters, associated with *Tellina*, *Corbicula*, etc.

*Iphigenia approximans* (Preston) = *Fischeria approximans* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) III, p. 186, Pl. VII, fig. 18. Podor, Senegal River.

*Iphigenia centralis* (Germain) = *Fischeria centralis* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 471; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 582, Lithogr. Pl., figs. 6 and 7. Middle Niger and Bani.

*Iphigenia congo* Pilsbry and Bequaert. See p. 373.

*Iphigenia curta* (Dunker). See p. 371.

*Iphigenia delessertii* (Bernardi) = *Fischeria delessertii* BERNARDI, 1860, 'Monogr. *Galatea* et *Fischeria*' p. 46, Pl. III, figs. 3 and 4 and Pl. IX, fig. 5. River near Cape Palmas.

[1] 1832, Ann. Sc. Nat., XXV, Pl. v, figs. 1–3. Also in Bernardi, 1860, 'Monogr. *Galatea* et *Fischeria*,' anatomical Plate.

*Iphigenia lævigata* (Gmelin). See p. 374.

*Iphigenia lenzi* (Dautzenberg). See p. 374.

*Iphigenia messageri* (Preston) = *Fischeria messageri* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) III, p. 186, Pl. VII, fig. 17. Senegal River.

*Iphigenia rostrata* Rœmer. See p. 372.

*Iphigenia truncata* (E. v. Martens) = *Fischeria truncata* E. v. MARTENS, 1877, Monatsber. Ak. Wiss. Berlin, (1876), p. 271, Pl. V, figs. 6–8. Mungo Creek in the delta of the Cameroon River.

*Iphigenia tumida* (E. v. Martens) = *Fischeria tumida* E. v. MARTENS, 1877, *op. cit.*, p. 271, Pl. V, figs. 9–11. Loango Coast.

*Iphigenia psammobialis* DESHAYES, 1854, Proc. Zool. Soc. London, p. 346, was described from an unknown locality.

### **Iphigenia curta** (Dunker)

Plate XXVIII, Figures 5–6*b*

*Fischeria curta* DUNKER, 1867, Malakoz. Blätter, XIV, p. 207, Pl. III, figs. 4–6 (type locality: West Africa).

*Fischeria globosa* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) IV, p. 91, Pl. IV, fig. 10 (type locality: Congo delta).

Banana, on the sandbanks near the entrance of the creek which leads to Moanda. San Antonio, at low tide on sandbanks at Point Padrão, buried from 1 to 2½ inches deep. Several hundreds of specimens (Lang and Chapin Coll.).

The shell is subtriangular, strongly inflated, with very full, and prominent beaks; covered with a thin, dull periostracum, chamois to isabella color in young, light brownish olive in old individuals; more or less extensively lacking at the beaks. The contour varies from even shorter than Dunker's type to much longer, as may be seen in the figures and measurements. There is a small elliptical lunule about as long as the short ligament. The interior is violet, more or less clouded with a lighter tint or almost white, and often showing light rays on the posterior half by transmitted light. The middle cardinal tooth of the right valve is distinctly bifid, and the low laterals are narrower than in *I. delessertii*. In the left valve the anterior and posterior cardinals are emarginate and there are no laterals or sockets. The pallial sinus is ample and extends about 65 per cent of the entire length.

Banana specimens

| | | | | | |
|---|---|---|---|---|---|
| Length, | 26.3 mm.; | height, | 21.5 mm.; | diameter, | 17.6 mm |
| " | 22.0 | " | 19.0 | " | 15.0 |
| " | 22.8 | " | 17.2 | " | 14.0 |
| " | 34.2 | " | 27.0 | " | 22.0 |
| " | 16.7 | " | 14.3 | " | 12.7 |

San Antonio specimens

| | | | |
|---|---|---|---|
| Length, 14.3 mm.; | height, 13.0 mm.; | diameter, 11.7 mm.; | young. |
| " 14.0 | " 11.2 | " 9.7 | " |
| " 18.4 | " 16.3 | " 14.3 | |
| " 22.2 | " 18.0 | " 15.2 | |
| " 25.0 | " 19.5 | " 16.0 | |
| " 26.0 | " 18.5 | " 15.0 | |
| " 23.3 | " 15.5 | " 14.0 | |

Specimens apparently adult vary a good deal in size and in the proportions of height to length. The longest examples would be taken for a distinct species were it not for numerous connecting links. The height varies from 60 to 78 per cent of the length in San Antonio examples. The very full beaks remain constant in all.

*I. tumida* (von Martens), from the Loango coast, is closely similar, but it differs by the shorter pallial sinus, which barely reaches beyond the middle of the shell's length.

### **Iphigenia rostrata** Rœmer

Plate XXX, Figure 1–1*b*

*Iphigenia rostrata* Rœmer, 1869, in Martini and Chemnitz, 'Syst. Conch. Cab.,' X, 3, Donacidæ, p. 116, Pl. xxi, figs. 5–8 (type locality: Lagos on the Slave Coast); 1870, Malak. Blätter, XVI, p. 154. Dautzenberg, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 95 (Rotuna, French Guinea).

Banana: on a sandbank at the entrance of the creek which leads to Moanda (Lang and Chapin Coll.).

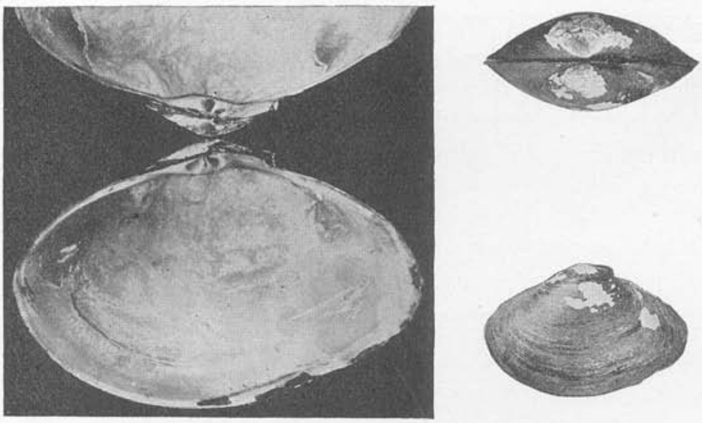
The shell is the largest of the genus, thin but moderately strong, triangular with convex base, the beaks small, projecting but little, about median. The front part tapers to a rounded end; posterior part is narrower, somewhat rostrate an bluntly pointed at end. Externally the shell is obliquely truncate posteriorly, a little depressed in front of the posterior ridge. Surface nearly smooth, marked with weak growth lines and much weaker traces of radial striæ, often hardly discernable. Covered with a somewhat dull light brownish-olive periostracum with lighter, dull buff concentric streaks. The interior is white, partly tinted with light violet. Median cardinal tooth in right valve is high, triangular, bifid and distinctly rugose. Lateral teeth are long, straight and extremely slender. In the left valve the two cardinals are high but thin, the anterior one bifid. The nymphs are well developed. The pallial sinus extends well past the middle of the shell's length.

| | | |
|---|---|---|
| Length, 62.0 mm.; | height, 45.6 mm.; | diameter, 26.0 mm. |
| " 63.0 | " 48.0 | " 28.4 |
| " 59.0 | " 41.0 | " 26.0 |

Compared with *P. curta* it differs by the less swollen shape, low beaks, straight margins on both sides of the beaks, light colored interior, etc.

In one specimen the anterior end is more broadly rounded than in the others. The degree of development of convexity of the ventral margin, corresponding to a swelling in the middle of the valves, varies individually (or possibly sexually).

We are not wholly satisfied that this species is really distinct from *I. lævigata* (Gmelin); but we have not been able to compare young *rostrata* of the size of *lævigata*.



a b c

Fig 83 *a-c*, *Iphigenia congo* Pilsbry and Bequaert. Type. Malela.

**Iphigenia congo,** new species

Text Figure 83*a-c*

?*Fischeria delessertii* "Bernardi." C. R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 114 (Lower Congo and San Antonio, in company with *I. lenzi;* P. Hesse Coll.).

Malela (Lang, Chapin, and J. Bequaert Coll.).

The shell is elliptical, thin, the dorsal and ventral margins about equally curved; moderately plump. The anterior end is rounded, the posterior end is narrower, rounded Beaks median, low, projecting but little above the hinge. Lunule narrow, a little shorter than the ligament. Periostracum dull, olive-brown (sometimes obscurely showing some wide, dusky rays), minutely laminate, chiefly at the ends. The interior is violet, varying in shade, usually showing some light rays by transmitted light. Hinge line very narrow. Middle cardinal tooth in the right valve triangular, deeply bifid, anterior cardinal very narrow; laterals very weak and narrow. In the left valve two subequal, triangular cardinals. Pallial sinus ample, extending a little beyond the middle of the shell's length.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length, | 27.2 mm.; | height, | 18.0 mm.; | diameter, | 12.5 mm. | Type. |
| " | 24.0 | " | 16.1 | " | 11.5 | Paratype. |
| " | 22.0 | " | 14.3 | " | 10.7 | |
| " | 20.3 | " | 14.0 | " | 10.7 | |

This species is decidedly thinner than the Liberian *I. delessertii* (Bernardi), less triangular, with a far weaker hinge-plate and weaker teeth. It is perhaps the species of the Congo estuary identified as *Fischeria delessertii* by C. R. Bœttger.

*Iphigenia centralis* (Germain), of the middle Niger, resembles this species closely in outline and teeth, but it is described as thick and solid, while the Congo shell is very thin. *I. messageri* and *I. approximans* (Preston), from the Senegal River, appear to belong to the same group. Preston mentions a "*F. lævigata* von Mts." as allied to *I. approximans;* probably *Iphigenia lævigata* (Gmelin) was intended.

## Other Species of *Iphigenia* Recorded from the Belgian Congo

### *Iphigenia lenzi* (Dautzenberg)

*Fischeria lenzi* Dautzenberg, 1891, Bull. Ac. Sci. Belgique, (3) XX, (1890), p. 578, Pl. III, figs. 3–8. (? C. R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 114).

Described originally from a pocket in the Congo alluvium, 15 m. above high water, near the mission of Nemlao, back of Banana (E. Dupont Coll.).

This species may turn out to be a form of *I. curta* (Dunker), but we have hesitated to place it in the synonymy of that species on account of the decidedly smaller, less inflated beaks shown in Dautzenberg's figures, though the other characters and the dimensions agree well. We therefore suspend judgment until authentic or topotypic examples can be compared with the living *I. curta.*

We have little doubt that the specimens collected alive by P. Hesse at San Antonio and referred by C. R. Bœttger to *I. lenzi* are really *I. curta,* since that species is abundant on the sandbanks there.

### *Iphigenia lævigata* (Gmelin)

*Donax lævigata* Gmelin, in Linnæus, 1791, 'Syst. Naturæ,' 13th Ed., p. 3265; based upon Chemnitz, 1782, 'Syst. Conch. Cab.,' VI, p. 253, Pl. xxv, fig. 249 (not binomial; said to have come from Tranquebar).

*Iphigenia lævigata* "Chemnitz" RŒMER, 1869, in Martini and Chemnitz, 'Syst. Conch. Cab.,' X, 3, Donacidæ, p. 111, Pl. I, fig. 7 and Pl. XIX, figs. 11–13 (Gaboon). DAUTZENBERG, 1912, Ann. Inst. Océanogr. Monaco, V, 3, p. 95 (Konakry and Rotuna, French Guinea).

Recorded by Dautzenberg from the estuary of the Congo at Banana (Gruvel Coll.).

## Cyrenoididæ

Characters of the following genus.

### CYRENOIDA de Joannis

*Cyrenoida* DE JOANNIS, June, 1835, Mag. de Zool., V, Moll., Pl. LXIV, with text; monotype: *Cyrenoida dupontia* de Joannis. DALL, 1903, Trans. Wagner Free Inst. Sci. Philadelphia, III, p. 1334.

*Cyrenella* DESHAYES, February, 1836, Mag. de Zool., V, (1835), Moll., Pl. LXX, with text (anatomy). Substitute for *Cyrenoida* de Joannis.

*Cyrenoides* G. B. SOWERBY, 1842, 'Conchol. Man.,' 2d Ed., p. 135, fig. 114, with *C. dupontia* de Joannis. Misspelling of *Cyrenoida.*

*Cyrenoidea* HANLEY, 1846, 'Ill. Cat. Rec. Biv. Shells,' Expl. Suppl., Pl. XV, p. 10. Misspelling of *Cyrenoida.*

*Cyrenodonta* H. and A. ADAMS, 1858, 'Gen. Recent Moll.,' II, p. 453, as a synonym of *Cyrenoida.*[1]

The shell is orbicular, with small beaks at about the anterior third, thin. Hinge with a thin, 7-shaped cardinal in each valve and a smaller, lamellar or v-shaped cardinal below it in the right valve; the narrow hinge-plate rounded posteriorly, without lateral teeth. Ligament external. Muscle scars and pallial line very faintly impressed, the latter entire.

Species few, in Australia, the Philippines, West Africa, and Middle America.

The following African species have been described.

*Cyrenoida dupontia* DE JOANNIS, June, 1835, Mag. de Zool., V, Moll., Pl. LXIV, with text = *Cyrenella* sp. DESHAYES, February, 1836, *op. cit.*, V, (1835), Moll., Pl. LXX, with text (anatomy). *Cyrenoides dupontii* WOODWARD, 1854, 'Manual of the Mollusca,' p. 298, Pl. XIX, fig. 19. *Cyrenella (Cyrenoida) dupontiæ* A. D'AILLY, 1896, Bihang Svenska Vet. Ak. Handl., XXII, Afd. 4, No. 2, p. 131. Senegal River.

*Cyrenoida rhodopyga* (E. v. Martens) = *Cyrenoidea rhodopyga* E. v. MARTENS, 1891, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 18. Mayumba, French Congo.

*Cyrenoida rosea* (A. d'Ailly) = *Cyrenella rosea* A. D'AILLY, 1896, Bihang Svenska Vet. Ak. Handl., XXII, Afd. 4, No. 2, p. 131, Pl. V, figs. 24–30. Ekumbi, Cameroon. This appears to be specifically distinct from the foregoing, since besides the difference in size its height is relatively less.

*Cyrenoida rosea brevidentata* Pilsbry and Bequaert. See below.

*Cyrenoida senegalensis* (Deshayes). See below.

[1]Not "Cyrénodonte" (French vernacular) of de Joannis, February, 1836, Mag. de Zool., V, (1835), last page of text following Moll. Pl. LXX.

**Cyrenoida senegalensis** (Deshayes)

Text Figure 84

*Cyrenella senegalensis* DESHAYES, 1854, Proc. Zool. Soc. London, p. 341 (type locality: Senegal).

*Cyrenoidea senegalensis* Deshayes. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 115.

On the roots of mangrove trees in the creek of Banana (P. Hesse Coll.).

Banana and Kunga (Lang and Chapin Coll.).

The shell is subcircular, deep olive-buff under a network of fine, crowded, anastomosing, brown, periostracal laminæ. The interior is light blue.

Length, 15.5 mm.; height, 14.0 mm.; diameter, 9.3 mm.

Fig. 84. *Cyrenoida senegalensis* (Deshayes). Banana.

**Cyrenoida rosea brevidentata,** new subspecies

Text Figure 85

Kunga, found dead on the mud with *C. senegalensis* (Lang and Chapin Coll.).

Two specimens, dead but with the periostracum preserved, agree with d'Ailly's account and figures of *C. rosea* in the size and shape of shell and hinge, but they differ by having the teeth much lower than they are represented in his fig. 30; so that we doubt whether the Kunga shells belong to the same species. In the left valve the teeth do not project ventrad as they appear in d'Ailly's fig. 29 of *rosea*. One of our examples is faintly pinkish at the beaks, the other white. The brown periostracum is densely covered with very short laminæ as in *C. dupontia* and other species.

| | | | | |
|---|---|---|---|---|
| Length, 13.0 mm.; | height, 10.6 mm.; | diameter, 8.0 mm. | Type. |
| " 14.4 | " 12.3 | " 9.0 | Paratype. |

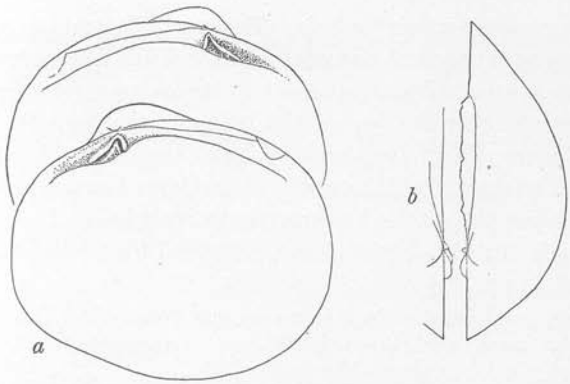



Fig. 85. *Cprenoida rosea brevidentata* Pilsbry and Bequaert. Type. Kunga.

## PRIONODESMACEA

### Unionidæ

Fresh-water bivalves of moderate or large size, the shell covered with a strong epidermis, having an external ligament; the interior conspicuously pearly; hinge provided with cardinal and posterior lateral teeth, with cardinals only, or without teeth; pallial line not sinuate.

Foot large and muscular, without byssus in the adult stage; the two adductor muscles subequal; mantle margins usually united to form short branchial, anal, and generally supra-anal siphons or orifices. Gills or parts of them modified to form marsupia n which the eggs develop into a larval, bivalve stage known as the glochidium. Diœcious, often with sexual differences in the shell, but these have not been studied in the African forms.

The family is of world-wide distribution and great antiquity, being known as early as the Triassic. Although Unionidæ are very common on the African continent, they appear to be poorly represented in Madagascar. But four species (*Cælatura cariei* Germain, *C. geayi* Germain, *Unio madagascariensis* Sganzin, and *U. malgachensis* Germain) have been recorded thus far from that island. None are known from the Mascarenes.

For practical purposes, the Ethiopian Unionidæ and Mutelidæ are distinguished by the possession of lamellar lateral teeth and shorter pseudocardinals by the former family. This dentition is not found in any Ethiopian Mutelidæ, so far as we know.

The species of Unionidæ known from the Belgian Congo have been here provisionally arranged in the two genera *Cælatura* and *Parreysia*, *Lævirostris* Simpson being treated as a subgenus of *Cælatura*. Some of the South African species, however, appear to be true *Unios* and Simpson has placed them in a section *Cafferia.* The conchological criteria of these several groups are at present obscure; and, since the soft parts are known for very few of the African species,[1] it seems unwise to attempt at present a generic classification of the many forms described from the Ethiopian Region. We have therefore listed the species in alphabetical sequence, the reference to Simpson's 'Descriptive Catalogue' indicating in each case where the species has been tentatively located. An exception has been made for the many names proposed for *Grandidieria,* which will be found on pp. 394–399.

The following species, which have been sometimes listed as African, do not belong to the Ethiopian fauna: *Unio divaricatus* I. Lea, *U. navigioliformis* I. Lea, *U. rectilinearis* Sowerby, and *U. sitifensis* Morelet.[2]

*Unio abyssinicus* E. v. MARTENS, 1866, Malakoz. Blätter, XIII, p. 102; 1867, *op. cit.*, XIV, p. 17. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 278, Pl. IX, figs. 5*a-c*. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 582 = *Unio habessinicus* HEUGLIN, 1868, 'Reise nach Abessinien,' p. 290. Lake Tsana, Abyssinia. Placed by Simpson in *Cafferia.*

*Parreysia acuminata* (H. Adams). See p. 303.

*Cælatura ægyptiaca* (Cailliaud). See p. 406.

*Cælatura ægyptiaca* var. *shambiensis* (Longstaff) = *Nodularia ægyptiaca* var. *shambiensis* LONGSTAFF, 1914, Journ. Linn. Soc. London, Zool., XXXII, p. 253, Pl. XVIII, figs. 4–7. Lake Shambe, Nile.

*Unio æneus* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 274, Pl. IX, fig. 2. Lake Tsana [Dembea], Abyssinia.

*Cælatura æquatoria* (Morelet). See p. 401.

*Unio aferula* I. LEA, 1864, Proc. Ac. Nat. Sci. Philadelphia, XVI, p. 109; 1866, 'Observ. Unio,' XI, p. 38, Pl. XIII, fig. 34 = *Parreysia aferula* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1134. Lake Nyasa.

*Unio africanus* I. LEA, 1856, Proc. Ac. Nat. Sci. Philadelphia, VIII, p . 94; 1857, 'Observ. Unio,' VI, p. 20, Pl. XXVII, fig. 15 = *Unio* (*Cafferia*) *caffer* var. *africanus* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 576. Cape of Good Hope.

*Unio alfierianus* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 43. Guebe River, affluent of the Oromo River, taking its source in the Ennerea Mts., Abyssinia.

*Unio* (*Parreyssia*) *alluaudi* DAUTZENBERG, 1908, Journ. de Conchyl., LVI, p. 26, Pl. II, figs. 13–16 = *Parreyssia alluaudi* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1141. Kavirondo Bay, Lake Victoria.

*Unio ambifarius* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 225, Pl. VII, fig. 20 = *Nodularia* (*Cælatura*) *ambifaria* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1036. Daressalaam, Tanganyika Territory.

*Unio angoniensis* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 59, Pl. IV, fig. 5. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 725. Angoniland, to the south of Lake Nyasa. According to Dupuis [1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 82] this is exceedingly close to *U. borellii* Ancey. Placed doubtfully in *Unio* by Simpson.

[1]So far as we are able to discover they have only been examined in *Unio caffer* (see p. 387) and in *Cælatura æquatoria* (see p. 400).

[2]Many additional names have been recently listed by Pallary, from Egypt (1924, Mém. Inst. d'Egypt, VII, 1, pp. 44-51).

*Reneus antiniloticus* "Bourguignat" Jousseaume, 1886, Bull. Soc. Zool. France, XI, p. 482 (without description). Senegal.

*Cælatura* (?) *araneosa* (A. T. de Rochebrune). See p. 407.

*Parreysia bakeri* (H. Adams). See p. 392.

*Unio bakoyi* A. T. de Rochebrune, 1882, Bull. Soc. Philomath. Paris, (7) VI, p. 33 = *Nodularia* (?) *bakoyi* Simpson, 1914, 'Descript. Cat. of Naiades,' p 1044. *Unio backoyi* A. T. de Rochebrune, 1904, Bull. Mus. Hist. Nat. Paris, p. 258. Bakoy River, Senegal.

*Unio* (*Nodularia*) *bangoranensis* Germain, 1907, Bull. Mus. Hist. Nat. Paris, p. 66; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 543, Pl. v, fig. 22 = *Nodularia* (?) *bangoranensis* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1039. Bangoran River, an affluent of the Chari River; rapids of the Gribingui River; Chari River at Fort Archambault; all French Equatorial Africa.

*Pharaonia bellamyi* Jousseaume, 1886, Bull. Soc. Zool. France, XI, p. 486, Pl. xii, figs. 7*a*-*b* = *Nodularia* (*Cælatura*) *bellamyi* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1026. Niger River at Faraba.

*Unio billottianus* Charmes, 1885, Bull. Soc. Malacol. France, II, p. 170 = *Unio billotianus* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1130 (placed doubtfully in *Parreysia*). Kingani River, Tanganyika Territory.

*Cælatura* (?) *böhmi* (E. v. Martens). See p. 407.

*Unio borellii* Ancey, 1894, Mém. Soc. Zool. France, VII, p. 226, fig. (on p. 227) = *Nodularia* (*Cælatura*) *borellii* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1035. Shiré River, 3 kilometers south of Lake Nyasa.

*Pharaonia bourguignati* A. T de Rochebrune, 1886, Bull. Soc. Malacol. France, III, p. 13. Mo aka, French Congo.

*Cælatura briarti* (Dautzenberg). See p. 403.

*Unio bridouxi* Bourguignat. See p. 409.

*Unio caffer* Krauss, 1848, 'Südafrik. Mollusk.,' p. 18, Pl. i, fig. 14. Simpson, 1914, 'Descript. Cat. of Naiades,' p. 574. Natal. This is the type of *Cafferia*.

*Unio caffer* var. *pentheri* Sturany, 1898, Anz. Ak. Wiss. Wien, Math. Naturw. Kl., XXXV, p. 161; 1898, Denkschr. Ak. Wiss. Wien, Math. Naturw. Kl., LXVII, p. 627, Pl. iii, figs. 64–65. Simpson, 1914, 'Descript. Cat. of Naiades,' p. 577. Panda ma Tinka, middle of Zambezi district.

*Cælatura calathus* (Bourguignat). See p. 407.

*Unio* (*Nodularia*) *cæsariana* Preston, 1913, Rev. Zool. Afric., III, 1, p. 60, Pl. iv, fig. 9. Lake Nyasa. According to Dupuis [1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 82], this is *Unio nyassænsis* E. A. Smith, 1893, Proc. Zool. Soc. London, Pl. lix, p. fig. 16.

*Cælatura charbonnieri* (Bourguignat). See p. 407.

*Unio charon* Preston, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 60, Pl. iv, fig. 6. Simpson, 1914, 'Descript. Cat. of Naiades,' p. 725. Silongwe, Nyasaland. Placed doubtfully in *Unio* by Simpson.

*Unio* (*Grandidieria*) *chefneuxi* Neuville and Anthony, 1906, Bull. Mus. Hist. Nat. Paris, p. 409; 1906, Bull. Soc. Philomath. Paris, (9) VIII, p. 287, Pl. xii, figs. = *Grandidieria chefneuxi* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1061. Lake Rudolf. This is not a *Grandidieria*, but appears to be related to *U. monceti* Bourguignat.

*Unio* (*Nodularia*) *chivoti* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 66; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 542, Pl. v, fig. 23 = *Nodularia* (?) *chivoti* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1038. Mamun River, in the Senussi country, French Equatorial Africa.

*Unio choziensis* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 60, Pl. IV, fig. 8. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 726. Chozi River, a tributary of the Chambezi River, Northeast Rhodesia. This appears to be hardly distinct from *Parreysia mweruensis* (E. A. Smith). Placed doubtfully in *Unio* by Simpson.

*Unio* (*Cafferia*) *connollyi* PILSBRY, 1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, p. 276, fig. 1, Pl. XIX, figs. 3–4 = *Cafferia caffra obesa* CONNOLLY, 1925, Rec. Albany Mus., III, p. 261, Pl. XII, figs. 3, 5. Port Natal.

*Nodularia croninæ* B. WALKER, 1922, The Nautilus, XXXVI, p. 5, Pl. I, figs. 2 and 3. Zambezi River, at Mongu Sealu in the Barotse Valley, Northern Rhodesia.

*Unio cyamus* PHILIPPI, 1851, Zeitschr. f. Malakoz., VIII, p. 125. South Africa.

*Unio decampsianus* WATTEBLED, 1884, Journ. de Conchyl., XXXII, p. 132, Pl. VII, fig. 1 = *Nodularia* (*Cælatura*) *decampsiana* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1026. *Unio campsianus* PÆTEL, 1890, 'Cat. Conch. Samml.,' III, p. 147. Niger River at Bamako.

*Unio dembeæ* "Rossmässler" SOWERBY, 1865, 'Conchol. Iconica,' XVI, *Unio*, Pl. XXIX, fig. 153. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 580 = *Unio dembea* BOURGUIGNAT, 1885, 'Moll. Choa,' p. 38. Lake Tsana, Abyssinia. Placed by Simpson in *Cafferia*.

*Unio diminutus* I. LEA, 1859, Proc. Ac. Nat. Sci. Philadelphia, XI, p. 151 (*diminutis*); 1860, 'Observ. Unio,' VII, p. 72. Pl. XXXIX, fig. 134. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 583 = *Unio gratiosus* "Parreiss" KÜSTER, 1848, in Martini and Chemnitz, 'Syst. Conch. Cab., IX, 2, Flussperlmuscheln,' p. 239, Pl. LXXX, fig. 3 (described from New Holland, but, according to Jickeli, from the Nile and the same as *U. gracilis* Parreyss). *Unio gracilis* "Parreyss" JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 280 (as a synonym of *U. diminutus* I. Lea). East Africa. Placed by Simpson in *Cafferia*.

*Zairia disciformis* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 10 = *Nodularia* (?) *disciformis* SIPMSON, 1914, 'Descript. Cat. of Naiades,' p. 1045. Mokaka, French Congo.

*Unio dumesnilianus* CHARMES, 1885, Bull. Soc. Malacol. France, II, p. 168 = *Unio dumesleanus* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 847; 1914, 'Descript. Cat. of Naiades,' p. 1130. Kingani River, Tanganyika Territory. Placed doubtfully in *Parreysia* by Simpson.

*Unio duponti* A. T. DE ROCHEBRUNE, 1882, Bull. Soc. Philomath. Paris, (7) VI, p. 34 = *Nodularia* (?) *duponti* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1038. Bakoy River, Senegal.

*Cælatura elegans* (A. T. de Rochebrune). See p. 400.

*Nodularia* (*Cælatura*) *ellenbergeri* GERMAIN, 1920, Bull. Mus. Hist. Nat. Paris, p. 242, figs. 36 and 37. District of Lealui, Upper Zambezi, Northern Rhodesia.

*Unio emini* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 224, Pl. VII, fig. 14 = *Nodularia* (*Cælatura*) *emini* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1035. Simin River near Massansa on the Speke Gulf of Lake Victoria.

*Unio* (*Nodularia*) *erlangeri* KOBELT, 1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 49, Pl. X, fig. 8 = *N. dularia* (?) *erlangeri* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1042. Somaliland.

*Unio essoensis* CHAPER, 1885, Bull. Soc. Zool. France, X, p. 481, Pl. XI, figs. 8 and 9 = *Nodularia* (*Cælatura*) *essoensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1025. Essoi River, Assinie, Ivory Coast.

*Unio* (*Nodularia*) *essoensis* var. *minor* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 172 = *Nodularia essoensis* var. *minor* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1026. Kanem, Lake Chad.

*Unio euphymus* CHARMES, 1885, Bull. Soc. Malacol. France, II, p. 171. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1130 (placed doubtfully of *Parreysia*). Kingani River, Tanganyika Territory.

*Unio eurysellinus* "Letourneux" PALLARY, 1903, Bull. Inst. Egyptien, (4) III, (1902), p. 94, Pl. II, fig. 4 = *Nodularia* (*Cælatura*) *eurysellina* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1022. Mahmoudich Canal, Lower Egypt; also said to occur in the White Nile. This appears to be very close to *U. rugifer* Küster.

*Reneus faidherbei* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 483, Pl. XII, figs. 5-5*a*. Bakoy River, Senegal.

**Unio fayumensis** PILSBRY AND BEQUAERT, new name for *Unio schweinfurthi* E. v. MARTENS, 1886, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 127. Fayûm basin, near Adue, Egypt. Not *U. parreyssi* var. *schweinfurthi* E. v. Martens, 1876.

*Unio Hyridella*) *fissidens* O. BOETTGER, 188', Ber. Senckenberg. Naturf. Ges., Abh., p. 27, Pl. II, figs. 6*a-b* and 7*a-b* = *Unio* (*Cafferia*) *fissidens* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 584. Dirk Filander's region, Southern Kalahari (subfossil).

*Unio forscali* "Parreyss" SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1192 (without description or reference). Egypt.

*Reneus fouladougouensis* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 485, Pl. XII, figs. 6-6*a* = *Nodularia* (*Cælatura*) *fouladougouensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1030. *Nodularia faladuguensis* KOBELT, 1909, Abh. Senckenberg. Naturf. Ges., XXXII. p. 84. Niger River at Fuladugu.

*Indonaia framesi* CONNOLLY, 1925, Rec. Albany Mus., III, p. 261, Pl. XII, figs. 1, 4.

*Unio gabonensis* KÜSTER, 1843 (?, or 1862), in Martini and Chemnitz, 'Syst. Conch. Cab., IX, 2, Flussperlmuscheln,' p. 291, Pl. XCVII, fig. 7 = *Nodularia* (*Cælatura*) *gabonensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1031. Gaboon.

*Unio* (*Nodularia*) *gaillardi* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 542, Pl. VIII, figs. 41 and 42 = *Nodularia* (?) *gaillardi* SIMPSON, 1914, 'Descript. Cat. of Naiades. p. 1041. Senegal.

*Nodularia* (*Cælatura*) *gaillardoti* "Bourguignat" PALLARY, 1909, Mém. Inst. Egyptien, VI, p. 78, Pl. V, figs. 7 and 8. Based upon *Unio ægyptiacus* var. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, Pl. X, figs. 5*a-b*. Egypt.

*Cælatura gereti* (Preston).. See p. 407.

*Cælatura gerrardi* (E. v. Martens). See p. 402.

*Unio guillemeti* Bourguignat. See p. 409.

*Unio hamyanus* BOURGUIGNAT, 1885, 'Voy. Choa,' p. 42. Lake Haussa, Abyssinia.

*Unio hauttecœuri* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza Oukéréwé,' p. 5, Pl., figs. 1–3 = *Parreysia hauttecœuri* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1126. *Unio edwardsianus* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza Oukéréwé,' p. 12, Pl., figs. 7–9. *Unio grantianus* BOURGUIGNAT, 1883, *op. cit.*, p. 14. *Unio grandidieri* BOURGUIGNAT, 1883, *op. cit.*, p. 7, Pl., figs. 4–6. *Unio duponti* BOURGUIGNAT, 1883, *op. cit.*, p. 8, Pl., figs. 10–12 (not *U. duponti* A. T. DE Rochebrune, 1882). *Unio postumus* A. T. DE ROCHEBRUNE, 1904, Bull Mus. Hist .Nat. Paris, p. 258, footnote (new name for *Unio duponti* Bourguignat, 1883). All from Lake Victoria, near the mouth of the Liwumbu River. Germain, 1906, Bull. Mus. Hist. Nat. Paris, p. 305, has named the following forms of this species, all from Lake Victoria: "mutations ex forma" *elongata, intermedia, curta, globosa, subcompressa,* and *compressa*; "var. ex colore" *lutescens, castanea, fusca, nigra, viridis,* and *ornata*. Of these only the var. *ornata* is described.

*Unio hermosus* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 38. Based upon *Unio nyassaensis* E. A. SMITH, 1881, Proc. Zool. Soc. London, Pl. XXXIV, fig. 34*B*. Lake Nyasa.

*Parreysia horei* (E. A. Smith). See p. 393.

*Unio* (*Hyridella*) *hygapanus* O. BŒTTGER, 1886, Ber. Senckenberg. Naturf. Ges., Abh., p. 26, Pl. II, figs. 5*a*-*b* = *Unio* (*Cafferia*) *hygapanus* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 585. Dirk Filander's region, Southern Kalahari (subfossil).

*Unio hypsiprymnus* E. v. MARTENS, 1897, 'Deutsch Ost Afr., VI, Beschalte Weichth.,' p. 230, Pl. VII, fig. 1 = *Parreysia hypsiprymnus* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1136. Mbampa Bay, Lake Nyasa.

*Unio ilqi* "Soleillet" BOURGUIGNAT, 1885, 'Moll. Choa,' p. 40 = *Unio* (?) *ilqui* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 862; 1914, 'Descript. Cat. of Naiades,' p. 1193. *Unio* (?) *idgi* "Bourguignat" SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 862. Lake Haussa, Abyssinia.

*Unio* (*Nodularia*) *jeanneli* GERMAIN, 1913, Bull. Mus. Hist. Nat. Paris, p. 235 = *Unio* (*Nodularia*) *jourdyi* GERMAIN, 1912, *op. cit.*, p. 438, figs. 63 and 64 (on p. 439) (not *Unio jourdyi* Morelet, 1886). Chari River, French Equatorial Africa.

*Unio jickelii* BOURGUIGNAT, 1883, Ann. Sc. Nat. Zool., (6) XV, p. 135. Based upon *Unio dembeæ* var. ? JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, Pl. IX, fig. 4. Lake Tsana, Abyssinia.

*Nodularia jickeli* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 826. Based upon *Unio teretiusculus* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, Pl. XI, figs. 3 and 3*a*-*b* = *Unio* (*Cafferia*) *jickeli* SIMPSON, 1914, 'Descript. Cat. Naiades,' p. 579. *Unio fourtaui* PALLARY, 1903, Bull. Inst. Egyptien, (4) III, (1902) p. 95 (based upon the same figure of *U. teretiusculus*, in Jickeli, as *N. jickeli* Simpson). Egypt.

*Pseudavicula johnstoni* (E. A. Smith). See p. 408.

*Unio josseti* Bourguignat. See p. 409.

*Unio jouberti* Bourguignat. See p. 409.

*Unio juliani* RANG, 1835, Nouv. Ann. Mus. Paris, IV, p. 306 = *Nodularia* (?) *juliani* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1044. *Unio juliana* SCHEPMAN, 1891, Notes Leyden Mus., XIII, p. 114. *Nodularia julieni* KOBELT, 1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 84. Creeks of Galam, Senegal.

*Unio kirkii* I. LEA, 1864, Proc. Ac. Nat. Sci. Philadelphia, XVI, p. 108; 1866, 'Observ. Unio,' XI, p. 36, Pl. XII, fig. 30 = *Parreysia kirkii* SIMPSON, 1914, 'Descript. Cat. Naiades,' p. 1133. Lake Nyasa.

*Unio* (*Nodularia*) *kœhleri* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 541, Pl. VIII, figs. 43, 44, and 47 = *Nodularia* (?) *kœhleri* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1040. Kolangui, French Guinea.

*Unio kunenensis* MOUSSON, 1887, Journ. de Conchyl., XXXV, p. 300, Pl. XII, fig. 10. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 586. Branch of the Cunene River in Northern Ovamboland. Placed by Simpson in *Cafferia*.

*Unio (Nodularia) lacoini* GERMAIN, 1906, Mém. Soc. Zool. France, XIX, p. 237, Pl. IV, figs. 11 and 12 = *Nodularia (Cælatura) lacoini* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1028. Northeastern shore of Lake Chad at Kanassarom. In the original description it is stated that the species is composed of the two varieties *elongata* and *curta*. Later Germain (1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 545) still adds a var. *compressa*. None of these varieties have, however, been formally described.

*Unio lacoini* var. *chudeaui* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 541 = *Nodularia lacoini* var. *chudeaui* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1029. Lake Chad at N'Guigmi.

*Unio lavigerianus* Bourguignat. See p. 409.

*Unio lechaptoisi* ANCEY, 1894, Mém. Soc. Zool. France, VII, p. 228, fig. = *Nodularia (?) lechaptoisi* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1037. *Unio shireensis* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 61, Pl. IV, fig. 11. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 727. Shiré River, 3 kilometers south of Lake Nyasa (type locality of both *U. lechaptoisi* and *U. shireensis*). The synonymy has been pointed out by Dupuis, 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 82.

*Unio lechaptoisi* var. *minor* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 227. Mbampa and Amelia Bays, Lake Nyasa.

*Unio ledoulxianus* CHARMES, 1885, Bull. Soc. Malacol. France, II, p. 173 = *Nodularia ledoulxiana* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 982. Kingani River at Bagamoyo.

*Parreysia leopoldvillensis* (Putzeys). See p. 390.

*Unio liederi* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 226, Pl. VII, fig. 19 = *Nodularia (Cælatura) liederi* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1037. Mbampa Bay in Lake Nyasa and Ulanga in the upper Rufiji region.

*Parreysia lobensis* FRIERSON, 1913, The Nautilus, XXVII, p. 85, Pl. V (lower figures). Lobo River, Cameroon (named *loboensis* on the plate).

*Parreysia lourdeli* (Bourguignat). See p. 394.

*Unio mandinguorum* A. T. DE ROCHEBRUNE, 1882, Bull. Soc. Philomath. Paris, (7) VI, p. 34. SIMPSON, 1914, 'Descript. Cat. Naiades,' p. 584 = *Nodularia mandingoensis* KOBELT, 1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 85. Bakoy River, Senegal. Placed doubtfully in *Cafferia* by Simpson.

*Unio mashonæ* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 61, Pl. IV, fig. 10. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 578. About 16 miles from Enkeldoorn, Southern Rhodesia. Placed by Simpson in *Cafferia*.

*Unio menardi* Bourguignat. See p. 409.

*Unio meneliki* "Soleillet" BOURGUIGNAT, 1885, 'Moll. Choa,' p. 41. Hauash River, Abyssinia.

*Cælatura mesafricana* Pilsbry and Bequaert. See p. 402.

*Pharaonia misraimica* "Bourguignat" SERVAIN, 1890, Bull. Soc Malacol. France, VII, p. 290. "Canal de l'usine des eaux à Suez."

*Unio moineti* Bourguignat. See p. 409.

*Unio monceti* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza Oukéréwé, p. 15, Pl., figs. 13–15. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 582. Lake Victoria near the mouth of the Liwumbu River. Placed by Simpson in *Cafferia*.

*Unio monceti* var. *rubra* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 306. Lake Victoria, near Entebbe.

*Unio mossambicensis* "Peters" E. v. MARTENS, 1860, Malakoz. Blätter, VI, p. 218, Pl. III, figs. 3–5 = *Nodularia mossambicensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 986. Zambezi River near Tete.

*Unio multicolor* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth., p. 236, Pl. VII, fig. 4 = *Parreysia multicolor* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1129. Lake Victoria, near Sirwa Island and near Bukoba.

*Unio mutelæformis* GERMAIN, 1906, Mém. Soc. Zool. France, XIX, p. 236; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 540, Lith. Pl., figs. 3 and 4 = *Parreysia mutelæformis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1135. Lake Chad.

*Unio mutelæformis* var. *chariensis* GERMAIN, 1906, Mém. Soc. Zool. France, XIX, p. 236 = *Parreysia mutelæformis* var. *chariensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1136. Mamun River, French Equatorial Africa.

*Parreysia mweruensis* (E. A. Smith). See p. 392.

*Unio mysticus* "Bourguignat" PALLARY, 1903, Bull. Inst. Egyptien, (4) III, (1902), p. 94, Pl. II, fig. 3 = *Nodularia* (*Cælatura*) *mystica* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1022. Upper Nile and canal near Suez.

*Unio natalensis* I. LEA, 1864, Proc. Ac. Nat. Sci. Philadelphia, XVI, p. 113; 1866, 'Observ. Unio,' p. 63, Pl. XX, fig. 57 = *Unio vaalensis* CHAPER, 1885, Bull. Soc. Zool. France, X, p. 480, Pl. XI, figs. 1–3 (type locality: Vaal River nea Barkly, Griqualand West). *Unio* (*Cafferia*) *caffer* var. *vaalensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 576. Umpingave River, Natal.

*Parreysia ngesiana* (E. v. Martens). See p. 389.

*Unio* (*Nodularia*) *nguigmiensis* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 540, fig. 40 = *Nodularia* (*Cælatura*) *nguigmiensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1029. Lake Chad, at N'Guigmi.

*Unio niloticus* CAILLIAUD, 1827, 'Voyage à Méroé,' IV, p. 263; 1823, Atlas, II, Pl. LXI, figs. 8 and 9 = *Nodularia* (*Cælatura*) *nilotica* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1020. Canal of Joseph and other canals of Lower Egypt. *Unio pumilus* "Ziegler" JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXII, 1, p. 272 (in the synonymy of *U. niloticus*).

*Parreysia nyangensis* FRIERSON, 1913, The Nautilus, XXVII, p. 86, Pl. V (upper figures). Nyang River, Cameroon.

*Unio nyassaensis* I. LEA, 1864, Proc. Ac. Nat. Sci. Philadelphia, XVI, p. 108; 1866, 'Observ. Unio,' XI, p. 37, Pl. XII, fig. 32 = *Parreysia nyassaensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1132. *Unio nyassæ* SOWERBY, 1866, 'Conchol. Iconica,' XVI, *Unio*, Pl. XLI, figs. 224*a*-*b*. *Unio nyassensis* SOWERBY, 1868, *op. cit.*, in Errata and Index. *Unio nyassanus* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 38. Lake Nyasa.

*Unio nyassaensis* var. *hercules* Preston = *Unio* (*Nodularia*) *nyassanus* var. *hercules* PRESTON, 1913, Rev. Zool. Afric., III 1, p. 59, Pl. IV, fig. 10. Shiré River, near its outflow from Lake Nyasa.

*Unio parreyssi* "v. d. Busch" PHILIPPI, 1848, 'Abbild. Beschr. Conchyl.,' III, p. 81, *Unio*, Pl. v, fig. 6 = *Unio parreissii* KÜSTER, 1848, in Martini and Chemnitz, 'Syst. Conch. Cab., IX, 2, Flussperlmuscheln,' p. 268, Pl. xc, fig. 6. Sennar, White Nile.

*Nodularia parreyssi* var. *obliqua* LONGSTAFF, 1914, Journ. Linn. Soc. London, Zool., XXXII, p. 255, Pl. xviii, fig. 11. Nile at Tawila, Masran Island, and Melut.

*Nodularia parreyssi* var. *elongata* LONGSTAFF, 1914, Journ. Linn. Soc. London, Zool., XXXII, p. 255, Pl. xviii, figs. 9 and 10. Nile at Ad-Duwen, Tawila, and Gebel Ahmad Agha.

*Nodularia* (*Cælatura*) *parreyssi* var. *pruneri* "Bourguignat" PALLARY, 1909, Mém. Inst. Egyptien, VI, p. 78. Based upon *Unio ægyptiacus* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, Pl. x, fig. 7 = *Nodularia nilotica* var. *pruneri* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1021. Egypt.

*Unio parreyssi* var. *schweinfurthi* E. v. MARTENS, 1876, 'Novit. Conchol.,' IV, p. 140, Pl. cxxxii, figs. 3–5. Tonji River, Anglo-Egyptian Sudan.

*Cælatura poirieri* (A. T. de Rochebrune). See p. 407.

*Cælatura putzeysi* (Preston). See p. 408.

*Cælatura randabeli* (Bourguignat). See p. 408.

*Unio ratidotus* CHARMES, 1885, Bull. Soc. Malacol. France, II, p. 166 = *Nodularia* (?) *ratidota* SIMPSON, 1914, 'Descript. Cat. Naiades,' p. 1044. *Nodularia radiota* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 824. *Nodularia radiata* KOBELT, 1909, Abh. Senckenberg. Naturf. Ges., XXXII, p. 84. Kingani River, Tanganyika Territory.

*Parreysia regis* Pilsbry and Bequaert. See p. 389.

*Unio* (*Grandidieria*) *rothschildi* NEUVILLE AND ANTHONY, 1906, Bull. Mus. Hist. Nat. Paris, p. 409; 1906, Bull. Soc. Philomath. Paris, (9) VIII, p. 286, Pl. xii, figs. = *Grandidieria rothschildi* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1057. Lake Rudolf. This appears to be a *Parreysia*.

*Cælatura* (*Lævirostris*) *rotula* Pilsbry and Bequaert. See p. 405.

*Reneus reneus* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 482, Pl. xii, figs. 4*a*-*b* = *Nodularia* (*Cælatura*) *renea* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1027. Niger River at Kayu (60 kilometers below Bamako).

*Unio ruellani* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza Oukéréwé, p. 10, Pl., figs. 16–18 = *Parreysia ruellani* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1128. Lake Victoria near the mouth of the Liwumbu River.

*Unio ruellani* var. *bayoni* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 275, Pl. iii, fig. 36 = *Parreysia ruellani* var. *bayoni* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1128. Bugalla Islands, Lake Victoria.

*Unio rugifer* KÜSTER, 1848, in Martini and Chemnitz, 'Syst. Conch. Cab., IX, 2, Flussperlmuscheln,' p. 157, Pl. xlv, figs. 3 and 4. Nile River, Egypt.

*Unio sennaariensis* KÜSTER, 1848, in Martini and Chemnitz, 'Syst. Conch. Cab., IX, 2, Flussperlmuscheln,' p. 280, Pl. xciv, figs. 5 and 6. Sennar.

*Unio silongweensis* PRESTON, 1912, The Nautilus, XXVI, p. 35. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 726 = *Unio vicinus* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 60, Pl. iv, fig. 7 (not *Unio vicinus* I. Lea, 1856). Silongwe, Nyasaland. Placed doubtfully in *Unio* by Simpson.

*Nodularia* (*Cælatura*) *sobaensis* PRESTON, 1914, Journ. Linn. Soc. London, Zool., XXXII, p. 266, Pl. xviii, figs. 1–3. Blue Nile at Soba.

*Unio soleilleti* Bourguignat, 1885, 'Moll. Choa,' p. 39. Lake Haussa, Abyssinia.

*Cælatura sordida* (A. T. de Rochebrune). See p. 408.

*Cælatura (Lævirostris) stagnorum* (Dautzenberg). See p. 404.

*Cælatura stagnorum bomæ* Pilsbry and Bequaert. See p. 405.

*Cælatura stanleyvillensis* Pilsbry and Bequaert. See p. 403.

*Parreysia stuhlmanni* (E. v. Martens). See p. 390.

*Unio subamygdalinus* Drouet, 1895, Journ. de Conchyl., XLIII, p. 35. Right bank of the Senegal River, 2 kilometers north of Bakel.

*Unio teretiusculus* Philippi, 1847, 'Abbild. Beschr. Conchyl.,' III, p. 45, *Unio*, Pl. III, fig. 3 = *Nodularia teretiuscula* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 981. *Margarita* (*Unio*) *cailliaudii* "Férussac" I. Lea, 1838, 'Synopsis of Naiades,' 2d Ed., p. 24 (without description). *Unio cailliaudi* "Férussac" E. v. Martens, 1866, Malakoz. Blätter, XIII, p. 13 (with description). *Unio lithophagus* "Ziegler" Philippi, 1847, 'Abbild. Beschr. Conchyl.,' III, p. 45 (in the synonymy of *U. teretiusculus*). White Nile. This species has been recorded from Lake Albert but its occurrence there is doubtful.

*Nodularia teretiuscula* var. *pallaryi* Longstaff, 1914, Journ. Linn. Soc. London, Zool., XXXII, p. 256 = *Nodularia teretiuscula* var. *lithophaga* Pallary, 1902, Bull. Inst. Egyptien, (4) III, p. 95 (not of Ziegler). Egypt.

*Unio traversii* Pollonera, 1888, Bull. Soc. Malacol. Italiana, XIII, p. 85, Pl. III, figs. 14 and 15. Simpson, 1914, 'Descript. Cat. of Naiades,' p. 577. Hauash River, Abyssinia. Placed by Simpson in *Cafferia*.

*Unio tricolor* Küster, 1848, in Martini and Chemnitz, 'Syst. Conch. Cab., IX, 2, Perlflussmuscheln,' p. 156, Pl. XLV, figs. 1 ♀ and ♂. Nile River, Egypt. Simpson (1914, 'Descript. Cat. of Naiades,' p. 1168) refers this as a variety to the Oriental *Lamellidens marginalis* (Lamarck), but we do not know whether this is correct.

*Unio* (*Grandidieria*) *tsadianus* E. v. Martens, 1903, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 8 = *Grandidieria tsadiana* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1060. Southern shore of Lake Chad. This appears to be a *Parreysia*.

*Parreysia ujijiensis* (Crosse). See p. 394.

*Unio verrauxi* "Charpentier" Küster, 1848, in Martini and Chemnitz, 'Syst. Conch. Cab., IX, 2, Flussperlmuschlen,' p. 150, Pl. XLIII, fig. 6. Zoetendal Valley, Cape Colony.

*Unio verreauianus* I. Lea, 1856, Proc. Ac. Nat. Sci. Philadelphia, VIII, p. 94; 1857, 'Observ. Unio,' VI, p. 21, Pl. XXVII, fig. 16 = *Margaron* (*Unio*) *verreauxianus* I. Lea, 1870, 'Synopsis of Naiades,' 4th Ed., p. 36. Cape of Good Hope. This is distinct from the preceding species.

*Nodularia verrucosa* F. Haas, 1910, Nachrichtsbl. Deutsch. Malakoz. Ges., XLII, p. 99. Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1043. Nile. Placed among the doubtful *Nodulariæ* by Simpson.

*Unio vignardi* Pallary, 1924, Mém. Inst. d'Egypte, VII, 1, p. 40, Pl. IV, figs. 16 and 18. In prehistoric deposits at Sebil near Kom Ombo, Upper Egypt.

*Unio vinckei* Bourguignat. See p. 409.

*Unio visseri* Bourguignat. See p. 409.

*Unio zambesiensis* Preston, 1905, Proc. Malacol. Soc. London, VI, 5, p. 301, fig. 1 (on p. 300). Simpson, 1914, 'Descript. Cat. of Naiades,' p. 724. Zambezi River, just above Victoria Falls. Placed doubtfully in *Unio* by Simpson.

*Unio zeyheri* Menke, 1848, Zeitschr. f. Malakoz., V, p. 28. Cape of Good Hope.

### UNIO Retzius

*Unio* RETZIUS, 1788, 'Diss. Hist. Nov. Test. Gen.,' p. 16. Type: *Unio tumidus* Retzius.

*Nodularia* CONRAD, 1853, Proc. Ac. Nat. Sci. Philadelphia, VI, p. 268. Monotype: *Unio douglasiæ* Griffith and Pidgeon.

A. E. Ortmann (1918, The Nautilus, XXXI, pp. 128–131) has shown that *Nodularia* is a synonym of *Unio*. The African species placed by Simpson in *Nodularia* appear to belong to *Cælatura* and *Parreysia*.

The genus as at present defined inhabits Europe, Asia and Africa. All the tropical and South African forms belong to the subgenus *Cafferia*, which was erected by Simpson as a section.

### Subgenus CAFFERIA Simpson

*Nodularia* section *Cafferia* SIMPSON, 1900, Proc. U . S. Nat. Mus., XXII, p. 824. Type by original designation: *Unio caffer* Krauss.

*Unio* section *Cafferia* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 574.

"Shell elongated or elliptical, rhomboid when old, solid; beaks full, the sculpture corrugated zigzag, the ridges often extending over the disk; epidermis yellowish-brown to nearly black, dull colored, somewhat sulcate; teeth rather strong; muscle scars deep, well defined" (Simpson, 1914).

This group was at first regarded by Simpson as a division of *Nodularia;* but having had later an opportunity of examining gravid specimens of one of the species, he found that it was a *Unio*.

*Cafferia* appears to be strictly African. Many of the South African forms belong here, but none are known from within our territory.

A. E. Ortmann, who has examined the soft parts of *Unio caffer*, states that they differ little from those of *Unio pictorum*. The gravid females collected in Natal, in July, had mostly eggs, but one of them had glochidia. Of specimens obtained near Pretoria, Transvaal, in April, only one female was gravid and also had glochidia. The anatomy is described as follows:

Anal opening separated from the supra-anal opening by a moderate mantle connection, slightly shorter than the anal. Supra-anal about as long as or slightly longer than the anal. The latter with the inner edge almost smooth. Branchia opening with distinct papillæ. No differentiating structure on mantle-edge in front of branchial. Palpi subfalciform, of medium size, their posterior margins united for nearly half their length. Gills of the unionid-type; gill diaphragm complete, separating anal and branchial openings. Anterior end of inner gills widely remote from the palpi. Inner lamina of inner gill free from abdominal sac, except at anterior end. Septa and water-tubes present, the former continuous and not interrupted, parallel to the gill-filaments. In the male, and in the inner gill of the female, they are weak and distant from each other. The outer gill of the female is marsupial practically in its entire length, with heavy and crowded septa.

Glochidia, as far as observed, were subtriangular in shape and without hooks, about 0.23 to 0.25 mm. long, 0.20 to 0.21 mm. high.[1]

### PARREYSIA Conrad

*Parreysia* CONRAD, 1853, Proc. Ac. Nat. Sc. Philadelphia, VI, p. 267. Monotype: *Unio multidentatus* "Parreyss" Philippi. This is said to be a synonym of *Mya corrugata* O. F. Müller of India.

The name is frequently misspelled *Parreyssia.*

Simpson has defined the genus upon shell characters as follows:

> Shell solid, inflated, oval to subrhomboid, with full, high, zigzag, radially sculptured beaks, the sculpture often extending over the disk; epidermis smooth and bright, sometimes a little rayed, with two irregular pseudocardinals in the left valve which are more or less broken into ragged denticles or are strongly, vertically striate, and two laterals, the lower the larger; right valve with one, sometimes two pseudocardinals, the upper small, compressed, and a few tubercles behind them, with two laterals, the upper the larger; cavity of the beaks rather deep, not compressed; dorsal scars under the hinge, not visible; the two upper anterior muscle scars very deep, confluent, the lower linear; nacre white to salmon, iridescent behind. (1914, 'Descript. Cat. of Naiades,' p. 1103).

It is not known whether the Ethiopian Region mussels which have been referred to *Parreysia* are really related to the Oriental forms for which that name was proposed. Their relation to the unionid section *Cafferia* is equally obscure, as there seem to be no definite distinctions in the shells. The use of generic names of such uncertain application appears to be no advance over the all-embracing use of *Unio* as in former times.

Frierson (1909, The Nautilus, XXII, p. 107) and Ortmann (1910, *op. cit.*, XXIII, pp. 139–140 and 1911, *op. cit.*, XXIV, p. 106) examined the soft parts of *P. wynegungaensis* (I. Lea), an Asiatic species closely allied to the genotype. It has essentially the structure of North American *Quadrula.* The anal and branchial openings, the diaphragm, the palpi, gills and marsupium are practically identical, as are also the general shape and insertion of the gills (the inner separated from the posterior end of the palpi). The only differences are, that the supra-anal opening is rather widely separated from the anal, and that the inner gills are entirely connected with the abdominal sac. In the female all four gills serve as marsupium. B. Prashad has published additional observations on the anatomy of some of the Indian species. He gives the following summary of the animal of *Parreysia*:

---

[1]1918, The Nautilus, XXXI, pp. 75–76.

The gills are three to five times as long as broad. Anteriorly the outer pair of gills is a little shorter than the inner, so that the margin of the latter projects beyond that of the former. The inner lamellæ of the inner pair of gills are connected along more than three-fourths of their length to the abdominal sac; the posterior one-fourth part unites with the lamella of the opposite side to form the diaphragm; other connections of the gills are the same as in *Balwantia* described already [viz., the outer lamellæ of the outer pair of gills are attached to the mantle of either side, while the inner lamellæ of the outer pair are attached to the outer lamellæ of the inner pair]. All the four gills are marsupial. The margin of the gills, even when full of glochidia, is quite sharp. The water-tubes are simple and the placentæ are slightly compressed, elongate structures. The palpi are well developed, sub-triangular with a broad base, along which they are attached to the abdominal mass and have the free outer angle rounded. The mantle has a slightly thickened entire margin. The foot is very large, occupying about half of the shell cavity. The branchial aperture is large, with three rows of small pointed papillæ of a light brown color. The anal is less than half the size of the branchial and is marked off from it by a feebly developed ridge of the mantle. The supra-anal is of the same size or a little larger than the mantle connection between it and the anal. The glochidia are semi-circular or semi-elliptic. (1919, Rec. Indian Mus., XVI, p. 292).

The anatomy of none of the African species thus far placed in *Parreysia* is known and it will be of interest to learn in how far they agree with the above descriptions.

### **Parreysia ngesiana** (E. v. Martens)

Plate XXXI, Figure 11

*Unio ngesianus* E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 234, Pl. VII, fig. 7. Germain, 1916, Bull. Mus. Hist. Nat. Paris, p. 204.

*Parreysia ngesiana* E. v. Martens. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 847; 1914, 'Descript. Cat. of Naiades,' p. 1129.

Lake Edward: Kishakka on the northwestern shore (type locality) and subfossil near Koha-ekjo (Stuhlmann Coll.).

Lake Edward at Kabare (J. Bequaert Coll.).

Two worn valves taken by the junior author agree very well with von Martens' account and figure. The zigzag sculpture is developed over about two-thirds to three-fourths of the surface. The pseudocardinal teeth are stronger than in *P. bakeri*. One of these valves is figured.

### **Parreysia regis**, new species

Plate XXXI, Figures 12–12*b*

Lake Edward at Kabare (J. Bequaert Coll.).

The shell is oblong, moderately convex; the dorsal and ventral margins subparallel, both slightly curved; covered with a thin, glossy, olive-brown epidermis. About a third of the width is finely zigzag ridged; at the beaks the apices of the V-shaped corrugations are emphasized, forming two radial series of tubercles.

The beaks are rather low, at about the anterior two-sevenths of the length. The interior is white, bluish posteriorly. The pseudocardinal teeth are rather compressed, ragged, double in the left valve, where there is also an inter-dental tooth-like prominence. The laterals are thin and short.

Length, 39 mm.; height, 23 mm.; diameter, 16 mm. Length from beaks to posterior end of the lateral teeth, 20 mm.

While this species appears related to *P. stuhlmanni* (E. v. Martens), it differs by the straighter dorsal and ventral margins, the thinner shell, thinner teeth, less brilliant nacre, and other characters.

**Parreysia stuhlmanni** (E. v. Martens)

Plate XXXI, Figures 7–7*b*

*Unio stuhlmanni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 231, Pl. VII, fig. 13. GERMAIN, 1916, Bull. Mus. Hist. Nat. Paris, p. 203.

*Parreysia stuhlmanni* E. v. Martens. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 846; 1914, 'Descript. Cat. of Naiades,' p. 1126.

Lake Edward: originally described from near Vichumbi, Kiruwe, and Katarenge, in the southwestern part of the lake (Stuhlmann Coll.).

Lake Edward at Kabare (J. Bequaert Coll.).

The shell is rather solid, inflated, long-ovate; the dorsal and basal margins about equally curved; the anterior end rounded, the posterior end prolonged, narrowly rounded. The epidermis is thin, brown (mainly worn off in our specimen). The surface has irregular growth lines, and near the beaks fine zigzag sculpture; there is also some corrugation on the dorsal slope anterior to the beak. There are also some indistinct, weakly raised lines radiating from the umbonal region to the basal margin over the anterior part of the valve. The beaks are rather low and wide, the tip at about the anterior two-sevenths of the length, nodular in two series, this sculpture soon giving place to zigzag ridges. The interior is bright silvery, with red and green reflections. Pseudocardinal teeth double in the left valve, deeply cut, or "ragged." Lateral teeth short, hardly one-third the length of the shell; interdental plate moderately developed.

Length, 42.5 mm.; height, 27.5 mm.; semi-diameter, 10.5 mm.; 20.0 mm. from beak to posterior end of the lateral teeth.

This is a longer, plumper shell than *P. ngesiana*, with a more pointed posterior end and less extensive corrugation, which became obsolete when the shell had reached a length of about 14 mm.

A new description is given as the specimen here figured differs a little from that described by von Martens. However, we believe that such differences as appear are individual rather than racial.

**Parreysia leopoldvillensis** (Putzeys)

Plate XXXI, Figures 1–4

*Unio leopoldvillensis* PUTZEYS, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. xxvii, figs. 12 and 13.

*Parreysia leopoldvillensis* Putzeys. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 846; 1914, 'Descript. Cat. of Naiades,' p. 1124.

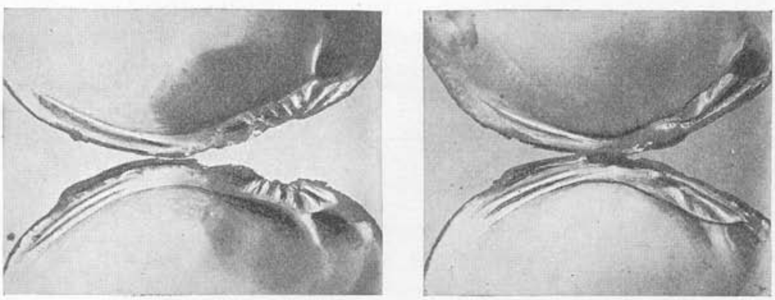
Stanley Pool near Leopoldville (type locality).

Zambi and Stanleyville in the Congo River; Faradje in the Dungu River (Lang and Chapin Coll.). Avakubi in the Ituri River (J. Bequaert Coll.).

A somewhat rhombic, solid species, higher posteriorly, with sculpture of fine zigzag ridges over the upper third or half, below which they are concentric. In occasional examples the pseudocardinal teeth are lacerated (Fig. 86*a*), much as in *Grandidieria*. In specimens from Zambi the height of the shell varies from 66 to 70 per cent of the length.

| | | | | |
|---|---|---|---|---|
| Length, 33.0 mm.; | height, 22.0 mm.; | diameter, 13.2 mm. | Zambi. |
| " 31.5 | " 22.0 | " 14.0 | " |
| " 35.0 | " 24.0 | " 14.3 | " |

Many specimens from Stanleyville and Avakubi do not differ from those of Zambi (Pl. XXXI, figs. 1–3). The constancy of the species over so great a range is remarkable. Putzeys gives the dimensions of the Stanley Pool types as: length, 45 mm.; height, 28–30 mm.; diameter, 15–19 mm. These are larger than any of the long series before us.



*a* *b*

Fig. 86. *Parreysia leopoldvillensis* (Putzeys). Hinge teeth of specimens from: *a*, Zambi, and *b*, Stanleyville.

A young shell is figured to show the sculpture pattern, which is more or less obliterated in adults (Fig. 87).

In specimens from Faradje (Pl. XXXI, fig. 4) the shell is relatively higher than in *leopoldvillensis*, the height about 73 per cent of the length, and the basal margin is more curved. Length, 29.5 mm.; height, 21.5 mm.; diameter, 12.2 mm.

Fig. 87. *Parreysia leopoldvillensis* (Putzeys). Young shell from Zambi, length, 23 m.

### **Parreysia bakeri** (H. Adams)

Plate XXXI, Figures 5 and 6

*Unio bakeri* H. ADAMS, 1866, Proc. Zool. Soc. London, p. 376. E. A. SMITH, 1888, *op. cit.*, p. 56; 1892, Ann. Mag. Nat. Hist., (6) X, p. 126, Pl. XII, fig. 11. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 231, Pl. VII, fig. 6. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 212.

*Parreysia bakeri* H. Adams. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 846; 1914, 'Descript. Cat. of Naiades,' p. 1125.

Lake Albert: originally described from that lake without more definite locality (S. Baker Coll.; Emin Pasha Coll.); Kassenje (Stuhlmann Coll.; Schubotz Coll.).

The specimens figured are part of a lot from Lake Albert without more exact location. As in *P. acuminata*, the sculpture is rather coarse. There is considerable variation in outline, as the figures show. The figured valves measure:

| | | |
|---|---|---|
| Length, 36.0 mm.; | height, 23.0 mm.; | semi-diameter, 9.5 mm. |
| " 34.0 | " 26.0 | " 8.5 |

### **Parreysia mweruensis** (E. A. Smith)

Plate XXXI, Figures 8, 9, 10

*Unio mweruensis* E. A. SMITH, 1908, Proc. Malacol. Soc. London, VIII, p. 13, figs. (on p. 14).

*Unio (?) mweruensis* E. A. Smith. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 730.

*Pareyssia mweruensis* E. A. Smith. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1142.

*Unio (Nodularia) luapulaensis* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 60, Pl. IV, fig. 11.

Lake Moero: originally described from that lake without more definite locality R. L. Harger Coll.). Confluence of the Luapula and Lukulu Rivers (type locality (of *U. luapulaensis*).

Lake Moero at Lukonzolwa; Luapula River at Kachiobwe and at Kasenga; Elisabethville (all Stappers Coll.).

Variable in shape and degree of sculpture development, as noted by Smith. A shell from Elisabethville (Pl. XXXI, fig. 8) is rather wide (as in *U. luapulaensis* Preston), strongly sculptured, the corrugation becoming weaker toward the basal margin and more or less parallel to growth lines.

In a Lukonzolwa shell (Pl. XXXI, fig. 9) the corrugation is finer, subobsolete in the lower third.

Specimens from Kachiobwe (Pl. XXXI, fig. 10) and Kasenga have corrugation close to the beaks only, a few narrow folds appearing farther down on the posterior slope. There are many inconspicuous green rays, in the region of the beaks. In sculpture these examples are like *U luapulaensis* Preston.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Length, | 27.5 mm.; | height, | 18.3 mm.; | diameter, | 12.0 mm. | Elisabethville |
| " | 38.0 | " | 23.5 | " | 13.7 | Lukonzolwa |
| " | 33.5 | " | 19.5 | " | 13.8 | Kachiobwe |

### **Parreysia acuminata** (H. Adams)

Plate XXXI, Figure 13

*Unio acuminatus* H. Adams, 1866, Proc. Zool. Soc. London, p. 376. E. A. Smith, 1888, *op. cit.*, p. 56; 1892, Ann. Mag. Nat. Hist., (6) X, p. 127, Pl. xii, fig. 12. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 227, Pl. vii, figs. 11 and 12. J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 212.

*Nodularia acuminata* H. Adams. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 826.

*Unio* (*Cafferia*) *acuminatus* H. Adams. Simpson, 1914, 'Descript Cat. of Naiades,' p. 579.

This is probably the *Unio caillaudi* H. Adams, 1866, Proc. Zool. Soc. London, p. 376; E. A. Smith, 1888, *op. cit.*, p. 56, recorded from Lake Albert.

Lake Albert: originally described from that lake, without more definite locality (S. Baker Coll.); near Kassenje (Stuhlmann Coll.; Schubotz Coll.).

Lake Albert: Butiaba (Mearns Coll.).

The figure represents a specimen collected by Mearns at Butiaba, Lake Albert, No. 215196 U. S. N. M. It measures:

Length, 35.0 mm.; height, 18.0 mm.; diameter, 13.0 mm.

## Other Species of *Parreysia* Recorded from the Belgian Congo

### *Parreysia horei* (E. A. Smith)

*Unio horei* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 429; 1881, Proc. Zool. Soc. London, p. 299, Pl. xxxiv, fig. 37. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 235.

*Grandidieria horei* E. A. Smith. Bourguignat, 1885, Bull. Soc. Malacol. France, II, p. 6.

*Nodularia* (*Cælatura*) *horei* E. A. Smith. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 823; 1914, 'Descript. Cat. of Naiades,' p. 1034.

*Nodularia horei* E. A. Smith. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 255.

Lake Tanganyika: originally described from that lake without more definite locality (Thomson Coll.).

## *Parreysia lourdeli* (Bourguignat)

*Unio lourdeli* BOURGUIGNAT, 1887, Ann. Soc. Malacol. France, IV, p. 271 (type locality: shores of Lake Victoria). E. A. SMITH, 1892, Ann. Mag. Nat. Hist., (6) X, p. 128, Pl. XII, figs. 13–15. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 212.

*Nodularia lourdelli* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 826.

*Unio* (*Cafferia*) *lourdeli* Bourguignat. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 581.

*Unio lourdeli* var. *smithi* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 306 (based upon Pl. XII, figs. 15 of E. A. Smith, 1892). SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 581.

Thiele refers to this species weathered valves from the Mkunga River near Ruasa, in Ruanda (Schubotz Coll.).

## *Parreysia ujijiensis* (Crosse)

*Unio nyassaensis* var. *tanganyicensis* E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 298, Pl. XXXIV, fig. 34*a* (not *Unio tanganyicensis* E. A. Smith, 1880).

*Unio nyassaensis* var. *ujijiensis* CROSSE, 1881, Journ. de Conchyl., XXIX, p. 294.

*Grandidieria ujijiensis* Crosse. BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 7.

*Parreysia ujijiensis* Crosse. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 848; 1914, 'Descript. Cat. of Naiades,' p. 1133.

*Parreyssia ujijiensis* Bourguignat. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), p. 256.

Lake Tanganyika: Ujiji (type locality; E. C. Hore Coll.).

## GRANDIDIERIA Bourguignat

*Grandidieria* BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 4. Type by designation of Simpson (1900, Proc. U. S. Nat. Mus., XXII, p. 827): *Unio burtoni* Woodward.

*Ruellania* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 92, footnote. Substitute for *Grandidieria*. Type by present designation: *Unio burtoni* Woodward.

"Shell small, oval, rounded or rhomboid, solid, much inflated, generally narrowly biangulate behind, often apparently of two forms, one more inflated in the basal and post-basal parts than the other; beaks high, curved forward and inward and pointed, very delicately and beautifully sculptured with zigzag liræ, which become finely nodulous and sulcate on the disk, especially in front and behind; posterior ridges well developed, often slightly double; hinge line curved; two pseudocardinals in the right valve separated by a parallel-sided socket, one or two in the left, with often an irregular, triangular, ragged tooth under the beak, which is frequently reflexed; one obliquely striate lateral in the right valve and two in the left; nacre of peculiarly soft, rich texture, white, coppery, or purplish, delicately radiate; beak cavities moderate; muscle scars distinct." (Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1051.)

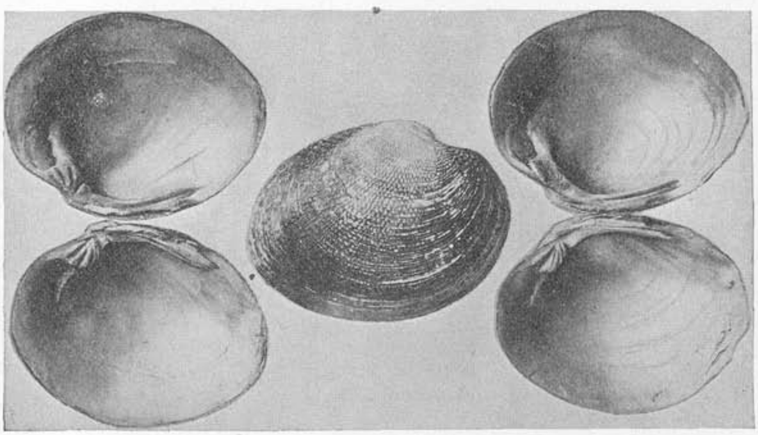
By conchological characters this group appears to be related to *Parreysia*, but the soft parts of none of the species are known.

All true *Grandidieriæ* occur in Lake Tanganyika only.

### *Grandidieria burtoni* (Woodward)

Text Figure 88*a-c*

*Unio burtoni* WOODWARD, 1859, Proc. Zool. Soc. London, p. 349, Pl. XLVII, fig. 1. PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 109. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 20. E. A. SMITH, 1906, Proc. Zool. Soc. London, I, p. 184.



*a* *b* *c*

Fig. 88. *a-c, Grandidieria burtoni* (Woodward). Tanganyika.

*Grandidieria burtoni* Woodward. BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 6; 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 99. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 828; 1914, 'Descript. Cat. of Naiades,' p. 1052.

*Unio (Grandidieria) burtoni* Woodward. .E v. MARTENS, 1897, 'Deutsch Os. Afr., IV, Beschalte Weichth.,' p. 237. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 683, with var. *lutea* Germain (= *U. gravida* var. *lutescens* Germain) and var. *rosea* Germain.

*Unio* (*Grandidieria*) *gravida* var. *lutescens* GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 260 (Tanganyika).

*Grandidieria cyrenopsis* BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 9, Pl. I, figs. 7–9; 1888, 'Iconogr. Malacol. Tanganyika,' Pl. XIX, figs. 1–3 (Tanganyika).

Lake Tanganyika: Ujiji (type locality; Speke Coll.); Karema; Kala on the southeastern shore; southern end of the lake (W. A. Cunnington Coll.); Pambete (Giraud Coll.); Albertville (Charles Hedley Coll.).

### *Grandidieria burtoni* var. *insignis* Bourguignat

*Grandidieria insignis* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 16. R. STURANY, 1894, in Baumann, 'Durch Massailand zur Nilquelle,' p. 302, Pl. XXIV, figs. 18 and 28.

*Unio* (*Grandidieria*) *burtoni* var. *insignis* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 238.

*Grandidieria burtoni* var. *insignis* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 828; 1914, 'Descript. Cat. of Naiades,' p. 1053.

Lake Tanganyika: Ujiji (type locality).

### *Grandidieria burtoni* var. *servainiana* Bourguignat

*Grandidieria servainiana* BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 6.

*Unio burtoni* var. E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 297, Pl. XXXIV, fig. 33.

*Unio* (*Grandidieria*) *burtoni* var. *servainiana* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 238.

*Grandidieria burtoni* var. *servainiana* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 828; 1914, 'Descript. Cat. of Naiades,' p. 1053.

Lake Tanganyika: no more definite type locality originally mentioned.

### *Grandidieria burtoni* var. *sturanyi* (E. v. Martens)

*Grandidieria* sp. n. (?) R. STURANY, 1894, in Baumann, 'Durch Massailand zur Nilquelle,' p. 302, Pl. XXIV, fig. 31 and Pl. XXV, fig. 35.

*Unio* (*Grandidieria*) *burtoni* var. *sturanyi* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 238.

*Grandidieria burtoni* var. *sturanyi* E. v. Martens. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 828; 1914, 'Descript. Cat. of Naiades,' p. 1054.

Lake Tanganyika: near the northern end (type locality; Baumann Coll.).

### *Grandidieria callista* Bourguignat

*Grandidieria callista* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 43, Pl. XIX, figs. 13–15. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 829; 1914, 'Descript. Cat. of Naiades,' p. 1059.

Lake Tanganyika: originally described from the lake without more definite locality.

## *Grandidieria elongata* Bourguignat

*Grandidieria elongata* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 94. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 830; 1914, 'Descript. Cat. of Naiades,' p. 1061.

Lake Tanganyika: Mpala (type locality; Giraud Coll.).

## *Grandidieria giraudi* Bourguignat

*Grandidieria giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 95. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 830; 1914, 'Descript. Cat. of Naiades,' p. 1059.

*Unio (Grandidieria) rostralis* var. *giraudi* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 683, figs. 33 and 34 (on p. 684).

*Grandidieria bourguignati* "Joubert" BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 43, Pl. XIX, figs. 7–9. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 829.

*Unio (Grandidieria) bourguignati* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 684, figs. 35 and 36.

Lake Tanganyika: Mpala (type locality; Giraud Coll.). No definite type locality is given of *G. bourguignati*.

## *Grandidieria gravida* Bourguignat

*Grandidieria gravida* BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 7, Pl. I, figs. 1–6; 1888, 'Iconogr. Malacol. Tanganika,' p. 41, Pl. XVIII, figs. 11–16. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 829; 1914, 'Descript. Cat. of Naiades,' p. 1056.

*Grandidieria rostrata* BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 10, Pl. I, figs. 10–12; 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 103; 1888, 'Iconogr. Malacol. Tanganika,' p. 41, Pl. XVIII, figs. 17–19.

*Grandidieria locardiana* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 18. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 830.

*Unio (Grandidieria) locardi* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 682, figs. 31 and 32 (on p. 683).

*Unio (Grandidieria) rostralis* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 238 (new name for *G. rostrata*). GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 681, figs. 27–36; 1911, Bull. Mus. Hist. Nat. Paris, p. 440.

*Unio tanganyicensis* var. E. A. SMITH, 1881, Proc. Zool. Soc. London, p. 298, Pl. XXXIV, fig. 35.

*Unio (Grandidieria) rostralis* var. *brevior* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 239 (new name for *G. gravida*).

*Unio (Grandidieria) rostralis* var. *gravida* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 682, figs. 27–28 (on p. 683).

Lake Tanganyika: originally described from the lake without more definite locality. There is also no definite type locality of *G. rostrata* and *G. locardiana*.

## *Grandidieria hauttecœuri* Bourguignat

*Grandidieria hauttecœuri* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 17.

*Unio* (*Grandidieria*) *hauttecœuri* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 683, figs. 29 and 30.

Lake Tanganyika: originally described from the lake without more definite locality.

### *Grandidieria incarnata* Bourguignat

*Grandidieria incarnata* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 101. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 830; 1914, 'Descript. Cat. of Naiades,' p. 1061.

Lake Tanganyika: Mpala (type locality; Giraud Coll.).

### *Grandidieria mira* Bourguignat

*Grandidieria mira* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 96. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 830; 1914, 'Descript. Cat. of Naiades,' p. 1061.

Lake Tanganyika: Mpala (type locality; Giraud Coll.).

### *Grandidieria rhynchonella* Bourguignat

*Grandidieria rhynchonella* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' p. 43, Pl. XIX, figs. 16 and 17. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 829; 1914, 'Descript. Cat. of Naiades,' p. 1058.

Lake Tanganyika: originally described from that lake without more definite locality.

### *Grandidieria rotundata* Bourguignat

*Grandidieria rotundata* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 98. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 830; 1914, 'Descript. Cat. of Naiades,' p. 1061.

Lake Tanganyika: Mpala (type locality; Giraud Coll.).

### *Grandidieria smithi* Bourguignat

*Grandidieria smithi* BOURGUIGNAT, 1885, Bull. Soc. Malacol. France, II, p. 7. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 829; 1914, 'Descript. Cat. of Naiades,' p. 1055.

*Unio burtoni* var. A. E. SMITH, 1881, Proc. Zool. Soc. London, p. 297, Pl. XXXIV, fig. 33*a*.

*Grandidieria anceyi* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 15; 1888, 'Iconogr. Malacol. Tanganika,' p. 43, Pl. XIX, figs. 4–6. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 829.

*Unio* (*Grandidieria*) *burtoni* var. *smithi* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 238.

*Unio smithi* Bourguignat. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 260.

*Unio* (*Grandidieria*) *burtoni* var. *smithi* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 681.

Lake Tanganyika: originally described from the lake without more definite locality. There is also no definite type locality for *G. anceyi*.

### *Grandidieria tanganyicensis* (E. A. Smith)

*Unio tanganyicensis* E. A. Smith, 1880, Proc. Zool. Soc. London, p. 351, Pl. xxxi, figs. 9 and 9*a*. Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 109. E. v. Martens, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 72.

*Grandidieria tanganikana* Bourguignat, 1885, Bull. Soc. Malacol. France, II, p. 7; 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 102.

*Unio (Grandidieria) tanganyicensis* E. A. Smith. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 240.

*Grandidieria tanganyicensis* E. A. Smith. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 828; 1914, 'Descript. Cat. of Naiades,' p. 1054.

Lake Tanganyika: Ujiji (type locality; E. C. Hore Coll.); Mpala (Giraud Coll.).; Albertville (C. Hedley Coll.).

### *Grandidieria tanganyicensis* var. *exalbida* (Preston)

*Unio tanganyicensis* var. *exalbida* Preston, 1913, Rev. Zool. Afric., III, 1, p. 60.

Lake Tanganyika: without more definite type locality.

### *Grandidieria thomsoni* (E. A. Smith)

*Unio thomsoni* E. A. Smith, 1880, Ann. Mag. Nat. Hist., (5) VI, p. 430; 1881, Proc. Zool. Soc. London, p. 299, Pl. xxxiv, fig. 36. G. B. Sowerby, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 21.

*Grandidieria thomsoni* E. A. Smith. Bourguignat, 1885, Bull. Soc. Malacol. France, II, p. 7; 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 100. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 829; 1914, 'Descript. Cat. of Naiades,' p. 1057.

*Unio (Grandidieria) thomsoni* E. A. Smith. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 240.

*Grandidieria corbicula* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 100; 1888, 'Iconogr. Malacol. Tanganika,' p. 43, Pl. xix, figs. 10–12.

*Grandidieria granulosa* Bourguignat, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 102; 1888, 'Iconogr. Malacol. Tanganika,' p. 43, Pl. xix, fig. 21.

*Grandidieria singularis* Bourguignat, 1888, 'Iconogr. Malacol. Tanganika,' p. 43, Pl. xix, figs. 18–20.

Lake Tanganyika: originally described from the lake without more definite locality (J. Thomson Coll.); Mpala (type locality of *G. corbicula;* Giraud Coll.); Pambete (type locality of *G. granulosa;* Giraud Coll.).

### CÆLATURA Conrad

*Cælatura* Conrad, 1853, Proc. Ac. Nat. Sci. Philadelphia, VI, pp. 267 and 268. Monotype: *Unio ægyptiacus* Cailliaud.

*Pharaonia* Bourguignat, 1880–1881, 'Matér. Moll. Acéph. Syst. Europ.,' I, p. 3 (without description or species). Jousseaume, 1886, Bull. Soc. Zool. France, XI, p. 486. Type by present designation: *Pharaonia bellamyi* Jousseaume.

*Zairia* A. T. de Rochebrune, 1886, Bull. Soc. Malacol. France, III, p. 10. Type by present designation: *Zairia elegans* A. T. de Rochebrune.

*Zaira* Simpson, 1900, Proc. U. S. Nat. Mus., XXII. p. 862. Misspelling of *Zairia.*

*Reneus* Jousseaume, 1886, Bull. Soc. Zool. France, XI, p. 481. Type by tautonomy: *Reneus reneus* Jousseaume.

*Renatus* A. T. de Rochebrune, 1904, Bull. Mus. Hist. Nat. Paris, p. 257, footnote. Emendation of *Reneus.*

*Cælatura* section *Horusia* Pallary, 1924, Mém. Inst. d'Egypte, VII, 1, p. 43. Type by original designation: *Unio rugifer* Küster.

? *Cælatura* section *Nitia* Pallary, 1924, Mém. Inst. d'Egypte, VII, 1, p. 43. Type by original designation: *Unio teretiusculus* Philippi. This group is probably valid as a subgenus, whether referable to *Cælatura* or *Parreysia* remains to be seen.

*Cælatura* section *Iaronia* Pallary, 1924, Mém. Inst. d'Egypte, VII, 1, p. 44. Type by original designation: *Unio niloticus* Cailliaud.

"Shell elliptical, pointed or rounded behind, usually slightly produced at the post-base; beak sculpture consisting of zigzag ridges which are generally quite pustulous, the sculpture often extending on to the usually rayed disk; teeth compressed; pseudocardinals lamellar." (Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1019.)

Simpson says (*op. cit.*, p. 951) that he examined the soft parts of *C. æquatoria* (Morelet): there seemed to be no striking differences in the more obvious characters from the majority of the Uniones, but the embryos filled the inner gills above as in *Diplodon.*

While many species can be referred to this group from their similarity with *C. ægyptiaca* in beak-sculpture, form, and teeth, yet there remain some forms which could as well be placed in "*Parreysia.*" The relations of *Unio* and *Parreysia* to *Cælatura* remain to be worked out.

## Subgenus Cælatura, proper

### **Cælatura elegans** (A. T. de Rochebrune)

Plate XXXII, Figures 5 and 6; Plate XXXIII, Figure 4

*Zairia elegans* A. T. de Rochebrune, 1886, Bull. Soc. Malacol. France, III, p. 12. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 862.

*Nodularia (Cælatura) elegans* A. T. de Rochebrune. Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1032.

*Unio (Nodularia) roubaudi* Germain, 1907, Bull. Mus. Hist. Nat. Paris, p. 429, fig. 28 (new name for *Zairia elegans* de Rochebrune).

Gancini or Nganchu, on the right bank of the Congo River (type locality; Thollon Coll.). Bamu Island in Stanley Pool (Roubaud Coll.).

Zambi (Lang and Chapin, and J. Bequaert Coll.). Leopoldville (J. Bequaert Coll.). Malela (Lang and Chapin Coll.).

The rather plump, thin, oblong or elliptical shell is dull citrine-drab, varying toward green or gray in different individuals. It varies from slightly to decidedly higher behind than at the beaks, which are between the anterior fourth and fifth of the shell's length. There is a rather large lunule bounded by angular ridges. The beaks have posterior and median series of short, rather coarse folds or low nodules, and an anterior series of fine folds radiating and running below toward the median line. The very fine growth-lines of the rest of the shell bear minute epidermal threads. The interior is very light blue. Pseudocardinals in the right valve very much compressed; in the left valve single, or with a second low, rudimentary one below the beaks.

Length, 52.0 mm.; height, 42.0 mm.; diameter, 22.0 mm.
" 47.0 " 29.0 " 18.5

The identification of this species was made possible by Germain's figure. In transferring the species to the genus *Unio* he changed the name on account of the prior *Unio elegans* of Lea; but if the mussel belongs to *Cælatura*, as we believe, this change is not necessary since de Rochebrune did not originally describe his species in the genus *Unio*.

Except in the form of the pseudocardinal teeth *C. elegans* closely resembles *Unio gabonensis* Küster. *C. putzeysi* (Preston) (= *U. subnigra* Preston) is a wider shell, with the beaks less anterior. *C. elegans* appears rather closely related to *C. æquatoria* (Morelet), and the scarcely separable *U. landanensis* Schepman, both of these being less elevated than our shells.

### **Cælatura æquatoria** (Morelet)

*Unio æquatorius* MORELET, 1885, Journ. de Conchyl., XXXIII, p. 31, Pl. II, fig. 9 (type locality: Mayumba River, district of Cacongo, 3° S., French Congo). DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 68.

*Nodularia æquitoria* Morelet. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 823.

*Cælatura æquatoria* Morelet. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 110.

*Nodularia (Cælatura) æquatoria* Morelet. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1032.

*Unio landanensis* SCHEPMAN, 1891, Notes Leyden Mus., XIII, p. 113, Pl. VIII, figs. 3*a*-*b* (type locality: Landana, Portuguese Congo). GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 430, fig. 29.

Channel leading from Lake Kabamba to the Lualaba River at Mulongo, between Kikondja and Ankoro (J. Bequaert Coll.). P. Hesse bought a valve of this species from natives at Banana. Simpson records having seen specimens from Leopoldville and different localities in the Congo drainage.

Leopoldville (J. Bequaert Coll.).

Three specimens from Leopoldville appear referable to this species, which is lower and less inflated than *C. elegans*. The largest measures:

Length, 40.5 mm.; height, 22.0 mm.; diameter, 15.7 mm.

Simpson found embryos in the inner gills only.

Germain (1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 542) has described a var. *minor* of this species from the Bangoran and Mamun Rivers, French Equatorial Africa.

### **Cælatura gerrardi** (E. v. Martens)

Plate XXXII, Figures 1 and 1*a*

*Unio gerrardi* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 223, Pl. VII, fig. 5.

*Nodularia nilotica* var. *gerrardi* E. v. Martens. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p . 822.

*Nodularia* (*Cælatura*) *gerrardi* E. v. Martens. SIMPSON, 1914, 'Descript. Cat. of Naiades,' 1914, p. 1022.

Lake Tanganyika: originally described from the lake without more definite locality.

According to E. v. Martens this is probably the species recorded from Tanganyika as "*Unio niloticus*" by E. A. Smith (1880, Proc. Zool. Soc. London, p. 351; 1881, *op. cit.*, p. 296).

*Unio gerrardi* was described from two single valves, the one figured having lost much of the epidermis. A specimen collected by Stappers in Lake Tanganyika is now figured. The color is fuscous, shading to blackish below, more cinnamon toward the beaks. The beaks have two radial series of tubercles, much smaller than in *C. ægyptiaca*, with groups of close folds in front and behind, these folds converging somewhat downward.

Length, 44.0 mm.; height, 30.0 mm.; diameter, 20.0 mm.

### **Cælatura mesafricana**, new species

Plate XXXII, Figures 2 and 2*a*

Garamba River (Lang and Chapin Coll.), February, 1913.

The shell is rather thin, oblong, inflated. The dorsal and ventral margins are subparallel; anterior end rounded, posterior end obliquely truncate. The posterior ridge is rounded. Olive-brown, having two narrow, indistinct green rays on the posterior slope and with an irregular, honey-yellow patch posteriorly. The surface is somewhat shining, striate finely and irregularly, the striæ with fine cuticular edges; these striæ are more prominent on the posterior slope. On the half of the posterior slope nearer the beaks there is fine, curved corrugation running toward the ligament (and in young shells traces of narrowly double-looped corrugation may be seen near the beaks in the median part, and oblique corrugation posteriorly). The beaks are eroded in all specimens seen. The interior is pale blue near the edges, pinkish in the cavity. The pseudocardinal teeth are much compressed, double in the right valve. In the left there is a well-developed tooth and farther back, nearly under the beaks, a subobsolete tooth. Laterals well developed but compressed.

| | | | |
|---|---|---|---|
| Length, 45.0 mm.; | height, 25.0 mm.; | diameter, 17.5 mm. | Type. |
| " 38.5 | " 22.0 | " 14.0 | Paratype. |
| " 43.0 | " 24.0 | " 17.5 | " |
| " 52.0 | " 30.5 | " 22.0 | " |

This species appears to be closely related to *Unio tricolor* Küster, from the Nile in Egypt, differing by the smaller size and corrugated posterior slope, which is not green as described and figured by Küster. The least eroded example shows two series of V-shaped loops near the beaks, which will therefore doubtless prove to have typical *Cælatura* sculpture.

A shorter specimen taken by Lang at Medje, which we refer provisionally to this species, measures: length, 34.0 mm.; height, 21.0 mm.; diameter, 13.5 mm.

### **Cælatura stanleyvillensis**, new species

Plate XXXII, Figures 3, 3*a*, 4; Plate XXXIII, Figure 3

Congo River at Stanleyville (Lang and Chapin, and J. Bequaert Coll.).

The shell is moderately solid, somewhat swollen, elliptical; the dorsal and ventral margins about equally curved; the anterior end rounded, posterior end obliquely truncate above, rounded below. Posterior ridge is well rounded, usually with two narrow, slightly raised or sunken rays. Surface finely striate, the striæ with cuticular edges. Behind and in front of the eroded beaks there is typically some oblique corrugation near the hinge line (but weak or wanting in many more or less eroded shells). The surface is dull, brownish olive to nearly black, or gray where the cuticular laminæ are well preserved. The interior is pale pink (or nearly white). Teeth much compressed, as described for *C. mesafricana*.

| | | | |
|---|---|---|---|
| Length, 52.0 mm.; | height, 31.0 mm.; | diameter, 22.0 mm | Type. |
| " 52.5 | " 32.0 | " 22.0 | Paratype. |
| " 48.0 | " 30.0 | " 19.0 | " |
| " 53.0 | " 32.7 | " 22.5 | " |

The plump form and dull, laminate epidermis distinguish this species, which was taken in abundance. In young shells, up to about 25 or 30 mm. long, the epidermal laminæ are but little or not at all developed. The surface is somewhat glossy, olive to deep olive-buff with many narrow darker rays.

### **Cælatura briarti** (Dautzenberg)

*Unio briarti* Dautzenberg, 1901, Ann. Soc. Malacol. Belgique, XXXVI, Mém., p. 6, Pl. i, figs. 3 and 4. Germain, 1913, Bull. Mus. Hist. Nat. Paris, p. 291, Pl. xi, figs. 67 and 68. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 68.

*Unio (?) briarti* Dautzenberg. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 719.
*Unio eduardi* "Dupuis" DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 68 (as a synonym of *U. briarti*).

Lofoi River (type locality; Briart Coll.). Lower Ubangi at Zongo (Poutrin Coll.). Lualaba River at Kibombo (J. Bequaert Coll.).

We have seen a young shell collected by the junior author at Kibombo and determined by Dautzenberg. It shows beaks having two series of tubercles; and up to a length of 20 mm. the anterior and posterior dorsal slopes are strongly corrugated.

### Subgenus **Lævirostris** Simpson

*Diplodon* subgenus *Lævirostris* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 894. Monotype: *Unio stagnorum* Dautzenberg.

Beaks unsculptured except for minute, concentric striæ.

The subgenus *Lævirostris* Simpson was originally placed under the South American genus *Diplodon*, a genus otherwise unknown in Africa. We hesitate to accept this classification for the reason that in all other characters the shell agrees well with *Cælatura*. In some species of *Cælatura*, such as *C. rotula*, the beaks have only faint, though still legible traces of tubercles. Temporarily, therefore, until the soft anatomy can give evidence, we subordinate *Lævirostris* to *Cælatura*.

### **Cælatura (Lævirostris) stagnorum** (Dautzenberg)

Plate XXXIII, Figures 1, 1*a*, 1*b*

*Unio stagnorum* DAUTZENBERG, 1891, Bull. Ac. Sci. Belgique, (3) XX, (1890), p. 572, Pl. I, figs. 7–10.

*Cælatura stagnorum* Dautzenberg. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 111.

*Diplodon (Lævirostris) stagnorum* Dautzenberg. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 894; 1914, 'Descript. Cat. of Naiades,' p. 1309.

Between Vivi and Isangila near the confluence of the Mpakassa (type locality; E. Dupont Coll.). Boma (De Jong Coll.).

Zambi (Lang and Chapin Coll.). Boma (J. Bequaert Coll.).

The shell is thin, subtriangular, the height about 67 to 74 per cent of the length, rather convex; deep olive-buff, the lower half or less colonial buff. The dorsal margin is only slightly convex; anterior end narrowly rounded; posterior margin nearly straight, oblique, almost as long as the dorsal margin; the basal margin is convex, the curvature greater toward the ends, slight (or sometimes nearly straight) in the middle. The beaks are small, moderately elevated, slightly in advance of the anterior fourth of the length; they are eroded in even the smallest specimens seen (18 mm. long, the eroded areas 2.1 mm. long); no sculpture except thread-like concentric striæ is visible. Posterior ridge rounded. Posterior slope very wide, flattened or slightly concave. The surface is finely striate, the striæ laminiferous toward the margins and on the posterior slope. Color ecru-olive with faint green rays on the posterior convexity and slope. The interior is light blue. Pseudocardinal teeth thin, compressed; in the right valve double, of equal length, but the lower one is thicker and much higher. The edges are weakly crenulate. The left valve has a single, rather high pseudocardinal and a slight widening of the narrow interdental area below the beaks. The lateral teeth are thin, rather short but well developed, double in the left, single in the right valve.. The hinge line is rather strongly curved. The anterior adductor scar is well impressed, the scar of the foot protractor small, separate. The ligament is narrow.

| | | | | | |
|---|---|---|---|---|---|
| Length, | 44.0 mm.; | height, | 30.0 mm.; | diameter, | 17.0 mm. |
| " | 42.5 | " | 30.0 | " | 16.0 |
| " | 41.0 | " | 27.5 | " | 16.0 |
| " | 42.0 | " | 29.0 | " | 18.0 |

The elevated, triangular shape of this thin species is characteristic. Beak sculpture, if present, must occupy an extremely small space.

Most specimens are more or less colored by the iron deposit, as shown in Dautzenberg's excellent figures; when cleaned of this the shell is deep olive buff in the older part, becoming straw or colonial buff in the last half or third of the height.

### **Cælatura (Lævirostris) stagnorum bomæ,** new subspecies

Plate XXXIII Figures 2 and 2*a*

Congo River at Boma (J. Bequaert Coll.).

The shell is similar to *C. stagnorum* except that on both sides of the eroded beaks there is well-developed corrugation running toward the hinge-margin.

Length, 38 mm.; height, 26 mm.; diameter, 12.5 mm.

The sculpture of this form would not be considered of much importance were it not entirely absent in long series of *C. stagnorum* from Zambi, and several from Boma.

### **Cælatura (Lævirostris?) rotula,** new species

Plate XXXIII, Figures 5 and 5*a*

Congo River at Leopoldville (J. Bequaert Coll.).

The shell is thin, very broad, moderately convex. The dorsal and basal margin are somewhat convex; the anterior end rather narrowly rounded; posterior end straight in its upper part, then broadly rounded. The beaks are small, project but little and are eroded in the type; on the anterior side there are a few short, curved corrugations running toward the hinge. The rest of the shell is smooth except for numerous narrow, irregular corrugations diverging upward from the rounded, posterior ridge. Surface is glossy, becoming dull and slightly laminate at the ends. Color ecru-olive, varying toward lighter or greener, the posterior slope duskier, with one or two green rays. The interior is very pale blue. Hinge line gently curved. Pseudocardinal teeth are long and very much compressed; in the right valve two, subequal; in the left single. Laterals are short, compressed. The anterior adductor scar is a little impressed.

| | | | | |
|---|---|---|---|---|
| Length, 46.5 mm.; | height, 37.0 mm.; | diameter, 20.5 mm. | | Type. |
| " 45.0 | " 34.5 | " 20.0 | | Paratype. |

This fine mussel stands close to *Unio essoensis* Chaper, of Assinie, but it differs by the decidedly narrower anterior end. *U. nguigmiensis* Germain and *U. jeanneli* Germain (= *U. jourdyi* Germain) resemble it in outline; they have coarsely tubercular beaks like *C. ægyptiaca*. *C. stagnorum* appears related to this species by the shape and texture, and until the beaks are known we refer *rotula* to *Lævirostris*.

## Other Species of *Cælatura* Recorded from the Belgian Congo

### *Cælatura ægyptiaca* (Cailliaud)

Text Figure 89

*Unio ægyptiacus* CAILLIAUD, 1827, 'Voyage à Méroé,' IV, p. 263; 1823, Atlas, II, Pl. LXI, figs. 6–7 (type locality: Joseph's Canal, Lower Egypt). H. ADAMS, 1886, Proc. Zool. Soc. London, p. 376. E. A. SMITH, 1888, *op. cit.*, p. 56. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 212.

*Margarita (Unio) egyptiacus* Cailliaud. I. LEA, 1838, 'Synopsis of Naiades,' 2d Ed., p. 21.

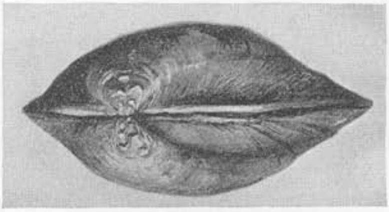


Fig. 89. *Cælatura ægyptiaca* (Cailliaud). Nile.

*Nodularia (Cælatura) ægyptiaca* Cailliaud. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 821; 1914, 'Descript. Cat. of Naiades,' p. 1019.

*Unio pumilus* "Ziegler" JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 272 (as a synonym of *U. ægyptiacus*).[1]

*Cælatura ægyptiaca* Cailliaud. C. R. BŒTTGER AND F. HAAS, 1915, Zool. Jahrb., Abt. Syst., XXXVIII, p. 382, Pl. XXVI, figs. 7*a-f*.

Lake Albert: recorded without more definite locality from that lake (S. Baker Coll.) by H. Adams and E. A. Smith; Kassenje (Schubotz Coll.).

A. T. de Rochebrune has listed this species from Mokaka, French Congo. We have seen no specimens from within our limits.

As this species is the type of the genus *Cælatura* we are figuring a specimen from the Nile to show the typical beak sculpture (Fig. 89).

[1]According to Germain (1922, 'Voy. Zool. Gadeau de Kerville Syrie, Moll. Terr. Fluv.,' II, p. 42) and others, *Unio eucyphus* Bourguignat (1857, Rev. Mag. Zool., IX, p. 19, Pl. III, figs. 1–3), supposedly from the Scamander River, Anatolia, is a synonym of *Cælutura ægyptiaca* and came most probably from Egypt.

### *Cælatura (?) araneosa* (A. T. de Rochebrune)

*Zairia araneosa* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 11.

*Nodularia araneosa* A. T. de Rochebrune. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1045.

Gancini or Nganchu, on the right bank of the Congo River (type locality; Thollon Coll.).

### *Cælatura (?) böhmi* (E. v. Martens)

*Unio böhmi* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth., p. 223, Pl. VII, fig. 9.

*Nodularia (Cælatura) bohmi* E. v. Martens. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 823; 1914, 'Descript. Cat. of Naiades,' p. 1036.

Lake Tanganyika: near Karema (type locality; Böhm and Reichard Coll.).

### *Cælatura calathus* (Bourguignat)

*Unio calathus* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 23. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 224.

*Nodularia calathus* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 824; 1914, 'Descript. Cat. of Naiades,' p. 1044.

Lake Tanganyika: originally described from that lake without more definite locality.

### *Cælatura charbonnieri* (Bourguignat)

*Unio charbonnieri* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 9; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XX, figs. 1 and 2. GERMAIN, 1911, Bull. Mus. Hist. Nat. Paris, p. 440; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 679.

*Nodularia (Cælatura) charbonnieri* Bourguignat. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1024.

*Unio coulboisi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 12; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XX, figs. 3 and 4.

*Unio dromauxi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 17; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXI, figs. 1 and 2.

Lake Tanganyika: western shore of the lake, north of the Lukuga River (type locality of all three forms here regarded as synonyms).

### *Cælatura gereti* (Preston)

*Unio gereti* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 61, Pl. IV, fig. 9.

*Unio (?) gereti* Preston. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 727.

Lake Tanganyika: originally described from the lake without more definite locality.

### *Cælatura poirieri* (A. T. de Rochebrune)

*Zairia poirieri* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 11.

*Nodularia poirieri* A. T. de Rochebrune. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1045.

Gancini or Nganchu on the right bank of the Congo River (type locality; Thollon Coll.).

### *Cælatura putzeysi* (Preston)

*Unio (Nodularia) subnigra* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) IV, p. 89, Pl. IV, fig. 5. Not *Unio subniger* I. Lea, 1857.

*Nodularia subnigra* Preston. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1042.

*Unio (Nodularia) putzeysi* PRESTON, 1912, The Nautilus, XXVI, p. 70.

Lower Belgian Congo (type locality).

This species appears to be closely related to *C. elegans* (A. T. de Rochebrune).

### *Cælatura randabeli* (Bourguignat)

*Unio randabeli* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 22; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXI, figs. 3 and 4.

*Nodularia (Cælatura) randabeli* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 822; 1914, 'Descript. Cat. of Naiades,' p. 1024.

Lake Tanganyika: western shore, north of the Lukuga River (type locality).

### *Cælatura sordida* (A. T. de Rochebrune)

*Zairia sordida* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 12. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 862.

*Nodularia sordida* A. T. de Rochebrune. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1045.

Gancini or Nganchu, on the right bank of the Congo River (type locality; Thollon Coll.).

### PSEUDAVICULA Simpson

*Pseudavicula* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 860. Monotype: *Unio johnstoni* E. A. Smith.

Shell with a well-developed anterior and posterior dorsal wing; dorsal line strongly incurved; beaks full, not high; a high, down-curved posterior ridge runs to the posterior basal point, and between this point and the posterior point of the wing the outline is deeply incurved; base and lower part of anterior end rounded; surface slightly sculptured with concentric ridges; beak sculpture not known. Anterior tooth of left valve elongate, slightly corrugated, that of the right double; laterals in left double, single in the right, straight, elongated, thin, and prominent. Animal unknown (after Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1190).

Only one species is known.

### **Pseudavicula johnstoni** (E. A. Smith)

Text Figure 90

*Unio (Metaptera) johnstoni* E. A. SMITH, 1893, Proc. Zool. Soc. London, p. 640, Pl. LIX, figs. 18–20. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 240.

*Pseudavicula johnstoni* E. A. Smith. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 861; 1914, 'Descript. Cat. of Naiades,' p. 1190. GERMAIN, 1909, Arch. Zool. Exp. Gén., XLI, p. 127, fig. 57.

Lake Moero: originally described from that lake without more definite locality (R. Crawshay Coll.).

Off Lukonzolwa in Lake Moero (Stappers Coll.). Stappers obtained it at several other places in the lake and also in the Luapula River at Kachiobwe.

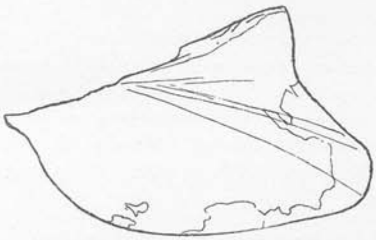


Fig. 90. *Pseudavicula johnstoni* (Smith). Lukonzolwa Lake Moero.

This peculiar mussel has been compared to *Hyriopsis bialata* Simpson (= *Unio delphinus* Gruner) and to *Prisodon obliquus* (Schumacher). Whether it is related to the Oriental genus or the South American remains doubtful. By the bialate form it approaches *Pseudospatha*, which is otherwise quite different.

The specimen figured is 50 mm. long.

## Unionidæ of Doubtful Affinity

The following species of "*Unio*," all described by Bourguignat from the western shore of Lake Tanganyika, north of the Lukuga River, have not been figured, and it is impossible to place them in the modern genera.

*Unio bri ouxi* Bourguignat, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 13.

*Unio guillemeti* Bourguignat, 1886, *op . cit.*, p. 15.

*Unio josseti* Bourguignat, 1886, *op. cit.*, p. 19.

*Unio jouberti* Bourguignat, 1886, *op. cit.*, p. 8.

*Unio lavi erianus* Bourguignat, 1886, *op. cit.*, p. 14 = *Unio lavigerinus* Simpson, 1900, Proc U. S. Nat. Mus., XXII, p. 862.

*Unio menardi* Bourguignat, 1886, *op. cit.*, p. 20.

*Unio moineti* Bourguignat, 1886, *op. cit* , p. 11.

*Unio vinckei* Bourguignat, 1886, *op. cit.*, p. 18.

*Unio visseri* Bourguignat, 1886, *op. cit.*, p. 21.

## Mutelidæ

*Platiris* I. Lea, 1838, Trans. American Phil. Soc., N.S., VI, pp. 118 and 141. Lea's genus *Platiris* included the Mutelidæ known at its date.

Mutelidæ and Mycetopinæ H. and A. Adams, 1858, 'Gen. Recent Moll.,' II, pp. 505 and 504.

Iridinidæ Bourguignat, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 24.

Pliodontidæ A. T. DE ROCHEBRUNE, 1904, Bull. Mus. Hist. Nat. Paris, p. 342.

Shell resembling that of the Unionidæ. In the African forms the teeth, when present, are taxodont. The beak-sculpture affords no reliable family-characters, since some species of *Aspatharia* have a zigzag sculpture similar to that of certain Unionidæ.

"Diaphragm complete, formed anteriorly by the gills, posteriorly by the mantle. Anterior end of inner gill in contact with the palpi. Branchial and anal siphons sharply separated from one another; the canal open or closed above, but there is never a supra-anal opening. Gills with very indistinct and intercommunicating water tubes, or with well-developed water tubes. Marsupium only in the inner gills" (A. E. **Ortmann, 1911,** The Nautilus, XXIV, p. 129). Labial palpi large, rounded below. Diœcious so far as known.

The Mutelidæ have been divided by Ortmann[1] into two subfamilies, as follows.

MUTELINÆ, in which the marsupial gill has well-developed, continuous septa forming well-defined water tubes, the non-marsupial gills also with distinct water tubes. The larva is a lasidium in the South American *Anodontites,* but is unknown in African genera. This group comprises genera with anodont or taxodont hinges.

HYRIINÆ, having interlamellar connections interrupted, standing in rows, forming incomplete, communicating water tubes in the marsupial gills, the non-marsupial with poorly developed, scattered interlamellar connections. The larva is a glochidium. This subfamily comprises four South American genera having schizodont hinges. We provisionally add the African *Pseudospatha.*

Among the African Mutelinæ the chief divergence in anatomic structure as now known is in the degree of concrescence of the margins of the mantle, as follows.

I.—Mantle concrescent below the branchial orifice for one-fourth to about half of the basal length. Genera *Mutela* and *Iridina.*

*Mutela rostrata:* about half of the lower margins concrescent. See Troschel, 1847, Archiv f. Naturgesch, XIII, 1, p. 273; Clessin, 1875, Malakoz. Blätter, XXII, pp. 24–25, Pl. I, fig. (as *Iridina cœlestis* Lea).

*Mutela (Chelidonopsis) hirundo* and *carrei*: nearly half of the lower margins concrescent. See Germain, 1909, Arch. Zool. Expér. Gén., XLI, pp. 4–34.

*Mutela nilotica:* margins concrescent for at least one-third of the lower border. See Deshayes, 1827, Mém. Soc. Hist. Nat. Paris, III, pp. 1–16, Pl. I; Rang, 1835, Nouv. Ann. Mus. Paris, IV, pp 315–316.

*Iridina (Cameronia) spekii:* one-fourth of the lower margins concrescent. See Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, pp. 116–128.

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[1]A. E. Ortmann, 1911, The Nautilus, XXIV, p. 130.

II.—Mantle very shortly concrescent below the branchial orifice. Genus *Aspatharia*, subgenus *Spathopsis*.[1]

*Aspatharia (Spathopsis) wahlbergi:* See Ortmann, 1918, The Nautilus, XXXI, pp. 77–78.

*Aspatharia (Spathopsis) rubens:* See Rang, 1835, Nouv. Ann. Mus. Paris, IV, pp. 315–316; Troschel, 1847, Archiv f. Naturgesch., XIII, 1, pp. 273–274, Pl. VI, fig. 2.

*Aspatharia (Spathopsis) rubens cailliaudi:* See Clessin, 1875, Malakoz. Blätter, XXII, pp. 22–24, Pl. I, fig. 2.

III.—Mantle entirely open between branchial and pedal orifices. Genus *Aspatharia* proper.

*Aspatharia kamerunensis:* See Ortmann, 1910, The Nautilus, XXIV, pp. 39–42.

*Aspatharia sinuata:* Specimens from Avakubi, examined by us.

## Key to African genera of Mutelidæ

1. The straight hinge has a narrow ridge in place of lateral teeth, a ledge diverging from the beaks forward representing pseudocardinals; shell thin, strongly compressed, polished, bialate .................... *Pseudospatha* Simpson.
   Hinge toothless, or with only a low blunt projection under the beaks ...... ..2.
   Hinge having a series of many short teeth (taxodont) .................... ..3.
2. Hinge-plate abruptly or obliquely terminated posteriorly by a rather deep triangular sinulus; shell oval or oblong ..............*Aspatharia* Bourguignat.
   Hinge-plate not abruptly terminated posteriorly; shell rather long and narrow or wedge-shaped ........................................ *Mutela* Scopoli.
3. Hinge-plate narrow, the teeth weak and short, mainly anterior to the beaks. Some species of *Mutela* Scopoli.
   Hinge-plate and teeth well or strongly developed ............ *Iridina* Lamarck.

### Mutelinæ

### ASPATHARIA Bourguignat

*Spatha* subgenus *Aspatharia* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 14. Monotype: *Margaritana vignouana* Bernardi = *Anodonta rugifera* Dunker.

*Asphataria* "Bourguignat" A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Mém. Soc. Zool. France, XVII, p. 24. Misspelling of *Aspatharia* Bourguignat.

Mutelinæ with oblong or oval shell and toothless hinge-plate, which is more or less abruptly terminated posteriorly by the deep triangular sinulus, and often has a low, blunt, toothlike prominence under the beak of the left valve. Scar of the foot protractor muscle of moderate or large size, and lengthened in the direction of the shell axis. Mantle margins either shortly concrescent below the branchial orifice or open from branchial to pedal orifices.

The genus is exclusively Ethiopian, extending also along the valley of the Nile into Lower Egypt.

[1]*Aspatharia chaiziana* seems to us to belong by conchological characters to *Spathopsis*, but the mantle is entirely open below, according to Rang (1835, Nouv. Ann. Mus. Paris, IV, p. 307, Pls. XXVIII and XXIX)—a character of *Aspatharia* proper. The possibility of breakage of a short mantle connection is to be considered, or perhaps the character is more variable than we now suppose.

*Aspatharia* is here used as the next available name to replace the generic name *Spatha* of recent authors. *Spatha* was originally proposed by Lea for the single species *nilotica* Sowerby.[1] It was thus a monotypic genus. Lea subsequently[2] added *Anodonta rubens* Lamarck, which has generally been considered the type of *Spatha*. Since the species *nilotica* is a *Mutela*, *Spatha* becomes a synonym of that earlier genus, and we are compelled to substitute *Aspatharia*, which was the first name based upon a member of the genus under consideration.

Subgenera of *Aspatharia*

1. Subgenus *Aspatharia*, proper. Beaks corrugated, the corrugations diverging in very broadly Λ-shape. The rest of the oblong, moderately convex valves may be smooth or corrugate-tuberculate. Mantle margins wholly open between branchial and pedal orifices. Type: *Margaritana vignouana* Bernardi.

2. Subgenus *Spathopsis* Simpson. Beaks having short, concentric waves, the rest of the oblong or oval, moderately convex valves smooth, or rarely having some corrugations on the posterior slope or borders. Lunule very narrow, its border slightly higher in the right valve. Mantle margins very shortly concrescent below the branchial orifice. Type: *Anodonta guillaini* Récluz.

3. Subgenus (?) *Arthropteron* A. T. de Rochebrune. Beaks and soft parts unknown. Valves oval, smooth, moderately convex. Lunule large, lanceolate. Type: *Arthropteron ouassouloui* A. T. de Rochebrune.

4. Subgenus *Brazzæa* Bourguignat. Beaks and soft parts unknown. Valves oval, much inflated, thin and lustrous; the thin, irregular margin of the left valve projects slightly above the right in front of the beaks in perfect examples. Type: *Brazzæa anceyi* Bourguignat.

5. Subgenus (?) *Moncetia* Bourguignat.. Beaks and soft parts unknown. Valves oblong with blunt ends, very much compressed and flattened; surface dull. Type: *Moncetia anceyi* Bourguignat.

The third, fourth, and fifth of these groups probably contain a single species each. *Arthropteron* seems to differ from the *rubens* group of *Aspathariæ* only by its large lunule, a character of rather minor importance, possibly abnormal. It is somewhat curious that de Rochebrune repeatedly speaks of this lunular area as posterior, while his figure shows that it is anterior to the beaks.

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[1]1838, Trans. American Phil. Soc., N. S., VI, p. 118.
[2]*Op. cit.*, p. 141.

*Moncetia* has the distally truncate hinge-plate of *Aspatharia.* The muscle impressions are imperfectly shown in the figure, and were not mentioned in Bourguignat's observations. The strong lateral compression appears to be slight ground for distinction from *Aspatharia,* and the subgenus may prove superfluous. From the figures given, there seems to be only one species.

*Brazzæa* of Bourguignat is apparently a more distinct group, its rank to be governed by considerations of the soft anatomy It has the deep sinulus of *Aspatharia,* terminating the hinge-line abruptly. The thin dorsal margin of the right valve projects a little above the left in front of the beaks, whilst in the *rubens* group of *Aspatharia* the left is slightly higher. Von Martens' remark[1] that the relations of the valves are as in *Corbula* goes far beyond Bourguignat's explicit statement. There is probably only one species of the subgenus *Brazzæa,* characterized by the strongly inflated, thin and lustrous shell.

*Chambardia* BOURGUIGNAT (1890, Bull. Soc. Malacol. France, VII, p. 304; type by present designation: *Chambardia letourneuxi* Bourguignat, the first species) is unknown to us by specimens. Possibly it also belongs in *Aspatharia.* Five species have been described: *C. bourguignati* "Letourneux" BOURGUIGNAT (1890, *op. cit.,* p. 313, Pl. VII, fig. 6); *C. letourneuxi* BOURGUIGNAT (1890, *op. cit.,* p. 307, Pl. VII, figs. 1–2); *C. locardiana* BOURGUIGNAT (1890, *op. cit.,* p. 310); *C. pharaonum* BOURGUIGNAT (1890, *op. cit.,* p. 312); and *C. rhynchoidea* BOURGUIGNAT (1890, *op. cit.,* p. 309, Pl. VII, figs. 3–5). All were found subfossil in Lower Egypt.

### Subgenus **ASPATHARIA** proper

The following species appear to belong in this group.

*Aspatharia chapini* Pilsbry and Bequaert. See p. 416.

*Aspatharia corrugata* (Dautzenberg) = *Spatha corrugata* DAUTZENBERG, 1893, Journ. de Conchyl., XLI, p. 50, Pl. VIII, fig. 5. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1348. Niari River, French Congo.

*Aspatharia dahomeyensis* (I. Lea) = *Anodonta dahomeyensis* I. LEA, 1859, Proc. Ac. Nat. Sci. Philadelphia, XI, p. 154; 1860, 'Observ. Unio,' VII, p. 79, Pl. XLI, fig. 141. *Anodonta senegalensis* I. LEA, 1859, Proc. Ac. Nat. Sci. Philadelphia, XI, p. 154; 1860, 'Observ. Unio,' VII, p. 78, Pl. XLI, fig. 140. *Mutelina senegalica.* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 488. *Spatha dahomeyensis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1341. Dahomey and Senegal.

*Aspatharia decorsei* (Germain) = *Spatha* (*Leptospatha*) *decorsei* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 469; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 557, Lith. Pl., fig. 5. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1339. Mamun, Senussi Country, French Equatorial Africa.

[1]E. von Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 258.

*Aspatharia decorsei* var. *persinuata* (Germain) = *Spatha decorsei* var. *sinuata* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 470. *Spatha decorsei* var. *persinuata* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 558, fig. 93 (on p. 559). SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1340. Mamun, Senussi Country, French Equatorial Africa.

*Aspatharia divaricata* (E. v. Martens) = *Spatha divaricata* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 250, Pl. VII, fig. 15. Simin River near Massansa, on the Speke Gulf of Lake Victoria.

*Aspatharia droueti* (Chaper) = *Spatha droueti* CHAPER, 1885, Bull. Soc. Zool. France, X, p. 43, Pl. I, figs. 1–3. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1323. Cania River, Assinie.

*Aspatharia droueti* var. *roseotincta* (Dautzenberg) = *Spatha* (*Leptospatha*) *droueti* var. *roseotincta* DAUTZENBERG, 1921, Rev. Zool. Afric., IX, p. 174. Dume River, an affluent of the Kadei, Cameroon.

*Aspatharia flava* Pilsbry and Bequaert. See p. 418.

*Aspatharia fourtaui* (Pallary) = *Spathella fourtaui* PALLARY, 1903, Bull. Inst. Egyptien, (4) III, (1902), p. 96, Pl. I, fig. 3. *Spatha fourtaui* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1332. White Nile. *Spatha fourteaui* DUPUIS, 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 82 (claims it to be a young *A. marnoi* (Jickeli), which seems doubtful to us).

*Aspatharia kamerunensis* (B. Walker) = *Spatha* (*Aspatharia*) *kamerunensis* B. WALKER, 1910, The Nautilus, XXIV, p. 38, Pl. III, figs. 1–2. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1349. Kribi River, 17 miles from Efulen, Cameroon.

*Aspatharia mabillei* (Jousseaume) = *Spatha mabillei* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 495, Pl. XIV, figs. 2–2*a*. SIMPSON, 1914, 'Descript. Cat. of Naides,' p. 1324. Kora, Senegambia.

*Aspatharia mabillei* var. *mamounensis* (Germain) = *Spatha mabillei* var. *mamounensis* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 67; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 556, fig. 92. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1325. Mamun River, Senussi Country, French Equatorial Africa.

*Aspatharia pfeifferiana* (Bernardi) = *Margaritana pfeifferiana* BERNARDI, 1860, Journ. de Conchyl., VIII, p. 331, Pl. XII, figs. 1–2. *Spatha pfeifferiana* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1341. *Spatha pfeifferi* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 560. Gaboon.

*Aspatharia protchei* (A. T. de Rochebrune). See p. 415.

*Aspatharia rugifera* (Dunker) = *Anodonta rugifera* DUNKER, December, 1858, Malakoz. Blätter, V, p. 225. *Margaritana vignouana* BERNARDI, March, 1859, Journ. de Conchyl., VII, p. 302, Pl. X, fig. 1. *Unio vignonana* REEVE, 1865, 'Conchol. Iconica,' XVI, *Unio*, Pl. XXV, fig. 120. *Spatha* (*Aspatharia*) *vignoni* GERMAIN, 1909, Arch. Zool. Expér. Gén., XLI, p. 57. *Spatha* (*Aspatharia*) *vignoniana* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1347. Lake near the Como River, Gaboon. From Dunker's account it is clear that he described specimens received from Bernardi and which the latter named *vignouana*.

*Aspatharia saræ* (Preston) = *Mutela saræ* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 61, Pl. VI, fig. 6. Shire River, near its outlet from Lake Nyasa.

*Aspatharia semicorrugata* (Preston). See p. 419.

*Aspatharia sinuata* (E. v. Martens). See p. 417.

*Aspatharia stuhlmanni* (E. v. Martens). See p. 419.

*Aspatharia stuhlmanni* var. *comoensis* (Germain) = *Spatha stuhlmanni* var. *comoensis* GERMAIN, 1908, Bull. Mus. Hist. Nat. Paris, p. 127. *Spatha stuhlmanni* var. *comoeensis* GERMAIN, 1908, Journ. de Conchyl., LVI, p. 114, Pl. III, fig. 12. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1338. Comoe River, Ivory Coast. This may be specifically distinct from *stuhlmanni*.

*Aspatharia subreniformis* (Sowerby) = *Anodon subreniformis* SOWERBY, 1867, 'Conchol. Iconica,' XVII, *Anodon*, Pl. XIV, fig. 50. *Spatha subreniformis* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1340. Lake Nyasa.

### **Aspatharia protchei** (A. T. de Rochebrune)

Plate XXXIV, Figures 1, 1*a*, 2, 3, and 3*a*

*Spathella protchei* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 8 (type locality: Mokaka, French Congo). BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 196.

*Spatha (Leptospatha) protchei* A. T. de Rochebrune. GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 543, Pl. VIII, fig. 46 (Bounji, in the Alima River, French Congo).

*Spatha protchei* A. T. de Rochebrune. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1337.

*Spatha cryptoradiata* PUTZEYS, 1898, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. xxvii, figs. 14 and 15. GERMAIN, 1913, Bull. Mus. Hist. Nat. Paris, p. 357 (in the Lobay River at M'Baiki, French Congo). C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 111. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 900; 1914, 'Descript. Cat. of Naiades,' p. 1337.

Leopoldville in the Stanley Pool (type locality of *S. cryptoradiata* Putzeys). Specimens bought from natives at Banana (P. Hesse Coll.).

Stanleyville (H. Lang and J. Bequaert Coll.).

An oblong, not very thick shell, only slightly higher behind than in front, the basal margin straightened, the beaks at or near the anterior third of the length. The most perfectly preserved shells show a fine,

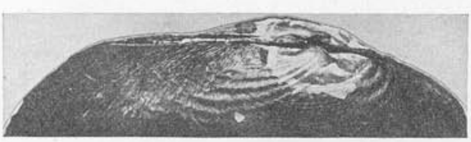

Fig. 91. *Aspatharia protchei* (Jousseaume). Stanleyville. × 2.

beautifully regular corrugation, broadly V-shaped at the beaks, the anterior members short, the posterior extending some distance, sometimes as much as 15 mm. along the posterior ridge (Fig. 91, a young shell 31 mm. long). The young shells are therefore very similar to *A. divaricata* (v. Martens), based upon a young specimen. In many examples little or nothing of this corrugation can be seen. On the median part of the valve the periostracum has a sculpture of minute concentric striæ interrupted by narrow smooth or striate rays, as though a comb had been drawn toward the beaks when the striæ were soft. Such sculpture is found in many fresh-water mussels. In some specimens the radii are wanting. Coarse sculpture of the posterior slope diverging from the posterior ridge, such as Putzeys figures for *cryptoradiata,* is an occasional but inconstant feature. The interior is faintly pink and blue. Length of the hinge from beaks to sinulus is contained 2⅝ times in that of the shell. The muscle scars are but little impressed.

Length, 67 mm.; height, 32 mm.; diameter, 20.5 mm.
" 66 " 32 " 18

We are unable to discriminate between *A. protchei* and *Spatha cryptoradiata* Putzeys. The distinctions pointed out by Germain[1] do not appear to hold good, since in the same lot we find specimens agreeing with *protchei* together with others having the characters of *cryptoradiata.* The latter was found to be abundant in the Chari.

*A. sinuata* and *A. stuhlmanni* of von Martens have the beaks farther forward than in *A. protchei.*

**Aspatharia chapini**, new species

Plate XXXIV, Figures 4 and 4*a*; Plate XLII, Figure 3

Congo River at Leopoldville (J. Bequaert Coll.).

The shell is moderately solid, rather inflated, squarish, highest at the posterior third, the height decidedly more than half of the length. Length before the beaks contained about 3½ times in the total length. The nearly straight dorsal and ventral margins converge anteriorly; anterior margin rounded, posterior steeply, obliquely truncate, rounded below. The posterior ridge is broadly rounded; above and parallel to it there is a low radial rib in the right valve, two in the left. On the posterior-dorsal slope there are a few short wrinkles diverging upward from the ridge. The periostracum is glossy, with weak growth lines, becoming dull and more or less laminiferous toward the base and ends, and minutely crinkled in places. In color it is a very deep brown on the polished portion, elsewhere blackish. The interior is vinaceous-pink, iridescent posteriorly. The hinge, from beaks to sinulus, is contained 1⅓ times in the total length, is very slightly curved, and quite obliquely truncate posteriorly, the sinulus rather semi-circular and not very deep. The ligament is partially immersed. The muscle scars are well impressed; foot protractor scar lengthened as usual; foot retractor scar small, separate.

Length, 77.5 mm.; height at beaks, 39 mm.; at posterior third, 44 m.; diameter, 28 mm.

The short, squarish shape, very steep posterior truncation and rather inflated valves appear to be characteristic. Probably the upper slope will show more corrugation when younger or less extensively eroded individuals come to light.

[1]1909, Bull. Mus. Hist. Nat. Paris, pp. 543–544.

**Aspatharia sinuata** (E. v. Martens)

Plate XXXV, Figures 1–4; Plate XXXVI, Figures 1–3*a*

*Spatha sinuata* E. v. Martens, 1883, Sitz. Ber. Ges. Naturf. F . Berlin, p. 73; 1885, 'Conchol. Mitth.,' II, 5–6, p. 190, Pl. xxxiv, figs. 5 and 6. Bourguignat, 1889, 'Moll. Afrique Equator.,' p. 196. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 899; 1914, 'Descript. Cat. of Naiades,' p. 1333.

*Mutela lukuluensis* Preston, 1913, Rev. Zool. Afric., III, 1, p. 61, Pl. vi, fig. 4.

*Mutela mathildæ* Preston, 1913, Rev. Zool. Afric., III, 1, p. 61, Pl. vi, fig. 7 (type locality: Shiré River).

In the Lubi and Lubilash Rivers, between 5° and 6° S. (Wissmann Coll.; type locality not more definitely mentioned). Confluence of Lukulu and Luapula Rivers (type locality of *M. lukuluensis* Preston).

Aba, abundant in the Aba River; Faradje; Medje (Lang and Chapin Coll.). Avakubi, in the Aruwimi-Ituri River (J. Bequaert Coll.).

Mr. Lang notes that this mussel is frequently used as food by the natives in the region of Aba.

An *Aspatharia* very abundant at Aba and Faradje agrees best with the account of *A. sinuata* (v. Martens), though some examples appear close to *A. stuhlmanni* (v. Martens) of the Upper Ituri River, therefore not far from our localities. The figure of *A. stuhlmanni* could pass for some of our specimens, but, according to the description, the beaks are somewhat less anterior and the ligament is relatively longer.

Our shells are dingy blackish brown or blackish olive. When washed with oxalic acid to remove the iron stain, they vary from olive-brown to isabella color and more rarely honey yellow, in either case becoming bright or dark green toward the beaks, blackish or olive-brown posteriorly. The middle or the anterior half shows more or less of the minute sculpture of rays composed of fine, looped, concentric costulæ, as seen in *A. protchei* and many other species. The contour is somewhat variable; in some specimens the dorsal and basal margins are nearly parallel, but more frequently the shell becomes higher posteriorly. These variations, as well as the variation in diameter, are shown in the figures.

The length of the hinge-plate, from beaks to sinulus, is 43 to 44 per cent of the total length. The anterior and visceral muscle impressions are rather deep. The internal color in Faradje shells is pale blue or rarely pale pink with olive to dull green stains. In those from Aba the pinkish tint is more frequent. There is not much iridescence. In a few individuals there is a distinct though low and blunt tooth under the beak of the left valve.

| | | | | |
|---|---|---|---|---|
| Length, 77.5 mm.; | height, 39.0 mm.; | diameter, 27.0 mm. | Faradje. |
| " 65.0 | " 33.0 | " 22.0 | " |
| " 77.0 | " 39.0 | " 28.5 | Aba. |
| " 68.0 | " 34.0 | " 20.0 | " |
| " 73.0 | " 35.0 | " 20.0 | Avakubi. |
| " 63.5 | " 34.0 | " 19.0 | " |

This species belongs to a group of medium-sized, oblong *Aspathariæ* having rather dull nacre and divaricate beak sculpture, only rarely preserved in the adult stage on account of the erosion of this part. Usually there is a sculpture of rays composed of minute, festooned riblets in the median part of the valves. This group of very closely allied forms extends from West Africa—*A. droueti* (Chaper), Assinie—through the Congo basin to East Africa—*A. divaricata* (v. Martens), in the Lake Victoria region, and various forms in and about Lake Nyasa. The discrimination of species in this series is a perilous adventure.

**Aspatharia flava,** new species

Plate XLIII, Figures 3 and 3*a*; Plate XLIV, Figures 2 and 2*a*

Medje, type locality; Aba; Faradje (Lang and Chapin Coll.). A specimen of this species was attached to a native anklet at Medje.

The shell is solid, ovate, rather inflated, highest near the middle; beaks about at the anterior fourth of the length. The dorsal margin is somewhat arched, the beaks rather prominent but deeply eroded; basal margin weakly convex; anterior end broadly rounded; posterior end obliquely truncate, produced and rounded below. The posterior ridge is broadly rounded, the slope above it somewhat concave, having one (or several) very low cords radiating to the end, and near the beaks some short corrugations diverging backward and dorsad from the ridge. The surface has a varnish-like gloss and is rather weakly and irregularly marked with growth-wrinkles, the middle and forward half marked with very weakly raised rays. Color, from mustard yellow to old gold, more or less stained with burnt sienna. The interior is light pinkish cinnamon with some olivaceous spots and stains. The cavities of the beaks are unusually deep for this genus, the visceral muscle impressions not readily visible, being on the overhanging hinge plate. Length of the hinge from beaks to sinulus contained 2.6 to 2.7 times in the length. Posterior end of the hinge plate abruptly truncate by the deep, triangular sinulus. The muscle impressions are moderately impressed. Foot retractor impression small, separate.

| | | | |
|---|---|---|---|
| Length, 74.0 mm.; | height, 46.0 mm.; | diameter, 30.0 mm. | Type. Medje. |
| " 71.0 | " 42.0 | " 29.0 | Paratype. Medje. |
| " 62.0 | " 38.0 | " 26.0 | Aba. |

This form appears to resemble *A. stuhlmanni* var. *comoensis* (or *comoeensis*) (Germain) in general shape, color and solidity, but it differs by having the beaks much nearer the anterior end of the shell than in that form of the Ivory Coast. The height and diameter of the present species are also somewhat greater in shells of the same length.

In specimens which have only a small area eroded at the beaks, a well developed corrugation is seen anteriorly and posteriorly, or posteriorly only. The middle region, next to the eroded area, shows under the lens a fine concentric costulation, the costulæ irregular in greater or less degree. At a rather early neanic stage, this species has therefore much the *Aspatharia* sculpture.

The specimens from Aba, where it appears to be somewhat abundant, are all smaller than those from Medje.

An apparently constant character of this species is that, as in *A. rubens* and some others, the right valve is higher than the left in the region of the small but distinct lunule.

## Other Species of *Aspatharia*, proper, Recorded from the Belgian Congo

### *Aspatharia semicorrugata* (Preston)

*Spatha semicorrugata* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) VI, p. 90, Pl. IV, fig. 7. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1349.

Lower Congo (type locality; no collector mentioned).

### *Aspatharia stuhlmanni* (E. v. Martens)

*Spatha stuhlmanni* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 260, fig. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 900; 1914, 'Descript. Cat. of Naiades,' p. 1338 (locality incorrectly given as "Lake Albert Nyanza").

Undussuma (type locality; Stuhlmann Coll.), in the region of the Ituri River; probably from the river itself and its affluents, for instance in the Duki River near Buessa in 1° 30′ N.; the detached valves are used as spoons by the Babira natives.

This appears to be closely related to *A. sinuata*(v. Martens).

### Subgenus SPATHOPSIS Simpson

*Lamellidens* subgenus *Spathopsis* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 857. Monotype: *Anodonta guillaini* Récluz.

*Spatha* subgenus *Spathella* BOURGUIGNAT, December, 1885,' Esp. Nouv. Ouk. Tanganika,' p. 14. Type by designation of Bourguignat (1889, 'Moll. Afrique Equator.,' p. 195, footnote): *Spatha petersi* E. v. Martens.

*Leptospatha* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Mém. Soc. Zool. France, XVII, p. 25. Substitute for *Spathella* Bourguignat (December, 1885), not of J. Hall (November, 1885). Type by designation of Germain (1909, Arch. Zool. Expér. Gén., XLI, p 49, footnote): *Spatha petersi* E. v. Martens.

*Mitriodon* A. T. DE ROCHEBRUNE, 1904, Bull. Mus. Hist. Nat. Paris, p. 462. Type by present designation: *Mitrio on martini* A. T. de Rochebrune.

*Spatha* of authors, not of I. Lea, 1838.

The following species belong in this group:

*Aspatharia (Spathopsis) adansoni* (Jousseaume) = *Spatha adansoni* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 498, Pl. XIV, figs. 4–4*a*. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1325. Diamuko River, near its confluence with the Senegal.

*Aspatharia adansoni* var. *major* (Germain) = *Spatha adansoni* var. *major* GERMAIN, 1917, Bull. Mus. Hist. Nat. Paris, p. 517, fig. 5. Region of the Tchis, district of Mono, Dahomey.

*Aspatharia* (*Spathopsis*) *anataria* (de Cristofori and Jan) = *Anodonta anataria* DE CRISTOFORI AND JAN, 1832, 'Catal. Rer. Nat.,' p. 8, and 'Mantissa,' p. 4. *Spatha anataria* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1350. Egypt.

*Aspatharia* (*Spathopsis*) *arcuta* (Cailliaud) = *Anodonta arcuta* CAILLIAUD, 1823, 'Voyage à Méroé,' Atlas, II, Pl. LXI, figs. 4 and 5; 1827, *op. cit.*, IV, p. 263. *Margarita* (*Anodonta*) *arcuata* I. LEA, 1836, 'Synopsis of Naiades,' p. 54. *Spatha arcuata* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1336. Lower Egypt (canal de Joseph).

*Aspatharia* (*Spathopsis*) *baikii* (H. Adams) = *Spatha baikii* H. ADAMS, 1866, Proc. Zool. Soc. London, p. 447. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1350. Niger.

*Aspatharia* (*Spathopsis*) *bellamyi* (Jousseaume) = *Spatha bellamyi* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 491, Pl. XIII, figs. 2–2*a*. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1318. Kulikoro, Niger.

*Aspatharia* (*Spathopsis*) *bozasi* (A. T. de Rochebrune and Germain) = *Spathella bozasi* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 144. *Leptospatha bozasi* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Mém. Soc. Zool. France, XVII, p. 26, Pl. II, fig. 7. *Spatha bozasi* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1328. Bass River near Lake Rudolf.

*Aspatharia* (*Spathopsis*) *chaiziana* (Rang) = *Anodonta chaiziana* RANG, 1835, Nouv. Ann. Mus. Paris, IV, p. 307, Pl. XXVIII, figs. 1–3 and Pl. XXIX, figs. 1–3. *Spatha chaiziana* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1319. *Anodonta tawaii* RANG, 1835, Nouv. Ann. Mus. Paris, IV, p. 310. *Spatha tawi* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 902. *Spatha tawai* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1320. *Spatha rochebrunei* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 494, Pl. XIV, figs. 1–1*a*. *Spatha tristis* JOUSSEAUME, 1886, *op. cit.*, p. 497, Pl. XIV, figs. 3–3*a*. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1321. Senegal and Upper Niger (type locality: "marigot de Gnédé, Senegal").

*Aspatharia chaiziana* var. *compressa* (Germain) = *Spatha chaiziana* var. *compressa* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 173. Lake Chad.

*Aspatharia* (*Spathopsis*) *clappertoni* (Kœnig) = *Anodon clappertoni* KŒNIG, 1826, in Denham and Clapperton, 'Narrative of Trav. and Discov. in N. and Centr. Africa, Appendix,' p. 255. "Gammaroo River" (from the text of the book this appears to be a locality called Gambaroo on the Komadugu Yobe River, also called the Yaou or Yo). This species has been generally synonymized with *A. rubens*, but it appears to be quite distinct and is probably one of the forms which have been later described from Nigeria.

*Aspatharia* (*Spathopsis*) *corneola* (A. T. de Rochebrune). See p. 425.

*Aspatharia* (*Spathopsis*) *guillaini* (Récluz) = *Anodonta guillaini* RÉCLUZ, 1850, Journ. de Conchyl., I, p. 55. CROSSE, 1883, *op. cit.*, XXXI, p. 222, Pl. IX, fig. 4. *Lamellidens* (*Spathopsis*) *guillaini* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1179. Denoq River near Brava (or Barawa), Somaliland. This appears to be very close to *A. wahlbergi hartmanni* (v. Martens).

*Aspatharia* (*Spathopsis*) *haasi* (Pilsbry) = *Spatha haasi* PILSBRY, 1923, Proc. Ac. Nat. Sci. Philadelphia, LXXV, p. 275, Pl. XIX, figs. 1 and 2. Boran, Kenya Colony.

*Aspatharia* (*Spathopsis*) *innesi* (Pallary) = *Spatha innesi* PALLARY, 1903, Bull. Inst. Egyptien, (4) III, (1902), p. 97, Pl. II, fig. 2. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1320. White Nile. Dupuis [1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 82] claims to possess a specimen from Lake Edward, and that it is not different from *A. chaiziana* (Rang).

*Aspatharia* (*Spathopsis*) *kirki* (Ancey) = *Spathella kirki* ANCEY, 1894, Mém. Soc. Zool. France, VII, p. 229, figs. 4–6 (on p. 230). *Spatha kirki* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1324. *Spatha approximans* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 63, Pl. v, fig. 14. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1332. *Spatha mwayana* PRESTON, 1913, Rev. Zool. Afric., III, 1, p. 62, Pl. v, fig. 15. Shire River near Lake Nyasa. Preston's photograph of *S. approximans* seems to show that he redescribed the very specimen shown in Ancey's figures 4 and 5 as *S. kirki*, as has also been pointed out by Dupuis, 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 81.

*Aspatharia kirki* var. *liederi* (E. v. Martens) = *Spatha kirki* var. *liederi* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 245. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1325. Mbampa Bay, Lake Nyasa.

*Aspatharia* (*Spathopsis*) *lacustris* (Simpson) = *Spatha anceyi* "BOURGUIGNAT" ANCEY, 1894, Mém. Soc. Zool. France, VII, p. 231, fig. 7 (on p. 232) (not *Brazzæa ancey*, Bourguignat, 1885). *Spatha lacustris* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 898; 1914, 'Descript. Cat. of Naiades,' p. 1330. *Spatha bertilloniana* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 63, Pl. v, fig. 15. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1334. Karonga, Lake Nyasa. Preston has evidently based his *S. bertilloniana* on the specimen described and figured by Ancey at *S. anceyi*, as a comparison of figures discloses, and as has also been pointed out by Dupuis, 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 81.

*Aspatharia lacustris* var. *major* (Germain) = *Spatha* (*Leptospatha*) *lacustris* var. *major* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 174. Lake Chad.

*Aspatharia* (*Spathopsis*) *lepsii* (Jickeli) = *Spatha lepsii* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 265, Pl. IX, fig. 4. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1319. Upper Egypt.

*Aspatharia* (*Spathopsis*) *maitenguensis* (R. Sturany) = *Spatha maitenguensis* R. STURANY, 1898, Anz. Ak. Wiss. Wien, Math. Naturw. Kl., XXXV, p. 161; 1898, Denkschr. Ak. Wiss. Wien, Math. Naturw. Kl., LXVII, p. 628, Pl. III, fig. 66. SIMPSON, 1914, 'Descript. Cat. of Naiades, p. 1330. Maitengue River, Matabeleland.

*Aspatharia* (*Spathopsis*) *marnoi* (Jickeli) = *Spatha ma noi* JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 264, Pl. VIII, figs. 3*a* and 3*c*. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1332. Land of the Nuer in the Bahr-el-Seraf, Anglo-Egyptian Sudan.

*Aspatharia* (*Spathopsis*) *martensi* (R. Sturany) = *Spatha martensi* R. STURANY, 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 308, Pl. XXV, fig. 39. SIMPSON, 1914, 'De cript. Cat. of Naiades,' p. 1323. Ngoroine, east of Lake Victoria, Tanganyika Territory.

*Aspatharia* (*Spathopsis*) *martini* (A. T. de Rochebrune) = *Mitriodon martini* A. T. DE ROCHEBRUNE, 1904, Bull. Mus. Hist. Nat. Paris, p. 462. *Mitriodon falemeensis* A. T. DE ROCHEBRUNE, 1904, *op. cit.*, p. 463. *Mitriodon heudeloti* A. T. DE ROCHEBRUNE, 1904, *op. cit.*, p. 463. *Spatha martini* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1343. Senegal.

*Aspatharia* (*Spathopsis*) *nyassaensis* (I. Lea) = *Spatha nyassaensis* I. LEA, 1864, Proc Ac. Nat Sci. Philadelphia, XVI, p. 109; 1867, 'Observ. Unio,' XI, p. 40, Pl. XIII, fig. 33. SIMPSON, 1914, Descript. Cat. of Naiades,' p. 1331. *Spathella nyassana* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 39. Lake Nyasa.

*Aspatharia* (*Spathopsis*) *pangallensis* (A. T. de Rochebrune) = *Spatha pangallensis* A. T. DE ROCHEBRUNE, 1882, Bull. Soc. Philomath. Paris, (7) VI, p. 33. *Spatha pangallicensis* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 902; 1914, 'Descript. Cat. of Naiades,' p. 1350. Bakoy River at Pangalla, Senegal.

*Aspatharia* (*Spathopsis*) *petersi* (E. v. Martens) = *Spatha petersi* E. v. MARTENS, 1860, Malakoz. Blätter, VI, p. 218, Pl. III, figs. 1–2. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1335. Tete, Mozambique.

*Aspatharia petersi modesta* (I. Lea) = *Spatha modesta* I. LEA, 1864, Proc. Ac. Nat. Sci. Philadelphia, XVI, p. 109; 1867, 'Observ. Unio,' XI, p. 41, Pl. XIII, fig. 35. Mozambique.

*Aspatharia* (*Spathopsis*) *renei* (Jousseaume) = *Spatha renei* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 492, Pl. XIII, figs. 3–3*a*. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1317. Niger River at Bamako, French Sudan.

*Aspatharia renei* var. *compressa* (Germain) = *Spatha renei* var. *compressa* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 554. Bani River, near San, French Sudan.

*Aspatharia* (*Spathopsis*) *rotundata* (E. v. Martens) = *Spatha rotundata* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 242, fig. (on p. 243). Wembere Steppe, near Nyaua, Tanganyika Territory. This appears to be specifically distinct from *A. rubens* (Lamarck).

*Aspatharia* (*Spathopsis*) *rubens* (Lamarck). See p. 425.

*Aspatharia rubens* var. *caillaudi* (E. v. Martens) = *Spatha caillaudi* E. v. MARTENS, 1866, Malakoz. Blätter, XIII, p. 9. Based upon *Anodonta rubens* CAILLIAUD, 1823, 'Voyage à Méroé,' Atlas, II, Pl. LX, fig. 12; 1827, *op. cit.*, IV, p. 262 ("canal de Joseph," Lower Egypt) (not of Lamarck). *Spatha rubens* var. *caillaudi* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1316. Nile.

*Aspatharia rubens* var. *chudeaui* (Germain) = *Spatha rubens* var. *chudeaui* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 66; 1908, in A. Chevalier, 'L' Afrique Centrale Française,' p. 552, fig. 91 (on p. 553). SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1316. Mamun River in the Senussi Country and Gribingui River, French Equatorial Africa.

*Aspatharia* (*Spathopsis*) *subæquilatera* (E. v. Martens) = *Spatha subæquilatera* E. v. MARTENS, 1887, 'Conchol. Mitth.,' III, 1, p. 18, Pl. XLI, figs. 8–9. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1333. *Spatha baumanni* R. STURANY, 1894, in O. Baumann, 'Durch Massailand zur Nilquelle,' p. 308, Pl. XXV, fig. 38. Lake Victoria.

*Aspatharia* (*Spathopsis*) *tabula* (Sowerby) = *Anodon tabula* SOWERBY, 1867, 'Conchol. Iconica,' XVII, *Anodon*, Pl. XVIII, fig. 68. Sierra Leone. This appears to be specifically distinct from *A. wahlbergi*.

*Aspatharia* (*Spathopsis*) *trapezia* (E. v. Martens) = *Spatha trapezia* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 243, fig. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1322. Lake Victoria.

*Aspatharia trapezia* var. *senilis* (E. v. Martens) = *Spatha trapezia* var. *senilis* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 244, fig. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1322. Lake Victoria.

*Aspatharia (Spathopsis) wahlbergi* (Krauss) = *Iridina wahlbergi* KRAUSS, 1848, 'Südafrik. Mollusk.,' p. 19, Pl. II, fig. 1. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1326. *Spatha natalensis* I. LEA, 1864, Proc. Ac. Nat. Sci. Philadelphia, XVI, p. 113; 1867, 'Observ. Unio,' XI, p. 68, Pl. XX, fig. 58. South Africa; originally described from the "Affenfluss," an affluent of the Limpopo.

*Aspatharia wahlbergi* var. *dorsalis* (E. v. Martens) = *Spatha wahlbergi* var. *dorsalis* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 247. SIMPSON, 1914, 'Descript. Cat of Naiades,' p. 1328. Mozambique (Zambezi River) and Tanganyika Territory.

*Aspatharia wahlbergi hartmanni* (E. v. Martens) = *Spatha hartmanni* E. v. MARTENS, 1866, Malakoz. Blätter, XIII, p. 10. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p 263, Pl. VIII, figs. 2*a–c*. *Spatha wahlbergi* var. *hartmanni* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1327. *Spatha (Spathella) bourguignati* "Ancey" BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' pp. 12 and 14 (southern shore of Lake Victoria). *Spathella bourguignati* BOURGUIGNAT, 1889, 'Moll. Afrique Equator.,' p. 197, Pl. VIII, fig. 1. *Spathella bloyeti* BOURGUIGNAT, 1889, *op. cit.*, p. 198, Pl. VIII, fig. 3 (Makata River, an affluent of the Vuami River, Tanganyika Territory). *Spathella spathuliformis* BOURGUIGNAT, 1889, *op. cit.*, p. 199, Pl. VIII, fig. 4 (Magogo River at Unyanguira in Ugogo, Tanganyika Territory). *Spathella brumpti* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 144. *Leptospatha brumpti* A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Mém. Soc. Zool. France, XVII, p. 26, Pl. II, fig. 6 (Bass River near Lake Rudolf). *Spatha wahlbergi* var. *bourguignati* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1327. *Spatha brumpti* SIMPSON, 1914, *op. cit.*, p. 1329. Birket Kura, Sennar (type locality of *hartmanni*).

*Aspatharia (Spathopsis) wissmanni* (E. v. Martens). See below.

*Aspatharia wissmanni bangalorum* Pilsbry and Bequaert. See p. 424.

### Aspatharia (Spathopsis) wissmanni (E. v. Martens)

Plate XXXVII, Figures 1 and 2; Text Figure 92

*Spatha wissmanni* E. v. MARTENS, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 73; 1894, 'Conchol. Mitth.,' III, 3, p. 9, Pl. XXXXIV.

*Spatha rubens* var. *wissmanni* C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 111. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., III, 1, p. 68 (in part).

Originally described from the Lubi and Lubilash Rivers, 5° to 6° S. (Wissmann Coll.; type locality not designated.) Mulongo, in the Channel leading from Lake Kabamba to the Lualaba River (between Kikondja and Ankoro; J. Bequaert Coll.).

The specimen from Malema recorded by Dautzenberg and Germain is subspecifically distinct and described below as *bangalorum*. To this form might also have belonged the isolated valves from the Upper Congo (O. Baumann Coll.), seen by C. R. Bœttger.

Medje (Lang and Chapin Coll.).

The most ponderous mussel yet known from the Congo. Young to half-grown shells are almost symmetrically elliptical, but with age the dorsal margin becomes rather highly arched, curved more than the basal.

The two ends are about equally curved. The strong periostracum is black. The interior is white with some ecru-olive spots and stains. It becomes iridescent posteriorly. The anterior and visceral muscle scars are deeply sunken. Foot protractor large. The hinge plate is broad but very short, covered with cuticular laminæ anteriorly, abruptly terminated by a deep sinulus posteriorly. Beaks are deeply eroded, situated at about the anterior fourth of the length.

Length, 135 mm.; height, 89 mm.; diameter, 49 mm.
" 112 " 70 " 36

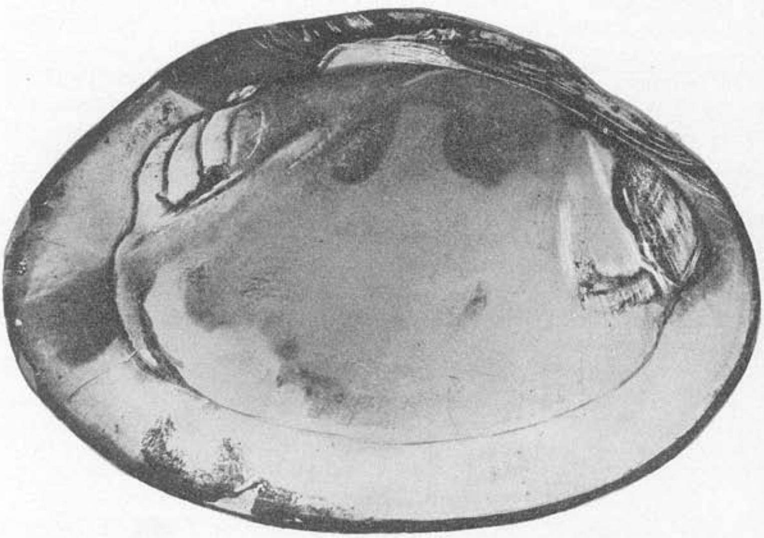

Fig. 92. *Aspatharia wissmanni* (v. Martens) Medje.

While this species is related to *A. rubens* (Lamarck), it is certainly distinct by the larger, more ponderous shell, constantly white nacre, the much heavier and relatively shorter hinge plate and the black periostracum. The more highly arched dorsal margin is also characteristic in adult shells. Old and young specimens from Medje are figured.

**Aspatharia (Spathopsis) wissmanni bangalorum**, new subspecies

Text Figure 93

*Spatha rubens* var. *wissmanni* Dautzenberg and Germain (in part), 1914, Rev. Zool. Afric., IV, 1, p. 68.

Malema (between Bumba and Basoko) (J. Bequaert Coll.). Type in the Congo Museum at Tervueren.

The shell is higher than *A. wissmanni*, the greatest height behind the middle, covered with a glossy vandyke brown periostracum which shades downward into black, and toward the beaks becomes lighter, somewhat olivaceous. Interior as in *A. wissmanni*.

Length, 107.5 mm.; height, 75.0 mm.; semi-diameter, 20.0 mm.

This form is eaten by the Bangala. It is known from valves picked from a kitchen midden during a steamer stop.

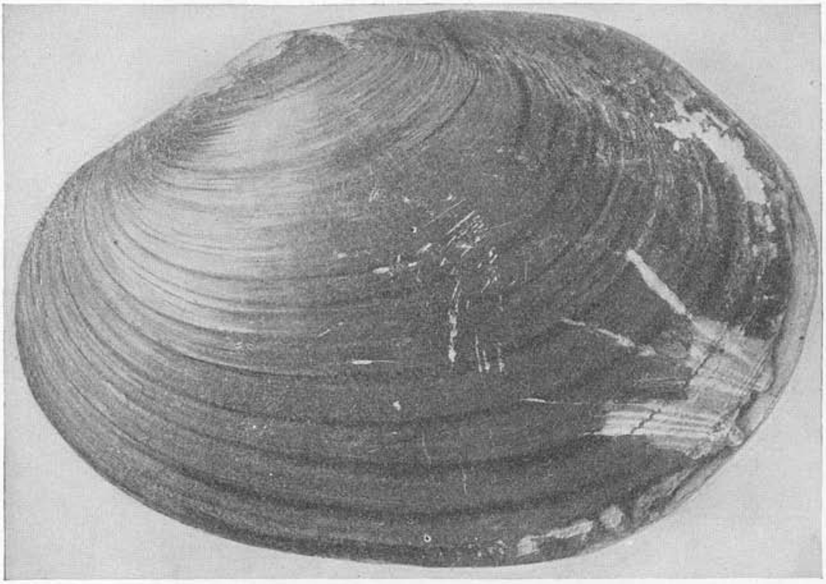

Fig. 93. *Aspatharia wissmanni bangalorum* Pilsbry and Bequaert. Type. Malema.

## Other Species of *Spathopsis* Recorded from the Belgian Congo

### *Aspatharia* (*Spathopsis*) *corneola* (A. T. de Rochebrune)

*Spatha corneola* A. T. de Rochebrune, 1886, Bull. Soc. Malacol. France, III, p. 9 (type locality: Mokaka, French Congo). Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 902; 1914, 'Descript. Cat. of Naiades,' p. 1318.

*Spatha ganciniensis* A. T. de Rochebrune, 1886, Bull. Soc. Malacol. France, III, p. 9. Germain, 1909, Arch. Zool. Expér. Gén., XLI, p. 55. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 902.

Gancini or Nganchu, on the right bank of the Congo River (Thollon Coll.; type locality of *S. ganciniensis*).

### *Aspatharia* (*Spathopsis*) *rubens* (Lamarck)

*Anodonta rubens* Lamarck, 1819, 'Hist. Nat Anim. sans Vertébres,' VI, 1, p. 85 (type locality: Senegal. Based upon Pl. ccI, figs. 1*a-b*, of Bruguière, 1797, 'Encyclop. Méthod., Vers,' I).

*Spatha rubens* Lamarck. H. AND A. ADAMS, 1857, 'Gen. Recent Moll.,' II, p. 507, Pl. CXIX. GERMAIN, 1913, Bull. Mus. Hist. Nat. Paris, pp. 292 and 357, Pl. XII, figs. 69 and 70. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 896; 1914, 'Descript. Cat. of Naiades,' p. 1314 (in part).

*Anodonta splendens* DE CRISTOFORI AND JAN, 1832, 'Catal. Rer. Nat., Mantissa,' p. 4 (Africa).

*Iridina solida* ANTON, 1839, 'Verzeichn. Conchyl. Samml.,' p. 16 (without locality).

Germain records this species from the Lobay River at M'Baiki, French Congo and from Zongo on the lower Ubangi (Poutrin Coll.); but the occurrence of true *A. rubens* in the Congo basin appears doubtful.

## Subgenus **ARTHROPTERON** A. T. de Rochebrune

*Arthropteron* A. T. DE ROCHEBRUNE, 1904, Bull. Mus. Hist. Nat. Paris, p. 461. Monotype: *Arthropteron ouassouloui* A. T. de Rochebrune.

This group contains only one species:

*Aspatharia* (*Arthropteron*) *ouassouloui* (A. T. de Rochebrune) = *Anthropteron ouassouloui* A. T. DE ROCHEBRUNE, 1904, Bull. Mus. Hist. Nat. Paris, p. 461, fig. 1. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1375. Region of Uassulu, French Sudan.

## Subgenus **BRAZZÆA** Bourguignat

*Brazzæa* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 32. Monotype: *Brazzæa anceyi* Bourguignat.

*Brazzea* GERMAIN, 1909, Arch. Zool. Expér. Gén., XLI, pp. 51, 54, and 57. Misspelling of *Brazzæa*.

The many names proposed by Bourguignat appear to refer all to one species, known only from Lake Tanganyika.

### *Aspatharia* (*Brazzæa*) *anceyi* (Bourguignat)

*Brazzæa anceyi* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 33; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXVIII, figs. 1–4. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 258. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 907. E. A. SMITH, 1906, Proc. Zool. Soc. London, I, p. 185. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 257 and 269. GERMAIN, 1909, Arch. Zool. Expér. Gén., XLI, p. 52, footnote. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1372.

*Brazzæa bourguignati* "Joubert" BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 58; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXVIII, figs. 5–6. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1372.

*Brazzæa bridouxi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 54.

*Brazzæa charbonnieri* BOURGUIGNAT, 1886, *op. cit.*, p. 52.

*Brazzæa coulboisi* BOURGUIGNAT, 1886, *op. cit.*, p. 50; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXIX, fig. 1. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1373.

*Brazzæa elongata* BOURGUIGNAT, 1886, 'Nouv. Malacol.,' I, Un. et Irid. Tanganika,' p. 51; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXIX, figs. 2–3. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1373.

*Brazzæa eximia* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 57; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXIX, fig. 5.

*Brazzæa jouberti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 48.

*Brazzæa lavigeriana* BOURGUIGNAT, 1886, *op. cit.*, p. 53.

*Brazzæa moineti* BOURGUIGNAT, 1886, *op. cit.*, p. 47.

*Brazzæa newcombiana* BOURGUIGNAT, 1886, *op. cit.*, p. 55.

*Brazzæa randabeli* BOURGUIGNAT, 1886, *op. cit.*, p. 46.

*Brazzæa ventrosa* BOURGUIGNAT, 1886, *op. cit.*, p. 45; 1888, 'Iconógr. Malacol. Tanganika,' Pl. XXIX, fig. 4. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1374.

Lake Tanganyika: originally described from the lake without more definite locality; Kibanga (W. A. Cunnington Coll.); Burton Gulf; near the mouth of the Luandazi River.

### Subgenus **Moncetia** Bourguignat

*Moncetia* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 34. Monotype: *Moncetia anceyi* Bourguignat.

There appears to be but one species from Lake Tanganyika.

### *Aspatharia (Moncetia) lavigeriana* (Bourguignat)

*Moncetia lavigeriana* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 60; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXX, fig. 6.

*Spatha (Moncetia) lavigerina* Bourguignat. SIMPSON, 1900, Proc. U.S. Nat. Mus., XXII, p. 901; 1914, 'Descript. Cat. of Naiades,' p. 1346.

*Moncetia anceyi* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 35; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXX, figs. 1–3. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 258. ANCEY, 1907, Bull. Scientif. France et Belgique, (5) IX, pp. 258 and 270.

*Spatha (Moncetia) anceyi* GERMAIN, 1909, Arch. Zool. Expér. Gén., XLI, p. 50. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 901; 1914, 'Descript. Cat. of Naiades,' p. 1345.

*Moncetia bridouxi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 65; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXX, fig. 5.

*Moncetia jouberti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 63; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXX, fig. 4.

*Moncetia moineti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 61; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXX, fig. 7.

*Spatha (Moncetia) monieti* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 901.

*Spatha (Moncetia) moineti* Bourguignat. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1345.

*Moncetia rochebruniana* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 62; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXX, fig. 8.

Lake Tanganyika: originally described from the lake without more definite locality; Ubuari Peninsula; on the western shore (Guillemé Coll.).

### **MUTELA** Scopoli

*Mutela* SCOPOLI, 1777, 'Introductio ad Historiam Naturalem,' p. 397. Monotype: *Mytilus dubius* Gmelin = Adanson's "Le Mutel."

*Spatha* I. LEA, 1838, Trans. American Phil. Soc., N.S., VI, pp. 118 and 141. On p. 118 monotypic for *Iridina nilotica* Cailliaud.

*Calliscapha* SWAINSON, 1840, 'Treatise on Malacology,' p. 380. Monotype: *Iridina nilotica* Cailliaud.

*Mutelina* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 11. Monotype (on p. 12): *Mutela subdiaphana* Bourguignat.

*Mutela* subgenus *Pseudomutela* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 905. Monotype: *Mycetopus plicatus* Sowerby.

Mutelinæ with the shell oblong to subtriangular, smoothish (except for a carina on the posterior ridge in the subgenus *Chelidonopsis*). The hinge is either smooth and narrow or set with many short similar teeth (taxodont), the sinulus of its posterior end shallow, rounded or inconspicuous. The scar of the pedal protractor muscle is small, short. Mantle margins are broadly concrescent for one-fourth to half of their ventral length between branchial and pedal orifices.

This genus is exclusively African and has the same distribution as *Aspatharia.*

## Subgenus **MUTELA**, proper

The following species have been described:

*Mutela ægyptiaca* (Pallary) = *Mutelina ægyptiaca* PALLARY, 1924, Mém. Inst. d'Egypte, VII, 1, p. 52, Pl. IV, figs. 14 (type), 13 (var. *obtusa* Pallary, p. 53), and 15 (var. *rhynchota* "Bourguignat" Pallary, p. 53). Mahmudieh Canal, Lower Egypt.

*Mutela alata* (I. Lea) SIMPSON, 1914, 'Descript. Cat. of Naiades,' p.1356 = *Spatha alata* I. LEA, 1864, Proc. Ac. Nat. Sci. Philadelphia, XVI, p. 109; 1867, 'Observ. Unio,' XI, p. 39, Pl. XII, figs. 31. Lake Nyasa.

*Mutela alluaudi* Germain. See p. 435.

*Mutela angustata* (Sowerby). See p. 435.

*Mutela angustata* var. *curta* GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 174, fig. 6. *Mutela dubia* var. *curta* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1354. Lake Chad.

*Mutela angustata* var. *ponderosa* GERMAIN, 1906,Bull. Mus. Hist. Nat. Paris, p. 56, fig. 1. *Mutela dubia* var. *ponderosa* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1354. Lake Chad.

*Mutela bourguignati* "Ancey" BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 8. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1358. Near the mouth of the Chimau River in Lake Victoria.

*Mutela bourguignati* var. *smithi* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 255. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1358 = *Mutela bourguignati* E. A. SMITH, 1892, Ann. Mag. Nat. Hist., (6) X, p. 128, Pl. XII, fig. 16 (not of Bourguignat). Lake Victoria.

*Mutela bourguignati* var. *truncata* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 255, Pl. VII, fig. 17. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1358. Lake Victoria.

*Mutela chevalieri* Germain. See p. 435.

*Mutela complanata* (Jousseaume) = *Mutelina complanata* JOUSSEAUME, 1886, Bull. Soc. Zool. France, XI, p. 489, Pl. XIII, figs. 1–1*a*. *Spatha complanata* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1343. Fuladugu, Niger River.

*Mutela complanata* var. *curta* (Germain) = *Mutelina complanata* var. *curta* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 68. *Spatha complanata* var. *curta* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1344. Chari River. This name is preoccupied by *Mutela angustata* var. *curta* Germain, 1906.

*Mutela complanata* mut. *abbreviata* (Germain) = *Mutelina complanata* mut. *abbreviata* GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 573. Chari River.

*Mutela complanata* mut. *elongata* (Germain) = *Mutelina complanata* mut. *elongata* Germain, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 573. Chari River.

*Mutela dubia* (Gmelin). See p. 430.

*Mutela emini* (E. v. Martens). See p. 435.

*Mutela falemeensis* (Germain) SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1362 = *Mutelina falemeensis* GERMAIN, 1907, Bull. Hist. Nat. Paris, p. 67; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 569, fig. 96. Faleme River, Senegambia.

*Mutela garambæ* Pilsbry and Bequaert. See p. 431.

*Mutela garambæ prætenuis* Pilsbry and Bequaert. See p. 432.

*Mutela hargeri* E. A. Smith. See p. 434.

*Mutela iris* Pilsbry and Bequaert. See p. 434.

*Mutela joubini* (Germain). See p. 436.

*Mutela langi* Pilsbry and Bequaert. See p. 432.

*Mutela lavigeriana* Bourguignat. See p. 436.

*Mutela lhotelleriana* PRESTON, 1909, Ann. Mag. Nat. Hist., (8) IV, p. 89, Pl. IV, fig. 6. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1364. Gaboon.

*Mutela mabilli* (A. T. de Rochebrune). See p. 433.

*Mutela mabilli* var. *frasi* (Germain) SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1361 = *Mutelina mabillei* var. *frasi* GERMAIN, 1907, Bull. Mus. Hist. Nat. Paris, p. 68; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 570, fig. 97. Uassulu, Niger River.

*Mutela mabilli* var. *gaillardi* (Germain) SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1361 = *Mutelina mabillei* var. *gaillardi* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 477; 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 214, Pl. III, figs. 5–6. Lake Chad.

*Mutela monceti* Bourguignat. See p. 436.

*Mutela nilotica* (Cailliaud). See p. 436.

*Mutela nilotica* var. *moineti* (Bourguignat). See p. 437.

*Mutela opalescens* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 62, Pl. IV, fig. 12. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1365. Shiré River, 3 to 4 kilometers south of Lake Nyasa. This appears to be the same as *M. simpsoni* Ancey.

*Mutela oudnoei* (Kœnig) = *Iridina oudnoei* KŒNIG, 1826, in Denham and Clapperton, 'Narrative of Trav. and Discov. in N. and Centr. Africa, Appendix,' p. 254. "Gammaroo River" (this appears to be Gambaroo, a locality on the Yaou or Yo River). This species has usually been synonymized with *nilotica*, but it seems improbable that such is the case; in our opinion it is more closely related to *M. dubia*.

*Mutela plicata* (E. v. Martens) = *Spatha* (*Mutela*) *plicata* "Parreyss" E. v. MARTENS, 1866, Malakoz. Blätter, XIII, p. 10. *Mycetopus plicatus* SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Mycetopus*, Pl. II, fig. 3. *Mutela* (*Pseudomutela*) *plicata* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1363. Egypt.

*Mutela rostrata* (Rang). See below.

*Mutela simpsoni* ANCEY, 1894, Mém. Soc. Zool. France, VI, p. 233, fig. 8 (on p. 234). SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1356 = *Mutela cuneata* PRESTON, 1910, Ann. Mag. Nat. Hist., (8) VI, p. 62, Pl. v, fig. 13. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1365. Shiré River, 3 kilometers south of Lake Nyasa and Karonga on Lake Nyasa. Allied to *M. alata* (I. Lea), according to Dupuis, 1923, Ann. Soc. Zool. Belgique, LIII, (1922), p. 81.

*Mutela singularis* (Pallary) = *Mutelina singularis* PALLARY, 1924, Mém. Inst. d'Egypte, VII, 1, p. 53, Pl. IV, fig. 17. Mahmudieh Canal, Lower Egypt.

*Mutela soleniformis* Bourguignat. See p. 437.

*Mutela subdiaphana* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza Oukéréwé,' pp. 5 and 17; 1887, Bull. Soc. Malacol. France, IV, p. 268. Nile. Apparently never described.

*Mutela welwitschii* (Morelet) = *Iridina welwitschii* MORELET, 1868, 'Voy. Welwitsch, Moll. Terr. Fluv.,' p. 98. Murie River near Trombete (Golungo Alto), Angola.

### *Mutela dubia* (Gmelin)

Plate XXXVIII, Figures 1, 1*a*, 1*b*, 2

"Le Mutel" ADANSON, 1757, 'Hist. Nat. Sénégal, Hist. des Coquillages,' p. 234, Pl. XVII, fig. 21 (Senegal).

*Mytilus dubius* GMELIN, 1791, in Linnæus, 'Syst. Nat.,' Ed. XIII, I, 6, p. 3363 (based upon Adanson's "Le Mutel," type locality: Senegal).

*Mutela dubia* H. AND A. ADAMS, 1857, 'Gen. Recent. Moll.,' II, p. 506; III, Pl. CXIX, figs. 1 and 1*a*.[1] SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 903; 1914, 'Descript. Cat. of Naiades,' p. 1353.

*Iridina mutel* RANG, 1835, Nouv. Ann. Mus. Paris, IV, p. 314.

*Mutela adansoni* BOURGUIGNAT.

Figures are here given to show the type species of *Mutela*. Like many West African species, it is more closely related to Nilotic than to Congo forms. Most of the specimens show very weak teeth on the posterior half of the hinge, as in Pl. XXXVIII, fig. 1*b*, but in some these are not perceptible. They were noticed by that remarkably acute observer, Adanson. While moderately strong, this shell is rather thin. It is by no means more solid than *Iridina exotica* Lamarck, as stated by Simpson, but, on the contrary, very much thinner. The bluish to pinkish nacre is beautifully iridescent throughout.

Length, 100 mm.; height, 40 mm.; diameter, 24 mm.
" 110

### **Mutela rostrata** (Rang)

Plate XXXIX, Figures 1 and 2

*Iridina rostrata* RANG, 1835, Nouv. Ann. Mus. Paris, IV, p. 316 (type locality: "Marigot de l'escale des Darmancoutz," Senegal). POTIEZ AND MICHAUD, 1844, 'Galerie Moll. Douai,' II, p. 147, Pl. LVI, fig. 1.

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[1]This figure is cited with doubt, as it has stronger and more numerous teeth on the hinge than any *M. dubia* we have seen.

*Iridina cœlestis* I. LEA, 1838, Trans. American Phil. Soc., N.S., VI, p. 82, Pl. XXII, fig. 70 (Africa) (1836, 'Synopsis of Naiades,' p. 57, without description).

*Mutela rostrata* Rang. JICKELI, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 269. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 905; 1914, 'Descript. Cat. of Naiades,' p. 1359.

*Mutelina rostrata* Rang. GERMAIN, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 567; 1913, Bull. Mus. Hist. Nat. Paris, p. 294. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 112.

*Mutelina legumen* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 6, No. 2.

*Mutelina prasina* A. T. DE ROCHEBRUNE, 1886, *op. cit.*, III, p. 7.

*Mutelina tholloni* A. T. DE ROCHEBRUNE, 1886, *op. cit.*, III, p. 6, No. 3.

*Mutelina thottoni* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 906.

Zongo on the Lower Ubangi (Poutrin Coll.); Kasai (Wissmann Coll.); Gancini or Nganchu on the right bank of the Congo (type locality of *M. legumen, M. prasina,* and *M. tholloni*; Thollon Coll.).

Stanleyville, numerous specimens (Lang and J. Bequaert Coll.). Channel leading from Lake Kabamba to the Lualaba River at Mulongo (J. Bequaert Coll.).

This widely spread species is abundant in Stanleyville. The color is usually in great part black to brownish-olive shading into blackish green or dark green toward the beaks, and generally with many narrow dusky rays, rather weak or indistinct; a few examples are brownish-olive with indistinct zones of citrine-drab. The interior in young shells is alice blue with red reflections, but in the old ones it becomes mainly livid pink. The contour varies as shown in the figures. The post-dorsal wing is always very narrow and roughened by fine, crowded, cuticular laminæ. The beaks, always eroded, are very low and a trifle behind the anterior fourth of the length. There is a very small anterior-dorsal wing, rounded at the end. The posterior end is bluntly pointed, above it obliquely truncate, and the basal margin rises enough to bring the point about midway of the height.

| | | |
|---|---|---|
| Length, 99.0 mm.; | height, 33.0 mm.; | diameter, 19.5 mm. |
| " 104.0 | " 40.0 | " 20.5 |
| " 104.0 | " 33.5 | " 22.0 |

### **Mutela garambæ**, new species

Plate XL, Figures 1, 1*a*, 2

Middle Garamba River, in sand and mud of the river bed, February, 1913 (dry season; Lang and Chapin Coll.).

The shell is rather solid, trapezoidal, the height contained 2¾ times in the length, with subparallel dorsal and ventral margins. Upper margin straight; basal margin nearly straight; the anterior end is broadly rounded, posterior end obliquely truncate, produced in a rounded point near the basal margin. The posterior ridge is rounded, gently curved, the area above it narrow and concave. The surface is concentrically plicatulate, with a bright gloss, dull and minutely laminate posteriorly. The eroded beaks are at the anterior third of the length. Color is bister with isabella colored zones, the ends blackish (or blackish green). Faint traces of rays are visible. The interior is livid pink, bluish and somewhat iridescent toward the borders, highly iridescent with red and green reflections posteriorly. Muscle scars, especially that of the posterior adductor, deep. Hinge toothless.

Length, 130 mm.; height at beaks, 47 mm.; at posterior third, 46 mm.; diameter, 24.5 mm.

Length, 107 mm.; height at beaks, 39 mm.; at posterior third, 38 mm.; diameter, 23.0 mm.

This species is more solid than *M. rostrata*, wider, with the beaks farther from the anterior end. The adductor muscle scars are smaller. In outline it resembles the Tanganyikan *M. soleniformis* as figured by Bourguignat.

In two paratypes the basal margin curves up at the ends, especially posteriorly, more than in the type.

### **Mutela garambæ prætenuis**, new subspecies

Plate XL, Figure 3

Aba River, near Aba (Lang and Chapin Coll.).

This form differs from *M. garambæ* by its very thin shell, the outside dark green with lighter water-green zones. The interior is very iridescent, pale grayish blue-violet with pink and green reflections. The muscle scars are not in the least impressed. The beaks are at the anterior third of the length.

Length, 112 mm.; height at beaks, 37.5 mm.; at posterior third, 36.5 mm.; diameter, 21 mm.

Length, 111 mm.; height at beaks, 37.0 mm.; at posterior third, 36.0 mm.; diameter, 21 mm.

### **Mutela langi**, new species

Plate XXXIX, Figures 3, *3a*, *3b*

Zambi, in the bed of an arm of the Congo (H. Lang and J. Bequaert Coll.). Numerous specimens.

The shell is quite thin, trapezoidal, the length about three times the height, with subparallel dorsal and ventral margins, the hinge margin straight; ventral margin straight in the middle, slowly rising a little posteriorly, more rapidly curving up anteriorly. The anterior margin is rounded, the posterior margin produced and bluntly pointed near the base, obliquely truncate above the point. The posterior ridge is rounded, the surface above it concave, compressed into a low wing toward the posterior-dorsal angle. The surface is very glossy, smooth except for slight concentric growth-wrinkles and, on the posterior slope, fine cuticular striæ which dull its luster. The beaks are low, projecting a little above the hinge line, with a quite small eroded area, and are situated at the anterior fourth of the length. The color is grape-green with a golden gleam in some lights to tawny olive; the posterior ridge is usually darker green, and the rest of the shell is indistinctly marked with narrow, faint, greenish rays. The interior is highly iridescent, pale bluish lavender, blue toward the borders, and with an irregular light vinaceous drab stain in the beak cavity and its neighborhood, and often some darker bronzed markings. The anterior adductor scar is lightly impressed, the other muscle scars not impressed. The visceral muscle scars are well in the beak cavities, oblong, oblique and single in each valve. There is an extremely narrow, rounded ridge running the length of the hinge, which under the lens is seen to be slightly swollen a little behind the beaks, forming an extremely weak, vestigial pseudocardinal tooth in each valve.

Length, 96.0 mm.; height, 31 mm.; diameter, 20 mm.

Length, 90.5 mm.; height at beaks, 28 mm.; at posterior third, 30 mm.; diameter, 18 mm.

While this species is related to *M. rostrata*, it differs by the shape of the posterior end and wing, and the less wrinkled surface. *Mutela ægyptiaca* (Pallary), from the Canal of Mahmudieh, Lower Egypt, appears to be very closely related to *M. langi*. According to Pallary's measurements of five specimens, it is higher relative to the length, the height 35.5 to 38 per cent of the length in *ægyptiaca*, including its two varieties, 30.9 to 32.3 per cent in *langi*. We would consider this without significance were it not that the habitat of *langi* is remote from that of *ægyptiaca*. Possibly both represent one widely spread species, which generally has not been differentiated from *M. rostrata*.

### **Mutela mabilli** (A. T. de Rochebrune)

Plate XLI, Figure 1

*Mutelina mabilli* A. T. de Rochebrune, 1886, Bull. Soc. Malacol. France, III, p. 7.

*Mutelina mabillei* A. T. de Rochebrune. Germain, 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 569.

*Mutela mabilli* A. T. de Rochebrune. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 906; 1914, 'Descript. Cat. of Naiades,' p. 1360.

*Mutelina paludicola* A. T. de Rochebrune, 1886, Bull. Soc. Malacol. France, III, p. 8.

Gancini or Nganchu, on the right bank of the Congo River (type locality of both *mabilli* and *paludicola*; Thollon Coll.).

Medje (Lang and Chapin Coll.).

A single example from Medje agrees well with the account of this unfigured species except that it is not solid, being about as thin as *M. rostrata*. The color is blackish, shading into very dark green upward, and having some brownish concentric streaks. The beaks are at the anterior fifth of the length. The concentric wrinkles are much more pronounced than in *M. rostrata*.

Length, 90 mm.; height at beaks, 23 mm.; at posterior third, 33 mm.; diameter, 16 mm.

**Mutela iris,** new species

Plate XLI, Figures 2 and 2*a*

Channel leading from Lake Kabamba to the Lualaba River at Mulongo (J. Bequaert Coll.).

The shell is rather thin, long, the upper and lower margins subparallel, but very slightly diverging posteriorly; posterior margin obliquely truncate, bluntly pointed near the base; anterior margin rounded. The beaks are low, wide, scarcely project above the hinge line, and are far forward, the anterior end being contained 5¾ times in the total length. There is a bluntly angular posterior ridge, which, together with the flattened area just below it, is irregularly broken into low, concentric folds, and toward the beaks some rather small, irregular, interrupted corrugation; a considerable area at the beaks being eroded. The rest of the valve has some very low, coarse wrinkles along growth lines. The periostracum is smooth and somewhat glossy in the median part, densely and finely laminate posteriorly, above the posterior ridge, and to a small extent at the anterior end. The color black toward the margins, shading upward into warm sepia, paler toward the beaks. Inside there is a very low, long (about $1 \times 5$ mm.), rounded anterior cardinal tooth, and under the ligament a long, slender ridge in the place of laterals. In the left valve there is no cardinal and the lateral ridge is just perceptibly grooved lengthwise. The anterior muscle impressions are hardly sunken, but there is a thickened anterior border. The anterior pedal retractor scar appears to be distinct from, but near, the adductor scar. Posteriorly there is a single long scar. The internal color is lavender-gray in the median and lower part, a peculiar bronzed reddish above and posteriorly, with conspicuous hessian brown and violet stains toward the beak cavity.

Length, 98 mm.; height at beaks, 27 mm.; posteriorly, 34 mm.; diameter, 18 mm.

This species is similar to *Mutela chevalieri* Germain in having the beaks far anterior. It differs from that, and from *M. plicata* (E. v. Martens) by the more truncate posterior end and stronger posterior ridge; and apparently also by the possession of vestigial hinge teeth, in which it has some resemblance to *Pseudospatha.* This genus, however, is so unlike our species in other characters that we doubt whether there is any direct relationship.

**Mutela hargeri** E. A. Smith

Plate XLI, Figures 3 and 3*a*

*Mutela hargeri* E. A. Smith, 1908, Proc. Malacol. Soc. London, VIII, p. 14, fig. Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1357.

Lake Moero: (type locality; R. L. Harger Coll.).

Lake Moero off Lukonzolwa (Stappers Coll.). The species has also been found in the Luapula River, at Kachiobwe and Kasenga, by Stappers.

The high wing and concave dorsal outline characterize this remarkable mussel. It varies in form of the posterior end, as will be seen by comparing our figure with Smith's.

Length, 91 mm.; height at beaks, 26 mm.; greatest height, 55 mm.; diameter, 13 mm.

**Mutela emini** (E. v. Martens)

Plate XLII, Figures 2 and 2*a*

*Mutela nilotica* var. *emini* E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 253. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 904; 1914, 'Descript. Cat. of Naiades,' p. 1355.

Lake Albert: near Kassenje (Stuhlmann Coll.). E. v. Martens mentions that the valves of this mussel are used as spoons in Undussuma and among the Babira; he therefore supposes that the species may live in the Ituri River; but the isolated valves which the junior author saw on the Lendu Plateau were all said to come from Lake Albert.

Lake Albert, western shore.

The inflated shape, the brilliance of the deep to light corinthian red nacre, with red, green and violet reflections at the posterior end, and the more strongly inequilateral shape, distinguish this form from *M. nilotica* (Cailliaud).

Length, 115 mm.; height at the beaks, 41 mm.; at posterior third, 47 mm.; diameter, 40 mm.

Under the microscope the nacre of this mussel is seen to be far smoother than that of *M. nilotica*. It is doubtless this which gives the glittering luster which characterizes *emini*.

## Other Species of *Mutela*, proper, Recorded from the Belgian Congo

### *Mutela alluaudi* Germain

*Mutela alluaudi* GERMAIN, 1909, Bull. Mus. Hist. Nat. Paris, p. 544, Pl. VIII, fig. 45. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1366.
Lake Albert: (type locality; C. Alluaud Coll.).

### *Mutela angustata* (Sowerby)

*Iridina angustata* SOWERBY, 1868, 'Conchol. Iconica,' XVI, *Iridina*, Pl. II, fig. 5.
*Mutela angustata* Sowerby. GERMAIN, 1906, Bull. Mus. Hist. Nat. Paris, p. 55· 1913, *op. cit.*, p. 293; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 564

Originally described from Africa with doubt, the exact habitat unknown. Ger main has recorded it from the Lower Ubangi River (Poutrin Coll.), a highly doubtful record. This species is generally regarded as a synonym of *M. dubia* (Gmelin), but, to judge from the figure, it is distinct.

### *Mutela chevalieri* Germain

*Mutela chevalieri* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 470; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 566, Lith. Pl., fig. 1.
Upper Ubangi River (type locality; A. Chevalier Coll.).

## *Mutela joubini* (Germain)

*Mutelina joubini* GERMAIN, 1904, Bull. Mus. Hist. Nat. Paris, p. 470; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 572, Lith. Pl., fig. 2.

*Mutela (Pseudomutela) joubini* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1363.

Upper Ubangi River (type locality; A. Chevalier Coll.).

## *Mutela lavigeriana* Bourguignat

*Mutela lavigeriana* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 26.

Lake Tanganyika: (no more definite locality given).

## *Mutela monceti* Bourguignat

*Mutela monceti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika, p. 29.

Lake Tanganyika: (no more definite locality given).

## *Mutela nilotica* (Cailliaud)

Plate XLII, Figure 1

*Iridina nilotica* CAILLIAUD, 1823, 'Voyage à Méroé,' Atlas, II, Pl. LX, fig. 11; 1827, *op. cit.*, IV, p. 262 (type locality: "Canal de Joseph" in Lower Egypt). FÉRUSSAC, 1823, Bull. Général Annonces et Nouv. Scientif., IV, p. 45 (without description). SOWERBY, March, 1824, Zool. Journ., I, p. 53 , Pl. II.

"Iridine du Nil" DESHAYES, 1827, Mém. Soc. Hist. Nat. Paris, III, pp. 1–16, Pl. I (anatomy).

*Mutela nilotica* "Férussac and Sowerby" H. AND A. ADAMS, 1857, 'Gen. Recent Moll.,' II, p. 506. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 904; 1914, 'Descript. Cat. of Naiades,' p. 1354. GERMAIN, 1909, Arch. Zool. Expér. Gén., XLI, p. 39, figs. 27–28; 1916, Bull. Mus. Hist. Nat. Paris, p. 204. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 213.

J. Thiele records this species from Lake Albert at Kassenje and from Lake Edward (Schubotz Coll.), but in all probability he had *M. emini* (v. Martens) before him.

This species is not known with certainty from the Belgian Congo, and is here figured to discriminate it from the Lake Albert *M. emini*, which was described as a variety of *nilotica*.

The specimen figured is from the Nile, and agrees very closely with Cailliaud's figures, by which the species was originally defined.

The shell is large, and one of the thickest, most solid *Mutelæ*. The hinge is without teeth, the hinge plate rather heavy and rounded posterior to the beaks. The lower-anterior margin rises rather rapidly in some specimens, giving that end an oblique outline, a feature prominent in

Cailliaud's figures. The nacre is pale pink, with vinaceous-brown stains, or brownish vinaceous throughout. In typical *nilotica* the height is about equal at beaks and at posterior third.

Length, 145 mm.; height, 59 mm.; diameter, 42 mm.

### *Mutela nilotica* var. *moineti* (Bourguignat)

*Mutela moineti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 27. GERMAIN, 1911, 'Doc. Scientif. Miss. Tilho,' II, p. 211, footnote, Pl. III, fig. 1.

*Mutela jouberti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 28; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXIII, fig. 1.

*Mutela visseri* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 31.

*Mutela vysseri* BOURGUIGNAT, 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXIII, figs. 2–3.

Lake Tanganyika: Pambete (type locality of *M. moineti* according to Germain). The subordination of this to *nilotica* appears doubtful.

### *Mutela soleniformis* Bourguignat

*Mutela soleniformis* BOURGUIGNAT, 'Esp. Nouv. Ouk. Tanganika,' p. 25; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXII, figs. 2 and 3. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 254. PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 109.

*Mutela bridouxi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 25; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXII, fig. 1.

Lake Tanganyika: shores near Kibanga and in the Burton Gulf.

### Subgenus CHELIDONOPSIS Ancey

*Chelidonura* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 3. Type by original designation: *Spatha hirundo* E. v. Martens. Not *Chelidonura* A. Adams, 1850.

*Chelidoneura* GERMAIN, 1908, Bull. Mus. Hist. Nat. Paris, p. 160, footnote (misspelling of *Chelidonura*, as a synonym of *Chelidonopsis*).

*Chelidonopsis* ANCEY, 1887, Conchol. Exchange, II, p. 22. Substitute for *Chelidonura* A. T. de Rochebrune; same type.

This group is restricted to the Congo basin. Two forms have been described:

*Mutela (Chelidonopsis) carrei* (Putzeys). See p. 438.

*Mutela (Chelidonopsis) hirundo* (E. v. Martens). See p. 438.

### Key to Species of *Chelidonopsis*

1. Carinæ of the posterior ridges conspicuously expanded and diverging at their posterior ends. Height slightly exceeding one-fourth of the length in adult shells, slightly less than one-fourth in young specimens.
*M. hirundo* (E. v. Martens).

Posterior ridge carinate, but the carinæ do not expand and diverge wing-like at their terminations . . . . . . . . . . . . . . . . . . . . . . . . . . . . *M. carrei* (Putzeys).

**Mutela (Chelidonopsis) hirundo** (E. v. Martens)

Plate XLIII, Figures 1, 1*a*, 2

*Spatha* (*Mutela*) *hirundo* E. v. MARTENS, 1881, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 122; 1882, Jahrb. Deutsch. Malakoz. Ges., IX, p. 248; 1883, 'Conchol. Mitth.,' II, 3–4, p. 139, Pl. XXVII, figs. 1–3.

*Chelidonura hirundo* E. v. Martens. A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, Pl. I, figs. 5–6.

*Chelidonopsis hirundo* E. v. MARTENS. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 906. GERMAIN, 1913, Bull. Mus. Hist. Nat. Paris, p. 294. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 69. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1368.

*Chelidonura arietina* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 4, Pl. I, figs. 1–4 (type locality: in the Congo River at Ngancini, French Congo).

*Chelidonopsis arietina* A. T. de Rochebrune. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 906. GERMAIN, 1908, Bull. Mus. Hist. Nat. Paris, pp. 160 and 162, fig. 32; 1909, Arch. Zool. Expér. Gén., XLI, pp. 4–34, figs. 2, 3, 5, 8–13, 15, 17–19, and 22–24. C. R. BŒTTGER, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 112. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1368.

Kwango River near Matjambo, in 6° S. and 17° E. (type locality; v. Mechow Coll.). Brazzaville in the Stanley Pool (Roubaud Coll.). Lualaba River at Kiabwa[1] (about midway between Kikondja and Ankoro; J. Bequaert Coll.). Zongo on the lower Ubangi (Poutrin Coll.).

Stanleyvile (H. Lang Coll.).

*Chelidonura arietina* was said to differ from *hirundo* by the slightly greater height, the fuller outline in the posterior-basal region, and the more diverging posterior carinæ. However, in immature specimens before us of the length of the type of *hirundo*, the divergence of the keels is not greater than in that species; the height to length ratio usually remains a little greater than in *hirundo*, but the narrowest individuals are about the same. We are in agreement with Germain that *arietina* was based upon old specimens of *hirundo*.

The color is naples yellow to olive lake, shading into deep grayish olive or green toward the beaks, having faint, narrow green or dusky rays, and dark green at the ends. Some old shells are rich prout's brown, shading upward into greenish olive, the carina and its neighborhood blackish green. The light blue to pinkish interior is splendidly iridescent.

| | | | |
|---|---|---|---|
| Length, 121.0 mm.; | height, 40.0 mm.; | diameter in the middle, | 26.0 mm. |
| " 121.0 | " 35.0 | " " " | 25.0 |
| " 101.0 | " 25.0 | " " " | 14.5 |

## Other Species of *Chelidonopsis* Recorded from the Belgian Congo

### *Mutela* (*Chelidonopsis*) *carrei* (Putzeys)

*Burtonia carrei* PUTZEYS, 1898, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. xxviii, fig. 16.

[1]Misspelled Kibawa by Dautzenberg and Germain.

*Mutelina carrei* Putzeys. GERMAIN, 1911, Bull. Mus. Hist. Nat. Paris, p. 226. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 69. G. C. SPENCE, 1923, Journ. of Conchology, XVII, p. 23.

*Pseudospatha leopoldvillensis* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 577 (error for *carrei*).

*Pseudospatha carrei* Putzeys. C. R. BŒTTGER, 1913, Ann. Soc. Malacol. Belgique, XLVII, (1912), p. 111. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 204.

*Chelidonopsis roubaudi* GERMAIN, 1908, Bull. Mus. Hist. Nat. Paris, p. 161, figs. 31 (on p. 161) and 33 (on p. 162); 1909, Arch. Zool. Expér. Gén., XLI, pp. 4–34, figs. 1, 4, and 6 (anatomy). SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1369.

Stanley Pool near Leopoldville (type locality; collector not recorded) and near Brazzaville (type locality of *roubaudi*; Roubaud Coll.). Lower Congo (P. Hesse Coll.). Lualaba River at Kibombo (J. Bequaert Coll.).

Also found in the French Congo at Ngandu on the right bank of the Congo River (F. M. Dyke Coll.), and at Makoua (Fourneau Coll.).

## IRIDINA Lamarck

*Iridina* LAMARCK, 1819, 'Hist. Nat. Anim. sans Vertèbres,' VI, 1, p. 88. Monotypic for *Iridina exotica* Lamarck.

*Platiris* I. LEA, 1838, Trans. American Phil. Soc., VI, pp. 118 and 144. On p. 118, where the genus is first proposed, it contains only *Iridina exotica* Lamarck and *Spatha nilotica* (Sowerby). Type by present designation: *Iridina exotica* Lamarck.

*Platyiris* AGASSIZ, 1846, 'Nomenclator Zool., Index Univ.,' p. 295. Emendation of *Platiris* Lea.

*Eufira* GISTEL, 1848, 'Naturgesch. Thierr. f. Höhere Schulen,' p. 173. Substitute for *Iridina* Lamarck.

Mutelidæ having a solid, oblong or oval shell with a strongly developed hinge-plate set with many short teeth (taxodont hinge). Muscle impressions as in *Aspatharia*.

Mantle margins united below the branchial orifice (for about ¼ the mantle length in *I. spekii*). Outer gill nearly as large as the inner.

*Iridina* resembles *Mutela* by the strong development of mantle concrescence; there are also some partial transitions in the hinge structure. Von Martens and Simpson have, indeed, united these two groups. While this may be a logical course in view of what we now know of these animals, we prefer for the present to segregate the strongly taxodont forms from the weakly taxodont or anodont genus *Mutela*, as Germain and some others have done. The soft anatomy has been investigated only in *I. spekii*.

The genus is restricted to Africa.

Three subgenera appear distinguishable as follows:

1. Teeth small and very numerous throughout the heavy hinge-plate which bears a low prominence under the beak of the left valve; shell elongate.
Subgenus *Iridina* Lamarck.

Teeth rather coarse, irregular, the hinge-plate narrowed under the beaks......2.

2. Shell oblong, the teeth weaker or obsolete anteriorly.
Subgenus *Cameronia* Bourguignat.
Shell oval, the teeth and hinge-plate strongly developed in front of the beaks.
Subgenus *Pleiodon* Conrad.

## Subgenus Iridina, proper

### The following species apparently belong to this subgenus:

*Iridina exotica* Lamarck, 1819, 'Hist. Nat. Anim. sans Vertèbres,' VI, 1, p. 89 (exact locality unknown) = Bruguière, 1797, 'Encyclop. Méthod., Vers,' I, Pl. cciv, figs. 1–1*b* (without name). *Iridina elongata* Sowerby, 1821, 'Genera of Shells,' pt. VII, *Iridina*, Pl., fig. 1 (apparently based upon the same specimen as Lamarck's *exotica* and perhaps only a clerical error). *Iridina striata* Swainson, 1823, Philos. Mag. and Journ., LXI, p. 112. *Mutela exotica* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1352. Africa.

*Iridina hardeleti* (Germain) = *Pliodon* (*Cameronia*) *hardeleti* Germain, 1906, Bull. Mus. Hist. Nat. Paris, p. 57, fig. 2. *Pleiodon hardeleti* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1382. Lake Chad.

*Iridina hardeleti* var. *molli* (Germain) = *Pliodon hardeleti* var. *molli* Germain, 1906, Bull. Mus. Hist. Nat. Paris, p. 58, fig. 3. *Pleiodon hardeleti* var. *molli* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1383. Lake Chad.

*Iridina tchadiensis* (Germain) = *Pliodon* (*Cameronia*) *tchadiensis* Germain, 1906, Bull. Mus. Hist. Nat. Paris, p. 60, fig. 4 (on p. 61). *Pleiodon tchadiensis* Simpson, 1914, 'Descript. Cat. of Naiades,' p. 1382. Lake Chad.

## Subgenus Cameronia Bourguignat

*Cameronia* Bourguignat, 1879, 'Descript. Moll. Egypte,' p. 42. Monotypic for *Iridina spekii* Woodward.

### All the known species, listed below, are from Lake Tanganyika.

### Iridina (Cameronia) spekii Woodward

Plate XLIV, Figures 1 and 1*a*

*Iridina* (*Pleiodon*) *spekii* Woodward, 1859, Proc. Zool. Soc. London, p. 348, Pl. xlvii, fig. 2.

*Pleiodon spekii* Woodward. Sowerby, 1866, 'Conchol. Iconica,' XVI, *Pleiodon*, Pl. i, fig. 2. E. v. Martens, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 71.

*Cameronia spekii* Woodward. Bourguignat, 1879, 'Descript. Moll. Egypte,' p. 43.

*Pleiodon spekei* Woodward. E. A. Smith, 1880, Proc. Zool. Soc. London, p. 350. G. B. Sowerby, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 22. E. A. Smith, 1906, Proc. Zool. Soc. London, I, p. 184.

*Pleiodon* (*Cameronia*) *spekii* Woodward. Crosse, 1881, Journ. de Conchyl., XXIX, p. 130. Simpson, 1900, Proc. U. S. Nat. Mus., XXII, p. 909; 1914, 'Descript. Cat. of Naiades,' p. 1378.

*Pliodon spekei* Woodward. Pelseneer, 1886, Bull. Mus. Hist. Nat. Belgique, IV, pp. 109 and 116–127 (anatomy), figs. 2 (on p. 110) and 3 (on p. 121).

*Cameronia admirabilis* Bourguignat, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 69; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xxxiv, fig. 1.

*Cameronia bridouxi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 71.

*Pliodon (Cameronia) bridouxi* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 691, figs. 43–44.

*Cameronia coulboisi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 77; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXXI, figs. 1–2.

*Cameronia gigantea* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 68; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXXV, fig. 1.

*Cameronia gosseti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 82; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXXII, fig. 3.

*Cameronia paradoxa* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 91; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXXII, figs. 1–2.

*Mutela (Iridina) spekei* Woodward. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 256.

Lake Tanganyika: originally described from that lake without more definite locality (Speke Coll.); Sumbua on the eastern shore (W. A. Cunnington Coll.); Karema.

Lake Tanganyika: without special locality (Stappers Coll.); Tembwe (Hubert Coll.).

The specimen figured lived with somewhat more than half of the shell buried, this part having a highly polished chestnut brown periostracum, fading upward to russet, and toward the margin to black. The exposed part of the shell is duller and incrusted. The nacre is shell pink, iridescent and bronzed violaceous posteriorly. The valves gape anteriorly.

Length, 135 mm.; height at beaks, 54 mm.; at posterior third, 56 mm.; diameter, 46 mm.

## Other Species of *Cameronia* Recorded from the Belgian Congo

### *Iridina (Cameronia) bourguignati* (Bourguignat)

*Cameronia bourguignati* "Ancey" BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 26; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXXIII, figs. 1–2.

*Pleiodon (Cameronia) bourguignati* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus. XXII, p. 909; 1914, 'Descript. Cat. of Naiades,' p. 1380.

Lake Tanganyika: Burton Gulf (type locality).

### *Iridina (Cameronia) giraudi* (Bourguignat)

*Cameronia giraudi* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 107.

*Pliodon (Cameronia) giraudi* Bourguignat. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 260; 1911, *op. cit.*, p. 441; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 692, figs. 47 and 48 (on p. 693).

*Pleiodon (Cameronia) giraudi* Bourguignat. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1380.

*Cameronia charbonnieri* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 83.

*Pliodon (Cameronia) charbonnieri* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 692, figs. 45 and 46.

*Cameronia lavigeriana* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 85.

*Cameronia lavigerina* "Bourguignat" SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 910.

*Pliodon (Cameronia) lavigeriei* GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 694.

*Pliodon (Cameronia) giraudi* mut. *elongata* GERMAIN, 1908, *op. cit.*, p. 694.

Lake Tanganyika: Mpala (type locality).

### *Iridina (Cameronia) landeaui* (Bourguignat)

*Cameronia landeaui* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 74; 1888, 'Iconogr. Malacol. Tanganika,' Pl. xxxi, fig. 3.

*Pleiodon (Cameronia) landeaui* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 909; 1914, 'Descript. Cat. of Naiades,' p. 1379.

Lake Tanganyika: originally described from the lake without more definite locality.

### *Iridina (Cameronia) vynckei* (Bourguignat)

*Cameronia vynckei* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 81.

*Pliodon (Cameronia) vynckei* Bourguignat. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 694, figs. 49–51.

*Pleiodon (Cameronia) vynckei* Bourguignat. SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1382.

Lake Tanganyika: originally described from the lake without more definite locality.

The following forms described by Bourguignat probably are mere synonyms of some of the foregoing species. They are all from Lake Tanganyika, mostly without more definite locality.

*Cameronia anceyi* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 30.

*Cameronia complanata* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 76.

*Cameronia dromauxi* BOURGUIGNAT, 1886, *op . cit.*, p. 84.

*Cameronia guillemeti* BOURGUIGNAT, 1886, *op. cit.*, p. 72.

*Cameronia jouberti* BOURGUIGNAT, 1886, *op. cit.*, p. 88.

*Cameronia locardiana* BOURGUIGNAT, 1886, *op. cit.*, p. 78.

*Cameronia mabilliana* BOURGUIGNAT, 1886, *op. cit.*, p. 86.

*Cameronia marioniana* BOURGUIGNAT, 1885, 'Esp. Nouv. Ouk. Tanganika,' p. 28.

*Cameronia moineti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 89.

*Cameronia obtusa* BOURGUIGNAT, 1886, *op. cit.*, p. 75.

*Cameronia pulchella* BOURGUIGNAT, 1886, *op. cit.*, p. 73.

*Cameronia randabeli* BOURGUIGNAT, 1886, *op. cit.*, p. 90.

*Cameronia revoiliana* BOURGUIGNAT, 1885, 'Notice Prodrom. Moll. Giraud Tanganika,' p. 107; 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 79. Type locality: Ujiji.

### Subgenus PLEIODON Conrad

*Pleiodon* CONRAD, 1834, Journ. Ac. Nat. Sci. Philadelphia, VII, p. 178. Monotypic for *Pleiodon macmurtrei* Conrad = *Iridina ovata* Swainson.

*Pliodon* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 44. Emendation of *Pleiodon* Conrad.

The following species have been described:

*Iridina (Pleiodon) ovata* Swainson = *Iridina ovata* SWAINSON, 1823, Philos. Mag. and Journ., LXI, p. 113 (no type locality given). REEVE, 1841, 'Conchol. System.,' I, p. 122, Pl. XCIII. *Pleiodon ovatus* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1376 = *Pleiodon macmurtrei* CONRAD, 1834, Journ. Ac. Nat. Sci. Philadelphia, VII, p. 180, Pl. XIII (Liberia). *Platiris (Iridina) leaii* "Sowerby" I. LEA, 1852, 'Synopsis of Naiades,' p. 54. *Iridina splendida* CHENU, 1858, 'Illustrations Conchyl.,' *Iridina*, Pl. I, figs. 2 and 2*a-e*.

*Iridina (Pleiodon) diolibana* (Bourguignat) = *Pliodon diolibanus* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 47. Exact locality unknown (either from the Niger, Senegambia, or Gambia).

*Iridina (Pleiodon) elongata* (Bourguignat) = *Pliodon elongatus* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 47. Exact locality unknown (probably from the Upper Senegal).

*Iridina (Pleiodon) letourneuxiana* (Bourguignat) = *Pliodon letourneuxianus* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 48. Exact locality unknown (probably from the Upper Senegal).

*Iridina (Pleiodon) pachyodon* (Bourguignat) = *Pliodon pachyodon* BOURGUIGNAT, 1879, 'Descript. Moll. Egypte,' p. 46. *Pliodon ovatus* var. *pachyodon* GERMAIN, 1909, Arch. Zool. Expér. Gén., XLI, pp. 44 and 59, fig. 41. *Pleiodon ovatus* var. *pachyodon* SIMPSON, 1914, 'Descript. Cat. of Naiades,' p. 1377. Exact locality unknown (either from the Niger, Senegambia, or Gambia).

## Hyriinæ

### PSEUDOSPATHA Simpson

*Burtonia* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza Oukéréwé,' p. 20. Monotype: *Spatha tanganyicensis* E. A. Smith. Preoccupied by *Burtonia* Bonaparte, 1850.

*Pseudospatha* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 577. Substitute for *Burtonia* Bourguignat. Type by original designation: *Spatha tanganyicensis* E. A. Smith.

Thin, strongly compressed, polished, yellow mussels, with the low beaks near the anterior fourth, and winged in front and behind; beaks either nearly smooth or undulate and pustulate, often retaining the circular glochidial shell. The hinge-plate has an angular or narrowly raised edge, diverging forward and back from the beaks, and similar in both valves. The muscle scars are scarcely impressed, the foot protractor apparently not distinct from the anterior adductor scar.

The genus is only known from Lake Tanganyika. *Burtonia carrei* Putzeys, of the Congo River, is a *Mutela* of the subgenus *Chelidonopsis*.

The number of valid species remains undetermined; *P. tanganyicensis* probably includes most of those described. The different contour of *P. livingstoniana*, *P. subtriangularis* and *P. bourguignati* probably denotes specific or subspecific rank for these forms.

Two small species collected by Stappers, *P. ortmanni* and *P. stappersi*, show no beak sculpture following the circular glochidium. This character has not hitherto been used for the discrimination of species, but it appears to be more important than variations of outline depended upon by Bourguignat for this purpose.

Simpson considered this group to be near *Lampsilis*, especially the section then comprising *U. tenuissimus* Lea. This American species, however, is in a late stage of tooth degeneration, and such resemblance as exists is doubtless due to convergence. Germain's view that *Pseudospatha* belongs to the *Mutelidæ* is supported by the examination of a dried specimen of *P. ortmanni*, which shows a strong connection of the mantle between anal and branchial orifices. Unfortunately the gills had been almost entirely macerated away before drying up. Whether the genus belongs to the *Mutelinæ* or to the *Hyriinæ* could not be ascertained.

### **Pseudospatha tanganyicensis** (E. A. Smith)

Plate XLV, Figures 1–3

*Spatha tanganyicensis* E. A. SMITH, 1880, Proc. Zool. Soc. London, p. 350, Pl. XXXI, fig. 8 (only). E. v. MARTENS, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 71. PELSENEER, 1886, Bull. Mus. Hist. Nat. Belgique, IV, p. 111. G. B. SOWERBY, 1894, 'List of Shells of Lake Tanganyika,' p. 2, Pl., fig. 19.

*Burtonia tanganikana* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza Oukéréwé,' p. 20. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 260.

*Burtonia tanganyicensis* E. A. Smith. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 257. E. A. SMITH, 1906, Proc. Zool. Soc. London, I, p. 184.

*Pseudospatha tanganyicensis* E. A. Smith. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 577; 1914, 'Descript. Cat. of Naiades,' p. 203. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 685; 1911, Bull. Mus. Hist. Nat. Paris, p. 441.

*Burtonia foai* J. MABILLE, 1901, Bull. Soc. Philomath. Paris, (9) III, 2, p. 58. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 686, figs. 39 and 40.

*Burtonia jouberti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 40. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 685, figs. 37 and 38 (on p. 686).

*Burtonia lavigeriana* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 36; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXIV, figs. 1–4.

*Burtonia magnifica* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 41; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXVI, figs. 1 and 2.

*Burtonia moineti* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 33; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXV, fig. 1.

Lake Tanganyika: Ujiji (type locality; E. C. Hore Coll.); Kombe on the eastern shore, and at the southern end of the lake (W. A. Cunnington Coll.); Mpala; Onondo at the outlet of the Lukuga (Storms Coll.).

The beaks of the specimen here figured show a few very low, coarse, unequal concentric waves upon which there are irregularly placed tubercles. The circular glochidial shell is sometimes retained in the adult stage. This specimen measures: length, 80.0 mm.; height, 34.0 mm.; diameter, 10.5 mm. It is without definite locality.

A single valve from Tembwe (Hubert Coll.) measures: length, 112 mm.; height, 47 mm.

The type of this species measured: length, 90 mm.; height, 43 mm.; diameter, 15 mm.

### **Pseudospatha tanganyicensis livingstoniana** (Bourguignat)

Plate XLV, Figure 4

*Spatha tanganyicensis* E. A. SMITH, 1880, Proc. Zool. Soc. London, Pl. XXXI, fig. 8*a*.

*Burtonia livingstoniana* BOURGUIGNAT, 1883, 'Moll. Fluv. Nyanza-Oukéréwé,' p. 23.

*Burtonia tanganyicensis* var. *livingstoniana* Bourguignat. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 258.

*Pseudospatha livingstonensis* SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 578; 1914, 'Descript. Cat. of Naiades,' p. 205.

*Pseudospatha livingstoni* GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 687.

*Burtonia bridouxi* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 37. GERMAIN, 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 687, figs. 41 and 42.

*Burtonia contorta* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 39; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXVI, figs. 3–5.

*Burtonia elongata* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 34; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXV, fig. 3.

Lake Tanganyika: originally based upon Smith's figure 8*a*, Plate XXXI of 1880 (*op. cit.*), which represents a specimen from Ujiji (E. C. Hore Coll.).

The specimens we identify as this form differ from *P. tanganyicensis* chiefly by having the posterior end higher, bringing the post-ligamental slope nearly in line with the hinge, and increasing the curvature of the ventral margin. We have not seen any shells of the size of *P. tanganyicensis* having this contour, and none have been figured; and with further growth, such a shell as that we figure certainly could not take on the contour of *P. tanganyicensis*. We therefore doubt whether E. A. Smith's figure 32, Pl. XXXIV of 1881 (Proc. Zool. Soc. London) was rightly included by Bourguignat in his *P. livingstoniana.* The beaks have the same sculpture as *tanganyicensis* but somewhat finer and weaker.

Length, 62.0 mm.; height, 25.0 mm.; diameter, 7.0 mm.

This form may turn out to be a mere mutation of *P. tanganyicensis,* rather than a separate race.

### **Pseudospatha ortmanni,** new species

Plate XLV, Figures 5 and 7

Lake Tanganyika: Bay of Toa in 5 m. (Station 1163; Stappers Coll. Type 132188 A.N.S.P.); Tembwe (Hubert Coll.); Moliro (Pilette Coll.).

The shell has the usual compressed form and polished surface. It is widest near the middle, the ventral border strongly convex. Anterior end oblique, being produced forward in the neighborhood of the hinge. Posterior end obtusely rounded, the margins tapering to it above and below. The beak shows a minute, rounded glochidial shell, after which it is finely concentrically striate, the striæ gradually becoming coarser on the rest of the valve. The low posterior ridge shows one or two very low radial welts. The color is pale yellow near the borders, becoming hydrangea pink toward the beaks. The hinge-plate is very narrow, but bears narrow, distinctly raised lateral and anterior ridges, single in both valves. The whole interior is hydrangea pink.

| | | | |
|---|---|---|---|
| Length, 43.0 mm.; | height, 17.5 mm.; | diameter, 5.3 mm. | Toa; type. |
| " 41.0 | " 17.2 | " 5.3 | Tembwe. |
| " 49.0 | " 20.0 | " 9.0 | Moliro. |

This species is separated from *P. tanganyicensis* chiefly on account of the diverse beak sculpture, but it differs somewhat also in outline, in color, and in the narrower hinge-plate.

It is named for Dr. Arnold E. Ortmann, in recognition of his important work upon the anatomy of fresh-water mussels.

### **Pseudospatha stappersi,** new species

Plate XLV, Figure 6

Lake Tanganyika: bay of Kilewa, in 12 m. (Stappers Coll. Type 132189 A.N.S.P.).

The shell resembles *P. ortmanni* by lacking distinct beak sculpture. The beaks are finely, weakly striate around the subcircular, convex, densely microscopically granulose glochidial shell. The height is less than in *P. ortmanni,* only one-third of the length. The anterior margin is truncate, not oblique in the upper part, and the posterior end is longer. The color is yellow toward the margins, pale and subtransparent toward the beaks.

Length, 32.3 mm.; height, 11.0 mm.; diameter, 3.7 mm.

There can be very little doubt that the type of this species is immature, perhaps not half grown; but in our opinion its characters do not permit union with any of the described forms.

### Other Species of *Pseudospatha* Recorded from the Belgian Congo

#### *Pseudospatha bourguignati* (Bourguignat)

*Burtonia bourguignati* "Joubert" BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 38; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXVII, figs. 4 and 5.

*Pseudospatha bourguignati* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 578; 1914, 'Descript. Cat. of Naiades,' p. 206.

Lake Tanganyika: described from the lake without more definite locality.

#### *Pseudospatha subtriangularis* (Bourguignat)

*Burtonia subtriangularis* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 35; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXV, fig. 2.

*Pseudospatha subtriangularis* Bourguignat. SIMPSON, 1900, Proc. U. S. Nat. Mus., XXII, p. 578; 1914, 'Descript. Cat. of Naiades,' p. 206.

*Burtonia grandidieriana* BOURGUIGNAT, 1886, 'Nouv. Malacol., I, Un. et Irid. Tanganika,' p. 42; 1888, 'Iconogr. Malacol. Tanganika,' Pl. XXVII, figs. 1–3.

Lake Tanganyika: described from the lake without more definite locality.

## **Etheriidæ**

Fresh-water mussels with the shell conspicuously irregular, covered with a dark periostracum, attached to a solid substratum by one valve; nacreous within. The hinge is toothless; ligament deeply sunken. Having two adductor muscle impressions or only the posterior; pallial line entire.

The mantle margins are united only to form an anal orifice; palpi large, semioval; foot degenerate or obsolete; gills like those of Unionidæ in form.

This family comprises two genera in tropical South America, *Bartlettia* H. Adams (=*Bartelettia* Sowerby) and *Acostæa* d'Orbigny (=*Mulleria* Férussac, 1823, not of Leach, 1814; *Muelleria* of some authors; *Eumulleria* Anthony, 1907); one in Africa and Madagascar, *Etheria* Lamarck; one in peninsular India, *Pseudomulleria* Anthony. Fossil forms are not known, but *Etheria* has been reported from supposedly Pleistocene deposits in Lower Egypt.

### ETHERIA Lamarck

*Etheria* LAMARCK, 1807, Ann. Mus. Hist. Nat. Paris, X, p. 400. Type by designation of Gray (1847, Proc. Zool. Soc. London, p. 193): *Etheria semilunata* Lamarck =*E. elliptica* Lamarck.

*Ætheria* BERTHOLD, 1827, in 'Latreille's Natürl. Fam. des Thierr.,' p. 208. Emendation of *Etheria*.

*Etherea* SCHWEIGGER, 1820, 'Handb. d. Naturgesch. der Skel. Ungeglied. Thiere, p. 708. *E. elliptica* Lamarck cited.

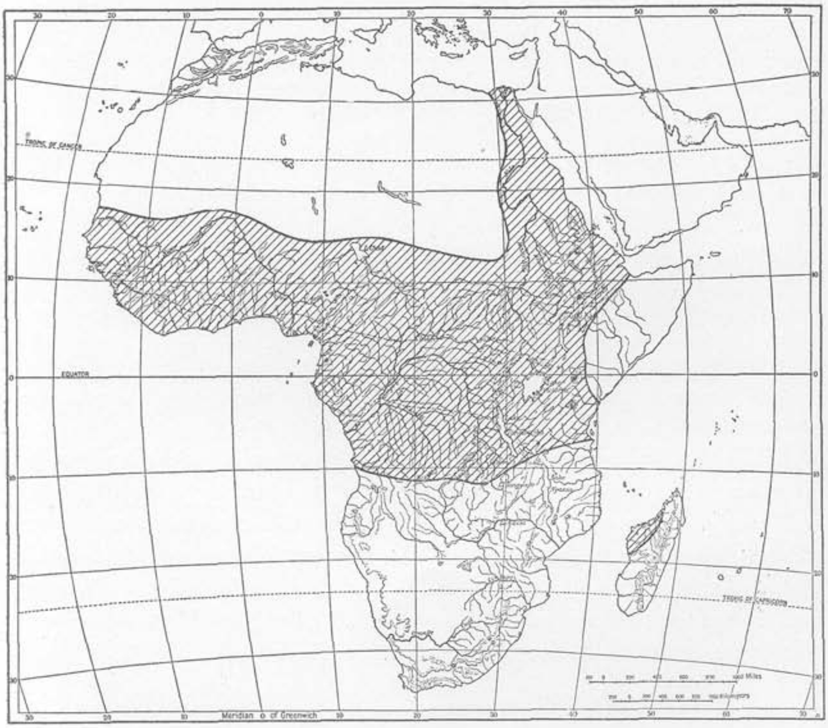
*Ætheria* group *Caillaudiana* BOURGUIGNAT, 1880–1881, 'Matér. Moll. Aceph. Syst. Europ.,' I, p. 63. Monotype: *Ætheria caillaudi* Férussac.

*Ætheria* group *Niloticiana* BOURGUIGNAT, 1880–1881, *op. cit.*, p. 65. Type by present designation: *E. elliptica* Lamarck.

*Ætheria* group *Chambardiana* BOURGUIGNAT, 1880–1881, *op. cit.*, p. 69. Monotype: *Æ. chambardi* Bourguignat.

*Ætheria* group *Letourneuxiana* BOURGUIGNAT, 1880–1881, *op. cit.*, p. 69. Type by present designation: *Ætheria petrettinii* Bourguignat.

Shell irregular, inequivalve, oyster-like, covered with a dark periostracum, attached by either valve; beaks anterior, that of the fixed valve often lengthened. Interior nacreous but rather dull, usually blistered or cellular. Hinge without teeth; ligament thickened inwardly posteriorly, forming a resilium, terminated by a deeply entering, narrow sinulus. Two large adductor impressions.




Map 6. Distribution of the genus *Etheria*.

*Etheria* is confined to the Ethiopian Region and Madagascar (Map 6). The widely spread continental species, *E. elliptica*, has been taken also in the Mahavavy and Androtsy Rivers, northwestern Madagascar.

Many supposed species have been defined, but in the latest considerations of the genus by von Martens (1897), by Germain (1907), and by Anthony (1907) all are recognized as forms of one species. *E. tubifera* and *E. cailliaudi* will probably be considered a distinguishable subspecies, the former mainly West African, the latter mainly Nilotic and East African.

According to Simroth and Germain the spinose forms grow in quiet, the smooth in rapid water. In some places smooth and spinose individuals appear to occur together, or at least are associated in lots having one field label. A careful study of an *Etheria* colony is needed. Anthony [1907, Ann. Soc. Zool. Malacol. Belgique, XLI, (1906), Pl. XII, figs. 18 and 19] figures an interesting specimen fixed upon a valve of *Aspatharia wissmanni.*

The soft parts and anatomy of *Etheria* were briefly studied by Rang and Cailliaud[1] and more recently with much detail by Anthony[2] and Sassi.[3]

### **Etheria elliptica** Lamarck

Plate XLVI, Figures 1, 1*a*; Plate XXX, Figures 2, 2*a*

*Etheria elliptica* LAMARCK, 1807, Ann. Mus. Hist. Nat. Paris, X, p. 401, Pl. XXIX and Pl. XXXI, fig. 1 (the exact type locality is not mentioned. Lamarck wrote: "on la dit originaire de la mer des Indes"). SOWERBY, 1872, 'Conchol. Iconica,' XVIII, *Etheria,* Pl. I, figs. 1*a*-*b*.

*Ætheria elliptica* Lamarck. E. v. MARTENS, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 216 (with form *globosa,* p. 218). VAN DEN BRŒCK, 1898, Ann. Soc. Malacol. Belgique, XXXIII, Bull. Séances, p. lii. E. A. SMITH, 1904, Proc. Malacol. Soc. London, VI, 2, p. 103. GERMAIN, 1905, Bull. Mus. Hist. Nat. Paris, p. 261; 1908, in A. Chevalier, 'L'Afrique Centrale Française,' p. 547; 1908, 'Rés. Scientif. Voy. Afrique Foà,' p. 678; 1909, Bull. Mus. Hist. Nat. Paris, p. 276, Pls. III and IV; 1911, *op. cit.*, p. 441. J. THIELE, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 213. W. WELTNER, 1913, *op. cit.*, IV, pp. 477 and 481. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 67. SPENCE, 1922, Journ. of Conchology, XVI, p. 266.

*Ætheria elliptica* var. *typica* "Germain" ANTHONY, 1907, Ann. Soc. Zool. Malacol. Belgique, XLI, (1906), p. 372 (new name for the typical, smooth form of *E. elliptica*).

*Etheria trigonula* LAMARCK, 1807, Ann. Mus. Hist. Nat. Paris, X, p. 403, Pl. XXX and Pl. XXXI, fig. 2 (also originally said to be from the "mer des Indes"; according to Bourguignat, 1880–1881, 'Matér. Moll. Acéph. Syst. Europ.,' I, p. 66, a Ms. note of Lamarck stated that it was from Senegal).

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[1]Rang, P., and Cailliaud, F. 1834. 'Mémoire sur le genre Ethérie et description de son animal.' Nouv. Ann. Mus. Paris, (3) III, pp. 128–144, 1 Pl.

[2]Anthony, R. 1905. 'Influence de la fixation pleurothétique sur la morphologie des Mollusques acéphales dimyaires.' Ann. Sc. Nat. Zool., (9) I, pp. 165–400, Pls. VII–IX. (Etheriidæ, pp. 339–372).
1907. 'Etude monographique des Ætheriidæ (Anatomie, morphogénie, systématique).' Ann. Soc. Zool. Malacol. Belgique, XLI, (1906), pp. 322–430, Pls. XI–XII.

[3]Sassi, M. 1910. (Beiträge zur Kenntnis der Anatomie von *Ætheria tubifera* Sow. Zool.) Anzeiger, XXXVI, pp. 25–31.

*Ætheria elliptica* var. *trigonula* Lamarck. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 219.

*Etheria semi-lunata* Lamarck, 1807, Ann. Mus. Hist. Nat. Paris, X, p. 404, Pl. xxxii, figs. 1 and 2 (originally said to be from the rocks on the coast of Madagascar).

*Ætheria semilunata* Lamarck. A. T. de Rochebrune and Germain, 1904, Mém. Soc. Zool. France, XVII, p. 27.

*Etheria semilunaris* "Lamarck" Sowerby, 1872, 'Conchol. Iconica,' XVIII, *Etheria*, Pl. i, fig. 1 (misspelling of *E. semilunata* Lamarck, as a synonym of *E. elliptica*).

*Etheria transversa* Lamarck, 1907, Ann. Mus. Hist. Nat. Paris, X, p. 406, Pl. xxxii, figs. 3 and 4 (originally said to be from the rocks on the coast of Madagascar).

*Etheria cailliaudi* Férussac, 1823, Mém. Soc. Hist. Nat. Paris, I, p. 359 (type locality: Blue Nile and its affluents.) Cailliaud, 1826, 'Voyage à Méroé,' II, p. 222 ("Ethérie"); 1827, *op. cit.*, IV, p. 261 ("Ethérie"); 1823, Atlas, II, Pl. lxi, figs. 1–3 (*Etheria cailliaudi*).

*Ætheria caillaudi* Férussac. Jickeli, 1874, Nova Acta Ac. Nat. Cur. Dresden, XXXVII, 1, p. 281.

*Etheria caillaudi* Férussac. Jousseaume, 1886, Bull. Soc. Zool. France, XI, p. 501 (Niger River at Kanguba, Bamako, and Kulikoro).

*Ætheria elliptica* var. *cailliaudi* Férussac. E. v. Martens, 1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 219. Dautzenberg and Germain, 1914, Rev. Zool. Afric., IV, 1, p. 67

*Ætheria cailliaudi* Férussac. Anthony, 1905, Ann. Sc. Nat. Zool., (9) I, p. 340, Pl. ix, figs. 22–26. E. v. Martens, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 72.

*Etheria lamarckii* Férussac, 1823, Mém. Soc. Hist. Nat. Paris, I, p. 359. New name for *E. elliptica* Lamarck+*E. trigonula* Lamarck.

*Etheria plumbea* Férussac, 1823, *op. cit.*, I, p. 359. New name for *E. semilunata* Lamarck+*E. transversa* Lamarck.

*Ætheria plumbea* "Sowerby" Anthony, 1905, Ann. Sc. Nat. Zool., (9) I, p. 343, fig. 47, Pl. viii, figs. 18 and 19.

*Etheria plombea* Jousseaume, 1886, Bull. Soc. Zool. France, XI, p. 501 (typographical error for *plumbea*; Senegal: rapids of Kora, Diubeba, and Sukutaly).

*Ætheria tubifera* Sowerby, 1825, Zool. Journ., I, p. 523, Pl. xix (locality unknown). Bourguignat, 1880–1881, 'Matér. Moll. Acéph. Syst. Europ.,' I, p. 65 (on p. 66, *Æ. cailliaudi* var. *rotundata*, Ms. in Paris Museum, is said to be a synonym). Simroth, 1890, Zool. Anzeiger, XIII, p. 663. E. v. Martens, 1883, Sitz. Ber. Ges. Naturf. Fr. Berlin, p. 72.

*Ætheria elliptica* var. *tubifera* Sowerby. E. v. Martens, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 219. J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' III, p. 213.

*Ætheria denhami* Kœnig, 1826, in Denham and Clapperton, 'Narrative of Trav. and Discov. in N. and Centr. Africa,' Appendix, p. 254 (type locality: Gammaroo River, Nigeria; probably the Gambaroo, Yeou or Komadugu Yobe River).

*Etheria carteroni* Michelin, 1830, Mag. de Zool., I, p. 1, Moll., Pl. i, figs. 1 and 2 (*carteronii* on plate) (Senegal).

*Ætheria petrettinii* Bourguignat, 1880–1881, 'Matér. Moll. Acéph. Syst. Europ.,' I, p. 53 (type locality: Ramleh, Lower Egypt).

*Ætheria petretinii* "Bourguignat" Anthony, 1905, Ann. Sc. Nat. Zool., (9) I, p. 340, Pl. ix, figs. 20 and 21 (Bourguignat's types).

*Ætheria letourneuxi* BOURGUIGNAT, 1880–1881, 'Matér. Moll. Acéph. Syst. Europ.,' I, p. 55 (type locality: Nile River and canals of the Fayum). ANTHONY, 1907, Ann. Soc. Zool. Malacol. Belgique, XLI, (1906), p. 364, Pl. XII, figs. 14 and 15 (Bourguignat's types).

*Ætheria chambardi* BOURGUIGNAT, 1880–1881, 'Matér. Moll. Acéph. Syst. Europ.,' I, p. 56 (type locality: in supposedly Pleistocene beds at Ramses, Lower Egypt).

*Ætheria nilotica* "Letourneux" BOURGUIGNAT, 1880–1881, *op. cit.*, p. 58 (type locality: Nile in Nubia and Lake Mariout near Alexandria).

*Ætheria senegalica* BOURGUIGNAT, 1880–1881, *op. cit.*, p. 68 (based on *Ætheria semilunata* WOODWARD, 1854, 'Manual of the Mollusca,' p. 275, Pl. XVIII, fig. 7, from Senegal).

*Ætheria bourguignati* A. T. DE ROCHEBRUNE, 1886, Bull. Soc. Malacol. France, III, p. 14 (type locality: Gancini, on the right bank of the Congo River). A. T. DE ROCHEBRUNE AND GERMAIN, 1904, Mém. Soc. Zool. France, XVII, p. 27, Pl. II, fig. 8.

*Ætheria elliptica* var. *bourguignati* A. T. de Rochebrune. DAUTZENBERG AND GERMAIN, 1914, Rev. Zool. Afric., IV, 1, p. 67.

*Ætheria tanganikana* BOURGUIGNAT, 1889, Bull. Soc. Malacol. France, VI, p. 65 (based solely upon the statement by E. A. Smith, 1880, Proc. Zool. Soc. London, p. 352, that of *Ætheria elliptica* Lamarck "a single old, thick, dead specimen forms part of the collection" made by Hore at Ujiji).

*Ætheria nidus hirundinis* SIMROTH, 1890, Zool. Anzeiger, XIII, p. 662 (type locality: falls of the Congo River; no more accurate locality given, but the specimens having been collected by Pechuel-Lœsche, probably came from the Cataract district in the Lower Congo).

*Ætheria heteromorpha* SIMROTH, 1894, Abh. Senckenberg. Naturf. Ges., XVIII, p. 287; to include mutation *tubulifera*, p. 288, Pl., figs. 1–7, and mutation *nidus hirundinis*, p. 288, Pl., figs. 8–10 (both from the falls of the Congo River).

*Ætheria heteromorpha* mut. *nidus hirundinis* Simroth. WAAGEN, 1905, Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., CXIV, Abt. 1, p. 162, Pl., figs. 1–5.

*Ætheria tubulosa* "Bk." SIMROTH, 1894, Abh. Senckenberg. Naturf. Ges., XVIII, p. 277 (with description; type locality: Nile).

The general distribution (Map 6) of this mussel appears to be: Nile system generally; Lake Tsana; Lake Stephanie[1]; Lake Victoria and its affluents; southeastward to the Wami (or Vuami) River (opposite Zanzibar Island)[2]; westward through the Chari-Chad basin and that of the Niger and Senegal (extreme northwestern locality: Brakna region, according to Germain, 1909); in West Africa southward to cover the entire Congo basin, and northern Angola (obtained in the Lucala River, an affluent of the Quanza River, by Welwitsch); also in northwestern

[1]Dead valves obtained in that lake by A. Donaldson Smith are referable to the var. *cailliaudi*.

[2]The Wami River is the farthest south given by v. Martens (1897, 'Deutsch Ost Afr., IV, Beschalte Weichth.,' p. 219). Germain (1909, Arch. Zool. Expér. Gén., XLI, p. 116, fig. 55) maps the range of *Etheria* as covering the Zambezi basin and reaching a point somewhat farther south on the west coast, but without giving authorities for these limits. We can find no record from farther south than the Wami River in East Africa.

Madagascar. Its occurrence in Lake Tanganyika appears very doubtful.[1] We can find no definite records from Lake Nyasa or from within the Zambezi system.

This species has been recorded from many localities in the Belgian Congo: Falls of the Congo (mut. *nidus hirundinis* and mut. *tubulifera*; Pechuel-Lœsche Coll. and O. Baumann Coll.). Kwango River and at its confluence with the Kasai River (*elliptica* and *tubifera*; R. Büttner Coll.). Nyangwe in the Lualaba River (*tubifera*; Wissmann Coll.). Between the Lulua and Lualaba Rivers (*trigonula*; Wissmann Coll.). Uele River (*bourguignati* and *semilunata*; du Bourg de Bozas Coll.). Yambuya in the Aruwimi River (*tubifera*; Schubotz Coll.). Confluence of Larger Lubembe River and Luapula in about 12° S. (*elliptica*)[2]; Kalengwe in the Lualaba River (*bourguignati*); Kibombo in the Lualaba River (*cailliaudi*) (J. Bequaert Coll.). Leverville; Kwilu River; northern bend of the Congo from Lisala to Basoko (*elliptica*; F. M. Dyke Coll.). E. v. Martens has also recorded the var. *cailliaudi* from the Chiloango River near Landana. According to the junior author's experience *E. elliptica* occurs in practically every fair-sized river of the Congo basin, but he has not seen it in Lake Edward nor in the estuary below Zambi. At the Congo Museum Tervueren, there are also specimens, both of typical *elliptica* and the var. *cailliaudi*, from Kasenga in the Luapula River (Stappers Coll.). The species also occurs in the Lubumbashi River near Elisabethville.

Congo River at Stanleyville; Faradje in the Dungu River (Lang and Chapin Coll.). Luapula River at Kasenga (L. Stappers Coll.).

Specimens of the race *tubifera* from the Dungu River reach a length of about 140 mm. In most of them both valves, when not adnate, bear tubular spines, but sometimes they are lacking on one (the left) valve. One of the Stanleyville lot is figured (Pl. XLVI, figs. 1–1*a*).

The forms described as *bourguignati* and *heteromorpha* mut. *tubulifera* appear to be merely *tubifera*.

Dr. Simroth described two forms, to which he applied three names, from the Congo Falls. They are thus defined:

*Ætheria heteromorpha* (1894). Of moderate size. Epidermis thick, internal layer iridescent. Either right or left valves attached to stones. Two very different forms:

Mutation: *tubulifera* (1894). Lower valve flatter, upper excavated, provided with tubules.

Mutation: *nidus hirundinis* (1890). Lacking tubules; lower valve excavated, angulate, the upper flat.

The mut. *tubulifera* appears to agree fully with the examples before us which we refer to *E. elliptica tubifera*. The mut. *nidus hirundinis* is

[1]The Tanganyika record rests upon an old, dead specimen sent by E. C. Hore and supposed to be from Ujiji, and another, also dead, from somewhere on the eastern shore. The late Dr. Stappers did not collect the genus in the lake.

[2]This is the southernmost definite record on the continent.

triangular in section, without spines, its shape probably due in large part to the situation.

The specimen from Kasenga (Pl. XXX, figs. 2–2*a*) is a young individual of the var. *cailliaudi*. It differs from typical *elliptica* by the more elongate beaks.

"The river oysters (*Etheria elliptica*), though occurring throughout the entire extent of the Congo basin, were only found on certain rocky sections about rapids and falls of fair-sized streams, where they form 'banks' in stony and generally turbulent places, often ten feet and more below the surface of the rushing floods. Even when the rivers are at their lowest level, as happens during the dry seasons, the uppermost shells alone become exposed. The mollusks attach themselves by one valve to the rock and also to other shells of their kind. In some places they are three and four deep and sometimes so hemmed in that probably not a few are thus suffocated, as many shells close to the rock base contain no animal. In spite of their great size (5 to 8 inches), generally spinous appearance, and relative abundance, they easily escape the attention of travellers, hidden as they are by the brownish torrents. Furthermore, like the stones about them, they are covered with a mass of fluviatile mosslike animals (Bryozoa and Spongillidæ). A number of such forms found in these *Etheria* associations have been recorded in various localities in Africa, such as fresh-water Bryozoa of the genus *Plumatella*[1]; *Spongilla sumatrana* from the Nile and Rukagura River, Usegua, Tanganyika Territory, *Corvospongilla loricata* from an unknown locality, *C. micramphidiscoides* from rapids of the Aruwimi River near Banalia at 3 to 4 m. depth, where Schubotz collected also *Spongilla (Stratospongilla) schubotzi*.[2] Annandale[3] describes two other species from the Nile—*Spongilla (Eunapius) ætheriæ* and *Cervospongilla scabrispiculis*. As Dr. Bequaert and others have pointed out, a more careful investigation will prove highly interesting, especially as regards other mollusks that find a home in such favorable places as the roughened, corrugated surfaces of these fresh-water oysters. Among them are small clams (Sphæriidæ), several forms of which are now known to occur in the Congo basin on shells of *Etheria elliptica*, such as *Eupera mediafricana* in the Tshopo River near Stanleyville, *E. m. etheriarum* in the Dungu River near Faradje, *E. bequaerti* in the Luapula River at Kasenga, and *E. sturanyi* in the Lower Congo at the District of Cataracts. There are

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[1]Ulmer, 1913, in 'Wiss. Ergeb. D. Z. Afr. Exp. 1907–1908,' IV, Zoologie, 2, p. 286.
[2]Weltner, 1913, *loc. cit.*, pp. 476–481.
[3]1913, Rec. Indian Mus., IX, pp. 237–238.

also the snails *Cleopatra broecki* from the Aruwimi, and several fresh-water limpets (Ancylidæ) from the Katanga, *Burnupia caffra* (Krauss) and *B. transvaalensis* (Craven).

"During very low water collectors often enough will find encampments of the natives close to the best sites, for at that period the rapids or falls offer favorable places also for fishing on a more extensive scale than at other times and the colonies of *Etheria* furnish a most welcome staple food. In the northeastern Belgian Congo the large banks of *Etheria* along the Dungu River are regularly exploited by the riverine Bakongo and Mangbetu tribes. The younger men are expert divers and, with specially made iron chisels or spikes, pry loose from the rocks great lumps of *Etheria*. When the shells are heaped close to the fire the adductor muscles relax. Women and children remove the mollusks from their shells, spike dozens of them on wooden skewers, and dry them as rapidly as possible. They are laid upon wooden racks where the combined action of fire, smoke, and sun quickly transforms them into heavy brownish flakes which in dry condition can be preserved for several months, like native dried fish and meat. Decay previous to or coincident with such preparation, far from being objectionable to the native taste, rather adds flavor. For consumption these dried mollusks are soaked in water until softened and after being thoroughly boiled are served as a highly seasoned oyster stew with palm oil and vegetables. Though apparently never eaten raw, in certain places in the Uele the riverine population prepare the fresh mollusks much like fish, either fried or boiled. Hardly any white men along the Uele, the Aruwimi, or the Congo in the neighborhood of Stanleyville seemed to be interested in these oysters as food. Some of them assured Chapin and myself that they were rather bitter. Dybowski,[1] however, in speaking of his stop at Bangi during his trip along the Ubangi River, mentions that when cooked these mollusks are rather good eating. The water must have been very low, for the Banziri, like other natives living near such favorable rapids, collected then their annual harvest of river oysters.

"With the years, small hills of empty shells accumulate about such native camps. On account of the relative scarcity of limestone in all these regions such shell heaps always attracted the attention of those who at the early period of Belgian occupation were in search of a proper substitute. These *Etheria* shells indeed furnished an excellent quality of lime for the mortar needed to erect brick houses in the different settlements and also for whitewashing the walls. This was also advantageous

[1]1893, 'Route du Tchad,' p. 366 (*Etheria tubifera*).

since many of these stations happened to be below or above places where banks of *Etheria* were common, because here falls or rapids interrupted transportation.

"The process of transforming these shells into lime is rather simple. A circular hole, serving as a primitive lime kiln, is dug in the ground. Its walls are lined with logs about six feet in length, and a quantity of firewood is placed at the bottom. The shells, after being thoroughly washed and dried again, are shoveled in to form a layer about a foot thick. More firewood is piled on, then another layer of shells, and finally the whole kiln is covered over with firewood. The photograph (Pl. XLVII) shows at the left a kiln burned out, with the calcined shells scattered around, and at the right another kiln about to be filled with a heap of dry shells (*Etheria elliptica*) lying nearby." (H. L.).

### Driessenidæ

The shell is mytiliform with anterior, nearly or quite terminal beaks, and without a nacreous layer within. There is a small septum (myophore of the anterior adductor) across the beak cavity. The ligament is immersed. The posterior adductor scar is very long.

The mantle margins are concrescent, leaving only the siphonal and small pedal openings. Byssiferous.

### **Congeria** Partsch

*Congeria* Partsch, 1836, Ann. Wiener Mus. Naturg., I, p. 97. Type by designation of Pilsbry (1911, The Nautilus, XXV, p. 95): *Congeria subglobosa* Partsch.

*Enocephalus* v. Münster, 1831, Zeitschr. f. Geogn., Geol. u. Naturg. Erde, X Stück, p. 92, without definition or described type.[1] Partsch, 1836, Ann. Wiener Mus. Naturg., I, p. 97, as identical with *Congeria*.

*Mytilopsis* Conrad, 1857, Proc. Ac. Nat. Sci. Philadelphia, IX, p. 167. Monotype: *M. leucophæatus* Conrad.

*Praxis* H. and A. Adams, 1857, 'Gen. Recent Moll.,' II, p. 522. Type by present designation: *Dreissena africana* Van Beneden.

*Mytiloides* Conrad, 1874, Proc. Ac. Nat. Sci. Philadelphia, XXVI, p. 29. Not *Mytiloides* Brongniart, 1822. For *Dresseina scripta* Conrad and *D. leucophæata* Conrad. Error for *Mytilopsis* Conrad.

[1]Graf von Münster, in a letter dated December 26, 1830, published in the following year, writes of certain Austrian mytiloid fossils, concluding: "In der v. Schlottheimschen Sammlung befindet sie sich unter dem Namen *Enocephalus*, daher ich sie in meiner Sammlung aufgeführt habe, als *Enocephalus carditæformis* von Wien, und *mytiloides* vom Plattensee."

The same fossils had been mentioned by Boué (1830, Journ. de Géol., II, pp. 374 and 378 as a "*Mytilus* d'eau douce, voisin de celui du Danube," but without name or description. Later (1833, Bull. Soc. Géol. France, III, séance du 21 janvier, p. 126), Boué mentioned "deux ou peut-être trois espèces de *Mytilus* ou d'un nouveau genre intermédiaire entre les Isocardes et les Moules, appellé *Enocephalus* (*E. carditæformis*, etc., par le comte Münster)." There is no description or figure.

No clue to the identity of *Enocephalus* was published until the name was mentioned by Partsch as identical with his new genus *Congeria*. Münster's two species, *E. carditæformis* and *mytiloides*, have never been correlated with any of the described forms, so far as we have been able to learn, though they are doubtless identical with species described by Partsch.

Driessenids in which there is a recurved myophore for the pedal retractor muscle accessory to the septum within the beaks. Externally the shell is without radial sculpture.

This genus occurs in estuaries of eastern North America, Africa, and, according to Dall, China and the Viti Islands. It was abundant in the European Miocene.

The thin-shelled, recent forms are referable to the subgenus *Mytilopsis* Conrad.

The species of this group have often been referred to *Driessena* ("*Dreissensia*"),[1] but they differ from that genus by possessing a separate myophore for the pedal retractor muscle, accessory to the septum, and directed toward the cavity of the valve. It is often scarcely seen in a direct view, but is conspicuous in an oblique view into the cavity (Fig. 94*b*).

The following species have been described from Africa:

*Congeria africana* (P. J. Van Beneden) = *Dreissena africana* P. J. Van Beneden, 1835 (April), Ann. Sc. Nat. Zool., (2) III, p. 211, Pl. viii, figs. 12 and 13. Upper Senegal. The author also describes the animal.

*Mytilus cochleatus* "Kickx" Nyst (1835, Bull. Ac. Sci. Belgique, II, p. 235, Pl., figs. 1–3; séance du 4 juillet), described from specimens found alive at Antwerp, where they may have been introduced from Africa, has been regarded by some authors as a synonym of *C. africana*, but the published drawings of the two forms are very different.

*Congeria cyanea* (P. J. Van Beneden) = *Dreissena cyanea* P. J. Van Beneden, 1837, Bull. Ac. Sci. Belgique, IV, p. 41, Pl., figs. 1–5. Presumably from Senegal; exact locality unknown.

*Congeria gibberosa* (Preston) = *Dreissensia gibberosa* Preston, 1909, Ann. Mag. Nat. Hist., (8) IV, p. 89, Pl. iv, fig. 4. Assinie, Ivory Coast.

*Congeria holmi* (A. d'Ailly) = *Dreissensia holmi* A. d'Ailly, 1896, Bihang Svenska Vet. Ak. Handl., XXII, Afd. 4, No. 2, p. 130, Pl. v, figs. 17–23. Ekumbi, Cameroon.

*Congeria lacustris* (Morelet) = *Dreissena lacustris* Morelet, 1860, Journ. de Conchyl., VIII, p. 191. *Dreissensia lacustris* Morelet, 1885, *op. cit.*, XXXIII, p. p. 32, Pl. ii, fig. 11. Lake Ebrié, Grand Bassam, Ivory Coast.

*Congeria ornata* (Morelet). See p. 457.

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[1]In the first notice of this genus by P. J. Van Beneden (1835, Bull. Ac. Sci. Belgique, II, p. 25; séance du 17 janvier) the name is spelled *Driessena*, and the specimens discussed were said to have been received from M. Driessens. The genus was then monotypic for *Mytilus polymorphus* Pallas. Subsequently in the report of the meeting of the Belgian Academy of February 7 (1835, II, p. 44), Dumortier mentions Van Beneden's memoir as "Histoire naturelle et anatomique du *Dreissena polymorpha.*" In the index of the same volume, p. iii, the name appears as *Dreissenia*. In the memoir published in 1835 (April), Ann. Sc. Nat. Zool., (2) III, p. 193, Van Beneden uses the form *Dreissena*.

P. Oppenheim (1891, Zeitschr. Deutsch. Geol. Ges., XLIII, p. 927) states that the name of the man whom it was the intention to honor was Dreyssens, so that the correct orthography would be *Dreyssensia*. He gave (pp. 932–934) a catalogue of recent and fossil species now included in *Driessena* and *Congeria*.

Dall (1898, Trans. Wagner Free Inst. Sci. Philadelphia, III, p. 808) prefers the form *Dreissensia*.

As there appears to be no way of reconciling the several versions of the name, we prefer to use the original form, *Driessena*.

The genus *Mytilina* Cantraine (1837, Ann. Sc. Nat. Zool., (2) VII, p. 306) included *M. polymorpha* (Pallas), type of *Driessena*, and *M. cochleata* "Kickx," a species of *Congeria*. *M. polymorpha* is here selected as type. Cantraine apparently had intended to call the genus *Mytilomya*, as he used the form "Mytilomyes" in his discussion under *Mytilina*. Bronn (1838, 'Lethæa Geognostica,' II, p. 921) latinized the name as "*Mytilomya* Cantraine." This name will take the same species *M. polymorpha* Pallas) as type.

**Congeria ornata** (Morelet)

Text Figure 94*a*, *b*, *c*

*Dreissensia ornata* Morelet, 1885, Journ. de Conchyl., XXXIII, p. 32, Pl. ii, figs. 10 and 10*a* (type locality: Mayumba River, French Congo). C. R. Bœttger, 1913, Ann. Soc. Zool. Malacol. Belgique, XLVII, (1912), p. 110.

*Dreissensia bananaensis* Preston, 1909, Ann. Mag. Nat. Hist., (8) IV, p. 88, Pl iv, fig. 3.

Creek of Banana (P. Hesse Coll.); also type locality of *D. bananaensis* Preston.

Congo; specimens in the Academy of Natural Sciences, Philadelphia, received from Morelet and probably part of the original lot.

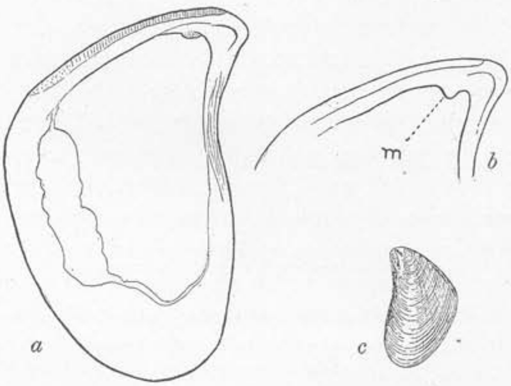



Fig. 94. ***a-c***, *Congeria ornata* (Morelet). At *b*, an oblique view into the cavity of the beak.
m, myophore.

A small, triangular species, rather broad, but variable in width, dull, light brown with many indistinct dark rays. The surface is minutely and closely laminiferous. Interior dull blue, the very large posterior adductor scar purplish black, or the cavity may be tinted and pencilled with blackish brown, the muscle scar and outside of it blue-white.

| | | |
|---|---|---|
| Length, 15.3 mm.; | width, 9.8 mm.; | diameter, 7.0 mm. |
| " 16.2 | " 9.0 | " 8.0 |

ZOÖGEOGRAPHY AND ECOLOGY OF THE LAND AND FRESH-WATER MOLLUSKS OF THE BELGIAN CONGO[1]

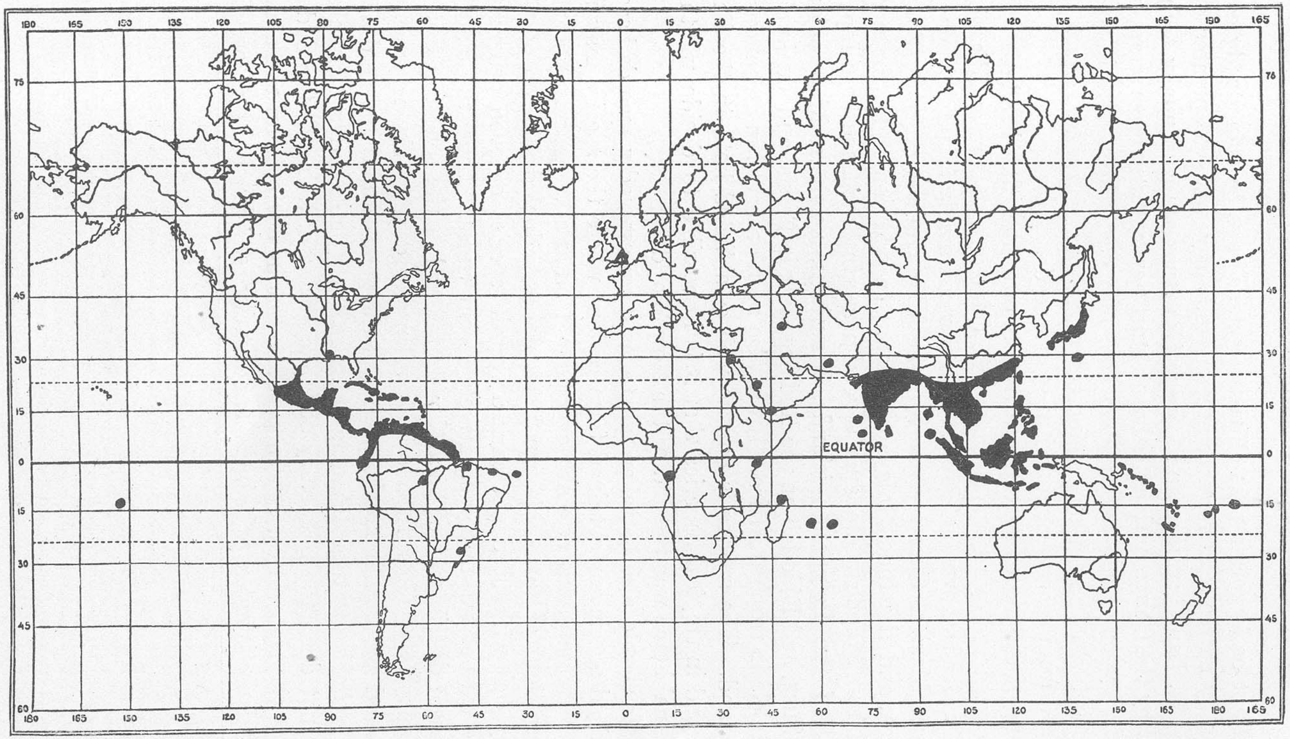
The composition of the molluscan fauna of a country is the result of two different sets of causes. Some act at present and are directly traceable to the environment, so that it takes comparatively little effort to analyze them in order to discover in how far they are responsible for the presence or absence of certain types or for changes in external form and behavior. Others may be called historical and are much more subtle, for they are essentially the environmental conditions of past geologic times, especially such as rendered possible the successive migrations and the survival of the various elements from which the present-day fauna evolved. In this ecological and geographical account of the mollusks of the Belgian Congo we have attempted to trace the influence of each of these two sets of causes upon the constitution of the fauna. This chapter should, however, be regarded as nothing more than an essay, which we are well aware is in many ways sketchy. Positive observations on the habits and distribution of tropical African mollusks are indeed so few that no very decisive conclusions could be drawn from them. Our chief aim is to suggest lines along which various problems may be further investigated. With this in view, we have rather liberally added references to the literature, preferably selecting papers containing further bibliographic information.

Before entering into a discussion of the peculiarities of the Congo fauna, it may not be amiss to mention certain sources of possible error in the study of the geographical distribution of African mollusks. In the first place, it is evident that the Ethiopian Region as a whole, and the Belgian Congo in particular, have thusfar received but scant attention on the part of malacologists. Much of the published information is based upon collections gathered incidentally by laymen and therefore usually containing only fair-sized or particularly abundant species. The minutiæ are still to a large extent unknown. In addition, these collections as a rule consist of dead specimens only and in the absence of soft parts a correct generic identification is sometimes impossible.

Another point of considerable importance is the facility with which certain tropical mollusks may be carried over great distances by the agency of man.[2] Especially with regard to the species common to India. the east coast of Africa, Madagascar, and the Mascarenes, it

[1]Much of the physical, geological, and botanical data on which the present ecology of Congo mollusks is based has been taken from an unpublished description of the Belgian Congo prepared by the junior author for The American Museum of Natural History.

[2]See Kew, H. W. 1893. 'The dispersal of shells.' (London), pp. 178–263.




Map 7. Distribution of *Opeas gracile* (Hutton), a land snail which is rapidly becoming tropicopolitan through the action of man.

should not be forgotten that all these regions have been in steady connection by native craft for several thousands of years.[1] As pointed out by Mr. H. Lang,[2] stumps and leaves of bananas are continually transported by the Congo natives, either to start new cultures or as wrapping material; young shells and mollusk eggs may easily keep alive in them for weeks. In East Africa a number of species of snails have been described from specimens found in stored seeds.

One of the most interesting examples of a snail that has been very widely scattered by man is *Opeas gracile* (Hutton), the present distribution of which is shown on Map 7. It is now commonly found throughout southern Mexico, Central America, the West Indies, northern South America, and the Indo-Malayan Region. In addition it has been reported from Mobile in Alabama, several places in Brazil, southern Japan, several of the Polynesian islands, Mauritius, northern Madagascar, Aden, Suez, and Djeddah on the Red Sea, Jalk in Persia, and Tuakungu and Malela in tropical Africa. It has also been observed in greenhouses in England. The species is now so well established both in the East Indies and in tropical America that it is impossible to decide whether its original home was the Old or the New World.[3]

Care should also be taken not to trust unreservedly records based upon dead specimens obtained from regions where the species may no longer be found living or may never have lived at all. Especially at the northern limit of the Ethiopian Region the gradual drying up of the country has without doubt caused certain species or even genera to become extinct within comparatively recent times. Thus, the map of the present distribution of *Limicolaria* published in the report of Congo land mollusks[4] was based exclusively upon records of specimens presumably found alive. The northern limit of the genus was therefore drawn much farther south than on similar maps recently published by Germain.[5] We do not deny the possibility of *Limicolaria* still living in the Sudan north of the sixteenth northern parallel, but in our opinion the available evidence is not convincing. The locality records cited by Germain

[1]H. H. Godwin-Austen. 1908. 'The dispersal of land shells by the agency of man.' Proc. Malacol. Soc. London, VIII, pp. 146–147. E. E. Green. 1911. 'The wanderings of a gigantic African snail.' Zoologist, (4) XV, pp. 41–45, Pl. (see also 1910, Spolia Zeylanica, VII, p. 56). G. C. Robson, 1914, Journ. Linn. Soc. London, Zool., XXXII, p. 377. Germain, 1921, 'Faune Malacol. Terr. Fluv. Iles Mascareignes,' pp. 188–189.

[2]1919, Bull. American Mus. Nat. Hist., XL, pp. 55–56.

[3]Compare the accompanying map of *Opeas gracile* with that given by Germain (1920, 'Voy. Afrique Orientale Anglaise G. Babault, Moll. Terr. et Fluv.,' p. 121, fig. 9) for *Subulina octona* (Brugierère). Dupuis and Putzeys have recently described from Boma, in the Lower Congo, *Cæcilioides spencei* (1922, Ann. Soc. Zool. Belgique, LIII, 1, p. 48, fig. 2). From the description this appears to be *C. gundlachi* Pfeiffer, a snail originally from the Antilles, but now widely scattered by man (Philippines, Hawaiian Islands, New Caledonia, etc.) and therefore several times renamed.

[4]1919, Bull. American Mus. Nat. Hist., XL, p. 91.

[5]1920, 'Voyage Afrique Orient. Anglaise G. Babault, Moll. Terr. Fluv.,' p. 81, fig. 6; 1920, Bull. Mus. Hist. Nat. Paris, pp. 527–533.

in 19° N., 20° 30′ N., and 21° N. are very few in number considering the extension of the territory involved and especially compared with the numerous records from south of the sixteenth northern parallel. Nor is it unequivocally stated that any of the specimens from the arid area of the Sudan were found alive. Dead specimens may well be subfossil remains of former flourishing colonies of these snails. Moreover, the possibility of their having been transported by native caravans, either dead or alive, as amulets or utensils, or accidentally with food or merchandise, cannot be entirely discarded.[1]

The ecological and, to some extent also, the historical causes responsible for the present composition and distribution of the mollusk fauna are in many respects so different for the terrestrial and the aquatic species, that they are most conveniently studied separately for each of these groups.

## Ecology and Distribution of Terrestrial Mollusks

### The Ecological Factors

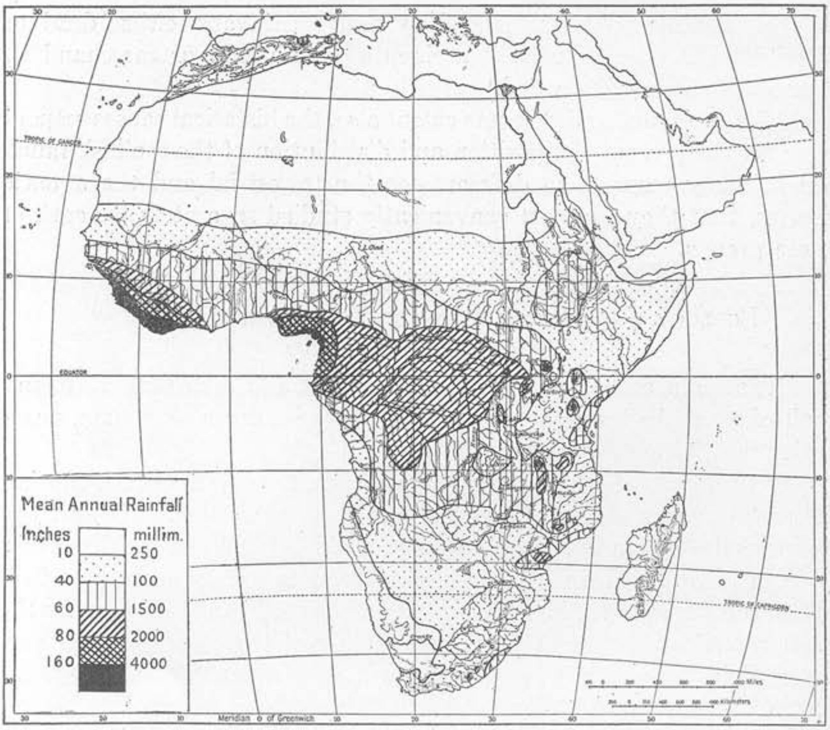
The main ecological factors which affect the distribution of land mollusks may be brought together under the headings of climate, vegetation, soil, topography, and other organisms.[2]

With few local exceptions due to altitude, the climate of the Belgian Congo is everywhere of the equatorial or tropical type. Most of the territory lies within the belt of calms or variable winds, the doldrum belt or equatorial cloud-ring, as it is sometimes called by meteorologists. When the sun is in the south (from December to March), the dry northeastern trades blow over the savanna district of the upper Ubangi and upper Uele. Again, in Upper Katanga and southern Kasai, the southeastern trades make themselves felt during the southern dry season (from May to September). The temperature is very uniform near the equator and, except at the top of some of the high plateaus and mountain ranges, it never drops to the freezing point, so that its variations are of little if any import for life. The total amount of rainfall is considerable[3]

[1]The discrepancy between Germain's eastern limit of *Limicolaria* in Somaliland and that given on our map appears to be merely due to his transferring longitudes calculated on the Greenwich meridian without reduction to a map based on the Paris meridian. With the exception of *Limicolaria oviformis* Ancey, from the "northern coast of Somaliland," a species which we had eliminated as of doubtful provenance (the specimen was at first said to have come from Aden!), the same locality records were used by both Germain and ourselves.

[2]Of the older accounts of the influence of the environment upon mollusks the most interesting perhaps are those of Locard, A., 1881, 'Etudes sur les variations malacologiques. II,' Ann. Soc. Agric. Lyon, (5) III, pp. 189-748; 1893, 'De l'influence des milieux sur le développement des Mollusques,' *op. cit.*, (6) V, (1891), pp. 1–140. A recent, systematized and exhaustive review of the subject is that by Pelseneer, P., 1920, 'Les variations et leur hérédité chez les Mollusques,' Mém. in-8° Ac. Belgique, Cl. des Sci., (2) V, pp. 1–826 (the influence of external factors is fully discussed on pp. 476–602).

being almost everywhere over 40 inches yearly and more than 60 inches in much of the territory (See Map 8). The seasonal variation of moisture then becomes the deciding factor in the ecology and distribution of plants and animals. In Africa, as in other tropical regions, it rains during the hottest season of the year, when the sun nears the zenith. Therefore




Map 8. Distribution of mean annual rainfall on the African continent (after Knox).

at the equator there are two seasons of heavy rains at intervals of about six months, while during the intervening periods the rains are scarcer or may even stop altogether. Farther north or south, the dry seasons become more marked, but, on the other hand, the two rainy seasons come closer together until near the tropics there is only one rainy season of a few months' duration. At least in the lowlands of the Congo, latitude thus gives a good clue to the yearly amount and seasonal distribution of rainfall. In the mountains, however, not only must one take into account the fact that humidity at first increases with altitude, while at higher levels the lower atmospheric pressure produces a drier atmosphere, but the orientation of the slopes too is of great importance in deciding whether they will be exposed to dry or wet winds. Other climatic factors, such as intensity of sunlight and wind, are hardly of importance in the life of mollusks and need not here be discussed.

The nature of the vegetation depends directly upon climatic conditions and, in tropical Africa, especially upon the total amount and seasonal distribution of rainfall. In the Congo lowlands the dominant plant formations belong to one of two main ecological types: rain forest and savanna. RAIN FOREST, as here understood, is any plant formation of dense, continuous growth chiefly composed of trees and bushes, while grasses are either entirely absent or restricted to a few, heliophobic or light-shunning types. Likewise, the term SAVANNA is meant to cover all plant formations where grasses predominate, whether there be or be not an admixture of shrubs, bushes, or trees. Rain forest in tropical Africa thrives wherever the rains are abundant enough and so evenly distributed over the year as to allow an uninterrupted development of woody plants. Savanna covers regions with sharply marked and prolonged dry seasons, during which most of the plants stop growing and many of the trees even drop their leaves. These two types of tropical vegetation affect molluscan life in a very different manner. In the rain forest the steady moisture, dense shade, and luxuriant vegetation allow land mollusks to thrive throughout the year and consequently this is the domain of the large, hygrophilous snails and of most of the slugs. Species which live in the savanna, on the other hand, must be able to bridge over the dry season in a dormant state. That mollusks are very few in species and individuals in the African grass-lands is due perhaps not so much to unfavorable ecological conditions as to the grass fires which every dry season sweep over the country (compare Pls. LII and LIII). Only those snails and slugs can survive that in order to estivate have dug in sufficiently deep or are hidden in crevices of rocks or in hollow branches or stumps of trees. In the Central African mountains the altitudinal distribution of plant formations, resulting in a corresponding succession of molluscan life-zones, is of a more complex nature, as we shall describe for some of the mountain ranges of the eastern Congo.

Soil conditions perhaps influence more directly the distribution and development of land mollusks than any other single factor and they are certainly of much greater importance to them than to most other animals.[1] Mollusks need considerable quantities of lime for the building up of their shells and where limestone is conspicuously absent, as is the case over very large areas of the Belgian Congo, this side of their metabolism must be seriously handicapped. Many of the land shells of the Congo are thin or transparent, and frequently of minute size. Others, such as certain of the mountain Helicidæ and the numerous Helixarionidæ, have soft or corneous shells. The scarcity of lime has undoubtedly favored the development of Helixarionidæ and of slugs of the families Vaginulidæ and Urocyclidæ. The Achatininæ are somewhat of an exception to the rule, but even in their case it may be observed that the shells of these vegetarian snails do not attain in the Congo basin the large dimensions and weight of some of their South and East African relatives. There is also a conspicuous difference in size and thickness of the shell and in number of individuals between the *Achatinæ* of the rain forest, where the soil is better protected and therefore less leached, much of the mineral matter being kept in solution in the groundwater; and those of the savanna, where the soil is more thoroughly deprived of soluble matter and frequently consists of bare granite, gneiss or quartz, bleached sand or laterite. The acidity or alkalinity of the soil is also a factor of some importance in the distribution of land snails and may often account for the local occurrence of certain species. Atkins and Lebour found in Ireland that snails with hyaline shells may occur on soils showing a wide range of acidity, while those with calcareous shells are restricted to more alkaline situations. Granite and quartzitic regions possess few species, basaltic districts are decidedly richer, and in limestone areas both species and individuals are very numerous.[2]

In his discussion of the causes which might be responsible for the poverty of the molluscan fauna of the Congo, E. Dupont[3] dwells upon the almost total absence of lime-containing rocks over much of the Lower and Middle Congo and he furthermore calls attention to the abundance of organic matter in the flowing waters. Yet he does not believe that either of these two factors is to be blamed, for, he says, certain Congo mollusks are nevertheless able to secrete rather heavy shells. The

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[1]See Strobel, P. 1876. 'Saggio sui rapporti esistenti fra la natura del suolo e la distribuzione dei Molluschi terrestri e d'acqua dolce.' Atti Soc. Ital. Sci. Nat., XIX, pp. 19–42.

Clessin, S. 1872. 'Ueber den Einfluss kalkarmen Bodens auf die Gehäusenschnecken.' Correspondenzbl. Zool. Miner. Ver. Regensburg, XXVI, pp. 50–58.

Holdhaus, K. 1912. 'Ueber die Abhängigkeit der Fauna vom Gestein.' Verh. VIII. Internat. Zool. Kongr. Graz (1910), pp. 726–744.

[2]Atkins, W. R. G. and Lebour, M. V. 1923. 'The hydrogen ion concentration of the soil and of natural waters in relation to the distribution of snails.' Scientif. Proc. Roy. Dublin Soc., N. S., XVII, pp. 233–240.

[3]Dupont, E. 1891. 'Sur des Mollusques vivants et postpliocènes recueillis au cours d'un voyage au Congo en 1887.' Bull. Ac. Sci. Belgique, (3) XX, (1890), pp. 559–566.

scarcity of terrestrial species he attributes chiefly to the yearly grass fires which restrict mollusks to certain protected areas, notably to the woods. Since, however, these animals are not, generally speaking, much more abundant in the African lowland rain forest than in the savanna, we fail to see how grass fires alone can account for the poverty of the fauna, although we fully recognize the influence of this factor. Undoubtedly, several ecological conditions concur to render our territory unfavorable for molluscan life, but for the present we are inclined to regard the extreme scarcity of lime in the soil as of foremost importance. A brief discussion of soil conditions in the Congo seems therefore quite in order.

The subsoil of the Belgian Congo consists of a base of old crystalline or metamorphic rocks of Archæan or early Palæozoic age. Toward the periphery of the Congo basin these older rocks come near the surface either as massive blocks or as much distorted, folded, and tilted strata. At one time they formed there mountain ranges which are now, however, much denuded and worn down to moderately high ridges or to extensive peneplains. Only in Katanga and in the highlands along the eastern border of the Belgian Congo are the outcrops of older rocks more rugged, due to recent fault movements of considerable amplitude in the region of the Albertine Rift. In the central, flattened, and more or less bowl-shaped portion of the Congo basin, the older rocks are buried beneath great thicknesses of horizontal sandstones and shales of continental or lacustrine origin and mostly of Permo-Triassic age, which cover about three-quarters of our territory. Similar non-marine strata also form the high plateaus of Katanga. In a narrow strip, not much over twenty miles wide, along the Atlantic coast, there are marine posits of Cretaceous or early Tertiary age. Whenever exposed to the meteoric agents, the weathering of all these rocks is extremely rapid under the combined action of heavy rains and uniformly high temperature, so that the bed-rock is as a rule hidden beneath thick layers of detrital products. According to the nature of the bed-rock, alteration *in situ* will produce either sand or clay and frequently leads to that peculiar, much leached tropical surface soil known as "laterite," which covers much of the country in the northern and southern portions of our territory. Laterite is a rock of somewhat variable composition, usually a mixture of hydrated oxids of iron, which give it a reddish or brown color, and hydroxids of aluminum, titanium, and rarely manganese. It is a residual accumulation resulting from the removal in solution from the rocks affected of combined silica, lime, magnesia, soda, and potash. Such soil, of course, can hardly sustain snail-life at all and, as it covers very great areas of the Congo, its predominance goes far to explain the general poverty of molluscan life in these regions.[1]

Outcrops of older rocks form locally residual hills ("Inselberge") of granite and gneiss, as in the peneplains of the northeastern Congo (Pl. LIV, fig. 1), dykes and ridges of quartz, as in the Crystal Mountains of the Lower Congo, rocky ledges in river beds, especially in the neighborhood of the numerous falls and rapids, or cliffs bordering certain ravines. Limestone or rocks that are rich in lime are rarely met with at or near the surface. They are perhaps more frequently found in the Lower Congo, between Matadi and Leopoldville, in the region occupied by Cornet's Palæozoic "Schistocalcareous System." This aggregate of strata consists for a large part of pinkish and gray dolomites, oölithic limestones, sandstones, schists, argillaceous limestones, etc. The limestones often form prominent landmarks or picturesque cliffs, such as the rocks of the Zole Pass, of the "Montagnes de Marbre," of Bafu, of Lamba, of Dia Bavo, of Mt. Kinsundi, and the magnificent cliffs of white, gray, and blue marbles at the left of the old caravan road between Nsona Kibaka and Lukungu. A number of caves are excavated in these calcareous rocks, notably in the region of Thysville. All these limestone outcrops should be explored malacologically at the proper season and may furnish interesting discoveries.

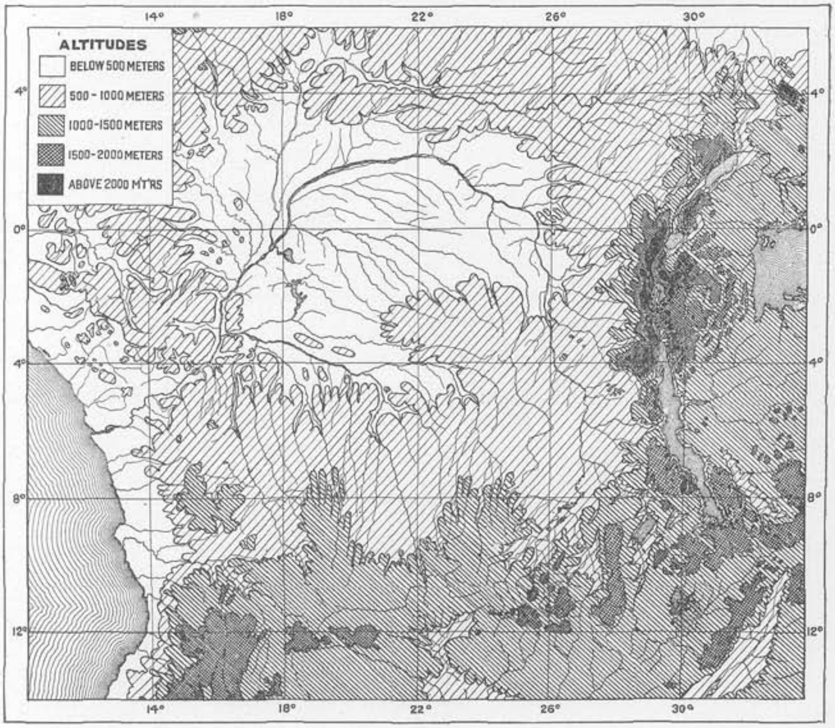
Similar limestone rocks are also present in southern Katanga, where the so-called "Kambove Beds" form an alternating series of dark to light dolomites, sandstones and shales, but the country here has passed through a much more complete cycle of erosion so that it is now worn down to a uniform peneplain, with few outcrops of unaltered bedrock. "Sinks," where running streams disappear into underground channels, and caves are sometimes found in the Katanga dolomites and such localities may be worth investigating by the malacologist.[2] Along the Aruwimi-Ituri River there are at a few points outcrops of a compact, white limestone, usually in rapids or at the shore, plunging directly into the waters of the stream. The best-known are those of Mopele (between Bomili and Avakubi) and those a few hours above Avakubi. Others, of small extent, have been noted at various points of the Upper Uele

[1]The scarcity of lime in the rocks of the Congo basin affects not only the mollusks. Van Saceghem (1919, Bull. Soc. Path. Exot. Paris, XII, pp. 238–243), for instance, attributes to the low content of calcium in the natural waters of the Belgian Congo the prevalence in that territory of osteoporosis among the equines.

[2]See Studt's map for the location of some of the outcrops of limestone in Upper Katanga. (F. E. Studt, 1908, 'Carte géologique du Katanga.' Ann. Musée du Congo, Géol., Sér. II, pt. 1, pp. 5–16, map.)

basin, as for instance near Niangara. Cliffs and hills of limestone have also been reported along the western shores of Lake Tanganyika, and it is perhaps in such places that one should look for the *Clausilia* which was described many years ago from the southern end of that lake and has not again been collected. In the narrow Atlantic coast strip of recent Mesozoic and early Tertiary strata, the molluscan fauna appears to be exceptionally rich wherever the soft, calcareous sandstones of these formations come at or near the surface. In such a location, at Zambi, Mr. H. Lang and the junior author collected many hundreds of specimens of land snails representing some eleven species. In the eastern Congo too, calcareous marls or sandstones of fresh-water origin and of very recent, Pleistocene or perhaps post-Pleistocene age, form much of the subsoil of the plain at the southern end of Lake Edward and extend into the hills farther south to beyond Rutshuru. These strata contain many fossil shells which are often well preserved and appear to belong to the same fluviatile species as live nowadays in Lake Edward. In certain of the ravines which cut through these lacustrine deposits, abundant collections of land snails may occasionally be made. Thus, no less than twenty-four species of terrestrial mollusks were obtained by the junior author during about six weeks stay at Rutshuru. Finally, the extraordinary richness in molluscan life of the Kivu volcanoes is certainly partly due to the abundance of lime-containing minerals associated with weathered eruptive ashes and lavas.

The topography of the country (Map 9) is not without its importance for the distribution of slow-moving, strictly terrestrial animals such as land snails and slugs. Where the country is level or but little and gently undulating, as is the case over easily two-thirds of the Belgian Congo, the environment is very uniform and there are few obstacles to dispersal over large areas. This factor, together with the similarity in climate and vegetation throughout the rain forest and savannas of the Congo lowlands, may explain the wide horizontal distribution of certain species. In higher and more rugged country, conditions are much more favorable for variation, isolation, and consequent intense speciation. This is quite conspicuous in the eastern highlands of the Belgian Congo, where every mountain range or peak, every ravine may yield peculiar forms, while the several slopes, exposed to different climatic conditions, often exhibit conspicuous faunal peculiarities. As so very few of the mountains and valleys of the eastern highlands of the Congo have thus far been investigated, it is safe to prophesy that several hundreds of species of terrestrial mollusks will yet be discovered there. In the present state of faunistic studies the mollusks show more distinct faunal features in these highlands than any other group of animals, and are as peculiar as the vegetation. Of course, much of the distinctiveness of the molluscan fauna of mountainous regions is traceable to the formation of life zones with increasing altitude.




Map 9. Orographic map of the Belgian Congo.

Redrawn under the direction of J. P. Chapin from map No. 2895, Geogr. Section, Brit. Gen. Staff, 1918.

But little is known at present of the ecological relations of Congo land mollusks with other organisms, and this is especially true of their feeding habits. The Helicidæ, Achatinidæ, Zonitidæ, Urocyclidæ, Enidæ, Vaginulidæ, and land operculates are mostly vegetarians, at least under normal conditions, but which species commonly attack living parts of plants we are unable to tell at present. It is certain that many of the Zonitidæ, Vaginulidæ, and Cyclophoridæ are merely scavengers, feeding upon decaying vegetable matter. Some of the large Achatinidæ, however, destroy living vegetation and may thus occasionally become pests of some economic importance. The African *Achatina fulica* (Férussac), introduced into Ceylon about 1900, has become so abundant there as to be a serious menace to agriculture.[1]

Vegetarian mollusks show decided preferences in the choice of their food, as is well known to all who have to deal with them as pests in gardens. In nature certain plants appear to be adequately protected against their depredations and Stahl has written a suggestive account of the various methods by means of which this is accomplished.[2] It is, however, difficult to accept Stahl's contention that plant-eating mollusks are usually in a famished condition, because many plants are so effectively protected against their attacks. This view certainly fails to account for the prodigious numbers of vegetarian snails and slugs found in certain localities.[3] Moreover, many snails and slugs are extremely partial to fungous food, even devouring without apparent harm fungi that are decidedly poisonous to man. Some slugs have a specialty of feeding on lichens, which they crop off from tree trunks.[4]

It has been asserted that in some cases terrestrial mollusks are instrumental in the pollination of certain flowers with openly exposed stamens and styles, the pollen adhering to the crawling snails and being thus carried upon the style. But whether there are flowers that could truly be called "malacophilous," because they normally rely upon these animals for their pollination, appears somewhat doubtful.[5]

The Streptaxidæ are all rapacious snails and perhaps the most important predaceous enemies of African land mollusks, although they occasionally attack also other soft-bodied invertebrates, such as earthworms. In the 'Review of Land Mollusks' the senior author has called attention to the extraordinary development of that family in Africa, where it probably numbers more species than any other. Terrestrial

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[1]Paravicini, E. M. M. 1922. 'Over schadelijke en nuttige weekdieren van tropisch Azië.' Teysmannia, XXXIII, pp. 24–28, Pl.
Gibbons (1879, Journ. of Conchology, II, p. 143) has reported that *Achatina panthera* may exceptionally become carnivorous.

[2]Stahl, E. 1888. 'Pflanzen und Schnecken. Biologische Studie über die Schutzmittel der Pflanzen gegen Schneckenfrass.' Jenaische Zeitschr. Naturw., XXII, pp. 557–684.

[3]Stahl's views have been critically examined by Heikertinger, F. 1914. 'Ueber die beschränkte Wirksamkeit der natürlichen Schutzmittel der Pflanzen gegen Tierfrass.' Biol. Centralbl., XXXIV, pp. 81–108.

[4]Elliott, W. T. 1923. 'Some observations on the mycophagous propensities of slugs.' Trans. British Mycol. Soc., VIII, pp. 84–90.
Ráthay, E. 1898. 'Ueber den "Frass" von *Helix hortensis* auf Baumrinden.' Zeitschr. f. Pflanzenkrankh., VIII, pp. 129–133.

[5]See Ludwig, F. 1891. 'Die Beziehungen zwischen Pflanzen und Schnecken.' Beihefte z. Bot. Centralbl., I, pp. 35–39.
Zaunick, R. 1916. 'Die Befruchtung der Pflanzen durch Schnecken.' Nachrichtsbl. Deutsch. Malakoz. Ges., XLVIII, pp. 74–91.
Ehrmann, P. 1917. 'Zur Frage der Bestäubung von Blüten durch Schnecken.' Nachrichtbl. Deutsch. Malakoz. Ges., XLIX, pp. 49–75.

mollusks are comparatively free from the attacks of other predaceous enemies, since they are well protected either by a calcareous shell or by an abundant slimy secretion of the skin. In many cases, too, the peculiar coloration and the arrangement of the markings upon the shell undoubtedly add to the difficulty of locating them in their natural environment, even if the pattern appears to be particularly showy in collections.[1] The secretive habits of most snails and slugs also contribute to their personal safety; many species are strictly nocturnal or crawl about during rainstorms only, when most of their potential enemies are inactive.[2]

Among arthropods, certain carnivorous beetles appear to be quite efficient enemies of snails. Récluz, in Southern France, observed *Staphylinus olens* Müller attacking *Helix ericetorum*, the snail being slowly killed by repeated bites. Certain Carabidæ do likewise and the Cychrinæ in particular appear to specialize in snails, their long, snout-like head allowing these beetles to reach far into the coils of the spire. The family Thelephoridæ contains many species whose larvæ feed exclusively upon snails. Lucas observed in Algeria how the larva of *Drilus mauritanicus* Lucas manages to enter the shell of live *Cyclostoma*, in spite of the operculum with which the aperture can be tightly closed. The larva patiently awaits the moment when the snail brings the operculum ajar, then suddenly wedges its mandibles between the operculum and the edge of the aperture, and attacks the muscle which fixes the operculum to the foot, so that the aperture can no longer be locked. It then leisurely devours the contents of the shell.[3] The common European *Drilus flavescens* (Rossi) and the rarer *D. concolor* Ahrens have similar habits: their larvæ destroy large quantities of *Helix nemoralis*, *H. ericetorum*, and many other Helicidæ.[4] Snail-eating habits are common

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[1]The vexed question of the efficacity of protective coloration in nature cannot be discussed here. So far as terrestrial mollusks is concerned, it is briefly treated by A. H. Cooke, 1895, 'Molluscs' (Cambridge Natural History, III), pp. 66–74. See also Taylor, J. W., 1894–1900. 'Monograph Land Freshw. Moll. Brit. Isl., Struct. Gen. Vol.,' (Leeds), pp. 327–332.

[2]See an interesting, though ancient, account by Petit de la Saussaye, S. 1852. 'Des ennemis des limaçons, ou des causes qui s'opposent à leur trop grande multiplication.' Journ. de Conchyl., III, pp. 97–106.

The junior author recently published an account of the arthropod enemies of mollusks, to which the reader may be referred for more details and a complete bibliography. See Bequaert, J., 1925. 'The arthropod enemies of mollusks, with description of a new dipterous parasite from Brazil.' Journ. of Parasitology, XI, pp. 201–212. (Reprinted with additions in 1926, 'Medical Report of the Hamilton Rice Seventh Expedition to the Amazon, in conjunction with the Department of Tropical Medicine of Harvard University,' pp. 292–303.)

[3]Lucas, H. 1842. 'Sur une nouvelle espèce du genre *Drilus* qui habite le nord de l'Afrique.' C. R. Ac. Sci. Paris, XV, pp. 1187–1189.

[4]Mielzinsky, I. 1824. 'Mémoire sur une larve qui dévore les *Helix nemoralis* et sur l'insecte auquel elle donne naissance.' Ann. Sc. Nat., I, pp. 67–77, Pl. VII.

Crawshay, L. R. 1903. 'On the life-history of *Drilus flavescens* Rossi.' Trans. Ent. Soc. London, pp. 39–51, Pls. I–II.

Rosenberg, E. C. 1909. '*Drilus concolor* Ahr.: Hunnens Forvandling i Skallen af *Helix hortensis*.' Entom. Meddel., Kopenhagen, (2) III, pp. 227–240, Pls. IV–V.

Schmitz, H. 1909. 'Zur Biologie von *Drilus flavescens* Fourcr.,' Bericht. Nederl. Ent. Ver., II, pp. 301–305.

with the larvæ of Drilinæ and Lampyrinæ, the latter being well known as fire-flies and glow-worms. The mouth-parts of the larvæ of many Lampyrinæ exhibit three remarkable features that may be regarded as adaptations to a snail diet. The mandibles are curved and very sharp and provided with an inner channel by means of which the insect injects in the snail a fluid that possesses toxic, paralyzing and digestive properties. The external mouth-parts are densely hairy and imbibe the partly digested tissues of the snail. The pharynx has a bivalve structure acting as a suction pump.[1] Godard (quoted by Petit de la Saussaye, 1852, p. 101) describes how the adult *Silpha lævigata* Fabricius and *S. atrata* Linnæus, European beetles of the family Silphidæ, break the shell of small *Helices* which form a large part of their food. The beetle grasps the margin of the aperture between the mandibles and, suddenly jerking back the head, pounds the shell against the hard, chitinous plate of the prothorax.

In the order Diptera. the larvæ of certain muscoid flies feed upon terrestrial snails. Many valuable observations have been made in recent years on these insects, notably by H. Schmitz and D. Keilin[2] who have published useful accounts of all cases recorded thus far. Some of these flies, such as the house-fly (*Musca domestica* Linnæus )and many species of *Sarcophaga,* are undoubtedly but accidental parasites of snails, as their larvæ live under a variety of other conditions. Others, however, appear to be restricted to snails. The best known of these is *Melinda cognata* (Meigen) in Europe: its larva is a specific internal parasite of living Helicidæ; the eggs are laid in the mantle cavity of the snail; upon hatching the young larva bores into the kidney, where it lies with

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[1]One of the best accounts of the methods used by the larva of the European *Lampyris noctiluca* to attack snails, is that of Newport, G. 1857. 'On the natural history of the glowworm (*Lampyris noctiluca*).' Journ. Proc. Linn. Soc. London, Zool., I, pp. 40–71. The older literature has been brought together by Rupertsberger, M. 1880. 'Biologie der Käfer Europas.' (Linz a. d. Donau), pp. 165–170.

See also Bugnion, E. 1922. 'Etudes relatives à l'anatomie et à l'embryologie des vers luisants ou Lampyrides.' Bull. Biol. France et Belgique, LVI, pp. 1–53.

Cros, A. 1924. '*Pelania mauritanica* L. Variations, mœurs, évolution.' Bull. Soc. Hist. Nat. Afrique du Nord, XV, pp. 10–52.

[2]Schmitz, H. 1917. 'Biologische Beziehungen zwischen Dipteren und Schnecken.' Biol. Zentralbl., XXXVII, pp. 24–43.

Keilin, D. 1919. 'On the life-history and larval anatomy of *Melinda cognata* Meigen parasitic in the snail *Helicella* (*Heliomanes*)*virgata* Da Costa, with an account of the other Diptera living upon mollusks.' Parasitology, XI, pp. 430–455, Pls. XXII–XXV.

1921. 'Supplementary account of the dipterous larvæ feeding upon mollusks.' Parasitology, XIII, pp. 180–183.

Spärck, R. 1920. 'Om Larven til *Philosepedon humeralis* Meig. (Dipt. Psychodidæ).' Entom. Meddel., Kopenhagen, XIII, pp. 120–127. (Saprophagous in dead land snails).

Rostand, J. 1920. 'Sur la biologie de *Sarcophaga filia* Pandellé.' Bull. Soc. Ent. France, pp. 215–216. (Apparently a true parasite of live *Helix*).

Séguy, E. 1921. 'Les Diptères qui vivent aux dépens des escargots.' Bull. Soc. Ent. France, pp. 238–239.

Mokrzecki, S. 1923. 'Ueber den Parasitismus von Fliegen im Körper von Land-Schnecken.' Zeitschr. Wiss. Insektenbiol., XVIII, pp. 135–137.

Another interesting record is that of L. Mercier (1921, Ann. Soc. Ent. Belgique, LXI, p. 164) who bred the sciomyzid *Salticella fasciata* (Meigen) from living *Helix pisana* in France.

its posterior end, bearing the spiracles, protruding into the mantle cavity; later the larva, having destroyed the kidney, attacks the liver and finally all the other organs of its victims. About that time the snail dies and shortly afterward the full-grown larva leaves the shell and penetrates into the earth, where it becomes a puparium from which about fourteen days later the adult fly emerges. The life-history of most of the other dipterous parasites of mollusks still remains to be worked out. They should be carefully distinguished from the numerous saprophagous or scavenger species which merely oviposit on dead snails and slugs. Phoridæ especially may be bred in large numbers from decaying mollusks. The remarkable epizoic Phoridæ (*Wandolleckia*) which occur upon the African forest *Achatinæ* have been treated by the junior author in the 'Review of Congo Land Mollusks.'[1]

In connection with the internal parasites of terrestrial snails and slugs mention should be made of the various Protozoa[2] and worms that are found in them. The worms usually are larvæ of cestodes or trematodes that later reach the adult stage in snail-eating vertebrates, particularly in certain birds. Certain nematodes too (*Rhadbitis*) are known to inhabit the intestine of *Arion* and the salivary glands of *Limax agrestis*.

Several species of mites (Acarina) infest land mollusks. They are commonly found on *Limax maximus* and on several of the European Helicidæ, retiring upon occasion into the pulmonary chamber.[3] The junior author also found mites, together with *Wandolleckia*, on a large *Achatina* of the Semliki forest.

Ants have also been accused of destroying snails,[4] but we have not been able to find observations showing this to be actually the case. The shells, which are frequently found on or near the mounds of certain ants, are probably dead specimens gathered, together with pebbles, bits of wood, etc., in order to build a protective cover at the entrance of the nest.

The vertebrate enemies of terrestrial mollusks are rather numerous, as snails and slugs "constitute a favorite and nourishing food for many animals, their defenceless conditions and sluggish movements rendering them an easy prey to many creatures besides man, their only protection being the distastefulness of certain species, or their power of concealment,

[1]1919, Bull. American Mus. Nat. Hist., XL, pp. 61–63.
[2]See Kühn, M. 1911. 'Die Trypanoplasmen und deren Verbreitung in einheimischen und ausländischen Schnecken.' Schrift. Phys.-ökon. Ges. Königsberg, LII, 1, pp. 63–89.
[3]A. H. Cooke. 1895. 'Molluscs' (Cambridge Natural History, III), p. 62.
[4]Lawson, A. K. 1920. '*Vitrea* and *Pyramidula* destroyed by ants.' Journ. of Conchology, XVI, 4, p. 127.

as their shell only affords protection against their weaker or less astute enemies."[1]

Among the amphibians, frogs and toads in Europe are said to devour considerable quantities of snails and slugs, so that they may conveniently be employed to clear gardens of such pests.[2] Terrestrial mollusks were found by Kirkland[3] to constitute one per cent of the total contents of 149 stomachs of the American toad, *Bufo americanus* Holbrook, both slugs and snails being taken. The amphibians of tropical Africa do not appear to be very efficient mollusk-hunters, as may be seen from the data contained in the subjoined table, based upon Mr. G. K. Noble's dissections of a considerable number of frogs and toads collected in the Congo by Lang and Chapin.[4] More than 550 stomachs belonging to some 45 species were examined, but mollusks were only recognized in a few cases, namely in certain species of *Bufo*, *Rana*, *Leptopelis*, and *Arthroleptis*.

| | Number of Stomachs with Recognizable Food | Total Number of Animals Eaten | Number of Mollusks |
|---|---|---|---|
| *Bufo regularis* Reuss | 31 | 982 | 4 |
| " *polycercus* Werner | 53 | 793 | 1 |
| *Arthroleptis variabilis* Matschie | 17 | 425 | 5 |
| *Rana occipitalis* Günther | 25 | 65 | 2 |
| " *albolabris* Hallowell | 19 | 48 | 3 |
| " *mascareniensis* Duméril and Bibron | 24 | 50 | 2 |
| " *ornatissima* Bocage | 14 | 38 | 3 |
| " *christyi* Boulenger | 6 | 11 | 1 |
| " *oxyrhynchus* A. Smith | 9 | 11 | 2 |
| *Leptopelis aubryi* (A. Duméril) | 25 | 36 | 7 |

It would appear from these figures that mollusks are only a very secondary item in the diet of Congo amphibians. This is, we believe, to be attributed to the poverty of the land snail and slug fauna. The abundant insects offer a supply of food so readily accessible at all times that

[1] J. W. Taylor. 1894–1900. 'Monograph Land Freshw. Moll. Brit. Isl., Struct. Gen. Vol.,' (Leeds), p. 416.

[2] Noël, P. 1891. 'Destruction des limaçons par le crapaud et la grenouille.' Rev. Sc. Nat. Ouest, I, pp. 261–262.

[3] 1904, U. S. Dept. Agric. Farmers' Bull. No. 196, p. 8.

[4] See also Noble, G. K. 1924. 'Contributions to the herpetology of the Belgian Congo based on the collection of the American Museum Congo Expedition, 1909–1915. Part III.' Bull. American Mus. Nat. Hist., N. Y., XLIX, pp. 147–347, Pls. XXIII–XLII.

amphibians need not search for the few and well-hidden mollusks. The somewhat larger proportion of mollusks in the stomach contents of the several species of *Rana* was perhaps mostly made up of aquatic snails. *Leptopelis* alone would deserve to be more carefully investigated in respect to its molluscan diet.

Some interesting data on the food of Congo reptiles are given by K. P. Schmidt.[1] Of the 36 species obtained by Lang and Chapin, only four showed molluscan remains in the stomach. They were very rare in *Agama colonorum* Daudin (remains of *Subulina* in one of 24 stomachs examined), *Mabuya maculilabris* (Gray) (small snails in one of 9 stomachs), and *M. polytropis* Boulenger. On the other hand, *Varanus niloticus* (Linnæus), the common tropical African monitor, has, in the Congo basin at least, largely taken to a molluscan diet, as shown by Lang and Chapin's records of stomach contents. Of five adult specimens of the Ituri forest four contained remains of large, crushed land snails; in two cases no other food was present and, in one of these, four specimens of a large *Achatina* filled the stomach. The additional food consisted chiefly of crabs, fish, and a water snake. Juvenile monitors contained mostly insects, in one case also four large slugs. Observations in other parts of Africa have shown that this monitor feeds on a great variety of substances. Yet Mr. K . P. Schmidt is of opinion that the strongly modified dentition in this species, in which the posterior teeth are developed into broad, round crushers, is correlated in the Congo forest with the diet of mollusks and crabs.[2] It would be of some interest to investigate in how far the other tropical African monitor, *Varanus exanthemicus* (Bosc), in which the posterior teeth are much more slender and conical, has a different diet. In one of the nine species of Congo chameleons, *Chamæleon ituriensis* Schmidt, a snail was found in one out of three stomachs examined.

Many insectivorous birds in Europe and North America make land mollusks a staple article of their diet during the winter months, this being especially true of the starling (*Sturnus vulgaris* Linnæus), fieldfare (*Turdus pilaris* Linnæus), redwing (*T. iliacus* Linnæus), bearded titmouse [*Panurus biarmicus* (Linnæus)], reed bunting (*Emberiza schœniclus* Linnæus), and titlark (*Anthus* sp.). It is on such occasions that these various song-birds become infected with the flukes that live as cercariæ in terrestrial snails and slugs (see p. 88). The song thrush (*Turdus musicus* Linnæus), however, feeds at all times largely upon *Helices*,

[1]Schmidt, K. P. 1919. 'Contributions to the herpetology of the Belgian Congo based on the collection of the American Museum Congo Exepdition, 1909–1915. Part I.' Bull. American Mus. Nat. Hist. N. Y., XXXIX, pp. 385–624, Pls. VII–XXXII.
[2]See K. P. Schmidt, 1919, Bull. American Mus. Nat. Hist., XXXIX, pp. 488–489. The peculiar dentition is illustrated, fig. 10*A*, *B*.

"seizing the shell by the outer lip, and striking it repeatedly against a stone until broken, or fixing the shell in some suitable crevice and pecking at it until fractured, a particular stone being often selected to which the shells are carried for the purpose of being broken thereon. These sacrificial stones known as 'thrushes' altars,' are usually in open positions and easily recognized, not only by their slimy surface and the shell-fragments adherent thereto, but by the little heaps of broken shells which are strewn around them."[1] In North America, where the starling is a rather recent introduction, this bird does not seem to have taken much to a molluscan diet.[2] In Australia, too, terrestrial mollusks are but little used as food by birds. Cleland[3] mentions that on one occasion seven small land snails (*Nanina marmorata* Cox) were found, together with seeds, in the stomach of a pigeon, *Leucosarcia picata* (Latham).

The following data concerning the molluscan food of birds in the Belgian Congo have been kindly furnished by Dr. J. P. Chapin.

"The gastropods living out of water we found to be preyed upon by far more species of birds than were those of aquatic habits. Yet in no case was a bird's diet restricted to mollusks, nor did they ever form any large part of its food. In brief, it seemed as though some insectivorous species, and others of mixed diet, occasionally picked up snails or slugs along with other organisms; and still less often a seed-eating bird, like a ground-dove, or even a fruit-eater, such as a turaco or a barbet, would do the same. Passerine birds but seldom ate mollusks, partly because the Passeres are more apt to be arboreal, and less likely to come upon snails, and still more, I believe, because they find them slimy and distasteful.

"More detailed notes from stomach examinations are given under the respective species.

"*Guttera edouardi sethsmithi* Neumann. The crops and stomachs of three of these blue-spotted Guinea fowl were opened. Two had eaten nothing but manioc root, the third had had a more varied meal, consisting of many fruits, some of them starchy, 4 small snails, 2 millipedes, a spider, 2 hemipters, 3 large termites, and a large ant.

"*Guttera plumifera schubotzi* Reichenow. Crops and stomachs of fifteen individuals were investigated. In most cases vegetable food predominated, one of the most characteristic things eaten being a bright blue, three-chambered seed-capsule from some ground-plant. Among the animals eaten, foremost come the snails,

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[1]Taylor, J. W. 1894–1900. 'Monograph Land Freshw. Moll. Brit. Isl., Struct. Gen. Vol.,' (Leeds), p. 418. This author figures shells of *Helix nemoralis*, illustrating the manner in which they are broken by thrushes.

[2]See Kalmbach, E. R., and Gabrielson, I. N. 1921. 'Economic value of the starling in the United States.' U. S. Dept. Agric. Bull. No. 868, pp. 1–66, 1 Pl. Mollusks formed but 1% of the annual food and were mostly *Melampus* of the salt marshes, in certain birds along the Connecticut shore.

[3]Cleland, J. B. 1918. 'The food of Australian birds.' Science Bull. No. 15, Dept. Agric. New South Wales, p. 45.

many with hard shells, but others, the helixarions,[1] with softer chitinous shells. They had been eaten by eight of the birds. Slugs were fewer in number.[2] Ants were more frequently found than insects of any other order, but among the Orthoptera were noted some small brown grasshoppers with high, keeled backs, which are found among the dead leaves of the forest floor.

"A summary of the animal food we found for *Guttera p. schubotzi* will show the abundance of mollusks: snails, 53[3]; slugs, 5; millipedes, 2; spider, 1; insects of various orders, 39. The vegetable food included seeds and small fruits, as well as leaves, the latter found only in one case.

"*Numida meleagris inermis* Dubois. Ten adults were examined of this Guinea fowl. Small stones were commonly found in the gizzard, and the food most often observed was the native millet, *Eleusine coracana*. This grain was present in abundance in the crops of five birds. A variety of other vegetable substances is consumed, roots of the sweet potato, and various seeds. A millipede and insects of various orders, numbering over 40, were listed, as well as a half-dozen small snails. The snails had all been swallowed by a single bird.

"*Excalfactoria adansonii* (Verreaux). The contents were noted of crop and stomach of eight individuals of the swamp quail. Every bird had eaten small seeds, and in five cases no other food was present. The three remaining birds had each eaten some insects, and one of them had taken a tiny snail. This quail usually inhabits far drier spots than its name would indicate.

"*Pternistes cranchi cranchi* (Leach). Examination of the crops of three bare-throated francolins from the Lower Congo showed that in each case the principal food had been small bulbs of a grass. In addition, however, one bird had eaten many termites, and another numbers of ants and one small snail.

"*Francolinus squamatus* Cassin. The food of the brown woodland francolin consists in part of cultivated plants, such as sweet potatoes, and of rice; but many other seeds are eaten, as well as fruit, and so are snails, insects, and millipedes. In the crops and stomachs of 8 individuals, vegetable food predominated, but five birds had eaten from one to several small snails apiece. A few ants, a hemipter, a caterpillar, and 2 millipedes completed the list of animal food.

"*Crecopsis agregia* (Peters). One such crake, captured in a dry field at Ngayu, Ituri district, had eaten insects and many tiny snails.

"*Sarothrura elegans reichenowi* (Sharpe). From the examination of five stomachs of this rail, it appeared that insects were most commonly eaten, including termites and a small roach. Small snails were also found in three stomachs.

"*Sarothrura pulchra centralis* Neumann. Insects form the greater part of the food, as was found in examining seven stomachs; but small snails had been eaten in three cases, small frog bones were found twice, and earthworms once. This little, rufous-headed rail is more nearly aquatic than the preceding, feeding mostly near the banks of wooded streams.

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[1]Genus *Helixarion* and allies, of subfamily Helixarioninæ.

[2]The slugs eaten were probably largely of the family Vaginulidæ, though perhaps also of the Urocyclidæ, which are found in the same region.

[3]The snails found in crops of *G. p. schubotzi* at Avakubi (July 10, 1914) belonged to eleven species, among which the following could be identified: *Nothapalus paucispira xanthophaes*, *Subulina pengensis*, *Pseudoglessula subfuscidula*, *P. cruda*, *Streptostele centralis*, *Marconia gaudioni*, *Gulella polloneriana*, *Gonaxis cavallii ituriensis* (immature), *Trochozonites* sp., *Gulella* sp., and *Pseudopeas* sp. [J. Bequaert].

"*Calopelia puella brehmeri* (Hartlaub). In seven examinations of crops and stomachs, seeds of various kinds were always found, and the only animal food consisted of 3 slugs, eaten by two of the doves.

"*Streptopelia semitorquata* (Rüppell). This large ring-dove, which often feeds on the ground, takes little else than vegetable food: seeds, starchy plant material, with fruits occasionally, while one bird had been catching winged termites in the air. In a single case some small, empty snail shells had been swallowed along with rice, probably to aid in grinding it in the gizzard. So we cannot say that the present species eats any mollusks.

"*Cercoccyx mechowi* Cabanis. The typical parasitic cuckoos are remarkably specialized toward a diet of caterpillars, which were contained in 9 out of 10 stomachs of the present species. Other insects were found in only two stomachs, and once a small snail with hard, conic shell.

"*Ceuthmochares æreus intermedius* Sharpe. The stomach contents of 14 individuals showed that they had devoured slightly more Orthoptera than caterpillars, and that insects of at least three other orders were eaten. Nine stomachs disclosed caterpillars, often of large size, but totalling only 13 specimens. Of Orthoptera, often large, green forms, there were 19, also in nine stomachs. Six of the cuckoos had eaten beetles; three, Hemiptera; and one a couple of large leaf-hoppers. A single slug had also been eaten.

"*Centropus leucogaster neumanni* Alexander. The coucals are much less fond of caterpillars than are the other cuckoos. In eight stomachs of this species there were only 2 caterpillars, other insects forming the bulk of the food, and being found in every case. One of the birds had eaten, in addition to insects, a frog, 3 spiders, and 5 snails. One of the snails had a thin but brittle shell, the others were helixarions, with softer shells. This species of coucal haunts only the densest thickets in the forest country.

"*Centropus anselli* Sharpe. In the stomach of a single bird, I found grasshoppers and crickets, larvæ of wasps, a caterpillar, some snails (probably helixarions, with their soft shells torn off), and a few slugs. Here again we are dealing with a bird of the forest country, living close to the ground.

"*Centropus monachus occidentalis* Neumann. Three stomachs we examined contained only grasshoppers and beetles. Schweinfurth,[1] however, credited this coucal with eating large land-snails of the genus *Limicolaria*, ingesting the shells as well.

"*Turacus schütti emini* Reichenow. The turacoes are well known as fruit-eaters, and some of the species occasionally add tender leaves to their diet. Of eleven stomachs of this common green forest turaco, only one failed to disclose fruit of some sort, and it held some other green vegetable material. One of the birds had added to its meal no less than 17 snails, mostly small. Yet these birds generally keep well up in the boughs of the trees.

"*Turacus leucolophus* (Hartlaub). All but one of the seven stomachs studied held berries or other fruits. The one exception had a fair-sized snail, swallowed with pieces of the shell. In addition to fruit, one of the birds had also eaten a small spherical flower-head. This turaco frequents the forest galleries in the northeastern savannas of Africa.

"*Halcyon albiventris orientalis* Peters. From two stomachs we took a mantis, a dragon-fly, a grasshopper, a millipede, and a small snail.

[1]1874, 'Heart of Africa,' I, p. 347.

"*Apaloderma æquatoriale* Sharpe. The African trogons differ from some of their American relatives in that they eat no fruit, but specialize in caterpillars and Orthoptera. Of 12 stomachs of this forest-dwelling species, 10 were noted as containing caterpillars; and Orthoptera were present in 7 cases, usually large, green, jumping forms, though it was rare to find more than one in a stomach. The only other things found were a single chrysalis and a helixarion with soft, flat shell.

"*Buccanodon duchaillui* (Cassin). Fruit is the principal nourishment of this barbet, and was contained in five stomachs, which otherwise showed only a single small snail.

"*Trachylæmus purpuratus elgonensis* (Sharpe). Of eleven stomachs, ten contained fruit. One bird had eaten nothing but two snails, and a second bird had a snail in the stomach, together with fruit.

"*Graucalus azureus* (Cassin). The cuckoo-shrikes are famous caterpillar-eaters; and in 8 stomachs of this species we found caterpillars in 7 instances, noting them as hairy only once. Orthoptera were present in 3 cases, a chrysalis once, and a small snail (with hard shell) once.

"*Crateropus tenebrosus* Hartlaub. Although nearly exclusively insectivorous, this babbler was found to have eaten fruit once, in an examination of 6 stomachs; and one of the birds had also eaten a single small snail.

"*Turdinus rufipennis albipectus* Reichenow. Being a ground bird of the heavy forest, the present species might be expected to pick up a minute snail now and then. But in 8 stomachs,which invariably contained insect-remains, we discovered only a single small snail. This does not reveal any pronounced taste for molluscan food.

*Geocichla princei batesi* Sharpe. Again in a ground-loving bird of the forest, we found a single small snail in examining but two stomachs, the other food consisting of insects.

"*Neocossyphus rufus gabunensis* Neumann. Another thrush of the forest undergrowth was found once to have taken a tiny, hard-shelled snail. Only three stomachs were investigated, and they also contained insects in every case: ants, beetles, and 2 caterpillars, as well as a small round millipede.

"*Aëdonopsis collsi* (Alexander). This also is a thrush, but of smaller size, living low down in the forest. Out of eight stomachs, seven contained remains of small insects and a millipede, while the eighth held some tiny snails, as well as pieces of another small millipede.

"*Laniarius luhderi* (Reichenow). We found this bush-shrike most common in the densest scrub along the northern edge of the Congo forest. In every one of the 9 stomachs opened, there were insects of some sort: beetles, caterpillars, and a leaf-hopper, as well as an isopod or "pillbug"; and two of the shrikes had each eaten a single, small, hard-shelled snail. It is not their custom to swallow any grit.

"*Lamprocolius purpureiceps* Verreaux. A strictly fruit-eating starling, which keeps usually high in the forest trees. Eleven stomachs, without exception, disclosed fruit, and yet one of them held a single small snail, in addition.

"*Malimbus rubricollis centralis* Reichenow. By no means all the weavers are granivorous, but the present species, besides being insectivorous, astonished me by seeking its food as it climbed, nuthatch-like, over the bark of the forest trees. Five stomachs all held the remains of insects, including small caterpillars, while one bird had also eaten a spider and two tiny snails. Another stomach had pieces of snail shell in it.

"*Sitagra tænioptera tænioptera* (Reichenbach). A yellow weaver, fond of river banks in the northern savanna. The diet is of seeds and insects, mixed; and our finding a bit of mollusk shell in one of the 9 stomachs examined is no proof that this bird had done more than swallow it to help in grinding its food."

Among the Mammalia many of the rodents are accused of regaling themselves upon land snails. Field mice (Arvicolidæ), in Europe and North America, consume large quantities of Mollusca, mainly *Helices*, breaking into the shell by gnawing away the side of the whorl in quite a characteristic fashion. Broken shells are often thickly strewn along their runways.[1] Rats, hedgehogs (*Erinaceus europæus* Linnæus), foxes, and even rabbits are believed to devour *Helices*, especially in winter, and some of the rodents even burrow into thick snow to gain access to hibernating snails. We know of no African mammal that shows a decided predilection for mollusks. In East Africa the common mongoose, *Mungos mungo* (Gmelin), an omnivorous animal, is said to include snails in its diet. According to Böhm[2] it breaks these by lifting them up in the forepaws and dashing them down upon a hard object.

Man himself should not be forgotten, for in some parts of the world land snails are an important item of his diet. The taste for this kind of food has always been highly developed in the countries surrounding the Mediterranean and it is quite possible that it has caused the total extinction of a number of species within historic times. At any rate, M. Pallary, who for many years has assiduously studied the snail fauna of Oran, told the junior author that in that vicinity some of the larger, local Helicidæ have within the last twenty years become exceedingly rare or practically extinct, due to heavy consumption by the Spanish settlers.

According to H. Lang,[3] in all regions visited by him in the Belgian Congo, the large snails of the genus *Achatina* "at times furnish a welcome addition to the food supply of most tribes, and in the Uele are served occasionally at the table of Europeans." He also describes the native method of preparing them.

## Zoögeographic Divisions of the Ethiopian Region

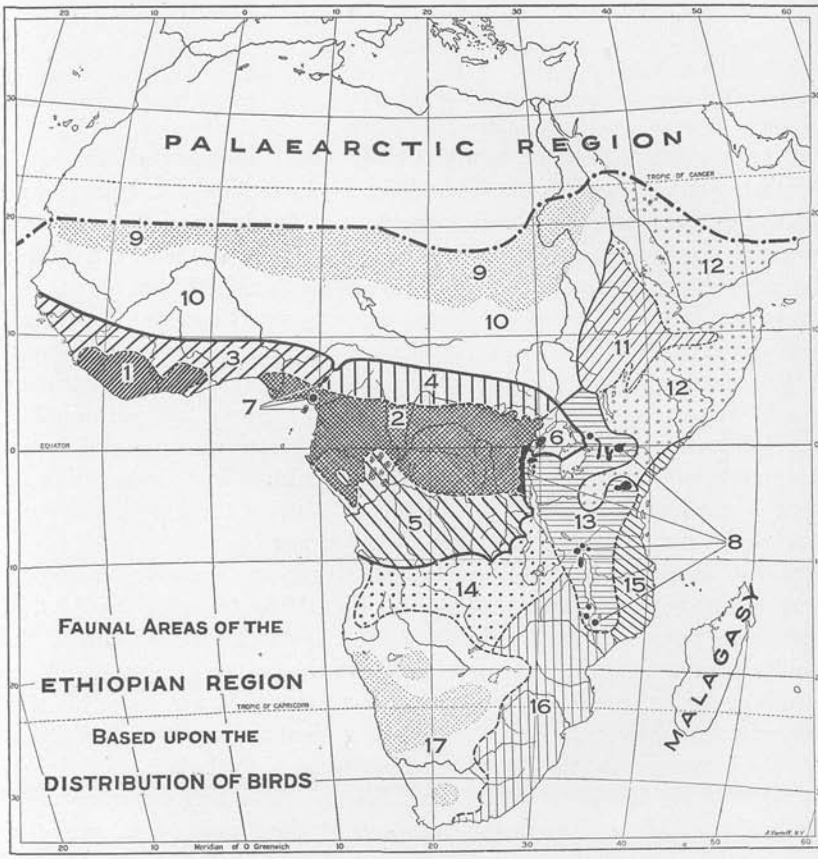
In the following ecological study of the distribution of land mollusks in the Congo we shall accept the seven main biogeographic districts into which our territory has recently been divided by J. P. Chapin.[4] Although these divisions were primarily based upon a study of birds, they neverthe-

[1]See J. W. Taylor, 1894–1900, 'Monograph Land Freshw. Moll. Brit. Isl., Struct. Gen. Vol.,' (Leeds), p. 417, where the manner in which field-mice destroy *Helices* is illustrated.

[2]Quoted by T. Noack, 1887, Zool. Jahrb., Abt. Syst., II, p. 254.

[3]1919, Bull. American Mus. Nat. Hist., XL, p. 56.

[4]J. P. Chapin. 1923. 'Ecological aspects of bird distribution in tropical Africa.' American Naturalist, LVII, pp. 106–125.

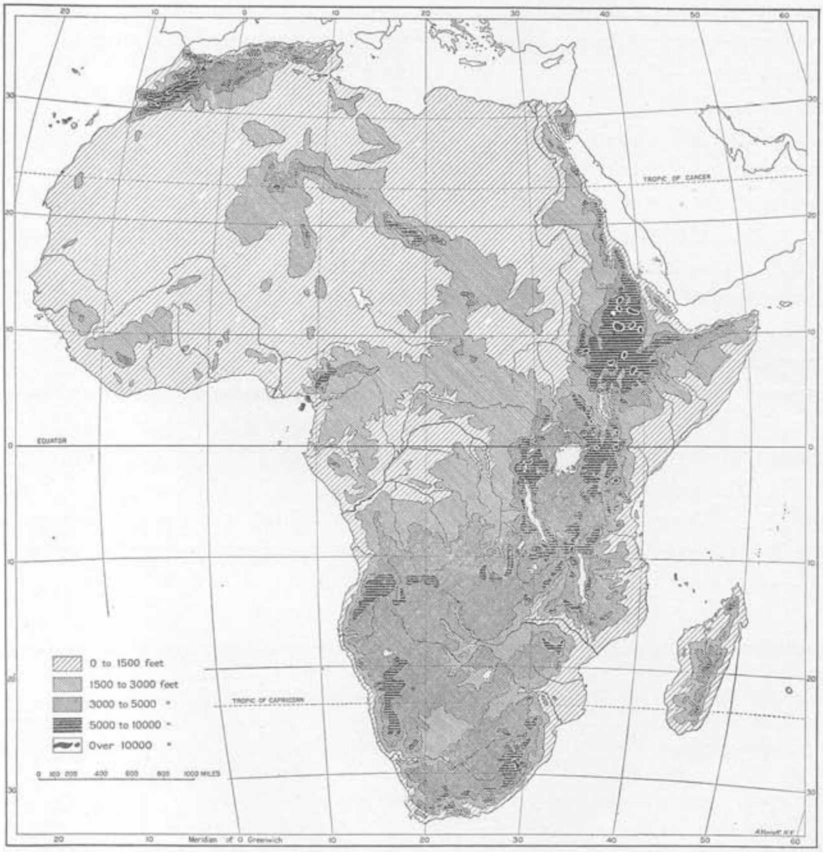



Map 10. Avifaunal map of the Ethiopian Region, prepared by J. P. Chapin.

I. West African Subregion.
  A. Guinean Forest Province.
    1. Upper Guinea Forest District.
    2. Lower Guinea Forest District.
  B. Guinean Savanna Province.
    3. Upper Guinea Savanna District.
    4. Ubangi Savanna District.
    5. Southern Congo Savanna District.
    6. Uganda-Unyoro Savanna District.
II. East and South African Subregion.
  C. Humid Montane Province.
    7. Cameroon Montane District.
    8. Eastern Montane District.
  D. Sudanese Province.
    9. Sudanese Arid District.
    10. Sudanese Savanna District.
  E. Northeast African Province.
    11. Abyssinian Highland District.
    12. Somali Arid District.
  F. Eastern and Southern Province.
    13. East African Highland District.
    14. Rhodesian Highland District.
    15. East African Lowland District.
    16. Southeast Veldt District.
    17. Southwest Arid District.

less recognize so completely the close correlation which exists in Africa between climate and vegetation on the one side, and vegetation and animal life on the other, that we believe they may be conveniently adopted as a basis for a discussion of the distribution of most other groups of animals.

The outstanding feature of Chapin's map (Map 10) is the recognition in the equatorial part of Africa of two main subregions: (1) the West African Subregion, which not only includes West Africa proper, viz., Upper and Lower Guinea, as has been generally done, but extends inland to cover the greater part of the Belgian Congo and Uganda; (2) the East and South African Subregion, which also comprises the Sudan and Abyssinia and thus encircles completely the West African area.




Map 11. Orographic map of Africa, prepared under the direction of J. P. Chapin.

The dividing line between these two subregions as drawn on the map by a heavy black line, is of considerable biogeographic interest. A comparison with an orographic map of Africa (Map 11) shows that this line nowhere coincides with mountainous ridges which could act as barriers to the migration of plants and animals. Quite to the contrary, the boundary of the West African subregion frequently cuts across the divides of the great river systems and, where it follows such hydrographic boundaries, these are, as a rule, so low and uniform as to be inconspicuous. The present limits of the two subregions of the Ethiopian Region are entirely due to present and past climatic conditions. As Chapin expresses it, the "Western fauna owes its distinctness to ecological or climatic conditions, as comparison with the rainfall map of Africa (Map 8) will prove. It is the principal area of more than 60 inches annual rainfall; and I am led to believe—from its dependence on the most fundamental movements in the atmosphere—that such a humid area near the equator is of vast antiquity."

It is, of course, not to be expected that highly mobile animals of relatively recent evolution, such as birds and mammals, will always agree in the distribution of families and genera with the relatively sedentary and more ancient mollusks. Yet the limits of the two avifaunal main divisions of equatorial Africa proper agree fairly well with those based on the distribution of land mollusks. South of the Zambezi, however, the avifaunal districts proposed by Chapin no longer serve our purpose. The South African Subregion (Map 12) is a division as least as strongly marked as the West African, from a malacological standpoint. Its limits do not appear to coincide with those of Sharpe's South African Subregion,[1] nor with Chapin's Southeast Veldt District and Southwest Arid District.

1. West African Subregion.—The following genera of terrestrial mollusks are confined to this part of the Ethiopian Region:

Achatinidæ
- *Archachatina*
- *Columna*
- *Pseudachatina*
- *Callistoplepa*
- *Atopocochlis*
- *Pseudotrochus*
- *Perideriopsis*
- *Ceras*
- *Thomea*
- *Pyrgina*

Streptaxidæ
- *Artemonopsis*

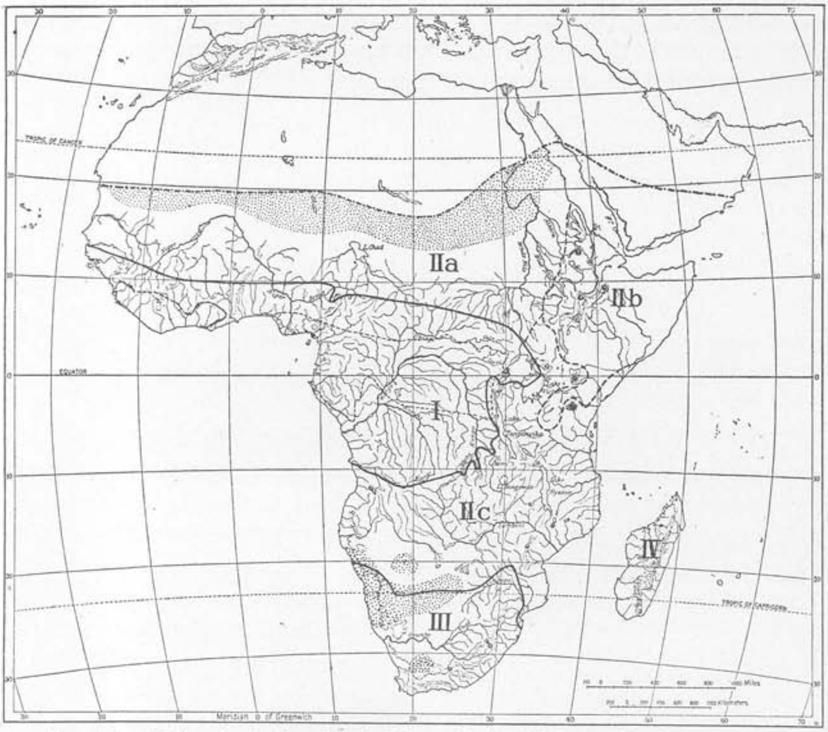
Zonitidæ
- *Trochozonites*
- *Thomeonanina*

Urocyclidæ[2]
- *Dendrolimax*
- *Aspidelus*

Thryophorellidæ
- *Thryophorella*

[1]1893, Natural Science, III, chart facing p. 108.

[2]Various other genera of Urocyclidæ and Helixarioninæ doubtless remain to be added, but the range of these groups is still very little known.




Map 12. Malacological main divisions of the Ethiopian Region.

I. West African Subregion. The limits of the continuous rain forest belt are indicated by an interrupted line.
II. East African Subregion.
 IIa. Sudanese Province.
 IIb. Northeast African Province.
 IIc. East African Province.
III. South African Subregion.
IV. Malagasy Subregion or Region.

The appearance of endemicity of the West African Subregion is further increased if we take account of its special subgenera of genera having a wider range, such as *Bocageia*, *Gulella*, and others. Moreover, it is significant that this subregion has less in common with the Oriental Region than any other part of the Ethiopian Region. The large number of special genera evolved there gives support to Chapin's belief that the "humid area near the equator is of vast antiquity."

2. East African Subregion.—The number of genera special to this subregion is much smaller than in the West or the South African Subregions, largely for the reason that the greater number of its genera range into the limits of one or both of the others. It is especially rich in genera related to those of the Oriental Region.

The following genera may be regarded as typically East African, although some of them have a few representatives in the extreme eastern portion of the West African Subregion:

Helicidæ
- *Halolimnohelix*
- *Vicariihelix*
- *Haplohelix*

Achatinidæ
- *Limicolariopsis*
- *Krapfiella*
- *Subuliniscus*
- *Mabiliella*

Streptaxidæ
- *Tayloria*
- *Colpanostoma*
- *Bloyetia*
- *Hamya*

Vitrinidæ
- *Vitrina*

Enidæ
- *Cerastus*

Pomatiasidæ
- *Tropidophora*
- *Otopoma*

3. South African Subregion.—The limits of this subregion are somewhat uncertain on account of the scarcity of data for its northern boundary, where very little collecting has been done. Roughly we take the Limpopo River in the east, though on the coast the East African Subregion probably penetrates to Delagoa Bay, and in the high interior the South African may extend some distance into Matabeleland. In the arid central and western veldt districts, the Tropic of Capricorn is taken in the absence of definite boundary. Toward the coast of the Atlantic the South African forms run farther north in Damaraland, probably about to 21° southern latitude. It should be noted that our South African Subregion in no way coincides with the Southwestern Cape Region generally accepted by botanists, which covers but the southwestern part of Cape Colony (see the botanical map of Africa, after Engler, in J. Bequaert, 1918, Bull. Amer. Mus. Nat. Hist., N. Y., XXXIX, p. 19).

Genera restricted to the South African Subregion are as follows:

Acavidæ (Dorcasiinæ)
- *Dorcasia*
- *Trigonephrus*
- *Tulbaghinia*

Achatinidæ
- *Metachatina*
- *Cochlitoma*
- *Hypolysia*
- *Xerocerastus*
- *Cœliaxis*

Rhytididæ
- *Natalina*

Aperidæ
- *Apera*

Zonitidæ
- *Kerkophorus*
- *Microkerkus*

Arionidæ (?)
- *Oopelta*

Endodontidæ
- *Afrodonta*
- *Phortion*
- *Trachycystis*
- *Sculptaria*[1]

Clausiliidæ
- *Austrobalea*

Pupillidæ
- *Fauxulus*

Cyclophoridæ
- *Chondrocyclus*

Amnicolidæ
- *Tomichia*

[1]Family uncertain.

The South African molluscan fauna is remarkably heterogeneous, in part composed of families elsewhere unrepresented in the Ethiopian Region. Many of them are well adapted to the peculiar arid or semi-arid environment, which may have contributed much to preserve the individuality of the fauna. Yet the presence of a large number of peculiar genera could by no means be accounted for by present-day ecological conditions. The general relationships of the genera may be stated briefly as follows.

(*a*) Generally spread Ethiopian groups, including all the Achatinidæ, except *Zootecus*; the Urocyclidæ, Streptaxidæ, and Veronicellidæ (Vaginulidæ).

(*b*) Groups chiefly East African, most of them extending into the Oriental Region, and some of the Pupillidæ into the Palæarctic· Zonitidæ, Enidæ, *Pupoides, Microstele, Pupilla, Nesopupa, Truncatellina, Lauria, Zootecus*, and *Tropidophora*.

(*c*) Genera most nearly related to those of the Palæarctic Region: *Fauxulus* and *Austrobalea*. As one of us has pointed out, *Fauxulus* appears to belong close to the European *Abida* and *Chondrina*, and to be without near relatives elsewhere. It appears to have been established a long time, as there are several strongly marked subgenera.[1] *Austrobalea* is a recently proposed genus for *Balea africana* Melvill and Ponsonby. This is evidently not a *Balea* and not closely related to that genus; but its affinities remain uncertain, though evidently with some Palæarctic or Oriental Clausiliidæ.

(*d*) Families characteristic of the Australian Region: Rhytididæ, Aperidæ, and Endodontidæ.

The family Rhytididæ, elsewhere Australasian, comprises many species of *Natalina*, a genus which may perhaps require division. The shell-less Aperidæ are believed to be a much modified branch of the same stock, and this family has not been found elsewhere.

The family Endodontidæ is widely spread, but the South African members (about 70 species of four genera) clearly belong to Austral stocks, apparently nearest to those of Australia, Tasmania and New Zealand.

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[1]Nearly all South African Pupillidæ appear to be congeneric with, or clearly related to, species of the European middle Tertiary (Oligocene and Miocene) or recent faunæ. Thus *Truncatellina* and *Lauria* are merely distinguishable specifically; but both genera occur also in Abyssinia and on mountains of Central Africa. Similarly, *Pupilla* and *Microstele* are found in European Miocene, in the Oriental Region, in the East African Subregion, and in South Africa. *Nesopupa* is now prevalent in Polynesia, but it occurs also in the East Indies and India, in the Oligocene and Miocene of Europe, as well as in the East African Subregion. We conclude that the wide distribution of Pupillidæ, not only here, but all over the world, is due to the great antiquity of the genera. In Europe many of the recent minor divisions of genera already existed in the Oligocene.

(*e*) Genera having relatives in Madagascar, the Seychelles, Ceylon, Australia, and South America. Family Acavidæ, comprising all of the subfamily Dorcasiinæ: *Dorcasia*, *Trigonephrus*, and *Tulbaghinia*. The "Gondwana" distribution of this family of large helicoid and bulimoid snails has been suggested by one of us[1] and discussed at length by Connolly[2]; also by von Ihering[3] and by Hedley,[4] who suggested an Antarctic origin for the group. It does not appear likely that existing Acavidæ are survivors of a group formerly living in the northern continents. No traces of such distribution have been found in the Tertiary or Mesozoic.

We have in South Africa, therefore, in addition to the widespread Ethiopian genera and their derivatives, a series of forms (Acavidæ, Rhytididæ, and Endodontidæ) which have been regarded as vestiges of a Mesozoic Gondwana distribution; a few highly peculiar forms of uncertain affinities (*Cœliaxis* and *Sculptaria*); and a group of Pupillidæ of Palæarctic affinities.[5]

The island of St. Helena may form a province of the South African Subregion. Its chief land mollusks are the genera *Chilonopsis* (Achatinidæ), *Helenoconcha* (Endodontidæ), *Nesopupa* and *Campolæmus* (Pupillidæ), and *Succinea*.[6]

## Regional Description of the Malacological Land Faunæ of the Belgian Congo

The seven zoögeographic districts of the Belgian Congo (Map 13) are further subdivisions of the two main subregions of Equatorial Africa.

In the West African Subregion we may distinguish (1) a Guinean Forest Province, represented in the Belgian Congo by the LOWER GUINEA FOREST DISTRICT; and (2) a Guinean Savanna Province represented in our territory by (*a*) the UBANGI SAVANNA DISTRICT; (*b*) the SOUTHERN CONGO SAVANNA DISTRICT; and (*c*) the UGANDA-UNYORO SAVANNA DISTRICT.

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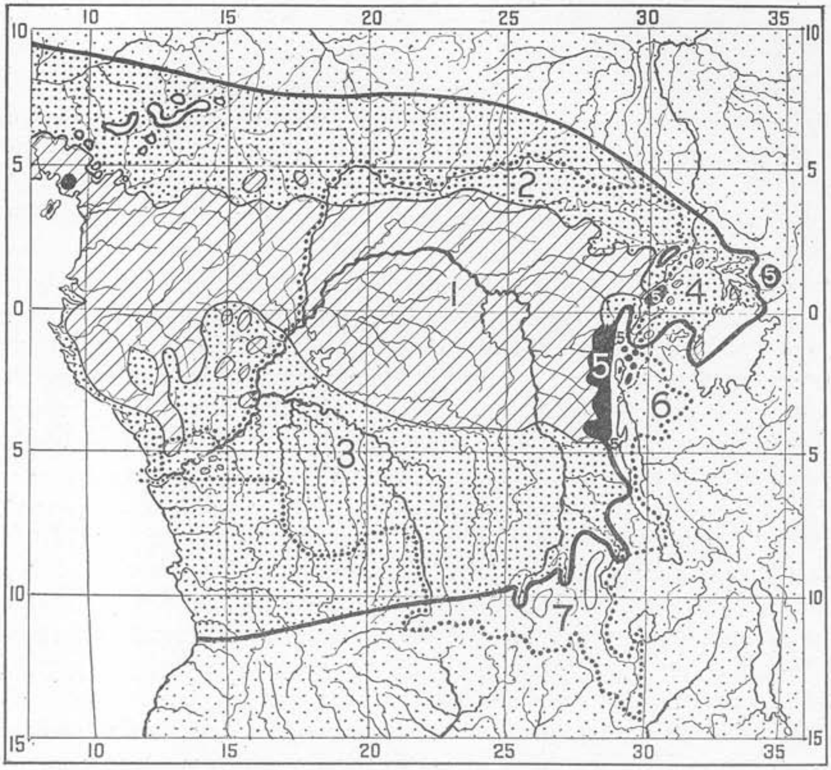
[1]Pilsbry, 1911, Rep. Princeton Univ. Exped. Patagonia, III, p. 614.
[2]Connolly, 1915, Ann. South African Mus., XIII, p. 122.
[3]H. von Ihering, 1912, Journ. Ac. Nat. Sci. Philadelphia, XV, p. 491, fig. 2.
[4]Hedley, 1899, Proc. Linn. Soc. New South Wales, XXIV, pp. 396–398.
[5]This last group has little significance. Practically all the Pupillidæ of Africa, Australia, and South America are congeneric with or closely related to those of the northern continents.
In this connection we must call attention to the inaccuracy of J. W. Taylor's zoögeographic map representing helicid distribution (1922, Journ. of Conchology, XVI, p. 288, Pl. x, opposite p. 309), reproduced by Hewitt (1923, South African Jl. Sci., XX, p. 101). An entirely different map would result from plotting the groups according to their occurrence. We do not follow Mr. Taylor in his hypothesis that Central Europe has been a great evolution center for the world, though it has been an important secondary center for certain groups, just as West Africa, the West Indies, and many other places have been.
[6]See E. A. Smith, 1892, Proc. Zool. Soc. London, pp. 258–270. Pilsbry, 1904, 'Manual of Conchology,' XVII, pp. 171–181; 1920, XXV, pp. 363–366.



Map 13. Zoögeographic regions of the Belgian Congo.

A. West African Subregion.
1. Lower Guinea Forest District.
2. Ubangi Savanna District.
3. Southern Congo Savanna District.
4. Uganda-Unyoro Savanna District.

B. East African Subregion.
5. Eastern Montane District.
6. East African Highland District.
7. Rhodesian Highland District.

The East and South African Subregion on the other hand comprises (1) a Humid Montane Province, present in the EASTERN MONTANE DISTRICT of the eastern Congo borderland; (2) a Sudanese Province and (3) a Northeast African Province, both not entering the Belgian Congo; and (4) an Eastern and Southern Province, represented in our territory by (*a*) the EAST AFRICAN HIGHLAND DISTRICT and (*b*) the RHODESIAN HIGHLAND DISTRICT.[1]

[1]This is J. P. Chapin's Angolan Highland District. We prefer to use the present term because this district occupies the major part of Rhodesia, while Angola proper (viz. the northern half of Portuguese West Africa) is entirely excluded from it.

## A. West African Subregion

### 1. Lower Guinea Forest District

The rain forest of Lower Guinea extends from west to east across the basin of the Congo as a continuous belt, approximately four degrees north and south of the equator. In its western portion, on the right bank of the Congo, this belt is considerablv narrowed, being only developed north of the equator, where it connects, moreover, uninterruptedly with the forests of Cameroon and Gaboon, the latter sending an outlier southward into the Mayombe district of the Lower Congo. In its northeastern corner the forest extends to beyond the 30th meridian and even crosses the hot and moist valley of the mid-Semliki to link up with the montane forest along the western slopes of Mt. Ruwenzori. South of the equator, however, it does not reach much farther than 28° E. and its boundary here forms a very irregular line as the lowland forest passes without break into the montane forest on the western scarp of the Albertine Rift.

It cannot be too strongly emphasized that the Lower Guinea forest forms an uninterrupted wooded area over 2,000 kilometers long, from west to east, and, in the Congo, 800 kilometers wide from north to south, and is by no means an alternation of forest in the lower portions and savannas on the divides between rivers, as has been so frequently asserted. Where the rain forest borders on the savanna the limits are generally well-defined, though occasionally there may be a transitional zone of grass-land or park-land with scattered patches of dense, humid woods. Sometimes, too, more extensive tracts of forest appear, under favorable local conditions of climate, in certain areas well beyond the boundary of the forest belt. A number of such Guinean forest islands are found in the Uganda-Unyoro District and shelter in this area many of the most typical West African forest plants and animals (see p. 502). As a rule, forest galleries extend along all permanent water-courses from the forest belt into the neighboring savanna, and in certain places these galleries may be so extensive and so numerous as to render the boundary of the continuous forest belt indistinct. Yet in many places the outer limit of the forest, as observed from the open country beyond, forms a clear-cut line, which may be easily followed across the irregularities of the topography.

The climate of the rain forest is characterized by a uniform and fairly high temperature and abundant rains equally distributed over the whole year. Throughout this region the total annual rainfall varies from 60 to 80 inches and rainless periods are unknown or very rare and then always of short duration. For example, at Eala, under the equator in about 18° 28′ E., the total rainfall in 1911 amounted to 80.83 inches (2,055 mm.); the driest months being January with 3.24 inches (82.4 mm.) of rain and August with 2.69 inches (68.4 mm.); the wettest, February with 10.6 inches (255.6 mm.), September with 12.92 inches (328.2 mm.), and October with 13.43 inches (341.3 mm.). The difference between the mean temperature of the hottest and coldest month was about 2° C. (April, 26° .12 C.; August, 24° C.). The highest temperature registered in the shade was 38° .7 C., the lowest, 16° .7 C.

The forest belt grows practically everywhere on a subsoil of horizontal sandstones and shales of Permo-Triassic age, so that limestone is scarce and of quite local occurrence. Only in its northeastern corner does it transgress over the peripheral rim of Archæan and crystalline rocks. As much of this district occupies the flattened bowl or Central Basin of the Congo, it is a generally level country of low altitude, on the average 500 m. or less above sea-level. In the eastern portion it rises gradually and becomes more hilly, forming there the foothills of the western scarp of the Albertine Rift. It stops, however, at the 1,500 m. contour line, since all regions above that altitude in the eastern Belgian Congo belong zoögeographically to the Eastern Montane District.

Except along certain low river banks and in the clearings made by the natives, the country is covered with typical forest of the moist, tropical, evergreen type. The chief characteristics of such a forest are the extreme density and endless variety of the woody vegetation, some of the trees attaining a considerable size, their height often exceeding 35 m. and even occasionally reaching 50 m. Below the canopy of higher trees numerous bushes and young trees fill all available space, while the soil itself is covered with marantaceous reeds, ferns, and low herbaceous plants. Grasses are altogether absent or represented by a few peculiar, broad-leaved, heliophobic types. Many of the herbaceous plants have in search of light left the soil to live as epiphytes along the bole and in the crown of the trees.

Three main ecological types of forest may be distinguished in the lowlands of the Congo, namely, inundated forest, virgin or primary forest on dry land, and second-growth forest.

The inundated forest (Pl. XLVIII) is the type with which one becomes first acquainted upon entering the Congo from its estuary, for in the Middle and Upper Congo the banks of the main stream and its affluents are usually very low and ill-defined, especially at high water, when much of the surrounding country is inundated. Thus great areas in the basin of the Mongala River form one immense wooded swamp; while in the lowest part of the Congo bowl, south of the great bend of the stream, the basins of the Lulonga, Ikelemba, Tshuapa-Busira, and Momboyo-Luilaka Rivers are almost entirely under water part of the year. The woody vegetation of these periodically inundated areas is rather uniform, while the muddy soil itself is frequently almost bare. The inundated forest is, however, the domain of creepers, lianas, and rattan palms, which frequently form almost impenetrable thickets. Ecological conditions of inundated woody areas are very unfavorable to land mollusks, as snails and slugs too often run the risk of being drowned. Yet we have observed that low, muddy places in the Congo forest seem to be the preferred haunts of the land operculate *Cyclopherus intermedius* E. v. Martens, which is frequently found on the decaying leaves covered with the black, slimy ooze left by the retiring flood.

The virgin or primary rain forest on dry ground is of much greater interest to the biologist. It is typically developed in the higher and more hilly regions of the Aruwimi-Ituri basin (Pl. XLIX) and to the east of the Lualaba. The flora and fauna of these eastern forests are extremely varied, much more so than anywhere else in the West African Subregion.[1] This is true too for mollusks, for we note that of the four hundred-odd forms of terrestrial snails and slugs known at present from the Belgian Congo, about 150 have been found in the small area of lowland Rain Forest east of the 25th meridian.

The molluscan forest fauna of the Congo basin is almost entirely made up of Achatinidæ, Streptaxidæ, and Zonitidæ. In the Achatinidæ the larger Achatininæ are represented by a fair number of species of *Achatina*, *Callistoplepa*, *Burtca*, *Limicolaria*, and *Perideriopsis;* but the smaller Stenogyrinæ of the genera *Homorus*, *Ceras*, *Nothapalus*, *Subulina*, *Pseudoglessula*, *Pseudopeas*, and *Curvella* are much more abundant in species. The rapacious snails of the family Streptaxidæ are one of the conspicuous elements of this fauna, presenting many beautifully shaped or elegantly sculptured forms of *Edentulina*, *Marconia*, *Gonaxis*, *Streptostele*, *Varicostele*, *Ptychotrema*, and *Gulella*. The forest Zonitidæ belong to two types: some have well-developed shells, more or less *Helix*-like in shape (*Thapsia*, *Ledoulxia*, *Trochozonites*, and *Kaliella*); while in the Helixarioninæ, which are often found in profusion, the shell is degener

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[1]Mildbraed (1914, 'Wiss. Ergebn. D. Z. Afr. Exp. (1907–08),' II, 7, pp. 667–688) has given a satisfactory description of the extent and botanical characteristics of the Ituri Forest. His list of floristic elements could, however, at present be considerably extended. The many additional genera and species collected by the junior author during his journey of 1914–1915 still further bring out the great similarity of the eastern Congo forests with those of Gaboon and Cameroon and the floristic unity of the Lower Guinea Forest District.

ate, very thin, and vitrinoid. The Enidæ are only represented by a few species of *Pachnodus*. The Vaginulidæ, though abundant in individuals, show but little specific diversity and the Urocyclidæ appear to be conspicuously rarer than in the montane forest of the eastern highlands. Striking negative features are the almost total absence of true Helicidæ (one species, *Halolimnohelix langi*, known from the Ituri forest) and the paucity of operculate land snails, the Cyclophoridæ being thus far known only by two species of *Cyclophorus* and one minute *Cyathopoma*. The relative abundance of the several groups of land snails is best expressed in figures: of the 150 forms known from the lowland forest east of 25° E., 58 are Achatinidæ, 46 are Streptaxidæ, and 32 Zonitidæ, the remaining 14 forms being divided between the Urocyclidæ (2), Vaginulidæ (4), Cyclophoridæ (3), Succineidæ (2), Enidæ (2), and Helicidæ (1).

The list of land mollusks obtained at Penge by the junior author in February, 1914, may be taken as a fair example of molluscan life in the virgin Congo forest. At the time of the writer's visit this locality, situated on the upper Ituri, was practically untouched by man. A number of clearings were being made affording unusual opportunities for a study of plant and animal life in primæval conditions. The month of February that year was remarkably dry, hardly a shower being observed. As a result the soil of the forest became gradually so dry that mollusks had to hide away for estivation. Perhaps this prolonged drought explains partly the scarcity of snails experienced by the writer, for hardly any of the species enumerated were found in large numbers, and in most cases only dead specimens could be obtained. The absence of *Limicolaria*, *Achatina* and Vaginulidæ in the collection must probably be explained in the same way. Moreover, mollusks of these three groups are rather rare in the virgin forest proper, being usually found in native plantations or on the grassy banks of streams, two kinds of habitats not to be found at Penge at the time of the writer's visit. The best collecting was done in scratching the superficial layer of humus and earth in well-shaded parts of the forest. In this connection it is necessary to mention that, notwithstanding the luxuriance of the vegetation, there is but little decaying vegetable matter on the soil of the Congo rain forest, considerably less so than in temperate forests. The combined efforts of termites and fungi, together with the rapid decay by fermentation due to moisture and heat, seem to rapidly dispose of dead leaves, branches and tree-trunks.

List of Land Mollusks of Penge

*Homorus ischnus*
*Nothapalus paucispira xanthophaes*
*Subulina pengensis*
*Pseudoglessula subfuscidula*
" *famelica*
" *cruda*
*Pseudopeas plebeium*[1]
*Curvella langi*
*Gonaxis cavallii ituriensis*
*Streptostele centralis*
" " *coloba*
" *dautzenbergi*
" *bacillum*
*Ptychotrema quadrinodatum*
" *runsoranum*
" *sororcula*
" *fraterculus*
" *silvaticum*
" *monotes*
" *cylindrus*
*Ptychotrema æquatoriale*
*Gulella bistriplicina*
" *polloneriana*
" *pupa ituriensis*
" *toticostata*
' *conospira polynematica*
*Thapsia pompholyx*
" *cinnamomeozonata*
" *rufescens*
*Trochozonites plumaticostata*
" *bellula*
" *trifilaris ituriensis*
" *aillyi*
" *adansoniæ*
*Mesafricarion haliotides*
*Helixarion insularis*
*Pachnodus rutshuruensis*
*Pleuroprocta silvatica*
*Cyclophorus intermedius*

In the virgin rain forest on dry ground of the Congo the surface of the soil, including leaf-humus, rotting logs and other débris, forms the main ecological habitat of land mollusks. Strictly arboreal species appear to be very few in number and are mainly Helixarioninæ and Urocyclidæ, which after showers or in the early morning may be seen crawling over the leaves of low bushes. Whether there are in the Belgian Congo, as elsewhere in the tropics, peculiar snails adapted to living on the branches and foliage of the higher trees or in the clumps of epiphytes, cannot be said at present; none have been reported thus far from such a habitat. Where mosses, liverworts, and small ferns cover the clay or stone walls of ravines, especially near a spring, one is likely to make good malacological finds. It is in such a location that the junior writer discovered at Avakubi the minute operculate *Cyathopoma africanum*. Further investigation of similar places might probably add to the extremely poor land operculate fauna of the Congo. The following species were also found at Vieux-Kasongo under decaying, very moist leaves near a spring in the forest: *Ceras dautzenbergi*, *Gonaxis micans*, *Gulella lævigata*, *Marconia kivuensis*, *Pseudoglessula stuhlmanni*, *Trochozonites bellula*, and *Cyclophorus intermedius*; mostly, however, in dead condition. On the whole it is difficult to

[1]We regard at present *Pseudopeas curvelliforme* Pilsbry as a synonym of *P. plebeium* (Morelet).

obtain forest mollusks alive: it is probable that many of them are nocturnal and should be searched for after dusk. Some could perhaps be baited by sugaring the base of trees.

The second-growth forest (Pls. L and LI) occupies the old clearings which were made for agricultural purposes and which are gradually invaded again by the forest. This reforestation, however, does not proceed by the virgin forest coming back at once, but there is an intermediate stage during which a number of peculiar, rapid-growing trees and bushes cover the much impoverished soil. Such second-growth is much lower than virgin rain forest and contains fewer species of plants; it is more open to the rays of the sun and the soil is therefore much drier. Its fauna on the whole is very poor and but few or no land mollusks are to be found there.

Banana plantations in forest clearings (Pl. LI) on the other hand, are likely to well repay the efforts of the collector and this is true also of the refuse heaps found near villages. They are about the only places in the forest region where molluscan life is at all conspicuous, as in the early morning or on rainy days one may see here the large *Achatinæ* and the beautifully colored *Limicolariæ* and *Perideriopsis* crawl about, often in considerable numbers; while Vaginulidæ and Helixarioninæ are sometimes even more abundant. The decaying leaves accumulated at the base of the banana stems usually contain in addition species of *Homorus*, *Subulina*, *Pseudopeas*, *Streptostele*, *Ledoulxia*, and *Thapsia;* occasionally also minute *Gulellæ* and *Trochozonites*. Many of the mollusks of this habitat are widely distributed, being liable to be carried by natives over considerable distances in bunches of plantains, in banana leaves used as wrapping material, or attached to the shoots with which new cultures are started. In a banana field at Kisantu, in the Lower Congo, the junior author collected in September, 1910, the following species: *Subulina leia*, *S. subangulata*, *Pseudoglessula stuhlmanni*, *Streptostele alluaudi*, *Ledoulxia rodhaini*, and "*Helicarion*" *sowerbyanus*. At Lukolela, in October, 1910, *Gulella lævigata*, *Subulina perstriata*, and *Pseudoglessula stuhlmanni* were found among the decaying leaf-sheaths of banana trunks, and *Ledoulxia mesogæa* var. *nsendweensis* occurred in a similar location at Ngombe near Irebu. It is undoubtedly in the native plantations that malacological collecting may be done with the least effort, but it should be remembered that the rare and more local species are only found in the virgin rain forest. Another habitat which sometimes teems with snails are the low, grass-grown and more or less marshy banks of the Congo River, between Stanleyville and Leopoldville. In such a locality, at Nouvelle Anvers, very large numbers of *Achatina sylvatica* were seen by the junior author in October, 1910, and Lang and Chapin found that species abundant under similar conditions at Mobeka and Stanleyville.

The foregoing description of ecological conditions and molluscan life in the rain forest applies to the forests of the Central Basin of the Congo. We have mentioned before that the forests of Gaboon continue southward into the Mayombe district to about 50 kilometers north of Boma. Though the botanical features of this "Lower Congo forest" are essentially the same as those of the Upper Congo, nevertheless it is possible to point out certain differences which are probably due to climatic peculiarities. At Ganda Sundi, for instance, in 4° 55′ S. and 13° 5′ E., observations made during 1910–1913 gave for these four years an average annual rainfall of 54.81 inches (1,394 mm.), the wettest months being February with 9.31 inches (236.5 mm.) and November with 8.64 inches (219.5 mm.); the driest months, June and July, were practically rainless. The difference of mean temperature between the hottest and the coldest month in 1913 was 6° .8 C. (February: 27°.9 C.; July: 21° .1 C.). The climate is, therefore, much more like that of the surrounding savanna country (see Southern Congo Savanna District) and the presence of rain forest in this region is merely due to the hilly and deeply ravined topography, and to the proximity of the sea, so that even in the dry season there is abundant moisture in the air and dense fogs are frequent in the morning.

Moreover, the rain forest is rapidly disappearing in the Belgian part of the Mayombe under the combined efforts of native agriculture and of European tropical cultures. In recent years large parts of forest have been transformed into plantations of cocoa. We have been unable to find any published records of terrestrial mollusks for the Belgian Mayombe; yet it would be of great interest to know to what extent this fauna differs from that of the Upper Congo forest. It is quite possible that some of the peculiar forms of the Cameroon and Gaboon, such as *Pseudotrochus*, are to be found there.

### 2. Ubangi Savanna District

North of the continuous belt of Lower Guinea rain forest, a fairly flat and moderately elevated peneplain extends between the bend of the Ubangi and the Albert Nile, from 18° to 31° E. Similar country is found north of the borders of the Belgian Congo, to slightly beyond the Congo-Nile divide, which is here so little marked as hardly to be a noticeable feature of the landscape. This whole northern district lies between

500 m. and 1,000 m. above sea-level, and its topography is exceedingly uniform. It is a much worn-down peneplain of Archæan and crystalline rocks, usually covered with a thick coat of lateritic surface soil. Occasionally the old, denuded mountain ranges have left witnesses in the shape of granite or gneiss hills (so-called "Inselberge" or monadnocks) which are quite distinctive of the Congo-Nile divide (Pl. LIV, fig. 1). These granite hills are often broken up by crevices in which moisture accumulates, so that dense thickets of entangled vegetation surround the base, affording a welcome shelter for many animals. Such a habitat might, therefore, be well worth investigating for mollusks, especially in the dry season for estivating species.

The climate of the northern Congo savanna is characterized by a sharp division of the year into a dry and wet season. During the summer, from April-May to September-October, it rains profusely and animal and plant life are then at their height. The balance of the year, however, is practically rainless and toward January the drought is so pronounced that plant life is almost at a standstill and many animals have either migrated to other parts of Africa or have hidden away for estivation. The country is usually covered with grass-lands of the various types that occur elsewhere in the West African and Guinean lowlands and which may best be included under the general designation of savannas (Pls. LII and LIII). High-grass savanna (with *Pennisetum*, *Panicum maximum* Jacquin, many *Andropogons*, etc.), practically without woody vegetation, appears to cover much of the country south of the Ubangi; while farther east, in the basin of the Uele, bushes and low trees (*Anona senegalensis* Persoon, *Acacia*, *Strychnos*, *Hymenocardia*, *Gardenia*, etc.) are scattered about more abundantly. On the border of the Anglo-Egyptian Sudan one even meets with savanna forest, though the trees never attain a great height or diameter. Here, too, some Sudanese elements appear in the flora, perhaps the most interesting of them being *Protea madiensis* Oliver. The district contains also many forest galleries (Pl. LIII) which extend along the rivers from the equatorial belt of rain forest and gradually narrow as one travels northward. In these galleries one finds, but in a somewhat impoverished condition, the flora and fauna of the rain forest proper.

To judge from the foregoing ecological description of the Ubangi District, the malacological fauna is not likely to be abundant nor varied in species. Unfortunately, very little collecting has been done thus far in that area. Schweinfurth obtained a number of species on the Congo-

Nile divide in 1869–71[1] and others were collected by the American Museum Congo Expedition in the region of Niangara and Faradje. Many of the snails brought back by these travelers were undoubtedly obtained in the forest galleries which fringe most of the rivers of the Northeastern Congo savanna and which possess essentially the same molluscan fauna as the rain forest belt farther south, though the number of species is much smaller. In this category would come *Achatina schweinfurthi* E. v. Martens, originally discovered by Schweinfurth at Mt. Baginze on the Congo-Nile divide, and the slug *Atoxon faradjense* Pilsbry found by Lang and Chapin at Faradje.

Whether the Ubangi Savanna District possesses typical, fragile grass-land *Achatinæ*, such as those that are known from the Upper Katanga, appears uncertain. On the other hand, *Burtoa nilotica schweinfurthi* E. v. Martens and *Limicolaria festiva* (v. Martens) seem to inhabit the savanna proper; during the dry season these snails bury themselves deep in the ground and close their aperture with a calcareous epiphragm. The manner in which large numbers of *Ledoulxia mozambicensis* (Pfeiffer) were estivating in the leaf-sheaths of wild bananas near Faradje has been described by H. Lang.[2] He also found other typical savanna snails in the same locality: *Rachis braunsii* (v. Martens), *R. böhmi delicatus* Pilsbry, and *Pachnodus herbigradus* Pilsbry. The last-named species estivated in colonies within hollow twigs, five feet or more from the ground.

### 3. Southern Congo Savanna District

This district comprises the region south of the continuous belt of Guinea rain forest, between 4° and 8° to 9° S. In the west it extends far beyond the borders of the Belgian Congo into Angola and includes most of the Portuguese Enclave of Kabinda. East of the Kasai it is bordered by the highlands of Marungu, Upper Katanga, and the Kasai-Zambesi watershed. From the mouth of the Congo to Lake Tanganyika it extends in longitude over some 1,800 kilometers, while from north to south it is about 300 kilometers wide.

Topographical and geological conditions are rather varied over this large area, but the altitude is rarely over 1,300 m. and most of the country is much below 500 m. to 800 m. Along the coast of the Atlantic one may distinguish a maritime zone forming a narrow strip, scarcely over 80

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[1] E. v. Martens. 1870. 'Conchylien aus dem obern Nilgebiet.' Malakoz. Blätter, XVII, pp. 32–36; 1873. 'Zusammenstellung der von Dr. Georg Schweinfurth in Afrika gesammelten Land und Süsswasser-Conchylien.' *Op. cit.*, XXI, pp. 37–46.

[2] 1919, Bull. American Mus. Nat. Hist., XL, pp. 247–248, Pl. x, figs. 2 and 3.

kilometers wide, of low-level country averaging 100 m. in altitude. The subsoil here consists of nearly horizontal marine strata of Cretaceous or Tertiary age, usually hidden beneath a thick layer of clay, sand, or laterite. The remainder of the Lower Congo, as far east as Stanley Pool, is an extremely hilly country of Archæan, crystalline or older Palæozoic rocks, mostly sandstones or schists, in strata which have been much folded and tilted. We have mentioned above some of the outcrops of limestone occasionally encountered in the Lower Congo. Through this region of the "Crystal Mountains," so-called because of the numerous blocks of quartz one frequently finds strewn over the surface, the River Congo has gradually worn a narrow outlet to the sea, interrupted by numerous rapids and falls. The average altitude of the Lower Congo is between 100 m. and 700 m. and the highest points, such as are found in Mt. Bangu, hardly reach above 1,000 m. The basin of the Kasai and its affluents, which occupies the central portion of the Southern Savanna District, belongs, physiographically speaking. still to the central basin of the Congo, the subsoil being formed by the horizontal, soft sandstones of the Lubilash system (Triassic). This area is at an average altitude of 500 m. to 1,000 m., the highest elevations not exceeding 1,500 m. Its northern portion is fairly level, but in the southern part comparatively recent movements of the soil have rejuvenated the topography, so that the country is here much cut up by erosion valleys. In the eastern portion of the district, in Manyema and the lower Katanga (or Urua), the subsoil is largely composed of crystalline rocks which have been worn down to a fairly uniform peneplain of about 600 m. average elevation. The highest point, Mt. Cleveland or Kitschima, on the upper Lualaba, in about 5° S., reaches 1,350 m. in height.

The climate presents the same characteristics of a sharp division into a dry and wet season which we have described for the Ubangi Savanna District, but, being south of the equator, the seasons are, of course, inverted. The rains usually last from September to April, but they frequently stop for a few weeks during January or February (little dry season); the dry season proper lasts from May to the end of August and, owing to the much greater distance of the Southern Congo Savanna from the equator, the drought is more severe than in the Ubangi Savanna and the temperature is markedly lower. At Banana, for instance, at the mouth of the Congo, the total rainfall in 1912 was 59.8 inches (1,519.1 mm.), practically all of which was received during January, February, March, April, November and December. The mean temperature was 26° .67 C.; that of the hottest month (March), 28° .91 C.; and that of the coldest (August), 23° .69 C. In the maritime region and throughout the Lower Congo the vicinity of the sea results in a considerable humidity of the atmosphere during the dry season, so that the sky is usually clouded and fogs are not uncommon in the early morning. Consequently, the influence of the drought on plant and animal life is much less marked than farther east in the Kasai basin and Lower Katanga.

The vegetation (Pl. LIV, fig. 2) is of the same general type as in the Ubangi Savanna District. The maritime zone, to a distance of about 80 kilometers from the shore of the Atlantic, is a low, level plateau mostly covered with high-grass savanna, occasionally with scattered boabab trees and, on the alluvial plains and islands of the Congo estuary, also with interspersed palms (*Hyphæne guineensis* Schumacher and Thonning).[1] The Crystal Mountains are a region of much greater barrenness, owing to the rocky nature of much of the surface soil. The hillsides are usually covered with a rather depauperate grass vegetation, with sparse and stunted scrubs. The many torrential streams, however, run in gulleys narrowly fringed with small trees; while more extensive patches of forest are met with along the alluvial banks of the larger rivers, such as the Inkisi, and along the slopes of certain mountain ranges (as on Mt. Bangu). Farther east, in the Kasai basin, the Manyema, and Lower Katanga, woody vegetation is more abundantly scattered in the grass and in many places the country has the aspect of a tree- or forest-savanna, and is sometimes park-like. Here, too, forest galleries are met with along all rivers and, on the lower Sankuru and mid-Kasai, they become very extensive, harboring there most of the forest animals and plants of the central Congo basin.

The malacological fauna of the Southern Congo Savanna is probably less known than that of any other part of our territory. In the large area of the Kasai basin, Manyema, and Lower Katanga collecting has been done in not more than a dozen localities, and in each of them but very few species have been obtained, so that a more detailed discussion does not appear worth while. The Lower Congo, however, is somewhat better known.

In June, 1915, Mr. H. Lang and the junior author found a rather rich molluscan fauna estivating in large numbers in the ravines of calcareous sandstone hills which at Zambi form the banks of the Congo River. The torrents during the rainy season had washed the soil from the limestone slabs, which we moved one by one. Empty shells were

[1]The peculiar mangrove vegetation on the tidal flats will be considered in connection with the brackish water mollusks of the mouth of the Con .

lying in the numerous crevices and a few live ones, mostly closed with calcareous epiphragms, were found unattached, nearly a foot down. The following species were obtained there:

*Achatina pfeifferi*
*Limicolaria subconica germaini*
*Homorus langi*
" *osborni*
*Pseudoglessula hessei*
*Pseudopeas plebeium*
*Pseudopeas thysvillense*
*Streptostele zambiensis*
" *congoris*
*Thapsia zambiensis*
*Succinea congoensis*

It may be noticed that the genera show a general affinity to the West African fauna and that East and South African types, such as Helicidæ and *Tropidophora*, are totally absent.

The various outcrops of dolomite in the Lower Congo should be carefully investigated malacologically. In the caves excavated in limestones at Thysville, Mr. H. Lang and the junior author found quite an interesting fauna of land mollusks: *Subulina glyptocephala, S. gratacapi, S. thysvillensis, Pseudopeas thysvillense, Curvella thysvillensis, Ptychotrema bequaerti thysvillense, Gulella langi, Thapsia stanleyvillensis*, and *Succinea congoensis*.

The Southern Savanna District possesses also several species of *Achatina* (*A. bandeirana, A. wildemani*, and *A. zebriolata*) and *Limicolaria* (*L. congolanica, L. paludosa*, and *L. wathenensis*) which have not been found elsewhere in the Congo, but whether these inhabit the savanna or occur only in forest galleries is at present unknown.

Bukama, where the junior author resided in 1911, is a locality of great interest to the biogeographer because it is situated close to the southeastern border of the West African Subregion. It lies at an altitude of about 730 m., in approximately 9° 20′ S. and 29° 55′ E., near the southern end of the great alluvial plain of the Lualaba, a region of periodically inundated marshes, papyrus swamps, and lakes which fill the bottom of a rift valley known as the "Graben of Lake Upemba" (see p. 543). At Bukama itself West African or Guinean elements still predominate in the flora, as evidenced by dense groves of oil palms (*Elæis guineensis* Jacquin) along the raised banks of the Lualaba. The following list of land mollusks obtained in that locality, though very small, clearly indicates the West African affinities of the fauna as a whole:

*Achatina rugosa*
" *glaucina*
*Burtoa nilotica nilotica*
*Limicolaria martensiana* var. *eximia*
*Subulina leia*
*Pseudoglessula boivini*
*Opeas venustum*
*Gulella lævigata*
*Trochozonites percostulata*
*Mesafricarion haliotides*
*Rachis braunsii*
" " *quadricingulatus* (at Kalengwe)

Of the above list only *Pseudoglessula boivini* and the thin-shelled *Achatina glaucina* appear to be East African elements, but even the *Pseudoglessula* is not quite typically so, since the junior author has also collected it at Malema in the central Congo forest. With the exception of *Achatina glaucina* and *Rachis*, which are typical savanna snails, the mollusks of Bukama were obtained in the moist and densely shaded oil palm groves that fringe the Lualaba in that locality.

Some forty kilometers south or east of Bukama the West African plants and animals gradually disappear. As altitude steadily increases, they are replaced by genera and species of East and South African affinity, until one finally enters the Katanga proper, part of our Rhodesian Highland District.

### 4. Uganda-Unyoro Savanna District

This district comprises all the areas of our territory below the 1,500 m. contour line in the region between the eastern limit of the Congo Rain Forest and the boundary of Uganda. It extends, however, considerably farther east to the northwestern shore of Lake Victoria and to the Victoria Nile. It forms, as it were, a West African wedge driven into the East and South African subregion and is on that account of particular interest, since many West African forms of life here reach their extreme eastern limits. In the northwest this district borders upon the Ubangi Savanna District. Although the transition between the two occurs in savanna country, yet there is an appreciable and rather rapid change in the ecological features of flora and fauna, as one proceeds from the savanna forest of the Congo Nile divide to the open grass-lands of Irumu and the lower Semliki valley.

The subsoil consists almost everywhere of granitic and old crystalline or metamorphic, Palæozoic rocks. These are usually weathered to a considerable depth into superficial layers of loam or laterite. In the valleys and on the shore of the lakes they are hidden beneath alluvial deposits of quite recent date, sand, gravel, grit, and clay, sometimes extremely rich in dead shells. In spite of this rather great uniformity of geologic structure, the country offers more varied ecological conditions than is generally the rule in the Belgian Congo. This is due primarily to the presence in this area of the deep, trough-like depression which forms the northern end of the Albertine Rift. The resulting topographic disturbances are nowadays evident as large lakes, filling the deeper parts of the depression, important mountain ranges separated by deep, trench-like valleys, and high plateaux bordered by abrupt scarps. The average altitude of the areas comprised within this district is about 1,100 m. The Lendu Plateau and Ruwenzori Range, which, of course, exceed 1,500 m. in altitude, are not treated here as belonging to the Uganda-Unyoro District, but are regarded as outliers of the Eastern Montane District.

The boundaries between the two major subdivisions of the Ethiopian Region, as indicated by the limits of the Uganda-Unyoro District, are entirely due to climatic conditions. The district under consideration covers all portions of the interlake region which still possess a humid, tropical climate. There are, as a rule, two rainy and two dry seasons, since the district extends about three degrees north and one degree south of the equator. Notwithstanding the equatorial location, these seasons are fairly well defined and recur at regular intervals: the heavy rains generally come in March, April, and May; the lesser rains in November and December. The cooler season extends from May till July, while January and February are the hottest months. At Entebbe, situated close to the equator on the shores of Lake Victoria, the average total rainfall a year was 58.64 inches (1,489.4 mm.) for a period extending over nineteen consecutive years. Although April and May were particularly wet, with 10.06 inches (255.5 mm.) and 7.79 inches (197.8 mm.) of rain respectively, no months were entirely rainless: the driest were July and January, with 2 inches (50.8 mm.) and 2.12 inches (53.8 mm.) of rain respectively. The difference between the mean temperature of the coldest and that of the warmest month, during the period 1901–1918, was 1° .6 C. (March, 22° .5 C.; August, 29° .9 C.). The highest temperature registered in the shade was, in 1918, 27° .8 C., the lowest 16° .4 C., the difference being 11° .4 C. A comparison of these figures with those given before for Eala shows that, although Entebbe is fourteen degrees farther to the east and about 200 kilometers beyond the eastern limit of the Congo rain forest belt, yet the only climatic differences between these two localities are a smaller total rainfall and a distinct seasonal distribution of the rains at Entebbe. It must, however, be noted that climatic conditions vary rather considerably from one locality to another within the district here under consideration. Thus, in the portions lying in the Belgian Congo the total annual rainfall is on the whole smaller than at Entebbe and the division into dry and wet seasons much sharper, so that conditions resemble more those prevailing in the Ubangi Savanna District. At Mahagi (in 2° 21′ N., 31° E.), for example, the mean annual rainfall, over a period of 2½ years, was 47.11 inches (1,196.5 mm.); January was entirely rainless and but 2.28 inches (57.9 mm.) of rain fell during June. These dry periods sharply separated two wet seasons of unequal duration, one with a maximum of 4.59 inches (116.5 mm.) in April, the other with 8.16 inches (208.2 mm.) in September.

The variety of topographic conditions, with their concomitant changes in the nature of the soil, exposure, and climatic conditions, inevitably produce in this district many local differences in the nature of vegetation and animal life. The district is, therefore, of more than usual interest to the ecologist. Although savannas (Pls. LVI and LVII) are the dominating plant formation, yet in parts with a heavy rainfall and dry spells of relatively short duration, one finds rather extensive patches of true rain forest of the West African lowland type. These forest islands are all situated in Uganda, the most important being those of Mabira, Buddu, Lwankoba, Kibale, Bugoma, and Budongo. With the exception of the Buddu Forest, they appear to be remnants of a former extension of the Guinean rain forest. Their vegetation shows unmistakable West African affinities, and this is true also for their higher animal life, especially for mammals and birds, and for some of the insects (Lepidoptera, Hymenoptera). A comparative study of their molluscan fauna with that of the Ituri and Semliki rain forest would certainly be of much zoögeographic interest.

The savannas which cover the district in Belgian territory belong to a number of types. Perhaps the most common is a short or medium-sized grass-land, chiefly composed of *Themeda triandra* Forskål and some of the smaller *Andropogons*, and almost destitute of woody vegetation. The grass rarely reaches 2 m. and is usually not over 1 m. high. This is quite typical of the gently undulating country near Irumu and south of Beni. In the exceedingly hot and low alluvial plain on the southern shore of Lake Edward, the grass becomes shorter still and grows in spaced tufts, so that the country has all the appearances of a steppe. Such dry savannas are practically without molluscan life, as the soil is often rocky and the animals can find no shelter against the scorching rays of the sun. The country is often deeply ravined by the heavy rains and it is quite indicative of the poverty of molluscan life that but very few dead shells can be gathered from the débris washed down into these gulleys. In the Semliki valley one also meets with bush savannas mostly of the thorny, subxerophytic type. On sandy, alluvial plains *Acacia* savanna, with umbrella-shaped trees, is quite frequent. Moreover these more wooded varieties of grass-land are hardly any richer in mollusks. On the lower slopes of the highlands, where rock débris washed down from the mountains form a fertile and rather moist substratum, there is usually a luxuriant and extremely dense growth of elephant grass (*Pennisetum purpureum* Schumacher and Thonning) reaching 4 m. to 6 m. in height. The grass stalks are well sheltered at their base and the humid, hot atmosphere produces there rather favorable conditions for snails and slugs. One can usually find in these grass thickets Vaginulidæ, Helixarioninæ, *Ledoulxia*, and *Thapsia;* sometimes also some of the Streptaxidæ. *Halolimnohelix intonsa* Pilsbry, a true helicid, was found in one of these growths of *Pennisetum*, at Boga, in about 1,000 m. The beautiful *Burtoa nilotica* (Pl. LV) is by no means rare in this district. Native plantations of bananas are often located on such fertile soil and, as usual, they contain a number of widely distributed snails and slugs. But by far the richest habitat, malacologically speaking, are the forest galleries which follow the water courses across the savanna. In some parts these galleries consist only of very few bushes and trees, but elsewhere they are quite extensive and present many of the environmental features of true rain forest. Near Beni a comparatively narrow forest gallery, shown on Plate LXIX, fig. 1, yielded numerous specimens of *Homorus amputatus*, *Ptychotrema runsoranum*, *Gulella linguifera*, and *G. mediafricana*. The narrow band of forest along the Rutshuru River, a short distance south of Rutshuru, possesses an extremely rich fauna, as may be gathered from the subjoined list. The exceptional abundance of land mollusks in that locality is evidently due to the high proportion of lime present in the soil, a fact to which attention has been called above (see p. 467).

*Halolimnohelix rutshuruensis*
*Homorus clarus*
*Pseudoglessula umbilicata*
" *subfuscidula*
" *cruda*
*Pseudopeas plebeium*
*Curvella langi*
*Gonaxis cavallii ituriensis*
*Varicostele rutshuruensis*
*Ptychotrema geminatum*
" *nyangweense*
*Gulella disseminata cymatonotus*
*Gulella rutshuruensis*
" *osborni*
*Thapsia rutshuruensis*
" *cinnamomeozonata*
" *consobrina*
" *rufescens*
*Helixarion insularis*
*Atoxon flavum rutshuruense*
*Dendrolimax osborni*
*Trichotoxon maculatum perforatum*
*Pachnodus rutshuruensis*
*Lævicaulis schnitzleri*

A comparison of this fauna with that of the Lower Guinea Forest District, as exemplified by the list given above for the rain forest at Penge, well brings to light its West African affinities. The only striking difference is the presence of a true helicid. The occurrence of Helicidæ in the forest galleries of the Uganda-Unyoro Savanna District is by no means exceptional. Thus *Halolimnohelix sericata* was also found crawling over leaves of low bushes on the densely wooded banks of the Loia River, between Irumu and Boga, at an altitude of 1,100 m. These lowland Helicidæ are evidently derived from some of the forms from the neighboring higher regions, where the family is fairly well represented.

## B. East African Subregion

### 5. Eastern Montane District

This district occupies in the Belgian Congo the Lendu Plateau, the Ruwenzori Range, and the highlands around Lake Kivu and to the northwest of Lake Tanganyika. It includes all parts of the eastern Congo situated above 1,500 m. These regions are characterized by a peculiar temperate and moist mountain climate, partly due to their altitude and partly to their location close to the equator and near the eastern margin of the West African rain forest. In the absence of exact meteorological data, it can only be stated in a general way that the absolute and mean temperatures are considerably lower than in the lowland forest and decrease steadily with increasing altitude. The summits of the Mfumbiro volcanoes are often temporarily capped with snow, while permanent glaciers partly envelop the peaks of Ruwenzori. These highlands are not only abundantly favored with rains, but in addition the hot winds saturated with humidity that blow from the western lowlands, upon ascending the slopes of the eastern mountains, rapidly cool off and form at a certain level a belt of dense fogs and clouds. Meteorological conditions are much the same throughout the year, so that altitude and exposure alone determine the differences of temperature, humidity, and light, thus producing along the slopes a regular succession of life zones. If one adds to this that the nature of the soil is much less uniform than elsewhere in the Congo, and that the country is extremely rugged, one readily realizes that this region offers us an extraordinary variety of ecological conditions. In fact, it is by far the most fascinating portion of our territory and it fully deserves, biologically speaking, the name of "Wonderland of the Eastern Congo" which an enthusiastic traveler has recently bestowed upon it. Nowhere else does one find so many interesting problems of adaptive radiation, isolation, and distribution, so that a detailed account is plainly justified.

The peculiar and intricate topography of eastern Central Africa is entirely due to the existence of two great fractures of the earth's crust, so-called rift valleys, which run parallel to each other in a general north to south direction. The easternmost of these fractures, or Great Rift Valley, can be followed from northern Palestine, along the Red Sea and across Kenya Colony to Lake Nyasa and the lower Zambezi. At its northern end the trough-shaped basin of Lake Nyasa is joined by a branch from the northwest which encloses Lake Rikwa and connects in the neighborhood of Karema, through a bifurcate breach in the eastern rim of Tanganyika, with the west-central African ALBERTINE RIFT. This branch contains Lake Tanganyika and continues northward along the Ruzizi Valley, Lake Kivu, Lake Edward, the Semliki Valley, and Lake Albert to the Upper Nile. In many places the western scarp of this trench is extremely abrupt; but on the northern shore of Lake Kivu the floor and walls have been buried and partly obliterated by the volcanic activity of the Mfumbiro Range. In the Belgian Congo the Albertine Rift may be followed over a distance of nearly 1,200 kilometers; its width usually varies between 40 and 80 kilometers, though it is much narrower in the Semliki and Ruzizi Valleys.

The several movements of the earth's crust which have eventually led to the African rift valleys in their present shape were accompanied by uplifts of varying importance, giving rise to the East African highlands. Their distribution, altitude, and extent probably varied from one geologic period to another. Furthermore, there is ample evidence of a former, extensive glaciation on Mt. Kilimanjaro, Mt. Kenya, and Mt. Ruwenzori. On Ruwenzori, to judge from the peculiar U-shaped higher valleys of the range, pointing to their formation by advancing glaciers, and from the presence of striated rocks and moraines at low levels, the glaciers at one time may have extended 10 to 12 kilometers beyond their present termination. On Mt. Kenya traces of former glaciation have been found some 1,500 m. below the actual glaciers. It is probable that this more extensive glaciation of the Central African mountains was contemporaneous with the Pleistocene glacial periods of Europe. At that time the climate of Central East Africa was not only much cooler over a large part of its area, but also considerably more moist. Temperate or mountain rain forest of the type found nowadays between 2,000 m. and 2,800 m. in the Eastern Montane District, could then occur at much lower altitudes and may thus have covered a large part of eastern equatorial Africa, allowing a wide horizontal distribution of its peculiar floristic and faunal elements. Later, upon the retreat of the glaciers and the gradual desiccation of the country, the temperate forest disappeared in the lower highlands and persisted only as disconnected islands in the higher mountain ranges. In each of these patches isolation later permitted the production of peculiar species. In short, we believe that the various highland areas which nowadays make up the Eastern Montane District of Africa are but the remnants of a much more extensive and more or less continuous area with a similar, temperate fauna and flora that formerly covered a large part of East Central Africa and of the eastern Congo basin.

From what we know at present, the land snails of the mountains of equatorial Africa appear to belong to widely distributed genera, but their species are peculiar to each range. A beautiful example in point is afforded by *Limicolariopsis*. This is evidently a type of achatinine land snail derived from lowland *Limicolariæ* under the influence of the temperate, moist conditions of the montane district. Its origin might be traced to the former period of more extensive glaciation which created temperate moist conditions over much of the territory occupied before by ordinary, megatherm *Limicolariæ*. With the return of tropical, drier conditions, *Limicolariopsis* migrated to the forest patches of the higher mountains giving rise by isolation to a number of "representative" species in the various highlands of East and Central Africa. The same process appears to have worked with the *Cerastus* stock but in a much more prolific manner, creating numerous species.

The most striking features of the molluscan fauna of our Eastern Montane District are: (1) its remarkable richness in genera, species, and individuals as compared with the other districts of our territory; (2) the absence or scarcity of a number of typically West African or Guinean land mollusks of the neighboring lowland rain forest; and (3) the appearance of many East African and Abyssinian types. Of the first point it will be sufficient to say that it is the only part of the Belgian Congo where mollusks are at all sufficiently varied and abundant to fulfill the expectations of the collector; and, although its area is very small and but few localities (perhaps a dozen in all) have been thus far investigated, yet the total number of genera and species recorded from that district is larger than that known from the remainder of the Belgian Congo. The large Achatininæ, which are a characteristic element of the lowland rain forest, are represented by but few species in the Montane District (*Achatina osborni* at Masisi, in about 1,800 m.; *A. graueri* Thiele in Kwidjwi, at 1,500 m.; *Limicolaria* is abundant in a few species up to 3,500 m.). Of the smaller Stenogyrinæ, *Ceras*, *Pseudoglessula*, and *Curvella* are much rarer than in the lowlands; but *Homorus* and *Nothapalus* are as well, if not better, represented. In the Streptaxidæ we note the absence of *Edentulina* and the scarcity of *Marconia*, *Gonaxis*, and *Streptostele;* while *Ptychotrema* and *Gulella* are abundant. In the Zonitidæ, *Thapsia*, *Ledoulxia*, and *Trochozonites* appear to be lowland genera that just barely invade the temperate mountain region; but *Mesafricarion* and *Helixarion* are exceedingly numerous in the highlands. Of true slugs the Urocyclidæ are abundant, while the Vaginulidæ do not seem to extend above 1,500 m. In the Enidæ we note the absence of *Rachis* and *Pachnodus*.

The peculiar East African element consists of *Limicolariopsis* in the Achatininæ; *Liobccageia* and *Subuliniscus* in the Stenogyrinæ; *Vitrina; Cerastus* in the Enidæ; and a fair number of true Helicidæ. As shown in the Report of Land Mollusks, these Central African *Helices* are related with the Belogonia Euadenia of the Oriental Region. With the exception of one species of the Ituri Forest (*Halolimnohelix langi*), they are unknown in the Lower Guinea Forest District, but some of them occur at rather low altitudes (1,000 to 1,200 m.) in the forest galleries of the Uganda-Unyoro Savanna District. Two species have also been described from Mt. Cameroon, where a very restricted area possesses some of the animals and plants of the Eastern Montane District.[1]

The peculiarities of the montane molluscan fauna are still better expressed by a detailed examination of Ruwenzori, one of the few areas that have been repeatedly visited by collectors and may therefore be regarded as somewhat better known, though the 80 species listed from the entire range (above 1,500 m.) undoubtedly represent but a portion of the fauna. This account will also give an idea of the altitudinal distribution of land mollusks in Central Africa in relation with faunal and floral life zones.[2] Mt. Ruwenzori, the third highest mountain of Africa, forms between Lakes Albert and Edward a lofty range covering an irregular triangle about 80 kilometers long and 40 kilometers wide. It is evidently due to an upheaval of the eastern escarpment of the Albertine Rift which has thrust a central core of greenstones and amphibolite through the folded strata of crystalline gneisses and micaschists. It consists of six groups of peaks with glaciers, quite distinct from one another, the highest reaching an altitude of 5,125 m. To the west it slopes very steeply to the Semliki, whose broad and deep valley separates it completely from the western escarpment of the Albertine Rift. In the east, and especially in the northeast toward Unyoro, the descent is much more gradual over the highlands of Toro.

The base of the mountain (Pl. LVII) and its foothills between 1,000 m. and 1,500 m. still retain all the faunal characteristics of the

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[1]For this reason J. P. Chapin includes Mt. Cameroon in his Humid Montane Province of the East and South African Subregion, erecting for it a "Cameroon Montane District."

[2]The known mollusks of Mt. Ruwenzori were all obtained from three valleys: the Mubuku on the eastern slope was visited by Woosnam (1906) and the Duke of Abruzzi (1906); the Butagu on the western slope, by Stuhlmann (1891), Schubotz (1908), and J. Bequaert (1914); and the Lanuri-Lamia on the northern slope, by J. Bequaert (1914).

West African Subregion[1] and it is important to note that the East African montane district of Ruwenzori is thus entirely disconnected from regions with a similar fauna and flora farther to the east and the south. Almost everywhere the mountain range is surrounded by the savannas of the Uganda-Unyoro District. On the western side, however, the Lower Guinea Forest, which covers the valley of the mid-Semliki, send out an outlier, some 20 kilometers wide, up the slopes of the range to meet the zone of mountain forest.

Four well-defined life zones, as characterized by the vegetation, may be recognized in Ruwenzori.[2]

(1) The lower slopes between 1,500 m. and 2,200 m. are moderately steep and, owing to the abundance of freshly weathered rocks washed down from higher levels, are extremely fertile. They are intensively cultivated, beans being the chief staple crop; plantain bananas are not grown much above 1,800 m. Outside the cultivated areas, the hillsides are covered either with almost impenetrable thickets of elephant grass (*Pennisetum purpureum* Schumacher and Thonning), 2 m. to 6 m. high, a conspicuous feature of the lower portions of this zone; or, above 1,900 m. to 2,000 m., with dense fields of the common brake (*Pteridium aquilinum* Linnæus). Within these are scattered a few trees, especially *Erythrina tomentosa* R. Brown and *Albizzia fastigiata* (E. Meyer), with an occasional *Raphia* palm. Higher up *Vernonia auriculifera* Hiern is a common bush of abandoned fields. The many ravines, however, are densely wooded and show a multitude of trees, with epiphytes, tree-ferns (*Cyathea Engleri* Hieronymus), wild bananas, and an abundance of heliophobic herbs, mosses and hepatics. This whole region of humid and warm temperate climate may conveniently be called the ZONE OF CULTIVATION. As Mildbread has pointed out, there can be little doubt that most of it is covered with secondary plant formations. At least its upper portions, above 1,800 m., were originally part of the mountain cloud or rain forest typical of the next higher zone. The wooded vegetation was cleared away to make room for native cultivation, which fact explains the very irregular upper limit of this zone.

The malacological fauna of the zone of cultivation is comparatively rich, but does not essentially differ from that of the mountain cloud forest above. The snails and slugs are usually found under moss or leaf-mould in the wooded ravines and may there occasionally be seen crawling over

[1]Some of the mollusks obtained in this lowland region at the foot of Ruwenzori (especially at Karevia, in 1,200 m.) by Stuhlmann have unfortunately been named "*runsoranum*," though they do not belong to the montane fauna.

[2]A recent, very complete account of the flora of Ruwenzori is given by A. Engler, 1925, 'Die Pflanzenwelt Afrikas,' V, 1, pp. 310–326.

the herbs and low bushes. Dead shells are often met with in abundance in native fields. By far the most numerous in individuals are *Limicolariopsis*, *Limicolaria*, and certain *Homorus*. No true *Achatinæ* were seen by the junior author anywhere on Mt. Ruwenzori. This is the more remarkable since at least one species of the genus is quite common in the lowland rain forest of the neighboring Semliki Valley.

The following is a list of the mollusks known from the zone of cultivation (between 1,500 m. and 2,200 m.):

*Halolimnohelix hirsuta*
" *mollitesta*
*Limicolariopsis ruwenzoriensis*
*Limicolaria saturata*
*Homorus lionepion*
" *fuscostrigatus*
" *bequaerti*
" *mamboiensis*
" *bicolor*
*Nothapalus sororcula*
" *cœlatus debilis*
" *ferussacioides*
*Subulina bequaerti*
" *roccatii*
*Subuliniscus ruwenzoriensis*
*Curvella dautzenbergi*
" *conoidea*
*Marconia lata ruwenzoriensis*
*Gonaxis cavallii*
*Varicostele subvaricosa*
*Ptychotrema geminatum*
*Ptychotrema edgarianum*
" *sublimbatum*
" *silvaticum*
*Gulella linguifera*
" *sellæ*
" *camerani*
" *heteromphala*
" *cara*
*Thapsia curvatula*
*Trochozonites leptalea*
*Mesafricarion œuriformis*
*Helixarion ruwenzoriensis*
*Kaliella barrakporensis*
*Atoxon brunneum*
*Bukobia cockerelli*
*Trichotoxon ruwenzoriense*
" *pardus*
*Cerastus retirugis*
" *aloysii-sabaudiæ*
*Cyclophorus intermedius*
" *elatior*

(2) The MOUNTAIN RAIN or CLOUD FOREST forms a girdle around the entire range, between the altitudes of 2,200 m. (or 2,000 m.) and 2,800 m. It is a temperate and very humid zone containing many peculiar types of trees (*Dombeya*, *Sideroxylon*, *Pygeum*, *Allophylus abyssinicus* (Hochstetter), *Hagenia abyssinica* J. F. Gmelin, etc.), shrubs (*Bersama*, *Weihea*, *Mæsa*, *Alangium*, etc.), and lianas (*Schefflera polysciadia* Harms, etc.) that are entirely unknown in the rain forest of the upper Ituri and Semliki, but are represented as such or by closely allied species in the other East and Central African mountains. Epiphytes are abundant and there is a dense undergrowth of high, bushy, sublignose Acanthaceæ, Labiatæ, and Compositæ, while most of the lower herbs belong to genera of the northern temperate zone (*Viola*, *Geranium*, *Sanicula*, *Plantago*, *Orobanche*, *Alchemilla*, *Galium*, *Valeriana*, *Carex*, etc.). Most of the land

mollusks listed for the preceding zone are also found here, perhaps with the exception of *Limicolaria;* but, as they are scattered over a much larger area, they are usually more difficult to discover. We believe that the faunas of zones (1) and (2) are essentially the same. The species listed below and which thus far have been obtained in the mountain forest only, will, we think, eventually be found in the ravines and wooded patches of the cultivated zone below, and vice-versa.

| | |
|---|---|
| *Nothapalus cœlatus* | *Gulella exogonia* |
| " *de-albertisi* | *Thapsia hanningtoni* |
| *Bocageia interioris* | *Cerastus trapezoideus* |
| *Ptychotrema limbatum* | *Cæcilioides* (?) *stuhlmanni* |

In the upper half of the mountain forest, bamboos (*Arundinaria alpina* K. Schumann) are mingled with the forest and, as one climbs, the dicotyledonous trees gradually become scarcer, while the bamboos are more abundant and reach larger dimensions. Between 2,600 m. and 2,800 m. there is usually, at least on the ridges between the ravines, a distinct, dense bamboo belt which has a fauna and flora of its own. Though the bamboo belt is occasionally enveloped in clouds, on the whole the environment is decidedly drier than in the mountain forest proper. The soil, covered with a thick, slippery layer of decaying bamboo-leaves, is more exposed to light and bears a scattered and uniform herbaceous vegetation. The molluscan fauna is much poorer than in the mountain forest, since the following are the only species that have been found there:

| | |
|---|---|
| *Halolimnohelix zonata* | *Varicostele subvaricosa major* |
| *Homorus castaneus* | *Gulella ovalis* |
| " *mamboiensis* var. *circumstriatus* | *Thapsia hanningtoni* |
| *Bocageia germaini* | *Helixarion subsucculentus* |
| *Bocageia liocephala* | |

(3) The SUBALPINE ZONE, or region of the Ericaceæ (Pl. LVIII), begins in about 2,800 m. and extends to 3,500 m. It is essentially a zone of tree-heaths, *Erica aborea* Linnæus and *Philippia Johnstonii* (Schweinfurth) being the dominant species. There are also scattered representatives of many other peculiar trees, such as *Mæsa, Cornus, Hagenia, Myrsine,* etc., of a conifer (*Podocarpus milanjianus* form *arborescens* Pilger), and of a tree fern (*Alsophila Mildbrædii* Braun). These low, more or less scrubby trees grow amidst a maze of fallen, decaying trunks and stumps, densely overgrown with cushions of peat-moss, liverworts, and mosses, and the whole is so thoroughly soaked with moisture as to transform it into a moor. Various terrestrial ferns and orchids grow between

the moss; also a species of cranberry (*Vaccinium Stanleyi* Engler). The temperature is considerably lower than in the mountain forest and this probably explains the small number of species of land snails to be seen here, although most of them are common. *Halolimnohelix ruwenzoriesnis, Vicariihelix orthotricha, Haplohelix anadenia, Homorus olivaceus, Bocageia runssorina, Streptostele teres,* and *Varicostele bequaertiana* are the only species obtained in the heath zone by the junior author. The predominance of Helicidæ in this list is certainly worthy of attention; most of them have exceedingly soft shells, which it is hardly possible to pick up without indenting.

(4) Above 3,500 m. one enters the ALPINE or PARAMOS ZONE (Pl. LIX), a region of giant, arborescent groundsels (*Senecio adnivalis* Stapf and *S. Erici-Rosenii* Fries) and of tall torch-like lobelias (*Lobelia Wollastonii* Sp. Moore, *L. Deckenii* Hemsley and *L. Stuhlmanni* Schweinfurth); while higher up still the ground is covered with a dense carpet of small-leaved, tough-branched *Alchemillæ* (of several species) and numerous low bushes of various everlastings (*Helichrysum Stuhlmannii* O. Hoffmann, *H. robustum* Mœser, and *H. Lentii* Volkens and O. Hoffmann). Toward 4,000 m. or 4,500 m. most higher forms of plant life disappear and the exposed rock only bears a few lichens and mosses.

Only four species of land mollusks were seen by the junior author in the Alpine Zone of Ruwenzori: *Halolimnohelix ruwenzoriensis, Vicariihelix orthotricha, Homorus olivaceus,* and *Vitrina oleosa.* Most of them were found hidden between the stem and the leaf-base of the arborescent groundsels and in favorable weather were seen crawling over the leaves of these plants. The three first-named species also occur in the swampy zone of tree-heaths; but the *Vitrina* appears to be peculiar to the very highest regions of the range. It is apparently the only mollusk to reach the snow-line, in about 4,500 m.

The region of the Kivu highlands is much more extensive than the Ruwenzori Range, since it covers most of the country between 1° and 5° S., and 28° and 30° E., wherever the altitude above sea-level is over 1,500 m. It thus comprises the Mfumbiro Volcanoes, northwestern Ruanda with the Rugege and Bugoie Forests, and the western scarp of the Albertine Rift from Lake Edward to a little north of the outlet of the Lukuga River. Lake Kivu, at an altitude of 1,460 m. (4,830 ft.), contains several islands which also belong to the same zoögeographic region; the most important of these is Kwidjwi. Much of the surrounding territory is covered with extremely fertile soil, partly due to weathered recent volcanic rocks, and consequently supports a large native population. Cattle, sheep, and goats are raised in considerable numbers, so that the combined efforts of man and beast have transformed most of the lower regions of this area, between 1,500 m. and 1,800 m., into a pasture land of short mountain grass almost bare of woody vegetation and extremely poor in mollusks. In fact the only known species is *Burtoa nilotica emini*, which the junior author found crawling about in the short-grass prairie at Boswenda (1,800 m. above sea-level), near the foot of Mt. Mikeno.[1] There is every reason to believe that, as on Mt. Ruwenzori, mountain rain forest originally covered most of the Kivu country; but it is nowadays preserved only above 1,800 m., namely in what is known as the Bugoie and Rugege forests and on the several volcanoes of Mfumbiro. In the highlands of the western scarp of the Albertine Rift conditions are, however, more favorable for the preservation of woody vegetation. Mountain forest (Pl. LX, fig. 1), often mixed with bamboo thickets (Pl. LX, fig. 2), here forms a north to south strip 80 to 100 kilometers wide, which is continuous at its western edge with the Guinean rain forest of the Congo lowlands. When one travels from Rutshuru westward to the Lualaba the passage from the mountain forest to the Guinean rain forest occurs about midway between Masisi and Lubutu, near the crossing of the Oso River, where the change in the nature of vegetation and fauna is extremely rapid and sharp.

The malacological fauna of the Kivu Mountain Forest, between 1,800 m. and 2,000 m., is extremely varied and very similar to that of the corresponding altitudinal life zone of Ruwenzori. This is well brought out by the following list of species obtained in the region of Masisi by the junior author (M) and on the island of Kwidjwi by Schubotz (K):

*Halolimnohelix mukuluensis* M
" *bulla* M
*Achatina osborni* M
" *graueri* M
*Limicolaria saturata* K
" " *masisiensis* M
" *elegans* M, K
" *pura* K
*Homorus kwidschwiensis* K
" " *nigricans* M
*Nothapalus sororcula* M
*Subuliniscus lucasi* M
*Pseudoglessula intermedia* K
" " *masisiensis* M
" *elatior* K
*Curvella bathytoma* M
" *dautzenbergi* M
*Marconia kivuensis* M
" *lata ruwenzoriensis* M
" *latula* M
*Gonaxis micans* M
" *vulcani* M
*Streptostele streptosteloides* K

[1]Schubotz also obtained *Burtoa nilotica* at the foot of Mt. Muhavura and in Wau Island, Lake Kivu. His specimens were merely referred by Thiele to the species, but it appears probable that they belonged to the subspecies *emini*.

*Streptostele bequaerti* M
" *centralis* M
*Ptychotrema myrmecoön* M
" *mukulense* M
*Gulella brevis* M
" *polloneriana* M
" *masisiensis* M
*Thapsia mukulensis* M
*Mesafricarion auriformis* K
*Helixarion insularis* K
' *niger* M
" *microgranulatus* M
"*Helicarion*" *kivuensis* M, K
" *schubotzi* K, M
" *stuhlmanni* K
*Kaliella barrakporensis* M
*Cerastus retirugis* M
" *bequaerti* M
" " *mokotoensis* M
" " *mukulensis* M
" *lucasi* M
" *drymæoides* K
*Cyclophorus intermedius* K, M

The outstanding differences between this mountain forest fauna of the Kivu highlands and that of the corresponding life zone on Ruwenzori, appear to be the presence in Kivu of the genus *Achatina* and the absence of *Limicolariopsis* and *Bocageia*. Whether these are merely due to insufficient collecting must be left for future explorers to investigate, but there appears to be no reason why *Limicolariopsis* and *Bocageia* should not occur in the Kivu highlands. At present the terrestrial mollusk fauna of Kivu is best characterized by the unusual development of the enid genus *Cerastus* which reaches here its extreme eastern limits. Especially in the region of Masisi these beautiful snails are very commonly met with in the early morning crawling over the moss and dead leaves or crossing the pathways. They should be collected with great care, since the region certainly possesses many additional species as yet unknown to science.

The Bugoie and Rugege Forests of northwestern Ruanda, a short distance from the eastern shore of Lake Kivu, at an altitude of 1,800 m. to 2,500 m., possess from all accounts a vegetation like that of the region of Masisi, so that one might expect them to have an equally profuse malacological fauna. Thus far, however, but very few species have been obtained there, as may be seen from the following list of available records[1]:

*Limicolaria saturata* B, R
*Pseudoglessula obtusata* R
*Gonaxis vulcani* R
"*Helicarion*" *kivuensis* R
" *schubotzi* R
*Cerastus retirugis* R
*Cyclophorus elatior* B

The Kivu highlands discussed thus far but rarely reach above 2,500 m., so that there is as a rule no occasion for the development of other types of vegetation than bamboo and mountain rain forest. The topmost ridges of Rugege and the mountainous country west of Kivu and of

[1]R = Rugege Forest; B = Bugoie Forest. These species have been mostly collected by Schubotz and Grauer.

Lake Edward sometimes exceed 2,500 m. and even very rarely reach 3,000 m. There is then a beginning of subalpine zone of Ericaceæ, but, as such areas are always of small extent, they never form a formal life zone.

Conditions are, however, quite different on the Mfumbiro Volcanoes, which rise considerably higher. They form a chain of eight isolated peaks north of Lake Kivu: Mt. Ninagongo and Mt. Namlagira in the west; Mt. Mikeno, Mt. Karisimbi, and Mt. Vissoke in the center; Mt. Sabinyo, Mt. Mgahinga, and Mt. Muhavura in the east. The two highest of these are Mikeno (4,434 m.) and Karisimbi (4,500 m.) and, though they are not covered with permanent ice, they nevertheless offer a succession of life zones somewhat similar to that of Mt. Ruwenzori.[1]

The two western volcanoes are still active and their slopes are covered with recent ashes and lavas. The various plant formations are, therefore, still in an incipient stage and, as even now they are occasionally disturbed by fresh eruptions, they cannot be expected to show a well-defined altitudinal succession. On Mt. Ninagongo, for instance, the lowest zone, between 2,300 m. and 2,800 m., is covered with peculiar thickets of low trees and bushes, occasionally mixed with bamboos (*Arundinaria alpina* K. Schumann), and evidently the first stage of a mountain or cloud forest. Above 2,800 m. begins a formation of subalpine bushes, with *Erica arborea* Linnæus and *Myrica salicifolia* Hochstetter as main elements, in which are scattered numerous high and low herbaceous plants, while mosses and lichens are very abundant. The highest points, around the rim of the crater, form an alpine or Paramos region with tree groundsels (*Senecio Erici-Rosenii* Fries) and *Helichrysum*. The torch lobelias, however, have apparently not yet taken a foothold on the summit of Ninagongo. The malacological fauna of this volcano is still very little known, only four species having been recorded thus far, all obtained by Schubotz, between 2,500 m. and 3,000 m.: *Limicolaria saturata*, *Marconia latula*, *Gonaxis vulcani*, and *Gerastus vexillum*.

The other volcanoes have become extinct centuries ago, so that the various plant formations which cover their slopes have had time to mature and to reach their climax, and now form regular altitudinal zones. Their alpine zone contains, in addition to *Senecio Erici-Rosenii* Fries, also giant torch lobelias (*L. karissimbensis* R. E. and Th. Fries and *L. Wollastonii* Sp. Moore). Moreover, the similarity of the plant growth of the Mfumbiro group as a whole with that of the Ruwenzori Range is ex-

[1]The vegetation of the Mfumbiro volcanoes is discussed by A. Engler, 1925, 'Die Pflanzenwelt Afrikas,' V, 1, pp. 303-310.

tremely pronounced; the genera and even the species are often the same, notwithstanding the fact that these two ranges are 150 kilometers apart and nowadays separated by lowland country covered with savanna and partly occupied by a lake. These peculiarities are best understood if we admit that during a rather recent glacial period the various life zones shifted to a considerably lower level.

A comparative study of the land mollusk fauna in the several volcanoes, at various altitudes, would be of extreme interest, but unfortunately we possess hardly any data on which this could be based. The lower region of Mt. Mikeno alone has been somewhat more completely explored by Robin Kemp. Preston and, more recently, Connolly have described from that mountain, between 1,700 m. and 2,000 m., the following species:[1]

*Burungaëlla oscitans*
" *imperforata*
" *buhambaënsis*
*Nakuruëlla soror*
" *ahena*
*Urguessella capillata*
*Nothapalus ugandanus*
*Pseudoglessula burungaënsis*
" *perobtusa*
*Gonaxis buccina*
*Gulella burungaënsis*
" *iridescens curta*
" *mikenoënsis*
*Thapsia inclinans*
" *inflata*
" *iridescens*
*Trochozonites expatriata*
"*Africarion*" *copiosus*
" *spatiosus*
" *tenebrosus*
*Cerastus kempi*

The very few mollusks recorded from the remaining Kivu volcanoes are as follows:

Mt. Sabinyo
*Limicolaria saturata*, at 3,000 m.
*Vitrina bambuseti*, at 3,000 m.

Mt. Karisimbi
*Limicolaria saturata*, at 2,400 m.
"*Helix*" *runssorina*, at 3,300 m.
*Vitrina tenuissima*, at 3,400 to 4,200 m., on leaves of tree *Senecio*.

Of great interest is the occurrence of true *Vitrinæ* in the higher regions of these two mountains. In both cases, the animal has been studied anatomically, so that the generic reference is beyond doubt.

### 6. East African Highland District

This district is mainly developed in Tanganyika Territory. It enters the Belgian Congo only on the northeastern shores of Lake Tanganyika, in the regions known as Urundi and Ruanda and in the valley of the lower Ruzizi. It covers there all areas below the 1,400 m. contour

[1]The species of *Burungaëlla, Nakuruëlla,* and *Urguessella* appear to be true Helicidæ whose relationship has, however, not yet been investigated.

line, so that northwestern Ruanda is excluded from it. The country is quite rugged and reaches an altitude of between 1,000 m. and 1,400 m. The climate is on the whole tropical, but the distinction between wet and dry seasons is very marked. Most of the district is covered with high-grass savanna, with very few or no bushes or low trees. Ecological conditions do not seem very promising to the malacologist, and in fact but little has been published thus far concerning the land mollusks of that area.

The territories of Ruanda and Urundi have been under Belgian mandate since 1920 only, so that their fauna was not included in the 'Review of Land Mollusks of the Belgian Congo' published by the senior author in 1919. The only records which we have been able to find in the literature refer to the occurrence on the northeastern shore of Lake Tanganyika of three species of *Limicolaria*, viz., *L. smithi* Preston obtained by Grauer near Usumbura,[1] *L. martensiana* Smith and *L. rectistrigata* Smith, both collected by O. Baumann.[2] Farther south, beyond the border of our territory, many land mollusks have been recorded from Ujiji, Ufipa, and Mbwe and it appears probable that most of these will eventually be found in Urundi.

### 7. Rhodesian Highland District

This district is chiefly developed in Northern Rhodesia, but it also covers the southeastern corner of the Belgian Congo, namely the elevated country known as Katanga, on the headwaters of the Lualaba and its tributaries. Its northwestern limits are roughly given by a line drawn in a general southwest direction from the outlet of the Lukuga to Lake Dilolo. They generally follow the 800 m. to 1,000 m. contour-lines, being found at a gradually higher altitude as one proceeds from the southwest to the northeast. This line is biogeographically of prime importance since it separates the two main divisions of the Ethiopian Region. Owing to the steep northwestern slopes of the Katanga highlands, it is extraordinarily well defined, the transitional zone being but a few kilometers wide. Still, it must be noted that several deep valleys, such as those of the Luvua-Luapula, Lufira, Lualaba, and Lubudi Rivers, penetrate from the north far down into the heart of Katanga, separating a series of high plateaus. Being considerably lower than the neighboring country, these valleys still possess a warm, tropical climate

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[1]See J. Thiele, 1911, 'Wiss. Ergebn. D. Z. Afr. Exped. (1907–1908),' III, p. 203.

[2]See R. Sturany, in O. Baumann, 1894, 'Durch Massailand zur Nilquelle,' pp. 311 and 312. In this work there is also a description of *Succinea baumanni* Sturany, from the sources of the Kagera River (p. 314).

and thus allow many West African forms of life to extend southward much beyond the limits indicated above. The disturbing influence of these valleys is well exemplified by the distribution of the tsetse fly, *Glossina palpalis* (Robineau-Desvoidy), a typical West African insect which, however, spreads along the rivers of Katanga to about 11° S. latitude. Some land mollusks appear to follow the same rule. Thus, among the species collected by the junior author at Lukonzolwa, on the shores of Lake Moero at an altitude of about 980 m., (*Pseudoglessula stuhlmanni, P. lemairei, P. boivini, Gulella lamyi, Gulella coarti, Marconia kivuensis, Kaliella barrakporensis, "Gonyodiscus" smithi, Subulina leia, Streptostele elegans*, and *Cyclophorus intermedius*), there are some which are either also found in the West African Subregion or closely related to species from that part of Africa. It is therefore important while collecting in this district to note topographic conditions and altitude of each locality.

The Katanga offers a much greater physical and geological variety than is the rule elsewhere in the Belgian Congo. In the north there are a series of plateaus known as the Biano and Kundelungu, reaching an altitude of 1,400 m. to 1,600 m., exceptionally 1,700 m. or even over 1,800 m. (west of Lake Moero). These plateaus are fairly level at the top and almost entirely built of nearly horizontal, Permo-Carboniferous sandstones of continental origin. The upper Katanga, or region of the copper mines, is a peneplain of old Palæozoic, much folded and tilted rocks, on the average 1,000 m. to 1,500 m. above sea-level and so completely worn down to near level that the divide between the Congo and Zambezi River systems is at present hardly to be noticed. The Biano plateau is bordered in the north by the Bia Mountains, a series of rugged elevations, 600 m. to 1,200 m. high, with outcrops of Archæan granites and gneisses, amid belts of tilted pre-Carboniferous strata. The Marungu, in the northeastern corner between Tanganyika and the Luvua River, is a similar but larger mountainous area. Its summits reach between 1,100 m. and 2,900 m. in height. In some places it develops fairly level table-lands, such as that of Massewa, apparently an outlier of Kundelungu with which it agrees in geologic constitution.

The climate is everywhere of the typical savanna type and, owing to the combination of southern latitude, high altitude, and rocky soil conditions, its effects upon plant and animal life are much more pronounced here than elsewhere within our territory. During the dry season, which lasts about six months—from May to October—and is practically rainless, the temperature is much lower than during the rains.

At Elisabethville, for instance, in 11° 40′ S. and 27° 25′ E., at an altitude of 1,237 m., the temperature about the middle of the dry season does not exceed 29° C. at noon, while during the night it may drop to 2° C. The hottest months are September and October, that is just before and during the first rains, when a shaded thermometer registers from 35° C. to 36° C. toward noon and from 8° .2 C. to 13° C. during the night. The total annual rainfall for two years in that locality was respectively 42.7 inches (1,084 mm.) and 53.5 inches (1,358 mm.). In the shallow, open valleys of Katanga, known as "dembos," there is often frost at night during the dry season and on the higher plateaus the thermometer may then mark as low as —3° C. or —4° C. just before sunrise. It thus appears that in many respects the climate of Upper Katanga places this region at the extreme limit of the tropical zone. In this connection it should be noted that extremes of temperature, especially minima, are of far greater importance for the life and distribution of animals and plants than the daily or seasonal averages usually given in meteorological tables. There can be little doubt that the occasional cold nights of the dry season are a foremost factor in preventing the spread of West African forms of life into Upper Katanga and that they are chiefly responsible for the sharp dividing line between the West African Subregion and the East and South African Subregion in the southeastern Congo basin.

Owing to the peculiar combination of a wet season with abundant rainfall and a dry season with extreme arid conditions, the vegetation of Katanga is almost everywhere a savanna forest (Pl. LXI) with decided tropophytic characteristics and of which papilionaceous trees, especially of the genus *Brachystegia*, are the dominating element. Shortly after the end of the rains many of the trees drop their leaves; the grass remains short and many of the perennials and suffrutescent herbs possess underground rhizomes or bulbs in which they store food and water for the periods of drought. This enables them to flower shortly before the first rains and usually before producing leaves. The long period of drought forces the land mollusks to estivate. Some, as *Rachis braunsi*, merely remain on the trunk of savanna trees and secrete a substance with glues the margin of the aperture fast to the bark, while they daub the surface of the shell with dirt so as to be concealed. Others burrow in loose soil or seek shelter in the galleries of the huge termitaria which are extremely numerous over much of this district. This is the common method of estivation used by the *Limicolariæ* and *Achatinæ*, which in addition close the aperture with a solid, calcareous epiphragm. The destructive action of the grass fires is not so much to be feared here by land snails as in the savannas of the Ubangi and Southern Congo Districts, since the grass is rather short and spaced, so that the flames but rarely scorch the trees and higher bushes.

Although the molluscan fauna of Katanga has been but very little investigated—land mollusks are not known from more than a dozen localities—yet it is possible to point out certain peculiarities by which it differs decidedly from that of the remainder of the Belgian Congo. Perhaps the most interesting is the presence in this area of a series of light-shelled, almost transparent *Achatinæ*, such as *A. greyi*, *A. nyikaensis*, *A. obscura*, *A. schoutedeni*, *A. transparens*, and *A. virgulata*. They are typical savanna forms, totally different from the heavy, dark-colored species met with in the Congo lowland forest. *Limicolaria* on the whole is rare. The curious operculate snail, *Tropidophora anceps*, which inhabits the dry forest savanna, is a typically East African element reaching in Katanga its extreme western limit.

An interesting assemblage of mollusks was found by the junior author on the Kundelungu Plateau, in about 1,800 m. It consisted of "*Zingis*" *bequaerti*, "*Gonyodiscus*" *ponsonbyi*, *Gulella haullevillei*, and *Ledoulxia consociata*. Unfortunately the radulæ and anatomy of these forms have not been studied, so that it is impossible to know whether the "*Zingis*" is a true helicid and whether the species described as "*Gonyodiscus*" has been referred to the correct genus and therefore belongs to the Endodontidæ.[1]

## Ecology and Distribution of Fresh-water Mollusks

The fluviatile mollusk fauna of the Belgian Congo does not lend itself to an analysis along the lines we have followed in the foregoing study of the terrestrial species. In the present state of investigation there does not appear to be any great distinctness in the aquatic faunæ of the several zoögeographic districts. If in a few cases certain forms are restricted to one or another of them, it is not quite evident that this is not merely due to present-day ecological conditions and has therefore no particular zoögeographic significance. In fact, the outstanding features of the fresh-water malacology of the Congo—and, as we shall see, of the Ethiopian Region as a whole—are its poverty in generic and specific types and its uniformity over immense areas.

The fluviatile mollusks recorded at present with certainty from the Belgian Congo number 150 species and subspecies (not including those

[1]Although no slugs have been thus far recorded from Katanga, the collections made in that region by the junior author (1911–1912) included both Vaginulidæ and Urocyclidæ.

of the Great Lakes), and, if we add some that are more or less dubious on account of possible misidentification or synonymy, we reach a total of 160, representing 33 genera. These figures are very low indeed, considering the size of the territory (about 900,000 square miles, a little less than one-third of the area of the United States), and the abundance of superficial water (the Congo system possesses over 5,000 kilometers of commercially navigable water-ways alone!). Naturalists not personally acquainted with African conditions will probably assume that this poverty is only apparent and merely reflects insufficient investigation. Our studies of the African fluviatile mollusks have, however, brought us to a different conclusion. No doubt many species remain to be discovered in the Congo basin, as elsewhere on the continent. Yet it should be remembered that collections have been made at present in many different localities, in some cases by professional zoölogists. It is hard to believe that all these collectors should have overlooked a large proportion of the aquatic mollusks in the localities they visited, especially since these animals are, with few exceptions, of fair or large size, and not minute like so many of the terrestrial species.[1] The extensive material gathered by the American Museum Congo Expedition, which numbers many thousands of specimens, as well as the junior author's personal experience, fully justify our opinion that the African fresh-waters actually nourish but few types of mollusks.[2] There is nothing here comparable with the abundant and varied mollusk faunæ of many of the North American river systems.[3]

## The Ecological Factors

Since aquatic mollusks normally spend most of their existence immersed in a liquid medium, they are more or less independent of some of the environmental factors that influence terrestrial snails and slugs, such as vegetation, topography, and climate. The physical and chemical

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[1]It is of course among the smaller forms, such as Ancylidæ, Amnicolidæ, and Sphæriidæ, that interesting accessions may most readily be made and these are therefore especially recommended to future collectors.

[2]Roubaud has quite expressed the feelings of the disappointed collector in a letter written from Brazzaville to Germain, which we beg to quote as fully pertinent to our subject: "Dès le début de mon arrivée, j'ai visité les bords du fleuve et les îles, m'attendant à trouver des monceaux de coquilles en cordon littoral. Je n'ai rien rencontré, sauf, de loin en loin, et le plus souvent vivants, des individus isolés que les eaux venaient d'abandonner. J'ai parcouru déjà pas mal de chemin dans le Congo de l'Hinterland, j'ai fait, tant dans la vallée de l'Alima que sur les plateaux de la route des caravanes, des recherches nombreuses sur un parcours de plus de 1,200 kilomètres, autant que me le permettaient les loisirs des étapes, et si j'ai été surpris d'une chose, c'est de la grande rareté des Mollusques au Congo. La faune du Pool [Stanley Pool] même, qui est la plus riche, me paraît jusqu'à présent singulièrement pauvre, étant donné sa surface qui couvre en largeur près de 40 kilomètres." (L. Germain, 1909, Arch. Zool. Expér. Gén., XLI, p. 109, footnote.)

[3]For instance, no less than 60 species and subspecies of snails and mussels have been found in the the Big Vermilion River system, which drains about 1,500 square miles in Illinois. See Baker, F. C. 1922. 'The molluscan fauna of the Big Vermilion River, Illinois.' Illinois Biol. Monogr., VII, 2, 126 pp., 15 Pls.

constitution of the soil, the concentration and nature of dissolved substances, and the movements, depth, and volume of the water are among the chief conditions with which they have to contend. On the whole, aquatic mollusks appear to be more sensitive to relatively slight changes in their surroundings than most terrestrial species. On the other hand, many fresh-water snails and mussels are extremely plastic, readily exhibiting changes in their shape or behavior as a result of altered ecological conditions.

In tropical Africa the temperature of the water remains fairly constant,[1] except in certain ice-fed small streams or ponds at very high altitudes; but not much is known as yet of the molluscan fauna of such cold waters. Mt. Ruwenzori, for example, possesses a number of glacier-fed streams and lakes, but the few aquatic mollusks known from the Range, viz., *Lymnæa natalensis, Planorbis bridouxianus,* and *Pisidium ruwenzoriense,* were obtained in the lower regions or in the foothills. The *Pisidium* alone is recorded from the base of the Kichuchu rock-shelter, in about 3,000 m., and, as the genus is generally found, in Africa at least, in higher mountains, it may well represent a boreal element in the fauna. Some of the peculiarities of the aquatic molluscan fauna of Upper Katanga possibly are due also to the low nocturnal temperatures that prevail there during the dry season (see p. 518).

The temperature of certain streams and ponds is considerably raised by the outflow of thermal springs. In North America and Europe certain Lymnæidæ and Physidæ produce dwarfed forms in abnormally warm water. Thus, *Lymnæa peregra* var. *thermalis* Boubée, of the hot springs of the Pyrenees (in water at 45° C.) and Vosges, and *L. p.* var. *geisericola* Beck, of the Iceland geysers (in water at 42.5° C.), are decidedly thinner and smaller than the typical form. *Physa aurea* Lea, apparently a dwarfed form of *P. heterostropha* Say, was described from Hot Spring, Bath Co., Virginia, living indiscriminately in water having a temperature of from 13° C. to 41° C. In other cases the increased temperature does not seem to affect much the appearance of the shells. Raymond (1852, Journ. de Conchyl., II, p. 325) records finding *Melanoides tuberculata* in hot springs (32° C.) near Constantine, Algeria. However, but very few aquatic mollusks—some twenty species in all—are known with certainty to thrive at temperatures above 30° C.[2]: *Neritina thermophila* v. Martens (52° C.; New Britain); *Bythinella thermarum* Bourguignat (42° to 46°

[1]In some of the larger lakes there is an appreciable change of temperature with increasing depth, as we shall show for Lake Tanganyika.

[2]See Pelseneer's recent review of the mollusks of thermal waters (1920, Mém. in 8° Ac. Belgique, Cl. des Sci., (2) V, pp. 499–506).

C.; Italy); *Ostrea cucullata* Born (45° C.; New Britain); *Bythinella peraudieri* Bourguignat (42° C.; Algeria); *Lymnæa peregra* Müller (29° to 46° .25 C.; Pyrenees, Iceland, Italy); *Lymnæa truncatula* Müller (32° to 42° .5 C.; Iceland, Italy); *Physa heterostropha* Say (41° C.; Virginia); *Paludestrina nickliniana* (Lea) (41° C.; Virginia); *Melanopsis etrusca* Villa (41° C.; Italy); *Pisidium casertanum* (Poli) var. *thermale* Dupuy (39° C.; Pyrenees); *Paludestrina protea* (Gould) (38° C.; southern California); *Fluminicola merriami* Pilsbry and Beecher (36° C.; Nevada); *Tryonia clathrata* Stimpson (36° C.; Nevada); *Physa acuta* Draparnaud (33° to 35° C.; Pyrenees); *Planorbis corneus* (Linnæus) (34° C.; Italy); *Melanoides tuberculata* (O. F. Müller) (32° C.; Algeria); *Melanopsis jordanica* Roth, *M. præmorsa* (Linnæus), and *Neritina* sp. (32° C.; Palestine); *Theodoxus fluviatilis* (Linnæus) (32° C.; Italy); etc. A few of these, such as *Bythinella thermarum* and *Melanopsis etrusca,* appear to be restricted to thermal springs. Most of them, however, are forms of species found elsewhere at a normal temperature. Thermal waters are usually very poor in oxygen, especially when they issue from boiling springs. On the other hand, they often show a concentration of salts dissolved (carbonate of lime, silica, sodium salts, arsenical compounds, etc.) much above the normal. As a rule, both of these factors influence the nature of their fauna much more than the increased temperature.

There are a number of hot springs in the Belgian Congo, notably in Katanga,[1] and it would be of great interest to know whether any of the local aquatic snails have become adapted to them. Those which the junior author visited contained no mollusks. Volcanic eruptions may sometimes temporarily raise the temperature of the water so as to kill off all life. This happens periodically in the northern part of Lake Kivu, where lava-flows have been known to bring the water near boiling point, causing the death of quantities of fish. This peculiar condition may be in part responsible for the exceedingly scant molluscan fauna of that lake.

In those parts of the Belgian Congo where the alternating wet and dry seasons are very pronounced, the aquatic mollusks, with the exception of those that inhabit permanent rivers and larger lakes, must be able to stand the severe drought. When the rains are at their height inundations are liable to flood extensive level areas and the floods then carry many aquatic snails far away from their permanent haunts. In the succeeding dry season the waters gradually retreat and extreme arid

[1]Matthieu, F. F. 1913. 'Les sources thermales du Bas-Katanga.' Ann. Soc. Géol. Belgique, Publ. Relat. Congo, (1912–1913), pp. 103–125, Pls. III–IV.

conditions may then prevail in a country which a few months before was practically flooded. The mollusks left stranded by the drought eventually die, unless they be able to bury themselves deep enough in the mud or to withstand prolonged desiccation by tightly closing the operculum.[1] We shall have occasion to point out some interesting adaptations to periods of drought and temporary aërial life, in describing the molluscan life in the swampy plains of the Upper Lualaba.

The physical nature of the bottom of the water is of considerable importance in the life of aquatic snails and mussels. Thus, in the Belgian Congo it may be observed that the species of *Lymnæa*, *Planorbis*, and *Physopsis*, prefer shallow ponds in the savanna country or even pools of water that accumulate in depressions of rocks and are partly filled with aquatic plants, so that the muddy bottom is rich in decaying vegetable matter. *Lanistes* and *Pila* are particularly abundant on the oozy mud of papyrus swamps. Many of the smaller *Melanoides* frequent the spits of shifting sand in the larger rivers, where they usually bury themselves a little below the surface of the sand. On the other hand, the bars of muddy silt near the quiet shores of shallow rivers are the peculiar habitat of most Congo Mutelidæ and Unionidæ. The Etheriidæ prefer a stony substratum on which to encrust themselves in oyster-fashion, and consequently are met with in rapids and falls.[2] In a similar habitat many species of *Potadoma* and certain *Bulimus* keep in the crevices of the rocky ledges. Finally, the clear, torrential streams of more rugged, mountainous country nourish the peculiar smaller Amnicolidæ, such as *Lobogenes* of Upper Katanga, and Sphæriidæ, which live among the fine pebbles of the gravelly bottom.

An interesting case is offered by certain Unionidæ for which the presence of coarse gravel bars under swift water, at moderate depth, appears essential for the early development of the mussel. In North America Isely[3] has shown that in several species the parasitic stage of the glochidium is followed by an early juvenile condition, when the small mussel is attached by a byssal thread to a pebble of immersed gravel beds, under a fairly swift current. He believes that such juvenile mussels

[1]The most remarkable adaptation of a fluviatile snail to periodically arid conditions is that exhibited by the South American "*Ancylus*" *moricandi* d'Orbigny which in the Bolivian Chaco covers the opening of the shell almost completely with a calcareous, convex septum, apparently part of the shell and leaving but a small opening at one end. See Nordenskiöld, E. 1903. 'Ueber die Trockenzeitanpassung eines *Ancylus* von Südamerika.' Zool. Anzeiger, XXVI, pp. 590–593. Also H. A. Pilsbry, 1914, Proc. Ac. Nat. Sci. Philadelphia, LXV, (1913), pp. 668–671.

[2]The much distorted shape of the valves of *Etheria* appears to us due rather to the irregular shape of their substratum, and not to the mechanical action of swift currents as Simroth (1890, Zool. Anzeiger, XIII, p. 662) suggests.

[3]F. B. Isely. 1911. 'Preliminary note on the ecology of the early juvenile life of the Unionidæ.' Biolog. Bull., XX, pp. 77–80.

as drop from fish in shifting sand and silt, die soon, being unable to fix themselves. It is quite possible that this explains the practical absence of Unionidæ over considerable stretches in the larger rivers of the Central Congo basin where gravel bars and stony situations are practically absent. The Unionidæ appear to be replaced there by the Mutelidæ. Unfortunately, the life-history of the African Unionidæ is still completely unknown.

The preferred habitat of each species is, of course, not due exclusively to the physical nature of the bottom, which moreover is itself the result of the movements, depth, and volume of the water. In shallow ponds or puddles and in muddy swamps the water is stagnant and there is usually abundance of aquatic vegetation so that much decaying matter is mixed with the mud, favoring the development of lower algæ on which certain aquatic mollusks feed by preference. In the larger rivers the current is very slight near the banks so that thick deposits of alluvial matter are formed; mountain streams, on the other hand, have swift-flowing waters rapidly carrying away all alluvial matter except coarse gravel, and the mechanical force of the water reaches its maximum in the rapids and cataracts, which are an extremely characteristic feature of all the headwaters of the Congo basin.[1] The mechanical action of the current not only regulates the distribution of the several species that inhabit a river system, but in some cases it may modify the morphological features of the shell.[2] In the North American *Io fluviatilis* the smoother forms occur in the upper reaches where the current is stronger, while the spinose varieties are found farther downstream in more quiet water.[3] Simroth has similarly sought to explain by differences in the rapidity of the current the occurrence in the rapids of the Congo of two forms of *E. elliptica:* the smooth form (typical *elliptica;* mut. *nidus hirundinis* Simroth) being the one of more quiet situations; the spinose form (var. *tubifera* Sowerby; mut. *tubulifera* Simroth), the one of swift currents.[4] Whether this is actually the case has been disputed, as the two forms have been found associated

[1]According to T. J. Headlee (1906, Biolog. Bull., XI, pp. 305–318), the physical character of the bottom is the most potent factor in regulating the distribution of fresh-water mussels in small lakes.

[2]See Jordan, H. 1881. 'Einfluss des bewegten Wassers auf die Gestaltung der Muscheln aus der Familie Najades Lam.' Biol. Centralbl., I, pp. 392–399.

March, Margaret C. 1911. 'Studies in the morphogenesis of certain Pelecypoda. (1) A preliminary note on variations in *Unio pictorum, Unio tumidus* and *Anodonta cygnea.*' Mem. Proc. Manchester Litt. Phil. Soc., LV, 2, No. 8, pp. 1–18, 1 Pl.

Sell, H. 1906. 'Einfluss des bewegten Wassers auf die Gestaltung der Muscheln aus der Familie Unionidæ Flem.' Nachrichtsbl. Deutsch. Malakoz. Ges., XXXVIII, pp. 38–44, 64–68.

[3]Adams, C. C. 1900. 'Variation in *Io.*' Proc. American Assoc. Adv. Sci., 49th Meet., pp. 208–225, Pls. I–XXVII.

1915. 'The variations and ecological distribution of the snails of the genus *Io.*' Mem. Nation. Ac. Sci., Washington, D. C., XII, 184 pp., 61 Pls.

[4]Simroth, H. 1980. 'Ueber einige Ætherien aus den Congo-fällen.' Zool. Anzeiger, XIII, pp. 662–664 (also 1894, Abh. Senckenberg. Naturf. Ges., XVIII, 3, pp. 273–288, 1 Pl.).

In most of the larger lakes the extent and volume of the water, freely exposed to the action of the wind, result in the production of formal waves that break against the rocky shore or roll in surf-fashion over the beaches. Only types of mollusks that can solidly adhere to the rocks or possess other devices to withstand successfully the assaults of the waves, can thrive in such an environment and this factor has undoubtedly had its share in shaping the individuality of the lake faunæ. Even in smaller bodies of water the volume and depth appear to influence the size as well as the number of species of mollusks. It has been shown experimentally that the size of the shell in *Lymnæa stagnalis* varies directly in proportion to the volume of the water in which it lives.[1] Whether this is a general rule in nature appears nevertheless somewhat dubious, though in many cases the largest specimens of certain species were obtained from fair-sized rivers or ponds. In North America, Ortmann concludes from his study of correlation of shape and station in fresh-water mussels:

"Certain Naiades change their shape along the course of one and the same river in such a way that, (1) the more obese (swollen) form is found farther down in the large rivers, and passes gradually, in the upstream direction, into a less obese (compressed) form in the headwaters; (2) with the decrease in obesity often an increase in size (length) is correlated; (3) a few shells which have, in the larger rivers, a peculiar sculpture of large tubercles, lose these tubercles in the headwaters. The question arises: what is the meaning of these changes in shape? No positive conclusion is as yet possible, chiefly for two reasons: first, that there are only some species (and comparatively few), in which this law is observed, while others positively do not show it; and in the second place, that, although the size of the stream undoubtedly is connected with this phenomenon, we do not know whether size alone is the essential factor, or whether additional factors belonging to those constituting the small-stream community are responsible."[2]

Grier found that Unionidæ from Lake Erie were as a rule smaller, had broader growth-lines, brighter colors and more polished epidermis, and were thinner than the same species or closely allied forms from the drainage of the upper Ohio.[3]

It has also been claimed that the number of genera and species of mollusks in each of the great lakes of Central Africa is directly proportional to the size of the lake. This interesting question will be taken up later.

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[1]Willem, V. 1896. 'Observations sur la respiration cutanée des Limnées et son influence sur leur croissance.' Bull. Ac. Sci. Belgique, (3) XXXII, pp. 563–577. Willem's experiments seem to indicate that neither volume nor exposed surface of the water are the important factors regulating growth, but the amount of oxygen present in the water. See also F. C. Baker, 1911, Chicago Ac. Sci., Special Publ. No. 3, pp. 47–51.

[2]A. E. Ortmann. 1920. 'Correlation of shape and station in fresh-water mussels (Naiades).' Proc. American Philos. Soc., LIX, pp. 269–312, map.

[3]See a series of papers on this subject by N. M. Grier: 1920, Ann. Carnegie Mus., XIII, pp. 145–182, Pls. II–III; 1920, American Midland Naturalist, VI, pp. 211–243, Pls. I–III, and pp. 247–285; 1922, *op. cit.*, VIII, pp. 129–148. Also G. H. Ball. 1922, 'Variation in fresh-water mussels.' Ecology, III, pp. 93–121. These publications contain extensive bibliographies. Further references are given by Pelseneer, 1920, Mém. in-8° Ac. Sci. Belgique, (2) V, pp. 552–557.

The nature and amount of various solid substances in suspension, such as slit and humic matter, and of the chemicals in solution are foremost among the environmental factors acting upon aquatic mollusks.[1] In the first place, many of these animals breathe through gills and even in the case of the pulmonates, cutaneous breathing is often quite active, so that the concentration of oxygen in the water is particularly important for survival and development.[2] It has been shown that the effect of various concentrations of oxygen is modified by the hydrogen ions present; particularly the ill effect of a low amount of oxygen is increased by the high hydrogen ion concentration that accompanies it in water of low alkalinity.[3] We have commented above upon the general deficiency of lime in the soils of the Belgian Congo and the consequent ill effects upon terrestrial mollusk life. The superficial waters likewise show a very low concentration of lime. Spence notes that "the ordinary river water (of the Congo) only contains 4 to 5 grains of solids per gallon and is almost like distilled water, except for the brown color of organic matter."[4] This scarcity of lime probably explains why mollusks are represented by so very few species and individuals over large stretches of the rivers, notably in the low, forested part near the equator, between the mouth of the Aruwimi and that of the Ubangi. Here the lack of lime in solution is accompanied by extreme acidity of the water due to an abundance of humic and decaying vegetable matter carried in colloidal suspension. That, in contrast, some of the great lakes offer a profusion of snails and mussels may be explained by a higher concentration of lime compounds due to active evaporation without much dilution by outflow.[5] From a very careful experimental study of the effects of environment upon the growth of the North American *Lymnæa columella* Say, H. S. Colton concludes that calcium salts in the water, particularly calcium sulphate, seem to be on the whole beneficial to the growth of the shell.[6] Moreover, the abundance or scarcity of lime in solution affects the various species of fluviatile mollusks quite differently, as justly pointed out by

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[1]E. Dupont [1891, Bull. Ac. Sci. Belgique, (3) XX, (1890), pp. 559–566] believes that the poverty of the Congo basin in fluviatile mollusks is due in the first place to the abundance of silt carried in suspension which, upon entering the organs of the animals, has a deleterious effect upon their functions.

[2]See Willem, V. 1896. 'Observations sur la respiration cutanée des Limnées et sur son influence sur leur croissance.' Bull. Ac. Sci. Belgique, (3) XXXII, pp. 563–577.

[3]See Shelford, V. E. 1923. 'The determination of hydrogen ion concentration in connection with fresh-water biological studies.' Bull. Illinois Nat. Hist. Survey, XIV, Art. 9, pp. 379–395.

[4]1923, Journ. of Conchology, XVII, p. 19.

[5]Many examples of the direct effects of varying concentrations of lime upon fluviatile mollusks are given by Pelseneer, 1920, Mém. in-8° Ac. Sci. Belgique, (2) V, pp. 573–575. S. G. Rich (1915, Science, N. S., XLII, pp. 579–580) has described *Unio complanatus* Dillwyn var. *mainensis*, with horny and somewhat flexible valves covered with a very thick epidermis, from a pond on granite gneisses in western Maine, where the water was totally destitute of lime.

[6]Colton, H. S. 1908. 'Some effects of environment on the growth of *Lymnæa columella* Say.' Proc. A c. Nat. Sci. Philadelphia, pp. 440–448.

J. W. Taylor. Some European species, he notes, "as *Unio margaritifer* and *Neritina fluviatilis,* appear able to extract the necessary lime carbonate to form thick and heavy shells even from the waters of granitic districts, whilst other species, as *Ancylus fluviatilis,* under similar conditions seem unable to do so, their shells being unusually delicate and thin."[1]

Most aquatic mollusks respond readily to relatively slight changes in the concentration of mineral matter, especially sodium chloride, affecting the osmotic pressure of their tissues. Some species, such as the *Lymnæa, Planorbis,* and *Bulininæ,* can apparently not stand in nature even a comparatively slight and gradual increase in salinity and consequently they are but seldom found near the mouths of the rivers. Others, however, show a much greater plasticity: thus, at the mouth of the Congo one finds several species of *Lanistes* under highly brackish conditions, sometimes associated with typically marine forms; yet they have undoubtedly been derived from species inhabiting the fresh waters of the interior of the Congo basin.[2] In this connection it is of interest that the junior author has found *Lanistes nsendweensis*[3] in a decidedly brackish-tasting stream near Kiabwa, about 75 kilometers south of Ankoro. The reverse process of marine species becoming gradually used to brackish conditions is observed at the mouth of the Congo and of the other African rivers. In the interior of the African continent sodium and potassium chloride are usually scarce and generally absent from flowing and stagnant water. In some of the larger lakes where evaporation is very rapid and little or no outflow takes place, salt accumulates and their water is more or less brackish. Lake Kivu is peculiar in the very high concentration of magnesium salts.

It is unfortunate that analyses of the water of the Congo have been but rarely made. The data obtained in the Nile are not applicable to the Congo system, since none of the head-waters of the Nile[4] run through swampy, rain forest areas such as occupy the equatorial parts of the Belgian Congo. It is much more likely that the water of the Congo may

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[1]1894–1900. 'Monograph of the land and freshwater Mollusca of the British Isles. Structural and general volume.' (Leeds), p. 79.

[2]Examples of fresh-water mollusks that have become adapted to more saline conditions are given by Pelseneer, 1920, Mém. in-8° Ac. Sci. Belgique, (2) V, pp. 506–507 and 570–571. *Melanoides tuberculata* occurs in highly brackish lakes of northern Africa, where it sometimes lives with *Cardium edule.*

[3]Recorded as *L. bourguignoni* by Dautzenberg and Germain (see p. 188).

[4]O. Chadwick and B. Blount found that the water of Lake Victoria contains 0.135% of mineral matter (25.13% of which was Na, 6.96% Ca, 7.61% $SiO_2$, and 1.92% $Fe_2O_3$). For comparison, we may quote the mean of 34 analyses of the water of the Miami River at Dayton, Ohio (the salinity of which is about mid-way between the extremes for waters of the Ohio River system): total salinity: 0.279%, 11.04% of which is Na, 16.10% Ca, and 5.89% $SiO_2$. These figures and those given for the Amazon in the text are taken from F. W. Clarke, 1920. 'The data of geochemistry.' U. S. Geol. Surv. Bull. 695, pp. 79, 91, and 105. The same author states (p. 106) that in the water of the Nile 10.36% of the dissolved solids is organic matter, while this figure increases to 15.03% in the Amazon, to 24.16% in the Rio Tapajos, and to 59.90% in the Uruguay River.

be compared to that of the Amazon River: between the Narrows and Santarem this is quoted by F. W. Clarke as having a total salinity of 0.059%, 1.94% of which is Na, 21.12% Ca, and 18.80% $SiO_2$; while at Obidos above the mouth of the Tapajos River the total salinity is 0.037%, 4.24% of which is Na, 14.69% Ca, and 28.59% $SiO_2$. A noteworthy feature of these tropical superficial waters is the high proportion of silica. In certain of the tributaries of the Orinoco and Amazon, which are colored nearly black by organic matter—a condition also met with in some of the equatorial affluents of the Congo—the water does not contain over 0.016% of mineral matter and lime is practically absent.

The corrosion so commonly observed on the fresh-water shells, especially Melaniidæ, Mutelidæ, and Unionidæ of the Congo, has not yet been satisfactorily explained. Some of the older authors[1] believed that, in some cases at least, it was started by the attacks of other mollusks in their craving for lime. This can, however, hardly be the cause of the deep corrosion at the beaks of most Unionidæ and Mutelidæ, which are well hidden within the mud. In their case, Clessin[2] attributes the corrosion to the chemical action of the soil in which they are embedded, although he admits that the periostracum must first be removed in some way. He also calls attention to the fact that the shells of certain species are much more resistant than others. More likely though, for snails at least, the direct action of certain dissolved chemicals, especially of free carbon-dioxid, must be incriminated.[3] According to Cooper, *Bulimus* (= *Bythinia*) and *Lymnæa* that are forced to live in brackish water sometimes have their summit eaten away.[4] It may be observed that in the estuaries of the African rivers some of the Melaniidæ (especially *Pachymelania fusca*) and Cerithiidæ often are very heavily decollated, but the phenomenon is by no means general. It has also been suggested that the corrosion is induced or at least activated by the work of certain microorganisms (confervaceous algæ) which are known to live in the calcareous

[1]L. Saulcy. 1851. 'Note sur l'Ampullaire œil d'Ammon (*Ampullaria effusa* Lamarck).' Journ. de Conchyl., II, pp. 132–140.
Fischer, P. 1852. 'Note sur l'érosion du têt chez quelques coquilles fluviatiles univalves.' Journ. De Conchyl., III, pp. 303–310.
[2]Clessin, S. 1871. 'Die Corrosion der Süsswasser-bivalven.' Correspondenzbl. Zool. Miner. Ver. Regensburg, XXV, pp. 125–130.
[3]See Grier, N. M. 1920. 'On the erosion and thickness of shells of the fresh-water mussels.' The Nautilus, XXXIV, pp. 15–22.
Shrubsole, G. W. 1886. 'On the erosion of certain fresh-water shells.' Journ. of Conchology, V, pp. 66–71. According to this author the shells are corroded in water that contains less than 4 grains of lime per gallon and then has a high proportion of carbon-dioxid in solution.
Moynier de Villepoix, R. 1892. 'Recherches sur la formation et l'accroissement de la coquille des Mollusques.' Journ. Anat. Physiol. Paris, XXVIII, pp. 461–518, 582–674.
[4]Cooper, J. E. 1910. 'Note on decollated shells.' Journ. of Conchology, XIII, p. 14.

matter of living shells.[1] The problem is evidently rather complicated and will require further investigation for a satisfactory solution.

Fresh-water snails and mussels of stagnant or slow-moving water in the Belgian Congo are usually covered with a thick and very adherent coat of brownish substance, consisting mainly of hydroxide of iron. It appears to be deposited by the action of several bacteria belonging to the genera *Cladothrix*, *Spirophyllum*, *Siderocapsa*, *Leptothrix*, and *Crenothrix*, which are also responsible for the production of brown flocks or strings in water.[2] These bacteria absorb ferrous carbonate in solution in the water and redeposit the iron later as ferric hydroxide. Other species of *Crenothrix* precipitate pure white to yellowish white oxid of aluminum or brown to almost black oxid of manganese. These bacteria "occur chiefly in ground waters and only grow with rapidity when the dissolved oxygen is lacking, or nearly so, and when the special salts are present which they precipitate. The presence of much organic matter seems to favor the growth, but the two former conditions are absolutely necessary. The absence of light and the presence of carbonic acid in the water are also usual conditions and seem to favor growth."[3]

When there is a plethora of calcareous matter in the water the shells may become covered with a heavy deposit of limy matter, often in the form of tufa. This is sometimes found on the exposed end of Unionidæ that live partly buried in the bed of rivers or ponds, but is seldom the case in the Belgian Congo. The free ends of the Tanganyikan *Iridina spekii* are usually encrusted with a growth of algæ in which grit is embedded. Algæ of various kinds, as well as fresh-water sponges, often overgrow the fluviatile mollusks and completely mask the true colors and minute, characteristic sculpture. In order to observe these it is necessary to clean them with a weak acid, preferably with a saturated solution of oxalic acid. The shells of *Planorbis* are sometimes coated all over with diatoms.

We now come to a brief examination of the ecological relations of fresh-water mollusks to other organisms. These animals feed, as a rule, upon vegetable matter, mainly microscopic forms of life, such as diatoms,

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[1]Noll, F. C. 1882. '*Micrococcus conchivorus* (Vorläufige Mitheilung).' Zoolog. Garten, XXIII, pp. 156–159. Attributes corrosion to the attacks of a unicellular alga, *Micrococcus conchivorus*.

Wedl, C. 1859. 'Ueber die Bedeutung der in den Schalen von manchen Acephalen und Gasteropoden vorkommenden Canale.' Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., XXXIII, (1858), pp. 451–472, Pls. I–III.

Bornet, J. and Flahault, C. 1889. 'Sur quelques plantes vivant dans le test calcaire des Mollusques.' Bull. Soc. Bot. France, XXXVI, pp. cxlvii-clxxvi.

[2]An excellent account of the iron depositing micro-organisms is that of Ellis, D. 1919. 'Iron Bacteria.' (London), xix+179 pp., 5 Pls.

[3]D. D. Jackson. 1902. 'A New species of *Crenothrix* (*C. manganifera*).' Trans. Amer. Micr. Soc., XXIII, pp. 31–39, Pl. x.

Infusoria, Desmidiaceæ, and other lower algæ.[1] In the absence of these, they also attack higher aquatic plants and *Lymnæa* is said to be particularly fond of duckweeds (Lemnaceæ).[2] The muscular gizzard of *Lymnæa* usually contains much sand and it appears from H. S. Colton's[3] observations that, unless such fine grit is present, the snail is unable to feed upon higher aquatic plants. There are among the fresh-water snails but very few normally carnivorous species, such as *Viviparus*, which, according to Geyer,[4] explores the mud with its snout in search of worms. Certain species, however, take to an animal diet under abnormal conditions. *Lymnæa*, *Planorbis*, and *Physa* have been repeatedly observed feeding upon meat or, in captivity, attacking other mollusks or their own eggs.[5]

Interesting cœnobiotic relations exist between most mussels of the family Unionidæ and certain fishes. In this family the larva, known as glochidium,[6] is enclosed within two minute shells furnished with strong hooks by means of which it fastens itself to the body of a fish. These larvæ are emitted in slimy masses by the mother mussel, when they sink to the bottom and remain resting on their dorsal side, with the valves gaping upward and a long filament (usually regarded as a byssus) streaming up into the water above them. If a fish comes within reach they close and open the valves violently and rapidly so as eventually to grasp the surface of their host. The glochidium then remains attached to the gills or fins of the fish for a number of weeks, enclosed in a sort of cyst, consisting of the epithelial cells of its host.[7] Certain species of fish

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[1]Brockmeier, H. 1898. 'Süsswasserschnecken als Planktonfischer.' Forsch. Ber. Biol. Stat. Plön, VI, p. 165.

Zacharias, O. 1907. 'Planktonalgen als Molluskennahrung.' Arch. Hydrobiol. Planktonk., II, pp. 358–361.

Allen, W. R. 1914. 'The food and feeding habits of freshwater mussels.' Biolog. Bull., XXVII, pp. 127–146, Pls. I–III.

Churchill, E. P., and Lewis, Sara I. 1924. 'Food and feeding in fresh-water mussels.' Bull. U. S. Bur. Fish., XXXIX, (1923–24), pp. 439–471, 9 Pls.

[2]Gartenauer, H. M. 1875. 'Ueber den Darmkanal einiger einheimischen Gastropoden.' (Strasbourg).

[3]1908, Proc. Ac. Nat. Sci. Philadelphia, p. 424.

[4]Geyer, D. 1909. 'Die Weichthiere Deutschlands.' (Stuttgart), viii+116 pp., 3 Pls.

[5]See an account of such cases by Pelseneer, 1920, Mém. in-8° Ac. Belgique, Cl. des Sci., (2) V, pp. 479–480.

[6]The glochidia found in fresh-water mussels were at first believed to be independent parasitic organisms of these mollusks. C. G. Carus (1832, 'Neue Untersuchungen über die Entwickelungsgeschichte unserer Flussmuschel.' Nova Acta Ac. Nat. Cur. Dresden, XVI, 1, 87 pp., Pls. I–IV (first showed that they were the embryos of Unionidæ.

[7]This curious development of the early stages in the Unionidæ was first discovered in *Anodonta* by Forel, F. A. 1867. 'Einige Beobachtungen über die Entwicklung des zelligen Muskelgewebe. Beiträge zur Entwicklungsgeschichte der Najaden.' (Würzburg), 40 pp., 3 Pls.

See also Faussek, V. 1903. 'Parasitismus der *Anodonta*-Larven.' Mém. Ac. Sci. St. Pétersbourg, Cl. Sc. Phys. Math., (8) XIII, No. 6, pp. 1–141, Pls. I–VIII (in Russian).

Le Fèvre, G., and Curtis, W. C., 1910. 'Reproduction and parasitism in the Unionidæ.' Journ. Exper. Zool., IX, pp. 79–115.

Surber, T. 1913. 'Notes on the natural hosts of fresh-water mussels.' Bull. U. S. Bur. Fish., XXXII, (1912), pp. 101–116, Pls. XXIX–XXXI.

Howard, A. D. 1914. 'Experiments in propagation of fresh-water mussels of the *Quadrula* group.' U. S. Bur. Fish. Doc. No. 801, 52 pp., 6 Pls. This author credits Leydig with the first discovery of the parasitism of the larvæ of fresh-water mussels upon fish, evidently through confusion with the reverse parasitism of young fish upon Unionidæ (see below).

appear to be specific distributors of particular species of unionids, but others are mere accidental or occasional hosts. The ecological peculiarities of the fish distribution must therefore necessarily be of importance to that of the Unionidæ. On the other hand, certain fresh-water fish deposit their eggs in living *Unio*, where they develop into young fish between the gills. Although this curious fact was known since 1787 (Cavolini), it was apparently v. Siebold, in 1863, who first showed that the eggs commonly found in the European *Unio pictorum* belong to the fish *Rhodeus amarus*.[1]

In the case of Unionidæ with parasitic embryos there can be little doubt that their distribution over the various branches of a river system is actively aided by the migrations of fishes that act as their hosts. Although most of these fresh-water mussels move about quite freely in later life, it would appear from Isely's experiments with marked specimens that they migrate but little and probably but seldom far from the point where the embryos were dropped from the fish. Their movements seem to be prompted mainly by the selection of a sufficient depth of water, which is essential to optimum development.[2]

It has been noticed many times that certain snails and small mussels appear suddenly in newly dug wells, cisterns, or ponds, far away from other fresh-water or in localities where these mollusks were entirely unknown before.[3] It is generally admitted that in such cases they were brought in accidentally by birds, to which they had become attached either as young or in the egg stage, or more rarely fixed to the legs of water beetles. Water fowl are probably more likely to carry mollusks and their eggs than other animals and Cawston[4] attaches a great importance to wild ducks as conveyors of snails that may act as intermediate hosts for flukes. Indeed, the gelatinous

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[1]See Noll, F. C. 1869. 'Bitterling und Malermuschel.' Zoolog. Garten, Frankfurt a.M., X, pp. 257–265, Pl.; 1870, *op. cit.*, XI, pp. 237–238.

[2]Isely, F. B. 1914. 'Experimental study of the growth and migration of fresh-water mussels.' U. S. Bur. Fish. Doc. No. 792, 24 pp., 3 Pls.

[3]A number of examples are discussed by Kew, H. W. 1893. 'The dispersal of shells.' (London), xiv+291 pp.

See also for the dispersal of mollusks by other animals:

Cockerell, T. D. A. 1921. 'The dispersal of snails by birds.' Nature, CVIII, pp. 496–497 (*Balea perversa* adhering to the plumage of birds, probably by means of a sticky slime).

Ramsden, C. T. 1914. 'The bobolink (*Dolichonyx oryzivorus*) as a conveyor of Mollusca.' The Auk, N. S., XXXI, p. 250 [live *Succinea riisei* (Pfeiffer) hidden among the feathers of migrating birds, in Cuba].

McAtee, W. L. 1914. 'Birds transporting food supplies.' The Auk, N. S., XXXI, pp. 404–405. Presents some evidence tending to show that birds hide mollusks on purpose among their feathers, so as to carry with them a supply of food. The upland plover, *Bartramia longicauda*, was several times found by G. E. Beyer in Louisiana, with 20 to 40 snails of the genus *Physa* concealed among the under wing feathers, while the stomachs always contained a number of crushed shells of the snail.

Tomlin, J. R. le B. 1910. 'The dispersal of shells by insects.' Journ. of Conchology, XIII, p. 108. Observed a bumble bee in England flying with a *Potamias elegans* attached to its hind tarsus which was firmly wedged between the shell and the operculum.

Fewkes, J. W. 1884. 'Ducks transporting fresh-water clams.' The Auk, I, pp. 195–196.

Sage, J. H. 1895. 'A Sora caught by a mussel.' The Auk, XII, pp. 297–298.

Ganong, W. F. 'Do young loons eat fresh-water clams?' The Auk, XIII. pp. 77–78.

[4]Cawston, F. G. 1921. 'Wild birds a cause of the spread of bilharzia infection.' Journ. Trop. Med. Hyg., XXIV, pp. 109–110.

egg-masses of *Lymnæa*, *Planorbis*, *Bulinus*, and *Physopsis* may possibly adhere to the feet or to the bill of aquatic birds. Such accidental conveyance by birds is, however, hardly possible with species that fix their egg capsules firmly to stones, water plants, or other shells, or that are viviparous. The distribution of such species over different hydrographic basins can in most cases be explained only on the basis of present or past connections between certain branches of these systems.[1] Other fluviatile mollusks are carried about by the movements of the water, either at times of flood when they are swept over inundated areas and thus reach swampy depressions or even the head-waters of other rivers[2]; or else fixed on drift wood or buried in the vegetation of floating islands. At Leopoldville fair-sized masses of living vegetation, especially papyrus and grass, are commonly seen at the season of high water, being swept down the cataracts of the Congo River.

Fresh-water mollusks are not more free of internal and external parasites than other animals. The most important of these are certain worms, especially trematodes, which infest certain organs as "sporocysts" and "cercariæ," larval stages which eventually migrate to another host in order to become adult.[3] When these worms are present in large numbers they may cause the death or sterility of the molluscan host. They even occur in fresh-water mussels,[4] where they frequently become encysted in nacreous excrescences or in free pearls if they happen to penetrate between the mantle and the shell (*Unio margaritifer*, etc.).[5] In other cases they merely produce a discoloration of the nacre.[6]

Among the external parasites the most interesting are certain aquatic mites (Hydrachnidæ) of the genus *Unionicola* Haldeman (= *Atax* Fabricius).[7] They are most frequently found in Unionidæ, often fixed on the gills, but some have been described from fresh-water snails. In some cases they may also become the center of a pearl growth.[8] Leeches of the genus *Glossiphonia* Johnson (= *Clepsine* Savigny) sometimes feed

[1]This is illustrated in Europe and North America by the spreading of certain species along canals connecting different hydrographic basins.

[2]Many of the African rivers originate in swamps that flow to different basins. A well-known example is the region of Lake Dilolo which is drained by the Kasai to the Atlantic and by the Zambezi to the Indian Ocean.

[3]A special chapter is devoted (pp. 87–96) to those parasites of snails that are of medical or veterinary significance.

[4]Kelly, H. M. 1899. 'A statistical study of the parasites of the Unionidæ.' Bull. Illinois State Lab. Nat. Hist., V, pp. 399–418.

[5]Filippi, F. de. 1852. 'Sull 'origine delle perle.' Il Cimento, Torino, I, pp. 429–437 (translated by F. Küchenmeister in Müller's Arch. Anat. Phys., 1856, pp. 251–268).
1856. 'Encore un mot sur la formation des perles.' Müller's Arch. Anat. Phys., pp. 490–493.

[6]Osborn, H. L. 1898. 'Observations on the parasitism of *Anodonta plana* Lea by a distomid trematode at Chatauqua, New York.' Zoöl. Bull., I, pp. 301–310.

[7]Wolcott, R. H. 1899. 'On the North American species of the genus *Atax* (Fabr. Bruz.' Trans. American Micro. Soc., XX, pp. 193–259, Pls. XXVIII–XXXII; with full bibliography.

[8]See Küchenmeister, F. 1856. 'Ueber eine der häufigsten Ursachen der Elsterperlen.' Müller's Arch. Anat. Phys., pp. 269–281.

on snails, often entering the pulmonary cavity of *Lymnæa.*[1] Most other leeches, too, probably at times attack mollusks.

Species of *Hydra,* or stalked Infusoria of the family Vorticellidæ (especially of the genus *Epistylis* Ehrenberg), occasionally become fixed upon the shell and it is believed that in some cases they are responsible for deformations or monstrosities.[2]

In an interesting paper Lundbeck[3] has recently shown that certain small European muscid flies of the family Sciomyzidæ live as larvæ upon the contents of fluviatile snails, most probably attacking the live mollusk. His observations were made in Denmark where he found the pupa of *Calobæa bifasciella* (Fallen) exclusively in *Lymnæa truncatula* Müller, closely attached within the aperture of the empty shell. The pupa of another species, *Ctenulus pectoralis* (Zetterstedt), occurs in *Planorbis vortex* (Linnæus), sometimes a whole whorl away from the aperture. The third species, *Ctenulus punctatus* Lundbeck, was bred from several snails, most commonly from young specimens of *Planorbis planorbis* (Linnæus), but also from *P. albus* Müller, young *P. corneus* (Linnæus), and *Lymnæa peregra.* There have been a few other incomplete records of dipterous larvæ attacking fresh-water snails.[4]

Certain aquatic Coleoptera, especially Dytiscidæ, prey freely upon fluviatile snails. In Europe *Dytiscus marginalis* Linnæus is said to prefer *Lymnæa stagnalis* to other species,[5] although accumulations of the shells of *Planorbis corneus* with the sides of the whorls bitten away, to allow of easy access of the animal, have been recorded as the work of this beetle.[6]

Aquatic snails must be an important item in the food of many amphibians, such as frogs and others that leave the water but for short intervals. Unfortunately, little definite information is available at

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[1]See E. J. |acquet]. 1885. 'Sur quelques parasites des Lymnées,' Echange, I, p. 2.
Elliott, W. T., 1917, Proc. Malacol. Soc. London, XII, p. 307.

[2]See A. Brot, 1877, Ann. Soc. Malacol. Belgique, XII, Bull. Séances, p. xliii.
Sykes, E. R. 1894. 'Note on *Limnæa auricularia.*' Journ. of Malacol., III, pp. 34–36.
Standen, R. 1899. 'Remarks on the cause of abnormality in *Planorbis spirorbis.*' Journ. Conchology, IX, pp. 216–217.

[3]Lundbeck, W. 1923. 'Some remarks on the biology of the Sciomyzidæ together with the description of a new species of *Ctenulus* from Denmark.' Vidensk. Medd. Dansk Naturh. Foren., LXXVI, pp. 101–109.

[4]Pelseneer |1920, Mém. in-8° Ac. Sci. Belgique, (2) V, pp. 79 (fig. 24), 115 (fig. 79), and 584] figures the larval tube of a "*Chironomus*" fixed upon the outside of the shell of *Physa fontinalis* and claims that this larva is responsible for a reduction of the digitations of the mantle edge and even for a bifurcation of the posterior end of the foot. From what we know of the habits of chironomid larvæ, it is very unlikely that this was a case of true parasitism. Larvæ of *Chironomus* sp. were also recorded by K. H. Barnard (1911, 'Chironomid larvæ and watersnails.' Ent. Monthly Mag., XLVII, pp. 76–78) as living in the mantle cavity of *Lymnæa peregra*, in England, but this case too needs verification, especially with regard to the feeding habits of the larva.
Van Hyning, T. 1919. 'Insect larvæ destroying *Physa.*' Nautilus, XXXIII, pp. 71–72. Records finding in Iowa dead *Physa integra* Haldeman enveloped in what was pronounced to be an insect case.

[5]J. W. Williams, 1889, Science Gossip, p. 280. According to H. Blunck (1916, Zool. Anzeig., XI VI, p. 279) *Dytiscus marginalis* attacks every kind of aquatic animal that is not too swift or too small and shows no particular predilection for mollusks.

[6]Taylor, J. W. 1894–1900. 'Monograph Land Freshw. Moll. Brit. Isl., Struct. Gen. Vol.,' (Leeds), p. 419.

present on this subject. J. G. Needham[1] found that the food of the North American bullfrog, *Rana catesbiana* Shaw, consists mainly of insects and snails [at Saranac Inn, N. Y., all of one species: *Physa heterostropha* (Say)] and that the bulk of the snails eaten was greater than that of the insects of any single order. According to C. J. Drake,[2] gastropods (mainly aquatics: *Goniobasis*, *Lymnæa*, and *Physa;* also *Zonitoides arb:reus*) constitute 3 per cent of the animal food of the leopard frog, *Rana pipiens* Schreber, in Ohio, and were seen in 10 per cent of the 209 stomachs examined. Mollusks were found in small numbers in the stomach of all five species of *Rana* of the Belgian Congo examined by Mr. G. K. Noble (see table, p. 473) and it is most likely that in this case they were aquatic snails, although they were not identified.

Mollusks form a substantial part of the food of fish, as is well brought out by J. W. Taylor[3]:

"The beneficial effect of water-snails as nourishing food, especially for trout, is shown by the rapid growth of fish placed in streams or ponds in which mollusks abound. The ravages of fish amongst mollusks are not, however, confined to such species as disport themselves more or less actively at the surface or amongst the vegetation, but is also carried on amongst the minute mud-loving *Pisidia*, which in America have been shown to be an important food of the Whitefish [*Coregonus clupeiformis* (Mitchill)]. The Gillaroo trout, which lives in the Irish loughs, and other famous breeds also, subsist chiefly upon mollusks which give them the exquisite flavour which has rendered them so famous and prized by epicures. Specimens of the Gillaroo trout have been caught gorged to repletion with *Bithynia tentaculata* and other fresh-water species, and the remarkable and peculiar thickening of the stomach-wall of this trout has been attributed to the fact of shelled snails forming so large a part of its diet. The eel is another rapacious devourer of the Mollusca, as many as 350 shells of *Valvata piscinalis*, in addition to those of other species, having been obtained from the stomach of a single eel. The barbel has been noted as having a special predilection for *Valvata piscinalis* and also for *Sphærium corneum*, and many fish, and more especially gold carp, regard *Physa fontinalis* as a choice and delicate morsel, while the roach is recorded to feed even upon the eggs of the various species.'"

The examination of the contents of the stomach of fishes obtained from natives may furnish the collector with valuable specimens. In this fashion the junior author secured some of the peculiar melanians that inhabit Lake Moero.

Aquatic birds are probably the most destructive enemies of fluviatile snails and mussels and some species appear to be almost restricted to that diet.[4] Shore birds, such as wagtails (*Motacilla*), dipper (*Cinclus aquaticus*

[1]1905, N. Y. State Mus. Bull. 86, p. 12.
[2]1914, Ohio Naturalist, XIV, p. 263.
[3]1894–1900, *op. cit.*, p. 419.
[4]Attention was called above (p. 531) to the curious habit certain birds have of concealing live snails in their plumage.

Bechstein), water-rail (*Rallus aquaticus* Linnæus), heron (*Ardea cinerea* Linnæus), etc., prey extensively upon them in Europe. The heron will even fish up *Anodonta* and fly into a tree, breaking the shell against the branches. It is claimed that the hooded and carrion crow (*Corvus cornix* Linnæus and *C. corone* Linnæus) also feed upon this mussel, carrying them to a considerable height to let them drop on the ground and thus easily reaching the animal in the broken shell. Domestic ducks are such efficient snail-hunters that they may clean out a pool in a surprisingly short time. Cawston has called attention to the practical absence of snails near Port Elizabeth, South Africa, in ponds where domestic ducks were kept, these birds thus being very helpful in the control of blood-flukes (see p. 96). The white-headed stilt of Australia, *Himantopus leucocephalus* Gould, was found by Cleland to include species of *Bulinus* in its diet.[1]

It is generally known that the snail-hawk or everglade kite, *Rostrhamus sociabilis* (Vieillot), of tropical and subtropical America, feeds exclusively upon aquatic snails mainly of the genus *Pomacea.* The lengthened, excessively acute claws are well adapted to catching hold of the slippery, smooth shell, while the upper bill forms a strongly arched, nearly circular hook on which the snail can be spiked. H. Lang[2] has recently described how this bird manages to extract the mollusk from the shell. At Georgetown, British Guiana, *Rostrhamus* mainly gathers *Pomacea dolioides* (Reeve), which it secures in the claws of one foot. "The hawks then perch on one foot and with the other quietly hold the snail in such a manner that it can emerge from the shell. The birds make no attempt whatever to extract it by force, but watch for the voluntary extension of the animal beyond the aperture of the shell. With that propitious moment comes the next step in the drama. Quick as a flash the hawk's bill pierces the snail apparently back of the operculum. It happens so rapidly that one is not able to clearly follow the operation. As a further step the snail, now spiked upon the beak, is instantly pushed up to the middle of the upper bill from which it stands off like a bump as big as a large walnut. Then begins a second wait. Gradually the mollusk's muscles relax. A few minutes later the snail-hawk vigorously shakes its head and before even the light, empty shell has reached the grassy ground *Rostrhamus* has swallowed its victim, operculum and all." The extent of the depredations of *Rostrhamus* upon the snail colonies may be judged from the fact that over 2,000 empty shells were obtained below

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[1]1918, Science Bull. No. 15, Dept. Agric. New South Wales, p. 46.

[2]Lang, H. 1924. '*Ampullarius* and *Rostrhamus* at Georgetown, British Guiana.' The Nautilus, XXXVII, pp. 73–77, Pl. IV.

the habitual perching trees of the birds: these shells were not in the least injured, but the corneous operculum was always lacking.

The North American subspecies of the snail-hawk, *Rostrhamus sociabilis plumbeus* Ridgway, has similar habits, as was frequently observed.[1] In Southern Florida, the adult birds eat mainly *Pomacea paludosa* (Say) and also feed their young with the same snail. Another interesting American snail-eating bird is the northern courlan or limpkin, *Aramus vociferus* (Latham), of Florida, the Greater Antillesn, and the coasts of Central America. The species most commonly eaten in Florida is *Pomacea paludosa* (Say). Mr. C. W. Johnson informs us that he observed a captive limpkin which was fed with this snail. "The bird," he says, "was very skillful in removing the animal from the shell; none of the shells were broken, but the opercula were missing, evidently swallowed with the animal. The exact method used by the bird to remove the animal from the shell was not observed."[2] The South American courlan, *Aramus scolopaceus* (Gmelin), has similar habits, as described by W. B. Barrows[3]: "They seem to feed almost exclusively on the large, fresh-water snail (*Ampullaria*) and the bills of many examined showed a perceptible lateral curve at the end, which I suppose is due to the constant wedging of the bill in the apertures of these shells." We suggest that this peculiar structure of the bill is a constant feature and probably an adaptation to a snail diet, like the recurved and drawn-out bill of *Rostrhamus*.

We are under great obligations to Dr. J. P. Chapin for the following notes on the molluscan food of African birds.

"It might naturally be supposed that mollusks would furnish an abundant food supply for the aquatic birds of Africa, yet this is far from being the case. There seems, indeed, to be only a single species with a specialized diet of mollusks, namely the open-bill stork, *Anastomus lamelligerus*.[4] Africa has no snail-hawk, and mollusks form such a small

[1]Scott, W. E. D., 1881, Bull. Nuttall Ornith. Club, VI, p. 16.
Bailey, H. B., 1884, The Auk, I, p. 95.
Wayne, A. T., 1895, The Auk, XII, p. 366.
Nicholson, D. J. 1926. 'Nesting habits of the everglade kite in Florida.' The Auk, XLIII, pp. 62 67, Pls. III–IV.

[2]See also Pearson, T. Gilbert, 1917, 'Birds of America,' I, p. 201.

[3]1884, The Auk, I, p. 277. Observations made along the Lower Uruguay River.

[4]Another group of birds which specialize in eating mollusks are the oyster-catchers, genus *Hæmatopus*, family Charadriidæ. They are confined for the most part to the sea coasts, but the Palæarctic *Hæmatopus ostralegus ostralegus* Linnæus occasionally migrates to central Africa, and I collected one at Avakubi on October 3, 1913. Its stomach, however, contained only insects and a millipede.

Along the coasts the oyster-catchers live very largely upon marine mollusks. Last summer in the Pearl Islands, off Panama, we collected three *Hæmatopus palliatus* Temminck, and Dr. Van Name gave me the following report on their stomach, contents:

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|---|---|
| Stomach No. 1. | 21 operculate mollusks. |
| Stomach No. 2. | 5 large operculate mollusks. |
| | 5 small mollusks. |
| | 2 small crabs of family Pilumnidæ. |
| Stomach No. 3. | 1 large operculate mollusk. |
| | 4 small mollusks. |
| | 1 crab, family Pilumnidæ. |

A second species of *Hæmatopus*, *H. moquini* Bonaparte, probably occurs at the mouth of the Congo, for it is a South African bird that ranges north—so it is said—to the Gaboon. Its feeding habits are said to be the same as those I have indicated for *H. palliatus*. [J. P. Chapin.]

proportion of the food of other birds feeding in the water that their capture would appear hardly more than incidental. The gastropods and other Mollusca which we found and noted in examining the stomachs of birds collected in the Congo were not preserved, as in most cases they seemed too badly damaged to serve as specimens for the malacologist, and we did not appreciate the interest of securing the scientific names of the species eaten. Consequently, we can only list them under very general terms, with some mention of the size.

"In the case of some of the rails it seems questionable whether all the snails they had eaten were truly aquatic species, since we know that the birds feed only along the margins of watercourses, and often on dry land as well. Certain of the rails, on the other hand, are known to feed on the land and have been discussed before in connection with the terrestrial mollusks.

"The number of species of birds of which we made rough stomach examinations in the Congo is probably about 550. Careful consultation of this mass of notes reveals only 40 species where mollusk remains were discovered, and in four of these the remains consisted of dead shells or bits of shell, which may have been swallowed to aid in triturating the food, in lieu of grit or pebbles. Only the following nine species of birds may be regarded as having eaten living aquatic mollusks.

"*Anastomus lamelligerus lamelligerus* Temminck. Where we did most of our work, in the Ituri and Uele districts, the open-bill stork is only a bird of passage and not abundant. From present information it seems that the species nests in marshes well to the south of the equator, on the Shire, Zambesi, and upper Lualaba rivers, toward July and August (the dry season). None have been known to nest in the equatorial forest belt, or in the open countries to the north of it, though birds that seem to be migrants have been reported in the Sudan from December to May and June. Such birds, migrating northward, could profit by the low level of the northern rivers at the time of their visit; but many also remain behind upon the breeding grounds.

"Among our five specimens, only three had food in their stomachs. One had extracted the soft parts (feet and gills) of 65 fresh-water mussels, and yet had swallowed just one small bit of shell. The other two had been feeding on large fresh-water snails of the genus *Pila*, ten being the largest number in one stomach; and while they had avoided swallowing any pieces of shell, they seemed less careful about the opercula, of which a few had been ingested. In a specimen collected at Kongolo on the Luabala, Mr. H. C. Raven tells me, he found one small snail in the stomach with the shell still attached, though cracked. This seemed to be due to its small dimensions, the length being only about a half inch.

"About Lake Kisale, where this bird is abundant, its food consists very largely, according to Dr. Bequaert, of another snail of the family Ampullariidæ, *Lanistes procerus*. Instead of pulling the animal out of its shell with the pincer-like top of the bill, the bird first crushes the shell between its mandibles. Dr. Bequaert observed this procedure by captive birds. In fact the gaping form of the beak is plainly the result of constant wear on the tomia, using up the horny sheath of the mandibles, and exposing a deep fibrous layer which forms a sort of brushy pad and tends to give a firmer grip on the smooth shells. The curved outlines of culmen and gonys, together with the greater hardness of the sheath in those regions, are responsible for the meeting of the mandibles at their tips.

"The shells of fresh-water mussels are probably too stout to be crushed in the beak of *Anastomus*, for such competent observers as Heuglin and Böhm have stated that the bird brings them out to the bank, allowing them to lie there until they open of their own accord. Although the open-bill has been said to eat other aquatic animals, and even insects, there can be no question as to the preponderance of mollusks in its diet.

"*Hagedashia hagedash nilotica* Neumann. The hadadah ibis is primarily an insect feeder, probing in the mud with its long bill; and I have found as many as 18 mole-crickets in a single stomach. Heuglin has described it as feeding on snails, but in the few stomachs we examined the only molluscan remains consisted of a single fragment of shell.

"*Pteronetta hartlaubi* (Cassin). Ducks are so scarce, in all the forested districts of the Congo, that evidence as to the proportion of Mollusca in their food is hardly satisfactory. Hartlaub's teal is the one duck characteristic of the region; and of the ten stomachs examined, six held only coarse sand, with no identifiable food remains. Of the four remaining birds, one had eaten 24 aquatic insect larvæ (mainly of dragonflies, some about two inches long); another, similar larvæ plus 8 fresh-water snails with hard conical shells; a third had taken a spider, a shrimp, and two tiny bivalve mollusks; and the fourth many small seeds.

"Of the seven other species of Anatidæ we collected, only 18 individuals were secured, none of which had any mollusk remains in the stomach.

"*Himantornis hæmatopus whitesidei* Sharpe. The large brown wood rail of Congo forests is hardly a bird of aquatic habits, and I am in doubt whether the small snails we found in the stomach of one individual were water-living forms. Six other birds were examined without our finding any sign of mollusks, five stomachs containing varied insect remains, and two some hardshelled yellow seeds.

"*Canirallus oculeus* Hartlaub. This second wood rail is little more aquatic than the preceding. In three stomachs examined we found pebbles, small snails (in two cases), slugs (in one), a small crab, a green caterpillar, and other insect remains. So far as it goes, the evidence shows a considerable proportion of molluscan food.

"*Podica senegalensis senegalensis* (Vieillot). The finfoot seldom if ever dives, and is not a fish eater. In the seven stomachs we examined there were invariably remains of insects (beetles, a green grasshopper, a dragon-fly larva, and wings of a dragon-fly). One of the birds had also eaten a small crab, another 2 snails, small shrimps, and a millipede.

"*Charadrius hiaticula* Linnæus. Only a migrant to tropical Africa. The stomach of a ring plover taken at Faradje in the Upper Uele district was found to contain many freshly hatched flies, a small beetle, several tiny clam-like bivalves, a very small snail, and a millipede.

"*Tringa ochropus* Linnæus. The green sandpiper is another migrant from Eurasia. One of the two stomachs we examined held pieces of mollusk shell, whereas the other had pieces of fresh-water shrimps and insects.

"*Actophilus africanus* (Gmelin). In two stomachs of the lily-trotter I noted small seeds and small bits of stone in both cases, one held in addition a small snail with conical shell. This bird may be expected to eat many tiny mollusks, provided they live close to the surface of the water."

Several of the North American ducks devour considerable quantities of snails along the sea-shore as well as in ponds, as may be seen from the following figures taken from a recent paper by Mabbott[1]:

*Chaulelasmus streperus* (Linnæus): but 2.15 per cent of the food is animal and three-quarters of this is mollusks, chiefly *Neritina virginea.*

*Mareca americana* (Gmelin): 6.77 per cent animal food, 6.25 per cent being snails.

*Nettion carolinense* (Gmelin): 4.57 per cent animal food, 3.59 per cent being snails (*Physa*, *Neritina*, and *Planorbis*).

*Querquedula discors* (Linnæus): 29.47 per cent animal food, 16.82 per cent mollusks and also eggs of snails.

*Querquedula cyanoptera* (Vieillot): 20.14 per cent animal food, 8.69 per cent mollusks.

*Dafila acuta* (Linnæus): 12.85 per cent animal food, 5.81 per cent mollusks.

In North America the muskrat [*Ondatra zibethica* (Linnæus)] although normally herbivorous, often subsists, in a great measure, upon the flesh of river mussels (Unionidæ). According to A. W. Butler,[2] this happens mainly in winter and early spring, when suitable vegetable food is scarce. Nevertheless this rodent when abundant in a locality may become the principal enemy of the mussels. Thus, Headlee believes that in Winona Lake, Indiana, *Anodonta* is confined to the deeper water at the edge of sandy and gravelly banks, beyond reach of the rodent.[3] F. C. Baker also writes that in the Big Vermilion River, Illinois, "the presence of the muskrat is attested by the number of piles of opened mussel shells, the animals of which have provided this animal with many a meal. In these muskrat piles have been found the shells of many species that are rare or difficult to find alive in the streams." [4] There has been some speculation as to just how the muskrat contrives to open the living mussel, considering the strength of the adductor muscles that lock the two valves. A. W. Butler believes that this is done in three ways. In species which withdraw the foot very slowly, the rodent may insert its paws or long teeth between the valves and tear them asunder.[5] In others the teeth may cut a sufficient opening to secure the animal by pulling the valves apart. For the heavier mussels, however, he says: "The only way in

[1]Mabbott, D. C. 1920. 'Food habits of seven species of American shoal-water ducks.' U. S. Dept. Agric., Bull. 862, Prof. Pap., pp. 1–67, 7 Pls.

[2]Butler, A. W. 1885. 'Observations on the muskrat.' Amer. Naturalist, XIX, pp. 1044–1055.

[3]Headlee, T. J. 1906. 'Ecological notes on the mussels of Winona, Pike, and Central Lakes of Kosciusko County, Indiana.' Biolog. Bull., XI, pp. 305–318, Pl. XII.

[4]1922, Illinois Biologl. Monogr., VII, 2, p. 18.

[5]W. S. Lee (1886. 'How the muskrat opens the *Unio*.' Journ. Trenton Nat. Hist. Soc., No. 1, p. 8) claims that he actually saw the animal insert its claws into the shell and then pull the valves apart.

which I can see the muskrat could obtain the body of one of these larger mollusks is by leaving the animal out of the water until it becomes weak or until it dies, when the valves could be easily separated." A. G. Apgar found that when the *Unio* is traveling along, its foot projects a half inch or more from the lower side of the shell. If, while the foot is in this, its usual, condition, the two valves be pinched, the foot will be caught between the closing shell; if the pinching be continued for a half or three-quarters of a minute, the animal, probably from the pain produced, becomes paralyzed and unable to make use of the adductor muscles. Now, if the shell is released, it will fly open about one-half inch, and can easily be torn entirely open. The strength needed to keep the foot from being drawn into the shell is not great, being far less than that of the jaws of the muskrat.[1] The procedure has, it would seem, not been observed with the muskrat itself. It is of some interest that shortly after its recent introduction into Bohemia (1906) this animal has taken to feed partly upon European unionids.[2]

In Europe rats and otters destroy large quantities of fluviatile mollusks and they have been known to break through the ice in order to reach this prey.[3] We know of no mammal in Africa, excepting perhaps the otters, that selects fluviatile mollusks as food. They are, however, relished by the natives of many tribes, especially *Etheria, Egeria*, and certain large Mutelidæ (*Aspatharia wissmanni, A. sinuata*, etc.).

In densely settled parts of Europe and North America sewage from the cities and waste products of certain industries emptied in large quantities in the rivers, have practically wiped out aquatic molluscan life in many districts. On the other hand, the pearly Unionidæ are fished for the manufacture of buttons and this industry has grown so much within the last thirty years in the valley of the Mississippi that several of the more valuable species are nearing extinction.[4]

## Mollusk Fauna of Stagnant Water

Open, shallow pools of small size are in the Belgian Congo the preferred habitat of *Lymnæa natalensis undussumæ, Physopsis africana*, and certain species of *Planorbis*. These snails are found in the savanna

[1]Apgar, A. C. 1887. 'The muskrat and the *Unio*.' Journ. Trenton Nat. Hist. Soc., No. 2, pp. 58–59.

[2]See Strassen, O. z. 1914. 'Brehms Tierleben.' 4th Ed. Säugetiere, II, (Leipzig and Vienna), p. 282.

[3]Lawson, A. K. 1921. '*Limnæa stagnalis* destroyed by rats.' Journ. of Conchology, XVI, 5, p. 144.

[4]Smith, H. M. 1899. 'The mussel fishery and pearl-button industry of the Mississippi River.' Bull. U. S. Fish Comm., XVIII, (1898), pp. 289–314, Pls. LXV–LXXXV.
Some researches are at present (1923–1924) being carried on in the Belgian Congo in order to find a new supply of pearl-button mussels, but from what we know of the unionid fauna of that district they are not likely to prove very productive.

country in shallow depressions which may completely dry up after the rains, when the mollusks either bury deep in the mud or survive only in the larger, permanent ponds. Such collections of stagnant water are usually abundantly provided with aquatic vegetation, especially green, thread-like confervoid algæ. In the peneplain of the northern Uele district, at the divide of the Congo and Nile basins, water often stagnates in the depressions or crevices of granitic outcrops, especially of the flattened type known as "whaleback." Such a pool on granitic rock is shown in Plate LXII, figure 2, from a photograph taken near Yakuluku, close to the Congo-Nile divide, in October, 1911. At that time of the year, toward the close of the rainy season, water is in abundance and consequently the vegetation is quite luxuriant. During the dry season, however, most of these ponds gradually disappear, although water is to be found all year round in some of the deeper crevices. J. W. Taylor[1] remarks that the shells of the *Lymnææ* "inhabiting tropical and sub-tropical countries are said to be usually much more constant and uniform in sculpture, as well as in size and shape, than their congeners from more northern districts, and their texture is also finer and smoother on the whole than that of species living in the colder regions." This statement is well borne out by an examination of Congo specimens. The generally thin, fragile, and translucid texture of the African *Lymnææ* is evidently due to the scarcity of lime in the water of these granitic pools. Such small collections of stagnant water contain no operculate snails, but one should look there for minute Pelecypoda, such as *Sphærium* and *Pisidium*.

Near the edge of the rapids and falls, which, as we shall see later, frequently interrupt certain stretches of the rivers, there are usually between the rocks small pools of stagnant water, renewed at intervals by the rise of the stream. Such pools probably offer the greatest variety of aquatic snail life of any habitat within our territory (except the shores of certain lakes). Plate LXIV, figure 1, gives the aspect of the rocky shore of the Congo River, at Stanley Falls, about a mile above Stanleyville, in August, 1909, that is at the season of lowest water. The following species were all obtained in the water puddles of that locality, and many of them were extremely abundant.

| | |
|---|---|
| *Physopsis africana* var. | *Melanoides kisangani congo* |
| *Lanistes nsendweensis* | *Potadoma ignobilis* |
| " *procerus langi* | " *ponthiervillensis* |
| " *graueri* | " " mut. *spoliata* |
| *Pila congoensis* | *Cleopatra langi* |
| " *microglypta* | " *cara* |
| *Melanoides wagenia* | *Corbicula radiata* |

[1] 1894–1900, 'Monograph Land Freshw. Moll. Brit. Isl. Struct. Gen. Vol.,' (Leeds), p. 71.

Since large stretches of country within our territory are level, shallow depressions permanently filled with water and more or less overgrown with aquatic plants are extremely common. Such swamps are of several types according to the nature of the vegetation, in relation with the depth of the water, altitude, nature and concentration of dissolved substances, etc. Sometimes they are so-called mixed swamps, with a rather varied flora of hygrophytes (grasses, sedges, marantaceous reeds, Eriocaulonaceæ, Melastomaceæ, etc.), rarely with *Sphagnum*. A typical example of a mixed swamp is shown in Plate LXIII, from a photograph taken near Vankerckhovenville, in the northeastern Uele district, April, 1912. The groves of wild date-palms (*Phœnix reclinata*) here shown are quite characteristic of this environment. Near the margin of these swamps there are also thorny bushes of *Mimosa asperata*. More commonly, however, one or a few species of plants predominate in the African swamps, such as cattail (*Typha*) or papyrus (*Cyperus Papyrus*). The papyrus swamps (Pl. LXII, fig. 1) are especially characteristic of all savanna regions of tropical Africa. They may occupy patches of only a few feet square in the quiet backwaters along the banks of rivers or cover certain alluvial plains over hundreds of square miles. The huge papyrus sedge, or Egyptian bulrush, grows 5 m. to 6 m. high, the culms being about 3 inches thick at the base. The rootstocks, often as thick as the wrist, are so densely matted together that they form a moving carpet, over which it is possible, with some care, to walk. Beneath it the water may be many feet deep and the bottom of the swamp is a thick layer of oozy, decaying vegetable matter. The swamp is often fed by springs and in addition the carpet of plants rises and falls with the variations of water level, during and after the rains. A good idea of an African papyrus swamp is conveyed by Plate LXII, figure 1, from a photograph taken near the sources of the Duru River, east of Yakuluku. This picture incidentally shows also the generally level condition of much of the Congo-Nile divide, a state of affairs not without importance for the present-day dispersal of Ethiopian fresh-water mollusks.

Perhaps due to the abundance of decaying vegetable matter, most African swamps nourish relatively few species of mollusks. Yet one finds here the largest of all fresh-water gastropods, namely most of the species of *Pila* and the *Lanistes* of the subgenus *Meladomus*. *Pila leopoldvillensis*, which lives in the mixed swamps near the shores of Stanley Pool, is one of the biggest of known Ampullariidæ and consequently of all fresh-water snails.

The most interesting swamps of the Belgian Congo are those of the valley of the upper Lualaba, between the confluence of the Lubudi and that of the Luvua. The Lualaba flows here in a wide, rift-like depression, known as the "Graben of Upemba," which is at present filled with deep, alluvial deposits. Apparently the whole depression was covered by a lake at some rather recent period. Nowadays the valley, some 40 kilometers wide and some 200 kilometers long, forms a low, swampy plain almost completely under water toward the end of the rainy season. The Lualaba winds its way through this plain between very low banks, which either form narrow levees or in many places are hardly defined. On either side, beyond the levees, there are extensive papyrus swamps surrounding numerous lagoons of open water of all sizes and shapes, the largest being Lakes Upemba and Kabamba. These lagoons are usually connected with the Lualaba by means of narrow channels and are partly obstructed by floating islands of papyrus. All the lakes are very shallow, so that some of them can be hardly crossed with a canoe, and they have a bottom of oozy mud many feet thick. Lake Kisale differs from the others not only in its larger size, but also because it is traversed by the main current of the Lualaba, in one or more channels, which, however, are frequently choked by floating water plants. Near Kisale, the Lualaba receives the Lufira and Lovoi Rivers and it has been shown that when these two tributaries swell, the volume of water they pour into Lake Kisale is such that the Lualaba upstream is forced back through the side channels into the many lateral lakes and swamps. At the height of the rainy season the surrounding alluvial plain itself is for the most part inundated. When the level of Kisale begins to drop at the beginning of the dry season, the water gradually recedes and during the succeeding months the smaller lakes flow into the Lualaba, thus regulating the water supply of that river.[1] The whole alluvial area of shallow lakes near Kisale is the counterpart on a smaller scale of the "sudd" swamps of the upper Nile, near the junction of the Bahr-el-Ghazal and the Bahr-el-Jebel. Ecological conditions are much the same in both regions, which accounts for many points of similarity in the fauna and flora.

The shallow, muddy lakes and papyrus swamps offer an excellent habitat for certain fresh-water snails which sometimes occur in considerable numbers, although they represent but few species. The following were obtained by the junior author in Lake Kisale: *Plancrbis gibbonsi*, *Segmentina angusta*, *Bulinus forskalii*, *B. lamellosus*, *Physopsis*

[1]See Mauritzen, 1912. 'Le problème du lac Kisalé. Rectification du cours du Lualaba dans les marais du lac Kisalé.' Revue Congolaise, II, pp. 388–391, Pl. xxxvi (map).

*africana* (probably subspecies *globosa*), *Pila* sp. (*ovata?*) *Lanistes procerus langi*, and *Bulimus kisalensis*. Of these, *Lanistes procerus langi* is by far the most common and most striking on account of its large size; it is the preferred food of the open-bill stork, *Anastomus lamelligerus* Temminck, which is extremely abundant in this region, often living in colonies (see p. 537). Many of the swamp mollusks are during the rainy season carried by the rising waters much beyond the limits of pools and marshes, into the flood plain. With the coming of the dry season they congregate in the pools that fill the depressions, but these, too, finally evaporate and the whole plain becomes for five or six months one expanse of baked clay or sand, fully exposed to the glaring rays of the tropical sun. Under such conditions most of the snails left stranded in the pools undoubtedly die; but certain species appear to be able to stand this prolonged desiccation without injury. This is especially the case with *Lanistes* and *Pila*. Writing of the common *Lanistes* of Angola (perhaps wrongly referred to *L. ovum*), Morelet says: "Mr. Welwitsch gives us, concerning this species, an observation which proves that life may remain latent for a considerable length of time in the Ampullariidæ. When the lakes dry up during winter, or when the ponds are drained through irrigation, these gastropods bury themselves deep in the soil. One day our traveler picked up on the shore of one of these reservoirs, lumps of hardened mud which had been dug up and which contained several specimens of *L. ovum*. They were forgotten at Loanda in a dark room of his house and it was only two years later that he thought of soaking them in order to extract the animal they contained. But, much to his surprise, he saw several of them return to life, leave the bowl in which they had been placed and crawl over the sides. Moreover, this persisting vitality is not the privilege of the Ampullariidæ alone nor even of certain gastropods. Strange to say, some acephalous mollusks possess it to a similar degree, as shown by Rang's curious observation of *Anodonta chaiziana* published by him in the *Annales du Museum* (1834, IV, p. 309)."[1] In the alluvial plain of the upper Lualaba live specimens of *Lanistes procerus*, tightly closed with the operculum, may often be found laying on the ground during the dry season. The *Bulinus*, *Planorbis*, and *Lymnææ*, however, do not appear to withstand drought to the same extent. Many of them die before they are rescued by the first rains; in some cases they may escape by hiding deep down in the mud.[2]

[1] 1868, 'Voy. Welwitsch, Moll. Terr. et Fluv.,' p. 95.
[2] *Planorbis spirorbis*, in Europe, is known sometimes to form a sort of epiphragm against evaporation and perhaps some of the Central African species do likewise.

Another interesting habitat of this region are the channels that connect the lagoon lakes with the main stream of the Lualaba. Their fauna is somewhat different from that of the surrounding papyrus swamps, for one finds here also Unionidæ and Mutelidæ. In the channel which serves as effluent to Lake Kabamba, near the village of Mulongo, the junior author obtained at the end of the dry season (October, 1911) the following species: *Pila* sp. (*ovata?*), *Lanistes procerus langi*, *Viviparus unicolor*, *Cælatura æquatoria*, *Aspatharia wissmanni*, *Mutela rostrata*, and *M. iris*. The mussels were all buried in the sandy bottom near the shallow banks.

## Mollusk Fauna of Flowing Water

In many parts of the world the malacological faunæ of fresh waters possess a certain degree of individuality. This remark applies not only to the main hydrographic basins, but in many cases it is found that certain tributaries possess their own species or that certain species are peculiar to the upper or lower reaches of a stream while they are totally unknown elsewhere. It would even appear that in some cases large and deep rivers, especially such with muddy waters, act as barriers preventing the interchange of species between their tributaries.[1] What is more, the same species may vary in size and shape in the several tributaries of a river or even in different parts of the same stream. These modifications were, of course, due to the effect of environment, as we have explained in our introductory remarks on the ecological factors which influence molluscan life, the resulting changes becoming permanent owing to prolonged isolation.

Faunistic differences between the several river basins are, however, but little apparent in Africa. In the flowing waters many genera and even certain species extend over immense areas, regardless of watersheds. This is especially true for *Lymnæa*, *Planorbis*, *Bulinus*, *Physopsis*, and some of the Mutelidæ and Unionidæ. Many described species in these groups are hardly separable or at any rate show extremely close affinities. In the case of the Etheriidæ, for instance, all recent authors are fairly agreed that Africa possesses but one protean species, the profound differences in shape being possibly due to direct action of the environment upon the individual and also in part to age.

The fresh-water molluscan fauna of Africa is far more homogeneous than that of the land, and the faunal subdivisions of the Ethiopian Region which we have discussed above (p. 479) have hardly any signif-

[1]See Goodrich, C. 1921. 'River barriers to aquatic animals.' The Nautilus, XXXV, pp. 1–4.

icance for them. Only in the extreme south and west is there some peculiarity. The extensive Orange River system appears to possess the negative feature of lacking Ampullariidæ, Viviparidæ, Mutelidæ, and Etheriidæ. The Melaniidæ are represented by a few *Melanoides* only and the Unionidæ by *Unio* (subgenus *Cafferia*). In the extreme west, in Upper Guinea, *Saulea, Afropomus,* and *Potamopyrgus* inhabit isolated Liberian streams and are not found elsewhere. *Rhinomelania, Pachymelania, Pseudogibbula,* and the very distinct bivalve genera *Egeria* and *Iphigenia* are known only from the western coastal rivers and estuaries. *Potadoma* is practically restricted to the Congo basin and Lower Guinea. It is also of interest that the many genera evolved in Lake Tanganyika have not spread from that center, though affluents have brought the generally distributed Ethiopian genera into the lake.

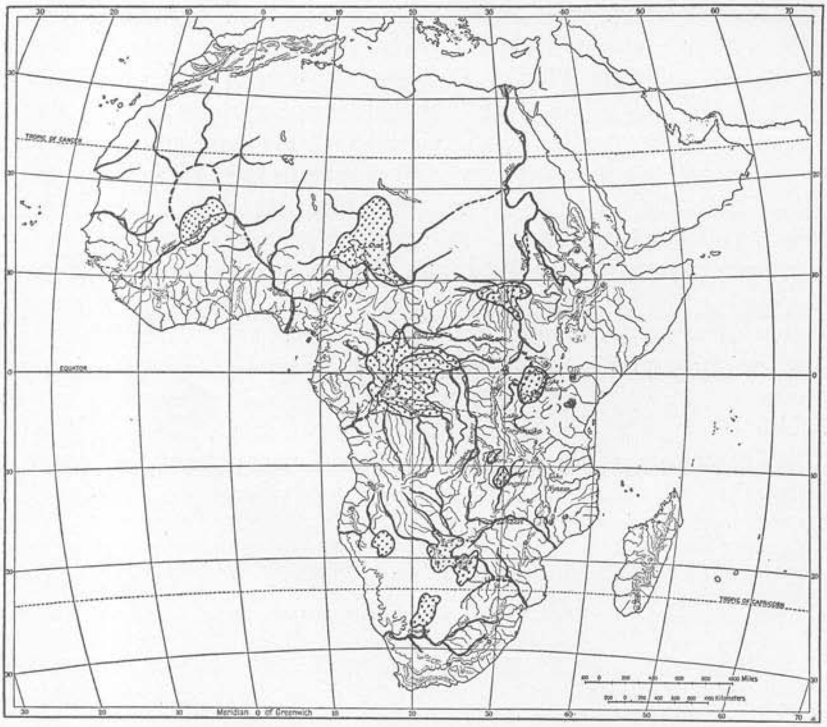
The general uniformity of the African fresh-water fauna is best accounted for by assuming that frequent and easy migrations have been possible between the various river systems. In the case of the Lymnæidæ, Planorbidæ and Sphæriidæ mechanical transportation by water birds may suffice to explain their wide distribution. But, it is extremely doubtful whether such a purely passive means of dispersal could have brought about the same result for the large Melaniidæ, Unionidæ, Mutelidæ, and Etheriidæ, especially for the viviparous species. It seems more reasonable to admit that they migrated actively to various parts of the continent.

There is fortunately plenty of geologic evidence to show (*a*) that during the Pleistocene there have been periods of extreme humid conditions in Africa, when the amount of rainfall, and consequently of superficial water, was considerably larger than nowadays; (*b*) that Africa has been undergoing a steady desiccation ever since the beginning of the modern epoch; and (*c*) that toward the end of the Pleistocene the limits of the hydrographic basins and watersheds were quite different from those prevailing at present. More in particular, there existed about that time a series of large lakes—quite apart from those that are now found in the depressions of the East African rift valleys, some of which may or may not have existed then, at least in their present shape.

We have attempted to represent on Map 14 hydrographic conditions as they may have existed at some very moist epoch toward the close of Pleistocene times.[1] Although such a map is, of course, largely

[1]There have been several previous attempts at similar cartographic reconstructions, notably those of F. Haas and E. Schwarz (1913, 'Zur Entwicklung der afrikanischen Stromsysteme.' Geolog. Rundschau, IV, pp. 603–607) and of L. Germain [1914, IXᵉ Congr. Intern. Zool. Monaco, (1913), p. 570]. It will be seen that our map presents a very different picture. In tracing the extent of the lakes which we supposed existed TOWARD THE CLOSE OF THE PLEISTOCENE we have taken as guides in the first place the existence of recent alluvial deposits—usually with fresh-water mollusks belonging to modern types—over large CONTINUOUS areas, and next the topographical features of the country. It could easily be shown that the lakes drawn by the above-mentioned authors do not agree with these two series of facts.

hypothetical, we have as much as possible kept within the limits of well-established geologic and topographic observations. We have also kept in mind that these lakes must have been fed by rivers draining a sufficiently extended continental area from which the alluviums were



Map 14. Hypothetical extent and distribution of lake and river basins on the African continent, toward the close of the Pleistocene.

eroded that eventually filled them. Even so they appear rather extensive as compared with the size of the present African lakes, and presuppose a rainfall at least four or five times as heavy as nowadays. These late Pleistocene lakes have been shown as occupying the lower portions of closed continental basins to which many of the rivers flowed whose waters nowadays find an outlet to the sea. Such may have been actually the case, for some of them. But even when they eventually obtained an effluent through capture by a coastal river, these lakes may have retained a considerable size for some time. It is probable that their disappearance was mainly due to silting up, as shown by the thick alluvial deposits now found in the areas which they formerly occupied. For it must be remembered that many of the coastal effluents even nowadays flow through narrow and deep gorges where their course is more or less interrupted by rapids and falls. In the case of the Congo basin, for instance, we assume that the lower, central portion was occupied by an extensive, but relatively shallow, body of water, of which Lake Leopold II, Lake Tumba and Stanley Pool are the remnants. We have traced the limits of this "Congo lake" at the present contour-line of 1,500 ft. (Stanley Pool is now 931 ft. above sea-level) and there are in the region of the cataracts where the lower Congo crosses the Crystal Mountains, many spots where such an altitude is reached right on the cliffs or steep hills that fringe the stream.[1] Quite apart from the tapping of these late Pleistocene lakes by coastal effluents, the gradual desiccation of the continent—due to a climatic change—also contributed to reduce their size through increased evaporation and decreased inflow. Lake Chad, Lake Bangweolo, and Lake Ngami are vanishing evidences of former lacustrine basins and in the other areas similar, though smaller, remnants may be traced.

The gradual drying up of Africa has been frequently discussed of late and we do not intend to go at length into this subject.[2] There can

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[1]The lowering of the region of the Crystal Mountains through erosion since the Pleistocene must also be taken in account in trying to gain an idea of the level which the Central Congo lake may have reached before it was connected with the Atlantic.

[2]See Anon. (after R. Williams). 1907. 'The Okavango and the former Lake Ngami.' Geograph. Journ., London, XXX, pp. 440–441.

Audouin. 1905. 'Notice hydrographique sur le lac Tchad.' La Géographie, XII, pp. 305–320.

Bovill, E. W. 1921. 'The encroachment of the Sahara on the Sudan.' Journ. African Soc., XX, pp. 174–185.

Chudeau, R. 1919. 'La capture du Niger par le Taffassasset.' Ann. de Géographie, No. 151, pp. 52–60.

1921. 'L'hydrographie ancienne du Sahara.' C. R. Ac. Sci. Paris, CLXXII, pp. 457–460.

1921. 'Les changements de climat du Sahara pendant le quaternaire.' C. R. Ac. Sci. Paris, CLXXII, pp. 604–607.

1921. 'L'hydrographie ancienne du Sahara (Les conséquences biogéographiques).' Revue Scientif., No. 8, pp. 193–198, 1 map.

1921. 'Le problème du dessèchement en Afrique occidentale.' Bull. Comité Et. Hist. Scientif. Afr. Occ. Franç., No. 3, pp. 353–369.

Germain, L. 1909. 'Recherches sur la faune malacologique de l'Afrique équatoriale.' Arch. Zool. Expér. Gén., XLI, pp. 1–195, Pls. I–II (see especially pp. 66–77).

Harger, R. L. 1917. 'The desiccation of Africa.' Journ. East Afr. Uganda Nat. Hist. Soc., VI, 11, pp. 142–152.

Hobley, C. W. 1916. 'The alleged desiccation of East Africa.' *Op. cit.*, V, 9, pp. 4–16.

Hubert, H. 1920. 'Le dessèchement progressif en Afrique occidentale.' Bull. Comité Et. Hist. Scientif. Afr. Occ. Franç., pp. 401–467, Pls. I–IV.

Marquardsen, H. 1916. 'Tschad-See und Bahr-el-Ghazal (Soro).' Mitt. Deutsch. Schutzgeb., XXIX, pp. 94–96.

Migeod, F. W. H. 1922. 'Some notes on the Lake Chad region in British territory.' Geograph. Journ. London, LX, pp. 347–359.

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Schwarz, E. H. L. 1918. 'The progressive desiccation of Africa: the cause and the remedy.' South African Journ. Sci., XV, pp. 139–178.

1920. 'The Kalahari or thirstland redemption.' (Cape Town), vi+163 pp., 14 Pls., 3 maps.

1921. 'The control of climate by lakes.' Geograph. Journ., LVII, pp. 166–174.

Tilho, J. 1906. 'Exploration du lac Tchad.' La Géographie, XIII, pp. 195–214, map.

hardly be any doubt that there has been a gradual regression of superficial water in northwestern Africa, the region of Lake Chad and central South Africa, while the accompanying climatic changes certainly affected hygrographic conditions in the remainder of the continent as well.[1] This happened at intervals, not only at the close of the last Pleistocene pluvial period, but even later and within historic times.

That quite recently more humid conditions were general in Africa is of considerable zoögeographic importance since it rendered possible migrations of fresh-water mollusks since the Pleistocene, that is, after the species were mostly differentiated in their present shape. There are many regions where the divides between the hydrographic basins run through old peneplains, so much degraded to near-level that the watersheds are hardly defined. The river systems are frequently separated by but a few feet of difference in level, while at times they are in direct communication either by means of seasonal swamps (as in the region of Lake Dilolo, where the upper Kasai is connected with the upper Zambezi) or even through a regular channel (as in the upper Benue, where a channel to the Logone, an affluent of the Chari, is at times passable for canoes and leads from the basin of the Niger into that of Lake Chad). Assuming that rains were more abundant at the beginning of the modern epoch, such connections between the river systems must have been at times quite frequent and extensive, giving ample opportunity to the mollusks of migrating from one basin to another.

Enough has been said to make it clear that, if in the following account we treat in succession the various river systems of the Belgian Congo, it is not because we regard them as faunistic entities. It merely appears to be the most convenient method of presenting the available data in orderly fashion.

By far the greatest part of our territory lies within the hydrographic basin of the Congo. The waters of a narrow, but important strip of territory, in the extreme northeast, flow to the Nile; while most of those from the western half of the Lower Congo drain directly into the Atlantic.

### Coastal Rivers of the Belgian Congo

The most important of these, the Shiloango River, forms the northern boundary of the Belgian Congo from Mt. Kiama (in about 13° 20′ E.) to the confluence of the Lubuzi, then flowing across the Portuguese

[1]This leaves open the much discussed question as to the cause of the regression of superficial water. It has been claimed that it is actually due to a change in climate. Other authorities claim that it can be sufficiently accounted for by the gradual draining off through coastal effluents of the inland lakes, while deforestation, greatly hastened through the agency of man, reduces the quantity of rain-water that seeps through the soil.

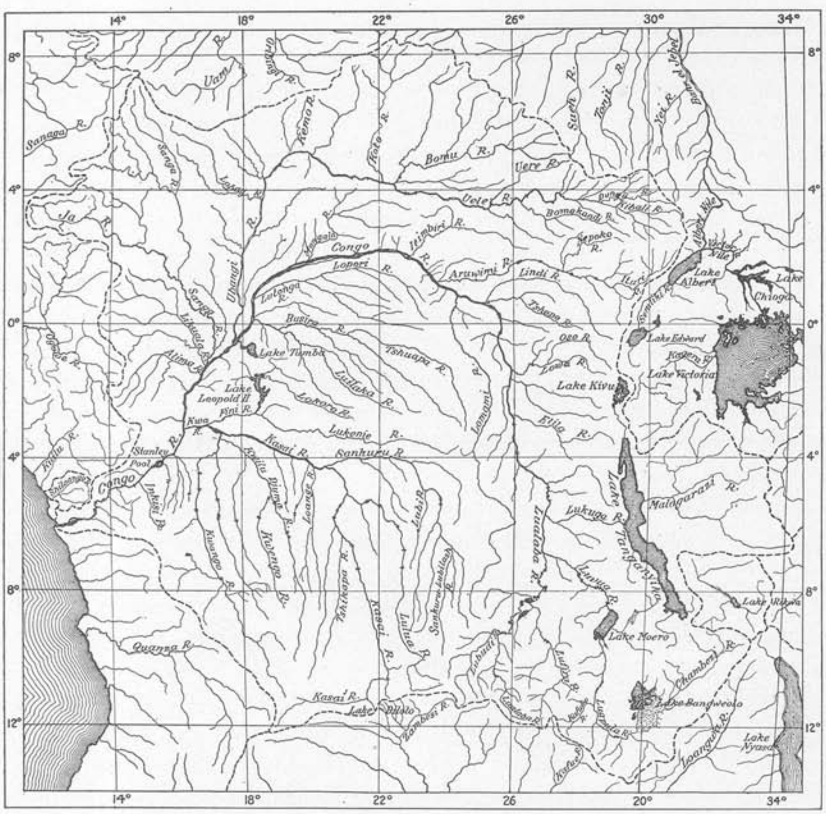
Colony of Cabinda to Landana. Its southern drainage comprises the Mayombe, in Belgian territory, a heavily forested, hilly country; its main affluent is the Lubuzi with the Lukula as a tributary. Little is known at present of the mollusk fauna of the Shiloango basin, but it may well possess some peculiar types not found in the Congo basin and perhaps more closely related to those of the rivers of Gaboon. Recently Dr. H. Schouteden has obtained in the Lukula River and some of the smaller streams of the Mayombe, certain Melaniidæ (*Potadoma graptoconus* and *P. schoutedeni*) which are conspicuously different from those of the Upper Congo and more closely related to the species of Gaboon and Upper Guinea.

The other coastal rivers of the Belgian Congo, such as the Moanda and the Kumbi, are very small; they are more or less connected by swamps or lagoons in the interior. Nothing is known of their mollusks, outside the estuarine forms.

## Congo River System

The Congo River drains an area of approximately 3,690,000 square kilometers, the second largest hydrographic basin of the world (Map 15). This basin extends beyond the limits of our territory to include the drainage of the Malagarazi River in Tanganyika Territory, much of Northeast Rhodesia mainly drained by the Chambezi River, the northeastern portion of Angola drained by the headwaters of the Kasai, and a large part of French Equatorial Africa. Some of the western headwaters of the Sanga even reach into Cameroon.

Most geographers consider the Lualaba as the upper branch of the Congo, which gives to the main stream a length of nearly 4,000 kilometers. This would be much increased if we regard the Chambezi-Luapula-Luvua system as the true headwaters. Many of the tributaries are also long and sizable rivers. The course of the Congo and its affluents is quite peculiar: south of 5° S. the rivers generally flow due north; but between 5° N. and 5° S. their course is sharply deflected toward the west, the Congo itself forming near the equator a bow-like bend which reaches 2° N. and finally turns due southwest to its mouth. Of the southern affluents the Lomami alone keeps a south to north direction throughout its course. The northern portion of the basin is much less extensive than the southern part. Here the Ubangi and its upper branches the Bomu and Uele, first follow the usual east-to-west direction; but in about 19° E. the Ubangi curves southward with a rather abrupt bend and thus reaches its confluence a little south of the equator.




Map 15. Hydrographic map of the Congo basin and the adjacent river systems.

The peripheral regions of the Congo basin are generally at an altitude of over 500 m. and in the southern and eastern portions frequently reach 1,000 m. and more. Much of this area is a fairly level or slightly hilly peneplain, occasionally interrupted by high plateaus (as in Katanga) or by moderately high mountains (as in the Crystal Mountains of the Lower Congo, the Bia and Hakannson Mountains of Katanga, etc.). On the level peneplains the streams are sluggish, though generally flowing within well-defined banks; but in truly mountainous country the headwaters are frequently swift torrents. The central portion of the basin, however, approximately between 3° N. and 4° S., 16° E. and 26° E., forms an almost level plain or flattened bowl rarely reaching 500 m. above sea-level. Here the rivers broaden considerably and become sluggish and shallow; their course is obstructed with many sand spits and mud banks which eventually form islands. Thus the Congo itself in the equatorial bend reaches from 6 to 16 kilometers in width. Its shores are so low that they often are hard to define, especially at high water when much of the surrounding forest is inundated and almost the whole region between the Mongala and Tshuapa-Busira Rivers forms one continuous, wooded swamp. The difference between the mean level of the Congo at Stanleyville and Leopoldville, a distance of over 1,500 kilometers, is less than 200 m. Between the mouth of the Aruwimi and that of the Ubangi, the stream flows through a maze of low islands, many of considerable size; that of Sumba, opposite the mouth of the Mongala, is 80 kilometers long, while the neighboring island of Ukaturaka, the largest of all, has a length of 100 kilometers, but is separated from the mainland by only a narrow channel. Moreover, there are frequently broad expanses of open water, sometimes 500 m. to 2,000 m. wide. There can be little doubt that this central, swampy part of the Congo basin was formerly occupied by a vast fresh-water lake, which most probably persisted throughout the Pleistocene and was gradually drained off across the Crystal Mountains to the Atlantic. Lake Tumba, Lake Leopold II, and Stanley Pool may be regarded as the last remnants of this equatorial lake.

The most interesting hydrographic feature of the Congo is the abrupt transition between the raised periphery or rim of the basin and its central, flattened bowl. A glance at the hydrographic map (Map 15) discloses that, after having traversed fairly level highlands, most tributaries suddenly enter a stretch of rapids, cataracts, or falls, where they drop rapidly from the level of the peripheral peneplain to that of the central bowl. The Congo itself does so, first in its upper part, the Lualaba, where it is frequently interrupted by reaches of rapids, and finally before reaching its estuary, when it forces its tortuous way across the peripheral rim in the district of the Cataracts. In this last, short stretch of 280 kilometers, between Stanley Pool and Matadi, the total fall is about 274 m., considerably more than in the whole distance between Stanley Falls and Stanley Pool. The abrupt transition from the peripheral peneplain to the equatorial bowl is especially well marked on the Kasai and its many affluents. Between 5° and 6° S., the course of all of them, with the exception of the Loange, is interrupted by a series of rapids. It has been shown that this belt of cataracts is due to a fault line which may be traced from the estuary of the Congo to the Upper Lualaba. The southern edge of this fracture is raised as a scarp about 200 m. above the country to the north.

Before reaching its mouth the Congo forms a broad and deep estuary, about 130 kilometers long, which begins below the rapids of Kasi, some 5 kilometers above Matadi. The waters here do not merely follow the thalweg of a simple erosion valley, but they evidently fill a deep fracture gorge. The stream is on the average 70 m. to 125 m. deep, but the greatest depth is found between Malela and Banana where a sounding of 280 m. has been reached; right opposite Matadi the river rapidly attains a depth of from 50 to 70 m. The gully is continued into the open sea for over 160 kilometers with depths as much as 1,200 m. below the general level of the sea floor. This fracture of the earth's crust follows the 6th southern parallel and is supposedly the western continuation of the fault which we have mentioned above as causing the line of rapids and falls of the Kasai and its affluents between 5° and 6° S. The lower depths of this trough-like bay are occupied by nearly motionless sea water on top of which the fresh-water, being lighter, flows with increasing velocity, but decreasing depth; just within the mouth there are only a few feet of fresh-water.

Between Matadi and Boma the Congo still flows in one deep, winding channel, 640 m. to 2 kilometers wide, between low hills, often with shallow, immersed stony ledges near the steep, rocky banks. The malacological fauna of this stretch, which is about 30 kilometers long, is practically unknown; yet the discovery of the peculiar littorinid snail *Pseudogibbula duponti* Dautzenberg on the immersed rocks near Vivi renders an investigation of this part of the river quite desirable.

A little above Boma, the Congo enters much lower country, where it broadens into a huge, delta-like expansion with a number of islands. The first to be met with, Prince's Island, Rocca, Sacra Baka, and Selonge, in the near vicinity of Boma, are rather high and hilly and contain a rocky core. Just below the fort of Skinkakasa, the river forms one broad expanse not interrupted by islands, the two banks being here at a distance of 4,720 m. Below that point, however, it widens again to a labyrinth of flat, alluvial islands, that of Mateba being the most considerable (32 kilometers long and 4 to 7 kilometers wide). At certain points the distance between the right and left banks of the river reaches 18 kilometers. Some of the branches are very wide, but they are frequently interrupted by sand-bars and mud-flats. Zambi is situated about mid-way in this stretch, on the slightly hilly right bank of the river; the northern channel of the stream, between Mateba and the mainland, being here obstructed by a multitude of banks and alluvial, swampy islands. At Ponta da Lenha, about 45 kilometers from the ocean, the character of the low banks changes once more; the tidal movements become very pronounced so that extreme brackish conditions prevail, resulting in the development of a peculiar mangrove vegetation. The current now keeps mainly to a central thalweg, forming one expanse of water 4 to 5 kilometers wide, On both banks, however, the mud-flats covered with mangrove forest (*Rhizophora Mangle* Linnæus) are cut up by numerous meandering bayous, so-called creeks, some of which are 4 to 8 m. deep. On the right bank the mangrove swamps thus extend to 12 kilometers north of the shore of the main river, the locality of Kunga (Plate LXXV) being situated at their extreme northern limit, where they are abruptly bordered by a raised, low table land. They are hardly less extensive on the southern shore, in Portuguese territory, where they are similarly bound in by a low plateau. The mouth itself of the Congo is 10 kilometers wide and is comprised between two narrow and low, sandy peninsulas. That on the southern, Portuguese shore is much the larger and broader and ends in Shark Point which encloses an interior harbor, Diego Bay, sheltering the port of San Antonio. On its seaward, western side it bulges out into the ocean, at Point Padrão (often misspelled Padron), where Diogo Cão (Diego Cam), the Portuguese navigator who discovered the Congo (or Zaire) about 1484, landed and erected a stone, thus claiming the land for the Portuguese Crown. Banana Peninsula, on the northern or Belgian side, is exceedingly narrow, in many places not over half a kilometer wide. It is nowhere more than 2 m. above high tide and at the equinoxes the flood from the sea frequently flows over it into Banana Creek. The peninsula ends in Banana Point, itself preceded by an extensive spit of sand and mud.

The volume of water carried by the Congo is considerable. John Murray[1] estimated that its mean annual discharge into the ocean was 419,291 cubic miles, making it second only to the Amazon. It has been calculated that at the season of greatest flood it pours 1,200,000 cubic feet of water per second into the Atlantic. This fact is mainly responsible for the current being still perceptible fully 50 kilometers out to sea, the greenish-yellow waters being distinguishable from the blue of the ocean. Factors of considerable importance to the life of fluviatile mollusks are the periodical rise and fall of the waters due to the seasonal distribution of the rains. This not only produces frequent changes in the depth, extent, and volume of the rivers as well as in the strength of the current, but it also influences the amount of silt carried by the water

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[1] Murray, John. 1887. 'On the total annual rainfall and the relation of rainfall to the annual discharge of rivers.' Scottish Geogr. Mag., III, pp. 65–77.

and of foreign substances dissolved or held in suspension. When the waters suddenly rise, islets of floating vegetation may become detached from the banks and be carried downstream together with drift; and snails and mussels, or their eggs, may thus be spread over great distances.

As the basin of the Congo extends far to the north and to the south of the equator, where, as we have explained above (p. 461), the rainy and dry seasons occur at different times of the year, the lower part of the Congo River has two seasons of greatest flood. Above the confluence of the Kasai, these come in May and November, that is to say, toward the end of the southern and northern rainy seasons. The Lualaba above Stanley Falls is swollen during March and April, at the end of the rainy season in Katanga, and the difference of level with the lowest water is quite considerable, since in Upper Katanga the dry season (May to September inclusive) is extremely pronounced. The highest waters in the northern tributaries (Uele, Bomu, Ituri-Aruwimi, etc.) are observed in October–November; on the lower Ubangi somewhat later (December). The flood of the Kasai basin corresponds to that of the upper Lualaba (March–April). Its great volume of water, carried more directly to the Lower Congo than is the drainage of Katanga, tends to accelerate and to lengthen one of the periods of flood in Stanley Pool and below, where the highest levels are reached about December and April–May. At Stanley Pool the maximum rise of the water is about 5 m., but it varies much from year to year. Below the Cataracts, at Matadi, the difference in level between high and low water is still greater, 6 to 8 m. Farther downstream it rapidly decreases, since it is neutralized by the action of the tides. At Boma it amounts to 3 m.; at the western extremity of Mateba Island to 1.8 m.; and at Mateba to only 0.9 m. Yet the difference in the volume of fresh-water carried by the river at the several seasons is such that it must profoundly modify the degree of salinity in the estuary. Even within the zone of brackish water the animals and plants are forced to adjust their metabolism to frequent and rather rapid changes in the concentration of mineral salts. With regard to the smaller tributaries of the Congo, it is generally true that the farther from the equator is the country they drain, the greater will be the difference between high and low water.

From the foregoing general description it appears that the flowing waters of the Congo basin belong to four ecological types, each of which possesses a number of peculiar mollusks.

(1) The brooks and streams of the headwaters are small, often but a few inches deep and moderately swift. They generally flow over a

bottom of fine gravel and are but little obstructed by water-plants. Thus far, these waters have been but little investigated malacologically, although they may possess some forms of great interest. In Upper Katanga they have yielded a number of species not known elsewhere within our territory, as may be seen from the subjoined list.

*Lymnæa natalensis*
*Planorbis adowensis*
" *costulatus*
*Segmentina kempi*
*Physopsis africana globosa*
*Burnupia caffra*
" *alta*
" *transvaalensis*
" *kimiloloensis*
*Lanistes nsendweensis*
*Lanistes nsendweensis katanganus*
" *ellipticus*
*Bulimus kisalensis*
*Lobogenes michaelis*
" *spiralis*
*Melanoïdes anomala*
*Cleopatra dautzenbergi*
" *nsendweensis*
" " *katangana*
*Pisidium katangense*

Unionidæ and Mutelidæ are generally absent from these smaller streams. *Planorbis costulatus, Segmentina kempi, Lanistes ellipticus, Bulimus kisalensis, Lobogenes michaelis, L. spiralis, Melanoides anomala,* and *Pisidium katangense* are an interesting assemblage from the clear water of streamlets near Elisabethville, the smaller species actually living partly buried in the fine pebbles of gravelly bottoms, near the sources, as noted by their discoverer, Dr. Michael Bequaert.

Sometimes these headwaters are interrupted by falls or rapids, such as those shown for the Lubumbashi River near Elisabethville on Pl. LXIX, fig. 2. Ecological conditions are then more like those of the cataracts of larger rivers, of which we shall have more to say later.

In the hilly portions of the Ituri forest there are many shallow brooks, gently meandering beneath the dense shade of the trees, except when a freshet transforms them into temporary torrents. These forest streams differ mainly from the brooks of the savanna country in that they nourish much plant growth and also contain abundant decaying vegetable matter. As seen in the photograph of Plate LXV, taken near Niapu, the partly immersed boulders and dead tree stumps of the bed and of the banks are covered with many hygrophilous plants, such as liverworts, mosses, selanigellas, club-mosses, ferns, sedges, etc. Among the dead leaves and decaying branches of the bottom one should look for the species of *Potadoma*, usually partly buried in the débris and heavily coated with hydroxid of iron and dirt. They are apparently the only mollusks to be found in this particular habitat, where they occur with river crabs of the genus *Potamon*. Since they present a number of species and local races throughout the Congo forest, they should be extensively collected, great care being taken to note which of the forms occur together and under what conditions they live.

(2) In the several stretches of rapids and falls which interrupt at various points the course of the Congo and of practically all of its affluents, the stony substratum and the violence and large volume of flowing water naturally exclude most mollusks. These are, however, found in fair numbers in the more quiet parts, in the back-waters and pools between the rocks of the shore, as we have explained above. True falls, with leaps of several feet, are not very common in the Congo, except in the mountainous country of Upper Katanga. Pl. LXIV, fig. 2, represents the falls of the Tshopo River near Stanleyville. The usual condition is that of rapids, such as shown in Pl. LXVI by a photograph taken on the Aruwimi River at Panga. Turbulent water spreads over a wide bed of boulders, which are completely submerged at high tide or protrude as islets with grasses or even shrubs at the season of low water. On the larger rivers these rapids can be passed almost everywhere by native canoes, at least at the proper season, although in rivers like the Aruwimi-Ituri and Uele-Ubangi, where they are extremely frequent, navigation is dangerous and rather exasperating.

Rocks and stones fully exposed to the flow of the water are, as a rule, covered with a peculiar growth of mosses, liverworts and certain remarkable, algæ-like dicotyledonous flowering plants belonging to the families Podostemonaceæ and Hydrostachyaceæ. Whether any minute mollusks are living within the dense floating cushions of these solidly anchored plants is not known. It is possible that some of the smaller species of *Cleopatra*, most of which are known from dead specimens only, should be looked for in such a location. The rocks themselves, however, are usually coated with the valves of the oyster-like Etheriidæ (*Etheria elliptica* in its various forms), one of the valves being solidly cemented to the stone by the whole or major part of its surface. The free surface of the shell is usually covered with fresh-water sponges (Spongillidæ),[1] while in the crevices of the somewhat spongy valves minute clams of the genus *Eupera* are rarely lacking. *Cleopatra broecki* Putzeys was found upon valves of *Etheria* in the Aruwimi River and Ancylidæ have been taken under similar conditions in Upper Katanga.

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[1]See Weltner, W. 1913. 'Süsswasserschwämme (Spongillidæ) der Deutschen Zentralafrika-Expedition, 1907–1908.' Wiss. Ergebn. D. Z. Afr. Exp. 1907–08, IV, pp. 475–485 (describes two species growing on shells of *Etheria* in the Aruwimi River).

Annandale, N. 1913. 'Notes on fresh-water sponges, XV. Sponges from shells of the genus *Ætheria*.' Rec. Indian Mus., IX, pp. 237–240.

(3) In the central bowl of the Congo basin the current of the rivers is slow and, owing to the extremely level condition of the surrounding country they expand their beds considerably and often overflow densely forested banks. The whole central area is more or less of a morass or wooded swamp, especially in the region between the Mongala and Busira-Tshuapa Rivers, where the many forest tributaries such as the Lopori, Maringa, Ikelemba, etc., are connected at high water by side channels. In some places the banks of these rivers are so low that the natives are compelled to raise their huts on piles. The water of these affluents carries much humus and decaying vegetable matter, giving it a chocolate-brown or black color, even noticeable when seen in small quantity—for instance, in a tumbler. The water of the Congo itself is usually much clearer, a pale brown or greenish yellow, and a sudden change to a darker shade discloses the approach of the mouth of one of these equatorial tributaries which is often hidden in the maze of islands of the main stream. Nothing is known at present of the malacological fauna of these equatorial forest streams, but, owing to the heavy proportion of organic matter, they probably nourish few if any mollusks.

Between the equator and 3° S., in about 18° to 19° E., there are two small lakes which may be regarded as the remnants of a much larger body of fresh-water that covered the major part of the central bowl at a comparatively recent period (probably during most of the Tertiary and perhaps even during the Pleistocene). Both lakes are very shallow and bordered by flat, marshy and frequently inundated shores. The largest, Lake Leopold II, covers an area of about 2,300 square kilometers. Lake Tumba is much smaller, some 1,200 square kilometers in extent. The mollusks which may inhabit them are thus far unknown, but they are probably few in number and present nothing peculiar.

Attention has been called above to the lacustrine conditions prevailing on the Congo River in the equatorial reach, beween the confluence of the Aruwimi and that of the Sanga. Extending as they do over a very broad but shallow bed, the waters lose much of their carrying power for eroded material so that silt deposits actively, forming mud banks and sand spits, which eventually are transformed into islands. At first it might be supposed that these waters, quietly flowing over a soft, muddy bottom, would offer almost ideal conditions for fluviatile molluscan life. One soon learns, however, that such is far from being the case. In fact, this is the part of the Congo drainage which is poorest in mollusks. Occasionally one may meet a mud bank where some of the Mutelidæ are extremely abundant, especially *Aspatharia wissmanni bangalorum* and *Mutela rostrata.*

Mollusks are more frequently met with on the stretches with sandy or gravelly bottom just below or above the rocky barriers, especially in certain of the tributaries. Here one must look for the elegantly sculptured species of *Melanoides*, which live sometimes by the hundreds on the immersed edges of the sand spits. These little snails crawl over the soft, moist sand or more often are buried just beneath the semi-liquid surface of the bank. In a similar habitat are found a number of Unionidæ and Mutelidæ, the most striking being *Mutela* (*Chelidonopsis*) *hirundo*, appropriately named for the swallow-tail-shaped expansions of its posterior ends. It is still worthy of notice that in such areas certain sand-spits are abundantly provided with melanians and naiades, while many other, apparently similar banks may be examined in vain. There must be, of course, some ecological reason for these differences, but at present we have no satisfactory explanation to suggest.

An important feature of all these rivers are the seasonal variations in level to which they are subject. How far-reaching their effects are, even in the smaller tributaries, may be easily gathered from a comparison of the two photographs of Pl. LXVII, both representing the Garamba River in the country north of Faradje. That of Fig. 1 was taken in September, 1911, that is, toward the close of the rainy season, when the water reaches its highest level. Fig. 2 shows conditions as they were in February, 1913, about the middle of the dry season, when the water is quite low. The type specimens of the unionid *Cælatura mesafricana* and of the mutelid *Mutela garambæ* were found buried in the sand banks shown in Fig. 2. Similar conditions are illustrated for the Dungu River, at Faradje, in Pl. LXVIII, the picture representing conditions in the dry season (March, 1910) when *Parreysia leopoldvillensis* and *Aspatharia sinuata* were obtained in large numbers from the sand spits.

The variations in level are more considerable in the main river Congo between Stanleyville and Leopoldville, where there are in addition two periods of flood every year. On the whole, the annual rise of the waters is very irregular, being sometimes more than one-third larger in succeeding years, as shown by the following figures[1]:

[1]These figures are based upon observations made during 1910, 1911, and 1912 and are taken from a short paper by H. Roussilhe, 1912. 'Le régime des crues dans le réseau fluvial congolais.' C. R. Ac. Sci. Paris, CLV, pp. 1141–1144.

This author argues that the double annual flood of the Congo at Leopoldville is not due, as is generally believed, to the combination of high water levels in the two hemispheres, resulting from the reversed rainy and dry seasons north and south of the equator. He rather incriminates a double pluviometric annual cycle in the region of the sources of the southern headwaters where, he says, the "tropical southern climate comprises two seasons of rains separated by a short dry season." There appears to be little evidence of this in the meteorological data published for the Katanga.

| | Total annual rise in meters Mean | Maximum |
|---|---|---|
| Congo at Stanleyville | 3.65 | 5.35 |
| " " Lukolela | 3.45 | 4.40 |
| " " Leopoldville | 3.40 | 5.60 |
| Ubangi at Bangui | 6.80 | 7.40 |
| " " Betu | 4.50 | 5.55 |
| " " Impfondo | 6.50 | 7.00 |
| Sanga at Nola | 2.30 | 3.21 |
| " " Ouesso | 3.50 | 4.32 |

The frequent changes of level not only modify the depth of the water and the strength of the current, two factors of great importance in the life of aquatic mollusks, but they also cause continual shifting about of the deposits of silt, thus rendering the existence of fresh-water mussels especially quite precarious. These many mechanical disturbances probably also account for the almost total absence in these shallow flowing waters of aquatic plants which could offer shelter and food to aquatic snails.

Just before entering the region of the Cataracts leading to its estuary, the Congo River suddenly broadens into the lake-like expansion of Stanley Pool. Being readily accessible from the coast and, as it were, the gateway to the interior, it has been visited by several collectors, so that its fauna is fairly well known. The Pool is some 24 kilometers long and 16 kilometers wide, obstructed by numerous sand banks and a number of islands. The large, alluvial island of Bomu, in the center, occupies much of its area. The surrounding country is hilly and along the right shore the banks are generally raised. At the extreme northern end they form bluffs of white sandstones, the so-called Dover Cliffs. The left shore is usually lower and frequently covered with papyrus swamps. The following is a list of the species at present known from that region:

*Physopsis africana*
*Pila leopoldvillensis*
*Lanistes congicus fraternus*
" *bicarinatus*
" *ovum* var. *major*
*Viviparus leopoldvillensis*
*Melanoides kinshassaensis*
" *liebrechtsi*
*Parreysia leopoldvillensis*
*Cælatura elegans*
" *æquatoria*
" *rotula*
*Aspatharia protchei*
" *chapini*
*Mutela hirundo*
" *carrei*

*Physopsis*, *Pila*, and *Lanistes* of this list are found mostly in the swamps which border the Pool. *Melanoides* and the several Unionidæ and Mutelidæ live on and in the sand banks and mud bars. Some of these, such as the elegant *Melanoides liebrechtsi*, are quite abundant in spots.

(4) The physical conditions of the Congo estuary between Matadi and the Atlantic were briefly described above. In the upper reach, between Matadi and Boma, the deep river flows in one rather narrow channel, margined by rocky shores. The water is not in the least brackish and the current rather strong, often forming whirlpools around the more or less submerged rocky ledges of the banks. Mud flats and sand spits are almost totally lacking, so that ecological conditions are quite different from those found elsewhere in the Congo basin. Unfortunately, but for the occurrence of the peculiar snail *Pseudogibbula duponti* on immersed rocks at Vivi, the malacological fauna of this reach is still an untrodden field.

Owing to the fjord-like structure of the Congo estuary where the fresh-water only forms a superficial sheet over the deeper filling of sea-water,[1] velocity due to slope alone is slight. Thus, the mean level of the stream at Matadi, some 130 kilometers from the sea, is but 0 m.1 above mean sea level. It follows that the action of the tides is of considerable ecological importance. At Boma, about 80 kilometers from the mouth, this is as yet of little import, since the difference between high and low tide is at most 2 to 3 cm., at full and new moon during the dry season, and the water is not perceptibly brackish. Below this point the influence of the tides steadily increases. At Malela, 30 kilometers from the sea, the amplitude of the tide is from 0.1 m. to 1 m., according to the phases of the moon and the seasonal variations of water level.

The malacological fauna undergoes quite decided changes as one progresses downstream.[2] The few mollusks known from the Congo River at Boma are all typical fresh-water species: *Lanistes intortus*, *L. adansoni*, *Cælatura stagnorum*, and *C. stagnorum bomæ.*

The fauna of Zambi is more abundant, since that locality shows a variety of conditions: swamps with papyrus, rocky shores at the cliff-like banks below the mouth of the Lukunga River, and sand spits and mud flats in the shallow portions of the northern branch of the Congo (Pls. LXXI, fig. 1 and LXXII).

| | |
|---|---|
| *Neritina oweniana* | *Parreysia leopoldvillensis* |
| *Lanistes intortus* | *Cælatura elegans* |
| " *adansoni* | " *stagnorum* |
| *Melanoides langi zambiensis* | *Mutela langi* |

[1]The fauna of the deeper portions of the estuarine waters of the Congo is totally unknown. All mollusks obtained in this region are shore or littoral species living between the limits of the upper and lower tides and a few feet below the lower limit.

[2]No representatives of the genera *Lymnæa*, *Bulinus*, *Planorbis*, *Pila*, *Potadoma*, and *Cleopatra* are known from the estuary of the Congo. Although it would be difficult to account for their absence there, at least in the region between Matadi and Zambi, yet it is hardly possible that they should have been overlooked by all collectors. The discussion of ecological conditions in this region may best be followed by referring to the detailed map published in the Report of Land Mollusks (1919, Bull. American Mus. Nat. Hist., XL, p. 15).

It may be seen that the fauna is still typically fluviatile, even though the water has a slight brackish taste. The species of *Lanistes* live mainly in the papyrus swamps. *Melanoides* crawls in the usual fashion over the immersed sand spits, in which are also buried the various Unionidæ and the *Mutela,* most of them in great abundance. The strikingly winged, large *Neritina* frequents deeper stretches of water with rather steady current, where it is attached to stones or to submerged dead branches.

In traveling downstream from Zambi toward Malela a decided change of conditions is noticed upon reaching the western extremity of Mateba Island. The river is then more fully exposed to the effect of the tides and the water becomes extremely brackish, at least at the flood. Malela is well within this brackish zone, an area of muddy tidal flats covered with halophytic vegetation, primarily with true mangrove-forest (*Rhizophora Mangle* Linnæus) and divided into numerous islands by tortuous and deep creeks. Although composed of but a few species of plants, the vegetation of these muddy islands, periodically covered and uncovered by the tide, is quite luxuriant. *Rhizophora Mangle,* the common mangrove tree of the shores of the Atlantic Ocean, reaches here much larger dimensions than anywhere else in the world. Along the creeks between Malela and Banana it forms dense stands, 25 to 30 m. high, with columnar boles frequently 60 cm. in diameter. As shown in Pl. LXXIV, from a photograph taken near Malela at low tide, these huge trunks are solidly anchored in the oozy bottom by a system of short, spreading prop roots. On the outer edges of such tall timber *Rhizophora* also sends down from the branches high up in the canopy long, dichotomous roots, which merely dangle loose in the water. These characteristics may be seen from Pl. LXXIII, which also illustrates the dense fringe of low *Raphia* palms, another peculiarity of the area immediately below Malela.

The vicinity of Malela possesses a rather varied and extremely interesting assemblage of mollusks, as may be seen from the following list:

*Neritina oweniana*
*Lanistes congicus* (?)
" *intortus*
*Potamides fuscatus*
*Melanoides langi*
*Pachymelania fusca*
*Egeria congica*
" *tenuicula langi*
" *nux*
*Iphigenia congo*
*Cælatura elegans*

But few truly marine species reach so far up river, the most common being a species of *Teredo* which bores into the piles of the wharf. On the muddy shores of the Congo estuary a species of *Corbula* also occurs in abundance together with *Iphigenia.* The most prominent members of this fauna are the ponderous clams of the genus *Egeria*, which are found in the mud banks of the main stream from Malela to Katala. In this region huge accumulations of dead and bleached valves of *Egeria congica* are found on both banks of the stream, often some distance above high tide (Pl. LXXI, fig. 2). By Dupont and others they were thought to represent ancient alluvial deposits of the stream but, from the junior author's observations, they are kitchen-middens or accumulations of valves thrown away by the natives who have for centuries fished these clams at the proper season. They usually open them at once upon reaching the shore, carrying only the animal back to their villages.

A few miles above Banana the salinity of the creeks is so high that a number of truly marine mollusks make their appearance. The most striking of these are the peculiar mangrove oyster (*Ostrea bicolor* Hanley) and a small *Mytilus* (*M. tenuistriatus* Dunker). Both these bivalves form dense accumulations near the lower end of the prop roots of *Rhizophora* and are, it appears, only fixed on living roots.[1] The *Ostrea* is especially abundant in the narrower, more muddy creeks and reaches a higher level than the *Mytilus*, being sometimes uncovered by the low tide. Some of the natives are extremely fond of mangrove oysters and gather them in large quantities. Their taste is generally too muddy to please the European palate, but was found that they may be much improved when tied in bags and left in pure sea-water for about a week; if left much longer they die. The *Mytilus* occurs much nearer the sea than the *Ostrea* and the two are not usually found together, at least in abundance. It covers only the lowest extremities of the prop roots, being seldom exposed above low tide, and is often associated with the burrowing isopod *Sphæroma destructor* Richardson.[2] Two peculiar marine snails are also found with the *Ostrea* on the mangrove roots. The heavy and extremely variable *Thais coronata* (Lamarck) often covers with its colonies whole roots to the exclusion of any other shells. It is always regularly uncovered by low tide. The animal is solidly anchored to its substratum by a long foot deeply inserted into a crevice. In traveling downstream from Malela the increase in salinity of the water is well indicated by the appearance of *Thais* (usually together with *Ostrea*) and their number steadily increases to reach its maximum on the wharf piles along the inner shore of Banana Peninsula.

[1]The species of *Cyrenoida* and *Congeria* are also found among the roots of mangrove, but the ecological conditions under which they occur are not known to us, as they were not found alive by Mr. H. Lang and the junior author. Their habitat must be quite different from that of the *Ostrea* and *Mytilus*. Perhaps they seek decidedly less saline water.

[2]See W. G. Van Name, 1920, Bull. American Mus. Nat. Hist., XLIII, pp. 63–67, figs. 16–19.

Another common marine snail of the mangrove is a large, turbinate *Littorina* (*L. angulifera* Lamarck), which, near the mouth of the Congo, is usually met with on the branches of mangrove trees above the high tide and often also on the leaves. It appears to live most of the time in open air and there is even a question as to whether it ever deliberately enters the water. Mr. Lang observed that in the central parts of the island of Bulabemba, where the mangrove swamps dry out completely during July and August, these *Littorinæ* secrete at that season a whitish pellicle along the edge of attachment between the aperture and the branch, which seems to exclude air completely So solidly are they thus fixed that the tree may be shaken without detaching them. In addition, the outer surface of the shell is thickly coated with crystallized salt, so that it shows none of its natural color. These estivating specimens are never attached more than three to five feet above the ground, while the snail crawls much higher in active life. It is of interest that at that period of the year this same species of *Littorina* is observed crawling about in the creeks near Banana. *L. angulifera* is also the first of the truly marine forms to appear when coming downstream from Malela, much earlier than *Thais coronata* and *Ostrea*. The individuals occurring farthest upstream are much smaller in size than those living near Banana. The genus *Littorina* is of more than ordinary interest to the ecologist because it contains all transitions between marine species that are strictly aquatic and have well-developed gills, such as *Littorina littorea* of Europe, to such as crawl at low tide among uncovered sea-weeds (*L. obtusata*), or occur only at the upper limit of high tide (like *L. rudis*), and finally species that may stay alive for months out of water. In the last group belong, not only the West African *L. angulifera*, but several other tropical species: *L. muricata, L. varia, L. fasciata, L. pulchra,* and *L. irrorata.* These changes of preferred habitat are accompanied by a gradual reduction of the gills, while the wall itself of the mantle cavity becomes more abundantly furnished with blood vessels, the cavity being filled with air when the animal is out of the water. We thus see illustrated one of the ways in which pulmonate land snails may have directly evolved from marine forms.[1]

The following list includes part of the mollusks which have been observed in brackish water at the very mouth of the Congo, that is, near Banana on the right shore and near San Antonio on the left bank. To be complete, it should include many true marine forms which live

[1]See V. Willem, 1895, Bull. Ac. Belgique, Cl. des Sci., (3) XXIX, pp. 73–83; P. Pelseneer, 1895, Arch. de Biologie, XIV, 2, pp. 351–393, Pls. XIV–XVIII. The genus *Littorina* is here used in the older and wide sense.

here together with brackish water species. Thus, along the inner shore of Banana Peninsula one finds in company with *Neritina adansoniana, Lanistes intortus, L. adansoni, Iphigenia curta* and *I. rostrata*, a number of other bivalves [*Tagelus angulatus* (Sowerby), *Tellina ampullacea* Philippi, *Loripes contrarius* (Dunker), *Corbula* sp., etc.] and snails [*Haminœa* sp., *Thais coronata* (Lamarck), *Dorsanum fuscum* (Craven), *Natica marochiensis* Gmelin, etc.].[1]

*Melampus liberianus*
*Neritina glabrata*
" *adansoniana*
" *oweniana*
*Lanistes intortus*
" *adansoni*
*Syncera hessei*
*Potamides fuscatus*
*Pachymelania aurita*
" *fusca*
*Iphigenia curta*
" *rostrata*
*Cyrenoida senegalensis*
*Congeria ornata*

The most characteristic mollusks of the mangrove area are the melanians (*Pachymelania*) and certain Cerithiidæ (*Potamides*), which in some places occur in profusion. Some idea of their fabulous numbers may be gained from the photographs reproduced in Pl. LXXVII. Figure 1 represents a colony of live *Potamides fuscatus* in the interior of the island Bulabemba. This picture was taken in July, 1915, when the shallow lagoons in which these snails occur had been for several weeks above the level of high tide and thus gradually dried out. The snails then slowly migrate toward the lowest and more humid portions of the lagoon; during the hottest hours of the day, when they are exposed to the blazing rays of the sun, they turn their shells continually, evidently to better withstand the heat. At night they get a new supply of moisture through the hygroscopic action of the salt that covers the shell and absorbs the dew. The operculum is retracted far inside the aperture, which, however, is kept moist by a continuous discharge of liquid. Figure 2 of the same plate is a closer view of part of the colony shown in Figure 1. When conditions become still drier, as was observed in nearby spots at Bulabemba, *Potamides fuscatus* digs in the moist, salty mud as deep as one inch below the surface, so that hardly an outward trace of their presence is visible. Some of the very largest specimens were thus dug up by Mr. H. Lang from completely dried out lagoons.

*Pachymelania fusca* prefers the quiet mud flats of the mangrove swamps, at the margin of the more shallow creeks, which are regularly covered and uncovered by the tide, a habitat they share with the multi-

[1]The names of marine mollusks here cited are only provisional as the marine fauna of the mouth of the Congo has not yet been studied by us. Some of the species have been designated under a variety of names and this remark especially applies to the mangrove oyster and *Mytilus*.

colored mangrove crabs of the genus *Sesarma* and the peculiar, amphibious fish *Periophthalmus kœlreuteri.* An environment typical of *P. fusca* is shown on Pl. LXXV, representing the upper end of a creek near Kunga at high and at low tide. Pl. LXXVI, fig. 1, a detail study of one of the mud flats seen in Pl. LXXV, illustrates the manner in which the snails are partly buried in the slimy, algæ-covered ooze. In such surroundings the shells are thickly coated with dirt and an adherent layer of hydroxide of iron, similar to that which encrusts the *Potadoma* in the brooks of the Upper Congo and Ituri forests. This crust is also produced by iron-depositing bacteria, which in brackish water appear to belong to the same species as in fresh-water.[1]

*Pachymelania fusca* also occurs in a much smaller, evidently depauperate form, on the sea shore of Pt. Padrão, west of San Antonio, together with *Neritina glabrata, Lanistes intortus,* and *Pachymelania aurita,* all of these snails being here quite clean of dirt, although frequently covered with barnacles. The smaller size of *P. fusca* at Pt. Padrão is evidently due to the higher salinity of the environment. In this connection it may also be pointed out that *Neritina oweniana* in brackish water at Malela reaches only half the size of the species in the practically fresh-water at Zambi.[2]

All these mangrove mollusks have decidedly the habit of congregating in colonies. They may be found by the thousands in certain spots, while in nearby locations under seemingly similar conditions they are totally absent. Upon arriving at Banana, for instance, one at first looks in vain for living examples of *Pachymelania* and *Potamides.* Those one finds most commonly are dead specimens, evidently washed ashore or usually inhabited by hermit crabs, as shown in Pl. LXXXVI, fig. 2.

The distribution of mollusks in the estuary of the Congo as sketched above is evidently regulated by the variations of salinity. Unfortunately we were unable to find that analyses of water have been made at any point in the lower course of the river, so that we must content ourselves with the general statement that salinity increases upon nearing the ocean from the interior. The variations are probably best shown by the concurrent changes in the vegetation, and the zone covered by mangrove forest (*Rhizophora*) may be accepted as that of decidedly brackish water. The problem is, however, by no means the simple matter of

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[1]See North, L. and Bridenstine, I. J. 1922. 'Some notes on iron-depositing bacteria.' Economic Geol., XVII, pp. 392–394.

[2]Similar variation in size apparently due to changes in the salinity of the water were noted by M. Metcalf (1904, American Naturalist, XXXVIII, pp. 565–569, Pl. ) for the West Indian *Neritina virginea.*

certain fluviatile mollusks having adapted themselves to increasing salinity and other, marine species gradually invading less saline water. For it must be remembered that the amount of sea-water that enters the estuary is considerably larger at high tide, when it is also allowed to reach much farther upstream. The seasonal variations of salinity, due to the rise and fall of the Congo River, are more gradual, yet not without significance. The animals and plants of the brackish estuarine zone must therefore not merely belong to the so-called "euryhaline" type of Mœbius, which includes organisms that support fairly well a gradual change of salinity. Of much greater importance is the ability of adjusting their metabolism to frequent and often very rapid changes in the concentration of dissolved salts.[1] As Pelseneer has pointed out, the adaptation of marine animals to brackish conditions is most easily achieved in the juvenile or larval stage, which is usually mobile and numerous. The penetration of these early stages in water of decreasing salinity is aided by the influx of the high tide, which thus has a mechanical action upon the distribution of the fauna within the estuary.

## Fluviatile Mollusks of the Congo Basin

The following list contains only the forms of mollusks that are known with certainty to occur in the hydrographic basin of the Congo, in stagnant as well as in flowing water. The faunæ of Lakes Moero, Kivu, and Tanganyika, however, are not included, since they are so distinctive as to require separate treatment. The very few species that have not yet been found within the political boundaries of the Belgian Congo are marked with an asterisk. That their number is so small may be in large part due to insufficient collecting. We should not expect many additions from the basins of the Lobay, Sanga, Likuala, Alima, and various other tributaries that enter the right bank of the Congo and Ubangi in French Equatorial Africa, ecological conditions being extremely similar there to those of the Upper and Middle Congo. The Malagarazi and Chambezi Rivers, and the many smaller eastern affluents of Lakes Moero and Tanganyika, in Tanganyika Territory and Northern Rhode-

[1]The conditions under which marine animals adapt themselves to estuarine life, and fluviatile species to brackish water, were studied by several authors. See among others:

Cooke, A. H. 1892. 'On the origin of the genera of land and fresh-water Mollusca.' Conchologist, II, pp. 41–48.

Pelseneer, P. 1906. 'L'origine des animaux d'eau douce.' Bull. Ac. Belgique, Cl. Sci., (1905), pp. 699–740.

sia, should, however nourish quite a number of peculiar forms, and their investigation is especially recommended to future collectors.[1]

*Melampus liberianus*
*Lymnæa natalensis undussumæ*
*Planorbis adowensis*
" *bridouxianus*
" *sudanicus tanganikanus*
" *gibbonsi*
" *avakubiensis*
" *costulatus*
*Segmentina angusta*
" *kempi*
*Bulinus forskali*
" *lamellosus*
**Physopsis choziensis* (Chozi R.)
" *africana* var.
" " *globosa*
*Burnupia caffra*
" *alta*
" *kimiloloensis*
" *transvaalensis*
" *walkeri*
" *trapezoidea* (?)
*Neritina glabrata*
" *adansoniana*
" *oweniana*
**Pila chevalieri* (Krebedje)
" *microglypta*
" *congoensis*
" " *amplior*
" *leopoldvillensis*
*Lanistes subcarinatus* (? = *intortus*)
" *congicus*
" " *fraternus*
" *nsendweensis*
" " *katanganus*
" *intortus*
" *bicarinatus*
" *ovum* var. *major* (?)
" *adansoni*
" *procerus langi*
" " *magnus*
" *ellipticus*
*Lanistes ellipticus luapulensis*
" *pyramidalis*
" *graueri*
* " *bourguignati* (Malagarazi R.)
**Viviparus kalingwisiensis* (Kalungwesi R.)
" *leopoldvillensis*
" *unicolor*
*Bulimus kisalensis*
*Lobogenes michaelis*
" *spiralis*
*Syncera hessei*
*Pseudogibbula duponti*
*Potamides fuscatus*
*Melanoides anomala*
" " *bukamana*
" *kinshassaensis*
" *liebrechtsi*
" *langi*
" " *zambiensis*
" *nsendweensis*
" " *consobrina*
" " *soror*
" " *megalobasis*
" *wagenia*
" " *tshopoicola*
" *kisangani*
" " *congo*
" *bavayi*
" *crawshayi*
" *depravata*
" *mweruensis*
" *nyangweensis*
*Pachymelania aurita*
" *fusca*
*Potadoma alutacea*
" *ignobilis*
" *pokoensis*
" *liricincta*
" " *major*
" " *walikalensis*

[1]The following species and subspecies, the occurrnce of which in the Congo basin appears extremely doubtful, were omitted, our reasons for doing so being given in the taxonomic part of this work: *Lymnæa natalensis exserta, L. anceyana, Planorbis sudanicus* (typical form), *Physopsis africana* var. *ovoidea, P. a.* var. *stanleyana, Pila speciosa, P. ovata, P. wernei, Lanistes ovum* var. *elatior, L. procerus* (typical form), *Bulimus humerosus, Cleopatra ferruginea,*[1] *C. bulimoides, Egeria paradoxa, Cælatura ægyptiaca, Aspatharia rubens,* and *Mutela angustata.*

*Potadoma liricincta latior*
" " *semperlirata*
" " *dryas*
" *medjeorum*
" *ponthiervillensis*
" " mut. *spoliata*
" *superba*
" " mut. *inculta*
" *mungwana*
" *tornata*
**Cleopatra hargeri* (Kalungwesi R.)
* " *smithi* (Chozi R.)
" *langi*
" *cara*
" *dautzenbergi*
" *nsendweensis*
" " *katangana*
" *bequaerti*
" *broecki*
" " var. *zonata*
" *dupuisi*
" *hirta*
" *johnstoni*
" " var. *minor*
" *pirothi* var. *elata* (?)
" *schoutedeni*
*Corbicula radiata*
*Egeria congica*
" *tenuicula langi*
" *nux*
*Iphigenia curta*
" *rostrata*
" *congo*
" *lævigata*
" *lenzi*
*Sphærium stuhlmanni*
*Pisidium katangense*
*Eupera mediafricana*
" " *etheriarum*
" *bequaerti*
" *sturanyi*
*Cyrenoida senegalensis*
" *rosea brevidentata*
*"*Pharaonia*" *bourguignati* (Mokaka)
*"*Unio*" *choziensis* (Chozi R.)
*"*Zairia*" *disciformis* (Mokaka)
*Parreysia leopoldvillensis*
" " *mweruensis*
*Cælatura elegans*
" *aequatoria*
" *mesafricana*
" *stanleyvillensis*
" *briarti*
" *stagnorum*
" " *bomæ*
" *rotula*
" (?) *araneosa*
" *poirieri*
" *putzeysi*
" *sordida*
*Aspatharia protchei*
" *chapini*
" *sinuata*
" *flava*
" *semicorrugata*
*stuhlmanni*
" *w ssmanni*
" " *bangalorum*
" *corneola*
*Mutela rostrata*
" *garambæ*
" " *prætenuis*
" *langi*
" *mabilli*
" *iris*
" *chevalier*
" *joubini*
" *hirundo*
" *carrei*
*Etheria elliptica*
*Congeria ornata*

The foregoing enumeration may eventually serve as a basis of comparison with the malacological faunæ of other Ethiopian river systems. We are not, however, prepared to do so at present, since it would require a critical study of the many described African species and of all published records, a task entirely outside the scope of this work and for which, moreover, we have not the necessary material. Since we have discussed at some length the general uniformity of the mollusks of Ethiopian flowing waters and its possible causes, we may as well point out here that the fauna of the Congo basin exhibits somewhat more individuality than is usual on the continent. This is mainly due to the presence of a fair number of elegant Melaniidæ belonging to the genera *Potadoma, Melanoides*, and *Cleopatra*, as well as of Mutelidæ, especially the curious subgenus *Chelidonopsis*. *Potadoma* is restricted to J. P. Chapin's Guinean Forest Province of his West African Subregion (see p. 486), while *Chelidonopsis* is not known outside the basin of the Congo.[1]

## Nile River System[2]

The Nile is the longest river of Africa and the second longest of the earth, coming close behind the Mississippi-Missouri. Taking the Kagera as its headwaters, its length from source to sea reaches about 6,500 kilometers. Its drainage system is, however, much smaller than that of the Congo, covering approximately 2,900,000 square kilometers. The volume of water it carries is still further reduced because of its crossing some 3,200 kilometers of desert country, where it receives no additions, but instead loses much through evaporation. Its upper reach, above Khartoum, is known as the Bahr-el-Abiad or White Nile and south of 10° N. as the Bahr-el-Jebel or Albert Nile, which drains the Lake Plateau basin or the waters of Lakes Victoria (by way of the Victoria Nile), Edward (by way of the Semliki), and Albert. Its chief tributaries are the Sobat, the Bahr-el-Asrek or Blue Nile, and the Atbara on the right, draining western Abyssinia; and the various branches of the Bahr-el-Ghazal system on the left. The divide between the headwaters of the Bahr-el-Ghazal and those of the Uele-Bomu-Ubangi is generally low, forming a fairly level peneplain 800 m. to 900 m. above sea level, with a series of granitic residual hills. In this region many of the swamps where the streams take their source drain both to the Congo and to the Nile, at least

[1]One species of *Potadoma*, *P. liricincta* (E. A. Smith), was originally described from "Lake Albert," supposedly collected there by Emin Pasha; but it has not been found again in that lake, so that its occurrence there is extremely problematical. From the introductory remarks of the paper in which it was described, it is quite evident that the specimens were not labeled as to localities. It is more likely that the types of this melanian came from one of the forest streams west of Lake Albert, a region actively explored by Emin Pasha.

*Potadoma liricincta major* (J. Thiele) was later described from the region between Beni and Boga. Schubotz, who collected the specimens, travelled to the west of the Semliki and it is possible that he obtained the snail from one of the forest brooks flowing to the Semliki. It may, however, have come equally well from the headwaters of one of the tributaries of the Ituri. An examination of the map of this region published in the Report of the Land Mollusks (1919, Bull. American Mus. Nat. Hist., XL, p. 17) will show how close the Congo-Nile divide here runs to the valley of the Semliki.

We conclude that on the whole the evidence that the genus *Potadoma* occurs anywhere within the basin of the Nile is not yet convincing.

[2]See Lyons, H. G. 1906. 'The physiography of the River Nile and its basin.' (Cairo), viii+411 pp., 48 Pls.

toward the close of the rainy season. We have called attention before to the great zoögeographical significance of this feature.

The course of the Nile is quite different from that of the Congo. Except at times of flood, when it inundates the surrounding valley, the river is comparatively narrow, its width varying between 300 m. and 1,000 m. below Khartoum. It generally flows through open savanna country or desert, within well-defined, flat banks, deprived of woody vegetation, and it contains very few islands. The waters carry but little organic matter in suspension; in the lower reaches they are turbid, being loaded with muddy silt, especially when swollen by the rains of the Abyssinian highlands. The water of the White Nile and its tributaries is much clearer, since it descends from the clear lakes and is in addition filtered by the swamps of the Bahr-el-Ghazal. Near its confluence with the Bahr-el-Ghazal, the Albert Nile crosses a very extensive swamp, in the country of the Nuer, between 7° and 10° N. Here an area of some 30,000 square miles forms an alluvial plain, mostly inundated throughout the year and covered with luxuriant aquatic plant growth, chiefly papyrus rushes (*Cyperus Papyrus* Linnæus), ambatch trees (*Herminiera Elaphroxylon* Guillemin and Perrottet), and certain floating grasses (*Vossia procera* Wallich and Griffith, etc.). At the season of high water patches or even whole islands of this vegetation break loose and come down the current, forming the accumulations known as "sudd" (or "sadd"), which block up the channels in the swampy part of the river. The malacological fauna of the sudd region appears to be quite similar to that of the swampy country near Lake Kisale, which we have studied in detail above (p. 543). It is likewise characterized by the abundance of *Lanistes* and *Pila*.[1]

The Lake Plateau basin furnishes by far the greatest volume of water to the Nile and comprises within the boundaries of the Belgian Congo a narrow, but quite important strip of territory. In the northeastern borderland of our territory the Congo-Nile divide is constituted by a conspicuous ridge of highlands nowhere below 1,000 m. and frequently reaching 2,500 m. to 3,000 m. above sea level. It at first follows from north to south the western scarp of the Albertine Rift, within ten

[1]For recent accounts of the mollusks of the Bahr-el-Ghazal see:

Sturany, R. 1913. 'Liste der von Prof. Dr. F. Werner im Sommer 1904 im ägyptischen Sudan und bei Gondokoro gesammelten Mollusken.' Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., CXXII, Abt. 1, pp. 549–556.

Bœttger, C. R. and Haas, F. 1913. 'On a collection of land and freshwater shells from the Upper Nile region.' Proc. Malacol. Soc. London, X, pp. 355–361.

1915. 'Beiträge zur Molluskenfauna des Sudans.' Zool. Jahrb. Abt. Syst., XXXVIII, pp. 371–384, Pl. XXVI.

Longstaff, Jane. 1914. 'On a collection of non-marine Mollusca from the southern Sudan.' Journ. Linn. Soc. London, Zool., XXXII, pp. 233–268, Pls. XVII–XVIII.

to twenty miles from the shores of Lake Albert, the Semliki, and Lake Edward. In about 1° S. it crosses the floor itself of the Rift by way of the Mfumbiro volcanoes and continues southward along the eastern scarp, some 20 miles from Lake Kivu and the Ruzizi River. Near the northern end of Tanganyika it turns abruptly to the east on the divide between the basin of the Kagera and that of the Malagarazi Rivers.[1]

The only important flowing waters of the Nile basin within our territory are the Rutshuru, Semliki, and Kagera Rivers and very little is known as yet of their faunæ. The Kagera drains the major part of the mountainous country of Ruanda and, like its affluents, follows a tortuous and often torrential course across this elevated and rugged province. At times, however, the valleys broaden out and the stream forms small lakes, with swampy shores. The various reaches are also often connected by picturesque falls. One might expect the fluviatile mollusks of this region to be of some interest, but the few species recorded thus far have been so imperfectly studied that their affinities are quite obscure.[2]

The Semliki, or "Semeliki," as the natives call it (also known in certain districts as Issango or Itiri), a river some 260 kilometers in length, serves as effluent to Lake Edward which it connects with Lake Albert. It flows at first northward and later northeastward through a deep, trough-shaped valley some 20 to 30 kilometers wide, between the western scarp of the Albertine Rift and the Ruwenzori Range. The valley is but slightly hilly, covered with sparsely wooded savanna in the northern half and with dense, tropical rain forest between Beni and Boga. Before entering Lake Albert through a swampy promontory, the river traverses a low, alluvial plain, covered with grass, and evidently quite recently raised above the level of the lake. The Semliki is generally narrow, rarely over 500 m. wide, with many obstructions in the shape of rapids and sand banks. The photograph reproduced on Pl. LXIX, fig. 1, well illustrates the aspect of the river in the savanna country south of Beni. It is generally so shallow that it can be forded in many places, at least at low water. The malacological fauna of the river itself is as yet totally unknown and it would be of great interest to investigate in how far it differs from that of the lakes it connects and of the Nile proper. The following are the only species reported from the territory drained by the Semliki: *Lymnæa natalensis undussumæ*, *Planorbis adowensis*, *Bulinus*

[1]The Congo-Nile divide is marked by a heavy dotted line on the map of the Lake Region published in the Report of Land Mollusks (1919, Bull. American Mus. Nat. Hist., XL, p. 17).

[2]These Ruanda records are all contained in Thiele, J. 1911. 'Mollusken der Deutschen Zentral-Afrika Expedition.' Wiss. Ergebn. D. Z. Afr. Exp. 1907–08, III, pp. 175–214, Pls. I–III.

*forskali*, *Physopsis africana globosa*, and *Potadoma liricincta major*.[1] All of these also occur in the Congo basin.

Moreover, the malacological fauna of the Nile basin as a whole offers nothing very distinctive. Throughout its course the river retains the usual Ethiopian types, which thus reach the shores of the Mediterranean. As first pointed out by Jickeli,[2] the fluviatile mollusk fauna of Lower Egypt is distinctly Ethiopian, while the terrestrial forms of the surrounding country are all of Palæarctic affinities. The very few Palæarctic fresh-water types of Lower Egypt, such as the true Physidæ, *Lymnæa truncatula*, and perhaps some of the Unionidæ, may be of quite recent introduction, possibly even brought in by man. At any rate they have not yet succeeded in entering the Ethiopian Region by way of the Nile

As compared with that of the Congo basin, the Nilotic fauna is chiefly characterized by the extreme poverty in Melaniidæ, this family being only represented by the very widely distributed *Melanoides tuberculata* and a few *Cleopatræ;* the one reported species of *Potadoma*, if at all present, having evidently strayed from the Congo drainage. The subgenus *Leroya* of *Lanistes* is also absent. On the other hand, the Nile basin shows a far greater abundance of *Bulinus*, *Viviparus*, *Corbicula*, and Unionidæ. It possesses but one genus, *Planorbula*, thus far unknown from the Congo system, although one species has been described from Lake Tanganyika.

## Mollusk Fauna of the Central African Lakes

The fauna of the Ethiopian Region exhibits on the whole less of the exuberance found in other tropical parts of the world. It possesses, however, two outstanding features unparalleled elsewhere. The first is its extraordinary wealth in Mammalia, in which respect it appears to have retained conditions that were more wide-spread during Tertiary times. The second is the existence close to the equator of several large freshwater lakes, some of considerable depth and nearly all with a profusion of aquatic animals, frequently of most unusual types. During the last sixty years the fauna of these lakes has been rather actively investigated. Its peculiar character is well indicated by the following figures taken from W. A. Cunnington's recent review of the subject: "Tanganyika contains 402 species [of all groups of animals] of which no less than 293 are endemic,

[1]As noted above, the occurrence of this *Potadoma* in the Semliki basin is somewhat doubtful.

[2]Jickeli, C. F. 1875. 'Rückblick auf die Land- and Süsswasser-Mollusken Nord-Ost-Afrika's, nebst einigen Bemerkungen über die Molluskenfauna Afrika's.' Jahrb. Deutsch. Malakoz. Ges., II, pp. 334–353.

Nyasa with a total of 361 and 86 endemics coming second. Victoria Nyanza has a somewhat smaller total, viz. 289, but a larger number of endemic forms (110). The three smaller lakes show a great falling off in numbers, Albert Nyanza mustering only 67 species of which 9 are endemic and Edward Nyanza 54 with 11 endemic species. Kivu, finally, only contains 23 types in all, 4 of which are peculiar to the lake. Thus, as regards its fauna, Tanganyika is distinguished from the other lakes not only by containing a larger number of forms, but especially by displaying a remarkable proportion of endemic species."[1]

The only African lakes that will be considered in the present discussion are Lakes Albert and Edward, belonging to the drainage of the Nile; and Lakes Kivu, Tanganyika, Moero, and Bangweolo, which flow into the Congo. These six important inland seas form a chain from north to south, along the eastern border of the Belgian Congo, between 28° and 32° E. Lakes Albert, Edward, Kivu, and Tanganyika occupy the deepest depressions of the Albertine Rift, a great, trough-like valley whose structure and biogeographic importance we have discussed before (see p. 505). Lake Moero appears to be situated in a similar, but much smaller trough, which, however, is entirely disconnected from the Albertine Rift in the north. Lake Bangweolo is of a different nature, filling merely a shallow depression near the Congo-Zambezi watershed.

The numerical strength of the malacological faunæ of these several lakes is given below in tabular form.[2]

| | Number of Species, Subspecies, and Varieties | | Number of Genera | |
|---|---|---|---|---|
| | Total | Endemic | Total | Endemic |
| Lake Albert | 17 | 8 | 11 | .. |
| Lake Edward | 19 | 10 | 9 | .. |
| Lake Victoria | 69 | 38 | 19 | 1 |
| Lake Kivu | 2 | .. | 2 | .. |
| Lake Tanganyika | 155 | 143 | 44 | 25 |
| Lake Moero | 20 | 10 | 14 | 1 |
| Lake Nyasa | 70 | 57 | 13 | .. |

[1]Cunnington, W. A. 1920. 'The fauna of the African lakes: a study in comparative limnology with special reference to Tanganyika.' Proc. Zool. Soc. London, pp. 507–622. This paper contains an extensive bibliography. Cunnington's figures are generally too low, as we shall have occasion to point out for the mollusks.

[2]Figures for Lakes Victoria and Nyasa, compiled afresh for the purpose, are included for comparison. Our figures are quite different from those given by Cunnington which are generally too low, the author not having included many of Bourguignat's species for Lakes Tanganyika and Nyasa. However, the species of this author were often based upon variations regarded as merely individual by other naturalists. For Lake Victoria the endemic genus *Pseudocorbicula* was overlooked by Cunnington. It should also be noted that our figures relate to the lakes themselves and do not include species that have only been found in their tributaries.

## Lake Albert

Lake Albert (also known as Muita Nzige or Itaka) lies at an altitude of 704 m., approximately between 1° N. and 2° N., in a deep trench forming the northern extremity of the Albertine Rift. It is fairly rectangular in shape, about 160 kilometers long in a southwest to northeast direction and 30 to 40 kilometers wide, covering a superficy of about 5,335 square kilometers. Both the western and eastern shores are extremely steep; especially on the west side they rise rapidly along the precipitous slopes of the Lendu Plateau to heights of 2,000 m. and more above sea level. No definite data are at present available as to the physical properties of the lake, but it is apparently quite deep. The water is only moderately brackish, though scarcely fit to drink. At several points along the western and eastern shores there are hot springs and oil seepages, while native fishermen have reported that small explosions, bringing mineral oil to the surface, occasionally occur some distance off shore. In the southwest corner, the lake is bordered by an extensive, low plain, where the Semliki brings in the waters of Lake Edward and of the western slopes of Ruwenzori through a delta partly covered with swamps of papyrus. The northern end extends into two narrow bays one of which receives the Victoria Nile, carrying from the east the waters of Lake Victoria; while from the western bay the lake flows out into the Albert Nile. The entrance to the outlet is obstructed by many sand banks and accumulations of floating vegetation. In the lake itself there are no islands worth mentioning.

It is evident that our knowledge of the fauna of Lake Albert is still extremely imperfect, since no extensive or organized collecting has ever been carried on. Of vertebrates only seventeen species of fishes and one tortoise have been reported. None of these are endemic and the fishes belong essentially to the Nile system. The Protozoa are represented by four, and the lower invertebrates by twenty species, including 2 Polyzoa, 12 crustaceans (2 prawns, 7 copepodes, 1 Branchiura, 1 Ostracoda, and 1 Cladocera), 2 Oligochæta, and 4 Rotifera; only three of the crustaceans are endemic.

The following is a list of the seventeen mollusks (9 Gastropoda and 8 Pelecypoda) known with certainty to occur in Lake Albert, the endemic forms being marked with an asterisk[1]:

[1]The first of these mollusks were collected by S. W. Baker when he discovered the lake on March 14, 1864. His material was described by Adams, H. 1866. 'List of the shells collected by Samuel White Baker, Esq., during his recent explorations in Central Africa.' Proc. Zool. Soc. London, pp. 375–376. No localities were mentioned in that paper, but E. A. Smith later (1888, *op. cit.*, p. 52) stated that S. W. Baker informed him "that all the shells mentioned by Mr. Adams and which he has presented to the British Museum, came from the Albert Nyanza." Additional specimens were obtained by Emin Pasha, F. Stuhlmann, J. E. S. Moore, and Schubotz.

*Planorbis gibbonsi*
* " *stanleyi* (? = *adowensis*)
" *sudanicus tanganikanus*
**Pila stuhlmanni*
*Viviparus rubicundus*
**Bulimus walleri*
" *alberti*
*Melanoides tuberculata*
**Cleopatra pirothi*
*Sphærium nyanzæ*
*Corbicula radiata*
" *pusilla*
**Parreysia bakeri*
* " *acuminata*
*Cælatura ægyptiaca*
**Mutela emini*
* " *alluaudi*

A number of other species have been reported at various times from the lake, but we believe that most of them were misidentified: *Planorbis adowensis*, *P. apertus*, *Pila wernei*, *Sphærium stuhlmanni*, "*Unio*" *cailliaudi*, "*Unio*" *teretiusculus*, and *Mutela nilotica*. *Potadoma liricincta* was originally described as from Lake Albert, but most probably the type specimens were obtained in some of the streams flowing to the Ituri.

Although about half of the species of the above list are not known from outside Lake Albert, the fauna shows nothing quite striking, being frankly Nilotic in its general make-up. Even the peculiar *Mutela emini* is undoubtedly a close relative of the more widely distributed *M. nilotica*. It should, however, be remembered that what we know at present of the fauna is based entirely upon shells picked up at the shore. The deep waters of the lake are totally unexplored.

## Lake Edward

Lake Edward (Ruite Ngize or Ngezi, formerly known as Lake Albert Edward) is situated south of the equator, at an altitude of 940 m., in one of the widest portions of the Albertine Rift. It stretches from north to south over some 80 kilometers, while its width, from east to west, reaches 50 kilometers in the northern half, but is considerably less in the south. Its total area has been calculated at 2,150 square kilometers. The western side rises rapidly to heights of 2,500 m. and more and the shore is quite steep, often forming cliffs 300 m. to 900 m. above the level of the water; there are, however, many intervening beaches of pebbles and coarse sand, usually fringed with thickets of reeds. Elsewhere the shores are generally low, more or less swampy, and frequently preceded by a belt of rushes (*Scirpus*) or cattail (*Typha*). This is especially true of the southeastern corner, where the water is shallow and choked with submerged aquatic plants and also presents a number of low, almost floating islets of mud and decaying vegetation. The lake is generally shallow, although its greatest depth has not yet been ascertained. It is only 5 m. deep at the distance of a kilometer and a half from the northern shore. It contains no islands of any importance.

In the south, east, and north, many small streams flow into the lake, the area drained being quite extensive, including the eastern slopes of Ruwenzori. Several of the Ruwenzori tributaries first empty in a depression to the northeast occupied by Lake George (Ruisamba or Dweru), which covers about 500 square kilometers and connects with Lake Edward by means of the broad Kazinga (or Kafuru) channel. Among the southern tributaries the Rutshuru ranks first, since it drains the northern slopes of the Mfumbiro volcanoes. The lake is thus well fed and there is a fairly steady outflow from its northwestern corner through the Semliki northward. The waters are but slightly brackish and still quite fit to drink.

Lake Edward appears to possess unusually favorable conditions for the development of life, at least to judge from the abundance of aquatic vegetation and the extremely numerous shore-birds, especially in the southern portion. The junior author, who made a brief visit to the lake in August, 1914, feels convinced that the animals thus far recorded represent but a fraction of the existing fauna, since a systematic exploration has never been attempted.[1] The known vertebrates include a water-snake and eighteen fishes; of the latter six species and one genus are endemic, the remainder being mostly Nilotic, although six species have only been found elsewhere in Lake Victoria. The fourteen lower invertebrates include 2 Polyzoa, 11 crustaceans (1 prawn, 1 crab, 3 copepodes, 1 Branchiura, and 5 Cladocera), and 1 hydrachnid; one of the Cladocera and the hydrachnid are endemic. All these animals belong to the usual fresh-water types.

The Mollusca definitely recorded from the lake are listed below, the endemic species being marked with an asterisk. They total 19 forms (14 Gastropoda and 5 Pelecypoda).[2]

| | |
|---|---|
| *Lymnæa natalensis undussumæ* | **Burnupia edwardiana* |
| *Planorbis bridouxianus* | **Pila ovata* var. *emini* |
| " *choanomphalus* | **Viviparus unicolor* var. *conoideus* |
| * " " var. *basisulcatus* | *Bulimus alberti* |
| * " *smithi* | *Melanoides tuberculata* |
| " *sudanicus tanganikanus* | **Corbicula radiata edwardi* |
| " *gibbonsi* | **Parreysia ngesiana* |
| " *fouladougouensis* | * " *regis* |
| * " *apertus* | * " *stuhlmanni* |

[1]Speaking in general of Lakes Albert and Edward, J. E. S. Moore (1903, 'The Tanganyika problem,' pp. 129–130) writes: "The fauna of both the Nyanzas is abundant—perhaps quite as abundant as that of Nyassa—but in both lakes it is composed of only a very few forms of fishes, and half a dozen species of Mollusca at the most. In many portions of both the Nyanzas the beach is composed of actually nothing else but the shells of *Melania tuberculata*." He also claims that the fauna of Lake Edward is practically identical with that of Lake Albert. These hasty statements are not quite borne out by the facts.

[2]The first mollusks of Lake Edward were obtained by Emin Pasha and F. Stuhlmann, travelling together in 1891–1892, and were recorded by E.v. Martens in 1897 ('Deutsch Ost Afr., IV, Beschalte Weichth.'). Subsequent additions were mostly made by Gromier, J. E. S. Moore, Schubotz and the junior author.

The other mollusks reported from Lake Edward appear to us of very doubtful occurrence there: *Pila stuhlmanni*, *Bulimus humerosus*, *Melanoides tuberculata* var. *dautzenbergi*, *Sphærium stuhlmanni*, *Aspatharia innesi*, and *Mutela nilotica*.

Practically all the species at present known from the lake were obtained in the shallow, southern part, where most of them are found in abundance, notably near the mouth of the Rutshuru River. The fauna of the deeper waters still remains to be investigated. The mollusks are generally of small size. Although ten out of the nineteen forms are endemic, the malacological fauna is not very distinctive, since even the peculiar species are rather closely related to common Nilotic or even more generally distributed Ethiopian forms. Only some of the *Planorbis* appear to be of a distinct type (*P. apertus*, *P. choanomphalus*, and especially *P. smithi*), the shell being often more heavy than usual. It may be of some interest that *P. choanomphalus* has been found elsewhere only in Lakes Victoria and Kivu. To the truly aquatic fauna of the lake should perhaps be added *Succinea bequaerti*, which lives at the southern shore in the thickets of rushes and reeds, fixed to these plants a short distance above the surface of the water.

Topographic and soil conditions of the surrounding territory clearly point to a former much larger extension of Lake Edward. Not so long ago, probably within historic times, it covered the low, alluvial, and more or less swampy plain to the northeast now partly occupied by Lake George and that near the mouth of the Rutshuru. Stuhlmann first reported the existence near Vichumbi, in the plain at the southern shore, of blackish alluviums containing an abundant shell fauna, in about 8 m. above the present level of the water.[1] E. v. Martens recognized that these subfossil shells belonged to species still living nowadays in the lake. The most abundant among them are *Corbicula radiata*, *Melanoides tuberculata*, *Planorbis choanomphalus*, and *Bulimus alberti*, but many others are also present. Gromier also collected them from deposits near Vichumbi, 5 m. above the level of the lake,[2] and the junior author found them in hardened marls more to the east, near Kabare.

[1]In 1894 ('Mit Emin Pasha ins Herz von Afrika,' I, p. 270) Stuhlmann describes these deposits as follows: "Die Ebene besteht, so weit wir sie durchmessen haben, aus schwärzlichen Ablagerungen, in denen sich zahlreiche Schneckenschalen finden. Noch in ziemlicher Entfernung vom See fanden wir westlich von Vitshumbi etwa 1 m. unter der Oberfläche eine 4-6 cm. starke Schicht, die mit Schalen von Süsswassermollusken (*Planorbis*, *Unio*, *Melania* und anderen) durchsetzt war. Nach unsere Schätzung lag dieser Schicht etwa 8 m. über dem heutigen Wasserspiegel; über ihr hatte sich ein graubrauner Thon abgelagert."

[2]Germain (1916, Bull. Mus. Hist. Nat. Paris, Pl. v) has published a photograph of a limestone with embedded fresh-water shells, obtained by Gromier near Vichumbi.

## Lake Kivu

Lake Kivu lies in the Albertine Rift about 110 kilometers north of Tanganyika, at an altitude of 1,460 m. In a north to south direction it is some 100 kilometers long and, from east to west, 50 kilometers wide in the middle, covering an area of approximately 2,650 square kilometers. It contains several islands, most of them of small size. The largest, that of Kwidjwi, is over 40 kilometers long, situated near the southern end, and traversed by a hilly, rocky ridge. The shore is steep everywhere, often rising in cliffs, with many fjord-like indentations. The deep, blue waters, which have not been properly sounded, contrast with the white, crust-like deposit of mineral matter on the rocky shore.[1] The water is remarkable for the excessive quantity of saline matter it contains, especially a very unusual amount of salts of sodium and magnesium, there being more than twice the amount of salts of magnesium present in Tanganyika. On the other hand, the water appears to be almost entirely free of calcium salts.[2] In addition, it contains a slight proportion of sulphuretted hydrogen (one part in 100,000) and a certain quantity of boric acid, probably present as magnesium borate. The presence of free sulphuretted hydrogen in solution shows that most of the oxygen has been eliminated to form various sulphates. There are a number of hot springs in the lake, while occasionally bubbles of oil come up suddenly, forming black patches on the surface. The lake, being quite deep, is often agitated by violent tempests. It should also be mentioned that, when the Namlagira volcano is in activity, the water of the northern part often reaches such a high temperature that many of the animals die; this being due either to submarine eruptions or to lava flowing into the lake. The watershed of Kivu is very small, since no sizable rivers flow into it. At the extreme southern end the lake flows out to Tanganyika, by way of the Ruzizi, a narrow, rocky mountain stream.[3]

The peculiar physical and chemical features of Lake Kivu account sufficiently for the extreme poverty of its plant and animal life, which are especially handicapped by the unusual high salinity. Only thirteen

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[1]According to J. E. S. Moore (1903, 'The Tanganyika problem,' p. 84), analysis of samples of these shore incrustations showed them to contain 26.65 per cent of CaO and 12.66 per cent of MgO. "This substance," he says, "gathers about the objects on the shore line, incrusting the pebbles and the reed-stems in such a manner, that extraordinary masses of incrustation are formed, which are as hard as Roman cement. The incrustation also encloses the shells of the few mollusks which exist in Kivu." The shells we have seen from Kivu were, however, quite free of incrustation.

[2]See Hundeshagen, F. 1909. 'Analyse einiger ostafrikanischer Wässer.' Zeitschr. Öffentl. Chemie, p. 201.

[3]Further details concerning the physiography of Lake Kivu are to be found in Bockelmann, A. V. 1901–02. 'Versuch einer Monographie des Kivu-Sees und seiner Umgebung als Begleittext zur Dr. Kandt's Karte.' Beitr. Kolonialpolit. u. Kolonialwirtsch., III, p. 357, map.

Kandt, R. 1905. 'Caput Nili. Eine empfindsame Reise zu den Quellen des Nils.' (Berlin), 2d Ed., xvi+538 pp., 12 Pls., 1 Map.

species of fishes are known to occur, but three of them are endemic and three others are found in Kivu and Tanganyika only (in one case also in the Ruzizi). The lower invertebrates include but four crustaceans (2 crabs and 2 copepodes) and two oligochetes (one endemic). Schubotz was unable to discover Polyzoa, although he paid especial attention to that group. Medusæ or jelly-fish have also been vaguely reported, but Schubotz was unable to confirm their presence. Otherwise the fauna of Kivu is typically fluviatile and it is noteworthy that, although in direct communication with Tanganyika, it possesses none of the thalassoid forms of that lake.

The malacological fauna of Kivu is exceptionally poor. J. E. S. Moore sums up his own experience as follows: "There was a small variety of *Planorbis*, a small *Bithynia* and *Melania tuberculata* among the gastropodean molluscs, one or two species of fresh-water bivalves, closely allied to the *Unios* found generally in the African lakes, and apparently nothing else; the most striking feature about the fauna of Lake Kivu being the apparent absence of *Viviparas*."[1] Schubotz only obtained in the lake *Plan rbis choanomphalus* and *Melanoides tuberculata* and these are also the two species recently collected by Mr. René Van Saceghem at Kisenje, near the northern end. It would be of great interest to know in how far Moore's statements with regard to the remainder of the mollusk fauna are correct. Cunnington says that no Pelecypoda appear to occur.[2] Moreover, it is quite possible that the fauna is much richer in the southern part of the lake, near Kwidjwi and the outlet of the Ruzizi, where the waters are better sheltered from the deleterious effects of the Mfumbiro volcanoes.

Kirchstein[3] has noted the existence along the shores of Kivu of calcareous tufa forming beaches raised as much as 8 m. above the present level of the water. These deposits contain fossil mollusks which, he says, belong to the same species now living in Lake Edward, but apparently extinct in Kivu.[4] This observation, if confirmed, will be of considerable zoögeographic significance, since it would point to rather recent and far-reaching changes in the topographic, hydrographic and ecological conditions of this region. It is therefore unfortunate that no taxonomic study of these fossils and critical comparison with the Lake Edward mollusks have been undertaken.

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[1]1903, 'The Tanganyika problem,' p. 129.
[2]1920, Proc. Zool. Soc. London, p. 605.
[3]In Adolf Friedrich zu Mecklenburg, 1909, 'Ins Innerste Afrika,' p. 159.
[4]These shore formations probably induced Moore's remark quoted above, that the few mollusks now living in Kivu become incrusted with mineral matter.

## Lake Tanganyika

Lake Tanganyika lies between 3° and 9° S., in about 29° to 31° E. It is the longest fresh-water lake in the world, extending from southeast to northwest over some 700 kilometers, while its width varies between 40 and 80 kilometers. It covers an area of approximately 32,900 square kilometers and occupies, at an altitude of 771 m., the southern end and deepest portion of the Albertine Rift. Almost everywhere the coast-line rises abruptly to a considerable height, frequently forming sheer cliffs. In many places the shore is rocky, but elsewhere there are beaches of pebbles or coarse sand on which dead shells are found in profusion (Pl. LXX). Some of the rivers flowing into the lake have also accumulated much silt at their mouth and the marshy shore is then fringed with dense thickets of reed (*Phragmites vulgaris*). Most of the tributaries, however, are small; the Malagarazi, on the eastern shore, which drains a large part of Tanganyika Territory, is by far the most important. In the extreme north the Ruzizi, coming from Lake Kivu, enters by several branches which form the delta of Ugende, a low, alluvial, swampy plain evidently once a portion of the floor of Tanganyika. About the middle of the western shore, in nearly 6° S., there is a break through the mountainous scarp, giving passage to the Lukuga, the outlet of Tanganyika to the Congo. There are very few islands, always of small size. In the northwestern corner the mountainous peninsula of Kibanga, 60 kilometers long and 15 kilometers wide, separates the broad and deep Burton Gulf from the main body of water.

The history of the Lukuga River is extremely interesting and not without importance from a malacological point of view, as it would appear to have had many vicissitudes. Before the final subsidence which produced the deep rift of which Tanganyika now fills the bottom, the primitive valley was subjected to active erosion by a stream which either drained a now vanished surface of land or was fed by a precursor of the present lake. This stream gradually scooped out its bed through the more recent continental formations and down to the older Palæozoic rocks. The formation of Lake Tanganyika in its present shape cut off the main source of supply of the Lukuga and during the period the lake filled up to its present level, alluvial sediments gradually choked the bed of the stream. Since the area drained by Tanganyika is not very great and rainfall relatively low, the amount of water which found its way into the lake may have been at certain periods nearly balanced by evaporation, so that there was little change in the surface level and no occasion for an outlet. If the waters did not flow out at all for some time, as is quite probable, they became more saline than at present and such past conditions of salinity may have influenced the nature and evolution of the fauna. At some comparatively very recent epoch, perhaps during the Pleistocene, the formation of the Mfumbiro Volcanoes diverted the waters of Lake Kivu from the basin of the Nile, to which they formerly flowed, southward into Tanganyika. This additional supply slowly raised the level, so that the Lukuga was eventually again opened up as an outlet. The lake at first sank rapidly and its level later became subject to fluctuations with the time of year and the amount of rainfall. There are observations on record showing a certain periodicity in the rise and fall of the level even since the relatively recent arrival of Europeans. At the time of Cameron's visit in 1874 and of Stanley's in 1876, the waters were beginning to filter through the outlet of the Lukuga at the end of the rainy season and for a number of years, about that time, the outflow may have been intermittent. About 1879 a definite channel was opened, the outflowing water sufficing to sweep away the alluvial silt and obstructing water plants. The consequent lowering of level in Tanganyika during the ensuing years appears to have amounted to about 11 m., and the lowest level was reached, it seems, about 1894, when a general rise set in, reaching its maximum in 1917. Since, a renewed fall has been recorded. It has also been contended that Tanganyika undergoes a gradual desiccation through evaporation or reduction of inflow, but the regulating function of the Lukuga appears to be quiet sufficient to explain the observed fluctuations of level.

In connection with the fluctuations of level of Tanganyika it is worthy of mention that at various places there are shore deposits of shells apparently belonging to species still living in the lake. Some "were found embedded in a coarse, sandy matrix upon the shore at Sumbua, about halfway up the east coast of the lake. One reef was so weathered that the shells (*Neothauma*) stood out very conspicuously, just in the breakers. Three similar reefs occur at intervals inland, on the summits of the former sandy beaches. These shells may be referred to a late Post-Pliocene age. Other specimens occurred in a cliff or ridge, about six feet high, in the northwest part of the Rukwa Valley, where the lake formerly was, but is now dried up. So far as one can judge, none of the shells which are more or less perfect, or of those of which there are only fragments, belong to other than recent species, showing that these ridges are of quite modern origin. Among those from Sumbua, besides the *Neothauma*, are remains of *Rumella*, a thalassoid genus, and of *Unio*; and from the Rukwa Valley are fragments of *Lanistes*, *Vivipara*, *Melania*, *Corbicula*, aud *Unio*, all ordinary fresh-water types. The amount of material at hand, however, is so small that one cannot say to what extent the thalassoid shells may be represented in the same locality."[1]

As Tanganyika extends from north to south over nearly six degrees of latitude, one might suppose that conditions of climate and salinity show enough differences at various points to produce appreciable changes in the fauna. That such is the case has been claimed by J. E. S. Moore: "In Tanganyika," he says, "there are at least three very well marked varieties of the ally of the genus *Vivipara*, *Neothauma*. One of these with the type of shell represented on page 261 (*a*) occurs exclusively at the south end of the lake, swarming in the broad and more or less sheltered reaches into which the southern end of Tanganyika expands. In the narrow, surf-swept, and turbulent portion of the lake, which stretches between the north of Cameron Bay and Tembwi *Neothauma* is only found in the little bays and sheltered places occurring along both shores, and here the character of the form changes, the double-keeled shell of the former variety being replaced by the elongated type shown on page 261 (*b*). Northward the lake terminates again in more or less sheltered expanses, like the Gulf of Ubuari, the deep bays near Ujiji, and the extreme northern extremity of Tanganyika. In these the form of the genus again changes, the two more southern varieties being replaced by the curious rounded form represented on page 261(*c*)."[2] Moore also states that *Tiphobia* and *Paramelania* show similar geographical varieties. A closer examination of the available records gives no definite support to this view. Like most fresh-water mollusks, the shells of Tanganyika appear to be subject to considerable variation and this is true of the thalassoid as well as for the more usual fluviatile types. But it is by no means apparent that any of the forms thus produced within the same species are restricted to certain areas of the lake. In the case of *Neothauma*, E. A. Smith has called attention to the occurrence together, at the southern end of the lake, of both the keeled and unkeeled varieties, and this is also brought out by the extensive collections made by Stappers and by Charles Hedley's collections from Albertville.

Tanganyika is, after Lake Baikal, the deepest fresh-water lake of the earth. About midway its length, a transverse crest, at a depth of 136 m. to 600 m., divides it into a northern and a southern basin. The northern

[1]E. A. Smith, 1906, Proc. Zool. Soc. London, I, p. 185.
J. E. S. Moore (1903, 'The Tanganyika problem,' p. 8) also mentions having met at several points along the shore, between Ujiji and Usumbura, modern lake-beds which are "now 100 feet above the water-line, and contain the same peculiar halolimnic shells which are now found inhabiting the lake."
[2]1903, 'The Tanganyika Problem,' pp. 149–150.
[3]1906, Proc. Zool. Soc. London, I, pp. 180 and 184.

half is probably over 1,100 m. deep over much of its area and soundings here have reached to 1,277 m. below the surface. The southern basin shows even greater depths, in one place as much as 1,435 m. The waters are of a dark green color and slightly brackish, though drinkable. They contain a relatively small amount of calcium salts, but are unusually rich in salts of magnesium.[1] The diurnal temperature of the surface water oscillates between 25° and 29° C.; it is slightly lower beneath the surface and remains fairly constant at about 23° C. between 400 m. and the bottom. The lake is subject to violent tempests and is usually quieter during the night than the day. These heavy movements of the surface water not only influence mechanically the distribution and structure of plants and animals, but they also contribute actively in aërating the water so that they are partly responsible for the abundance of life at greater depths.[2] L. Stappers found the transparency, as measured with a white disk, to vary from 2 m. to 8 m.

Tanganyika thus possesses many of the physical and perhaps also some of the mechanical features of the ocean. If such marine-like conditions lasted sufficiently long in past geological periods, while the lake remained isolated from other fresh-water bodies, they may go far to explain its remarkable forms of life. The flora, as far as higher aquatic plants is concerned, shows nothing distinctive; but the Algæ have proved to be a strange and interesting collection, a considerable number being peculiar to the lake, while several show undoubted marine affinities. The fauna, however, is in every way unique. No other assemblage of animals has roused so much discussion among biologists and it will be necessary to consider it somewhat in detail before attempting to draw any inferences from it.

Considered as a whole, the animals of Tanganyika fall into two groups, which are especially well marked among the mollusks. Some forms do not differ conspicuously in general appearance from the usual fresh-water types and belong to genera or even species that occur in other African lakes or rivers. Others, however,—and they are the largest number, as well in species as in individuals—are totally unlike the members of the neighboring fluviatile faunæ and differ from all

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[1]These are evidently derived from Lake Kivu, where they are present in large quantities.

[2]Interesting physical data concerning Lake Tanganyika are contained in a series of papers by L. Stappers:

1913. 'Note sur les variations saisonnières de l'embouchure de la Lobozi, affluent de la Tanganika.' Revue Congolaise, IV, pp. 100–110, Pls. vi–x. (Pl. x illustrates the action of the surf on the shore).

1914. 'Exploration scientifique du Dr. L. Stappers aux lacs Moëro et Tanganika. I. Recherches bathymétriques sur les lacs Moëro et Tanganika.' Ann. Biol. Lacustre, VII, pp. 83–114, Pls. ii–iv, map.

1913. 'Mission Stappers, 1911–1913. Répertoire général des échantillons d'histoire naturelle recueillis.' (Brussels), xii + [67] pp.

fresh-water animals living at present. Many of these belong to endemic genera and in a few cases to peculiar families or subfamilies. The endemic mollusks are especially striking, often showing all the outward appearances of oceanic types and consequently Bourguignat proposed calling them "thalassoid" or marine-like,[1] an appropriate term which, moreover, does not commit us to any view as to the possible origin of these animals.

There are no endemic forms among the few mammals, crocodiles, turtles, and amphibians known from the lake, but of the five water-snakes recorded two are peculiar; one of these belongs to an endemic genus, while the other possesses a relative in Nyasaland. The fishes are better represented than any other group, no less than 146 species, belonging to 55 genera being known at present, and of these 121 or 83%, belonging to 26 genera, are endemic. These fishes pertain to eleven families which, however, are all typical fresh-water groups or at least contain elsewhere fresh-water forms. The Cichlidæ are extremely well represented by 89 species, 84 of which are endemic. The Polyzoa, though only five in number, are of especial interest: at least two of them are endemic, while another has only been found in India. Three belong to the Phylactolæmata, a group generally found in fresh-water; the two others are Gymnolæmata, the members of which are, with few exceptions, marine and it is of some significance that both belong to genera (*Victorella* and *Arachnoidia*) that are represented by living, true marine species in the East Indies. Among the Crustacea, the Macrura are represented by twelve species of prawns (of four genera), all of which are endemic, although they belong undoubtedly to fresh-water groups; the Brachyura contain five species of crabs (of two genera), four of which are endemic, but in this case too they are allied to fresh-water types. The groups of smaller Crustacea (Eucopepoda, Branchiura, and Ostracoda) are represented by many species (62, of which 49 are endemic), but none of them show any affinity to marine forms. The six species of Hydrachnida (three endemic), three species of Oligochæta (two endemic), five or six species of Hirudinea (leeches), twenty-nine species of Rotifera (one endemic), one endemic species of Turbellaria, six species of Porifera (four endemic), and seven species of Protozoa (one endemic) are all essentially fresh-water types.

[1]J. R. Bourguignat. 1885. 'Notice prodromique sur les mollusques terrestres et fluviatiles recueillis par M. Victor Giraud dans la région méridionale du lac Tanganika.' (Paris), p. 9.
We shall use the term "thalassoid" in preference to that of "halolimnic," which was proposed later by J. E. S. Moore for the same mollusks. The latter designation implies a direct marine origin of these mollusks, independent from that of the usual fresh-water fauna, a theory which will be discussed in the sequel.

The occurrence of a true medusa or jelly-fish (*Limnocnida tanganicæ* R. T. Günther) in Lake Tanganyika, discovered by Böhm in 1883, for the first time focussed the interest of the scientific world upon the lake. The number of fresh-water medusæ then known was very small, so that considerable significance was attached to this find. In recent years, however, allied forms of *Limnocnida* have been found in Lake Victoria, in various African rivers, such as the Nile, the Zambezi and the Limpopo, and in certain streams of India; while other types of fresh-water medusæ are known from Lake Qurum in Egypt, the Caspian Sea, the Yang-tse-Kiang, and some North American rivers.[1]

Notwithstanding the considerable amount of work done on the fauna of Lake Tanganyika, we are as yet far from being adequately informed with regard to the distribution in depth of its various inhabitants, except, perhaps, in the case of some of the mollusks. It is quite possible that some of the true deep-water or bathylimnetic forms are still totally unknown. At any rate, it does not appear possible to draw up a list of the forms occurring only beyond a depth of 50 meters. It is furthermore impossible to state with any degree of certainty whether the bathylimnetic fauna is different at various depths and whether it is the same over the entire area covered by the lake.

The Mollusca are by far the most interesting part of the Tanganyikan fauna. Ever since Richard Burton and J. H. Speke upon discovering the Lake (February 13, 1858) obtained the first specimens, they have aroused the curiosity of biologists and been the subject of much speculation.[2] The literature dealing with them has become quite extensive, yet they are far from being satisfactorily known. Of the so-called thalassoid forms not half of the genera have been e amined anatomically and the ecological conditions under which they live have been but very superficially studied.[3]

The molluscan fauna of Lake Tanganyika is extremely abundant in species as well as in individuals. According to our present estimate, based

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[1]They have also been vaguely reported by Kandt from Lake Kivu and from one of the small lakes, Tshohoha, in Ruanda.

[2]The shells collected by Burton and Speke were studied by Woodward, S. P. 1859. 'On some new freshwater shells from Central Africa.' Proc. Zool. Soc. London, pp. 348–350, Pl. XLVII. The comprised: *Iridina spekii, Grandidieria burtoni, Spekia zonata,* and *Edgaria nassa.*

[3]In the taxonomic part of this Report all mollusks known from Tanganyika were listed with full references to published records. With regard to the synonymy of the numerous forms named by Bourguignat we have generally accepted the conclusions reached by C. F. Ancey, E. A. Smith, and L. Germain as exposed in the following recent publications:

Smith, E. A. 1904. 'Some remarks on the Mollusca of Lake Tanganyika.' Proc. Malacol. Soc. London, VI, 2, pp. 77–104.

Ancey, C. F. 1907. 'Réflexions sur la faune malacologique du lac Tanganika et catalogue des Mollusques de ce lac.' Bull. Scientif. France et Belgique, (5) IX, (1906), pp. 229–270.

Germain, L. 1908. 'Mollusques du lac Tanganika et de ses environs.' In 'Rés. Scientif. Voy. Afr. Foà.' (Paris), pp. 612–702. This valuable account contains photographic reproductions of several of Bourguignat's types.

upon a critical examination of the synonymy as adopted in the taxonomic part of this work, the number of forms that may claim recognition as species, races, or varieties runs to 155 (109 Gastropoda and 46 Pelecypoda), of which 143 are endemic (97 Gastropoda and 46 Pelecypoda). Although the lists given below certainly include names that eventually will be eliminated, we believe that these losses will be amply made up by new discoveries. The rather high figures might easily convey the impression that the malacological fauna of Tanganyika is now prefectly well investigated; but nothing would be farther from the truth, for, even in the small material we have studied, we have recognized several forms that had escaped our predecessors.

The Mollusca of Tanganyika are readily distributed among three groups, based upon the degree of relationship to the usual fresh-water types.[1]

(1) The first group comprises forms belonging to the usual fluviatile genera, also found elsewhere in African fresh waters.

*Lymnæa natalensis*
* " *caillaudi* var. *jouberti*
* " *gravieri*
*Planorbis adowensis*
" *bridouxianus*
* " " var. *foai*
* " *lavigerianus*
" *sudanicus tanganikanus*
* " *monceti*
* " *lamyi*
*Segmentina angusta*
**Planorbula tanganyicensis*
**Bulinus coulboisi*
* " *randabeli*
" *calaris*
**Physopsis tanganyicæ*
**Ancylus tanganyicensis*
*Pila ovata*
* " " var. *bridouxi*
*Lanistes ellipticus*
* " *jouberti*
" *bourguignati*
*Viviparus unicolor*
" *costulatus*
* " *foai*
* " (?) *brincatianus*
* " " var. *bridouxianus*
*Melanoides tuberculata*
**Melanoides admirabilis*
**Cleopatra guillemei*
* " *jouberti*
* " *trisulcata*
* " " var. *foai*
**Corbicula tanganyicensis*
* " *foai*
**Pisidium hermosum*
* " *giraudi*
**Parreysia horei*
* " *ujijiensis*
**Cælatura gerrardi*
* " (?) *böhmi*
* " *calathus*
* " *charbonnieri*
* " *gereti*
* " *randabeli*
**Aspatharia anceyi*
* " *lavigeriana*
**Mutela lavigeriana*
* " *monceti*
* " *nilotica* var. *moineti*
* " *soleniformis*
**Iridina spekii*
* " *bourguignati*
* " *giraudi*
* " *landeaui*
* " *vynckei*

[1]As in other similar lists, the endemic forms are marked with an asterisk.

This group comprises 19 genera with 56 forms, no less than 44 being endemic, the last figure especially being surprisingly high. There is, however, no difficulty in showing that all these mollusks are closely allied to the usual Ethiopian fluviatile species. In some cases, as in *Lymnæa*, *Bulinus*, *Physopsis*, *Pila*, and *Lanistes*, it is even somewhat doubtful whether the Tanganyikans are really separable from the more widely distributed forms. But others, such as *Melanoides admirabilis*, the species of *Cleopatra* and *Corbicula*, and *Iridina spekii*, are quite peculiar and among the most characteristic animals of the lake. Some of them are distinguished from their Ethiopian relatives by the unusual large size and thickness, the bright coloration, or the elegant sculpture.

So far as we are informed, most, if not all, of the mollusks of this group live in the quiet lagoons, marshes, or swamps of the shore, where sand spits shelter them against the mechanical action of the waves, and where fresh water drained from the coastal highlands tends to lower the normal salinity of the lake water. Under such favorable conditions they are frequently found in flourishing colonies.

(2) The second group comprises a number of strictly endemic genera, but whose affinities to the usual Ethiopian fresh-water genera are still beyond dispute.

*Neothauma tanganyicense*
*Neothauma tanganyicense* var. *bicarinatum*
*Neothauma tanganyicense* var. *euryomphalum*
*Neothauma tanganyicense* var. *major*
*Mysorella (?) multisulcata*
*"*Melania*" *tanganyicensis*
*Grandidieria burtoni*
* " " var. *insignis*
* " " var. *servainiana*
* " " var. *sturanyi*
* " *callista*
* " *elongata*
* " *giraudi*
* *gravida*
*Grandidieria hauttecœuri*
* " *incarnata*
* " *mira*
* " *rhynchonella*
* " *rotundata*
* " *smithi*
* " *tanganyicensis*
* " " var. *exalbida*
* " *thomsoni*
*Pseudospatha tanganyicensis*
* " " *livingstoniana*
* " *ortmanni*
* " *stappersi*
* " *bourguignati*
* " *subtriangularis*

Some of these 29 forms are quite variable in shape and sculpture, so that the specific limits in this group are far from cleared up. *Neothauma* is a true viviparid, on characters of shell and operculum, as well as on soft parts and anatomy. It may be regarded as an enlarged edition of *Viviparus*, remarkable for its bulk and extreme variability. The curious little amnicolid which we have provisionally referred to the Indian genus

*Mysorella*, is apparently not closely allied to any of the Ethiopians. "*Melania*" *tanganyicensis*, unknown to us in nature, does not seem to find its natural place among the common fresh-water melanid genera of Africa and it might be better placed in a genus of its own, *Horea* of Bourguignat. The *Grandidieriæ* are modified unionids, striking on account of the rather small, short, stumpy shell, often with angular contour; outside they are covered with a silky periostracum. By far the most interesting type is *Pseudospatha*, a mutelid with thin, strongly compressed valves, polished and bright amber yellow outside, pinkish iridescent inside.

The mollusks of this second group all belong to the so-called littoral zone, between shore line and depths of 20 to 50 m. *Neothauma* is abundant to depths of 20 m. and it also enters some of the ponds of the coast, in the alluvial plains near the mouth of rivers. *Mysorella* (?) *bisulcata* was dredged by Stappers in 100 m., but in dead condition, and it probably lives near the shore. The *Grandidieriæ* occupy muddy bottoms at depths between 25 and 50 m. The thinness of the shell of *Pseudospatha*, a unique feature among Tanganyikan mollusks, must be correlated with some peculiarity of its habitat, concerning which unfortunately no information is available at present.

(3) The last group contains the so-called "thalassoid" snails, a strange and extremely varied assemblage of forms, so different from what we find in the rivers and other lakes of Africa that their relationship can only be traced through a careful study of the soft parts and anatomy and is in some cases still open to question.

**Syrnolopsis lacustris*
* " " *molirensis*
* " *minuta*
* " " *carinifera*
* " *gracilis*
**Anceya giraudi*
* " *admirabilis*
* " *bella*
* " *rufocincta*
* " *terebriformis*
**Martelia tanganycensis*
* " *dautzenbergi*
**Tanganyicia rufofilosa*
* " " var. *minuta*
* " *fagotiana*
* " *duveyrieriana*
* " *milne-edwardsiana*
**Stanleya neritinoides*
**Baizea giraudi*
* " *leucoraphe*
* " *giraudi* (?)
* " *rotundata*
* " *smithiana*
* " *minima*
* " *præclara*
**Reymondia horei*
* " " var. *giraudi*
* " *minor*
* " *tanganyicensis*
**Bridouxia giraudi*
**Spekia zonata*
**Tiphobia horei*
**Bathanalia howesi*
**Limnotrochus thomsoni*

*_Chytra kirkii_
*_Paramelania bridouxi_
* " " var. _jouberti_
* " _crassigranulata_
* " _damoni_
* " _iridescens_
* " _minor_
*_Joubertia baizeana_
* " _spinulosa_
* " _stanleyana_
*_Lavigeria callista_
* " _combsa_
* " _coronata_
* " _diademata_
* " _grandis_
* " _jouberti_
* " _pereximia_
* " _ruellaniana_
*_Randabelia catoxia_
* " _hamyana_
*_Hirthia littorina_
* " _globosa_
*_Edgaria arenarum_
* " _crassilabris_
* " _giraudi_
* " _lechaptoisi_
* " " var. _obliqua_
* " _nassa_
* " " var. _nassatiformis_
* " _paucicostata_
* " " var. _callopleuros_
* " _reymondi_
* " _singularis_
* " _tiarella_
* " _variabilis_
*_Lechaptoisia ponsonbyi_

The 70 thalassoid forms belong to 20 genera.[1] We provisionally regard _Syrnolops s_ and _Anceya_ as forming a peculiar family Syrnolopsidæ, of doubtful affinity since the soft parts and operculum are unknown; possibly related to Amnicolidæ. As more fully explained in the taxonomic part of this work, the other thalassoid genera are in our opinion true Melaniidæ. We include in that family even the genera _Tiphobia_ and _Bathanalia_, which many authors have separated into a distinct family Tiphobiidæ.

The thalassoid gastropods of Tanganyika live under at least three different sets of environmental conditions. Most species of _Paramelania_, _Edgaria_, _Reymondia_, _Tanganyicia_, and _Spekia_ are shore snails that live firmly attached to rocks where they are fully exposed to the movement of the waves. Of _Edgaria nassa_ J. E. S. Moore says: "During life this mollusc inhabits the surface rocks of Tanganyika, and its shells are always richly encrusted with the green algæ which clothe the rocks for a considerable depth. It is sluggish, and appears to browse within a very limited area, like the _Patellas_ of the ocean beach."[2] On p. 246 of Moore's book we also read: "Upon the shore rocks and flourishing among the surf and the breakers of Lake Tanganyika there are several species of small molluscs, which in the fauna of the lake fill the place of the _Littorinas_ and _Neritinas_ of the sea shores, and among these littoral forms there occurs in great abundance the animal, to the empty shell of which

[1]We rank _Burtonilla_ as a subgenus to _Anceya_, _Coulboisia_ and _Giraudia_ as subgenera to _Baizea_, and _Bythoceras_ as a subgenus to _Paramelania_.
[2]1903, 'The Tanganyika Problem,' p. 250.

Crosse gave the name of *Tanganyicia*." Other snails, such as the Syrnolopsidæ (*Syrnolopsis* and *Anceya*), *Limnotrochus thomsoni*, and *Chytra kirkii*, live freely on the muddy or gravelly bottom, overgrown with aquatic weeds, of the littoral zone, between the shore and depths of 50 to 80 meters. Here they are accompanied by the snails and mussels of our second group, which are much more typical of this particular habitat than any of the thalassoid species. Finally, a relatively small number of types inhabit the lake bottom at greater depth, between 50 and 200 meters. Among these the most frequent is *Tiphobia horei*, which Moore found in 100 fathoms and over, while Stappers dredged it in depths of 90 to 160 meters. Moore also writes that *Paramelania* (*Bythoceras*) *iridescens* and *P.* (*B.*) *minor* were obtained between 300 and 1,000 feet. *Bathanalia howesi* also is a true deep water form: Stappers found it in 76 meters. Beyond a depth of 200 meters there is very little if any molluscan life, in what should properly be regarded as the true "bathylimnetic" zone, although it would seem that these deeper regions have not yet been adequately investigated.[1]

Most thalassoid snails present a number of striking peculiarities by means of which they differ markedly from the usual fresh-water types. As they belong to many different species, several of which are of large size and extremely abundant, they form an assemblage not to be duplicated anywhere else. With very few exceptions the shells are solid, thick, and heavy, which points to a steady and fairly abundant supply of lime. In addition they show none of the corrosion at the top of the spire which is so common a feature of other African fresh-water gastropods, and their surface is generally free of incrustations or coating of foreign matter. As in many truly marine snails, the periostracum is comparatively thin and the outer surface is clean and often smooth. They are handsome shells, beautifully sculptured and often provided with spines or protuberances. The size, the proportions of the spire, the shape of the aperture, and the details of sculpture are as a rule so variable that the limits between the species are hard to draw. The strangest among the thalassoid genera are *Tiphobia*, *Bathanalia*, *Chytra*, *Limnotrochus*, and *Spekia*, in which it would be impossible to recognize Melaniidæ without a study of the soft parts, opercula, and radulæ.

In our opinion the term "thalassoid" applied to these mollusks has befogged the whole "Tanganyika Problem." Even authors like Dr. Cunnington, who discredit the relationships of these genera with marine

[1]Other deep fresh-water lakes, in Switzerland, Japan, and elsewhere, possess in their bathylimnetic zone a number of small, usually thin-shelled, fragile snails and mussels, evidently derived from normal species of the littoral zone. No such types have thus far been found in Tanganyika.

gastropods claimed by J. E. S. Moore, return time and again to their thalassoid appearance. It is true that a few genera, such as *Spekia*, *Tanganyicia*, *Lavigeria*, *Limnotrochus*, the Syrnolopsidæ, etc., recall various marine shells by their form or sculpture or solidity; but the marine appearance is most convincing to those who are relatively unfamiliar with marine mollusks, and in no case has actual relationship with the particular marine shells imitated been demonstrated. These mollusks are in no way comparable to the Polyzoa *Victorella* and *Arachnoidia* or the fresh-water medusæ of Tanganyika, which are directly related to marine stocks and which, together with some of the algæ, alone merit Moore's term "halolimnic." To class the so-called "thalassoid" gastropods with these "halolimnic" organisms muddles the whole inquiry. In the mollusks we have to do with cases of adaptive convergence, such as *Spekia*, which mimics petricolous Littorinidæ; or with mature stages of sculptural evolution, as in *Tiphobia*, *Paramelania*, and others, where the convergence to marine shells is merely adventitious. In these forms the evolution of sculpture based upon axial ribs and spiral cords, such as many melanians have, parallels or converges toward that of some marine snails having the same fundamental sculptural elements. In either case, details of sculpture have absolutely no phylogenetic significance outside of the limits of each narrow group. The solidity of many Tanganyikan Melaniidæ may be adaptive in the case of littoral forms; but many melanians elsewhere, such as *Paludomus* and its allies, are equally solid.

While we thus disbelieve all phylogenetic relationships between the thalassoid gastropods of Tanganyika and marine snails, past or present, yet we are unable to agree with Germain that the melanians of the lake are not fundamentally different from those that inhabit Lake Moero, Lake Nyasa, and the Upper Congo basin.[1] Nor could we subscribe to his statement that the fauna of the upper and mid-Congo "shows a whole series of melanians of marine appearance." These Congo melanians are mostly of small size, usually covered with a thick periostracum, and frequently corroded or decollate. They are not in our opinion more heavily sculptured nor more solid than many members of the same family from the fresh waters of other parts of the world. We fail to find anything in the fauna of the Congo and its affluents that could be regarded

[1]1914, IX[e] Congr. Internat. Zool. Monaco (1913), pp. 563–565.

as ancestral to or derived from such Tanganyikan types as *Chytra*, *Tiphobia*, *Spekia*, etc.[1]

The perplexing questions raised by the origin and evolution of Tanganyikan mollusks are closely linked up with the more general problem of the origin of the lake itself. We do not intend to enter deeply into it, since it has been often discussed at length, more recently again by L. Germain. Although the marine-like appearance of some of the mollusks had been noticed several times before, it was the discovery of medusæ that prompted R. T. Günther[2] to argue that Tanganyika was a "residual sea," the remnant of an extension from the Atlantic, which at one time, he claimed, covered most of the present Congo basin. Left behind by a subsequent regression of the sea, the lake, he said, gradually lost most of its former salinity through dilution with rain water and drainage to the ocean, while the fauna retained many of its marine characteristics and acquired through migration a number of strictly fluviatile types. We know, however, that the medusæ, though undoubtedly of marine origin as a group, are much more widely distributed in fresh waters —especially in Africa—than was at first suspected. These animals can no longer be used as an important argument in favor of Günther's theory, since there has been plenty of opportunity for their migration along fresh-water streams into Tanganyika. The theory was considerably stressed by J. E. S. Moore,[3] who held the opinion that Tanganyika represented an ancient extension of the Jurassic ocean. The thalassoid mollusks he regarded as "halolimnic" survivors of Jurassic, marine forms. Moore has even attempted to show that "the very remarkable facies which the shells of the halolimnic gastropods possess is unmistakably again presented by a similar number of gastropods which are characteristic of the deposits left by the old Jurassic seas."[4] His efforts in that direction appear somewhat futile, since in external appearance the thalassoid shells could equally well be matched with fossils of other geologic periods or with present-day marine forms. It is sufficient to mention

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[1]We cannot well agree with Germain's statement that *Pseudogibbula* is "un véritable Troque d'eau douce" analogous to *Chytra* and *Limnotrochus*. It appears to be either a littorinid (as Dautzenberg thought), which like *Cremnoconchus* has become adapted to fresh water and is most likely a recent derivative from a marine ancestor; or possibly it may belong to the Amnicolidæ. It remains without meaning until the dentition can be examined.

[2]Günther, R. T. 1894. 'Further contribution to the anatomy of *Limnocnida tanganyicæ*.' Quart. Journ. Micr. Sci., N. S., XXXVI, pp. 271–293, Pls. XVIII–XIX (see pp. 289–290).

[3]Moore, J. E. S. 1898 (March). 'On the zoological evidence for the connection of Lake Tanganyika with the sea.' Proc. Roy. Soc. London, LXII, pp. 451–458.

1898 (June). 'On the hypothesis that Lake Tanganyika represents an old Jurassic sea.' Quart. Journ. Micr. Sci., N. S., XLI, pp. 303–321, Pl. XXIII.

1903. 'The Tanganyika Problem.' (London), xxiii+371 pp., Pls. and maps.

[4]A somewhat similar theory was advanced by H. Nicolas (1898, 'Origine marine de certaines espèces de mollusques, en cours de transformation, du lac Tanganyika.' C. R. Ass. Franç. Av. Sci., 2e p., pp. 508–525). Pelseneer [1906, Bull. Ac. Belgique, Cl. Sci., (1905), pp. 706–707], although condemning Moore's hypothesis, yet believes that Tanganyika was partly populated by forms of marine origin that migrated from the west.

that the anatomy of the Tanganyikan thalassoid mollusks, as known at present, shows that they are related to the living fresh-water melanians. Moreover, Moore's hypothesis is contradicted by the geological structure of the region of Lake Tanganyika.[1] There are no indications that the sea extended anywhere near the lake during the Mesozoic, as no marine deposits of that period are known in the interior of Central Africa, the rocks all belonging to continental or lacustrine formations. This region appears to have undergone no marine transgression since the middle of Palæozoic times. It is now generally admitted that after the close of the Palæozoic the earth crust of this part of Africa was dislocated by a series of tremendous fracture movements, so-called faults. These movements covered a long lapse of time and must have been interrupted by several periods of relative quietness. In the region of Tanganyika they probably began about the middle of the Mesozoic and continued till the present day: even now earthquakes are quite frequent on the shores. The lake nowadays fills the bottom of the southernmost and deepest portion of a huge trough, known as the Albertine Rift, which resulted from the successive faulting movements. It is therefore in no way a residual sea.

On the whole, the most plausible explanation of the peculiarities of the Tanganyikan mollusk fauna seems to be that it is a mixture of several distinct faunæ, all derived from FLUVIATILE ancestors, but which have reached the lake at different epochs of its geologic past. So many have been the vicissitudes of the history of the lake and of that of the surrounding territory, that connections must have been repeatedly established and severed again with other hydrographic basins. It seems equally safe to assume that at intervals Tanganyika formed for some length of time a closed basin, where truly marine-like conditions prevailed, perhaps even more pronounced than nowadays, as for instance in a higher salinity. Thus there was ample opportunity for repeated immigrations of fluviatile stocks from neighboring river basins, while at least some of them could later evolve into peculiar types better adapted to their new environment. It is quite possible that some of the most strikingly thalassoid genera are the direct descendants of fluviatile forms which migrated into the lake at the beginning of its history, perhaps during the Mesozoic. But, even in their case, it is likely that they have been deeply

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[1]See for a discussion of the geological side of the argument:

Cornet, J. 1896. 'Le Tanganyika est-il un Relikten-See?' Le Mouvement Géographique, Nos. 25 and 26.

Stromer, E. 1901. 'Ist der Tanganyika ein Relikten-See?' Petermann's Mittheil., XLVII, pp. 275–278.

Hudleston, W. H. 1904. 'On the origin of the marine (halolimnic) fauna of Lake Tanganyika.' Geological Mag., pp. 337–382, 2 Pls.

modified from the ancestral type, so that it seems to us meaningless to look for their ancestors among Mesozoic fluviatile snails similar in appearance to some of the present day Tanganyikans.[1] To speculate further upon the history of the Tanganyikan mollusks would hardly serve a useful purpose, since we know nothing whatsoever of the fluviatile forms that lived in Central Africa during the Mesozoic and early Cænozoic.

## Lake Moero

Lake Moero (or Mweru) extends over an area of about 4,850 square kilometers, between 8° 30′ and 9° 30′ S., 28° 30′ and 29° E., being about 120 kilometers long from northeast to southwest and nearly everywhere some 40 kilometers wide.[2] In the west it is bordered by the steep, mountainous slopes of the Kundelungu Plateau, rapidly rising to 1,400 m. above sea level. Here the shore often forms cliffs and presents no harbors nor bays, while the few small affluents come down in cascades. The northern shore is rather gentle, with occasional, narrow, sandy beaches; it receives two affluents of moderate size, the Lunkinda and the Loao. The Luvua (usually called Lualaba by the natives), the outlet of the lake, flows out of the extreme northwestern corner. The east coast is also bordered by cliffs, but they are much lower than on the western shore, and the ascent to the highland is more gradual. An important eastern affluent, the Kalungwesi, drains a large portion of Northeast Rhodesia. The southern shore is very low, frequently marshy or covered with rushes or papyrus swamps, and continues inland as a slightly raised, uniformly flat, alluvial plain, almost as large as Lake Moero itself. This plain is still partly flooded at the height of the rainy season. Topographic conditions show that it has only recently emerged above the waters and the shrinking process of the lake appears to be steadily continuing nowadays. The Luapula, carrying the waters of Bangweolo, enters at the southern end through a small, swampy peninsula which projects into the lake. West of the mouth of the Luapula there is a deep bay which receives

[1]C. A. White and L. Tausch have called attention to the superficial resemblance between certain thalassoid gastropods of Tanganyika and some lacustrine Upper Cretaceous or Eocene fossils; especially between *Pyrgulifera* and *Paramelania*, and between *Fascinella* and *Syrnolopsis*. They assume that this similarity is sufficient proof of a direct relationship between the forms in question. There is no way of proving that in these cases the resemblance is not as fortuitous as is the external likeness with certain Jurassic marine snails.

White, C. A. 1881. 'Tanganyika shells.' Nature, XXV, pp. 101–102.

1882. 'New molluscan forms from the Laramie and Green River group, with discussion of some associated forms heretofore known.' Proc. U. S. Nat. Mus., V, pp. 94–99, Pls. III–IV (see p. 98).

Tausch, L. 1884. 'Ueber einige Conchylien aus dem Tanganyika See und deren fossile Verwandte.' Sitz. Ber. Ak. Wiss. Wien, Math. Naturw. Kl., XC, Abt. 1, pp. 56–70, Pls. I–II.

Oppenheim, P. 1892. 'Ueber einige Brackwasser- und Binnenmollusken aus der Kreide und dem Eocän Ungarns.' Zeitschr. Deutsch. Geol. Ges., XLIV, pp. 697–818, Pls. XXXI–XXXVI (see pp. 750–752).

[2]The altitude of Lake Moero is variously given as 912 m., 936 m., or 972 m. above.

the Lufukwe, an affluent draining part of the Kundelungu Plateau from which it descends in a series of picturesque leaps.[1]

Lake Moero contains but two islands, both elevated and rocky and situated in the southern corner. The largest is that of Kilwa, near the western shore; the other, Sokwa, lies near the eastern bank. The lake is extremely shallow, the bottom gently sloping from the southern shore to the center, at an average depth of 10 m. The deepest depression discovered thus far reaches only 15 m. and is found close to the eastern coast. The main current of the Luapula crosses the lake along the eastern shore, the lake itself being at present but little more than a pool-like expansion of the stream. The bottom consists of a layer of oozy, gray mud, at least 1.5 m. thick. Since the Luvua steadily lowers the level of the lake by wearing down the rapids between Pweto and Kiambi, Lake Moero will shortly be transformed into a swampy district similar to that of the upper Lualaba valley near Lake Kisale. Much of its malacological fauna is probably doomed to extinction in the near future. Even at present the characteristic, carinate *Viviparus mweruensis* and its var. *pagodiformis* are but rarely found alive, although thousands of dead specimens may be picked up at the shore or dredged from the bottom. The water is fresh, but dirty and opaque. Stappers gives 0.40 m. to 0.50 m. as the transparency measured by means of a white disk. The day temperature at the surface varies between 21° C. in the morning and 27° C. to 28° C. (rarely 29° C.) in the afternoon, during the rainy season (October to January). Below the surface it rapidly decreases to 24° C.–26° C., remaining fairly uniform and varying but little with depth.[2]

The fauna of Lake Moero was extensively investigated by the late Dr. L. Stappers from September 1911 to January 1912. Unfortunately, but few of his results have been published thus far, so that it is not possible to give a brief account of the numerical strength of various groups as we have done with the other lakes. The fishes are very abundant in individuals and belong to 46 species, 14 of which are endemic.[3]

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[1]In the valley of the Kampemba, an affluent of the Lufukwe, about 50 kilometers west of the southern end of Lake Moero, there are deposits of a lacustrine limestone, apparently of quite recent age, with remains of *Physopsis*, *Lymnæa*, and *Planorbis*, differing but little from living Ethiopian species. See Leriche, M. 1925. 'Les fossiles du calcaire lacustre observé récemment sur le plateau du Kundelungu (Katanga).' Rev. Zool. Afric., XIII, pp. 150–155, Pl. v.

[2]For physical data concerning Lake Moero, consult:

Stappers, L. 1912. 'Expériences de pêche faites au lac Moéro.' Revue Congolaise, II, pp. 397–403, Pl.

1914. 'Exploration scientifique du Dr. L. Stappers aux lacs Moéro et Tanganika. I. Recherches bathymétriques sur les lacs Moéro et Tanganika.' Ann. Biol. Lacustre, VII, 1, pp. 83–114, Pls. II–IV, 1 map.

1913. 'Mission Stappers 1911–1913. Répertoire général des échantillons d'histoire naturelle recueillis.' (Bruxelles), xii+[67] pp.

[3]See G. A. Boulenger, 1920, Rev. Zool. Afric., VIII, pp. 3–5.

Many of the Mollusca known from the lake were examined by us.[1] They total 20 forms (13 Gastropoda and 7 Pelecypoda), belonging to 14 genera:

*Lymnæa natalensis* (perhaps subsp. *undussumæ*)
*Planorbis adowensis*
*Physopsis africana globosa*
*Burnupia* sp. (recorded as *stuhlmanni*)
*Lanistes ovum*
**Viviparus crawshayi*
* " *mweruensis*
* " " var. *pagodiformis*
**Melanoides crawshayi*
* " *imitatrix*
**Melanoides mweruensis*
**Cleopatra johnstoni*
* " *mweruensis*
*Corbicula radiata*
*Parreysia mweruensis*
**Pseudavicula johnstoni*
**Mutela hargeri*
" *carrei*
*Aspatharia* sp. (undescribed)
*Etheria elliptica*

Of these twenty forms, ten may be regarded as endemic and were marked as such in the above list. It should, however, be noted that five of them, viz. *Melanoides crawshayi*, *M. mweruensis*, *Cleopatra johnstoni*, *Pseudavicula johnstoni*, and *Mutela hargeri*, are not absolutely restricted to the lake proper, but extend into the lower reaches of the Luapula, below the Johnston Falls, where the river becomes shallow and sluggish. All of these mollusks are evidently related to the usual Ethiopian fresh-water types. Yet in some cases they have acquired a peculiar shape or sculpture, and this, added to their great abundance, lends to the fauna a facies quite its own. This is especially true of the heavy and strongly keeled *Viviparus mweruensis*, which some authors have even transferred to *Neothauma;* but we do not believe that it has any real relationship to that Tanganyikan genus. The curiously bialate unionid *Pseudavicula johnstoni* has been separated as a distinct genus, endemic in Moero, from the other African members of the family; it reminds one somewhat of the Tanganyikan *Pseudospatha*, but it lacks the bright periostracum and iridescent nacre of that genus. *Mutela hargeri* is equally remarkable among the Mutelidæ.

*Lymnæa*, *Planorbis*, and *Physopsis* inhabit the pools at or near the shore, together with a species of *Succinea* (*S. baumanni*, according to Dautzenberg and Germain) that crawls over the amphibious plants above the surface of the water. *Lanistes* is mostly found in the swamps of the southern coast. The junior author collected *Burnupia* from the under side of floating leaves of water-lilies in the bay of Kilwa. The typical Moero fauna, however, such as the species of *Melanoides*,

[1]The junior author collected a number of them in December, 1911 and January, 1912.

*Cleopatra*, *Viviparus*, *Pseudavicula*, and *Mutela*, lives on the oozy bottom of the open lake, the bivalves being buried deep in the mud. In some places dead shells of these species form important deposits.

## Lake Bangweolo

Lake Bangweolo (or Bangweulu, called by the natives "Bemba") lies in about 30° S., between 10° 40′ and 11° 30′ E., at an altitude of 1,140 m. It covers about 3,000 square kilometers and occupies an extremely shallow basin bordered on all sides by low shores. The eastern and southern parts especially, where it receives the Chambezi and other small tributaries and where it flows out into the Luapula, are little more than an extensive morass of reeds and papyrus, divided by many channels into muddy, partly floating islands. Only on the western side are the banks clearly defined. The greatest extent of open water is not more than 100 kilometers long from north to south and hardly 40 kilometers wide from east to west. Even in this open portion the lake is nowhere over 5 m. deep. The water is apparently quite fresh. A considerable amount of alluvial matter is steadily carried into the basin, while the Luapula slowly drains more of the water as it erodes a deeper channel through the various stretches of rocky barriers that interrupt its upper course. The gradual silting up and disappearance of Lake Bangweolo is therefore steadily progressing.[1]

We were unable to find much information concerning the fauna of this lake. Weatherley[2] has reported that it is absolutely shell-less, but it seems difficult to believe that such is actually the case. The region appears never to have been visited by a malacologist.

## Notes on the Relations of the Ethiopian to Other Regions

The isolation of the Ethiopian Region from the Palæarctic appears to have been of long standing, since the European Tertiaries, rich in land and fresh-water shells from the Palæocene to the Pliocene, appear about as free from Ethiopian forms as the modern European fauna. The characteristically Palæarctic genera now found in the Ethiopian Region (such as Pupillidæ, *Lymnæa*, *Vitrina*) probably came by way of Asia. Chapin believes that "in Miocene time there was a belt of tropical rain forest stretching most of the way between India and Africa," and such a

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[1]Recent accounts of physical conditions in the Lake Bangweolo area are to be found in:
Rosen, E. von. 1916. 'Träskfolket.' (Stockholm), 468 pp., 3 Maps, 78 Pls.
Fries, R. E. 1921. 'Wissenschaftliche Ergebnisse der schwedischen Rhodesia-Kongo-Expedition 1911–12, unter Leitung von Eric Graf von Rosen. I. Botanische Forschungen.' Ergänzungsheft, 135 pp., 16 Pls.

[2]Weatherley, P. 1898. 'Circumnavigation of Lake Bangweolo.' Geograph. Journ. London, XII, pp. 241–262, Map.

connection is required to explain the presence in Africa of a great series of Oriental genera of Zonitidæ, Enidæ, Cyclophoridæ, Viviparidæ, Unionidæ, etc. In exchange southeastern Asia received genera of Achatinidæ, Streptaxidæ and some other groups from Africa. We strongly believe that the African continent, with its great antiquity, was an important autochtonous center of evolution for several groups of terrestrial and fluviatile mollusks.[1] In many cases the same genera occur in the Ethiopian and Oriental Reigons; in others the genera are distinct but closely related.

The relations existing between the fresh-water faunæ of Africa and South America have been so fully discussed by H. von Ihering, A. E. Ortmann, J. D. Haseman and many others that we give here only the salient points.

It is generally admitted that, if direct land connection ever existed between these continents, it was interrupted before the beginning of of Tertiary time. Only the older and more slowly changing groups can be expected to show relationship; but groups of great antiquity have had time to reach Africa and South America by way of the northern continents, so that only such groups as we have reason to believe never existed in the north are really significant in this inquiry.

Fresh-water Mussels.—The affinities of African Unionidæ are clearly with those of the Oriental Region. The Mutelidæ, on the other hand, have relatives only in South America.[2] This family is unknown in the northern continents, either recent or fossil.[3] Important in this connection is von Ihering's discovery of a mussel with the strongly taxodont hinge of the Ethiopian genus *Iridina*, in the Brazilian State of São Paulo.[4]

The highly peculiar family Etheriidæ has representatives in South America, the Ethiopian Region, Madagascar, and peninsular India. It has not been found fossil.

Fresh-water Gastropods.—The family Ampullariidæ has in the Ethiopian Region one genus, *Pila*, with calcareous operculum, occurring also in Madagascar and the Oriental Region; three genera, *Lanistes*,

[1]The African continent is now generally accepted to have been the center of dispersal of the three mammalian orders Hyracoidea, Proboscidea, and Sirenia. See Osborn, H. F. 1921. 'Adaptive radiation and classification of the Proboscidia.' Proc. Nat. Ac. Sci. Washington, VII, pp. 231–234.

[2]If, as A. E. Ortmann claims, *Diplodon* and its immediate allies belong to the Mutelidæ, then the family includes also all of the naiades of Australia and New Zealand.

[3]Unless the Pennsylvanian Triassic *Mycetopoda diluculi* Pilsbry, 1921, Proc. Ac. Nat. Sci. Philadelphia, p. 36, based on a fragmentary specimen, proves really to belong to this South American genus. The generic reference was provisional, as the hinge is unknown.

[4]*Pleiodon priscus* H. von Ihering, 1912, Journ. Ac. Nat. Sci. Philadelphia, XV, p. 489, Pl. XLII, figs. 20–23. Unfortunately the age of the deposit containing this mussel has not been determined. It is supposed to be Upper Cretaceous or Lower Eocene.

*Saulea*, and *Afropomus*, have corneous opercula, like the tropical American genera. This family is not represented, recent or fossil, in north temperate regions.

The Melaniidæ or melanians of Africa are partly related to those of the Oriental Region (Melaniidæ), but the genus *Potadoma* (Potadominæ) is closely related to the Tropical American genus *Pachychilus*. *Rhinomelania* was considered by E. von Martens to be a subgenus of the South American genus *Hemisinus*. It does not appear related to any Old World genus.

All of the fresh-water forms mentioned are large or moderately large shells, generally occurring in abundance. Their absence in Europe and especially in western North America, though negative evidence, has a certain significance. From the Laramie formation (Upper Cretaceous) on, rich faunæ of Unionidæ, Cyrenidæ, Viviparidæ, Melaniidæ and other fresh-water mollusks are known in western North America. If the Ampullariidæ, Mutelidæ, Etheriidæ, etc., migrated to or from South America around the North Pacific, it is certainly strange that no trace of them has been found in these deposits.

The absence of these African and South American families in European Mesozoic and Tertiary faunæ yet known renders migration around the North Atlantic unlikely.

Some other groups common to the fresh-waters of South America and Africa, such as Cyrenidæ, *Eupera*, *Neritina*, Amnicolidæ, are well represented in northern Mesozoic and Tertiary deposits. Thus, the genus *Eupera* is now confined to the Ethiopian Region, South and Middle America. It would be thought an evidence of former union of these continents, were it not that species have been found in the Eocene of Europe, China, and western North America, showing that it is a group formerly having a Holarctic range, probably migrating south and now, like the camels, existing in the peripheral areas of its migrations.

TERRESTRIAL MOLLUSKS.—Among land mollusks the Acavidæ, Streptaxidæ and Achatinidæ are the most significant families. The subfamily Streptaxinæ is special to Africa and South America. The subfamily Ptychotreminæ is distributed over Africa and the Oriental Region. Two Italian Eocene species and one French Pliocene species have been referred to the group, but their relations have been disputed and must be regarded as uncertain. Otherwise the family is unknown in northern regions.

The Achatinidæ have their greatest development in Africa, but with numerous genera also in tropical America and a few in the Oriental Region, all of the latter identical with or close to African genera.

The Acavidæ and their immediate allies appear also to be an Austral group, present in Australia, Ceylon, Madagascar, South Africa and South America, and unknown in northern regions, either recent or fossil. They are large snails, not likely to be overlooked.

It appears, therefore, that the Ethiopian and Neotropical faunæ contain one series of land and fresh-water mollusks belonging to groups known in the northern continents as recent, Tertiary or Mesozoic forms, and another series of groups unknown anywhere along the northern routes of inter-continental migration. This second group consists partly of conspicuous forms, not likely to be transported far without actual land communication. These facts seem to lend support to the hypothesis of a Mesozoic "Western Gondwana" or Brazilo-Ethiopian continent, "Archhelenis" as it has been termed by H. von Ihering. That the evidence is largely negative must not be lost sight of. It can by no means be considered conclusive until we have a far more complete knowledge of land and fresh-water fossils of Tertiary and especially of Mesozoic deposits of Asia and North America.

## Recent Additions to the Land Mollusks of the Belgian Congo

Since the publication of the senior author's 'Review of the Land Mollusks of the Belgian Congo,' in this Bulletin, Vol. XL, 1919, a number of papers have appeared containing additional information on the subject. For the convenience of the student, we subjoin a list of these publications and indicate the new terrestrial forms described therein.

Connolly, M. 1922 (November). 'Notes on African non-marine Mollusca, with descriptions of many new species.' Ann. Mag. Nat. Hist., (9) X, pp. 485–517, Pl. XIV.

*Gulella (Paucidentina) dupuisi*, p. 497, Pl. XIV, fig. 39. Nsendwe.

1923. 'Notes on African non-marine Mollusca, with descriptions of many new species (cont.).' *Op. cit.*, (9) XI, pp. 345–362, Pl. I; (9) XII, pp. 633–659, Pl. XIX.

*Nothapalus ugandanus*, p. 354, Pl. I, fig. 26. Buhamba and Burunga.

*Nothapalus adelus*, p. 355, Pl. I, fig. 27. Between Lake Mutanda and Lake Kivu.

*Subulina viridula*, p. 359, Pl. I, fig. 25. Mukanda near Lake Kivu.

*Pseudoglessula mutandana*, p. 347, fig. 2 and Pl. I, fig. 23. Lake Mutanda.

*Pseudoglessula perobtusa*, p. 347, Pl. I, fig. 8. Burunga, Mt. Mikeno, 6,000 ft.

*Pseudoglessula (Kempioconcha) pilsbryi*, p. 349, new name for *Kempia kivuensis* Preston, 1913, Rev. Zool. Afric., III, p. 53; not *Ena kivuensis* Preston, 1913, *op. cit.*, p. 50, which, according to Connolly, is also a *Pseudoglessula*.

*Pseudopeas burunganum*, p. 644, Pl. XIX, fig. 41. Burunga, Mt. Mikeno (type) and Lake Mutanda.

*Opeas thomasi*, p. 653, Pl. XIX, fig. 3. Mukanda near Lake Kivu (type) and Mbarara to Kigezi (Uganda).

Dupuis, P. 1922. 'Notes malacologiques concernant la faune de l'Afrique continentale et insulaire. I.' Ann. Soc. Zool. Belgique, LIII, pp. 46–48.

*Subulina sinistrorsa*, p. 47, fig. 1. Kindu.

*Cæcilioides spencei*, p. 48, fig. 2. Near Boma. This appears to be *C. gundlachi* Pfeiffer.

1923. 'Notes malacologiques concernant la faune de l'Afrique continentale et insulaire. II.' *Op. cit.*, LIII, (1922), pp. 80–83.

Dupuis, P. and Putzeys. 1922 (December). 'Notes sur la faune malacologique africaine.' *Op. cit.*, LIII, pp. 40–45.

*Pseudotrochus janssensi*, p. 42, fig. 2. Inkongu and Dima.

*Ptychotrema (Parennea) connollyi*, p. 40, fig. 1. Nsendwe and Barumbu. *P. dykeiana* Spence is a synonym of this.

1923. 'Deuxième note concernant la faune malacologique africaine.' *Op. cit.*, LIII, (1922), pp. 69–79.

*Succinea chudeaui* Germain var. *leyneni*, p. 70, fig. 2. Nyangwe.

*Ptychotrema (Nsendwea) nobrei*, p. 74, fig. 7. Nsendwe.

Dyke, F. M. 1922. 'Some uses of shells in the BelgianCongo.' Journ. of Conchology, XVI, p. 309.

Spence, G. C. 1922. 'A collection of Mollusca from the Belgian Congo.' *Op. cit.*, XVI, pp. 265–267.

1923 (January). 'Mollusca from the Belgian Congo (II).' *Op. cit.*, XVII, pp. 19–24, Pl. I.

*Achatina schweinfurthi* var. *semifusca*, p. 20, Pl. I, fig. 4. Leverville.

*Homorus (Subulona) bumbaensis*, p. 32, Pl. I, fig 7. Bumba.

*Ceras texistriatum*, p. 21, Pl. I, fig. 3. Elizabetha.

*Pseudoglessula (Ischnoglessula) pulchella*, p. 20, Pl. I, fig. 5. Leverville.

*Ptychotrema (Parennea) dykeiana*, p. 20, Pl. I, fig 6. Leverville. This is the same as *P. connollyi* Dupuis and Putzeys, which has priority (see Spence, 1924, *op. cit.*, XVII, p. 118).

G. C. Spence (1923, Journ. of Conchology, XVII, p. 96 and 1924, *op. cit.*, p. 118), has also recorded from the Belgian Congo *Achatina weynsi* Dautzenberg (Alberta) "*Trachycystis*" *seminium* (Morelet) (Boteke), and *Thapsia mixta* (Smith) (Boteke).

# INDEX TO VOLUME LIII

New names of genera, sections, species, subspecies, and mutations are printed in **heavy-faced type**, also the main reference in a series of references; synonyms are printed in *italics*.