EOCENE NAUTILOIDS OF BRITISH SOMALILAND

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WITH A NOTE ON THE GEOLOGY OF THE DABAN AREA AND THE LOCALITIES OF THE DESCRIBED NAUTILOIDS BY W. A. MACFADYEN

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ABSTRACT, INTRODUCTION, ACKNOWLEDGMENTS

SOME 20 YEARS AGO, W. A. Macfadyen and J. A. Hunt collected well over a hundred Tertiary nautiloids from British Somaliland (which had previously yielded only two specimens), and these constitute the basis for this study. All but one of them came from the north central portion of the country. The great majority were secured from the section exposed along the Biyo Gora River at Daban, some 25 kilometers southeast of Berbera. At that place, nautiloids occur in two zones, one in the Lower and one in the Middle Eocene; they are so abundant in the latter that the containing strata have been termed the Nautilus beds. A few sporadic individuals were secured from strata of comparable age at several other localities.

Almost all of the forms known from British Somaliland belong in two closely related genera, *Cimomia* and *Deltoidonautilus*, but we have in addition a single representative of *Aturia* (a new species) and a very incomplete specimen that we are referring with question to *Eutrephoceras*. One species of *Cimomia* and one of *Deltoidonautilus* had already been described and named from the country; we are establishing six more of the former genus and four of the latter, and in addition are including discussions (and in some cases illustrations) of fragmentary and/or poorly preserved representatives of both. Figure 1 elucidates the relative abundance and general distribution of all of these forms.

The literature contains references to a good many sporadic occurrences of Tertiary nautiloids in various parts of Africa. However, none of the British Somaliland forms seems to belong in species known from elsewhere, and none of the assemblages is similar except in a general way. The closest are perhaps those known from Senegal and Sudan in French West Africa. The fauna of the upper Ranikot series of western India (Sind) is somewhat reminiscent of the only large one known from Somaliland, that of the Nautilus beds at Daban, but the relationship is rather distant. Furthermore, close counterparts of the African faunas under consideration are not known from any of the other continents.

The discovery of nautiloids in the Eocene of British Somaliland was recorded in 1925 by R. B. Newton. He illustrated and described two large, well-preserved internal molds which had been collected at Kohl Der by B. K. N. Wyllie, and he coined for them the names *Nautilus wylliei* and *N. somaliensis*. The former belongs in the genus *Cimomia* and the latter in *Deltoidonautilus*, as now interpreted.

From 1928 to 1930, W. A. Macfadyen and J. A. Hunt, while conducting field investigations for the Somaliland Petroleum Company, secured more than 100 additional specimens. These came from several horizons and localities. They were deposited in the Sedgwick Museum at Cambridge (hereinafter referred to, with catalogue numbers, as Sedgk. Mus.), and from there most of them were sent to the British Museum (Natural History) to be studied by L. F. Spath. In June of 1939, Dr. Spath entrusted this material to one of the authors of the present report, Otto Haas, who was at that time working in London, and he prepared a detailed account of the assemblage. Before it was published, the other author of this report, A. K. Miller, issued general studies of both American and west coastal African Tertiary nautiloids, and in them are included certain revisions of the genera involved. Furthermore, 17 additional specimens (which were also collected by Macfadyen and Hunt) were presented to the Sedgwick Museum. These facts necessitated a revision of the manuscript written some 13 years ago by Haas. This work was undertaken by both authors in 1949 but was not completed until 1951. Haas wishes to emphasize that the burden of this revision rested on Miller.

In Miller's report on American Tertiary forms, issued in 1947, there are included a glossary of nautiloid shell terminology and detailed discussions of the genera known to be represented in the Cenozoic. Also, there have recently been published summary accounts of the families and genera involved, as well as the existing knowledge in regard to the evolution of these nautiloids (Miller, 1951). Inasmuch as both of these studies are readily available, it did not seem desirable for us to duplicate considerable portions of them.

Acknowledgment is due to many people who in one way or another facilitated our work. Dr. L. F. Spath, F.R.S., released the Macfadyen-Hunt collections of nautiloids to Haas for study and because of his extensive knowledge of fossil cephalopods was able to make many helpful suggestions and criticisms. The authorities of the British Museum (Natural History), particularly the former Director, the late Dr. C. Forster-Cooper,

F.R.S., and the Deputy Keeper of the Department of Geology, Dr. E. I. White, granted Haas permission to work in the Museum for several months and to make comparisons with the numerous specimens in the extensive collections housed there. Dr. A. T. Hopwood and Mr. T. H. Withers helped in many ways, and the former read Haas' manuscript. Mr. A. G. Brighton of the Sedgwick Museum at Cambridge kindly sent all of the nautiloids in the Macfadyen-Hunt collections to Miller on loan and supplied him with the available data in regard to the horizon, locality, and catalogue number of every specimen. African collections that were of great help to us for comparative purposes were lent by M. L. S. Cahen and Dr. Edmond Dartevelle of the Musée du Congo Belge, Dr. Jean Roger of the Centre d'Étude et de Documentation paléontologiques (of the Muséum National d'Histoire Naturelle in Paris), and Engº. Henrique Vieira of the Angolan Repartição Central dos Serviços de Geologia e Minas. Dr. W. A. Macfadyen read our completed manuscript and offered many helpful suggestions and constructive criticisms, and he also wrote the Note at the end of this paper which explains the geology of the localities that yielded the described cephalopods. The photographs that accompany our text were retouched by Mr. Howard Webster of Iowa City, Iowa, and he also prepared the drawings. The completion of the report was made financially possible by the Graduate College of the State University of Iowa and particularly by Mr. F. O. Thompson of Des Moines.

GENERAL CHARACTERISTICS OF THE FAUNAS

IT SHOULD BE MADE CLEAR at the outset that unfortunately neither of us has had an opportunity to visit Somaliland and study there in the field the occurrence of the Tertiary nautiloids dealt with in this report. Furthermore, the associated fossils have as yet not been considered in detail. Our observations are therefore of necessity based entirely on laboratory studies of numerous nautiloids collected by others, viz., W. A. Macfadyen and J. A. Hunt, though we have, of course, attempted to make full use of the existing literature. Many of the data are presented in summary fashion by the accompanying tabular synopsis of British Somaliland Eocene Nautiloidea (fig. 1).

Both geographically and stratigraphically nautiloids are widely distributed in the marine Eocene of at least the north central portion of the country, and they are known to occur also in the east central part of it. Nevertheless, they have been found in abundance only in the section exposed along the Biyo Gora River at Daban, some 25 kilometers southeast of Berbera, where they occur in two zones which are rather far apart stratigraphically.

According to Macfadyen (1933, pp. 17, 18) and the labels on the specimens we are studying, in the Biyo Gora section these cephalopods are characteristic of "a marine intercalation locally termed the *Nautilus*-Beds, near the base of the great freshwater Daban Series in the Daban basin. . . . The *Nautilus*-Beds have a rich fauna which includes the foraminifera *Nummulites somaliensis* Nuttall and Brighton, *N. discorbinus* var. *major* Rozlozsnik, and *Dictyoconoides* of the group of *D. kohaticus* (Davies), and serves to correlate them precisely with a horizon of the normal marine succession of the Middle Eocene Karkar Series developed farther east. This correlation is supported also by some of the molluscan species, which, generally speaking, if common in one facies are rare in the other." Of the 116 specimens of nautiloids now known from British Somaliland, 89 came from these Nautilus beds in the Biyo Gora section at Daban, and the following forms are known to be represented there:

Eutrephoceras? sp. (one specimen)
Cimomia hunti, new species (two specimens)
Cimomia macfadyeni, new species (10 specimens)
Cimomia wyllei (Newton) (34 specimens)
Deltoidonautilus biyogorensis, new species (33 specimens)
Deltoidonautilus spathi, new species (seven specimens)
Deltoidonautilus? sp. (one specimen)
Aturia somaliensis, new species (one specimen)

Only one of these, *Cimomia wylliei*, has been described previously. That species was established by Newton (1925, pp. 166–167, pl. 17, figs. 1–3) for a single specimen from Kohl Der, a few kilometers west of the Biyo Gora section, where it was found in association with the only known representative of *Deltoidonautilus somaliensis* (Newton). The age of the beds that yielded the holotypes of these two species was believed by Newton to be Lower Eocene, but the geological map that accompanies Macfadyen's report of 1933 indicates that the specimens came from the Daban series, which is Middle Eocene. Furthermore, the reasons given by Newton for his age determination no longer seem to be valid. For example, he concludes that he considers "it demonstrated that, so far as can be ascertained, . . . angulate Nautili are confined in the Tertiaries to the Lower or oldest Eocene, being besides entirely absent in succeeding formations or in recent seas," whereas we now know that the genus *Deltoidonautilus* is represented in the Paleocene of Senegal, the Middle Eocene of Texas and Peru, and the Oligocene of Australia.

The great majority of the available specimens from the Nautilus beds are composed of more or less arenaceous buff-colored limestone, which weathers to a somewhat darker shade. However, all seven of the type specimens of *Deltoidonautilus spathi*, one of the paratypes of *D. biyogorensis* (Sedgk. Mus. No. C.12086), and one of the paratypes of *Cimomia macfadyeni* (No. C.12032), a total of nine specimens, are of brown calcareous sandstone, which apparently becomes friable upon weathering. According to Macfadyen (1933, p. 65) in the Biyo Gora section the Nautilus beds are approximately 65 meters

Genus					E[1]	Cimomia								Deltoidonautilus							A[2]		
Species					?sp.	buccinaeformis	hunti	karkarensis	macfadyeni	pusilla	septemcastrensis	wylliei	spp.	biyogorensis	aff. D. molli	singularis	somaliensis	spathi	sp.	?sp.	somaliensis	Totals by beds or localities	Totals by stages
Number					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
	Stage	Series	Bed or locality		Number of specimens																		
Eocene	Middle	Lower Daban	Nautilus beds		1		2		10			35		33			1	7		1	1	91	93
		Karkar	σ204 and φ255					1											1			2	
	Lower	Auradu	Allahkajid beds	Upper Camp 7[3]		2					6				1							9	25
				Middle φ45									2									2	
				Lower φ66							1		1			1						3	
			Relative position unknown	φ85						1												1	
				φ110 (σ172)							1		4									5	
				φ117 (σ187)							2											2	
				φ157						1												1	
Totals by species					1	2	2	1	10	2	10	35	7	33	1	1	1	7	1	1	1	116	
Totals by genera					1	69								45							1		

[1]Eutrephoceras. [2]Aturia. [3]Includes φ36 and φ42

FIG. 1. Synopsis of British Somaliland Eocene Nautiloidea.

thick and consist largely of brown calcareous sandstone with some shale, the upper portion of the sequence being relatively calcareous. He also indicates that nautiloids occur there in at least five zones, and the labels on certain of the specimens add a sixth (Macfadyen's ϕ25). The great majority of these specimens are marked as being merely from the Nautilus beds of the Biyo Gora. However, a more nearly precise horizon is given for a few of them, and we can be certain that *Eutrephoceras?* sp. occurs in the fourth zone from the bottom (Macfadyen's ϕ26); *Cimomia macfadyeni* in the third and fourth (Macfadyen's ϕ27 and σ26); *C. wylliei* in the first and fifth (Macfadyen's ϕ30 and σ25); and *Deltoidonautilus biyogorensis* in the first, second, third, and fourth (Macfadyen's ϕ30, ϕ28, ϕ27, and ϕ26). We can of course not be sure that specimens were collected from every zone in which their occurrence was observed and recorded. For this reason and because most of the specimens are not labeled in detail and their lithology does not seem to be distinctive, we cannot determine which species occur in the sixth zone (Macfadyen's σ24), nor can we ascertain the exact range of each of the several species within the Nautilus beds. This lack of precise data is most probably not very serious, for it seems likely that all of the species in question are part of a single fauna and that their distribution was controlled chiefly by ecological conditions.

It should perhaps be emphasized that many of the specimens from the Nautilus beds of the Biyo Gora section are much larger than those we have from elsewhere, except the two individuals from Kohl Der, described by Newton in 1925, which are likewise large and are now believed to be from the same general horizon. In these strata at Daban, both large and small specimens occur in abundance, suggesting that they are indigenous to that locality. All in all, it would seem that in Middle Eocene times nautiloids found essentially optimum living conditions there. Presumably these occurred in a sea that was of relatively short duration in the Daban basin, a depression which for the most part received only fresh-water sediments during the Middle Eocene.

The only large collection of Tertiary nautiloids obtained in British Somaliland came from the Nautilus beds in the Biyo Gora section at Daban. However, between 600 and 677 meters stratigraphically lower in the same general section, at a locality which Macfadyen designated "Camp 7," a total of nine specimens was secured. These represent the following species:

Cimomia buccinaeformis, new species (two specimens)
Cimomia septemcastrensis, new species (six specimens)
Deltoidonautilus aff. *D. molli* (Douvillé) (one specimen)

All of the specimens are composed of buff-colored limestone, which is not distinctive. According to the labels they bear, all are from the Allahkajid beds of the Auradu series, and a more nearly precise horizon is given for only five individuals, paratypes of *C. septemcastrensis*. One of these is from Macfadyen's ϕ42, one from his ϕ36, and three are from the "top 67 m. of Allahkajid" beds. Macfadyen (1933, pp. 23, 66) indicates that at this locality the Allahkajid beds are 189 meters in thickness, and he states that the "fossils labelled 'Camp 7' were collected by natives strictly" in the upper 77 meters. None of these forms is very close to those that occur in the Nautilus beds higher in the same general section, nor are the assemblages in these two zones reminiscent of each other. Furthermore, the strata that yielded the species just listed are regarded as Lower Eocene.

Cimomia septemcastrensis is also known to occur at Habal Reren, Dinasyu, and possibly Allahkajid. The last of these three localities is only about 25 kilometers to the northeast of Daban, but the other two are some 125 kilometers to the east of that place. Nevertheless, the containing strata at all of them were mapped by Macfadyen as being definitely Lower Eocene in age and as belonging in the well-characterized Auradu series. No other species of nautiloids are known to occur at Habal Reren. From Dinasyu we have, in addition to one of the paratypes of *C. septemcastrensis*, only four poorly preserved and/or distorted congeneric specimens of which we are unable to determine the specific affinities, and at Allahkajid were found a questionable representative of *C. septemcastrensis*, a

crushed specimen identified as *Cimomia* sp., and the holotype and only known representative of *Deltoidonautilus singularis*. All of these assemblages in which *C. septemcastrensis* occurs could well be of the same age, but the cephalopods alone cannot be said to justify a correlation of the containing beds.

Single specimens have been found at four additional localities in British Somaliland, and a fifth has yielded two individuals, of which unfortunately the specific affinities could not be determined. None of the forms seems to be diagnostic, and from these isolated occurrences no reliable conclusions can be reached as to the age and correlation of the fossiliferous beds.

In concluding this discussion, it will perhaps be well for us to mention that almost all of the nautiloids known from the Eocene of British Somaliland belong in two closely related genera, *Cimomia* and *Deltoidonautilus*, for we have, in addition, only a single representative of *Aturia* and an incomplete specimen that is being referred with question to *Eutrephoceras*. Furthermore, *Hercoglossa*, which is a conspicuous element in many early Tertiary faunas, is not represented here, though some of the more advanced species of *Cimomia* have rather strongly sinuous sutures and therefore approach it. *Cimomia* is also more or less gradational with *Deltoidonautilus*, and one of the most abundant Somaliland forms, *D. biyogorensis*, could be referred with about equal propriety to either of these genera. Both of them, as interpreted by us, have a considerable stratigraphic and geographic range in the country. As might be expected, this statement is particularly applicable to the more primitive one, *Cimomia*.

COMPARISONS WITH RELATED FAUNAS

THE LITERATURE on African Tertiary nautiloids is, in general, not very satisfactory, for it is anything but voluminous, is scattered and therefore difficult of access, and for the most part represents the work of authors who were primarily interested in other things and dealt with nautiloids more or less incidentally. Furthermore, a considerable portion of it is old, commonly illustrations are wanting and when present leave much to be desired, many of the descriptions are brief and generalized, and the terminology employed varies greatly and is not always readily understood. An attempt at a more comprehensive treatment of this subject is Miller's (1951) recently published study of west coastal African Tertiary forms.

Fourtau (1901, p. 171) long ago stated that nautiloids are not abundant in the Tertiary of Egypt, but Dr. W. A. Macfadyen has written us (January 16, 1950) that aturias are "common in parts of Egypt and the Mediterranean area." The Mokattam escarpment near Cairo has yielded *Cimomia mokattamensis* (Foord), of which *Nautilus nubari* Cossmann is a synonym, *Deltoidonautilus aegyptiacus* (Foord), and the forms Oppenheim (1906, pp. 346–347) referred to *Aturia ziczac* (Sowerby). All of these are presumably of Eocene age, but in so far as we can tell from the published data, none is very similar to any of the Somaliland species we are describing. *Aturia praeziczac* Oppenheim of the Esneh shale (Paleocene or possibly Danian; see Faris, 1947) near Thebes is more primitive than the only congeneric species known from British Somaliland, and *A. pre-aturi* Cuvillier of the Upper Eocene (Bartonian) near Gizeh appears to have a relatively wide conch which is very broadly rounded ventrally. Hume (1916, pp. 40, 42, 69, 94, pl. 11, fig. 7) indicates that "*Aturia aturi*" occurs in the Miocene of the Egyptian Red Sea oilfields region near the mouth of the Gulf of Suez, and he states that in this area "a valley draining the southern end of the Inner Zeit depression . . . is characterized by the abundance of the nautiloid *Aturia* and will be termed the *Aturia Valley*." In connection with Egyptian and Sinaiic geology, Macfadyen (1931) cites the occurrence of *Aturia* in the Miocene of the "Clysmic (or Greater Gulf of Suez) Area" as well as Austria, Transylvania, Malta, and Cyprus; and he has written us that it "was used in Egypt and Sinai as a very useful index fossil." The representative of the same genus which Miller and Downs (1950, pp. 16, 17, pl. 4, fig. 4) illustrated and described from the Miocene of Sinai is small and immature, but it is so greatly different in age from *A. somaliensis* that the two are almost certainly not very close. For the sake of completeness, it should also be added that VanderHoof (1950) has recently mentioned "celestitized nautiloids from the Eocene of Faiyum, Egypt." In 1943 Avnimelech (pp. 115–119) described some poorly preserved aturias from both southwestern and northwestern Palestine and referred all of them to *A. rovasendiana* Parona of the Upper Eocene of northern Italy, but the data available in regard to these specimens do not permit detailed comparisons. Macfadyen indicated in his letter of January, 1950, that F. R. S. Henson had told him that "*Aturia aturi*" is known from the Miocene of Syria and "that a large-Nautiloid horizon in the Middle Eocene is also found in parts of Arabia, including the Qatar Peninsula." Henson, Browne, and McGinty (1949, pp. 20, 21) note the occurrence of "*Aturia aturi*" in the Miocene of Cyprus.

Altogether, a good many nautiloids have been reported from Libya by Agnesotti (1937) Alberici (1940), Fucini (1919), Krumbeck (1906), Negri (1934), Quaas (1902), Sorrentino (1932), de Stefani (1913), and others. However, none of the assemblages seems to bear more than superficial resemblance to those we are describing from British Somaliland, a fact that was perhaps to be anticipated because most of these north African forms are Cretaceous in age. To be sure, part of them, for example, collections studied by Agnesotti and Negri, are stated to be from the early Tertiary, but if they are closely related to the Somaliland forms under consideration, we have not been able to detect it from the available literature in regard to them.

From Morocco Miller (1951, pp. 35–36,

pl. 2, figs. 3, 4) has described a typical representative of *Eutrephoceras*. That genus is known to be of widespread occurrence in both the Cretaceous and the Tertiary, but the only representative of it that has been found in British Somaliland is a fragment of uncertain affinities.

French West Africa has yielded Tertiary nautiloids in Senegal, French Sudan, Niger, and Togo. All the available data in regard to them have recently been summarized by Miller (1951, pp. 18–20). Through the work of a good many men, especially Douvillé and Tessier, we now know the following forms from this general region:

Senegal
  Paleocene
    Cimomia tessieri Miller
    Hercoglossa sp. (aff. *H. diderrichi* Vincent)
    Deltoidonautilus rogeri Miller
  Eocene
    Deltoidonautilus molli (Douvillé)
    D. senegalensis (Douvillé)
    D. sp. (aff. *D. togoensis* Miller)
French Sudan
  Paleocene
    Cimomia sudanensis Miller
    Deltoidonautilus molli (Douvillé)
  Eocene
    Cimomia sahariensis (Keller)
    Deltoidonautilus chudeaui (Douvillé)
    D. lemoinei Miller
    D. molli (Douvillé)
Niger
  Eocene
    Deltoidonautilus molli (Douvillé)
Togo
  Eocene
    Deltoidonautilus togoensis (Miller)

The only one of these several species that is particularly close to a British Somaliland form is *Deltoidonautilus molli*, which seems to be a widespread, long-ranging type of relatively little value for precise correlation. Perhaps all of the specimens that have been assigned to it are only superficially similar and represent more than one species, but that does not appear to be the case. Presumably the Somaliland and the French West African faunas show only a general similarity, because the two regions are fairly remote from each other, and during the Eocene they may have been separated by a barrier so that migration between them was restricted.

Almost a hundred nautiloids have been collected from the early Tertiary strata in the sea cliff at Landana of the Angolan Cabinda exclave, and a few specimens have been found at near-by localities. Altogether, only four species appear to occur there: *Eutrephoceras dartevellei* Miller, *Cimomia landanensis* (Vincent), *Hercoglossa diderrichi* (Vincent) and *Deltoidonautilus caheni* Miller. The first and the last of these occur in the Eocene and possibly the Paleocene; the other two are exclusively Paleocene. None of them is very close to the forms we have from British Somaliland, as was to be expected, for the great majority of the Cabinda specimens came from the Paleocene and therefore are older than the forms under consideration.

Central western Angola has yielded a single specimen that is referable to *Aturoidea*, the holotype of *A. vieirai* Miller. No congeneric forms have been found in British Somaliland.

Aturia is known from two localities in Angola proper and from one locality in Southwest Africa. All of the known representatives of that genus are very much alike, but it is not probable that these southwestern African forms are closely related to the one we have from the Eocene of British Somaliland, for they are all believed to be Miocene in age.

Two rather poor nautiloids from the Lower Miocene of Pemba Island, Zanzibar, were studied by Cox in 1927. One of these appears to be a rather advanced representative of the genus *Aturia*, whereas the other, for which Miller (1947, p. 88) proposed the name *Aturia? coxi*, is unique. The only aturia known from British Somaliland is a relatively primitive form and is not similar to either of Cox' specimens. Furthermore, there is little likelihood that it is closely related to the form that Cottreau and Collignon (1925, p. 278) list from the Lower Miocene of Makamby Island, northwestern Madagascar. *Hercoglossa*, which according to Basse (1931, pp. 8, 13, pl. 1, fig. 15, pl. 10, fig. 6) is represented in Madagascar, is not known from Somaliland.

The many publications of the Geological Survey of India contain a wealth of paleontological data compiled by a number of distinguished authors, and one can be reasonably certain that the Tertiary nautiloids found in south central Asia have received

careful consideration. In view of the general proximity of this region to Somaliland and especially because of the belief that at least some of the Tertiary seas there were connected with those in central Africa, it seemed probable that close counterparts of the faunas we are studying would occur in India. However, in the writings of Blanford, Cossmann, Das-Gupta, Douvillé, Pissarro, Stoliczka, Vredenburg, and others, we find no such faunas discussed. To be sure, all the genera known from British Somaliland are also represented in India, and one can point to certain specific similarities, but no assemblage is known from southern Asia that is comparable to that which we have from the Nautilus beds at Daban, the largest single fauna of Tertiary nautiloids from all Africa. Probably the one that comes closest is that studied by d'Archiac, Haime, Cossmann, Pissarro, and Vredenburg from the upper Ranikot series, especially near Kotri in Sind. Both *Cimomia* and *Deltoidonautilus* seem to be abundantly represented there. Nevertheless, only in general is the fauna related to that of Daban, and the differences are probably more significant than the similarities. Of course it is possible that a direct comparison of large collections from the two areas would reveal closer affinities than we can recognize from a study of the specimens and the literature available to us.

As is well known, the literature contains abundant reference to Tertiary nautiloids from many other localities in Asia, and in Australia, Europe, and the Americas, but none of the assemblages from these distant places seems to bear more than a general similarity to those we are studying from British Somaliland. This fact is, of course, in harmony with the belief that nautiloids are of less stratigraphic value than ammonoids, though they were almost certainly free-swimming, rapidly moving creatures and presumably could have migrated quickly and even crossed open oceans. The chief difficulties encountered in their use are owing to the lack of definite characteristics that can be employed in the determination of precise affinities. For example, most of the cimomias of the Eocene are more or less generalized forms which are not very distinctive, and *Cimomia* is known to have a long range in the early Tertiary. Furthermore, collections from those localities that yield many specimens indicate clearly that we should allow species a considerable amount of latitude, for there is much gradational variation, and inasmuch as essentially all the individuals have been subjected to at least some distortion during preservation, it is not practical to rely on precise measurements or on ratios determined from them.

Two genera are known to be represented in the British Somaliland faunas under consideration by only one specimen each. That which we are referring to *Eutrephoceras* is so incomplete that even its generic affinities are uncertain, and no species have been described that are very similar to it. Our single aturia is quite a satisfactory study specimen, but *Aturia* is known to be of world-wide distribution and stratigraphically to range from the Paleocene (and possibly the Cretaceous) well up into the Miocene, and as noted by Olsson (1928, p. 97) most of the numerous forms that have been named "are very similar, and it is still a question, how many really distinct species should be recognized." *Aturoidea* and *Hercoglossa*, which are intermediate between *Aturia* and *Cimomia* and which occur in early Tertiary faunas in many parts of the world, are conspicuous by their absence in the British Somaliland collections, as is also the rare genus *Woodringia*.

All in all, it therefore seems that *Deltoidonautilus*, the other genus known from the Tertiary of Somaliland and elsewhere, is perhaps the best for stratigraphic purposes. It was not recognized and named until relatively recently (Spath, 1927a, p. 22) but is now known to occur in such widely separated localities as England, India, Australia, French West Africa, Angola, Texas, and Peru. Although this genus has been generally believed to be "confined to the Eocene" (Miller, 1947, p. 65), it is now known to range from the Paleocene to the Oligocene, inclusive. Our *D. biyogorensis* and *D.* aff. *D. molli* (Douvillé) are perhaps distantly related to *D. elliotti* Stenzel of the Middle Eocene Reklaw formation of Texas, our *D. singularis* to *D. hazarensis* (Das-Gupta) of the Eocene of Punjab in northern India, and our *D. spathi* to *D. sowerbyi* (Wetherell) of the Lower Eocene London clay of England. It should, however,

be emphasized that in no case is the species identical or is the similarity great enough to be of more than general stratigraphic significance. At most localities in which this genus has been found, it is fairly rare (only a very few specimens are known from both North and South America), but from British Somaliland a total of 44 or 45 specimens has been collected, of which all but four came from one horizon and locality, the Nautilus beds at Daban. This fact merely serves to emphasize the uniqueness of the Somaliland faunas under consideration and accentuates the difficulty of correlating the beds that yielded them with cephalopod-bearing Tertiary strata in other parts of the world.

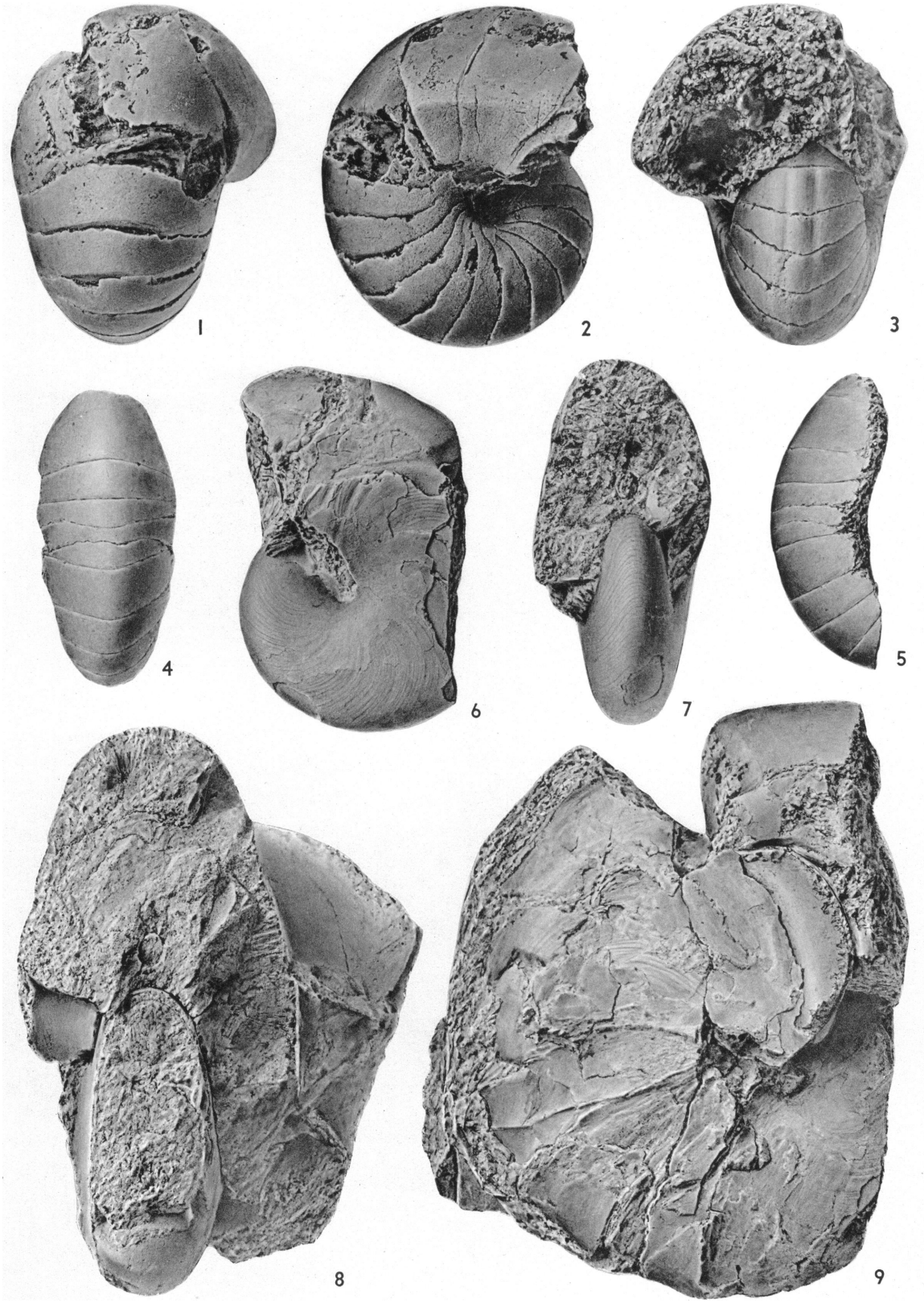
It seems clear that during the early Tertiary nautiloids must have been locally more abundant and in general far more numerous than they are today. In such widely separated areas as northwestern Angola, western India, northwestern Peru, and the North American Gulf Coastal Plain they occur in quantities reminiscent of those we are studying from north central British Somaliland. However, the faunas of each of these regions are distinctive and exhibit only a general similarity to those of the others. The British Somaliland assemblage is perhaps closest to that of Sind in western India.

PLATE 21

1–3. *Cimomia pusilla*, new species. Holotype from the Lower Eocene Auradu series at Bihen Gaha, British Somaliland (Macfadyen's ϕ85). ×3½. Sedgk. Mus. No. C.11979.

4, 5. *Eutrephoceras?* sp. Ventral (4) and lateral (5) views of an incomplete specimen from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland (Macfadyen's ϕ26). ×1. Sedgk. Mus. No. 12004.

6–9. *Aturia somaliensis*, new species. Holotype (8, 9) and early mature portion of the same specimen (6, 7) from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×1. Sedgk. Mus. No. C.12073.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SYSTEMATIC PALEONTOLOGY

FAMILY **EUTREPHOCERATIDAE** MILLER, 1951

GENUS **EUTREPHOCERAS** HYATT, 1894

Eutrephoceras? sp.

Plate 21, figures 4, 5

The collections under consideration contain a moderately small specimen which is an internal mold of the ventral portion of part of one volution of a coiled phragmacone. In its present slightly crushed, very incomplete state, its over-all length measures about 48 mm. and its maximum width about 23 mm.

The general physiognomy of this specimen indicates that the conch was tightly coiled and deeply involute, and that the umbilicus was therefore small. The ventral zone is rather narrowly rounded, and the ventrolateral zones are broadly rounded. Although the dorsal portion of the conch is not represented, the cross section was almost certainly higher than wide.

The surface of the internal mold is almost smooth, but faint traces of the increments of growth can be discerned on it. These suggest that the conch bore a deep, narrowly rounded, ventral sinus.

The eight camerae that are represented are of variable length, but in general they seem to become longer adorally. On at least the ventral and ventrolateral zones of the conch, the sutures are essentially straight and directly transverse. Structures that may possibly represent the siphuncle suggest that it was located about halfway between the venter and the mid-height of the conch.

REMARKS: The general shape of this specimen is not reminiscent of the genotype of *Eutrephoceras*, *E. dekayi* (Morton), of the Upper Cretaceous of North America. However, all of its characters that can be determined seem to indicate that it is closer to that species than to any other genotype. Therefore, it is being referred with question to that genus.

Because of the incompleteness of the specimen, detailed comparisons with other forms are not possible. However, it does not seem to be particularly close to any of the Eocene species with which we are familiar. It may well represent the inner adolescent volutions of a conch that was much different at full maturity.

OCCURRENCE AND MATERIAL: A 1-meter, soft brown, calcareous sandstone just above the middle of the Nautilus beds in the lower Daban series (Middle Eocene) of the Biyo Gora section (Macfadyen's ϕ26), at Daban, north central British Somaliland; one specimen (Sedgk. Mus. No. C.12004).

FAMILY **HERCOGLOSSIDAE** SPATH, 1927

GENUS **CIMOMIA** CONRAD, 1866

Cimomia buccinaeformis, new species

Plate 22, figures 1, 2

In the Biyo Gora section at Daban, the upper part of the Allahkajid beds yielded two rather well-preserved internal molds of nautiloids which differ from all of the other known Somaliland specimens in that the apertures of their conchs seem to have been flared. Both individuals appear to be almost complete orad, and both have a maximum over-all dimension of about 74 mm. One (pl. 22, figs. 1, 2) is essentially free from distortion and is designated the holotype. The paratype represents only about half a volution of the conch, and its adoral portion is somewhat distorted.

The conch is subglobular in shape and is more or less helmet-shaped in cross section, as it is broadly rounded laterally and especial-

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PLATE 22

1, 2. *Cimomia buccinaeformis*, new species. Ventral (1) and lateral (2) views of the holotype from the upper Allahkajid beds of the Auradu series (upper Ypresian) in the Biyo Gora section at Macfadyen's "Camp 7," Daban, British Somaliland. ×1. Sedgk. Mus. No. C11993.

3, 4. *Cimomia* sp. A small, somewhat crushed specimen from the Auradu series (upper Ypresian) at Dinasyu, British Somaliland (Macfadyen's ϕ110 [σ172]). ×1½. Sedgk. Mus. No. C.11984.

5, 6. *Cimomia karkarensis*, new species. Holotype from the Karkar series (Lutetian) at Daurarin, British Somaliland (Macfadyen's σ204). ×1. Sedgk. Mus. No. C.12090.

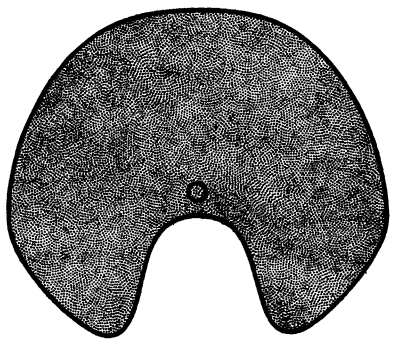


FIG. 2. *Cimomia buccinaeformis*, new species. Cross section of the conch, based on the adapical portion of the paratype. ×1½.

ly so ventrally, is rather deeply impressed dorsally, and is considerably wider than high. Near the junction of the phragmacone and the living chamber, the conch of the holotype is about 41 mm. wide and 29 mm. high. The maximum width is attained at or just outside the umbilical shoulders. Near the adapical end of the paratype, the width and height of conch measure about 35 mm. and 28 mm., respectively, and the impressed zone is about 11 mm. deep.

The preserved portion of the living chamber of the holotype is about a third of a volution in length. On the figured side of this specimen (pl. 22, fig. 2) the extreme adoral part of the conch appears to be somewhat flared. Only the adoral quarter volution of the paratype is non-septate and therefore referable to the living chamber. Although this part of the specimen is crushed and distorted, the aperture appears to have been considerably flared.

The umbilicus is rather small, closed, and inconspicuous. The umbilical shoulders are rounded and not very definite.

Each suture forms a very low, broadly rounded, ventral saddle and on either side of it a similar but narrower and somewhat asymmetrical lateral lobe, a relatively prominent, narrowly rounded, lateral saddle which centers near the umbilical shoulder, a shallow rounded lobe on the umbilical wall, and a small, moderately prominent, internal lateral saddle which centers just inside the umbilical seam and extends to the broad, shallow, rounded, dorsal lobe. As is clear from figure 2 on plate 22, there is a certain amount of variation in the shape of the sutures, but it is most probably more apparent than real. Nevertheless, the lateral lobes of the sutures become progressively more prominent during ontogenetic development.

The siphuncle is small and is located close to the dorsum. At the adoral end of the paratype, the siphuncle is about 2 mm. in diameter, and its center is about 3 mm. from the dorsum and 14 mm. from the venter. The internal structures of the holotype are not exposed.

REMARKS: Presumably the flared aperture of this species distinguishes it from all the other similar forms that have been found in Somaliland. Superficially it may resemble the inner portion of *Cimomia sahariensis* (Keller), a rather poorly known species from the Eocene of the southern Sahara. That form, which attains a very large size, has sutures which suggest a possible relationship to *C. vaughani* (Gardner) of the Paleocene of the North American Gulf Coastal Plain.

OCCURRENCE AND MATERIAL: Upper part of Allahkajid beds of Auradu series (Lower Eocene) in the Biyo Gora section at Macfadyen's "Camp 7," Daban, north central British Somaliland; two specimens (Sedgk. Mus. Nos. C.11993, holotype; C.11994, paratype).

Cimomia hunti, new species

Plate 23, figures 1–3; plate 24, figure 5

Two of the numerous Somaliland nautiloids now available for study differ from all the others in that they have exceptionally broad conchs. One is much larger than the other, and they may therefore not be conspecific. However, both are from the same horizon and locality, and the smaller is septate throughout and may well represent only the earlier portion of a conch.

The larger specimen is being designated the holotype. It represents about a quarter volution of a conch which is estimated to have attained a diameter of more than 25 cm. This specimen is primarily an internal mold of the adoral two camerae of the phragmacone and the adapical portion of the living chamber, but a large segment of the test is retained. The maximum width and height of the preserved portion of the conch measure about 18 cm. and 12 cm., respectively; and corresponding measurements of the impressed zone

are some 75 mm. and 45 mm. The shape of the cross section is shown in text figure 3.

The thickness of the test seems to be somewhat variable. Along the venter of the holotype it measures some 2 mm. near the junction of the phragmacone and the living chamber but decreases to about 1 mm. in the adoral portion of the specimen. Near the middle of the lateral zones it measures some 3 mm. The surface markings of the test are not preserved.

The umbilicus appears to be small, rounded, and rather inconspicuous. The umbilical shoulders are broadly rounded and indefinite.

The ventral length of each of the two preserved camerae of the holotype measures about 25 mm. The sutures form a low, broad, rounded, ventral saddle and on either side of it a similar but slightly asymmetrical lateral lobe, a smaller, much more narrowly rounded and more prominent dorsolateral saddle near the umbilical shoulder, a shallow, broadly rounded lobe on the umbilical wall, and a moderately prominent, rather narrowly rounded saddle which centers just inside the umbilical seam and extends to a broad, rounded, dorsal lobe.

The siphuncle is located fairly close to the dorsum. At its passage through the impression of a septum which forms the adapical end of the holotype, it is about 8 mm. in diameter and its center is some 15 mm. from the dorsum and 65 mm. from the venter.

The single paratype is a slightly distorted internal mold. It resembles the much larger holotype, but its conch seems to be a little more narrowly rounded ventrally and its sutures seem somewhat more strongly sinuous. Along the venter of this specimen there is a faint but clearly discernible raised line.

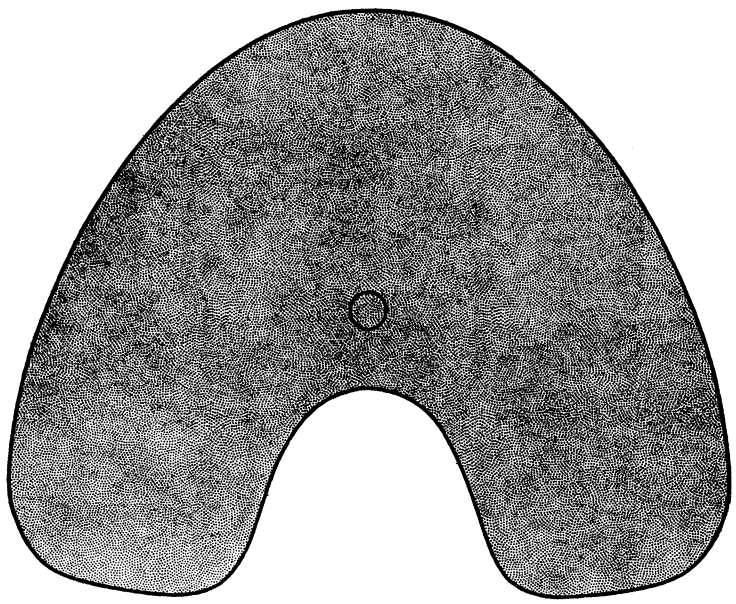


FIG. 3. *Cimomia hunti*, new species. Cross section of the conch, based on the adapical portion of the holotype. ×⅝.

REMARKS: The large size and subglobular shape of conch of this species suggest a relationship to *C. wylliei*, with which it occurs in association. However, in that form at full maturity the whorls are relatively higher and more narrowly rounded ventrally. Presumably the similarity between these two species is more or less superficial.

OCCURRENCE AND MATERIAL: Nautilus beds of the lower Daban series (Middle Eocene) in the Biyo Gora section at Daban, north central British Somaliland; two specimens (Sedgk. Mus. Nos. C.12076, holotype; C.12014, paratype).

Cimomia karkarensis, new species

Plate 22, figures 5, 6

One of the two nautiloids that have been found in the Karkar series is clearly referable to *Cimomia* but seems to be distinct from all the known representatives of that genus. This specimen is a subglobular internal mold about 106 mm. in diameter. It is largely free from distortion and is moderately well preserved in cream-colored, fine-grained limestone. Portions of the sutures are clearly visible in both umbilical depressions, and these indicate that this holotype is septate throughout.

The whorls are rounded ventrally, very broadly rounded laterally, and impressed dorsally. Near the adoral end of the holotype, the conch is about 65 mm. high, and its corresponding width (which is attained well outside the umbilical shoulders) is some 70 mm.; the impressed zone at this place is some 20 mm. deep.

The umbilicus is small and may have been filled with shell material. The maximum diameter attained by that of the holotype measures only about 13 or 14 mm. The umbilical shoulders are rounded and not very definite. The umbilical walls are moderately steep.

Each external suture forms a rather shallow, broad, rounded ventral saddle and on either side of it a similar but narrower lateral lobe, a relatively small but prominent lateral saddle, and a shallow rounded lobe which extends across the umbilical wall. No trace of the siphuncle seems to be visible on the only known representative of the species.

REMARKS: This form resembles *Cimomia wylliei* and *C. macfadyeni*, both of which occur in British Somaliland at about the same horizon, that is, in the Nautilus beds of the lower Daban series. It differs from the former particularly in that its conch is more broadly rounded ventrally. In *C. macfadyeni* the whorls are relatively high and narrow and the umbilicus is larger.

OCCURRENCE AND MATERIAL: Karkar series (Middle Eocene), at Daurarin (Macfadyen's σ204, 141 to 161 meters from the top of his Daurarin section XVII), north central British Somaliland; one specimen (Sedgk. Mus. No. C.12090).

Cimomia macfadyeni, new species

Plate 27, figures 5, 6

A relatively slender form of *Cimomia* is not rare in the Nautilus beds of the lower Daban series in the Biyo Gora section, and 10 representatives of it are available to us for study. All of these are only moderately well preserved, and most of them are internal molds. Two are composed of brown calcareous sandstone, but the rest are of buff limestone.

The largest is also the most nearly complete, is in many respects the best, and is therefore chosen as the holotype (see pl. 27, figs. 5, 6). This specimen is a completely septate internal mold, which has a maximum diameter of about 118 mm. Near the midlength of its adoral half volution, the height and corresponding width of conch measure some 55 mm. and 60 mm., respectively. Ventrally the conch is rather narrowly rounded, laterally very broadly rounded, and dorsally rather deeply impressed.

The umbilicus is small, and that of the holotype, at least, does not seem to be closed. The umbilical shoulders are rounded but fairly distinct.

The test is moderately thick. One of the paratypes shows that at least during early maturity it bears rather prominent surface markings, or growth lines. Each of these forms a fairly deep, narrowly rounded, ventral sinus and on either side of it a broad rounded salient which extends to the umbilicus.

The camerae are short, and there are about 10 in the adoral half volution of the holotype. Each external suture forms a low, rather narrowly rounded (for this genus) ventral saddle and on either side of it a shallow, broadly rounded lateral lobe, and a prominent, narrowly rounded dorsolateral saddle which centers just outside the umbilical shoulder. Although the shape of the internal sutures was not ascertained in detail, it is clear that they do not differ essentially from those of other congeneric forms.

The holotype does not reveal its siphuncle. Some of the paratypes, however, show that it is small and is located fairly close to the dorsum, the distance of its center from the dorsum being about one-fourth that from the venter.

REMARKS: For the most part the paratypes are not very satisfactory study specimens as they are crushed, rather incomplete, and/or not very well preserved. Some are of about the same general size as the holotype, but others are smaller, the maximum diameter of the smallest specimen being only about 55 mm. In general characteristics these specimens seem to coincide fairly well with the holotype. However, some are relatively broad ventrally and flattened laterally.

Although the conch in this species is much narrower than in the congeneric forms known from Somaliland, it is not so narrow as in the representatives of *Deltoidonautilus* which occur in association with it. In the latter genus, the ventral zone of the conch is subangular, or nearly so, and the whorls are therefore more or less triangular in cross section (impressed zone disregarded).

OCCURRENCE AND MATERIAL: Nautilus beds in the lower Daban series (Middle Eocene) of the Biyo Gora section at Daban, north central British Somaliland; more nearly precise data are available for two of the paratypes, one from Macfadyen's $\sigma 26$ and the other from his $\phi 27$; 10 specimens (Sedgk. Mus. Nos. C.12003, C.12006, C.12032–C.12036, C.12060, C.12061, C.12064; the holotype is No. C.12033).

Cimomia pusilla, new species

Plate 21, figures 1–3

This species is based largely on a small, well-preserved, limonitic internal mold, but another specimen from the same general horizon (at a distance of about 75 km.) is available for comparisons. Both are the only cephalopods known from the localities that yielded them.

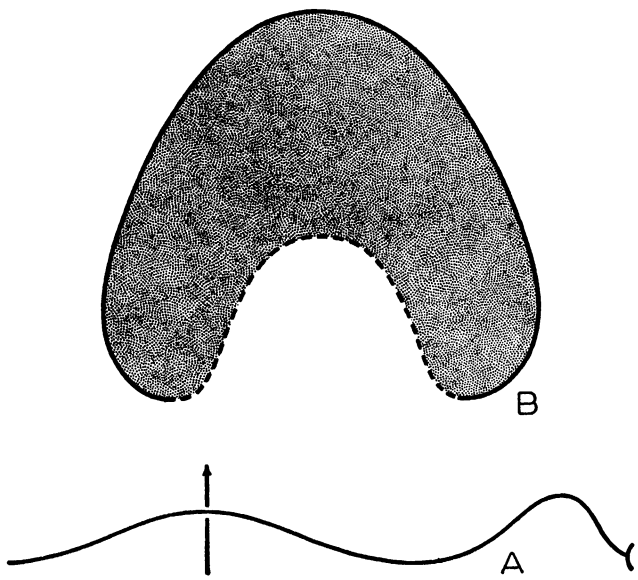


FIG. 4. *Cimomia macfadyeni*, new species. Diagrammatic representation of an external suture and a cross section of the conch, based on the mid-portion of the adoral half volution of the holotype. ×1.

The better specimen, which we are designating the holotype, has a maximum diameter of only about 16 mm., and the adoral third of its outer volution is non-septate and assumed to belong to the living chamber. Its conch is subglobular in shape and is rapidly expanded orad. The cross section is more or less semicircular (impressed zone disregarded), and the ventral and lateral zones are rounded. The depth of the impressed zone is estimated to be something like a third of the height of the conch. The maximum width of conch is attained well outside the umbilical shoulders. Near the mid-length of the adoral half volution of the holotype, the conch is about 10 mm. wide,

and its corresponding height measures about 7½ mm.

The umbilicus, though small, is fairly conspicuous. It may, however, have been largely filled by the test. The umbilical shoulders, though fairly definite, are rounded.

No trace of the surface markings of the test can be discerned on either of the type specimens. However, on the adapical fourth of the outer volution of the holotype, an internal mold, there is a low, rounded, ventral ridge which is bordered by shallow longitudinal grooves (see pl. 21, fig. 3).

The camerae are of about average length, and there are nine in the adoral half volution of the phragmacone of the holotype. Each external suture consists of a low, broad, rounded, ventral saddle and on either side of it a similar but somewhat asymmetrical lateral lobe and a much smaller but more prominent, narrowly rounded, dorsolateral saddle which centers just inside the umbilical shoulder. The nature of the internal sutures and the siphuncle is not revealed by either of the type specimens.

The single paratype is quite incomplete and is not very well preserved. In all available particulars, it does not seem to differ materially from the holotype, though its conch may be somewhat less rapidly expanded orad. Its maximum diameter measures about 15 mm. Inasmuch as both this specimen and the holotype are of about the same size, it seems logical to conclude that they had attained maturity although they are small.

REMARKS: In so far as we have been able to ascertain, this form is not very close to any previously described.

OCCURRENCE AND MATERIAL: Auradu series (Lower Eocene) of north central British Somaliland at Bihen Gaha (Macfadyen's ϕ85, holotype) and Garasgoi Hill about 7 kilometers south-southeast of Sheikh (Macfadyen's ϕ157, paratype); two specimens (Sedgk. Mus. Nos. C.11979, holotype; C.11988, paratype).

Cimomia septemcastrensis, new species

Plate 27, figures 1, 2; plate 28, figures 4, 5

At several localities in the north central part of British Somaliland, especially in the Biyo Gora section at Macfadyen's "Camp 7," there occurs a species of Eocene nautiloids characterized by a subglobular conch and only slightly sinuous sutures. It can be thought of as being more or less intermediate between typical representatives of *Eutrephoceras* and *Cimomia*, but it appears to be closer to the type species of the latter genus than to that of the former. We have 10 representatives of this form, all of which are internal molds.

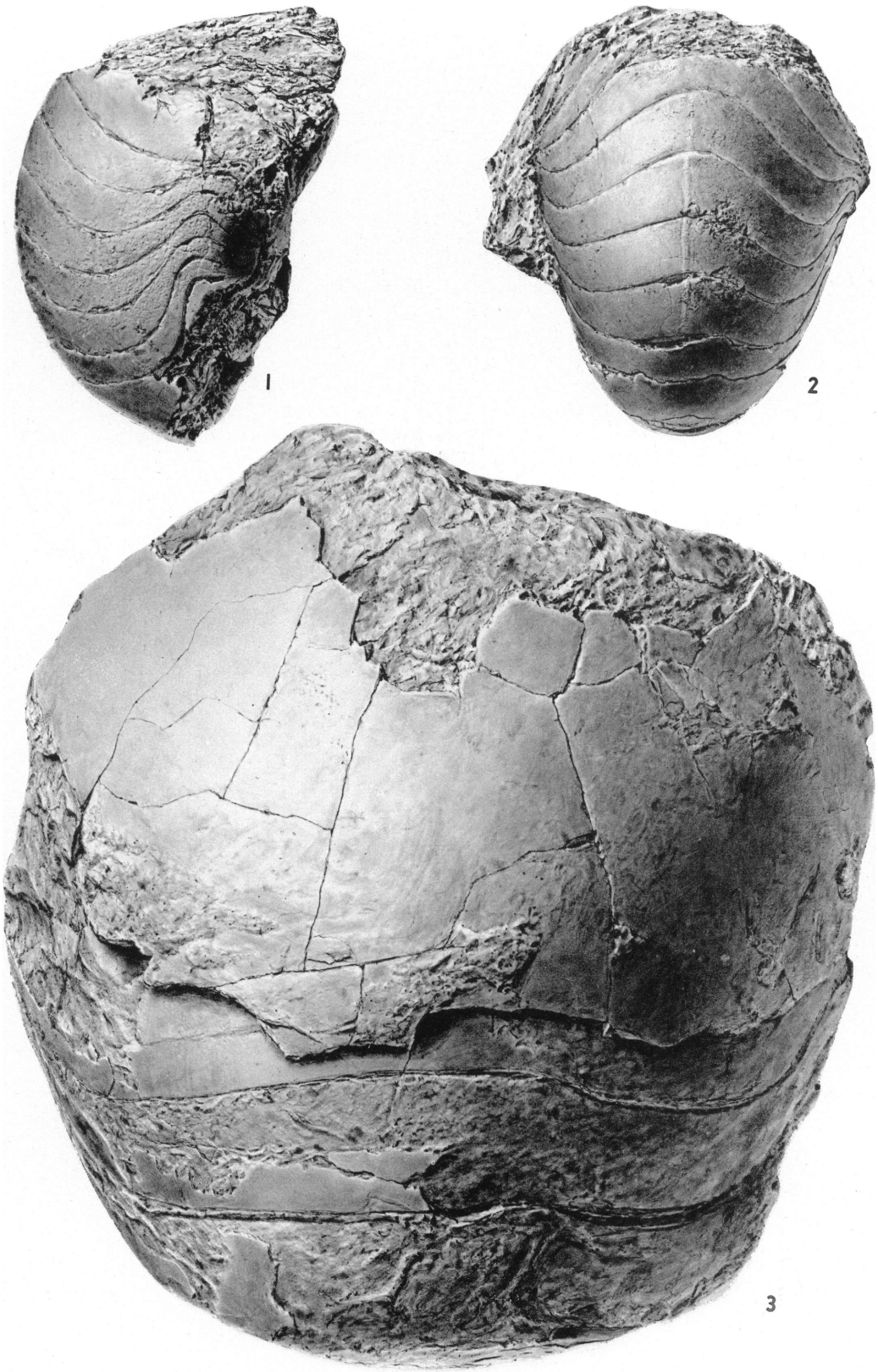
Of the two specimens illustrated, that shown by figures 4 and 5 on plate 28 is the better and is therefore designated the holotype. It represents the adoral six camerae of the phragmacone and apparently most of the living chamber. The adoral four camerae of this specimen are shorter than the preceding ones, suggesting that we are dealing with a fully mature individual. Its diameter measures about 85 mm. Three of the paratypes are of about the same general size as the holotype which therefore most probably approached the maximum attained by the species. However, the largest of the type specimens is about 106 mm. in diameter.

The whorls are low and broad and are more or less helmet-shaped in cross section, being broadly rounded ventrally and laterally and rather deeply impressed dorsally. Near the junction of the phragmacone and the living chamber, the width and height of conch in the holotype measure about 49 mm. and 38 mm., respectively. One of the unfigured paratypes shows that the living chamber attained a length of at least a little more than half a volution.

As in other congeneric forms, the umbilicus is small, inconspicuous, and almost certainly closed. The umbilical shoulders are rounded and not very definite.

PLATE 23

1–3. *Cimomia hunti*, new species. The paratype (1, 2) and the holotype (3), both from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×⅔. Sedgk. Mus. Nos. C.12014, C.12076.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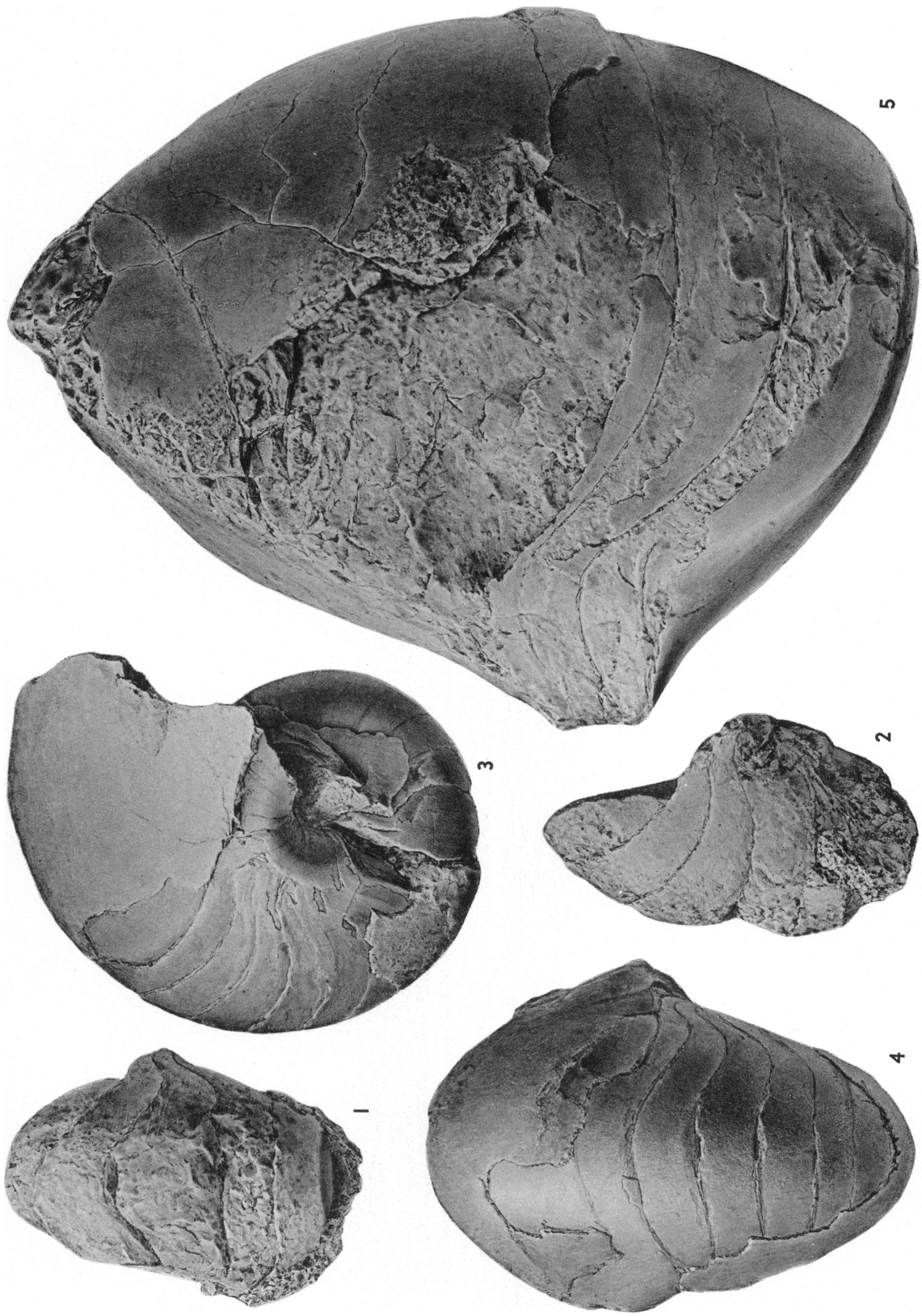
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Faint traces of the growth lines which are present on the holotype suggest that the aperture bore a moderately deep, rounded, hyponomic sinus and on either side of it a broad, rounded lateral salient. Also on the adoral portion of the living chamber of the next to the largest paratype, there are very low, broad, rounded, easily overlooked ridges which follow a course similar to that of the growth lines on the holotype.

As shown by figure 4 on plate 28, each external suture forms a low, broad, rounded, ventral saddle and on either side of it a similar lobe, and a narrower somewhat more prominent dorsolateral saddle which centers near the umbilical shoulder. One of the paratypes makes it clear that the internal sutures form a low, broad, rounded lobe on each umbilical wall and, centering just inside each umbilical seam, a moderately prominent, narrowly rounded saddle which extends to a broad, rounded, dorsal lobe.

The siphuncle is small and is located fairly close to the dorsum. At the adapical end of the preserved part of the adoral volution of the holotype, it is about $2\frac{1}{2}$ mm. in diameter and its center is about $11\frac{1}{2}$ mm. from the venter and is estimated to be less than 5 mm. from the dorsum.

REMARKS: The several specimens that we are referring to this species exhibit a certain amount of variation and may therefore not all be conspecific. For example, as mentioned above, the next to the largest paratype (which is from "Camp 7") possesses traces of low, sinous, transverse ribs. Also the adoral portion of the ventral zone of the conch of this specimen is slightly but distinctly flattened, possibly in part, at least, as a result of distortion during preservation. Nevertheless in all these specimens that we are grouping together the similarities appear to be more significant than the differences.

The slight sinuosity of the sutures and particularly the fact that their dorsolateral saddles are not very prominent are perhaps the most distinctive characteristics of this species. Furthermore, they might be taken to indicate that its affinities are with *Eutrephoceras* rather than *Cimomia*. However, all the other features of the conch, especially its general physiognomy, are reminiscent of the latter genus. None of the other forms known from Somaliland are more than superficially similar to this.

OCCURRENCE AND MATERIAL: All specimens are from the Auradu series (Lower Eocene) of north central British Somaliland. The holotype and one paratype are from Habal Reren, locality ϕ117[1] (σ187). Six more paratypes are from the Allahkajid beds in the Biyo Gora section at Macfadyen's "Camp 7"; of these, one is labeled ϕ36, one ϕ42, and three (including the specimen shown in pl. 27, figs. 1, 2) are marked as from the "top 67 m. of Allahkajid." Of the two remaining paratypes one is from Macfadyen's ϕ100 (his σ172) at Dinasyu, and the other (a poor specimen of somewhat uncertain affinities) is from the lower portion of the Auradu series, Macfadyen's ϕ66, at Allahkajid. Total of 10 specimens (Sedgk. Mus. Nos. C.11978, C.11985–C.11987, C.11989–C.11992, C.11996, C.11997; the holotype is No. C.11986).

Cimomia wylliei (Newton)

Plate 24, figures 3, 4; plate 25, figures 1, 2; plate 26, figure 1

Nautilus wylliei NEWTON, 1925, Monogr. Geol. Dept Hunterian Mus., Glasgow Univ., no. 1, pp. 166–167, pl. 17, figs. 1–3.

Cimomia wyllei SPATH, 1927, Ann. Mag. Nat. Hist., ser. 9, vol. 20, p. 427.

[1] The designation σ117 on the label of the holotype is obviously erroneous.

PLATE 24

1, 2. *Deltoidonautilus* sp. An incomplete specimen from the Karkar series (Lutetian) at Burud (Sawl), British Somaliland (Macfadyen's ϕ255). ×1. Sedgk. Mus. No. C.12074.

3, 4. *Cimomia wylliei* (Newton). Lateral (3) and ventral (4) views of the early mature portion of a phragmacone, from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×1. Sedgk. Mus. No. C.12011.

5. *Cimomia hunti*, new species. Lateral view of the holotype, from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×$\frac{2}{3}$. Sedgk. Mus. No. C.12076.

Cimomia Wyllei MILLER, 1947, Mem. Geol. Soc. Amer., no. 23, p. 39.

Cimomia wylliei MILLER, 1951, Ann. Mus. Congo Belge, ser. 8°, sci. geol. vol. 8, p. 44.

The original description of this species was based on a single, moderately large, well-preserved, completely septate internal mold from the Daban series at Kohl Der in the north central portion of British Somaliland. We have not studied this holotype, but the collections available to us contain 34 specimens that appear to be conspecific. All of these came from the lower portion of the Daban series in the Biyo Gora section, a few kilometers east of Kohl Der. As might be expected, there is a certain amount of variation among these specimens, but it does not seem to us to be constant and therefore to be of any appreciable taxonomic significance.

From a study of this new material and the published data in regard to the holotype, we have prepared the following description of the species. Conch large, attaining a maximum diameter of at least 38 cm. (pl. 26, fig. 1). At full maturity, the living chamber is half a volution or more in length. General shape of conch subglobular, as whorls are rounded ventrally, considerably flattened (but nevertheless very broadly rounded) laterally, and rather deeply impressed dorsally. The individual illustrated in plate 25 is of about the same general size as the holotype and resembles it closely. Near the midlength of the outer volution of our figured specimen, where its diameter measures about 12½ cm., the width and corresponding height of conch are approximately 9 cm. and 6 cm., respectively. During early maturity, the whorls are somewhat more narrowly rounded than at full maturity (cf. figs. 3 and 4 of pl. 24 with figs. 1 and 2 of pl. 25).

The umbilicus is moderately small but is not closed. It is more or less oval in shape, and its maximum diameter is about a seventh of that of the specimen; the umbilicus of the large specimen illustrated in plate 26 attains a maximum diameter of some 5½ cm. The umbilical shoulders are rounded and not very definite. On the internal mold they are more broadly rounded than on testiferous specimens. The umbilical walls are distinctly convex exteriorly and are moderately steep.

The test is fairly thick, particularly in the umbilical region. Where the diameter of the conch is some 16 cm., the thickness of the test measures about 4½ mm. on the umbilical wall, 5 mm. on the umbilical shoulder, and 1 mm. on the venter. The thickness decreases rather abruptly ventrad of the umbilical area, and 25 mm. from the umbilical shoulders it measures only about 1½ mm. The surface of at least the mature portion of the test bears fine but nevertheless quite distinct growth lines. Each of these forms a moderately deep, rather narrowly rounded ventral sinus and on either side of it a broadly rounded lateral salient which extends across the umbilical shoulder and onto the umbilical wall.

The length of the camerae varies somewhat, but in fully mature phragmacones there are about 11 camerae to the half volution. During adolescence the sutures are only slightly sinuous. However, each mature suture consists of a moderately low, broad, rounded, ventral saddle and on either side of it a similar but more broadly rounded lateral lobe, a smaller but somewhat more prominent, very narrowly rounded saddle just outside the umbilical shoulder, a shallow, rounded, umbilical lobe (which extends across the umbilical wall), and a rather narrowly rounded, internal, lateral saddle which extends to a broad, shallow, rounded, dorsal lobe.

The siphuncle is small in size, dorsal but not marginal in position, orthochoanitic in structure, and composed of essentially cylindrical segments. At its passage through the septum which forms the adoral end of the

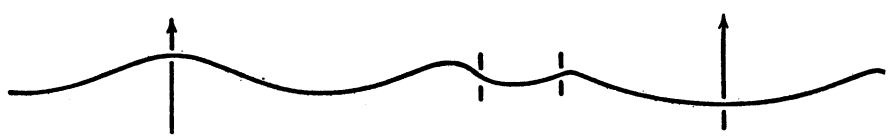

FIG. 5. *Cimomia wylliei* (Newton). Diagrammatic representation of a mature suture where the conch is some 65 mm. in diameter (a composite figure based on two specimens, with calculated portions). ×1.

figured portion of the specimen illustrated in plate 24 (figs. 3, 4), the siphuncle is about 4 mm. in diameter, and its center is about 8 mm. from the dorsum.

REMARKS: This species and the one for which we are proposing the name *Deltoidonautilus biyogorensis* are by far the most abundant in the collections under consideration. In both of these the shape of the conch is somewhat variable, and we have a few specimens that appear to be more or less intermediate, in part, at least, as a result of distortion during preservation. However, in typical *C. wylliei* the conch is more broadly rounded than that of *D. biyogorensis* and is therefore much less nearly triangular in cross section.

Although the sutures of *C. wylliei* are more strongly sinuous than those of some representatives of *Cimomia*, their inflections are not nearly so great as those of the genotype of *Hercoglossa*, *H. orbiculata* (Tuomey), of the Paleocene of Alabama. Furthermore, they seem to be quite similar to those of *C. burtini* (Galeotti) of the Eocene of Belgium, the genotype of *Cimomia*. That species is unfortunately not very well known, but it appears to differ from the one under consideration especially in that its umbilicus is relatively small and the lateral saddles of its sutures are more prominent. In both of these species the conch attains a large size and in general physiognomy is quite similar. It should perhaps be mentioned that the genera *Cimomia*, *Deltoidonautilus*, and *Hercoglossa* are closely related and are more or less gradational.

Cimomia wylliei is not close to any of the other forms known from the Tertiary of Africa, but superficially it resembles *C. haltomi* (Aldrich) of the Paleocene of Alabama. However, in that American species the whorls are relatively low and broad.

OCCURRENCE AND MATERIAL: Nautilus beds of the lower Daban series (Middle Eocene) in the Biyo Gora section at Daban, north central British Somaliland; more nearly precise data are available for only four specimens: two are from Macfadyen's $\sigma 25$ and two are from his $\phi 30$; 34 specimens (Sedgk. Mus. Nos. C.12000, C.12008–C.12013, C.12015–C.12031, C.12039, C.12053, C.-12054, C.12075, C.12079, C.12080, C.12083, C. 12085, C.12088, C.12089).

The holotype, the only other known representative of the species, came from the Eocene at Kohl Der (given by Newton as longitude 45° 15′ E., latitude 10° 10′ N.), Daban, north central British Somaliland. Newton believed the limestone bed that yielded this holotype to be Lower Eocene in age, but the geological map accompanying Macfadyen's report of 1933 indicates that it is part of the Daban series which belongs in the Middle Eocene.[1] The specimen is deposited in the Hunterian Museum at Glasgow.

Cimomia spp.

Plate 22, figures 3, 4

Largely for the sake of completeness, it should be mentioned that the collections we are studying contain seven specimens from three localities in north central British Somaliland that are so incomplete, distorted, and/or poorly preserved that their specific affinities cannot be ascertained with a reasonable degree of certainty. Furthermore, only one of these seems to merit illustration. All are internal molds, and their general physiognomy together with the shape of their sutures indicates that they are most probably referable to the genus *Cimomia*.

Four of these specimens, including the one illustrated by figures 3 and 4 in plate 22, are from the Lower Eocene Auradu series (Macfadyen's $\phi 110$ which equals his $\sigma 172$) at Dinasyu. All of these are of about the same general size and may well be conspecific. However, two of them are greatly crushed, and the others leave much to be desired. They are deposited in the Sedgwick Museum at Cambridge where they bear the following

[1] Wyllie recently wrote in a letter to W. A. Macfadyen dated January 20, 1950, that his specimens were collected from "some distance west of the Biyo Gora river." Other details published by him (1925, p. 10) indicate the stratigraphic position of his nautiloid horizon relative to two distinctive zones, one of massive black chert and the other of large silicified logs of wood. Both of these were observed by Macfadyen, and they stood in the same relation to his Nautilus beds. It is therefore reasonably certain that Wyllie's specimens also came from these strata (that is, Macfadyen's Nautilus beds) some distance west of the Biyo Gora section, along the strike.

Wyllie adds that the geographical coordinates given by Newton are merely rough approximations to indicate the site in an area that had not been mapped in detail. Macfadyen has informed us that "the name Kohl Der is useless as a precise indicator of position."

catalogue numbers: C.11980–C.11982, C.-11984 (the last is figured).

From the Allahkajid beds of the upper Auradu series in the Biyo Gora section (Macfadyen's ϕ45), we have two completely septate internal molds preserved in fine-grained, almost white limestone. The smaller is so severely crushed that it is of little significance. The larger has a maximum over-all diameter of about 79 mm., and its whorls are so low and broad as to be reminiscent of *C. hunti* of the Daban series. However, in view of the fact that the types of that species came from much younger beds, the similarity is probably more apparent than real. In the Sedgwick Museum these two specimens are No. C.11998 (larger individual) and No. C.11999 (smaller individual).

The other specimen under consideration (Sedgk. Mus. No. C.11977) is a crushed, "worn" fragment representing the umbilical portions of a phragmacone. Its present maximum over-all measurement is about 53 mm. Although the shape of its conch cannot be ascertained, its sutures suggest a relationship to *Cimomia*. It came from the lower Auradu series (Macfadyen's ϕ66) at Allahkajid.

Genus **DELTOIDONAUTILUS** Spath, 1927

Deltoidonautilus biyogorensis, new species

Plate 28, figures 1–3; plate 29, figures 4–7

Almost a third of the nautiloids from the so-called Nautilus beds of the lower Daban series in the Biyo Gora section at Daban, that is, more than 30 individuals, appear to represent a species intermediate between *Cimomia* and *Deltoidonautilus* but apparently closer at the latter.

The conch, which is very thickly sublenticular in shape, attains a large size, and we have one completely septate individual which is about 18 cm. in diameter. Near the adoral end of this specimen, the maximum height and width of conch measure about 8 cm. and 14 cm., respectively. During adolescence the whorls are rounded ventrally and are more or less helmet-shaped in cross section, as the lateral zones are broadly rounded and are somewhat converged ventrally, and there is a rather prominent dorsal impressed area. In later ontogenetic stages, the ventral zone of the conch becomes more narrowly rounded, the lateral zones are more nearly flat and more strongly converged, and the cross section is more nearly subtriangular (impressed zone disregarded). (See fig. 3 of pl. 28.) The living chamber is at least half a volution in length.

The umbilicus is small but not closed. Its diameter is only about a sixth (or less) of that of the specimen. The umbilical shoulders are abruptly rounded on the exterior of the test but on the internal mold are more broadly rounded. The umbilical walls are steep and slightly convex exteriorly.

The test is thick, particularly in the umbilical regions. That of a large specimen, some 18 cm. in diameter, attains a thickness of about 2 mm. along the venter and 5 mm. on the umbilical shoulders. The thickness decreases rather abruptly ventrad of the shoulders.

During early adolescence, the surface of the test bears prominent transverse lirae which form broad, shallow, rounded, ventral sinuses and similar lateral salients. These are particularly well preserved on an inner volution of the specimen represented by figures 5 to 7 on plate 29. On the mature portions of the conch there are finer and much less pronounced transverse markings, or growth lines. Each of these forms a deep, narrowly rounded, ventral sinus and on either side of it a broad rounded salient (which extends to the umbilical shoulder) and apparently a shallow sinus on the umbilical wall.

The camerae, of which there are approximately 10 in the adapical half of the outer volution of the holotype, are of about average length.

Each mature suture consists of a rather narrowly rounded ventral saddle and on each side of it a broad, shallow, lateral lobe, a smaller but prominent lateral saddle which centers outside the umbilical shoulder, a

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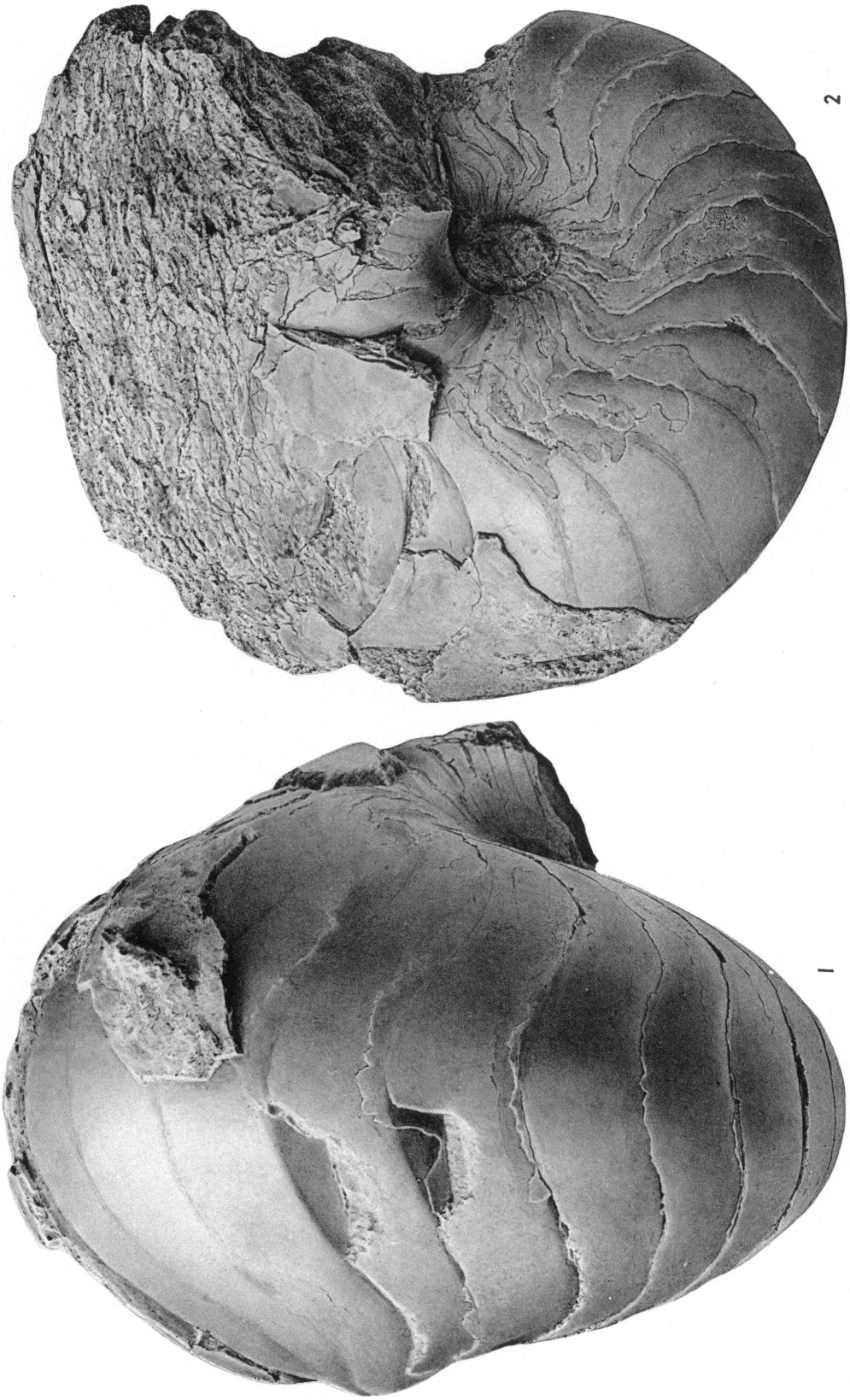
PLATE 25

1, 2. *Cimomia wylliei* (Newton). Ventral (1) and lateral (2) views of a completely septate mature specimen, from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×⅔. Sedgk. Mus. No. C.12030.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shallow, broadly rounded lobe on the umbilical wall, and a small, narrowly rounded saddle which centers just inside the umbilical seam and extends to the broad, shallow, rounded dorsal lobe. After maturity is attained, the sinuosity of the sutures does not seem to increase greatly.

The siphuncle is small in size, dorsal (but not marginal) in position, and composed of segments which are only slightly expanded within the camera (pl. 28, fig. 3; pl. 29, fig. 4). At the adoral end of the holotype, where the conch is about 63 mm. wide and 60 mm. high, the siphuncle is about 4½ mm. in diameter at its passage through a septum, and its center is about 11 mm. from the dorsum. The septal necks are short and straight and are only about a fourth as long as the camera.

FIG. 6. *Deltoidonautilus biyogorensis*, new species. Diagrammatic representation of an external suture where the conch is about 55 mm. high. ×1.

REMARKS: The specimens on which we are basing this species show a certain amount of variation in the relative proportions of the conch, the details of the shape of the sutures, and the position of the siphuncle. Most probably the differences are, in part at least, more apparent than real and are due to distortion, preservation, interpretation, and possibly sexual dimorphism.

Moderately early mature specimens can be confused with equal-sized representatives of *Cimomia wylliei* (Newton). (Cf. pl. 24, figs. 3, 4, with pl. 28, figs. 1–3). However, in that species the conch is more broadly rounded ventrally, and the whorls are therefore less nearly triangular in cross section.

Deltoidonautilus biyogorensis is believed to be a rather primitive representative of the genus, for its sutures are not very strongly sinuous and its conch is narrowly rounded rather than angular ventrally. It is perhaps somewhat comparable in its stage of development to *D. elliotti* Stenzel of the Middle Eocene Reklaw formation of Texas, in which the conch is even less nearly triangular in cross section and the dorsolateral saddles of the sutures seem to be more broadly rounded. In the genotype of *Deltoidonautilus*, *D. sowerbyi* (Wetherell) of the Lower Eocene London clay of England, the conch is much more nearly angular ventrally and the sutures are more strongly sinous. None of the congeneric forms known from Africa seems to be very close to the species under consideration, though *D. aegyptiacus* (Foord) of the Eocene of Egypt is perhaps somewhat related.

OCCURRENCE AND MATERIAL: Nautilus beds of the lower Daban series (Middle Eocene) in the Biyo Gora section at Daban, north central British Somaliland; more nearly precise data are available for only five specimens: two (including the holotype) are from Macfadyen's ϕ26, one is from his ϕ27, one from his ϕ28, and one from his ϕ30; 33 specimens, Sedgk. Mus. Nos. C.12001 (holotype), C.12002, C.12005, C.12007, C.12037, C.12038, C.12040–C.12052, C.12055–C.12059, C.12062, C.12063, C.12077, C.12078, C.12081, C.12082, C.12084, C.12086, C.12087.

Deltoidonautilus aff. **D. molli** (Douvillé)

Plate 29, figures 1, 2

One of the British Somaliland specimens seems to resemble rather closely *D. molli* (Douvillé) of the early Tertiary of French Sudan and Senegal (see Douvillé, 1920, pp. 139–140, text fig. 1, pl. 1, figs. 1, 2; Miller, 1951, pp. 57–61, pl. 24, figs. 3, 4; pl. 25,

PLATE 26

Cimomia wylliei (Newton). Lateral view of an exceptionally large specimen, from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×½. Sedgk. Mus. No. C.12088.

figs. 1, 2; pl. 26, figs. 1, 2; pl. 27, fig. 7). It is an internal mold representing most of a phragmacone and the adapical portion of the living chamber. Although one of its lateral zones is worn and incomplete, this individual does not seem to have been distorted very much during preservation. It is preserved in hard, very fine-grained limestone that is almost white but is somewhat mottled with light brown.

The whorls are flattened (but nevertheless very broadly rounded) laterally, very narrowly rounded ventrally, and deeply impressed dorsally. The lateral zones converge ventrally, and the maximum width of conch is attained well outside the umbilical shoulders. The phragmacone attains a maximum diameter of some 120 mm.; near its adoral end the conch is a little more than 70 mm. high and some 55 mm. (calculated) wide, and is impressed dorsally to a depth of about 30 mm.

The umbilicus is small; that of the specimen under consideration attains a diameter of only some 20 mm. The umbilical shoulders are rounded and rather indefinite.

No trace of the surface markings of the test is preserved. The camerae are rather short, and there are about 14 of them in the adoral half volution of the phragmacone. Each suture forms a very narrowly rounded, ventral saddle and on either side of it a low, broad, broadly rounded, lateral lobe, a similar but narrower lateral saddle, a shallow rounded lobe on the umbilical wall, and a rounded, internal, lateral saddle which extends to the deep, narrowly rounded, dorsal lobe.

The siphuncle is small, is circular in cross section, and is located fairly close to the dorsum. At a break near the mid-length of the adoral volution of the specimen, the siphuncle is about 4 mm. in diameter and its center is about 5 mm. from the dorsal wall of the conch.

REMARKS: This form is not very close to any of the congeneric forms in the collections under consideration. However, it is quite similar to *D. molli* (Douvillé), though it is most probably not referable to that species. A direct comparison with Douvillé's type specimen makes it clear that in the Somaliland form the umbilicus is smaller, the camerae are shorter, and the lateral saddles of the sutures are lower.

OCCURRENCE AND MATERIAL: Upper Allahkajid beds of Auradu series (Lower Eocene) at "Camp 7" in the Biyo Gora section at Daban, north central British Somaliland; one specimen (Sedgk. Mus. No. C.11995). The two pieces into which this specimen has been broken were treated as independent individuals by the collectors and were marked somewhat differently; however, both are labeled as being from Macfadyen's "Camp 7" and there is, therefore, no doubt as to the locality from which they came.

Deltoidonautilus singularis, new species

Plate 27, figures 3, 4

This species is based on a unique, small, very incomplete internal mold, the preserved portion of which is estimated to have attained a diameter of some 50 mm. It is well preserved and shows many of the more significant characters of the species.

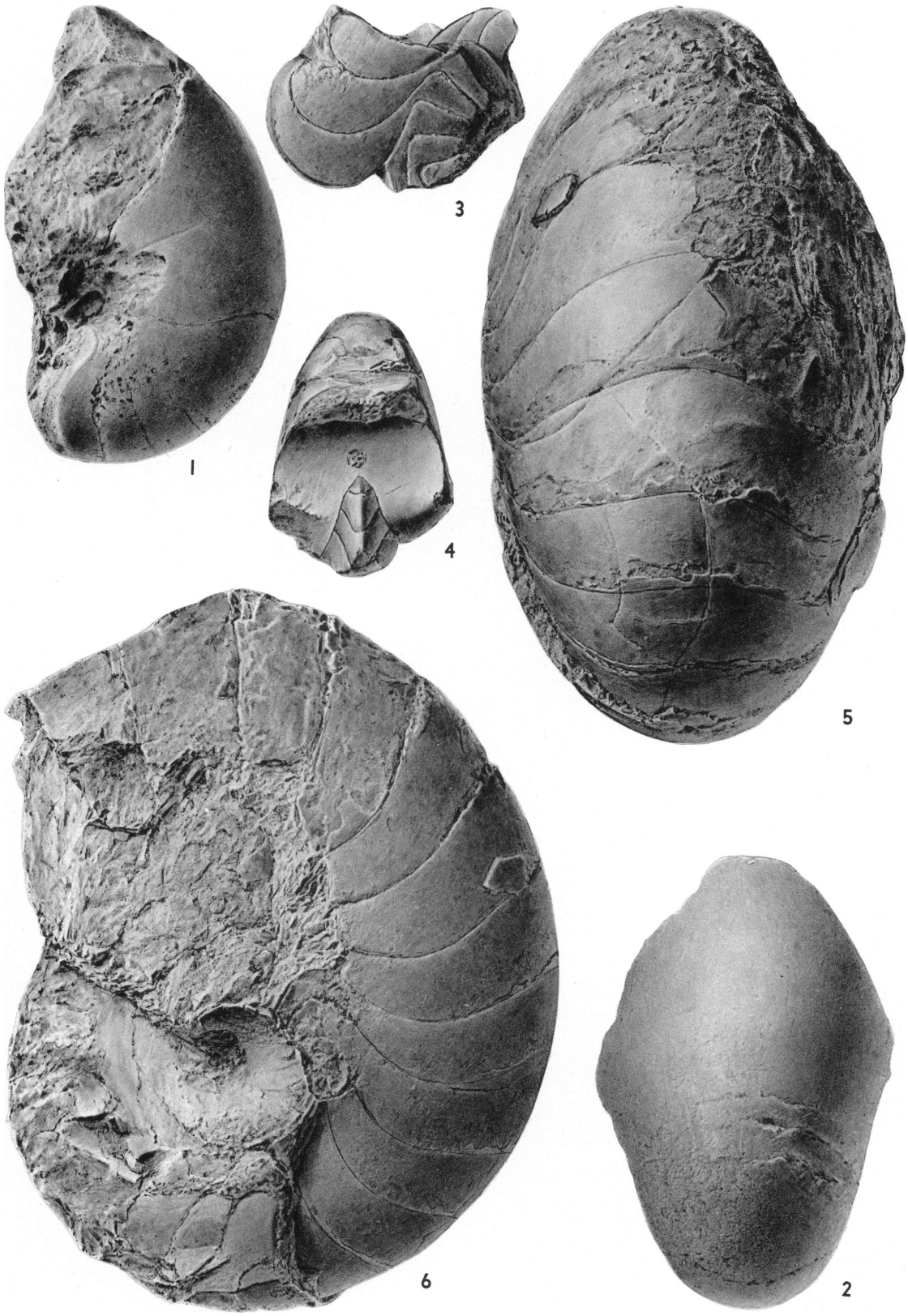
The general shape of the two volutions that are represented by the holotype was asymmetrically lenticular. The conch is almost triangular in cross section, as its lateral zones are strongly flattened and converged ventrally and its ventral zone is angular. The dorsal impressed zone is moderately deep. At the adoral end of the holotype, the conch is about 24 mm. wide, its corresponding height is estimated to have been some 35 mm., and the impressed zone is about 15 mm. deep. The maximum width of the conch

PLATE 27

1, 2. *Cimomia septemcastrensis*, new species. Lateral (1) and ventral (2) views of a paratype, from the upper Allahkajid beds of the Auradu series (upper Ypresian) in the Biyo Gora section at Macfadyen's "Camp 7," Daban, British Somaliland. ×1. Sedgk. Mus. No. C.11992.

3, 4. *Deltoidonautilus singularis*, new species. Holotype from the lower Allahkajid beds of the Auradu series (upper Ypresian) at Allahkajid, British Somaliland (Macfadyen's ϕ66). ×1½. Sedgk. Mus. No. C.11976.

5, 6. *Cimomia macfadyeni*, new species. Ventral (5) and lateral (6) views of the holotype, from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×1. Sedgk. Mus. No. C.12033.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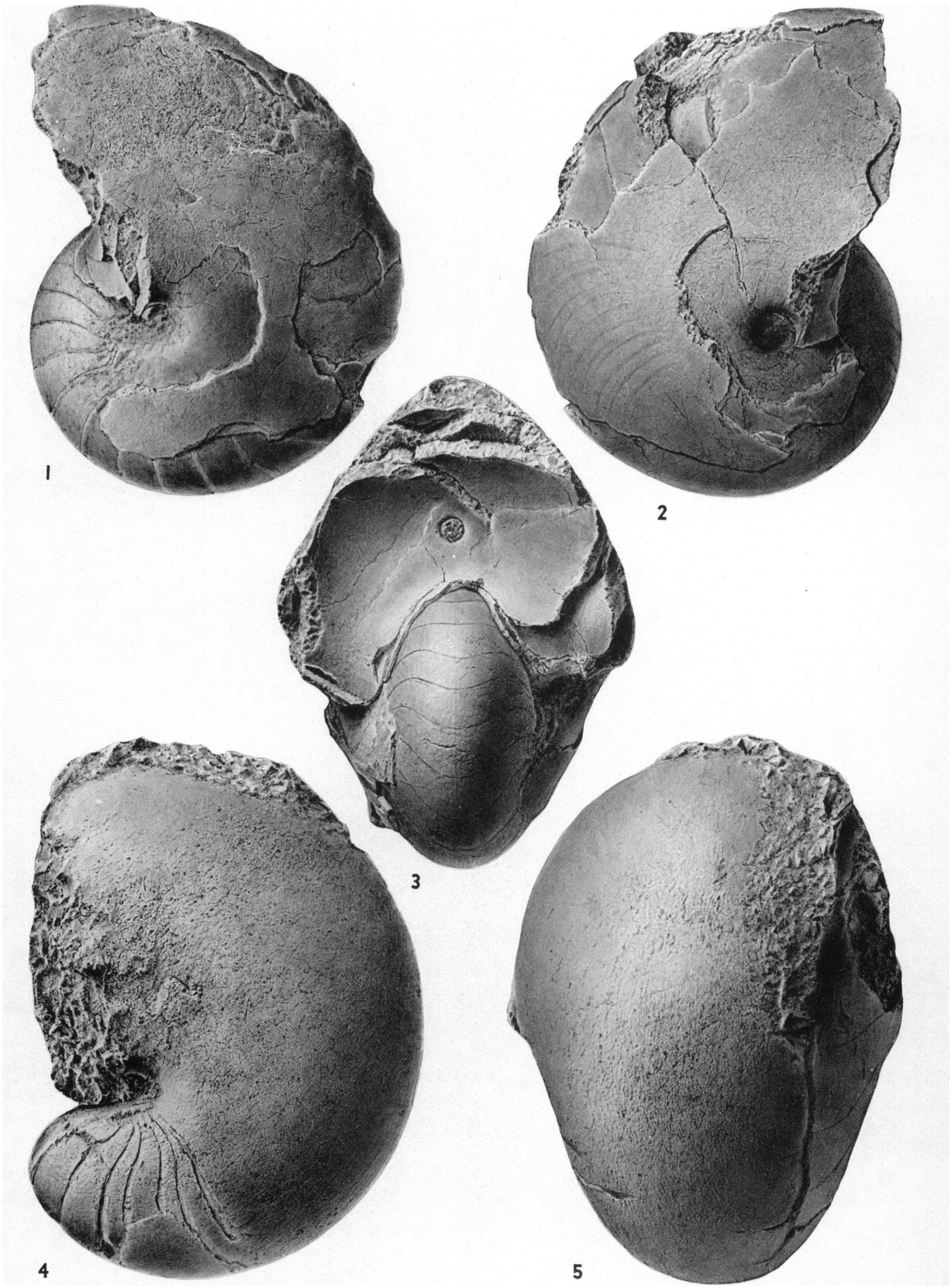
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is attained well outside the umbilical shoulders.

The diameter of the umbilicus cannot be ascertained, but it appears to have been small. The umbilical shoulders seem to be rounded but fairly distinct.

The surface of the holotype is marked by only the sutures, and no trace of growth lines or other surface "ornamentation" is discernible. The camerae seem to be of about average length. Each suture forms a high angular (or essentially so) ventral saddle and on either side of it a deep, rounded, almost symmetrical lateral lobe, a prominent subangular lateral saddle (located well outside the umbilical shoulder), presumably a shallow lobe centering on or near the umbilical wall, and a broad, rounded, internal, lateral saddle which extends to a rather deep subangular dorsal lobe.

The siphuncle is small and is located close to the dorsal wall of the conch. At the adoral end of the holotype it is about 2 mm. in diameter, and its center is a little more than 2 mm. from the dorsum.

REMARKS: Although this form came from the Lower Eocene, it appears to be an advanced member of the genus *Deltoidonautilus*. This conclusion is based on the fact that the two volutions represented by the holotype are small but nevertheless angular ventrally, and in both the sutures are strongly sinuous and form ventral and external lateral saddles which are almost angular.

None of the other congeneric forms known from British Somaliland is very close. *D. hazaraensis* (Das-Gupta) of the Eocene of India is somewhat similar, but both the ventral zone of its conch and the saddles of its external sutures are narrowly rounded.

As was noted by Vredenburg (Vredenburg and Cotter, 1928, p. 19) in several species of Tertiary nautiloids there is an "extreme scarcity of known individuals." This statement is certainly applicable to the form under consideration, for only a single representative of it has been found. Nevertheless, the specimen is quite distinct from all those previously recorded in the literature.

OCCURRENCE AND MATERIAL: Lower Allahkajid beds of Auradu series (Lower Eocene), at Allahkajid (Macfadyen's $\phi 66$ in his section IV), north central British Somaliland; one specimen (Sedgk. Mus. No. C.11976).

Deltoidonautilus somaliensis (Newton)

Nautilus somaliensis NEWTON, 1925, Monogr. Glasgow Univ. Hunterian Mus. Geol. Dept., no. 1, pp. 167–169, pl. 18, figs. 1, 2.

Deltoidonautilus somaliensis SPATH, 1927, Ann. Mag. Nat. Hist., ser. 9, vol. 20, p. 428.

Deltoidonautilus somaliensis STENZEL, 1940, Publ. Texas Univ., no. 3945, p. 762.

Deltoidonautilus somaliensis MILLER, Mem. Geol. Soc. Amer., no. 23, p. 65.

The single specimen on which this species is based, a large, well-preserved, thickly sublenticular internal mold, was illustrated and described by Newton in 1925, and the reader is referred to his work. We have not examined this holotype, but its periphery is stated to be "angulate in middle age but later becoming completely rounded and furnished with a median flattened groove extending for some distance around the body-chamber to the summit." This feature seems to be unique, and none of the specimens in the extensive collections we are studying possesses it. The generic affinities of this form are with *Deltoidonautilus*, a fact first noted by Spath, and it may well be related to *D. senegalensis* (Douvillé) of the Eocene of Senegal, for in that species also the venter becomes rounded during late ontogenetic development.

OCCURRENCE AND MATERIAL: Eocene at Kohl Der (given by Newton as longitude 45° 15′ E., latitude 10° 10′ N.), Daban, north central British Somaliland (footnote, p. 337). Newton believed the limestone bed that yielded the holotype to be Lower Eocene in age, but the geological map accompanying Macfadyen's 1933 report indicates that it is part of the Daban series that belongs in the

PLATE 28

1–3. *Deltoidonautilus biyogorensis*, new species. Holotype from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland (Macfadyen's $\phi 26$). ×1. Sedgk. Mus. No. C.12001.

4, 5. *Cimomia septemcastrensis*, new species. Lateral (4) and ventral (5) views of the holotype, from the Auradu series (upper Ypresian) at Habal Reren, British Somaliland (Macfadyen's $\phi 117$ [$\sigma 187$]). ×1. Sedgk. Mus. No. C.11986.

Middle Eocene; one specimen (Hunterian Mus., Glasgow).

Deltoidonautilus spathi, new species

Plate 29, figure 3; plate 30, figures 1, 2

Conch sublenticular and large, attaining a diameter of at least 23 cm. (the maximum over-all measurement of the holotype). Living chamber a third of a volution or more in length. Whorls are flattened laterally, narrowly rounded to subangular ventrally, and considerably impressed dorsally. As shown by figure 3 of plate 29, during early maturity the ventral zone of the conch is narrowly rounded, but at full maturity it becomes subangular. The lateral zones are converged ventrally, and the fully mature whorls are therefore subtriangular in cross section (impressed zone disregarded). The portion of the holotype represented by figure 3 of plate 29 is about 160 mm. in diameter, and near its adoral end the height and width of conch measure about 93 mm. and 82 mm., respectively, and the depth of the impressed zone measures about 30 mm. The maximum width of the conch is attained just outside the umbilical shoulders.

The umbilicus is moderate in size; that of the holotype attains a diameter of some 40 mm. The umbilical shoulders are rounded and indefinite, and the umbilical walls are very steep and slightly but distinctly convex.

All the seven type specimens are internal molds preserved in light reddish brown, fine-grained, friable sandstone. None retains traces of the surface markings of the test.

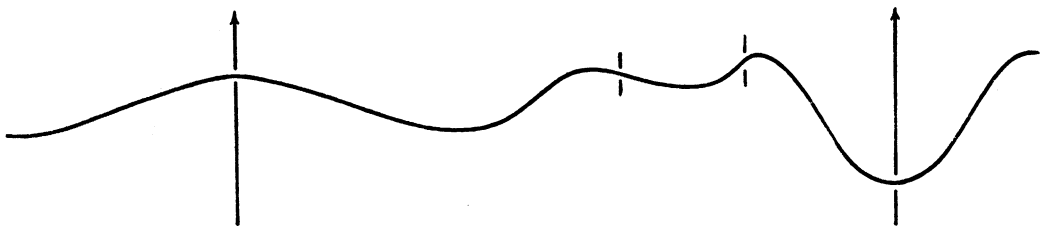

FIG. 7. *Deltoidonautilus spathi*, new species. Diagrammatic representation of an adoral suture of the holotype. ×½.

The camerae are fairly short, and there are about 12 in the adoral half volution of the phragmacone of the holotype. As shown in text figure 7, each mature suture forms a low, broad, subangular, ventral saddle and on either side of it a shallow, broadly rounded asymmetrical, lateral lobe, a more prominent rounded lateral saddle which centers just outside the umbilical shoulder, a very slight lobe on the umbilical wall, and a rather narrowly rounded, internal, lateral saddle which centers just inside the umbilical seam and extends to the large, rounded, dorsal lobe.

The siphuncle is small and dorsal but not marginal in position. Where the conch is about 85 mm. high, the siphuncle is about

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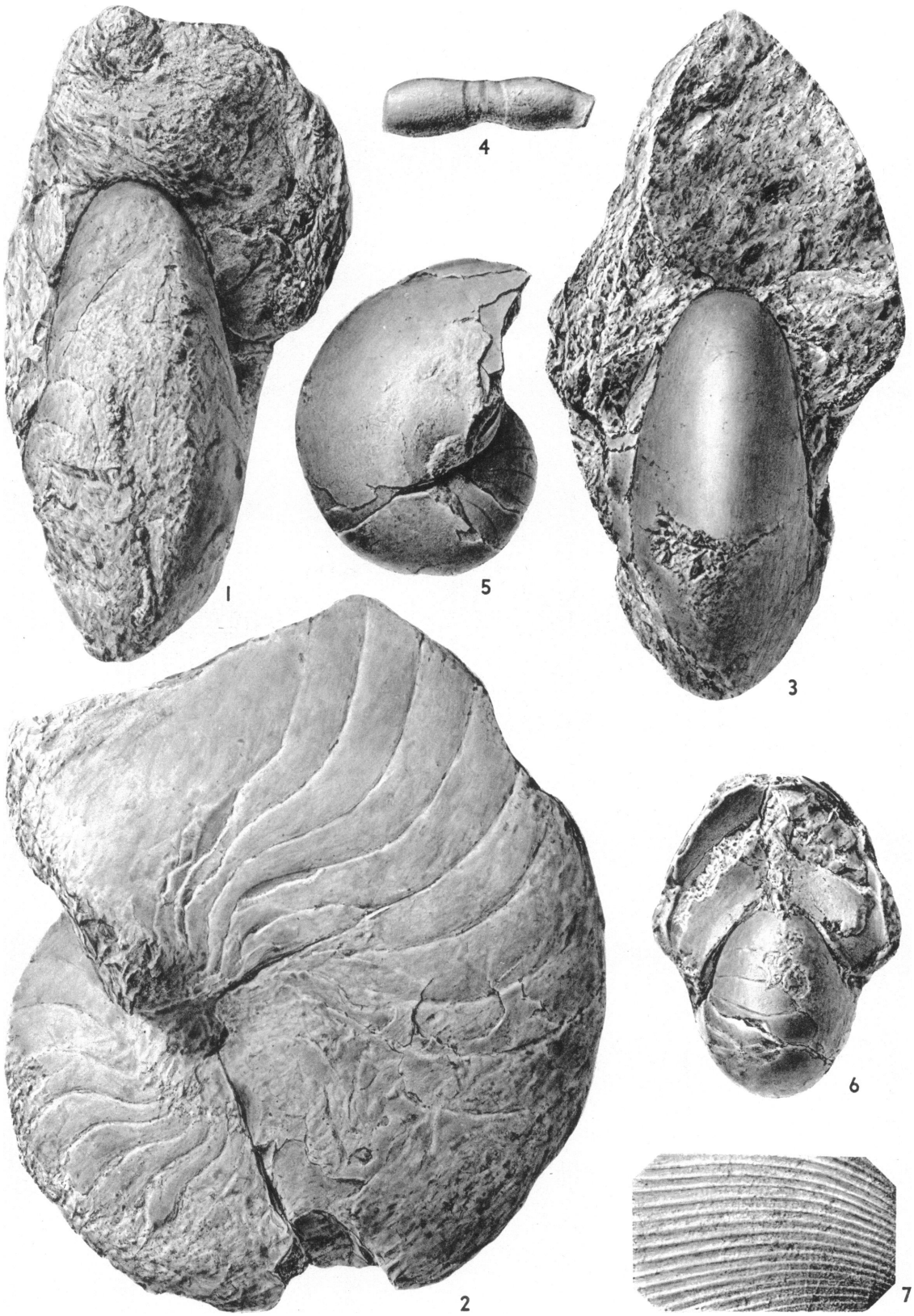
PLATE 29

1, 2. *Deltoidonautilus* aff. *D. molli* (Douvillé). A unique specimen from the upper Allahkajid beds of the Auradu series (upper Ypresian) in the Biyo Gora section at Macfadyen's "Camp 7," Daban, British Somaliland. ×1. Sedgk. Mus. No. C.11995.

3. *Deltoidonautilus spathi*, new species. "Apertural" view of all but the adoral half volution of the holotype, from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. ×⅔. Sedgk. Mus. No. C.12066.

4–7. *Deltoidonautilus biyogorensis*, new species. 4. Ventrolateral view of an internal mold of two fully mature segments of a siphuncle. 5, 6. An early mature portion of a phragmacone. 7. Enlargement of the ventrolateral portion of the test of an inner volution of the same specimen as shown in 5 and 6. Both from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. 4–6, ×1½; 7, ×10. Sedgk. Mus. Nos. C.12007, C.12037.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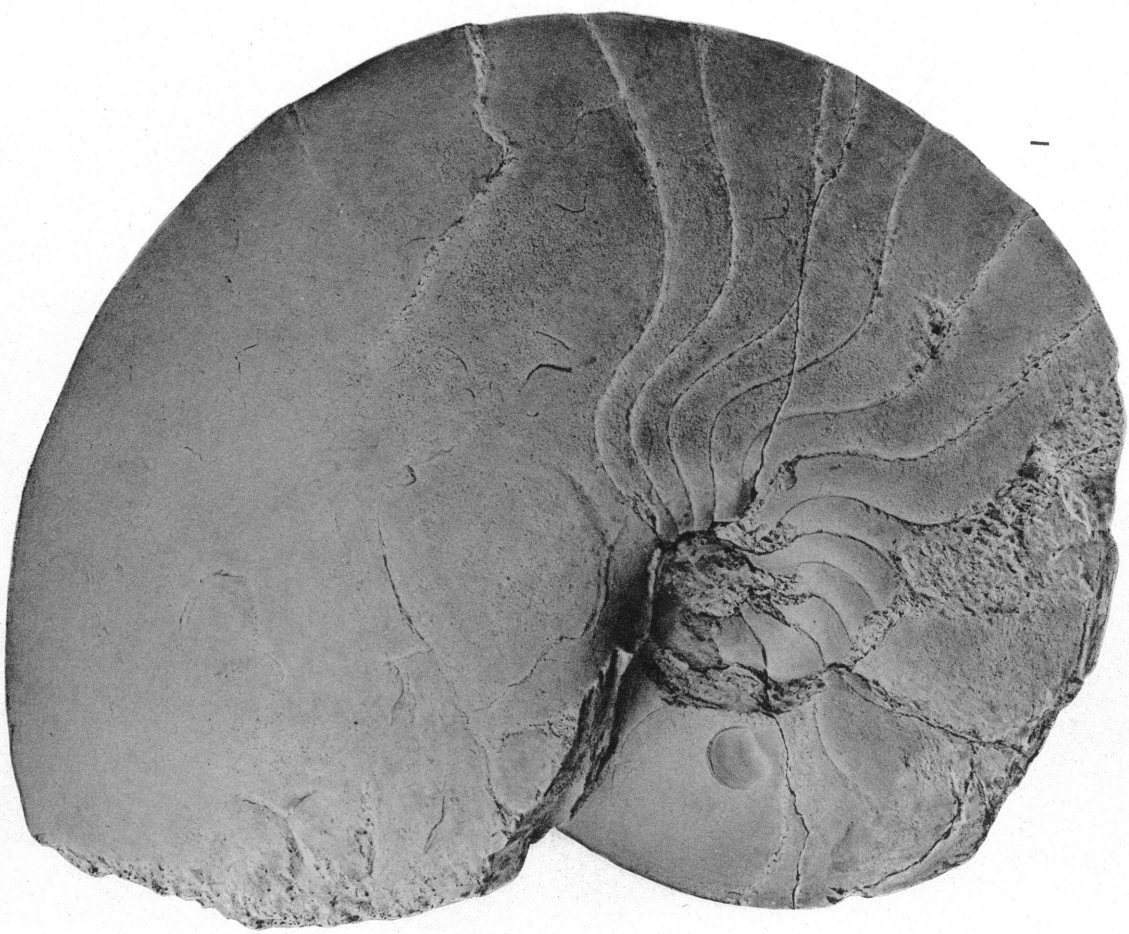

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6½ mm. in diameter and is located about 13 mm. from the dorsum and 47 mm. from the venter.

The holotype is the largest of the type specimens, but two of the paratypes are of the same general size. One of these, which is almost as well preserved as the holotype, is about 21 cm. in diameter, and its living chamber, like that of the holotype, is about a third of a volution in length. The adoral camera of this specimen is considerably shorter than the preceding camerae, indicating that we are dealing with remains of a fully mature individual.

REMARKS: Presumably this species is a moderately primitive member of the genus *Deltoidonautilus*. This conclusion is based on the fact that the sutures are not very strongly sinuous (the lateral lobe being shallow and the lateral saddles being rounded) and the conch does not become subangular ventrally until it has attained a very large size.

The new species is in general similar to the genotype, *D. sowerbyi* (Wetherell), of the Eocene of England, but in that form the lateral lobes of the sutures are more nearly symmetrical and the lateral saddles are more nearly angular. *D. somaliensis* (Newton), a very large form from the same general horizon and locality as *D. spathi*, is stated to develop a "median flattened groove" along its venter at full maturity, and also the lateral saddles of its sutures are relatively wide and the lateral lobes relatively narrow in comparison to those of our species. *D. molli* (Douvillé) of the early Tertiary of French Sudan and Senegal resembles *D. spathi*, but it is clear from a direct comparison of the type specimens of these two species that in the Sudan-Senegal form the ventral zone of the conch is less nearly angular and the lateral lobes of the sutures are more nearly symmetrical. None of the members of the same genus known from India or the Americas seems to be very close to the one under consideration.

OCCURRENCE AND MATERIAL: Nautilus beds of the lower Daban series (Middle Eocene) in the Biyo Gora section at Daban, north central British Somaliland; seven specimens (Sedgk. Mus. Nos. C.12065–C.12071; the holotype is No. C.12066).

Deltoidonautilus sp.

Plate 24, figures 1, 2

The Karkar series of British Somaliland has yielded only two nautiloids. One is a worn, incomplete, internal mold representing about a quarter of a volution of a phragmacone. This portion of the conch is estimated to have attained a diameter of some 75 mm.

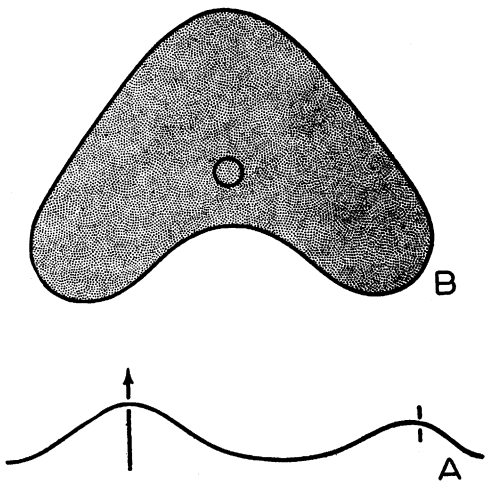

FIG. 8. *Deltoidonautilus* sp. Diagrammatic representation of an external suture and a cross section of the conch (somewhat restored), based on the adoral portion of specimen illustrated in plate 24, figures 1, 2. ×1.

As shown in text figure 8 the cross section is subtriangular in shape. The conch is flattened laterally, rather narrowly rounded ventrally, and impressed dorsally. The lateral zones are rather strongly converged ventrally, and the maximum width of the conch is attained just outside the umbilical shoulders. Near the adoral end of the specimen, the conch is about 38 mm. high and 50 mm.

PLATE 30

Deltoidonautilus spathi, new species. Holotype from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. 1. Lateral view. 2. Ventral view. ×⅔. Sedgk. Mus. No. C. 12066.

(calculated) wide, and the impressed zone is about 10 mm. deep.

The umbilicus appears to be small. The umbilical shoulders, though rounded, are fairly abrupt, and the umbilical walls are steep.

The internal mold is marked by only the sutures. The camerae are rather short. Each external suture forms a moderately high, narrowly rounded, ventral saddle and on either side of it a broad, rounded, lateral lobe, a small but rather prominent lateral saddle which centers on or near the umbilical shoulder, and a shallow rounded lobe on the umbilical wall.

The siphuncle is small and is located fairly close to the dorsum. At the adoral end of the specimen, it is about 4 mm. in diameter and its center is about 6 mm. from the dorsum and 22 mm. from the venter.

REMARKS: Because of its incompleteness, the specific affinities of this specimen cannot be determined. However, the subtriangular cross section of its conch, the shape of its sutures, and the dorsal position of its siphuncle all indicate that it belongs in the genus *Deltoidonautilus*. Its conch is relatively wider than that of most of the other congeneric forms known from British Somaliland. In *D. singularis*, which also has a wide conch, the sutures are more strongly sinuous.

OCCURRENCE AND MATERIAL: Karkar series (Middle Eocene) at Burud (Sawl) (Macfadyen's ϕ255), east central British Somaliland; one specimen (Sedgk. Mus. No. C. 12074).

Deltoidonautilus? sp.

Plate 31, figures 1, 2

The collections under study contain a single large specimen which is somewhat similar to the types of *D. spathi*, but it is lithologically different and narrowly rounded rather than subangular ventrally. It is composed of grayish brown sandstone, but considerable portions of the test (or a replacement of it) are retained.

The specimen is subdiscoidal in shape and is about 20 cm. in diameter. Its whorls are very broadly rounded laterally, narrowly rounded ventrally, and impressed dorsally. At the adoral end of the specimen, the conch is about 90 mm. wide (calculated) and 115 mm. high, and the impressed zone is about 37 mm. deep. The maximum width of conch is attained just outside the umbilical shoulders, and the lateral zones converge ventrad.

The umbilicus is moderate in size and attains a diameter of some 45 mm. The umbilical shoulders are rounded and indefinite.

The test appears to be rather thin, and its surface bears numerous fine growth lines. These lines are sinuous, and each forms a rather deep, narrowly rounded, ventral sinus and on either side of it a broad, rounded, lateral salient.

REMARKS: The above-described specimen is somewhat crushed and worn. Furthermore it does not reveal the shape of its sutures or the position of its siphuncle. Accordingly we are uncertain in regard to even its generic affinities, but its general physiognomy suggests a relationship to *Deltoidonautilus*, of which it may well be a primitive representative.

OCCURRENCE AND MATERIAL: Nautilus beds of the lower Daban series (Middle Eocene) in the Biyo Gora section at Daban, north central British Somaliland; one specimen (Sedgk. Mus. No. C.12072).

FAMILY **ATURIDAE** HYATT, 1894

GENUS **ATURIA** BRONN, 1838

Aturia somaliensis, new species

Plate 21, figures 6–9

Conch thickly subdiscoidal and large; the last essentially complete volution of the only known representative of the species is about 95 mm. in diameter, and adhering fragments show that the phragmacone consisted of at least nine-tenths of an additional adoral whorl. At maturity, the conch is strongly compressed and is flattened laterally, rather narrowly rounded ventrally, and deeply impressed dorsally. The broad, almost flat, lateral zones converge ventrad, and the maximum width of conch is attained just outside the umbilical shoulders. Where the holotype is about 95 mm. in diameter, its conch is about 43 mm. wide and 57 mm. high, and the depth of the impressed zone measures some 25 mm.

Umbilicus small, closed, and inconspicuous. Umbilical shoulders low, rounded, and indefinite.

Test thin. Its outer surface marked by numerous fine, closely spaced growth lines, each of which forms a deep, narrowly rounded, ventral sinus and on either side of it a broad, rounded, lateral salient which extends to the umbilicus.

As shown in text figure 9, each mature external suture consists of a very broad, nearly flat, almost straight-sided, ventral saddle and on either side of it a narrow, asymmetrically pointed, first lateral lobe, a broad, high, broadly rounded, lateral saddle, and apparently an umbilical lobe. The adoral portion of the ventral saddle is slightly sinuous, and a pair of very shallow, rounded, secondary lobes divide it symmetrically into three low, rounded, secondary saddles, of which the median one is relatively broad.

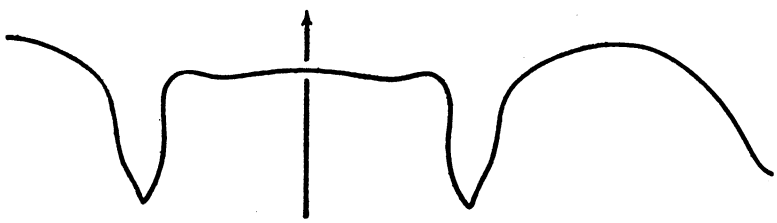

FIG. 9. *Aturia somaliensis*, new species. Diagrammatic representation of an external suture, a composite drawing based on the adoral portion of the last (outermost) nearly complete volution of the holotype. ×1.

The siphuncle is dorsal in position and located in adapical infundibular flexures of the septa. Polished and thin sections through the siphuncle of the outer (incomplete) whorl of the holotype show that it is exceptionally well preserved and that its structure does not differ materially from that of *A. peruviana* Olsson of the Eocene of Venezuela, described in detail by Miller and Thompson (1937, pp. 65–67, text fig. 3, pl. 9, fig. 5).

REMARKS: This species does not seem to be very close to any African forms that have been previously described. *A. praeziczac* Oppenheim of the Paleocene? of Egypt is smaller and more primitive, its conch is more nearly globular, and the lateral lobes of its sutures are relatively blunt. The only known representative of *A. pre-aturi* Cuvillier of the Eocene of the same country is a portion of a moderately small phragmacone in which the conch is relatively broad and is broadly rounded ventrally and the inflections of the sutures are in contact along the ventrolateral zone. *A. lotzi* Böhm of the Tertiary diamond fields of Southwest Africa, though equally large, is relatively slender, and its whorls are more nearly triangular in cross section. The beds in which it occurs are stated to be Miocene in age. *A. luculoensis* Miller of the Miocene of Angola, which probably includes "*A. aturi*" of Douvillé (1933, pp. 72–73, pl. 3, figs. 1a, 1b) of the same general horizon and locality, seems to be similar, but there is no good reason to believe that it attained a large size. The small specimen from the Miocene of Sinai which was recently illustrated and described by Miller and Downs (1950, p. 17, pl. 4, fig. 4) leaves so much to be desired that adequate comparisons with it are not possible; however, because of the difference in age between it and the species under consideration, it is not likely that the two are very close. Similarly the two fragmentary individuals from the Miocene of Zanzibar, which were illustrated and described by Cox (1927, pp. 19–20, pl. 19, figs. 6, 7) are almost certainly not closely related to *A. somaliensis*. Miller (1947, p. 88) recently proposed the name *A.? coxi* for one of the Zanzibar specimens, calling attention to the fact that there is a prominent secondary median ventral lobe in the dorsal saddle of its sutures.

Somewhat similar congeneric forms have been described from the Eocene of Europe. The typical *A. ziczac* (Sowerby) of the Eocene of England has a relatively wide conch and sutures with long, slender, lateral lobes. In *A. charlesworthi* Foord, also of the English Eocene, the conch is narrower and the closely spaced sutures again form long, slender, lateral lobes. Relatively wide whorls differen-

tiate the two comparable forms known from the north German early Tertiary: *A. koeneni* Gagel and the specimens that Gagel (1928, pp. 481–483, pl. 21, fig. 6; pl. 22, figs. 7, 8) illustrated and described as *A. basteroti* Benoist.

All the numerous representatives of *Aturia* that have been found in North America, like those known from elsewhere, are at least superficially very much alike. Those that appear to be closest to *A. somaliensis* are *A. alabamensis* (Morton) of the Upper Eocene Jackson group of the Atlantic-Gulf Coastal Plain (southeastern United States and northeastern Mexico) and *A. grandior* Schenck of the Oligocene and possibly the Eocene of the northwestern United States. In both of these species, the conch attains a large size, as does that of the Somaliland form. The sutures of the American specimens seem to differ in detail, but the variations may be more apparent than real. Because of the incompleteness of the outer volution of the only known representative of our new species, satisfactory comparisons with large individuals are not possible.

Aturia peruviana Olsson, which is of widespread occurrence in the Eocene of northern South America and Panama and which has been found also in the Oligocene of Peru, is very similar to *A. somaliensis*. However, its sutures seem to be farther advanced than are those of the African holotype at the same diameter.

Two related forms have also been described from the Eocene of Japan: *A. yokoyamai* Nagao and *A. tokunagai* Shimizu, the latter having been regarded as a variety of *A. aturi* by its author. The conch of Nagao's species is relatively narrow, and that of Shimizu's has sutures with narrow, rounded, lateral lobes. Only a single small specimen of *A. tokunagai* is known.

OCCURRENCE AND MATERIAL: Nautilus beds of the lower Daban series (Middle Eocene) in the Biyo Gora section at Daban, north central British Somaliland; one specimen (Sedgk. Mus. No. C.12073).

PLATE 31

Deltoidonautilus? sp. A large specimen of uncertain affinities from the Nautilus beds of the lower Daban series (Lutetian) in the Biyo Gora section at Daban, British Somaliland. 1. Ventral view. 2. Lateral view. ×¾. Sedgk. Mus. No. C. 12072.


2
1

NOTE ON THE GEOLOGY OF THE DABAN AREA AND THE LOCALITIES OF THE DESCRIBED NAUTILOIDS

W. A. MACFADYEN

AN ACCOUNT OF THE GEOLOGY, with a map, and details of the measured sections and fossil localities were published by Macfadyen in 1933. Since that volume may not be conveniently available, and because some more nearly precise dating has been ascertained by Dr. L. R. Cox, the general succession at Daban, in north central British Somaliland, is given here.

The Biyo Gora section (the name is that of a stream traversing the area) was measured in 1928 by Macfadyen and Hunt, bed by bed, with the help of a 2-meter ranging pole subdivided into 20-cm. lengths. The strata are extremely well exposed over almost the whole extent of the section, which is some 25 kilometers long, and the nautiloids here described were collected at that time.

TABLE 1

BIO GORA SECTION I

? Age	Upper Daban series	1212 m.	0–1212 m.
? Age	Middle Daban series	733	1212–1945
Middle Eocene, Lutetian	Lower Daban series	345	1945–2290
Middle Eocene	Anhydrite series	320	2290–2610
Lower Eocene, upper Ypresian	Allahkajid beds	189	2610–2799
Lower Eocene, upper Ypresian?	Auradu limestone	201	2799–3000
Cretaceous	Nubian sandstone	?	—

The main stratigraphic units of the Eocene are very well characterized and easily recognized lithologically in the field, the only difficulty being with regard to the Allahkajid beds, which are largely white, greenish, or spotted shales, with subsidiary limestone bands that are in some cases chalky, and the hard and massive Auradu limestone. In places these interdigitate, and it has yet to be determined how far one is more than a facies of the other.

The great Eocene Tethys Ocean stretched from the East Indies across northern India, Arabia, Somaliland, and the Mediterranean basin and so far as the West Indies. But the margins of that part of the Tethys which covered the Somaliland area are found to have lain partly in that country.

The Lower Eocene Auradu sea extended for at least 110 kilometers west of Daban to its nearest known boundary, and a little farther to the south. It stretched much farther north, into what is now Arabia, and to a minimum distance of 400 kilometers to the east and southeast. L. R. Cox (1931) has given the age of the Allahkajid beds, laid down in this sea, as upper Ypresian.

Deposition of the massive anhydrite followed. However, Daban was then near the western edge of the basin.

The Middle Eocene Karkar sea, which succeeded, lay almost wholly to the east, and deposition in it came to an end about the close of Middle Eocene time or a little later. Daban was on its western margin. Instead of the normal marine succession, the thick Daban series was laid down in conditions that are still not clearly understood, and deposition here apparently continued until a considerably later date. The lowest strata contain oyster beds and plant remains and appear to be of estuarine nature. They are followed by soft sandstones and shales whose only discovered fossil is wood.

After this came the intercalation of the Nautilus beds, which from their fossils are essentially marine. In addition to the nautiloids there are abundant Foraminifera of two species, *Nummulites somaliensis* Nuttall and Brighton and *N. discorbinus* var. *major* Rozlozsnik; and rare *Dictyconoides kohaticus* (Davies). These serve to date the beds and to correlate them precisely with the normal marine Karkar succession of Lutetian age (Cox, 1931). The two species of *Nummulites* are found only in the lower half of the

Karkar series, as checked at Daurarin and Burud.

The Nautilus beds also contain many mollusks. Wyllie and Smellie collected some that were identified by Weir in 1925. The only locality he gives is "Daban," oyster banks "about 2500 feet above the base of the series," though according to my measured section they cannot have come from higher than about 1000 feet above the base. Other mollusks, collected by Macfadyen and Hunt, were partly determined by Mr. A. G. Brighton in 1929–1930, but his results have not so far been published. The mollusks are not the normal marine Karkar assemblage. The collections commonly contain forms rare in the Karkar, and rarely the common Karkar species. In the Nautilus beds the shell material is in many cases preserved, whereas in the Karkar the fossils are generally found as casts.

The Nautilus beds also yielded sirenian remains, other obscure and fragmentary mammalian bones (some of large size), and a large turtle. On the other hand, echinoids, common in the Karkar, are wanting. This last fact may point to a diminished salinity of the water.

TABLE 2

HORIZONS AND LOCALITIES OF THE DESCRIBED NAUTILOIDS

Middle Eocene: Lutetian
- Lower Daban series; Nautilus beds[a]
  - Biyo Gora Section I, *ca.* latitude 10° 20′ N., longitude 45° 13′ E.
    - σ24 1945–1952 m.
    - σ26 (φ26) 1975–1976 m.
    - σ27 (φ27) 1978–1980 m.
    - σ28 (φ28) 1988–1989 m.
    - σ30 (φ30) 2004–2010 m.

    } 279–344 m. above top of Anhydrite series
  - Karkar series
    - Daurarin Section XVII, latitude 10° 12′ N., longitude 46° 34′ E.
      - σ204 141–161 m. below top of series here = 67–87 m. above top of Anhydrite series
    - Burud (Sawl) Section XXXVII, latitude 9° 17′ N., longitude 48° 19′ E.
      - φ255 137–141 m. below top of series here = 80–84 m. above top of Anhydrite series

Lower Eocene: upper Ypresian
- Auradu series; Allahkajid beds
  - Biyo Gora Section I, *ca.* latitude 10° 23′ N., longitude 45° 10′ E.
    - "Camp 7" 2610–2687 m. = 312–389 m.
    - φ36 2628–2632 m. = 367–371 m.
    - φ42 2675–2681 m. = 318–324 m.
    - φ45 2726–2730 m. = 269–273 m.

    } above base of Eocene
  - Allahkajid Section IV, latitude 10° 28′ N., longitude 45° 25′ E.
    - φ66 433–464 m. = 283–313 m. below top of Auradu series, and 62–92 m. above base of Eocene
  - Dinasyu, latitude 10° 02′ N., longitude 46° 21′ E.
    - φ110 (σ172)

Lower Eocene: upper Ypresian?
- Auradu series: Auradu limestone
  - Bihen Gaha, latitude 10° 26′ N., longitude 45° 39′ E.
    - σ85
  - Habel Reren,[b] latitude 10° 09′ N., longitude 46° 28′ E.
    - φ117 (σ187)
  - Garasgoi Hill, 7 kilometers south-southeast of Sheikh, latitude 9° 53′ N., longitude 45° 13′ E.
    - φ157 Probably from top of cliff, about 73 m. above base of Eocene

[a] Wyllie's Kohl Der specimens came from the Nautilus beds a few kilometers west of the Biyo Gora section.
[b] Cox (1931) gives the age of other fossils collected at Habal Reren as upper Ypresian.

The Nautilus beds are followed by a thick series of fresh-water deposits, greenish sandy clays intermixed with thin-bedded white limestone bands which weather to paper shales and which contain fish remains, ostracodes, wood, and leaves. These strata alternate with red, gray, and greenish sandy shales, with some gypsum and chalcedony in the lower part of the sequence. Deposition came to an end with conglomerate.

Some of the wood has been identified as *Capparidoxylon geinitzi* Schenk, described from the Oligocene of Egypt, but apart from that indication, no further evidence of age has been obtained.

The apparent great thickness of the largely fresh-water Daban series is difficult to credit, but no other plausible hypothesis has yet been proposed to account for the measurements made from the outcrop.

The specialized conditions in the Middle Eocene at Daban, whatever they were, seem to have been particularly congenial to the nautiloids, some of which grew to a large size and are found much more abundantly than in the purely marine conditions of the Karkar sea. These peculiar local conditions may help to explain why the nautiloid species found here do not compare closely with those described from other areas. Otherwise it would be difficult to appreciate why the same or closely similar species should not be found throughout the deposits of the Eocene Tethys, which was inhabited by a very distinctive molluscan fauna (Cox, 1931, p. 177).

Dr. F. R. S. Henson has recently mentioned in conversation that large nautiloids are also found in a Middle Eocene horizon in parts of Arabia, including the Qatar Peninsula.

The Nautilus beds at Daban are very well exposed in the semi-desert country, with little or no overburden. They dip at about 16° to the south. The specimens were found weathered out on the surface of the gentle dip slopes. There is no doubt that many more nautiloids could have been collected if the beds had been followed along the strike, but there is a limit to the number of large fossils that can be transported during the ordinary field work of an expedition primarily concerned with other matters.

For convenience in the field, where their collecting was sometimes done quite independently, Macfadyen and Hunt labeled their localities and collections with their own serial numbers prefixed by the Greek letters ϕ (phi) and σ (sigma), respectively.

Finally, it may be of interest to note that whereas Allahkajid and Garasgoi are the names of conspicuous mountains, and Bihen Gaha that of a faulted pass through the hills, marked by hot springs and two groves of tall trees, Daban, Kohl Der, Daurarin, Burud (at the edge of the Sawl Haud Plateau), Dinasyu, and Habal Reren are mere *noms de lieux-dits*, names of uninhabited pieces of ground. For example, Daban, from which many nautiloids were obtained, includes something like 800 square kilometers, of which half is mapped as outcrop, the remainder being covered by superficial deposits. The great majority of the nautiloids came from only a small part of the outcrop here, most of the beds being devoid of them.

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