THE VERNAY COLLECTION OF CRETACEOUS (ALBIAN) AMMONITES FROM ANGOLA

BY OTTO HAAS

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Article I.—THE VERNAY COLLECTION OF CRETACEOUS (ALBIAN) AMMONITES FROM ANGOLA[1]

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[1] Introduction and Part I were awarded an A. Cressy Morrison Prize in Natural Science in 1941 by the New York Academy of Sciences.

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INTRODUCTION

THE MATERIAL: LOCALITY, FACIES, FAUNA

The work of which this paper is the result was carried out from 1940 to 1942, first at the Museum of Comparative Zoölogy at Harvard University, then at The American Museum of Natural History.

The material here dealt with was collected by Mr. Herbert Lang, on The American Museum of Natural History-Vernay Angola Expedition of 1925, from a cliff on the river bank near Hanha, sixteen kilometers northeast of Lobito;[1] this locality is shown in Pl. XLVII. Unfortunately no further information about this locality was available from Mr. Lang, now at Pretoria, Transvaal. Dr. R. W. Boulton, another participant of that expedition, now at Chicago, in a letter dated October 20, 1941, says that he feels "pretty sure that some ammonites were also collected in the limestone cliffs on the east shore of Lobito Bay" (about ten kilometers to the southwest from the above locality). However, there is no evidence of the latter ammonites having been incorporated into this collection. The indication given as to locality in the explanations of plates, "Hanha, near Lobito, Angola," has, therefore, not been changed after receipt of the above letter. All the specimens which were obtained only by preparation in the laboratory (all *Neokentroceras*, *Oxytropidoceras* (?), *Beudanticeras*, *Aconeceras* (?), *Gaudryceras*, *Ptychoceras*, *Anisoceras*, *Idiohamites* and *Pseudhelicoceras*, almost all *Dipoloceras*, *Hysteroceras*, *Prohysteroceras*, *Neoharpoceras* and *Hamites*, and the small examples of *Pervinquieria*, *Elobiceras*, *Phylloceras* and *Puzosia*) are certainly from Hanha. Furthermore, all the forms discussed in this paper, except *Pervinquieria* cf. *lampasensis* (Choffat) (p. 97), are undoubtedly of Albian age; thus there would be no considerable stratigraphic significance, even if one or another of the ammonites from the east shore of Lobito Bay were mixed among those from Hanha.

The rock at the latter locality, which has yielded the fossils, is a light yellowish to grayish limestone of variable texture, compact patches of almost lithographic character being surrounded by argillaceous and arenaceous areas. Some specimens proved in the course of preparation to be almost chalky. The surface of the fossils is frequently coated with limonitic films; some specimens, particularly small ones, have chalky coatings. The inner whorls of larger ammonites are often destroyed through replacement by calcite druses or partially preserved in isolated calcite crystals. On the whole, this facies seems to be that of the "Couches à *Schloenbachia inflata*" at Lobito Bay and Dombe Grande, as described by Choffat (1905, p. 27).

When the writer took charge of the present material, it consisted of some single

[1] This locality (Hanha Estate) must well be distinguished from the Hanha about 100 kilometers southwest of Benguela which is much farther inland. In Hill and Carter (1941, p. 7, "Gazetteer of Localities"), however, the data as to the latitude and longitude of these two homonymous localities are interchanged (oral communication from Dr. J. E. Hill, July, 1941).

unprepared specimens, most of them with one side only exposed, and of some blocks containing abundant smaller fossils. Such blocks were also attached to the largest discs of ammonites, most of them belonging to *Pervinquieria arietiformis* and *Puzosia spathi*. From the fact that fragments fitting together were found in quite different blocks it may be inferred that the whole material was included in a mass of rock not exceeding a few cubic feet in volume.

This rock is crowded with fossils to an almost unbelievable degree. Almost every body chamber of ammonites, be they large or small, is filled with other fossils which, most frequently, contain still smaller ones, and so forth. Also the large discs are often pierced at their centers by conchs of smaller individuals. Many, if not most, of the remains of ammonites scattered in the body chambers of larger ones or attached to the latter have obviously been reduced to a fragmentary state before fossilization.[1]

After having noted the abundance of fossils even in the smallest pieces of matrix, all of them were split up methodically; by this procedure, which took several months, the total of specimens available for study was multiplied to a very high degree. There was, for example, not a single *Neokentroceras* visible in the collection when it was entrusted to the writer, but 117 individuals of this genus are now discussed in the present paper. The corresponding figures as to other genera are: *Dipoloceras*, 1 : 69; *Hysteroceras*, 1 : 303; *Pervinquieria*, 35 : 52; *Elobiceras*, 22 : 127; *Prohysteroceras*, 3 : 19; *Neoharpoceras*, 1 : 4; *Oxytropidoceras* (?), 0 : 1; *Phylloceras*, 1 : 3; *Puzosia*, 9 : 185; *Beudanticeras*, 0 : 1; *Aconeceras* (?), 0 : 2; *Gaudryceras*, 0 : 1; *Hamites*, 1 : 62; *Ptychoceras*, 0 : 1; *Anisoceras*, 0 : 3; *Idiohamites*, 0 : 1; *Turrilitoides*, 1 : 2, and *Pseudhelicoceras*, 0 : 3. The greatest increase is, of course, found in the micromorphous genera, *Hysteroceras*, *Neokentroceras* and *Hamites*, as well as in the genera *Dipoloceras* and *Puzosia*, which are represented in the collection mostly by small forms.

It would, however, be quite wrong to assume that ammonites are the majority of fossils in the present fauna. They are certainly outnumbered by gastropods of many different genera, ranging in height from less than 1 mm. up to almost 30 mm. Most of them, however, are extremely small; they fill, by the hundred, the cavities of the larger fossils and are found even in the gas chambers of some ammonites, where they are at times hidden under the finest leaflets of the suture line.[2] A neat example of this intrusion of little gastropods into the most unlikely places is seen in Pl. II, fig. 13, showing a natural section of a whorl fragment, about 8 mm. high, of a little ammonite (*Hysteroceras varicosum*, var. *angolana*) into which is squeezed, in the most space-saving way, a complete, still far smaller gastropod. In addition to the ammonites and gastropods, the material includes quite a considerable number of brachiopods, which seem to belong to a few species only, and of bryozoans, but only few pelecypods (among them a valve of a pectinid attaining almost 75 mm. in height) and corals and, finally, two fish teeth, one of them with parts of the jaw.

It is hoped that the non-ammonites of the present fauna, especially the gastropods, will be identified and as far as necessary described at a later date.

Disposition of Parts; Taxonomic Sequence

It seemed advisable to arrange the subject of the present paper according to large morphological groups rather than to some merely taxonomic sequence. Part I will deal with the Dipoloceratidae (*sensu lato*, see p. 11), sculptured, normally coiled forms corresponding to Gayle Scott's (1940b,pp. 302–304)palaeoecological groups 4 and 5, which include the sculptured shells with quadrate to ovate whorl section (*Dipoloceras*, *Hysteroceras*, *Neokentroceras*,

[1] Short terms to distinguish such pre-fossil fragments from post-fossil ones might be desirable: the former might be named "ostracs" (*'όστρακον* = shred) and the term "fragments" restricted to the latter.

[2] It does not seem easy to explain how they succeeded in getting there. Might it not have happened during the lifetime of both animals (parasitism)?

Pervinquieria, Elobiceras pro parte, Prohysteroceras) and the tenuous, involute, finely costate, non-tuberculate or only slightly tuberculate shells (*Oxytropidoceras, Elobiceras pro parte* and *Neoharpoceras*), respectively. Part II will discuss the remaining normally coiled ammonites, belonging to the families Phylloceratidae, Desmoceratidae and Lytoceratidae (*sensu stricto*); they correspond to Scott's smooth —or almost smooth—groups 1, 2 and 3, group 1 including involute shells (*Phylloceras*), group 2 evolute, obese shells with circular or subcircular whorl sections (*Gaudryceras*), and group 3 moderately involute shells (*Tetragonites*,[1] *Puzosia, Beudanticeras* and *Aconeceras*).[2] In Part III the abnormally coiled forms, corresponding to Scott's group 7, will be dealt with. In addition to the *Pervinquieriae, Anisoceras* and *Idiohamites* from Hanha some representatives of these genera from other Angolan localities, found south of Cabo Ledo and south of Benguela Velha, respectively, will be described.

The extent of the present collection, in which many of the forms described are represented by a large number of individuals, has made it seem desirable to include full descriptions not only of new species and varieties, but also of some previously named but hitherto never described (e.g., *Neokentroceras choffati* Spath) and of others whose earlier descriptions were based on poor or inadequate material [e.g., *Pervinquieria arietiformis* (Spath), *Prohysteroceras wordiei* Spath and *P. decipiens* Spath]. In the case of those comparatively few species for which a complete and up-to-date description was found in literature chiefly in Dr. Spath's papers, only supplementary observations have been made. As I have earlier (1913, p. 226) pointed out, faunal lists are of no value for precise palaeontological work. Also, as every careful ammonitologist knows, the varying ontogenetic stages of the same species, even of the same specimen, may differ to an even higher degree than do individuals of about the same size but belonging to different (small) genera. I endeavor, therefore, to describe the forms not as they appear at any one more or less accidental stage but throughout *all* stages of growth.

Taxonomic Issues

So dominant are Dr. L. F. Spath's works in contemporary ammonitology that every author's attempt to fix his own position necessarily amounts to a discussion of Spath's taxonomic principles. Again and again (e.g., Diener, 1925, p. 3; Collignon, 1932a, p. 14; Roman, 1938, p. 3) Spath is reproached with "pulverization"[3] of genera or, as Kutassy (1933, p. 378) puts it, with "assigning almost every new species to a new subgenus." To that it may just be added that this procedure of Spath's is not at all restricted to new species or to the creation of subgenera, but that quite a considerable number of his genera were based on known species. Thus Diener's (*loc. cit.*) statement that Spath's genera correspond approximately to Depéret's "great species" appears to be just.

On the one hand, it is easily understandable that a scientist like Spath, who has dealt with more different forms of ammonites than any other living man, feels the need of differentiating the various groups by generic, or at least subgeneric, names. On the other hand, the steady multiplication of genera continues to such a degree that not even the specialist can keep pace with it, still less so the general palaeontologist, stratigrapher or field geologist. Moreover, such a task is rendered the more difficult by the fact that many, if not most, of Spath's generic names are hidden in papers which do not deal explicitly with the groups concerned and often occur even in footnotes.

As a result, every modern student must take a position as to the size of genera he

[1] Scott includes this genus in his group 2, but its representative at Hanha is so involute that it undoubtedly belongs to his group 3.

[2] The sculptured, normally coiled ammonites seem to coincide with Douvillé's (1931, p. 22) second group ("formes ornées"), the more or less smooth ones with his first group ("formes simples").

[3] The writer did not succeed in finding out who used this word first.

thinks to be desirable. Diener's (*loc. cit.*) compromise proposal to keep the "old" generic names and to add Spath's new ones in brackets as subgeneric names appears to me to be the worst possible solution of the problem. As emphasized in an earlier paper (1912–13, p. 130), such nomenclatorial compromises are always somewhat weak and tolerable only for periods of transition which should be as short as possible. The use of subgeneric names is deemed by the writer to be undesirable since it tends the more to violate the fundamental principle of binomial nomenclature, which, at any rate, cannot strictly be maintained in modern usage, owing to the necessity of establishing subspecies and varieties. Furthermore, in actual practice the juxtaposition of a generic name and a subgeneric one proves to be unserviceable in the long run, with the consequent gradual disappearance of the former name. Thus all subgenera turn out to be "genera in the making" and, later on, increase the number of genera *ad infinitum*.

I, therefore, while opposed to subgenera in general, rather believe in small, though not too small, genera.[1] As in 1913 (p. 129), I still cite Buckman's (1887, p. 11) statement, "It having been once agreed that a division of '*Ammonites*' was necessary, limits cannot directly be set to such division." I also fully agree with the opinions voiced by two renowned French palaeontologists, de Grossouvre (1893, p. 21), "Ne craignons donc pas de pousser l'analyse trop loin, si nous voulons rendre possible une reconstitution sérieuse; je tiens qu'il est plus utile d'établir un genre bien homogène, même restreint, que de constituer un group trop vaste avec des membres étrangers les uns aux autres"; and Jacob (1908a, p. 7), "Ainsi qu'on l'a de nombreuses fois et très justement fait observer, tout travail de synthèse, dans le groupe difficile des Ammonites, doit etre précédé d'une analyse minutieuse; et, à ce titre, les genres ou sous-genres, dont on voit le nombre s'augmenter tous les jours, auront leur utilité, au moins passagère, en séparant les rameaux qui pourront ultérieurement raccordés dans la reconstitution des séries généalogiques que recherche, aujourd'hui, toute classification paléontologique rationelle."

However, this does not imply the writer's belief in the absolute necessity of all the genera (subgenera) created by Spath, some of which are by far too small indeed.

In the present paper almost all of Spath's generic names could be kept, but *Mortoniceras* is, for the reasons specified below (pp. 66, 67), replaced throughout by *Pervinquieria*. No subgeneric names are admitted within the latter genus, or within *Hamites*. Furthermore, *Neoharpoceras* and *Ptychoceras*, recently relegated to the rank of subgenera by Spath, are kept as independent genera. Also the boundaries between the genera *Dipoloceras* and *Hysteorceras*, *Hysteroceras* and *Neokentroceras*, and *Pervinquieria* and *Elobiceras*, as fixed in this paper, deviate here and there from those chosen by Spath.

The problem of the limitation of species always seriously concerned palaeontologists. Much has been said[2] about the difference between the "palaeontological" species as a merely descriptive one and the "biological" species, supposed to be a physiological one, as stressed quite recently by Hiltermann (1939, p. 127). Pia (1913, p. 489), however, questions this antithesis, emphasizing that most of the recent species are no less descriptive and no more physiological than the palaeontological ones. Simpson (1940, p. 414) most justly points out that "a species, as it is actually defined or diagnosed and used in the literature, is a subjective concept" and that this "mental concept that is the species of taxonomy" is just "an estimate of the other, the real species" which ought to be "a real thing in nature, a group of individual animals that makes them a natural unit of a certain approximate scope."[3]

Jayet, in his fine study on variation in ammonites (1929, pp. 10, 11), objects to the

[1] The writer agrees with Pia (1914, p. 158; 1921), Schindewolf (1927) and Stromer (1940, p. 273) in that the genus and the higher taxonomic units can be but morphological assemblages, desirable as a phylogenetic taxonomy may be. Hyatt's opposite conception is advocated by Spath (1922, p. 97, footnote). For further literature see Schindewolf (1927).

[2] For references see Haas (1912–13, pp. 127, 128) and, for earlier literature, Wepfer (1913, pp. 411 ff.).

[3] Similar thoughts are found in Hatch (1941).

usual creation of types as representatives of the species and suggests that the species be considered a continuous series of individuals differing from each other by individual variations. This conception is, however, subject to two essential objections. The first is a logical one. Jayet misjudges the significance and the indispensableness of types as name bearers (Simpson, 1940, pp. 414 ff.).[1] This very mistake misled him to split the species thoroughly studied in his paper, *Hysteroceras varicosum* (Sowerby), into two varieties, unaware of the fact that no typical form was left and that one of his varieties included Sowerby's holotype and was, therefore, merely a synonym of the *forma typica* (cf. below, p. 25). The second objection is a rather practical one. Collections are but seldom sufficiently adequate to permit the study of individual variation in 300 specimens of the same species, such as were at Jayet's disposal. That author questions the establishment of new species on a single specimen or even on a fragment thereof; it must, however, be kept in mind that collections from new localities or horizons are most frequently restricted to such scanty material.

It seems still to be true that "there is no prescription for the limitation of species" (Wepfer, 1913, p. 411). It must not be forgotten that what is called "species" is, according to Simpson (*loc. cit.*), a mental concept. The only norm as to how to form it seems to be indicated by the need for distinction of forms which are essentially different from each other. In the writer's opinion the limitation of species as found in Spath's works meets this postulate, notwithstanding Douvillé's (1931, p. 19) desire to relegate Spath's species to the rank of mere varieties or races. The best evidence of the validity and serviceableness of Spath's limitation of species may be found in the fact that a considerable number of the species of *Hysteroceras* and *Hamites*, as distinguished in his Gault Monograph, could be recognized in the Albian of Angola, although those of the former genus are, as a rule, more or less dwarfed or slightly varied. That transitions occur between species of such limitation cannot be an objection to their validity. As repeatedly stressed in the course of the present paper, transitions occur most frequently not only between species of the same genus, but even between different (small) genera; whatever the limitation of species, widely circumscribed ones will be linked with each other by transitions as well as more restricted ones. It is important that such transitional forms be mentioned, described and if possible figured, and their transitional character emphasized, as Spath does quite regularly. The same is attempted in the present paper; besides, wherever it seemed to be feasible, new varieties rather than new species are created for forms deviating from similar known forms in one way or another.

The aforementioned frequency of transitions should, however, not discourage students from creating species and types, as only the latter can be of any value to research. I do not agree with Collignon's (1932a, p. 17) defeatism, as voiced after the discussion of various Albian forms included by him in "*Schloenbachia* (*Pervinquieria*)" *varicosa*, but referred in this paper to several species of *Hysteroceras* and *Neokentroceras*. He mentions "the difficulty, if not the impossibility, of defining types clearly separated and well distinct species." From my own experience, I would point out that, while this may be difficult, sometimes even very difficult, it is certainly not impossible.

The same author (1932a, p. 14) also reproaches Spath with "pulverization" not only of genera but also of species, adding that the number of Spath's genera and species is such as to make "la determination du moindre fossile ressortissant au groupes étudiés par lui une tâche des plus malaisées." However, Collignon's attitude toward Spath's taxonomy became less reluctant, as time went on (see 1937, pp. 32, 59 ff.).

The distinctive characters on which to rely for the distinction of genera and species have also been frequently discussed. Spath (1934, pp. 468, 469) is certainly right in pointing out that purely morphological

[1] In Simpson's terminology the series of varying individuals defined as a species by Jayet would be not the species, but just its "hypodigm."

characters like ornamentation should not be given a greater systematic importance than the suture line and that the one-sided stressing of any single feature should be discouraged. However, he considers, "in the present family at least" (i.e., Dipoloceratidae, *sensu lato*, as understood by him, 1921a, p. 277, and 1934, p. 443), "the ribbing the most characteristic feature of diagnostic value."[1] The writer, on his part, has found that every genus and to a certain degree even every species has a sutural character of its own and he would not like to underrate the systematic value of suture lines, as one among several distinctive characters. Thus Douvillé's (1931, p. 19) criticism of Spath's Angola paper for its neglect of suture lines seems to be quite justified, for of the sixty forms dealt with in that paper the suture lines of only four are depicted and, if the silhouette visible in fig. 2a of Pl. I is left out of account, not a single one of the genus *Elobiceras*.[2] On the other hand, some authors undoubtedly are inclined to overrate the taxonomic value of sutural details, particularly for the distinction of higher units. Douvillé (1921, p. 22), for instance, claims that the sculptured Cretaceous ammonites can be divided into two families, Hoplitidae and Pulchelliidae, according as the first lateral lobe ends in unpaired or in paired elements. However, Spath (1938b, p. 7, text fig. 2) stresses the frequently arising uncertainty as to "whether a given lobe of the suture line is branching in a symmetrical or an unsymmetrical manner," and it is shown in the present paper (p. 91, Pl. XXII, figs. 2–8, text fig. 10) how the first lateral lobe can be either bifid or trifid in one and the same species (*Pervinquieria arietiformis*).

Terminology

Although fully agreeing with Simpson's (1940, pp. 421 ff.) criticism of the exuberance of names for all possible kinds of types, I could not quite avoid using in this paper two names instead of plainly "type." As a rule, the type of a new form is called "holotype"; however, if some of the characters thought to be distinctive cannot be well observed in the holotype but are present in another specimen, the latter is chosen as the "paratype."

Some of the terms used in the following descriptions may require some explanation (text fig. 1). Hyatt's expressions "orad," "apicad," "ventrad" and "dorsad" are used to indicate the direction toward the aperture, the apex, the venter and

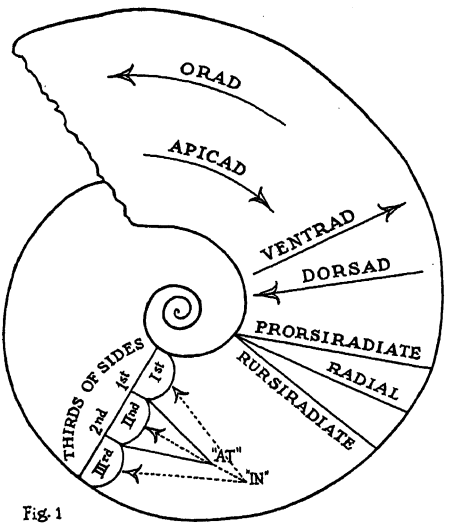

Fig. 1

the dorsum, respectively, or sometimes the sites of the parts under description. The

[1] As to relation of shell to animal, cf. Merriam, 1941, p. 5, "The shell . . . is regarded as a structure of significance broader than that relating solely to its function as a protective covering, for it faithfully records the developmental history of the soft organism which it contains. In the shell ornamentation is recognized the expression of fundamental tendencies inherent within the germ plasm of the living animal; these tendencies are progressively manifested through controlled secretion of calcareous material at the advancing fringed or papillate mantle edge. . . . It is certain . . . that different types of sculpture and shell structure among the various species must be linked with differences in genetic constitution and anatomical structure, and these factors might ultimately prove favorable or unfavorable to the species in its struggle for survival."

[2] Proper suture line drawings of this interesting genus are also missing elsewhere in literature; just a few details are visible in the side view of "*Prohysteroceras*" *pseudelobiense* Spath (1934, Pl. LV, fig. 1b), considered by the writer to be a genuine *Elobiceras*, whereas "*Elobiceras*" *arietiforme* Spath, the sutural outlines of which were made visible, though rather coarsened, in Airaghi's (1931, Pl. II) fig. 4, is referred to *Pervinquieria* in the present paper.

words "first third," "second fifth" and the like are always based on counting ventrad or orad, respectively. "At the first third" refers to the point situated at the first third, e.g., of the sides, "in the first third" refers, continuing the example, to the space between the umbilical edge and the aforementioned point. The umbilical shoulder (edge) marks the boundary between the sides and the umbilical wall; the umbilical seam is the line of contact between the former with the surface of the precedent whorl. Inasmuch as ribs are not strictly radial in direction, they are either prorsiradiate, if their ventrad end is ahead of the radius, or, in the opposite case, rursiradiate. For other terms, reference may be made to those listed by Spath (1923, pp. 7–9, as "adopted mainly from Hyatt and Buckman," and 1938b, pp. 183–185). However, only a few of those numerous (in the writer's opinion by far too numerous)[1] technical terms are applied in the present paper. The word "bullate" is not used in Spath's sense (= elongated radially) but, perhaps more correctly from the etymological viewpoint,[2] for semiglobular tubercles, and no special terms are used for radially or spirally elongated tubercles.

In the descriptions of suture lines the conventional nomenclature is applied throughout this paper. The writer agrees with Diener (1916, pp. 590 ff.) in the belief that the merely descriptive (morphological) designation of sutural elements is for practical reasons preferable to the genetic one favored by Noetling and Wedekind and more recently also by Spath (1923, pp. 10–13); all the more so since there is hardly ever an opportunity to trace back the ontogeny of the lobes and saddles seen in a given suture line.

In the tables of dimensions "D" means the greatest diameter that could be measured, "H" the height of the last whorl from the umbilical seam to the periphery, "H'" its height from the dorsum to the periphery, "W" the width of the intercostal (internodal) section, "W'" that of the costal (nodal) one, "U" the width of the umbilicus. In measuring D, H and H' the height of the keel or, in some *Neokentroceras*, of outer tubercles rising above the level of the venter was left out of account. D is always expressed in mm. and tenths of mm.; the other dimensions are, unless otherwise noted, expressed in per cent of D or, if that proved to be impossible, of a smaller diameter which is, in such cases, explicitly indicated. In these percentage figures decimals have been reduced, or increased to full or half per cent.

Remarks on Plates and Figures

The larger specimens had to be reduced, the highest degree of reduction being two and a half times. Small ones are enlarged as far as necessary for visibility of details. Wherever possible photographed sectional views are shown instead of merely diagrammatic sections. The excellent suture line drawings and diagrams of whorl sections were made by Miss Helen Babbitt.

Previous Literature on the Geology and Palaeontology of the Cretaceous of Angola

Important résumés of previous literature are found in papers by Choffat (1888, pp. 5–15, 58, 59), Gregory (1916, pp. 495–497) and Douvillé (1931, pp. 17–21). Furthermore, reference may be made to Mouta's (1938) Geological Bibliography of Angola. In consequence, it is necessary here to mention only the most important papers. Among them Szajnocha (1885), although dealing with Middle Cretaceous cephalopods from the Elobey Islands (at about 1° north latitude, off the southern frontier of Spanish Guinea, some 1550 kilometers north northwest of Lobito), cannot be omitted, as his paper contains the first *Elobiceras* ever published, and this genus is one of the most characteristic and spec-

[1,2] Similar and other, more general objections to the artificial terminology created by Hyatt, Buckman and Spath were justly raised by Seitz (1929, pp. 149–154).

tacular present in the Albian of Angola.

Some months after Meunier had published early in 1888 a short note on some ammonites from Lobito Bay, the first important geological-palaeontological paper on the Cretaceous of Angola (Choffat's and de Loriol's "Matériaux pour l'Étude stratigraphique et paléontologique de la Province d'Angola") appeared. The first part by Choffat deals with the stratigraphy and includes a most careful historical review as far back as the middle of the sixteenth century. There are also a study of the Malheiro collections, which include Albian ammonites from both Catumbela (eight kilometers south of Lobito) and Dombe Grande (about forty kilometers southwest of Benguela), and a stratigraphic résumé in which the "Crétacique fossilifère" is thoroughly discussed. The beds with "*Schloenbachia*" *inflata* are correlated with the horizon "immediately beneath the Cenomanian," referred to the Cenomanian by Hébert but considered a separate stage, the Vraconnian, by Renevier; Choffat, however, points out that these beds are more closely related to the Gault than to the Cenomanian (*sensu stricto*). The second part of this monograph, also by Choffat, in which the Cretaceous mollusks are described, will have to be referred to repeatedly in the descriptions.

Another important paper by Choffat entitled "Nouvelles données sur la zone littorale d'Angola" appeared in 1905; for the scope of the present paper Sections "B—Résumé Stratigraphique" and "C—Remarques sur quelques Espèces" are most significant. The former includes a revision of the stratigraphy of the Cretaceous, as discussed in 1888; the beds with "*Schloenbachia*" *inflata*, recorded from Egito, Lobito Bay, Catumbela and Dombe Grande, are definitely referred to the Vraconnian. Twenty-one species are described in Section C, among them sixteen ammonites, most of which are discussed also in the present paper.

J. W. Gregory's (1916) "Contributions to the Geology of Benguella" explicitly discuss (pp. 498–504) the environs of Lobito, particularly a section from that place northeastward to the mouth of the Hanha River and another from the shore eastward across the Hanha Gorge (Fig. 3). In the "Correlation of the Benguella Series" the Inflata beds, referred to also as "Inflata marls" in the region of Catumbela, are placed at the top of the Vraconnian (p. 521). As far as ammonites are concerned, the results of this study lost most of their significance with the publication of Spath's (1922) paper, which induced Gregory to publish in the same year a "Supplementary Note." However, some of the statements made in the latter paper can no longer be maintained, e.g., the supposed "absence from South America of the most characteristic West African genus of this zone—*Elobiceras*" (p. 162).

L. F. Spath's (1922) paper "On Cretaceous Ammonoidea from Angola, collected by Professor J. W. Gregory, D.Sc., F.R.S." is most important, not only for the classification of Albian ammonites in general but also for the progress of the knowledge of those of Angola, particularly as far as the genera *Pervinquieria* (named first "*Subschloenbachia*," then "*Inflaticeras*" in that paper), *Elobiceras*, *Neokentroceras* and *Prohysteroceras*, almost all of them created by the author, are concerned. For the first time various species of *Elobiceras* are distinguished. This paper established the significance of the Albian fauna of Angola for ammonitological studies in a wider field and in consequence was again and again referred to in almost all the later papers not only by Spath (see this paper's Bibliography), but also by nearly every author dealing with Albian ammonites. Among the localities from which material was obtained some near Hanha are listed (p. 95: Nos. 166, 271, 272, 281, 286, 287, 290). In his stratigraphical results Spath for the first time definitely refers this fauna to the Upper Albian, correlating it with his Beds XI–XIII of the English Gault and rejecting the term "Vraconnian" as used by Choffat and Gregory.

Haughton's (1924) "Notes sur quelques Fossiles Crétacés de l'Angola (Céphalopodes et Échinides)" are important for recording some of the Albian ammonites, as described by Spath (1922) from the province of Benguela, and some new species

of the same age also from the northern province of Loanda and for listing various ammonites from other Angolan localities which are referable to various epochs of the Upper Cretaceous.

Rennie's (1929) paper on "Cretaceous Fossils from Angola," although dealing only with pelecypods and gastropods, is interesting for its stratigraphical and palaeogeographical sections.

Mouta's and Borges' (1928) study, "Sur le Crétacé du Litoral de l'Angola (Districts de Benguela et de Mossamedes)," though important from the geological viewpoint, is less interesting for the reader of this paper, as its faunal lists contain many gastropods and pelecypods but not a single ammonite. The "group of limestones and clays with ammonites" is referred to the Albian, based on *Stoliczkaia dispar* in the northern part of the district of Benguela (Egito-Catumbela) and on *Douvilleiceras mammillatum* in its southern part (Dombe Grande, Cuio). These two ammonites are supposed to represent a different horizon each. It may be worth noting that both[1] are described by Choffat, though represented neither in the collection studied by Spath nor in the present one.

In 1931 two papers relative to Cretaceous ammonites from Angola appeared: Airaghi's on an Albian collection from Lobito, wrongly referred to the Upper Cretaceous by that author and including the first full disc of *Pervinquieria arietiformis*, of which only scanty fragments had previously been figured by both Choffat (1888) and Spath (1922), and Douvillé's on the Ammonites of Salina (about 110 kilometers north of Mossamedes), referred by him to five different epochs of the Cretaceous from the Barremian to the Turonian.

Thiele's paper of 1933, dealing chiefly with two Upper Cretaceous ammonites and with the Cretaceous stratigraphy of Angola and attempting to discuss the phylogeny of *Pervinquieria*, was intended to be a preliminary one; his study on Cretaceous ammonites of Angola, as planned at that time, is, however, not likely ever to appear.[2]

Finally, Mouta published in 1938 a "Notice Géologique sur l'Angola (Afrique occidentale portugaise)"; the compact limestones with "*Acanthoceras mammilare*" are considered the lower, the marly limestones with "*Inflaticeras*" the upper horizon of the Calcareous Series, referred to the upper part of the Lower Albian, whereas the marly limestones and clays with *Stoliczkaia dispar* are correlated with the Upper Albian which the author, however, prefers to call Vraconnian. Also, the presence of the Senonian north of Benguela Velha and south of Dombe Grande is mentioned. The geological map 1:5,000,000 accompanying that paper is a reduction of one 1:2,000,000 by the same author and H. O'Donnell, issued in 1933 by the Portuguese Ministry of the Colonies. Locality data in the present paper are based on the latter map.

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[1] The latter species under the name "*D. mamillare*."

[2] Communication from Prof. von Huene, Tübingen, to Prof. A. S. Romer of Harvard University, in a letter of September, 1940.

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PART I: DIPOLOCERATIDAE (SENSU LATO)

Spath primarily (1921, p. 277; 1922, p. 107) included all the genera discussed in this part of the present paper in this family. After having expressed several other opinions as to this problem in his intermediate papers, in his Gault Monograph he divided his former family Dipoloceratidae into three: the Dipoloceratidae (*sensu stricto*), including, of the genera occurring at Hanha, *Dipoloceras* and *Oxytropidoceras*, the Mortoniceratidae (1932, p. 379), including, of the above genera, *Pervinquieria*, *Elobiceras*, *Prohysteroceras* and *Neoharpoceras*, and the Brancoceratidae (1934, p. 467), including, among other genera, *Hysteroceras* and *Neokentroceras*. Even as he did this, he doubted (1934, p. 443) whether it would not be preferable to restore the Dipoloceratidae in their old circumference.

The writer definitely prefers the latter procedure, particularly as it agrees with the limitation given to this family by Roman (1938, pp. 367, 368). Thus all the genera discussed in Part I of this paper[1] can be included in the family Dipoloceratidae. Their sequence in this paper deviates from Roman's only in that the scanty fragment doubtfully referred to *Oxytropidoceras* is dealt with by way of an appendix to this family and that *Hysteroceras* and *Neokentroceras* are discussed before *Pervinquieria* and *Elobiceras*, a procedure which seemed advisable, as *Hysteroceras* appears in some ways to be rather closely connected with *Dipoloceras*. Also there are some features of *Hysteroceras* and *Neokentroceras* which facilitate the elucidation of *Pervinquieria* and *Elobiceras*.

It may be added that, particularly within this family, the taxonomic arrangement could not possibly follow the sequence of the latest edition (1927) of Zittel-Eastman's Textbook of Palaeontology, as its taxonomy of the groups of ammonites concerned is rather obsolete. Not one of the eight generic names used here can be found there. The genus *Pervinquieria* as interpreted here would, under this textbook's classification, have to be included in "*Mortoniceras*," the other seven genera discussed in Part I in *Schloenbachia*. Thus all of them would be referred to the family Prionotropidae. In the sixth edition of Zittel-Broili's "Grundzüge" (1924) the following genera are, in addition to *Schloenbachia*, included in the latter family: *Oxytropidoceras*, "*Inflaticeras*," "*Subschloenbachia*," *Dipoloceras*, *Elobiceras*, *Neokentroceras* and *Prohysteroceras*, whereas *Hysteroceras* is not listed at all, and *Mortoniceras* seems to be restricted to the group of *Ammonites texanus*. But this textbook also cannot be considered up-to-date as far as these groups are concerned, for it ignores the priority of "*Inflaticeras*" to "*Subschloenbachia*" and of *Pervinquieria* to both these names, and defines "*Inflaticeras*," *Dipoloceras* and "*Subschloenbachia*" as of rectangular-quadratic section and as "lacking a high, sharp keel," the latter being the most characteristic feature of *Dipoloceras*.

DIPOLOCERAS HYATT[2]

This genus is represented in the collection by the following forms: the typical *D. bouchardianum* (d'Orbigny) and its variety *alticarinata* Spath; *D. rectangulare*, established by Spath (1931, p. 376) as a variety of the former species, and its new variety *elegans*; *D. symmetricum* (Sowerby), var. *obesa*. The latter species, thought by Spath (1934, pp. 492, 493) to occupy an

[1] Including *Neokentroceras*, not listed by Roman but undoubtedly belonging to the same family as *Hysteroceras*, and *Neoharpoceras*, which Roman, following Spath's (1934, p. 459) example, considers merely a subgenus of *Prohysteroceras*.

[2] *In* Zittel-Eastman, 1900, p. 589.

intermediate position between the genera *Hysteroceras* and *Dipoloceras*, is here referred to the latter genus for reasons stated below.

There are seventy-four specimens of this genus in the collection. Except for two individuals referred to the typical *D. bouchardianum*, all are small, and the majority of them belong to *D. rectangulare*.

Although Spath (1934, pp. 351–353) justly qualifies this genus as an "easily recognized" one, the specimens of *Dipoloceras* in the present collection, especially the smaller individuals, exhibit many convergences with, and even transitions to, other genera. It thus seems to be the best point of departure for the present study. The related genera are particularly *Hysteroceras*, *Neokentroceras* and *Prohysteroceras*, but also there are forms transitional to *Elobiceras* and *Pervinquieria*. All these resemblances will be dealt with in the discussion of the forms concerned.

As to the taxonomic position and the general relationships of this genus reference may be made to Spath (*loc. cit.*) and to the Palaeontological Résumé at the end of this part.[1]

Dipoloceras bouchardianum (d'Orbigny)

(A) **forma typica**

Pl. I, figs. 1a–c, 2; Pl. III, fig. 1

A. M. N. H. No. 25095: twelve specimens

Dipoloceras bouchardianum (A. d'Orbigny); SPATH, 1931, p. 374, *pro parte, cum synon.;* text figs. 122c, d, 124a–c; Pl. XXXIII, fig. 5; Pl. XXXIV, figs. 4, 5 only.

? *Schloenbachia* (*Inflaticeras*) *Bouchardiana* d'Orb.; COLLIGNON, 1931b, p. 34, Pl. III, fig. 18.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1 (a)	30.6 mm.[2]	48[2]	41	40	42½	?
(b)	39.6 mm.[3]	39½[3]	?	?[4]	?[4]	37
(c)	43.6 mm.[5]	38½	?	?[4]	?[4]	38

DESCRIPTION.—The largest specimen (No. 1, Pl. I, figs. 1a–c, Pl. III, fig. 1) seems to have attained a diameter of about 60 mm., but only a little more than a half of the outer whorl is well preserved, the inner ones being destroyed. The preserved part of the outer whorl is septate almost up to the front end; its anterior part is crushed.

The section, best seen at a fracture across its rear part (fig. 1b), is broad-elliptic and even a little more rounded than in d'Orbigny's (1841, Pl. LXXXVIII) fig. 7, although the venter appears to be slightly truncate; the peripheric shoulders are distinct, though rounded, in the Angola specimen also. Anteriorly the section becomes far more rectangular and the sides flatten, but it cannot be said that this may not be due solely to crushing. Also, where it is not crushed, the whorl is higher than thick; the umbilical shoulder is rounded and the umbilical wall not steep. The venter is broad, crowned by a sharp and very high keel (almost 2 mm. at a diameter of the disc of about 40 mm.), which is neatly separated from it but not accompanied by furrows.

There are, as in the holotype, twelve ribs per quarter whorl at the periphery and from six to seven of them at the umbilical edge where they are raised, forming sharp tubercles which occasionally culminate a little more ventrad. Either the ribs bifurcate at these tubercles or secondary ribs are intercalated which begin at the first third of the sides only. Here and there lateral nodes develop in the middle or at the second third of the sides. Only a single flared rib is seen. All the ribs swell slightly at the latero-ventral edge, thus accentuating it, and continue on the venter, turning sharply forward and gradually vanishing, as far as the base of the keel. On the sides, the ribs are distinctly sigmoidal and slightly prorsiradiate. On the whole, the costation of this individual is, in its anterior part, not so regular and graceful as it appears in d'Orbigny's side view. That, too, may be due, at least partly, to crushing, as the ribbing is far more regular in the uncrushed part of the shell.

The costae are crenulated throughout, this feature becoming more and more distinct toward the body chamber. On the anterior part of the well preserved whorl fragment up to twelve indistinct, blunt

[1] As to van Hoepen's (1941) generic name "*Ricnoceras*" see below, p. 144.

[2] If keel is not taken into account; if so, D = 33.4 mm., H = 49½.

[3] If keel is not taken into account; if so, D = 44 mm., H = 41.

[4] Specimen crushed.

[5] If keel is not taken into account.

spiral ridges can be observed on every rib, preservation permitting.

Only the external part of a suture line could be studied at the rear end of this specimen (Pl. III, fig. 1). The siphonal lobe is comparatively broad, with two almost perpendicular terminal points separated from each other by a slender, though low, median knob and three more lateral points on each side which become gradually less inclined orad. The external saddle is very broad, subdivided by a rather deep,[1] three-pronged lobule pointing a little dorsad, the outer stem being broader but lower than the inner one and rather deeply intersected at its external margin. The badly damaged first lateral lobe seems to be rather broad and two-pronged. The degree of indentation appears to be about the same as in d'Orbigny's (*ibid.*) fig. 8.

Another specimen (No. 2), very worn, seems to have attained, when complete, about the same size as No. 1. There are also ten fragments (Nos. 3–12) all of which agree so well with the example described above that they too were referred to the typical *D. bouchardianum*. Among these fragments one (No. 3) is worth mentioning for a flared rib which equals almost three others in width (fig. 2). There are some traces of suture lines in another (No. 4), but they are too poor for delineation.

(B) var. **alticarinata** Spath

Pl. I, figs. 3a–b; Pl. III, fig. 2; text fig. 2a

A. M. N. H. No. 25096: one specimen

Dipoloceras bouchardianum (A. d'Orbigny), var. *alticarinata* SPATH, 1931, p. 378, Pl. XXXIV, figs. 6, 7.

DESCRIPTION.—A single, very worn specimen, not permitting proper measurements, is, especially in ventral view, so strongly reminiscent of Spath's fig. 6 that the writer does not hesitate to refer it to the above variety.

The type of costation is the same as in the typical form but for the fact that the ribs are, in their inner parts, decidedly rursiradiate. The sides are far more rounded and, in consequence, the external shoulders less distinct. These features are considered by Spath to be distinctive of this variety; furthermore, its section is wider and has its maximum width farther dorsad than the *forma typica*. Another distinctive feature, clearly visible in both the Folkestone (Spath's fig. 6) and the Angola specimen, is the rapid increase of the whorl width.

It may be added that the choice of the varietal name is perhaps not a very happy one as the keel of both examples figured by Spath is relatively lower than that of the holotype of the typical *D. bouchardianum*. The same is true of the Angola specimens: the keel appears to be higher in fragments of about the same size which had to be referred to the typical form than in the specimen here dealt with.

In a fragment of a smooth inner whorl with a diameter of not quite 5 mm., which obviously belongs to the same specimen, two entire suture lines are seen (Pl. III, fig. 2). The siphonal lobe is rather broad, with two strongly diverging points and a low median knob; the external saddle is not too broad, bifid, the first lateral lobe comparatively broad with two terminal points and two lateral ones only slightly above them. The first lateral saddle is about equal in height to the external one and also bifid; the second lateral lobe trifid and pointing slightly dorsad. The second lateral saddle is a reduced repetition of the first; two auxiliary lobes and two auxiliary saddles are visible up to the umbilical seam.

REMARKS (AD *D. bouchardianum*, SENSU LATO).—As to the synonymy of this species, reference may be made to Spath's complete list. The small size of Collignon's (*loc. cit. in syn.*) specimen from Madagascar makes it difficult to decide whether it should be referred to this species or to one of its relatives.

The differences between the variety *alticarinata* and the typical form have been pointed out above; both will be compared below to Spath's variety *rectangulare*, here raised to the rank of an independent species. As to comparison with *D. symmetricum* reference is made to the description of its variety *obesa* (p. 18).

D. bouchardianum has the crenulation

[1] This does not quite agree with Spath's opinion, based on d'Orbigny's drawings reproduced in Spath's text figs. 124c, d, that the external saddle is less distinctly bifid in this species than in *D. cristatum*.

of the ribs in common with *D. pseudaon* Spath (1931, p. 373, Pl. XXXIV, figs. 1–3) from the English Gault; this species is, however, far stouter. Such crenulations appear to be most distinct in *D. pseudaon* var. *moniliformis* (*ibid.*, Pl. XXXII, fig. 10); as far as the species under discussion is concerned, this feature is visible neither in d'Orbigny's protograph nor in any of Spath's figures, but this author mentions it among the characters of "some varieties" of *D. bouchardianum*.

Stieler (1922b, p. 336) and Spath (1925b, p. 187; 1931, p. 378; 1934, p. 447) consider the form named "*Schloenbachia rostratus*, var. *antipodeus*" by Etheridge (1909, p. 237, Pl. LXVII, figs. 3, 4) and since renamed *Prohysteroceras richardsi*, var. *nitidum* by Whitehouse (1926, p. 223, Pl. XXXVI, fig. 3) to be indistinguishable from *D. bouchardianum*, but its section as figured by Whitehouse is somewhat different from that seen in our Pl. I, fig. 1b.

Among forms of the present collection referred to other genera, *Elobiceras*, indeterminate new species No. 1, and *Prohysteroceras hanhaense*, new species, will have to be compared below (pp. 14 and 132, respectively) with the species under discussion.

Dipoloceras rectangulare Spath

(A) **forma typica**

Pl. I, figs. 4a, b, 5, 6a, b, 7a–d, 8a, b, 9a, b, 10a, b, 11a–d, 12–14; Pl. III, figs. 3–6; text figs. 2b, c

A. M. N. H. No. 25097: fifty-one specimens

Dipoloceras bouchardianum (A. d'Orbigny), var. *rectangularis* SPATH, 1931, p. 376, Pl. XXXII, fig. 19.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
5	16.8 mm.	41	36	36½?	44	35½

DESCRIPTION.—Among the numerous individuals, most of them fragments, a single one (No. 5) permitted exact measurements. As frequently happens, the whorls are slightly stouter at an early stage than later on; in the smaller individuals they are as a rule a little wider than high, whereas in maturity the height usually equals or even, though rarely, exceeds the width.

The best preserved specimen (No. 1, Pl. I, figs. 4a, b; text fig. 2b), in which the thickness of the whorl exactly equals its height, perfectly agrees in the shape of the conch with the only individual depicted by Spath.

D. rectangulare seems to have been considerably smaller than *D. bouchardianum*, some representatives of which in the Angola fauna must have attained diameters of from 75 to 80 mm., whereas the largest individuals of the former species do not seem to have exceeded about 50 mm., the last septum being at diameters from 15 to 25 mm.

The conch is but slightly involute, the costal section, throughout development, quadrate or, if wider at the umbilical shoulders than at the peripheral ones, slightly trapezoidal (Pl. I, figs. 7d, 11d, 12–14; text figs. 2b, c). Both inner and outer edges are rounded; the umbilical wall is rather high and steep, though not perpendicular. The sides and the venter are flat, the keel is strong and rather high, though less so than in *D. bouchardianum*.

The development of the ornamentation could be studied from a diameter of 5 mm. on. At that stage (inner whorl of specimen No. 5, fig. 7a), earlier than mentioned by Spath (1931, p. 378) for *D. bouchardianum*, var. *alticarinata*, about seven decidedly sigmoidal ribs per quarter whorl are present, most of them confined to the venter and to the two outer thirds of the sides. Only every second or third among them reaches the umbilical edge where from three to four blunt tubercles per quarter whorl can be seen. The costae become gradually sharper, longer and less sigmoidal; at a diameter of about 15 mm. there are about fourteen of them per half whorl; longer and shorter ones alternate regularly, the former arising from the umbilical tubercles (seven to eight per half whorl) which are bullate at first and later become gradually elongated radially. At this stage the ribs just begin to turn forward on the venter. The mature stage of sculpture is best seen in specimen No. 1 (fig. 4a). Here there are ten prominent, distinctly sigmoidal ribs per quarter whorl; every second among them arises at the umbilical shoulder,

forming a distinct, radially elongated tubercle; the secondary ribs branch off from the primary ones or are intercalated between them at the first third of the sides. All the ribs continue beyond the peripheric shoulders on the venter (fig. 4b), where they run, at first with a slight, then with a sharper bend forward toward the keel, stopping at a short distance from it so that narrow, smooth bands remain on both its sides. Preservation permitting, a very fine imbrication of the keel may be seen, caused by delicate, inverted V-shaped striae running over its sides and top. Where preservation is excellent, as in specimen No. 1, faint traces of a fine spiral striation are observable on the ribs. Most characteristic of this species' costation are its regularity and elegance, as seen in Spath's holotype as well. In some individuals here referred to this species (e.g., Nos. 3, fig. 5, and 4, fig. 6a) it is somewhat coarser and stiffer, but there are all shades of transition.

In some other specimens (Nos. 6–8, figs. 8–10) flared ribs occur, two or even three ribs coalescing into more or less flat protuberances covering either the outer half or even the whole extent of the sides, but hardly ever expanding beyond the latero-ventral shoulders. These protuberances sometimes show slight median depressions indicating the continuation of one intercostal or, more frequently, of two amalgamated intercostals.

Suture lines could be studied, though incompletely, in many specimens (Nos. 4, 6–9, 10, 15–18, 45) from a diameter of about 6 mm. (inner whorl of No. 9, Pl. III, fig. 4) on. At that early stage all the main elements appear to be broad and low; both the external and first lateral saddles are bifid, the latter is higher than the former; the first lateral lobe is only about half as deep as the siphonal one and two-pronged, the second is triangular in shape and apparently three-pronged. Details which have disappeared in specimen No. 9 owing to etching are visible in the slightly larger inner whorl of No. 10; the median part of its suture line is depicted in Pl. III, fig. 5; the median knob is triangular, the indentation being rather rich for the small size. A later sutural stage can be well observed in specimen No. 15 (Pl. III, fig. 6, diameter about 12 mm.). Here the first lateral lobe is about two-thirds as long as the siphonal one; its inner point is a little shorter than the outer one and turns slightly ventrad. The lobule intersecting the external saddle is short, rather stout and decidedly two-pronged. The second lateral lobe trends obliquely ventrad and is distinctly trifid and only about half as long as the first. Beyond the low and bifid second lateral saddle a slender, still more oblique, first auxiliary lobe is visible on the umbilical shoulder; there follows, on the umbilical wall, the first auxiliary saddle; a rather deep, tongue-shaped second auxiliary lobe is just halved by the umbilical seam. In the impressed zone one more saddle, one more lobe and a very high and slender, richly indented, internal saddle can be seen, the latter bordering the deep and narrow, two-pronged, antisiphonal lobe. In specimen No. 6 the top of the external saddle can be studied more in detail (Pl. III, fig. 3). Here the intersecting lobule appears to be deeper and more slender than in No. 15, but here too it is two-pronged. The outer stem of this saddle is both broader and higher than the inner one, though on its part over-topped by the first lateral saddle.

(B) var. **elegans**, new variety

Pl. I, figs. 15a–c, 16; Pl. III, fig. 7

A. M. N. H. No. 25098: three specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
3	11.0 mm.	40	?	?	40	37½
Holotype: 1	19.9 mm.	36½	?	?	39	36

DESCRIPTION.—The holotype (Pl. I, figs. 15a–c; Pl. III, fig. 7) consists of a little more than half a disc, the inner whorls of which are almost entirely destroyed; the rear end only of the outer whorl is septate, about half of it belongs to the body chamber.

This variety differs from the typical form by its much finer and more graceful costation. Furthermore, the ribs are more sigmoidal and turn more sharply forward on the venter. The gracefulness of the ornament makes it appear to be denser than in the typical form, although, as a matter of fact, there are only seventeen ribs per half whorl in the holotype as compared to twenty in the former.

The variety also seems to be more slender, but

at its front end the holotype proves to be even stouter, its height attaining only 94 per cent of its width. At the rear end, however, the whorl is remarkably higher than thick (H = 5.5 mm., W′ = 4.7 mm.); this rapid increase in the width of the outer whorl occurs in *D. symmetricum* as well. Otherwise the holotype, except for its slightly lower keel, agrees fairly well with typical individuals of this species.

Its ultimate (or penultimate ?) suture line is well preserved (Pl. III, fig. 7); it is not very different from those of the typical form; the lobule intersecting the external saddle is short, stout and two-pronged as in specimen No. 15 of the latter. This suture line is, however, most remarkable for its asymmetry, its left half being shifted orad as compared to the right one; both its left external saddle and the bottom of its left first lateral lobe are, therefore, considerably higher than the corresponding elements on the right side; besides, this lobe is much shallower and broader on the left side than on the opposite one. On the former, the second lateral saddle is just bordering the umbilical shoulder, and on the umbilical wall the first auxiliary lobe and saddle are visible.

Two smaller individuals differ from those of the same size referred to the typical form by their finer and more sigmoidal ornament, e.g., specimen No. 2 (fig. 16), and are, therefore, also referred to the variety *elegans*.

REMARKS (AD *D. rectangulare*, SENSU LATO).—This species is based upon Spath's (*loc. cit. in synon.*) *D. bouchardianum*, var. *rectangularis*, called by this author the "inflated variety" of d'Orbigny's species; two individuals are mentioned among the measured ones on p. 376 of the Gault Monograph. One depicted in its Pl. XXXII, fig. 19, though unfortunately in side view only, is considered the holotype of the new species.

It seemed advisable to raise this variety to the rank of an independent species not only because it is by far the most common *Dipoloceras* in the Albian fauna of Angola, where it is represented by almost four times as many individuals as *D. bouchardianum, sensu stricto*, but also because the differences separating it from the latter do not seem to be of merely varietal character. Furthermore, there is much variability within the boundaries of the new species.

Spath assigned to it an intermediate position between the typical *D. bouchardianum* and his *D. quadratum*[1] (1921a, p. 278, Pl. XXV, fig. 3) which is based on a specimen of Pictet's from the Grès Verts and is found also in Zululand. Spath distinguishes the three forms chiefly on the basis of their W′:H relations, but in the writer's opinion the most distinctive feature of *D. rectangulare* is the flatness of both sides and venter, found even in the earliest stages and causing the whorl section to be decidedly quadratic or subquadratic. Moreover, it does not grow so large as d'Orbigny's species, its costation is slightly less dense and its keel not so high.

D. symmetricum, which has some resemblance to the new variety *elegans*, especially as far as the rapid increase in width of the outer whorl is concerned, will be compared below.

D. rectangulare shows remarkable similarities to forms belonging to various other genera. Its earliest stages, up to diameters of about 12 mm., are rather similar to those of several forms of *Hysteroceras*, e.g., *H. varicosum*, var. *angolana*, *H. orbignyi*, var. *minor*, *H. intermedium*, *H. carinatum* and *H. semilève;* it requires very careful comparison to distinguish inner whorls of all of them from those of the present species (see pp. 26, 29, 37, 45). As far as *H. carinatum* is concerned, the similarity persists up to a larger size of the conch (for detailed comparison see pp. 41, 42).

The adolescent stages of *Prohysteroceras gracile* and even more so those of *P. decipiens* and *P. hanhaense* can be distinguished only by very careful comparison from individuals of the same size of the species here dealt with (pp. 128, 130, 132.)

Dipoloceras symmetricum (J. de C. Sowerby)[2] var. **obesa**, new variety

Pl. I, figs. 17a–c, 18a, b, 19a, b; Pl. III, fig. 8; text fig. 2d

A. M. N. H. No. 25099: seven specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
2	15.8 mm.	36½	?	?	ca. 50	39½
Holotype: 1	16.1 mm.	38	?	?	49	37½
3	18.7 mm.	40	?	?	43	32
4	20.6 mm.	40½	?	?	45½	36

[1] This specific name would be far more appropriate for *D. rectangulare*, the whorl section of which is really almost quadratic, whereas that of the Zululand species is depressed, with strongly vaulted sides.

[2] For synonymy of this species see Spath, 1934, pp. 492, 493 *sub* "*Hysteroceras* (*Dipoloceras?*) *symmetricum*."

DESCRIPTION.—The anterior quarter of the holotype's (specimen No. 1) outer whorl belongs to the body chamber, and in the three other individuals, consisting of more or less complete outer whorls (Nos. 2–4), the last septum seems to be between diameters of 15 and 20 mm. Thus this variety may hardly have exceeded 25 or 30 mm. in diameter, so it agrees fairly well in size with the examples measured by Spath (*loc. cit.*). In addition to the aforementioned specimens there is a poorly preserved quarter whorl (No. 5) corresponding in size with the posterior half of the holotype's outer volution, and two little fragments of the ventral parts of very small individuals (Nos. 6, 7).

The characteristic feature of this variety is the rapid increase of the width of the whorls at a certain phase of development, as seen best in the ventral views (figs. 17b and 18b). Up to diameters of 10–12 mm. the whorls are comparatively slender and rectangular in section; beyond this point and up to a diameter of about 18 mm. there is a sudden acceleration in the rate of increase in whorl width. However, this rate of increase does not appear to be maintained beyond that diameter. It may be noted as another peculiarity of this variety that the maximum width of the section is not, as is usual, near the umbilical edge but in the outer third of its height. Thus the section is compressed-rectangular at first, then depressed-rectangular and seems eventually to approach a quadratic shape.

The ornament of the earlier stages can be well studied in the crystallized inner whorls of the holotype (fig. 17a). The innermost ones appear to be smooth, but toward the beginning of the outer whorl there are nine very broad, almost straight, slightly rursiradiate ribs per half whorl. They are prominent on the outer half of the sides only and end in strong, though blunt outer nodes running in ventral view perpendicularly toward the rather high and sharp keel, from which they are separated by broad shallow furrows. Around the umbilicus there are six blunt, bullate tubercles, some of them connected by indistinct folds with outer ribs. In the front half of the outer whorl the costae become more distinct on the inner half of the whorl, though still less so than on the outer one. They are sharper throughout the sides, and there are now fourteen of them per half whorl. Simultaneously the inner tubercles become radially elongated. Every second rib arises from one of the tubercles, whereas the others begin at the middle of the sides or at their outer third only. The ribs are still slightly rursiradiate and straight or form a shallow, orad convex arc. On the venter they run, as a rule, perpendicularly toward the keel, but in exceptional instances there is an indication of forward projection of a single rib. The keel is still rather high and considerably overtops the outer ends of the ribs from which it is separated by distinct, though extremely shallow furrows.

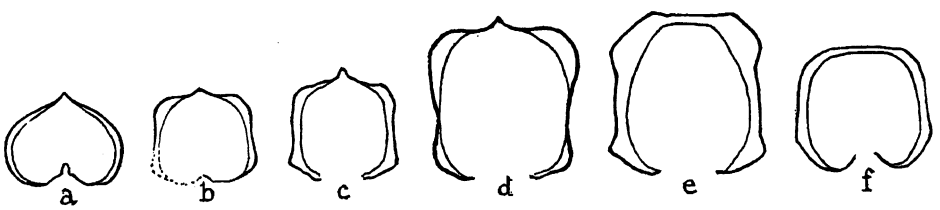

Fig. 2. Costal and intercostal sections of:
(a) *Dipoloceras bouchardianum* (d'Orbigny), var. *alticarinata* Spath, A.M.N.H. No. 25096, at anterior end, × 2.
(b, c) *Dipoloceras rectangulare* Spath, (b) A.M.N.H. No. 25097:10, inner whorl, × 3; (c) A.M.N.H. No. 25097:1, at posterior end, × 2.
(d) *Dipoloceras symmetricum* (Sowerby), var. *obesa*, new variety, holotype, A.M.N.H. No. 25099:1, × 3.
(e) *Hysteroceras varicosum* (Sowerby), var. *rarecostata*, new variety, holotype, A.M.N.H. No. 25102, × 7/2.
(f) *Hysteroceras orbignyi* Spath, var. *minor*, new variety, holotype, A.M.N.H. No. 25103:4, at posterior end, × ca. 3.
Actual ratios of enlargement about 5 per cent less than indicated above.

The costation of the other individuals referred to this variety agrees fairly well with that of the holotype but for the slightly denser ribbing of specimen No. 3 (sixteen ribs per half whorl as compared to fourteen in the former) and for the more distinct bifurcation of ribs in specimens Nos. 2 and 4 at diameters from 12 to 15 mm.

In both the holotype and specimen No. 4 an indistinct crenulation or a slight tendency of some ribs to flare is observable in some places.

The suture line could be studied in the holotype only (Pl. III, fig. 8); the siphonal lobe is not very broad and subdivided by a slender and comparatively high trapezoidal knob into two long, but little diverging terminal points; it has one long, oblique, lateral point on each side. The external saddle is very broad and intersected by a short, triangular, three-pronged

lobule; both its stems are about equal in height and width and bifid as well. The first lateral lobe is not very broad and attains only about two-thirds the length of the siphonal one. It is decidedly two-pronged and points slightly ventrad. The first lateral saddle is rather slender, equaling the external one in height and bifid as well. The second lateral lobe is triangular, trifid and oblique, its middle point directed ventrad. Beyond the second lateral saddle, which is considerably lower than the first and also distinctly intersected, there follow the tongue-shaped first auxiliary lobe and on the umbilical wall the first auxiliary saddle. In the median part, where the details have not been destroyed by corrosion, the indentation of this suture line can be seen to be rather rich, although the bodies of the saddles are not deeply intersected. By this feature and by its characteristic external lobe it proves to be a genuine *Dipoloceras* suture line.

REMARKS.—This variety differs from the typical *D. symmetricum* in being less involute and in maturity considerably stouter, as well as by its broader and less numerous ribs. Although thicker than the typical form, it cannot be identified with Spath's (1934, p. 493, text figs. 173d, e) "inflated example" which has a denser costation (twenty ribs per half whorl) and is also more evolute. Specimen No. 3, the ribbing of which is denser than that of the holotype, might be considered transitional to Spath's inflated form were it not even more involute. In its keel decidedly overtopping the outer ends of the ribs the new variety agrees even better with Sowerby's protograph (reproduced in Spath's text fig. 173a), which does not at all show an "immersed" keel, than it does with Spath's neotype.

Spath was uncertain as to whether this species should be referred to *Hysteroceras* or to *Dipoloceras*, but in the writer's opinion its rather high and sharp persistent keel, the occasional tendency of its ribs to flare and the character of its (hitherto unknown) suture line, wrongly supposed by Spath to be very simple, give full evidence of its being a *Dipoloceras*.

This species can be readily distinguished from the other representatives of this genus in the present collection, *D. bouchardianum* and *D. rectangulare* and their varieties, by its less dense and stiffer costation, by the outer ends of the ribs not being projected on the venter, by its more distinct and, at an early stage, more bullate umbilical tubercles, by its lower keel and above all by the rapid increase in width of its whorls. It can also be distinguished from *D. rectangulare* by the lack of the regularity and gracefulness of the latter's ribbing.

Some evolute individuals of *Hysteroceras carinatum* and perhaps also certain stages of the rapidly changing development of *Prohysteroceras hanhaense* are very similar to this species; both will be compared in detail below (pp. 41 and 133, respectively).

It should also be pointed out that the inner whorls of *Pervinquieria bassleri* closely resemble individuals of the present species of about the same size (p. 86).

HYSTEROCERAS HYATT

It seems that not much use was made of this generic name, established by Hyatt as early as 1900,[1] until 1925. Crick (1907, p. 248, Pl. xv, figs. 8, 8a) had described and figured a "*Hysteroceras* sp.," which is doubtfully referred to *H. choffati* by Spath (1925b, pp. 188, 189) and which may be closely related to *H. orbignyi*, from Zululand, but Spath in his Angola paper (1922, p. 99) had considered *Hysteroceras* a synonym of *Brancoceras* Steinmann, proposing to reserve Hyatt's name to the group of *H. carinatum*. However, he used it as a generic name in its primary sense in his paper on Upper Albian Ammonoidea from Portuguese East Africa (1925b, pp. 182, 187–189) and discussed the genus more explicitly in his Gault Monograph (1934, pp. 470–473).

In the present paper *Hysteroceras* is taken in the circumscription given to it in the latter paper, except that the writer cannot agree in including *Neokentroceras pseudovaricosum* in this genus (see p. 61), and he prefers to include *Dipoloceras symmetricum*, which was, though doubtfully, referred to *Hysteroceras* by Spath, in *Dipoloceras*.

After Choffat (1905, p. 34, Pl. iv, fig. 6) had referred "une douzaine d'échantillons incomplets" from Lobito to "*Schloenbachia*" *varicosa* Sowerby and figured one specimen out of this dozen, which was afterwards renamed *H. choffati* by Spath (1925b, p. 187), no further representatives of this genus

[1] *In* Zittel-Eastman, p. 590.

were recorded from Angola. In the present collection, however, it is, in the number of individuals, the largest generic group recognized, being represented by no less than 303 specimens. Of these, thirteen are too poorly preserved to permit specific determination; the remaining 290 are referred to twenty-two specific and varietal groups, distributed among ten different species.

A notable feature is the small size of all these individuals; the largest one, preserved up to the apertural margin, has a diameter of 25.5 mm. The average diameter is considerably less. Although the only *Hysteroceras* from Angola hitherto figured in literature (see above) attains about 33 mm. in diameter, the Angolan types of this genus may, on the whole, be considered dwarf forms as compared to those from Portuguese East Africa (the holotype of *H. choffati* Spath measuring 47 mm. in diameter), from the English Gault and from the Perte du Rhône which, although small as compared to other ammonite genera, attain diameters up to about 60 mm.

Two natural groups are apparent in the present assemblage. At first glance these appear to be best distinguished as a group in which the keel tends to fade, as compared to a group with a persistent keel. This is, however, not a strictly exact differentiation, as a vestigial keel may be visible in some of the forms of the first group even after the union of the ribs from the sides over the venter, while, on the other hand, the keel shows a more or less distinct tendency toward fading in a few forms of the second group. The distinctive feature of the first group is rather the coalescence of the ribs across the venter, and the writer, therefore, prefers to distinguish the forms in which the ribs coalesce ventrally from those in which they do not.

The first group is represented in the collection by the genotype *H. varicosum* and its new varieties, *angolana* and *rarecostata;* by two new varieties, *minor* and *evoluta*, of *H. orbignyi;* by *H. choffati* and a form comparable to this species; by two new varieties, *lobitoensis* and *angusteumbilicata*, of *H. binum;* by a single individual closely related to *H. subbinum* and by an interesting new species, *H. falcicostatum.*

To the second group belongs another new species, *H. intermedium*, together with its variety *compressa; H. carinatum*, known since d'Orbigny from Europe, with two new varieties, *robustecostata* and *exigua;* and two new species, *H. semilēve* and *H. propinquum;* from the former three distinct varieties, *elegans*, *densicostata* and *sparsicostata*, had to be separated. Thus the group of *Hysteroceras* with a persisting keel and ribs not coalescing on the venter, hitherto represented only by *H. carinatum* Spath, proves to be far larger and more multiform. The question may arise whether it can at all be left with *Hysteroceras*. It could not, should the ventral coalescence of the ribs in maturity be considered a generic character of *Hysteroceras*. However, the species under discussion appear to be so closely related to other species, which doubtless belong to this genus, that generic separation would be, in the writer's opinion, most unnatural. This view seems to be supported by Spath who in his Gault Monograph, although certainly not too hesitant about splitting up genera, leaves *H. carinatum* with the genus under discussion.

Hysteroceras varicosum (J. de C. Sowerby)

(A) forma typica

Pl. I, figs. 20a–c; Pl. III, fig. 9

A. M. N. H. No. 25100: four specimens

Inflaticeras varicosum (Sow.), var. *crassicostata* JAYET, 1929, p. 4, figs. 4, 7/1, 2, 5, 6, 10.

Hysteroceras varicosum (J. de C. Sowerby); SPATH, 1934, p. 473, *cum synon.* (pp. 473–475); text figs. 161e–g, 162–164; Pl. XLIX, figs. 5, 10, 11.

Not *Hysteroceras varicosum* (Sow.); VENZO, 1936, p. 97.

DESCRIPTION.—Among sixty-nine individuals referred to *H. varicosum* (*sensu lato*) four only could be fully identified with Sowerby's holotype, as refigured in Spath's text figs. 162a–c. The best of these, a half disc (No. 1), and specimen No. 3 are, it is true, somewhat stouter than the holotype; however, this seems to be due only to their smaller size.

Spec. No.		Dimensions D	H	H′	W	W′	U
1	(a)	17.7 mm.	40	31½	36½	38½	31½
	(b)	ca. 25.0 mm.	ca. 40	ca. 33	ca. 33½	ca. 36	ca. 36
3		26.4 mm.	37	32	33½	36	39

As seen in the above table of dimensions, the conch of specimen No. 1 becomes more slender and evolute toward the anterior end of the preserved half of the outer whorl. Both of the aforementioned specimens are obviously septate up to the front end. It may be worth noting that the decrease of both width of whorls and involution can be seen in Sowerby's holotype as well and that the "egression" of the spiral of involution in the body chamber is throughout this paper repeatedly observed also in other costate genera from Angola, e.g., *Pervinquieria* and *Elobiceras*.

The section (fig. 20b) of the penultimate whorl of specimen No. 1 is almost oval, though with distinctly flattened sides, whereas the costal section of the outer whorl is almost quadratic, though a little higher than wide and slightly tapering from the umbilical shoulder to the peripheric one. Both these shoulders are, in costal section, very pronounced; the former is but slightly rounded, the latter becomes decidedly slanting in the anterior part of specimen No. 3. The umbilical wall is high and steep, though not perpendicular. The venter is decidedly truncate.

At first sight, the penultimate whorl of specimen No. 1 seems to be smooth, but careful examination discloses very blunt umbilical tubercles, continuing ventrad as most indistinct folds. The well preserved third of the outer whorl, however, has a very pronounced costation, consisting of eight ribs. Four among them arise from distinct, though not prominent tubercles, situated just on the umbilical edge and elongated in a more and more distinctly prorsiradiate sense. These primary ribs are weakest in the innermost part of the sides; at about their first fourth they turn decidedly backward and, gradually thickening, run ventrad in a rursiradiate sense. Only two of them follow each other immediately; between each two of the others secondary ribs are intercalated which begin at the first fourth or third of the sides. Toward the periphery all ribs become uniform. In the posterior part of the outer whorl they end in strong, though blunt nodes pointing perpendicularly toward the keel in ventral view. The latter is, in that part of the body chamber, still distinct, though blunt, and just equaling the outer nodes in height. Although these are still neatly separated from the keel, they are already connected across the venter by indistinct folds separated from each other by broad and still rather shallow interstices. Toward the front end of the outer whorl the keel gradually disappears and the peripheric nodes coalesce from both sides straight across the median line. The intercostals have meanwhile become narrower and deeper. As seen in sectional view, the keel is more distinct on the penultimate whorl than on the outer one and decidedly overtops the peripheric shoulders on the former. (The same is seen in Sowerby's protograph of the section.) The sculpture of specimen No. 3 agrees fairly well with that of No. 1, but the outer nodes are a little more prominent, and the keel seems to vanish a little earlier.

Only some details of the suture line could well be studied on the penultimate whorl of specimen No. 1 (Pl. III, fig. 9). The first lateral lobe is distinctly two-pronged; its length cannot be compared with that of the median one. The first lateral saddle is rather slender; the second lateral lobe is comparatively broad and distinctly three-pronged. There follow the second lateral saddle, the triangular first auxiliary lobe, just on the umbilical edge, and the first auxiliary saddle on the umbilical wall.

To judge by the costation, specimens No. 2, a poorly preserved fragment of an individual of about the same size as No. 1, and No. 4, about a sixth of a septate whorl, seem also to belong to the typical form of this species.

(B) var. **angolana**[1] Haas

Pl. I, figs, 21a–c; Pl. II, figs. 1–17; Pl. III, figs. 10–12; Pl. VI, figs. 1, 2

A. M. N. H. No. 25101: sixty-four specimens

Hysteroceras varicosum (Sow.), var. *angolana* Haas, 1941, p. 661, Pl. I, figs. 1a–c, 2a–d, text figs. 1, 2.

This rises, however, but slightly above the level of the venter (Pl. II, figs. 2a, b).

Besides the usual insignificant deviations in dimensions between individuals of the same size, as seen best by comparison of the measurements of the specimens Nos.

		Dimensions				
Spec. No.	D	H	H′	W	W′	U
Holotype: 1	(a) 8.4 mm.	35 1/2	?	?	ca. 35 1/2	37
	(b) 20.0 mm.	33 1/2	30	31 1/2	34	40
12	12.0 mm.	33	28 1/2	?	35 1/2	43 1/2
60	19.1 mm.	37 1/2	?	32 1/2	34 1/2	36 1/2
13	21.4 mm.	35	32	27	32	40
14	21.4 mm.	35	32	29 1/2	33 1/2	39 1/2
Paratype: 2	25.5 mm.	34 1/2	30 1/2	26 1/2	32	42 1/2

Description.—Except for the four specimens discussed above and the single individual referred to the next variety, *H. varicosum* (*sensu lato*) is represented at Hanha by this variety. Being the commonest form not only among the *Hysteroceras* but among all the ammonites occurring there, it may well be considered one of the chief index fossils of the Albian of Angola, although the genera *Elobiceras* and *Neokentroceras* may be no less characteristic of this fauna.

Most of the specimens, it is true, are merely fragments and where the outer whorls are complete the inner ones are, as a rule, calcitized or even destroyed. Of other individuals, on the other hand, only the inner whorls are preserved. There are but three full, or almost full, discs (Nos. 1, 20 and 60). In one of them (No. 1) both inner and outer whorls could be thoroughly examined, and it was, therefore, chosen as the holotype of this variety, although it had to be removed, bit by bit, from the rock and to be reconstructed afterwards in the best way possible. The largest specimen (No. 2) was chosen as the paratype; it consists of a little more than half an outer whorl and of the anterior end of the penultimate one. The former seems to be preserved up to the aperture, to judge by the indication of a rostrum at its front end.

13 and 14, there are other variations which are due to development. As seen in the above table, the young are more involute and slightly stouter than the adults, as observed also in the typical *H. varicosum;* a decidedly accelerated development as to the decrease of involution occurs in the most evolute individual (No. 12). On the other hand, the height of the whorls does not decrease in the course of growth in Nos. 13 and 14 to such a degree as in the holotype and in the paratype.

The last septum is found at diameters of 9 mm. in specimen No. 16, which seems to be a young individual; of almost 15 mm. in the holotype and in No. 14; and of 16.5 mm. in the paratype, and in specimen No. 60. The body chamber of the paratype occupies not quite three-quarters of the last whorl.

The earliest stage that could be examined at diameters from 4 to 7 mm. shows a section that is oval or almost circular (Pl. II, figs. 8d, 7b). Later the intercostal section becomes elliptic, the costal one subquadratic (specimen No. 16, D = 9 mm., Pl. II, fig. 8c; holotype, D = 11 mm., Pl. II, fig. 1d; specimen No. 11, D = 11 mm.; specimen No. 13, D = 16 mm., Pl. II, fig. 4c) and in maturity when the height of the whorl exceeds its width the section is rectangular (specimen No. 13, D = 21.5 mm.). The upper corners of both the quadrate and rectangular sections are always distinctly rounded. As a rule, the sides are strictly parallel, but if the section happens to be at a pair of secondary ribs

[1] This Latin adjective was hitherto formed "*angolaensis*," but in the writer's opinion there is no more reason for doing so than for deriving from "*Roma*" an adjective "*romaensis*."

the sides seem slightly to converge dorsad.[1] A typical section is shown in Pl. II, fig. 13; here is also seen a complete little gastropod squeezed obliquely into this whorl but 6 mm. wide and 7 mm. high.

As observed also by Jayet (1929, p. 7, fig. 9) in the *H. varicosum* of the Perte du Rhône, the innermost whorls are smooth up to a diameter of about 5 mm., lacking both keel and costation (Pl. II, fig. 7b). Both are, however, present at a diameter of 6 mm. in the holotype of the present variety and in specimen No. 15. In the former there are at first blunt circumumbilical tubercles and broad, fold-like ribs, every second of which begins at the first third of the sides only. At a diameter of 7 mm. the costation becomes very distinct (holotype, specimens Nos. 15, 19) and there are ten rather prominent ribs per half whorl; longer, primary ones, originating from distinct, though blunt inner tubercles, and shorter, secondary ones alternate almost regularly. All of them run in an almost straight or slightly apicad concave, rursiradiate line across the sides, widening ventrad. At the periphery they form distinct nodes which continue beyond the latero-ventral shoulder. On the venter they run perpendicularly or with a slight forward bend toward the keel from which they still are neatly separated.

The keel is blunt and comparatively broad and hardly overtops the outer nodes at that early stage, which persists in the holotype up to a diameter of about 17 mm. In other individuals (e.g., No. 15) the keel becomes considerably finer at diameters of from 8 to 12 mm.

At that stage the ribs are more prominent and have increased in number up to twelve per half whorl. Still longer and shorter ones alternate, and the inner tubercles from which the former arise gradually become stronger and more pointed. Also the outer tubercles become stronger and more prominent and gradually encroach upon the keel. They definitely coalesce across the latter at diameters between 9 mm. (specimen No. 9) and 17 mm. (specimen No. 60). That seems to happen, as a rule, just at the beginning of the body chamber; in the paratype, however, it occurs a little earlier. The keel definitely disappears at diameters between 14 and 17 mm. only, and it remains traceable as a fine, imperceptibly raised line, especially in the intercostals.

On the body chamber the ribs, which have meanwhile gained both strength and sharpness, cross the venter in a continuous line which is almost straight or forms a shallow forward sinus, tending slightly to assume the inverted V-shape of a chevron. This trend is most distinct in the holotype and in the front parts of the paratype and of specimen No. 13 (Pl. II, figs. 1f, 2b, 4b). Quite rarely (in only two individuals out of sixty-four) a single pair of ribs (specimen No. 21, Pl. II, fig. 9a) or several subsequent pairs (specimen No. 22, Pl. II, fig. 10) form V-shaped backward sinuses, but the costation of the latter individual is most irregular on the whole. On the largest conchs, e.g., in the paratype and in specimen No. 14, the costae are distinctly broader and less sharp on the venter than on the sides. There is still an alternation between longer and shorter ribs, only the longer ribs arising from the umbilical tubercles which are still distinct in the body chamber, though in the holotype they gradually lose sharpness and become radially elongated. Occasionally, in the third quarter of the outer whorls of the holotype, the paratype and specimen No. 14, bifurcation of ribs occurs at the umbilical tubercles. The ribs still tend to be rather stiff and only in their inner parts slightly sigmoidal; they are, as a rule, slightly rursiradiate, and there are twelve (on exception [paratype] thirteen) of them per half whorl.

The outer part of the suture line could be studied in various individuals at different developmental stages. The earliest one is that seen in the inner whorl of specimen No. 16 at a diameter of about 4 mm. (Pl. VI, fig. 1), exhibiting a two-pronged siphonal lobe, a bifid external saddle, the inner stem of which is broader than the outer one, and a distinctly bifid first lateral lobe, all of them being very broad and low. The next

[1] In the photograph (fig. 1d) the sides seem to be concave owing to the rursiradiate direction of the ribs and to the fact that this section runs across outer tubercles, an intercostal and inner tubercles successively.

stage (diameter about 6 mm., specimen No. 18) is seen in Pl. III, fig. 12. Here the second lateral saddle is just riding on the umbilical shoulder, and one auxiliary lobe is still visible on the umbilical wall. In the holotype suture lines could be examined at diameters of from 4 up to 14 mm., although complete ones are observable between the diameters of 6 and 8 mm. only (Pl. VI, fig. 2). At that stage the following elements are observed: a rather broad siphonal lobe, subdivided by an extremely low median knob; a very broad, bifid, external saddle, the inner stem of which is both wider and higher than the outer one; a first lateral lobe, distinctly two-pronged and somewhat shorter than the median one; a first lateral saddle, slightly higher than the external one and but very little intersected at its top; a second lateral lobe which seems to be only half as long as the first and two-pronged as well; the second lateral saddle and on the umbilical wall a little auxiliary lobe. Some more suture lines can be seen at a diameter of about 12 mm. in spite of the poor preservation of this part of the holotype, giving clear evidence of the main lobe being two-pronged. Pl. III, fig. 11, shows a suture line of specimen No. 31, corresponding to about the same diameter; here the first lateral lobe is considerably shorter than the siphonal one.

The suture line of this variety could be studied best in specimen No. 60 at diameters from 10 to 12 mm. (Pl. III, fig. 10), although the siphonal lobes are not well visible owing to corrosion of the ventral surface. The external saddle is very broad and subdivided by a short three-pronged lobule into two stems equaling each other in both height and width. The first lateral lobe is rather broad, about as deep as the siphonal one, rectangular in shape and two-pronged. The first lateral saddle is lower and much narrower than the external one and is also distinctly bifid; its outer stem is broader than the inner one. The second lateral lobe does not quite attain two-thirds of the length of the first and is three-pronged; its inner border runs along the umbilical edge. On the umbilical wall follow the second lateral saddle, which seems also to be intersected at its top, and an auxiliary lobe.

In both the holotype and this example, at a stage not far from the last septum, the degree of indentation is still moderate and the general character of the suture lines rather simplified.

In specimen No. 11 the septa are, as usual, crowding toward the beginning of the body chamber so that the last camerae, the cast of one of which is figured both in side and sectional view (Pl. II, figs. 6a, b), become extremely thin.

Specimen No. 20, in which the five last suture lines are, most peculiarly, reversed, has been discussed and figured in an earlier paper (Haas, 1941, pp. 662–663, text fig. 2, Pl. I, figs. 2a–d).

It is to be noted that the characters of the suture line are rather variable in this species. As seen in Spath's text figs. 161e–g and 163d and in Jayet's[1] fig. 8, the first lateral lobe can be bifid, regularly trifid or trifid with a blunt, two-pronged middle point and, although it is, as a rule, shorter than the siphonal lobe (sometimes even considerably so, as in Stieler's variety *binodosa*, see Spath's text fig. 163d), it can equal the latter in length or even grow longer, as in Spath's text figs. 161f and g or in the third, sixth and seventh suture lines from above of Jayet's fig. 8.

Besides the fifty-seven individuals hitherto discussed, all of which agree more or less with the holotype of the variety *angolana*, there are some which deviate from it, though not so far as to justify further varietal separation:

Three fragments (Nos. 50–52), the most characteristic one of which is shown in Pl. II, figs. 15a, b, differ by their slightly less dense and somewhat coarser ribbing (from nine to ten ribs per half whorl only in maturity).

Another individual (No. 53, Pl. II, figs. 14a–c) differs from the typical forms of this variety by being considerably less evolute and stouter, as seen from the following dimensions:

[1] This author (p. 6) states, "lobe latéral plus ou moins large, plus ou moins divisé à terminaison bifide ou grossièrement trifide etc."

D	H	H′	W	W′	U
10.3 mm.	42	37	?	41	38½

From these measurements it might be considered a form transitional to *H. choffati* (see below, p. 29), but its costal section is decidedly quadratic, and it is, therefore, left with the variety *angolana* of *H. varicosum*.

On the other hand, two other individuals (specimens Nos. 54, Pl. II, figs. 16a, b, and 55, figs. 17a, b) are in their costation transitional to *H. orbignyi*, var. *minor* (see p. 28). Their ribs are more sigmoidal and show a far more pronounced forward bend at the periphery; on the venter they converge distinctly before coalescence and after it form regular, distinct chevrons. They agree, however, with the variety *angolana* in being evolute and in the coarseness and lesser density of costation; in consequence, they too were left with this variety.

(C) var. **rarecostata,** new variety

Pl. I, figs. 22a, b; text fig. 2e

A. M. N. H. No. 25102: one specimen

	Dimensions					
Spec. No.	D	H	H′	W	W′	U
Holotype: 1	19.7 mm.	39	31½?	29½	35½	34½

Description.—Among the more than sixty individuals referred to *H. varicosum* (*sensu lato*) a single one stands forth by its strong, prominent, very rursiradiate and sigmoidal ribs which are far more distant from each other than they are in both the *forma typica* and the variety *angolana*. There are no more than eight ribs and four inner tubercles per half whorl (as compared to twelve and six, respectively, in the former). Here, too, longer (primary) and shorter (secondary) ribs alternate, the former originating from strong umbilical tubercles, the latter beginning at the innermost fourth (or third) of the sides. The outer nodes of the ribs grow very strong on the body chamber and, being higher than their lateral parts, they cause the costal section (text fig. 2e) to assume a subtrapezoidal shape with slightly concave sides and slanted upper corners. The intercostal section, however, is about the same as in the variety *angolana*. A lateral node can be seen, slightly beneath the middle of the sides, in one of the last ribs. Owing to the prominence of the outer tubercles the costae appear in ventral view to be particularly strong and separated from each other by deep, broad interstices.

The ribs begin to coalesce from both sides, and the keel, which is rather strong in adolescence, begins to fade at a diameter of 13.5 mm. The union of the ribs is achieved, and the keel has almost disappeared at a diameter of about 17 mm., although a very faint trace of it continues up to the front end of the specimen. A little more than a quarter of the last whorl belongs to the body chamber, the last septum being at a diameter of 15.5 mm.

The suture line agrees fairly well with that of the variety *angolana* and was, therefore, not delineated separately.

Remarks (ad *H. varicosum*, sensu lato).—As seen from the above descriptions, both variety *angolana* and variety *rarecostata* represent accelerated developments of this species. The keel begins to vanish and the ribs begin to coalesce across the venter at diameters of from 9 to 15 mm., as compared to about 20 mm. in the best Angola specimen referred to the typical *H. varicosum*. The keel has practically disappeared at diameters of from 14 to 17 mm., whereas it disappears in the typical form at a diameter of 22.5 mm. only. Besides, both varieties do not seem to have ever attained the size of the *forma typica;* even the paratype, the largest individual among the sixty-four specimens representing the variety *angolana*, does not exceed 25.5 mm. in diameter, as compared to 39 mm. in Sowerby's holotype of this species (see Spath, 1934, p. 476). Also the examples representing the typical form of this species in the present collection, which are septate throughout at diameters of about 25 mm., must have grown considerably larger than that paratype. It may be due to this smaller size that the whorls of both the above described varieties are a little stouter than those of the typical form. On the other hand, they attain at maturity the same umbilical width as the *forma typica*, though at a smaller diameter. Besides, the ribs of the variety *angolana* are less sigmoidal, less rursiradiate and narrower and (in the holotype) sharper[1] than those of the

[1] This difference becomes, however, less distinct in the largest specimens of this variety, e.g., in the paratype.

typical *H. varicosum*, and in consequence its costation appears to be stiffer and more dense, although the total of ribs is about the same (twenty-four per whorl on the average). The differences in ornament between the new variety *rarecostata* and both the *forma typica* and the variety *angolana* have been noted above.

The writer shares Spath's (1934) opinion, based on Sowerby's holotype of 1824, as to the taxonomic position of *H. varicosum*, the considerable variability of which has been dealt with by a number of authors in the last fifteen years, and as to the problem of its delimitation from other *Hysteroceras* with a vanishing keel. As stated above (pp. 5, 6), the writer fully appreciates Jayet's (1929) excellent study on "La variation individuelle chez les Ammonites" which deals almost exclusively with the species under discussion, but he can by no means follow this author in his conclusions as to the taxonomic use of types.[1] On the contrary, only the strictest respect for types, as found to such a high degree in Spath's papers, is likely to maintain or (as so often necessary in ammonitology) to reëstablish taxonomic order. Jayet's attempt to emancipate himself from types has thoroughly misled him in this very paper. He distinguishes, within *H. varicosum*, a variety *multicostata* with thirty to forty ribs per whorl and a variety *crassicostata* with twenty to thirty of them only. It is true that he speaks also of a "type moyen" which "chevauche sur l'une et l'autre," but no diagnosis of this intermediate form can be found in his paper. Thus scholars dealing with these forms have to accept Jayet's diagnoses of the above varieties for their guidance, and as his leading feature is the density of costation[2] they have to count the ribs of every individual to find out whether it belongs to one variety or to the other. In doing so, however, they cannot fail to find that Sowerby's holotype has twenty-eight ribs and that, in consequence, Jayet's variety *crassicostata* proves to be merely a synonym of the *forma typica*. The possibility of the identity of his variety *multicostata* with *H. orbignyi* Spath will be discussed below (p. 28).

The writer agrees with Spath that none of the ammonites from Madagascar figured by Besairie (1930, p. 633, Pl. LXV, figs. 1–7, Pl. LXVII, figs. 6–8) under the name *"Inflaticeras" varicosum* really belongs to Sowerby's species. Some of those figured in Pl. LXVII may have to be referred to *H. carinatum* (see p. 41), while some figured in Pl. LXV belong to various species of *Neokentroceras*.

None of the individuals from the Mont Raynaud, Madagascar, referred to *H. varicosum* (*sensu stricto*) by Collignon (1932a, pp. 14–16, Pl. II, figs. 1–21), can be considered to be conspecific with the typical form of this species, nor can Venzo's (1936, p. 97) from Zululand, compared by him to Collignon's. The identification of that author's forms is rendered very difficult by their being septate throughout[3] and that may account for Collignon's stressing the presence of a "carène forte et tranchante" in all the individuals referred by him to his first group ("série des formes à ornementation accentuée") and for the presence of a keel in all his other figures as well, although the reduction in strength and subsequent disappearance of the keel and the ventral coalescence of the ribs on the body chamber are doubtless the most distinctive features of this species. Collignon's variety *attenuata* (*ibid.*, Pl. II, figs. 14–21) has since been identified by Spath with *H. binum* (Sowerby) (see p. 33); some of the specimens figured in Collignon's Pl. III have been justly referred by him to *Neokentroceras pseudovaricosum*, whereas others seem to belong either to some variety of that species or to other species of *Neokentroceras* (see p. 60). The correct specific identification of figs. 1–13 of

[1] *Ibid.*, p. 10, "La méthode généralement usitée, qui consiste à choisir un type représentatif de l'espèce, ne donne pas de bons resultats."

[2] It may be doubted whether the total number of ribs is a reliable and distinctive character, as it usually increases in the course of development. At least Jayet should have added: "in maturity." Collignon (1932a, p. 15), when wishing to use Jayet's new varieties, had to change the latter's ranges from thirty to forty to twenty-four to twenty-six for the variety *multicostata* and from twenty to thirty to sixteen to eighteen for the variety *crassicostata*, adding that "le petit nombre des côtes est en relation avec la petite taille des fossiles etudiés."

[3] Loss of body chambers seems to occur rather frequently in pyritized ammonites, e.g., in those from Texas studied by Gayle Scott (oral communication by Dr. H. E. Vokes).

Collignon's Pl. II remains doubtful due to the absence of body chambers; the same is true of Venzo's unfigured specimens.

Within the present collection the various forms of *H. varicosum* (*sensu lato*) will have to be compared with the following species which appear to be most closely related to them: *H. orbignyi* Spath (p. 28), *H. choffati* Spath (p. 30) and *H. binum* (Sow.) (p. 33).

At earlier stages (diameters from 8 to 12 mm.) the inner whorls of the variety *angolana* show a striking resemblance to those of *Dipoloceras rectangulare* (see p. 16), but the latter can, though not easily, be distinguished by their more pronounced peripheric shoulders, their more truncate venter and their stronger, comparatively sharp keel which is decidedly higher than the outer ends of the ribs, whereas it is blunt, inconspicuous and hardly overtopping the external nodes even in the inner whorls of the variety *angolana*. Besides, there are slightly more ribs in the young *Dipoloceras* (six per quarter whorl as compared to five in the variety *angolana*) and their external ends appear in ventral view as rounded, blunt knobs in the latter, whereas they continue obliquely toward the keel in the former.

Hysteroceras orbignyi (Spath)

Synonymy of the *forma typica:*

Ammonites varicosus Sowerby; D'ORBIGNY, 1841, I, p. 294, *pro parte*, Pl. LXXXVII, fig. 3 only.

Brancoceras orbignyi SPATH, 1922, p. 99.

Inflaticeras varicosum JAYET, 1929, pp. 4 ff., espec. p. 9, *pro parte*, figs. 5, 6, 7/4, 7, 8, 12?

Inflaticeras varicosum, forme *orbignyi;* BESAIRIE, 1930, p. 633, none of figured specimens.

Schloenbachia (*Pervinquieria*) *varicosa* Sow., type *Orbignyi;* COLLIGNON, 1932a, p. 16, none of figured specimens.

Hysteroceras orbignyi (Spath); SPATH, 1934, p. 483, *cum synon.;* text figs. 161a–d, 166a, 167, 168?; Pl. XLIX, fig. 6?; Pl. L, figs. 2, 3, 4?, 5?; Pl. LII, figs. 2–4, 8; Pl. LVI, fig. 15.

Hysteroceras orbignyi Spath; COLLIGNON *in* Besairie, 1936, p. 197.

Hysteroceras Choffati Spath; VENZO, 1936, p. 98, *pro parte* ?; Pl. VIII, fig. 6; Pl. IX, fig. 6?

(A) var. minor, new variety

Pl. II, figs. 18–26; Pl. III, figs. 13, 14; Pl. IV, figs. 1–5; text figs. 2f, 3a

A. M. N. H. No. 25103: fifty-nine specimens

DESCRIPTION.—This species also is represented in the fauna of Angola by a dwarfed local race: none of the almost sixty individuals of this variety exceeds 21 mm. in diameter, as compared to diameters of 37 mm. in Spath's holotype from the Pas de Calais, and of more than 40 mm. in some specimens from Folkestone.

The holotype of this new variety (specimen No. 4), though consisting of about half an outer whorl only,[2] best shows the characteristic costation of this species and also the "rostrate lip of the aperture," as mentioned by Spath. It consists entirely of the body chamber, as does, except for the rear end, the outer whorl of specimen No. 1 in which, however, parts of the penultimate whorl are also preserved. Specimen No. 10, the only individual whose outer whorl shows both the keeled and unkeeled stages, was chosen as the paratype.

Along with these three specimens there are numerous others (Nos. 2, 3, 5–9, 11–46, 52, 54), all more or less fragmentary, none of which is considerably larger than No. 1. Although there is much variability in dimensions, ribbing and rate of development, especially as far as the disappearance of the keel is concerned, the differences between all of them may be considered merely individual ones.

The conch is but little involute, the impressed zone rather shallow. The section is subcircular to subquadratic at a diameter of about 5 mm. (specimen No. 28, text fig. 3a) and subquadratic with gently rounded upper corners at a diameter of about 9 mm. (specimen No. 20, Pl. IV, fig. 1b). At the rear end of the holotype (diameter 12 mm., text fig. 2f) the costal section is almost quadratic except for a slight ventrad tapering; later the section becomes more oblong, the whorls not expanding so rapidly in thickness as in height. The sides are in costal section parallel, or they may slightly converge ventrad. The venter is truncate, sometimes quite flat, sometimes slightly rounded; as distinct chevrons cause it to rise in the median line, there are differences even within the same whorl of an individual.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Paratype: 10	ca. 18.0 mm.	39	33	?	34	39½
Holotype: 4	18.6 mm.	41[1]	?	?	34	41½
1	20.8 mm.	?	?	?	?	46

[1] Including additional height of rostrum; without it, the height of the whorl would amount to about thirty-four only.

[2] Its inner whorls are, however, visible in a natural mold.

Both costation and keel appear earlier than in *H. varicosum*, var. *angolana*. In some individuals (e.g., No. 31) both are present at a diameter of less than 4 mm., whereas in No. 28, text fig. 3a,

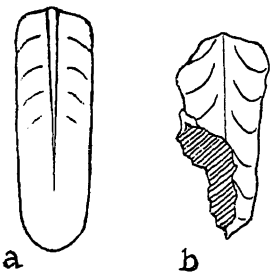

Fig. 3. Ventral views of:

(a) *Hysteroceras orbignyi* Spath, var. *minor*, new variety, A.M.N.H. No. 25103:28, showing first appearance of keel and costation, × 11/2.

(b) *Hysteroceras binum* (Sowerby), var. *lobitoensis*, new variety, A.M.N.H. No. 25107:14, showing outer ends of ribs slightly bent forward, × 3.

they are seen appearing rather suddenly between the diameters of 4 and 5 mm. At the earliest stages the ribs seem to be confined to the outer parts of the sides. At diameters of from 6 to 7 mm., however, they run across the sides, every second of them starting at the umbilical edge, the others a little more ventrad; in the outer half of the sides all the ribs are entirely uniform. There are, at that early stage, from five to six ribs per quarter whorl, all distinct and rather prominent, but as yet there are no umbilical tubercles. In the holotype, however, the latter are very distinct at a diameter of about 8 mm. The next stage (diameters from 8 to 14 mm.) is represented by the first quarter of the outer whorl of specimen No. 10 or by specimen No. 20, which is much more slender than the former. Six to seven rather strong, slightly sigmoidal ribs occur per quarter whorl; every second of these arises from an umbilical tubercle. These are stronger in No. 10 than in No. 20. In the latter the ribs have joined each other ventrally, forming chevrons which become more and more pronounced orad, whereas in the former they are just coalescing. In both individuals the keel is still visible at that stage, though more distinctly in No. 10 than in No. 20, where the median line is just marked by a weak ridge. In some individuals, however, this development appears to be highly accelerated, e.g., in No. 42, where fully developed chevrons and no trace of a keel are seen as early as at a diameter of less than 8 mm.

The mature stage of ornament is seen best in the outer whorl of the holotype. Here there are eight prominent and rather sharp costae per quarter volution; almost regularly every second rib starts at a distinct umbilical tubercle, or occasionally two ribs bifurcate from it. The beginning of the secondary ribs appears to be shifted to the middle or even to the second third of the sides. At the beginning of this volution the umbilical tubercles are prominent and pointed, but they become blunter and more and more radially elongated toward the aperture. The ribs are slightly rursiradiate and distinctly sigmoidal on the sides. On the venter they form pronounced, inverted V-shaped chevrons which, however, become blunter toward the front end of the whorl. It is worth noting that in side view the posterior slope of the ventral parts of the costae is seen to be much steeper than the anterior one. No keel is visible, but there is a slight elevation of the venter along the median line, as marked by the vertices of the chevrons. In specimen No. 1 there are, at a diameter a little greater than that of the holotype, only fourteen ribs per half whorl, but generally the same ornamentation of the body chamber as described above is found in the other adults as well, if allowance is made for individual variations.

Traces of crenulation can be found here and there on the ribs of some individuals, as on specimen No. 5.

The suture line could be studied as early as at diameters between 6 and 8 mm. in specimens Nos. 31 (Pl. III, fig. 14) and 41 (Pl. III, fig. 13). In the former it exhibits a comparatively broad siphonal lobe, an extraordinarily narrow, bifid, external saddle and a rectangular, distinctly two-pronged, first lateral lobe which is considerably shorter than the siphonal one. In specimen No. 41, on the other hand, the external saddle is very broad, as seen also in Spath's text figs. 161a, c, d, and also the first lateral lobe is comparatively broad; it ends in a broad, two-pronged, terminal point and two strong lateral ones, appearing almost trifid on the whole, and it equals the siphonal lobe in length. The first lateral saddle is slender and low; there follows a triangular, rather short, second lateral lobe. The other elements of the suture line could not be studied in either of these individuals, nor could the suture line be properly examined in any specimen of a larger size.

A single inner whorl (specimen No. 47), which otherwise perfectly agrees with those described above, requires separate mention owing to its stouter section which is remarkably wider than high (Pl. II, fig. 26).

Six other individuals (Nos. 48–51, 53, 59) differ from those typical of this variety by being more slender and involute and in possessing finer, slightly denser ribbing. There are, from a diameter of about 13 mm. on, seven to eight ribs per quarter whorl. As a representative of this group, which is obviously transitional to *H. falcicostatum* (see p. 36), specimen No. 50 is depicted (Pl. IV, figs. 5a–c).

(B) var. **evoluta,** new variety

Pl. IV, figs. 6a, b, 7

A. M. N. H. No. 25104: seven specimens

? *Hysteroceras orbignyi* (Spath); SPATH, 1934, p. 483, *pro parte;* Pl. XLIX, fig. 6; Pl. L, figs. 4, 5.

DESCRIPTION.—None of the seven fragments referred to this variety permitted proper measurements, but it is nevertheless seen at first sight that the holotype (specimen No. 1, Pl. IV, figs. 6a, b) is much more evolute than the variety *minor* of this species, as the height of the quadratic whorls, amounting to about 5 mm., is extremely small in relation to the diameter of the disc which may have attained almost 20 mm. In its other features this individual seems fairly well to agree with the variety *minor*, especially in density of costation (eight ribs per quarter whorl).

Specimen No. 7 (Pl. IV, fig. 7), however, shows less dense costation (six ribs per quarter whorl), but it agrees with the holotype in being very evolute, as do the other fragments (Nos. 2–6).

The individuals figured by Spath in his fig. 6 of Pl. XLIX, and figs. 4 and 5 of Pl. L, all of which are distinguished by a wide umbilicus[1] and seem to be somehow dwarfed, may belong to this new variety.

REMARKS (AD *H. orbignyi*, SENSU LATO).—As to the synonymy of the *forma typica* reference may be made, in addition to the list given above, to Spath's Gault Monograph. That author, however, does not specify which among Jayet's forms he refers to his *H. orbignyi*. It seems doubtful whether all those included by Jayet in his variety *multicostata* of *H. varicosum* can be referred to this species. This seems to apply to Jayet's fig. 6 and probably also to his fig. 5 which very much resembles Spath's (1934, text fig. 166a) holotype and which is referred by Jayet to his "forme moyenne," although it should be included, according to his own diagnosis, in his variety *multicostata*, as the total number of ribs exceeds thirty. Whether or not the individuals depicted in Jayet's figs. 7/4, 7, 8, 12 also belong to *H. orbignyi* cannot be decided without side views.

The specific differences between *H. varicosum* and *H. orbignyi*, questioned by Jayet (1929) and Collignon (1932a), have been clearly pointed out by Spath (1934). His statement (p. 485), "the typical individuals in any case are well separable," is true also of the dwarfed local races representing the European species in Angola: the variety *angolana* and the variety *rarecostata* of *H. varicosum* on the one hand and the variety *minor* and the variety *evoluta* of *H. orbignyi* on the other. For this hardly more convincing evidence can be found than the fact that of among the more than 130 individuals referred to these two species only two were found to be transitional between them (see p. 24).

The varieties of the present species can, in the young, readily be distinguished from those of *H. varicosum*. Both keel and costation seem to appear a little later in the variety *angolana* of *H. varicosum* than in the variety *minor* of *H. orbignyi*. At diameters from 8 to 10 mm. the ribs are straight and slightly rursiradiate on the sides and end on the venter perpendicularly to the keel in the former, whereas they are slightly sigmoidal and distinctly prorsiradiate on the sides and decidedly bent forward at the peripheric shoulder in the latter. Moreover, the character of the ribbing seems to be subject to less developmental change, and the venter is throughout development slightly less truncate in *H. orbignyi*.

In maturity both varieties of this species differ from those of *H. varicosum* by their denser, sharper, less coarse and more sigmoidal costation and above all by their more pronounced chevrons. Another distinctive character mentioned by Spath for the typical *H. orbignyi*, however, does not seem to apply as well to its variety *minor* or to the variety *evoluta*. In both varieties the keel does not persist "more or less enfeebled to the end," but it gradually disappears on the body chamber where occasionally only a slight rising of the ventral parts of the ribs in the median line is reminiscent of the former keel.

Among other *Hysteroceras* of the present collection *H. choffati*, *H. binum* and *H. falcicostatum* will be compared below with the species under discussion; transitional specimens to the latter species have been mentioned above. Spath's (1930b, p. 55, Pl. VIII, fig. 6) *Hysteroceras* sp. ind., from the Albian of the Samana Range resembles in degree of involution the variety *evoluta* of the present species, but it has a persist-

[1] U = 49½ in Pl. L, fig. 4; U = 46½ in Pl. L, fig. 5.

ent keel and more prominent umbilical tubercles.

The resemblance of the young of *H. orbignyi*, variety *minor*, at diameters of from 8 to 12 mm., to those of *Dipoloceras rectangulare* is even greater than that of equally small individuals of *H. varicosum*, variety *angolana*, to the latter; this is owing to the pronounced forward bending of the outer ends of the ribs in *H. orbignyi*. Their distinction from *D. rectangulare* is, however, possible by means of the remaining distinctive features mentioned (p. 26) in the discussion of *H. varicosum*.

Hysteroceras choffati Spath

Pl. IV, figs. 8–11; Pl. VI, fig. 3; text fig. 4a

A. M. N. H. No. 25105: nine specimens

Schloenbachia varicosa Sow.; CHOFFAT, 1905, p. 34, *pro parte*, Pl. IV, fig. 6.

"*Schloenbachia varicosa*" Choffat *non* Sowerby; SPATH, 1922, pp. 107, 157.

Hysteroceras choffati SPATH, 1925b, p. 187, Pl. XXVIII, figs. 1, 4; Pl. XXX, fig. 5.

Hysteroceras choffati; SPATH, 1934, *passim*, especially p. 486.

? *Hysteroceras Choffati* Spath; VENZO, 1936, p. 98, *pro parte;* Pl. IX, fig. 6; *non* Pl. VIII, fig. 6.

tween 20 and 25 mm. in diameter. The venter is rather narrow and rounded, and the costation is comparatively dense. There seem to have been, as in Choffat's type, about thirty ribs per whorl. The same total number of costae is found also on the second fragment (No. 9, Pl. IV, fig. 9). In the first the keel has entirely disappeared, and the ribs cross the venter either in a straight line or with a very shallow forward sinus which can by no means be called a chevron. It may be worth noting that in the foremost intercostal an indication of a very weak secondary rib can be seen on the venter.

Measurements could be taken of only two very small specimens (No. 2, Pl. IV, figs. 10a, b, text fig. 4a, and No. 3, Pl. IV, figs. 11a–c) of the nine referred to this species. These are, owing to their small size, considerably stouter and more involute than both Choffat's and Spath's types, in agreement with the observed general trend of this genus to decrease both in thickness and in involution in the course of growth. At the posterior end of fragment No. 2 the costal

	DIMENSIONS					
Spec. No.	D	H	H′	W	W′	U
2	13.5 mm.	ca. 38½	?	?	41	38½
3	ca. 16.0 mm.	ca. 34	ca. 30	?	ca. 32	ca. 40

DESCRIPTION.—Only two fragments (Nos. 1, 9) could be found which are undoubtedly conspecific with the only previously figured *Hysteroceras* from the Albian of Angola, viz., by Choffat (1905) under the name of "*Schloenbachia varicosa.*"[1] They differ from the commonest Angola forms of this genus, *H. varicosum*, var. *angolana*, and *H. orbignyi*, var. *minor*, chiefly by their distinctly rounded venter and by their oval section which tapers decidedly ventrad (Pl. IV, fig. 8b). The better preserved fragment (No. 1, Pl. IV, figs. 8a, b) is apparently from an adult individual and belongs to the body chamber of a disc which may have attained be-

section (text fig. 4a) is still broad and subtrapezoidal, the venter truncate. The intercostal section is here inverted heart-shaped. Toward the anterior end of this specimen, however, the costal section becomes more rounded ventrally, and it is decidedly so at the anterior end of specimen No. 3 (Pl. IV, fig. 11c). The smaller number of ribs (eleven per half whorl in specimen No. 2, and twelve in specimen No. 3) may be accounted for by their adolescent stage. In both these individuals there are distinct, bullate, umbilical tubercles. In No. 2 only the primary ribs arise from them, every second rib beginning at the first third of the sides, whereas in No. 3 two ribs bifurcate at each of those inner tubercles, as seen in Spath's holotype at a far greater diameter. The inner whorls of example No. 2 seem to be smooth. Dis-

[1] This author's description seems, however, to include also examples belonging to other species of *Hysteroceras;* the individuals with chevrons compared by Choffat to Pictet's (1847) fig. 4b probably belong to *H. orbignyi*.

tinct crenulation can be seen in several of its ribs. In both individuals the outer parts of the ribs are still separated at the posterior ends but have joined each other at the anterior ends; in both, the ribs run strictly perpendicularly toward the venter, and they cross it later in a straight line. The keel is still distinctly visible at the posterior ends, but only a faint trace of it is perceptible at the front ends, as in both Choffat's and Spath's types. These two individuals apparently represent, like the variety *angolana* of *H. varicosum* and the variety *minor* of *H. orbignyi*, a dwarfed race of this species, the last septum corresponding in specimen No. 2 to a diameter of 9 mm. only. The material available is, however, too scanty for the creation of a separate variety, and they are, therefore, questionably referred to Spath's species.

The last suture lines could be traced in specimen No. 2 at a diameter of about 8 mm. (Pl. VI, fig. 3). Both siphonal lobe and external saddle are very broad and low; the first lateral lobe is shorter than the siphonal one, broad and two-pronged. The succeeding sutural elements can be seen in their outlines only.

Five more very incomplete specimens (Nos. 4–8) agree with this species, especially in the rounded venter, better than with any other *Hysteroceras* of the present collection and are, therefore, referred to this species, though doubtfully, in consideration of their poor preservation. In one (No. 8) a flared rib almost twice as broad as its neighbors can be seen.

Hysteroceras cf. choffati Spath

Pl. IV, fig. 12; Pl. VI, fig. 4

A. M. N. H. No. 25106: one specimen

Another septate fragment, consisting of not quite half a whorl, is remarkable by the rapid increase of its width which is strongly reminiscent of *Dipoloceras symmetricum*, var. *obesa* (see p. 16), but it cannot be referred to the latter as there is at a diameter as small as 9 mm. no trace of a keel. A sectional view of this specimen is shown in Pl. IV, fig. 12a; it differs from the typical *H. choffati* by stouter whorl and greater involution. Its suture lines (Pl. VI, fig. 4) exhibit the same general outlines as those of the specimen No. 2 described above. Here, too, some ribs are distinctly crenulated.

REMARKS (AD *H. choffati*, SENSU LATO).—As to the synonymy of this species, the Zululand specimen figured by Venzo (1936) in Pl. VIII, fig. 6, certainly belongs to *H. orbignyi;* that figured on Pl. IX, fig. 6, may be transitional between that species and the present one rather than a true *H. choffati*. This species differs from both *H. varicosum* and *H. orbignyi* as well as from their varieties, by its more oval, less angular section, especially by its rounded venter, and by its slightly more dense and stiff costation; it differs from *H. orbignyi*, furthermore, by its ribs, which in maturity cross the venter in a straight line without any chevrons. All these differences can be verified in the present material. *H. binum* will be compared below.

Hysteroceras binum (J. Sowerby)

Synonymy of the *forma typica:*

? *Schloenbachia (Pervinquieria) varicosa* SOW., var. *attenuata* COLLIGNON, 1932a, p. 15, Pl. II, figs. 14–21.

Hysteroceras binum (J. Sowerby); SPATH, 1934, p. 478, *cum synon.*, text figs. 161j, 165; Pl. LIII, figs. 8, 9.

(A) var. lobitoensis, new variety

Pl. IV, figs. 13–18; Pl. VI, figs. 5a, b, 6; text figs. 3b, 4b

A. M. N. H. No. 25107: seventeen specimens

DESCRIPTION.—The separation of this Angola form from the typical one is chiefly owing to its accelerated development. Whereas in the

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
4	ca. 15.0 mm.	ca. 40	ca. 35	?	33½	33½
7	15.1 mm.	40½	35½	33	34½	ca. 33
Holotype: 1	ca. 17.0 mm.[1]	38	?	26	28	37½
Paratype: 5	17.0 mm.	41	33½	33½	36	33

[1] The holotype attains a slightly greater diameter (about 18 mm.), but its foremost part is damaged and, in consequence, does not permit proper measurements.

Folkestone example, depicted in Spath's text fig. 165d, the keel is still sharp and decidedly overtopping the venter at a diameter of 30 mm., in the Angola form the ribs become continuous across the venter at diameters between 10 and 15 mm., although a vestigial keel may remain visible for some time afterwards. It is true that Sowerby's holotype, refigured by Spath (text fig. 165a), is rather small, too, attaining only about 20 mm. in diameter, but it seems to be septate throughout. As compared to the other individuals depicted in the Gault Monograph, those here dealt with in which the outer whorls belong, at least in part, to the body chamber must be considered as belonging to a micromorphic local race.

In their proportions, however, they agree fairly well with the English types. There are some variations, especially in W and W′, some examples (Nos. 4, 5 and 7) being less compressed than the holotype, which equals the typical Gault specimens in width. The writer has not separated the thicker individuals from the thinner ones as there are transitional forms in one little specimen, No. 14 (text fig. 3b), do they turn slightly forward on the venter. In the later course of development they gradually become stronger and reach farther down the sides. Simultaneously their peripheric ends, still trending perpendicularly toward the keel, approach each other from the sides, and blunt, broad tubercles begin to develop at the umbilical edge. In the paratype (specimen No. 5, Pl. IV, fig. 14b) the keel begins to vanish at a diameter of less than 10 mm.

In the mature stage of ornament, best seen in the holotype, the paratype and specimen No. 4, every second rib is more or less distinctly connected with an umbilical tubercle, so that longer and shorter costae alternate almost regularly, though occasionally two ribs may bifurcate at one of those tubercles. The costation, on the whole, is still much weaker on the inner zone of the sides than on the outer one. The ribs are now distinctly sigmoidal and rursiradiate on the sides but always straight on the venter across which they definitely coalesce at diameters between 11 and 14 mm. Before doing so, their

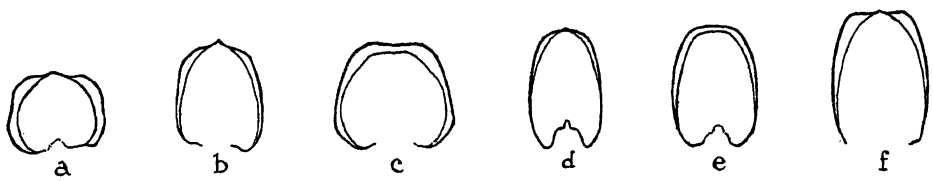

Fig. 4. Costal and intercostal sections of *Hysteroceras*.
(a) *H. choffati* Spath?, A.M.N.H. No. 25105:2, at posterior end, × 3.
(b) *H. binum* (Sowerby), var. *lobitoensis*, new variety, A.M.N.H. 25107:14, at anterior end, × 3.
(c) *H. binum* (Sowerby), cf. var. *lobitoensis*, new variety, A.M.N.H. No. 25108, at posterior end, × 3.
(d, e) *H. falcicostatum*, new species, (d) A.M.N.H. No. 25111:12, at posterior end, × 3; (e) A.M.N.H. No. 25111:22, at fracture, × 3.
(f) *H. intermedium*, new species, holotype, A.M.N.H. No. 25112:1, at anterior end, × 2.
Actual ratios of enlargement about 5 per cent less than indicated above.

connecting them. It may be added that the costation of the Angola variety is a little less dense than that of Sowerby's type.

The conch is moderately evolute, more or less compressed. The intercostal section is lancetiform and very slender in the young (Pl. IV, fig. 17b, text fig. 4b), and later is elliptic (Pl. IV, figs. 14d, e, 15c, 16c). The section attains its maximum width at about the first third of the sides, which are more or less flattened. The venter is comparatively narrow, roof-shaped at the earliest stages, later truncate, though becoming slightly rounded in the body chamber. The umbilical edge is rounded, the umbilical wall steep, though not high.

The innermost whorls are entirely smooth, the inner region of the sides remaining so up to a diameter of from 6 to 10 mm., but in their outer halves (or thirds) there are five short, straight, radial ribs per quarter whorl present from a diameter of about 5 mm. on. They stop at some distance from the thin sharp keel, and only peripheric ends form strong, though blunt nodes at both sides of the median line which is in some individuals still marked by a vestigial, thread-like keel even after the ribs have become continuous across the venter. At the very front end, however, the keel has entirely disappeared in all examples examined. In some of them, e.g., No. 4, there are not more than ten ribs per half whorl on the body chamber, whereas their number has increased to eleven to twelve in others. In the paratype (Pl. IV, fig. 14a) some costae show in their outer half four to five distinct spiral ridges, causing them to appear beaded (cf. Spath, 1934, p. 476, in description of *H. varicosum*).

Suture lines could best be studied at diameters of about 5 and 10 mm. in specimen No. 4 (Pl. VI, figs. 5a, b) and at a diameter of about 8 mm. in the paratype (Pl. VI, fig. 6). In the inner whorl of the former there are: a two-pronged first lateral lobe; a slender, bifid, first lateral saddle; a triangular second lateral lobe, at-

taining about two-thirds of the length of the first; a second lateral saddle the indentation of which is but slightly indicated; an auxiliary lobe, just on the umbilical shoulder; and one more saddle on the umbilical wall. The inner stem of the external saddle and the sutural elements following dorsad are also seen in the two last suture lines of this specimen which are, as usual, crowded together. Some further details can be observed here than in the inner whorl: the second lateral lobe proves to be three-pronged, the intersection of the second lateral saddle is more distinct and the first auxiliary lobe is seen to be two-pronged; moreover, the first auxiliary saddle is very broad and slightly notched at its top; dorsad of it follows, just at the umbilical seam, a second auxiliary lobe. In the paratype the siphonal lobe can also be studied. This is rather narrow and considerably longer than the first lateral one; the latter is distinctly two-pronged, whereas the second lateral lobe, which does not fully attain two-thirds of the length of the first, is, as usual, trifid. The broad external saddle is intersected by a three-pronged lobule.

Specimen No. 8 (Pl. IV, fig. 18), which is more involute (U = 26½) and has somewhat finer ornament, appears to be transitional to the variety *angusteumbilicata* to be dealt with below, but in the general character of its costation it approaches more closely the present variety.

(B) cf. var. **lobitoensis,** new variety

Pl. IV, fig. 19; text fig. 4c

A. M. N. H. No. 25108: one specimen

DESCRIPTION.—A single fragment, exhibiting only three pairs of ribs and apparently belonging to the body chamber, does not permit proper measurements. It is most closely related to the preceding variety, but it cannot be fully identified with it owing to the nature of the ribs which are much broader and also a little more distant from each other. There cannot have been more than nine ribs per half whorl, as compared to ten to twelve in the variety *lobitoensis*. The ribs coalesce from both sides at a diameter of between 15 and 20 mm. and form an extremely shallow, orad convex sinus across the venter.

The section (text fig. 4c) agrees with that of the variety *lobitoensis*.

(C) var. **angusteumbilicata,** new variety

Pl. IV, figs. 20–22; Pl. VI, fig. 7

A. M. N. H. No. 25109: nine specimens

DESCRIPTION.—Some individuals had to be separated from the variety *lobitoensis* because they are considerably more involute and have a much narrower umbilicus. Moreover, the costation is in maturity less prominent in the outer zone of the conch, so that there is a less perceptible difference between the latter and the inner one, where it is usually obsolescent in this species.

In adolescence, up to a diameter of about 14 mm. (specimen No. 7, Pl. IV, fig. 22a), there are about five distinct, though blunt inner tubercles and ten to twelve ribs per half whorl. The latter are almost invisible in the inner third of the sides, and longer and shorter ones seem to alternate. In the outer part of the sides the costae are rather strong and form a very shallow, orad concave arc, the chord of which is radial or slightly rursiradiate. Here and there vestigial lateral tubercles can be seen, as in *H. intermedium* (cf. p. 36), at about the second third of the sides. On the periphery the ribs appear to be slightly bent forward at first; later they run almost perpendicularly toward the fine keel, which is still distinct at this stage, and they end at some distance from it. In the adult stage, however, the ribs are distinctly sigmoidal and rursiradiate, and they seem to reach a little farther down the sides than in the variety *lobitoensis*. There are never less than twelve ribs per half whorl at this stage, as in the most densely ribbed individuals of the latter variety. Umbilical tubercles are now weak, and the alternation of primary and secondary ribs is indistinct.

Both the holotype, a half disc, and specimen No. 2 are septate throughout, as are the smaller examples as well. The body chamber seems to begin at diameters of between 18 and 20 mm. The external ends of the ribs join each other at diameters of between 12 and 14 mm., and the coalescence of the ribs from both sides across the venter is achieved at a diameter of about 16 mm., but a very fine, thread-like keel can be seen, preservation permitting, up to the anterior ends of the present specimens, at least in the intercostals.

The section (Pl. IV, figs. 20c, 21b, 22b) is elliptical, with a truncate, though narrow venter which becomes gradually more rounded in the course of development; the impressed zone, owing to the higher degree of involution in this variety, is less shallow than in the *forma typica* and in the variety *lobitoensis*.

Excellent suture lines could be studied in specimen No. 3 (Pl. VI, fig. 7). The siphonal lobe is comparatively broad; the medium knob very low and crenulated at its top. The external saddle is broad, its inner stem slightly wider than the outer one. The first lateral lobe is com-

	DIMENSIONS					
Spec. No.	D	H	H′	W	W′	U
7	14.2 mm.	43½	33	?	36	22
2	ca. 16.0 mm.	42½	32?	30	32	ca. 21
Holotype: 1	18.3 mm.	44½	37½?	28½	31	20

paratively narrow, just a little longer than the siphonal one, two-pronged. The first lateral saddle equals the external one in height but is far more slender and bifid. The second lateral lobe is only half as long as the first and three-pronged; the second lateral saddle is distinctly bifid. There follows the first auxiliary lobe, almost as long as the second lateral one and distinctly three-pronged as well, situated just on the umbilical shoulder; and on the umbilical wall there are a broad, low, slightly bifid, auxiliary saddle and one more auxiliary lobe.

REMARKS (AD *H. binum*, SENSU LATO).—For the synonymy of this species reference may be made to Spath's Gault Monograph (1934, pp. 478, 479). However, it seems doubtful whether all the examples figured by Collignon (1932a) under the name *H. varicosum*, var. *attenuata*, can really be referred to this species.

The distinctive characters of the variety *lobitoensis* and the differences between both varieties established in the present paper have been pointed out above. From the typical *H. binum* the variety *angusteumbilicata* differs not only by its higher degree of involution, its narrower umbilicus and its finer, more elegant costation, but also by its smaller size and its accelerated development, especially as far as the ventral ornamentation is concerned.

Within the present collection *H. binum* is most closely related to both *H. varicosum* and *H. orbignyi* on the one hand and to *H. falcicostatum* on the other. Among the former species *H. varicosum* seems to be closer to the variety *lobitoensis* of *H. binum* and *H. orbignyi* to its variety *angusteumbilicata*. There is, moreover, a remarkable resemblance betwen the young of *H. orbignyi*, var. *minor*, and those of the variety *lobitoensis* of *H. binum* at a diameter of about 8 mm. But the latter can be readily distinguished because they are more involute and slender and have a far less truncate, almost roof-shaped venter and straighter ribs which are in exceptional cases bent slightly forward on the periphery.

Adults of both new varieties of *H. binum* can easily be distinquished from both the typical *H. varicosum* and its variety *angolana* as they are less evolute and on the average slightly more slender, by their more elliptical section which shows flatter sides and less pronounced peripheric shoulders and, above all, by their slightly less dense, more sigmoidal and more rursiradiate costation which is obsolescent in the inner zone of the sides. In the stouter forms of *H. binum*, var. *lobitoensis* (e.g., specimens Nos. 5, 7), there are not many differences in whorl-section, and the differences in the degree of involution and in ornament must be relied on. Even in ornament there is increased resemblance between the stouter forms of *H. binum*, var. *lobitoensis*, and the variety *rarecostata* of *H. varicosum* which has fewer and more rursiradiate and sigmoidal ribs than either the typical form or the variety *angolana* of the latter species. The variety *rarecostata* can, however, be distinguished by its more prominent and less dense ribbing which does not become obsolescent on the inner part of the sides.

The main difference between *H. binum* and *H. orbignyi* appears to be the lack of chevrons, the ribs crossing the venter in a straight or almost straight line in the former species; moreover, the ribs of the latter are sharper and more prominent and do not fade around the umbilicus.

Within the present collection, *H. falcicostatum* is without doubt the next of kin to the species under discussion. The two are not always easily separated, especially since *H. binum*, var. *angusteumbilicata*, is somewhat transitional between both species. Detailed comparison will be made later in the remarks on *H. falcicostatum* (p. 36).

H. choffati has denser costation and a more rounded venter than *H. binum* and can also readily be distinguished by the fact that its costation is straight on the sides and not weakened on the inner zone.

H. subbinum, to which a single specimen is doubtfully referred (p. 34), will be compared later, as will also *H. intermedium* (p. 37).

Attention must also be drawn to the striking resemblance in both side and ventral view between *H. binum*, var. *lobitoensis*, and *Stoliczkaia dispar* (d'Orbigny), var. *africana* Pervinquière (1907, pp. 389–391, text fig. 149, Pl. XII, fig. 10, Pl. XVI, figs. 19–23) from the Vraconnian of Tunis, renamed *Stoliczkaia africana* by Spath

(1931, p. 332). At first glance no one would doubt the identity of the holotype of the variety *lobitoensis* of *H. binum* (Pl. IV, figs. 13a, b) with Pervinquière's fig. 21 (Pl. XVI) and especially with his fig. 10 (Pl. XII). This extreme similarity is, however, due merely to convergence; not only is there no trace of a keel to be found even in the earlier stages of Pervinquière's form, but the suture lines furnish even more reliable distinctive characters. Whereas three auxiliary lobes can be seen in his text fig. 149, the second of which is on the umbilical edge, there are but two in both the variety *lobitoensis* and the variety *angusteumbilicata* of *H. binum* (see Pl. VI, figs. 6 and 7, respectively), the first of which is just on the umbilical shoulder. Also, Spath's suture line of the typical *H. binum* (1934, text fig. 161j) shows only two auxiliary lobes. Furthermore, the external saddle in the Tunisian *Stoliczkaia* is more deeply intersected; all the saddles are more slender, and the first lateral lobe is not decidedly two-pronged but rather three-pronged with a bifid middle point.

Hysteroceras cf. **subbinum** Spath ?

Pl. IV, figs. 23a–c; Pl. VI, fig. 8

A. M. N. H. No. 25110: one specimen

Cf. ? *Hysteroceras subbinum* SPATH, 1934, p. 481, *cum synon.*, Pl. LII, figs. 5–7; Pl. LIII, figs. 6, 7; Pl. LVI, figs. 3, 4.

Hysteroceras subbinum Spath; VENZO, 1936, p. 98, *pro parte*, Pl. VIII, fig. 3; *non:* Pl. VII, fig. 9; Pl. VIII, fig. 4.

DESCRIPTION.—The single fragment here dealt with consists of about one-sixth of a septate outer whorl with a badly worn inner one attached to it. No exact measurements were feasible, but even without them it can be seen that the conch was almost fully evolute. In the outer whorl, which is 5.2 mm. high and 3.9 mm. wide at the posterior end of the fragment, the ratio H:W′ is 4:3.

The section (Pl. IV, fig. 23c) is regularly oval. Just the outer ends of five ribs per one-sixth whorl can be seen which assume the shape of broad blunt knobs at the peripheric shoulders and are, in ventral view, directed perpendicularly toward the keel, but it cannot be decided how far the ribs continue down the sides, the surface of the latter being very corroded. Between the two rows of external knobs and neatly separated from them is a rather weak, though distinct keel. Owing to the shortness of the preserved part of the outer whorl it cannot be reliably stated as to whether or not this keel is fading, especially since the venter is badly damaged near its anterior end.

Some suture lines (Pl. VI, fig. 8) are well shown. These include a broad siphonal lobe with but slightly diverging terminal points; a broad bifid external saddle; a first lateral lobe attaining about two-thirds of the length of the siphonal one, comparatively narrow, trifid, with a decidedly two-pronged middle point; a first lateral saddle which is but very little intersected, equaling the external one in height; a second lateral lobe far shorter than the first, triangular and three-pronged; a second lateral saddle, one auxiliary lobe and one auxiliary saddle are visible, the latter on the umbilical wall.

REMARKS.—Within the present collection this poorly preserved individual seems to be most closely related to *H. binum*, var. *lobitoensis*, although its keel apparently persists longer. The main differences are in its more evolute shape and its denser ribbing, amounting to about thirty costae per half whorl as compared to twenty to twenty-four in *H. binum*, var. *lobitoensis*. As these differences are exactly those mentioned by Spath (*loc. cit. in synon.*) in his comparison of *H. subbinum* and *H. binum*, the reference of this specimen to the former species seems obvious, especially since its suture line agrees perfectly with that shown in Spath's Pl. LII, fig. 5, where the middle point of the trifid first lateral lobe seems to be also two-pronged.

However, this fragment also appears to belong to a dwarfed variant as do almost all the *Hysteroceras* of the present collection; it is, therefore, only doubtfully referred to *H. subbinum*.

Venzo's Zululand specimen figured in his Pl. VIII, fig. 3, may be conspecific with the typical *H. subbinum* Spath, but the examples seen in his Pl. VII, fig. 9, and Pl. VIII, fig. 4, thought by him to be transitional to *H. orbignyi*, belong in the writer's

opinion to *H. carinatum*, as well as Besairie's Madagascar types erroneously included by Venzo in the synonymy of *H. subbinum*.

Hysteroceras falcicostatum, new species

Pl. IV, figs. 24–28; Pl. VI, figs. 9–11; text figs. 4d, e

A. M. N. H. No. 25111: twenty-three specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
4	11.4 mm.	44½	35	?	30	25
5	17.5 mm.	52?	?	?	28½	22?
Holotype: 1	18.7 mm.	46½	39½	?	30	25
Paratype: 3	21.9 mm.	48	?	?	33½	24

DESCRIPTION.—The holotype seems to be preserved up to the apertural margin; septa can be traced just at the posterior end; thus the body chamber would have been about two-thirds the length of a whorl. In the largest specimen (No. 3), chosen as the paratype, the last septum was located at a diameter of about 14 mm.

The conch is slender, discoidal, more involute than in the species of *Hysteroceras* hitherto described. The section at a diameter of about 10 mm. (text fig. 4d) is elliptical with flat sides, which are most distant from each other at about their middle and converge slightly ventrad, and a truncate, rather narrow venter. In maturity (text fig. 4e, Pl. IV, fig. 24c) the venter becomes a little rounded, but the shape of the section is still about the same. The umbilical shoulder is distinct, though rounded, the umbilical wall low, oblique in the young, almost perpendicular in the adults.

This species remains smooth up to a comparatively late ontogenetic stage. Ribs first appear as faint crescents in the peripheric parts of the whorl at diameters of between 7 and 13 mm. and later gradually expand down the sides. In most of the individuals, however, the shell appears to be smooth up to a diameter of about 15 mm., the weak, fold-like ribs being observable only if seen in an oblique light. On the body chamber the ornament becomes more distinct, but even there it is much finer than in other *Hysteroceras* and is obsolescent on the innermost part of the sides. There are, however, seven to eight umbilical tubercles per half whorl on the body chamber; they are, at first, very blunt; later they become sharper and elongated prorsiradiately, suggesting the handle of the sickle, as best seen in specimen No. 11 (Pl. IV, fig. 28). From seven to nine ribs per quarter whorl, according to size, can be counted at the periphery, about two of them corresponding to each inner tubercle. As seen only in individuals with distinct costation, every second rib begins at the first third of the sides or even further ventrad, or some indistinct bifurcation of ribs takes place in about the same zone. The costae are, however, entirely uniform in the outer parts of the sides and on the venter. They are very broad and blunt on the sides and separated from each other by narrower, furrow-like interstices. Most characteristic of this form is the course of its ribs on the sides; in their innermost parts, insofar as they can be seen, they are distinctly prorsiradiate, then at about the first fourth of the sides they turn decidedly backward and run in a broad, orad concave arc, the chord of which is slightly rursiradiate, across the remainder of the sides. This distinctly falciform course of the ribs follows, as in other genera of "*falciferi*" ammonites, the shape of the apertural margin which can distinctly be seen in the holotype (Pl. IV, fig. 24a) and still better in a little fragment (specimen No. 6, Pl. IV, fig. 27).

The ribs from both sides begin to coalesce on the venter at a diameter of about 8 mm. in specimen No. 8, of 15 mm. in specimen No. 5 and of 17.5 mm. in the paratype. The fine thread-like keel which seems to appear simultaneously with the ribs disappears on the holotype at the stage of coalescence of the ribs, but in many other individuals it persists as an extremely fine thread, visible, especially in the intercostals, far longer, e.g., on specimen No. 5 and on the paratype up to diameters of 17 mm. and 20 mm., respectively. On the venter the ribs form a distinct orad convex sinus, which toward the aperture gradually assumes the shape of a blunt chevron. The intercostals are now almost as broad as the ribs. It may be worth noting that the posterior slope of the costae is distinctly steeper than the anterior one; this is true of their lateral portions as well, but it is best seen in side view in the ventral ones (Pl. IV, fig. 24a).

Suture lines could be studied in several specimens, best in Nos. 2, 5 and 15, at diameters of from 9 to 14 mm. The siphonal lobe is subdivided by a low median knob and is comparatively broad; the external saddle is more or less broad and intersected by a triangular lobule; its inner stem seems to be slightly broader than the outer one. The first lateral lobe is a little deeper than the siphonal one and is distinctly two-pronged in specimens Nos. 5 (Pl. VI, fig. 10) and 15 (Pl. VI, fig. 11), though rather trifid with a two-pronged middle point, as also observed in *H.* cf. *subbinum* ? (see p. 34, Pl. VI, fig. 8), in specimen No. 2 (Pl. VI, fig. 9). The first lateral saddle is almost as high as the external one and is distinctly bifid; the second lateral lobe is comparatively deep, though shorter than the first, and is slender, triangular and three-pronged;

the second lateral saddle repeats the outlines of the first but on a slightly reduced scale. A triangular, trifid, first auxiliary lobe is seen on the umbilical shoulder, the first auxiliary saddle and a part of the second auxiliary lobe on the umbilical wall.

REMARKS.—As already stated, the species here dealt with is most closely related to *H. binum*. It can be readily distinguished from the variety *lobitoensis* because it is considerably more involute and a little more slender and by its finer, more dense, falciform costation. It seems to be less easy to distinguish *H. falcicostatum* from the variety *angusteumbilicata* which by being more involute than both the typical form and the variety *lobitoensis* appears to be transitional to this species. Its costation is, however, less dense, stiffer and more rursiradiate and does not show any trend toward forming ventral chevrons; for these reasons it seemed to be more closely related to *H. binum* than to *H. falcicostatum*, and it was, therefore, attached to the former species.

The density of costation, the sigmoidal course of the ribs on the sides and their distinct chevrons on the venter in *H. orbignyi* give evidence of some relationship between that species and the one under discussion. The latter can, however, readily be distinguished from both the typical *H. orbignyi* and its Angola representative, the variety *minor*, as it is much more involute and slightly more slender, and especially by its costation which consists of flat, broad ribs and becomes distinct on the body chamber only, and even there it is almost absent in the inner zone of the sides, whereas the ribbing appears at a very early stage in *H. orbignyi* and consists of high, sharp ribs throughout the sides. Moreover, the chevrons, which are decidedly triangular in *H. orbignyi*, are more trapezoidal in *H. falcicostatum*. It is true that some individuals of the variety *minor*, described above (p. 27), must be considered transitional to the present form owing to their more slender and involute conch and to their finer costation. They exhibit, however, at a comparatively early stage a very distinct, sharp ribbing throughout the sides, and the ribs are separated from each other by intercostals as broad as, or broader than the ribs. Because of this character of the costation those individuals were left with *H. orbignyi*, var. *minor*.

The smoothness of the shell, especially of its inner parts, up to a comparatively large size results in some resemblance between *H. falcicostatum* and *H. semilēve* and its varieties.

Hysteroceras intermedium, new species

(A) **forma typica**

Pl. v, figs. 1–5; Pl. ix, fig. 1; text fig. 4f

A. M. N. H. No. 25112: fourteen specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	18.1 mm.	41½	?	?	34	25½?

DESCRIPTION.—This form is also a small one. The largest individual (No. 2) may have attained a diameter of slightly more than 20 mm. In the holotype the body chamber seems to begin at a diameter of about 10 mm.

The section (text fig. 4f; Pl. v, figs. 2c, 4, 5), is subelliptical and slightly tapering from the umbilical edge to the peripheric one; the sides are almost flat, the venter is truncate; both latero-ventral and umbilical shoulders are rounded; the umbilical wall is low but steep, almost perpendicular.

The costation is the most characteristic feature of this species. There are twelve ribs per half whorl, all very broad and rather prominent on the outer half of the volution but gradually fading dorsad. Occasionally (specimen No. 3, Pl. v, fig. 3a) the ribs also remain distinct on the inner region of the sides, but as a rule only indistinct folds representing the primary ribs can be followed up to the blunt umbilical tubercles, of which there are six per half whorl. The costae run straight in a radial or slightly rursiradiate direction across the outer parts of the sides, widening rather quickly ventrad, thus assuming a club shape and leaving but narrow interstices between each other. In maturity they carry a vestigial lateral node, which is more or less visible (best seen in specimen No. 3 [fig. 3a]) at about the second third or third quarter of the sides. In ventral view, the outer tubercles appear to be rather strong; they run perpendicularly or, on the foremost part of the body chamber, with a slight forward turn toward the keel. From the latter they always remain neatly separated by smooth bands or, at the largest size, by shallow furrows. The keel is neither strong nor high and just slightly overtops the outer tubercles; it does not, however, show any suggestion of fading in the course of development.

Good suture lines can be seen in specimens Nos. 5 and 6. In the former (Pl. ix, fig. 1) both siphonal lobe and external saddle are very broad; the latter is subdivided by a short lobule into

two stems, the outer of which is considerably broader than the inner one; at its external margin this saddle is rather deeply intersected by a lateral point of the siphonal lobe. The first lateral lobe equals the siphonal one in length; it is comparatively narrow with two terminal points and two more lateral ones on each side. The first lateral saddle is as high as the external one and bifid as well but is much narrower; the second lateral lobe is triangular and three-pronged. There follow the second lateral saddle; the first auxiliary lobe; the first auxiliary saddle, riding just on the umbilical edge; and one more auxiliary lobe on the umbilical wall. The general character of this suture line is a simplified one, as in other species of this genus.

(B) var. **compressa**, new variety

Pl. v, fig. 6

A. M. N. H. No. 25113: three specimens

DESCRIPTION.—Three fragments so differ from the typical form in their compressed whorls that they have been separated from it under the above varietal name. They are too poorly preserved for measurement, but it could be determined that W′ amounts to about 25 in the holotype, which is damaged, though not crushed, as compared to 34 in the holotype of the typical *H. intermedium*. In costation these compressed individuals fully agree with the *forma typica* so that there is no doubt about their specific position. Furthermore, the suture line, observable in specimen No. 2, seems to be the same as in the typical form.

REMARKS (AD *H. intermedium*, SENSU LATO).—Although this species belongs to the second group of the genus *Hysteroceras* which includes forms with ribs which do not coalesce across the venter, it is nevertheless very closely related to some species of the first group with coalescing ribs, especially to *H. binum*. It can, however, be readily distinguished from the latter, even in side view, by its stiffer costation, with the club-shaped ribs running straight toward the periphery. In ventral view the differences are even more obvious. In the species under discussion the characteristic outer nodes of the ribs of both sides remain separated from each other, and the keel persists undisturbed up to the anterior end. Moreover, the venter is more distinctly truncate and slightly broader than in *H. binum*. These differences are even more pronounced in comparing this species with *H. falcicostatum*.

On the other hand, there is a rather close relationship between *H. intermedium* and the other keeled *Hysteroceras* of the present collection, especially *H. carinatum* and *H. propinquum*, both of which will be compared below (pp. 41 and 46, respectively). A variant somewhat transitional between the species here dealt with and *H. carinatum* will be discussed as the variety *robustecostata* of the latter (p. 40).

Earlier stages of this species do not differ greatly from young *Dipoloceras* (e.g., *D. rectangulare*) of the same size, but they can be distinguished by the blunter, broader and more rounded ribs of the present species. These are more strictly confined to the outer half of the sides, and their outer ends are not bent forward on the venter.

Inner whorls of *Elobiceras raymondi* are at diameters from 10 to 15 mm. so similar to adults of the present species that they can be distinguished only by means of the suture lines. The latter agree in their general outlines, but both lobes and saddles are more richly indented,[1] taller and more slender in *E. raymondi* (cf. Pl. XXXV, fig. 4, with Pl. IX, fig. 1).

Hysteroceras carinatum Spath

(A) **forma typica**

Pl. v, figs. 7–17; Pl. vi, figs. 12–14; Pl. ix, fig. 2; text fig. 5a

A. M. N. H. No. 25114: twenty-eight specimens

Ammonites varicosus, D'ORBIGNY, 1841, p. 294, *pro parte*, Pl. LXXXVII, fig. 4 only.

Hysteroceras carinatum, SPATH, 1922, p. 99.

Hysteroceras carinatum, SPATH, 1925, p. 187.

Inflaticeras varicosum Sow., BESAIRIE, 1931, p. 633, *pro parte*, Pl. LXVII, figs. 6–8 only.

Hysteroceras carinatum, SPATH, 1934, p. 482; text figs. 161m, n, 166d; Pl. LI, fig. 5; Pl. LIII, figs. 4, 5, 10, 11.

Hysteroceras subbinum Spath; VENZO, 1936, p. 98, *pro parte;* Pl. VII, fig. 9; Pl. VIII, fig. 4, *non* fig. 3.

DESCRIPTION.—This species is most variable in both measurements and ornament. As to the former, a comparison of the above table with Spath's (1934, p. 482) shows that the Angola examples are, on the whole, stouter and more involute than the European ones. That seems, however, to be due merely to their smaller size, as *Hysteroceras* usually tend to decrease in thickness and increase in width of the um-

[1] A similar statement is made by Spath (1934, p. 482), when comparing *H. carinatum* with an evolute variety of *Prohysteroceras candollianum*.

	Dimensions					
Spec. No.	D	H	H′	W	W′	U
1	8.8 mm.	37½	?	?	41	33?
7	17.3 mm.	39	?	?	23½[1]	31½
4	17.6 mm.	36½	32½	?	34½	36½
8	17.8 mm.	38	36?	?	35½	34½
5	19.9 mm.	34	?	?	34	35½
6	22.7 mm.	40	35½	?	33½	38
19	22.8 mm.	40½	36½	?	38½	32½

bilicus in the course of growth. If allowance is made for ontogenetic differences, a stouter and more involute type (e.g., specimen No. 19) and a more slender, less involute one (e.g., specimen No. 6) may be distinguished among the Angola material. There are, however, many intergrading forms. The last septum is found at diameters of between 12 and 17.5 mm.

The section is rectangular to quadratic, with rounded umbilical and latero-ventral shoulders, more or less flat sides and truncate venter (text fig. 5a; Pl. v, figs. 8c, 9b, 11c, 12b, 15c, 16c), but occasionally it may be more elliptic (specimen No. 10, fig. 14). The index W′ : H varies from 0.63 in specimen No. 7 up to 0.835 in No. 6 [which agrees in section exactly with Spath's fig. 5 (Pl. LVII) of a "transition to *H. subbinum*"], and 0.945 in No. 19, whereas W′ = H in specimen No. 5. The umbilical wall is remarkably steep and rather high in some individuals.

The keel is present, though still weak, at a diameter of about 6 mm. (specimen No. 1, Pl. v, fig. 7b), and it becomes comparatively strong and high in maturity. It does not show any tendency toward vanishing on the body chamber.

Costation appears at a diameter of less than 5 mm. and is at that stage confined to the outer third of the whorl where five to six broad, blunt, prorsiradiate, slightly arched ribs can be counted per quarter whorl. On the periphery they run obliquely toward the keel, but they stop at some distance from it. Immediately after the outer parts of the ribs, three to four blunt, broad, inner tubercles appear per quarter whorl (Pl. v, fig. 7a). In the further course of development the costae extend farther down the sides. At a diameter of 12 mm. they occupy their outer half and have become distinctly sigmoidal and slightly rursiradiate. There are at that stage nine to ten ribs, together with five distinct, decidedly bullate tubercles on the umbilical edge per quarter whorl.

The mature stage of ornament is reached rather quickly. Whereas at the preceding stage indistinct folds, which are perceptible only in obliquely incident light, serve to connect the outer ribs with the inner tubercles, the costae have become at diameters of between 15 and 18 mm. quite distinct also on the inner part of the sides. Here they converge in pairs to the circumumbilical tubercles, which simultaneously become radially elongated both dorsad and ventrad. Meanwhile the costae, which were still flat and rather broad in the preceding stage, become narrower and more prominent. They follow a radial direction and bending sharply forward continue on the venter almost as far as the keel. This development of ornament, very like that shown by Spath's fig. 4 (Pl. LIII), can be well observed in specimen No. 7 (Pl. v, fig. 12a).

The same general character of ornamentation prevails throughout the material referred to the typical form of this species, although there is much individual variation. For example in specimen No. 2 (Pl. v, fig. 8a) the ribs continue across the inner zone of the sides without any considerable loss of distinctness, appearing to be almost uniform throughout the sides, and the inner tubercles are radially elongated to a high degree, whereas in specimen No. 3 the latter are at about the same diameter still rather bullate and the ribs are more prominent in the outer third of the sides than in the middle zone (Pl. v, fig. 9a, strongly reminiscent of Spath's fig. 5 of Pl. LI). In

[1] Specimen seems to be crushed.

some individuals, e.g., No. 6 (Pl. v, fig. 11a), the ribs become rather coarse, making the distinction from some forms of *Dipoloceras* very difficult, whereas they remain fine and graceful in others, (No. 3, Pl. v, fig. 9a, and especially No. 27, a very slender individual, Pl. v, fig. 17, which is made more remarkable by the sudden change to stronger ribbing on the body chamber). The degree of flexure shown by the ribs is variable. They are strongly sigmoidal in some individuals (No. 10, No. 27, Pl. v, fig. 17) but rather stiff in others (e.g., No. 6, Pl. v, fig. 11a). Furthermore, although the ribs always remain neatly separated from the keel, they approach it more or less closely, leaving either shallow furrows (No. 2, Pl. v, fig. 8c) or flat (No. 19, Pl. v, fig. 15b, c) or slightly sloping (No. 6, Pl. v, fig. 11c) bands between the keel and their outer swellings.

In summary, it may be pointed out that there are in maturity always about ten costae per quarter whorl which are to a varying degree sigmoidal and more or less distinctly obsolescent in the middle part of the sides and which trend obliquely forward on the venter, bifurcating with varying regularity from about five umbilical tubercles per quarter whorl, the latter being more or less radially elongated on the body chamber. The bifurcation of ribs may be replaced by an alternation of longer and shorter ones, the latter originating in the intercostals between the former at about the first third or at the middle of the sides.

Faint traces of an extremely fine spiral striation seem to be visible on the shell of specimen No. 3, the best preserved one in the present collection.

The suture line could be studied as early as at a diameter of a little more than 5 mm.; at that stage it exhibits a broad external lobe, subdivided by a low, triangular, median knob; a very broad, bifid, external saddle; a two-pronged first lateral lobe equaling the siphonal one in length; a first lateral saddle about as high as the external one; and a triangular second lateral lobe which seems to be three-pronged.

The last suture line of specimen No. 10 is preserved at a diameter of about 15 mm. in perfect condition (Pl. vi, fig. 13). The siphonal lobe is rather narrow with but slightly diverging terminal points; the external saddle is not very broad, rather deeply intersected by a triangular, three-pronged lobule, with both its stems about equal in width and height; the first lateral lobe is comparatively broad, decidedly two-pronged; the first lateral saddle slightly exceeds the external one in height and is bifid as well; the second lateral lobe is about half as long as the first and distinctly three-pronged; the second lateral saddle is about as high as the external one and is deeply intersected at its top by a three-pronged lobule. There follow on the umbilical wall a three-pronged first auxiliary lobe; the first auxiliary saddle, which also is deeply bifid; the two-pronged second auxiliary lobe; and the second auxiliary saddle, intersected by a short, though distinct three-pronged lobule.

Similar sutural features can be observed, though less distinctly, in specimens Nos. 27 (Pl. ix, fig. 2), 7 and 19. A detail of the suture line of the latter specimen, showing the rather long, almost perpendicular terminal points of the first lateral lobe, is depicted in Pl. vi, fig. 14.

On the whole, the suture line of this species is more elaborate than those of the species of *Hysteroceras* hitherto dealt with; however, it maintains the general character of this genus. The indentations of the lobes are neither very deep nor much ramified and thus do not intersect the bodies of the saddles to such a high degree as in other related genera with more elaborate suture lines.

Although allowance was made for the extreme variability of this species in leaving individuals with various measurements and different characters of ornament with its typical form, a few individuals deviate so far from the norm that they had to be referred to separate varieties:

(B) var. **robustecostata,** new variety

Pl. v, figs. 18a, b; Pl. vii, figs. 1, 2, 4

A. M. N. H. No. 25115: five specimens

Description.—This variety is represented by fragments only, and, therefore, no proper measurements could be made. The index W′:H amounts to 0.73 in the holotype (specimen No. 1).

The section (Pl. VII, fig. 1b) is about the same as in the *forma typica* except for being slightly trapezoidal, owing to the fact that the sides, which are most distant from each other at the umbilical edge, tend to converge from there a little ventrad. They are always decidedly flat. The venter is slightly more truncate than in the typical form.

The distinctive feature of this variety is its costation. The ribs are stronger, broader and slightly stiffer than in the typical *H. carinatum*, and their outer parts assume a club shape, as in *H. intermedium*. There are never more than eight of them per quarter whorl. These differences in costation are observable as early as at diameters of 10 mm. (specimen No. 3, Pl. VII, fig. 2a) and 15 mm. (specimen No. 4, Pl. V, fig. 18a), respectively. The largest individuals (Nos. 1 and 5) attain a diameter of about 20 mm.; they are apparently not septate. Except for the above distinctive characters, the costation (Pl. VII, figs. 1a, 4) agrees with that of the typical form. It is more or less obsolescent on the middle part of the sides; and there are blunt, bullate, or at later stages slightly elongated umbilical tubercles from which only the primary ribs arise, secondary ones being intercalated between them; or there may be indistinct bifurcation of ribs at the inner nodes. In this variety also the costae are slightly sigmoidal in maturity.

In both the holotype and the crushed specimen No. 6 the outer swellings of the ribs are occasionally seen to be faintly bituberculate (not seen in Pl. VII, fig. 1a), thus reminding one of the lateral nodes of *H. intermedium* to which this variety seems to be transitional. Here, however, these lateral nodes appear to have been shifted a little farther ventrad.

The keel, best seen in specimens No. 3 (Pl. VII, fig. 2b), No. 4 (Pl. V, fig. 18b) and No. 5 (Pl. VII, fig. 4), is very distinct, although it is neither broad nor high, and is neatly separated from the outer ends of the ribs.

No suture lines could be traced.

(C) var. **exigua**, new variety

Pl. VII, figs. 5–7; text fig. 5b

A. M. N. H. No. 25116: eight specimens

DESCRIPTION.—This variety is represented only by fragments, none of which permitted proper measurements. The degree of involution seems to be about the same as in the more evolute individuals of the *forma typica*.

All of these fragments possess a whorl section (text fig. 5b) which is more slender, with a narrower venter and less pronounced peripheric and umbilical shoulders than that of the typical *H. carinatum*. The costation is also of a different character. There are never more than seven ribs per quarter whorl, and they appear to be broader and perhaps also more sigmoidal; longer and shorter ones alternate not quite regularly. The keel seems to be comparatively strong.

Suture lines could be traced in a single specimen only (No. 3), but they are too poorly preserved for detailed description or delineation.

In that individual the last septum seems to be at a diameter of about 10 mm.; this together with the fact that the diameter does not seem to exceed 20 mm. in any of the specimens examined induced the writer to consider this to be a dwarfed and somewhat degenerate variety.

The costation of a single apparently crushed specimen (No. 8) agrees very well with that of those described above, but it deviates by its whorl section, becoming at the front end suddenly broad and truncate ventrally. It is, therefore, but doubtfully referred to this variety.

REMARKS (AD *H. carinatum*, SENSU LATO).—The differences between the typical form of this species and its varieties *robustecostata* and *exigua* have been pointed out above, while those between the varieties may be easily inferred. It may be added that the resemblance in ventral view of the variety *exigua* (e.g., specimen No. 5, Pl. VII, fig. 7) to Spath's (1934, p. 489, text figs. 170c, d) *H. bucklandi* from the Isle of Wight seems to be due merely to the compression of the latter, *H. bucklandi* being a much larger form developing true chevrons in maturity.

Spath (*loc. cit. in synon.*) has expressed doubts as to the taxonomic range of this species, emphasizing its extreme variability. The writer, however, believes that it can be maintained in spite of this variation in its original circumference, provided that the forms deviating too far from d'Orbigny's are recognized as distinct varieties. The features of the section and ornament common to all the forms included by the writer in Spath's species and duly stressed in the above descriptions seem to be sufficiently characteristic of *H. carinatum* as a species. As all these features can be found in the Angola individuals as well as in those from Europe discussed and figured by Spath, there can be no doubt left as to their conspecificity. Although the former are, on the average, considerably smaller than the latter, it did not even seem necessary to distinguish the Angola form from the English type as a separate variety, as individuals about as small as those with body chamber in the present collection are also recorded from the English Gault (see Spath, *ibid.*, Pl. LI, fig. 5, Pl. LIII, figs. 4, 11).

As to the synonymy of *H. carinatum*, the Madagascar forms figured by Besairie (*loc. cit. in synon.*) and considered by him intermediate between *H. orbignyi* and *H. choffati* were compared by Spath (1934, p. 481) with the inner whorls of examples transitional between *H. subbinum* or its evolute variety and *H. carinatum*, although he admitted that the earlier whorls of the latter are also similar to Besairie's specimens. In the writer's opinion, however, they well might be fully identified with the species under discussion as well as two of Venzo's (1936) Zululand specimens (Pl. VII, fig. 9, Pl. VIII, fig. 4), recognized by Venzo to be conspecific with the former.

Within the present collection, this species shows close affinity to the other keeled *Hysteroceras;* and among those *H. intermedium* and *H. semilēve* may be considered most closely related. From the former *H. carinatum* can be readily distinguished by its wider umbilicus, by its less rounded peripheric shoulders and more pronounced keel and above all by its denser and finer costation; its ribs are hardly rursiradiate in maturity, distinctly projecting forward on the venter and more sigmoidal on the sides, and they do not weaken to such a degree in their inner zone. The variety *robustecostata* is without doubt transitional between both species, but the last two distinctive characters are valid for this variety as well. It is these characters which in the writer's opinion seem to indicate that this variety is more closely related to *H. carinatum* than to *H. intermedium*, and it was, therefore, left with the former species. *H. semilēve* will be compared with it below.

The persistent keel of *H. carinatum* in maturity easily distinguishes that species from the *Hysteroceras* of the group with a vanishing keel. In the earlier ontogenetic stages, however, during which the latter are also still distinctly keeled, there is some resemblance between them. Nevertheless, the young of the present species can be distinguished from those of *H. varicosum*, var. *angolana*, and of *H. orbignyi*, var. *minor*, by their more slender whorls which are not quadratic in section, and by their ornamentation which is on the whole weaker and confined to the outermost and innermost zones of the sides up to a much greater diameter.

Except for those from the English Gault and its French equivalents and for those from Madagascar dealt with above, no other known Albian forms seem to be fully or nearly conspecific with *H. carinatum*. *"Schloenbachia" aguilerae* Böse (1923, p. 167, Pl. XI, figs. 33–36, 37–40, 42–44) from the Vraconnian of Mexico appears, however, somewhat related to it, but it can be readily distinguished by its fastigate venter and less distinct keel which is not so neatly separated from the outer ends of the ribs. The individual depicted in Böse's figs. 33–36, which must be considered the holotype of his species, is, furthermore, far more evolute. *"Schloenbachia" schnaebeli* Collignon (1931a, p. 20, Pl. III, fig. 5) from the Senonian of Madagascar is so similar in section in the main features of ornamentation and even in the general outlines of its suture line[1] that it might be considered a late offshoot of the *carinatum-semilēve* group.

As pointed out in the introductory remarks on this genus, *Hysteroceras* occupies a most interesting intermediate position between almost all the other genera of sculptured ammonites of the Angola fauna, and there is hardly another species of this genus which makes this more obvious than *H. carinatum*. Most striking is its close affinity to the group of *Dipoloceras bouchardianum*, as mentioned by Spath (*loc. cit. in synon.*), who stresses its "being connected by transitions with the early *D. bouchardianum.*" As a matter of fact, certain more evolute and more strongly ribbed individuals of the species under discussion (e.g., Nos. 4, 5, 6) are hardly distinguishable from specimens of the same size (15–25 mm. in diameter) of *D. rectangulare* and of *D. symmetricum*, var. *obesa* (see pp. 16 and 18, respectively). The former can, however, be distinguished by means of its ribbing which is equally strong and sharp throughout the sides, the latter by its thicker whorls which increase suddenly in width, by its more truncate venter, its

[1] As seen in Collignon's fig. 5, the first lateral lobe is bifid or at least trifid with a decidedly two-pronged middle point, but not plainly trifid as asserted in that author's description.

sharper and higher keel and its more coarse and less regular costation.

Also even at diameters of from 5 to 10 mm. the inner whorls of *D. rectangulare*, though not very different from those of *H. carinatum*, can nevertheless be distinguished by their more pronounced latero-ventral edges as well as by their more numerous and slightly sharper ribs which are at that early stage confined to the outer third of the sides in both forms.

Finally, there is also a remarkable homeomorphy between the present species and *Prohysteroceras gracile*, *P. decipiens* and *P. hanhaense*, especially insofar as the inner whorls are concerned. All of them will be compared in detail below (pp. 127, 130, 133, respectively). Here, however, reference should be made to the similar resemblance between *H. carinatum* and the inner whorls of an evolute variety of *Prohysteroceras candollianum* (Pictet) which has been pointed out by Spath (1934, pp. 456, 482).

Hysteroceras semilēve, new species

(A) forma typica

Pl. v, figs. 19a–c; Pl. vii, figs. 8–11; text figs. 5c, d

A. M. N. H. No. 25117: twelve specimens

Dimensions

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	25.5 mm.	40½[1]	?	?	28	26½

Description.—The holotype consists of almost two-thirds of a disc; its outer whorl seems to be unseptate. The other individuals referred to the typical form of this species are fragments, some of the discs attaining diameters up to about 30 mm.

The conch is discoidal, rather involute, with a subrectangular whorl section (Pl. v, fig. 19c; text figs. 5c, d) showing flat sides, a truncate venter, pronounced, though rounded, umbilical shoulders and a steep, almost perpendicular and comparatively high umbilical wall throughout development. It attains its maximum width immediately above the umbilical edge, from which point the sides converge slightly ventrad. The relation W′:H decreases in the course of growth, as it does in other species of this genus. The peripheric shoulders are gently rounded in intercostal section but are pronounced where they are marked by the outer nodes. The keel is already fully distinct at a diameter of about 6 mm. (specimen No. 10, Pl. vii, fig. 8b). In the outer whorl of the holotype it is rather broad and decreases decidedly in height; it still considerably overtops the external nodes at the rear end of this whorl, but only slightly at its front end (Pl. v, figs. 19b, c; text fig. 5c). In some of the unseptate fragments of larger individuals, e.g., No. 6 (Pl. vii, fig. 11, text fig. 5d), No. 8 (Pl. vii, figs. 10a, b), the keel remains considerably higher than the outer tubercles up to the front ends; it is broad, as in the holotype, in Nos. 5 and 7, but almost sharp in Nos. 4, 6 and 8.

About eight rather weak crescentic ribs per quarter whorl are visible in specimen No. 10 (Pl. vii, figs. 8a, b) at diameters of from 6 to 9 mm. where they are confined to the outer third of the whorl. This is obviously the reason that the visible part of the penultimate whorl of the holotype is smooth, except for faint umbilical tubercles. The latter may be better observed in specimen No. 10, at the above mentioned stage where they are distinctly bullate; there are from four to five of them per quarter whorl. In the outer whorl of the holotype (Pl. v, figs. 19a, b) ornamentation is restricted to the peripheral and circumumbilical zones of the sides. In the former there are seventeen short, rather blunt and almost straight radial ribs per half whorl. They are slightly swelling on the latero-ventral edge and continue on the venter at an angle of about 45° toward the keel from which they are, however, separated by a shallow furrow which can be noticed in nodal section only. The ribs are about as broad as the intercostals, and they appear a little narrower on the venter than on the sides. Fine swellings can be seen, in oblique illumination only, also at their dorsad ends at about the second third of the sides. Around the umbilicus, on the other hand, there are eight elongated inner tubercles per half whorl; they begin slightly beneath the umbilical shoulder, cross it in a distinctly prorsiradiate direction and vanish very soon afterwards. Just above the umbilical edge they carry a tiny "bulla" each, at least in the last third of this whorl. Except for very indistinct folds, which connect the outer ribs with the inner tubercles in a very shallow, orad convex arc, about one-half of the side is smooth, as indicated in the specific name.

In this species also the ornamentation shows considerable variability. In a fragment exhibiting only the umbilical edge and the inner two-thirds of a whorl (No. 2, Pl. vii, fig. 9) the inner tubercles are a little more prominent, and the connecting undulations of the middle zone of the sides are slightly more distinct than on the holotype. This is apparently owing to the larger size of this fragment, but the general aspect of the ornamentation is almost the same. In another fragment (No. 8, Pl. vii, fig. 10a), however, the sculpture is much stronger; both inner and outer nodes are rather prominent and every second of the latter is connected with one of the inner tubercles by an almost continuous,

[1] This ratio and the following ones measured at a diameter of 23.7 mm.

slightly sigmoidal rib which, however, weakens and becomes indistinct on the middle of the sides. Furthermore, the vestigial lateral nodes mentioned in the description of the holotype as occurring about at the second third of the sides are here much more distinct, though blunt. It is true that this aspect of costation is very different from that of the holotype, but there cannot be any doubt that the two are fully conspecific, particularly since the holotype of the variety *elegans* of this species (described below) shows exactly the same development of costation toward its front end, if allowance is made for its finer and more dense ornamentation.

Suture lines could be traced only in the tiny fragment No. 12, and then only at a diameter of about 9 mm.; they exhibit the general sutural character of the genus, but they are too corroded for detailed description or for delineation.

DESCRIPTION.—The separation of this variety from the *forma typica* is based on the fact that it is considerably more slender and has finer and denser ornamentation which otherwise agrees perfectly with that of the typical form, as also does the section except for its smaller width.

The holotype of this variety (Pl. v, figs. 20a, b; text fig. 5e) has a somewhat wider umbilicus than that of the typical *H. semilēve*, but this difference does not seem to be important. In the rear part of its unseptate outer whorl the ornament agrees with that of the holotype of the typical form; in the front part, however, it agrees rather with the latter's more distinctly ribbed specimen No. 8; it thus seems to be somewhat accelerated in development. All the sculptural elements are considerably finer and more numerous than in the typical *H. semilēve*. There are, on the last half whorl, twenty outer

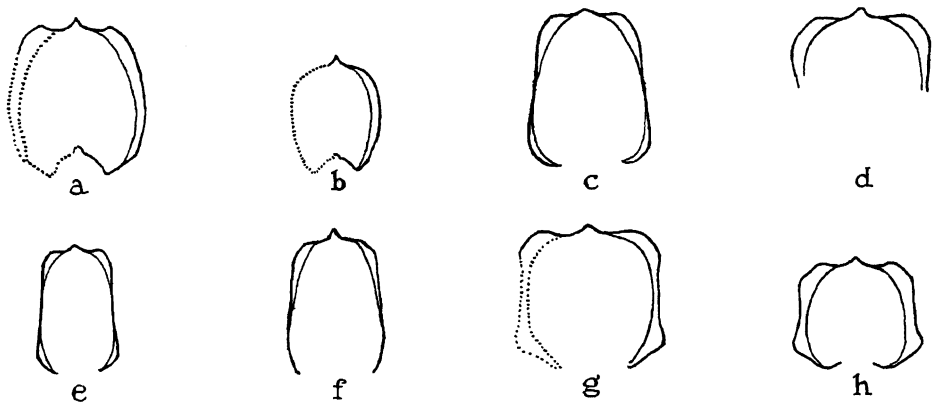

Fig. 5. Costal and intercostal sections of *Hysteroceras*.

(a) *H. carinatum* Spath, A.M.N.H. No. 25114:19, at anterior end, × 2.
(b) *H. carinatum* Spath, var. *exigua*, new variety, holotype, A.M.N.H. No. 25116:1, at anterior end, × 3.
(c, d) *H. semilēve*, new species, (c) holotype, A.M.N.H. No. 25117:1, at anterior end, × 3; (d) a large individual, A.M.N.H. No. 25117:6, ventral part of section at posterior end, × 2.8.
(e) *H. semilēve*, new species, var. *elegans*, new variety, holotype, A.M.N.H. No. 25118:1, at posterior end, × 3.
(f) *H. semilēve*, new species, var. *densicostata*, new variety, holotype, A.M.N.H. No. 25119:1, × 2.
(g, h) *H. semilēve*, new species, var. *sparsicostata*, new variety, (g) holotype, A.M.N.H. No. 25120:1, at anterior end, × 3; (h) A.M.N.H. No. 25120:2, at anterior end, × 3.
Actual ratios of enlargement about 5 per cent less than indicated above.

(B) var. **elegans**, new variety

Pl. v, figs. 20a, b; Pl. VII, figs. 12a–c; Pl. IX, fig. 3; text fig. 5e
A. M. N. H. No. 25118: ten specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
2	11.2 mm.	43	?	?	29½	27
3	15.5 mm.	45	?	?	28½	23
Holotype: 1	23.2 mm.	41[1]	?	?	21?	30

[1] This ratio and the following ones measured at a diameter of 21.7 mm.

ribs and ten inner tubercles, as compared to seventeen and eight, respectively, in the typical form. Also, the keel is a little higher and sharper in this variety.

The smaller individuals (e.g., No. 4, Pl. VII, figs. 12a–c) differ from the equally small ones of the typical form solely by their more slender section and finer and more dense ornamentation.

The last septum is seen at diameters of from 8 to 14 mm. (specimens Nos. 10, 2, 3 and 6) In five individuals (Nos. 2, 3, 6, 9 and 10) the suture lines could be studied, some of them being excellently preserved. Only that of specimen No. 2 is depicted (Pl. IX, fig. 3). It agrees in general character fairly well with those of *H.*

carinatum figured by Spath (1934, text figs. 161m, n) and even in the details with those depicted in Pl. VI, figs. 13, 14, and Pl. IX, fig. 2, of the present paper. The last suture line is to a very remarkable degree much more elaborate than the precedent ones, especially as the terminal points and the lowest lateral ones of the first lateral lobe increase quite suddenly in length, thus causing also the leaflets separating them to appear to be more conspicuous. This feature seems to have possible phylogenetic interest as a precursory one, although the genus, whose sutural development is thus forecast, is not certainly indicated. However, the sutural character thus produced is a distinctive one of *Elobiceras*.

(C) var. **densicostata,** new variety

Pl. v, figs. 21a, b; text fig. 5f

A. M. N. H. No. 25119: five specimens

DESCRIPTION.—None of the few examples referred to this variety permits proper measurements; it can, however, be stated that the relation W′:H amounts in specimen No. 2, at a diameter of about 20 mm., exactly to two-thirds; the same seems to be true of the holotype (specimen No. 1) which is but a little larger.

This variety is intermediate between the *forma typica* and the variety *elegans*, agreeing with the former in shape of the conch, which is perhaps a little more involute, and in the width of the whorls and their general section, while it agrees with the latter in fineness of ornamentation (ten to eleven outer ribs and about five inner tubercles per quarter whorl) and in its rather sharp and comparatively high keel.

The outer whorl of the holotype (Pl. v, figs. 21a, b; text fig. 5f) consisting of less than half a disc is unseptate, and this seems also to be true of specimen No. 2. Furthermore, suture lines could not be traced in any of the three smaller fragments (Nos. 3–5), although they do seem to be septate.

(D) var. **sparsicostata,** new variety

Pl. v, figs. 22a–c; Pl. VII, figs. 13a, b; text figs. 5g, h

A. M. N. H. No. 25120: two specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	18.1 mm.	36½	?	32	35	30

DESCRIPTION.—The holotype, consisting of about half an outer whorl, is so well preserved as to justify the creation of the above variety.

It differs from the typical *H. semilēve* by being less involute and much stouter (its section being still almost quadratic at a diameter of about 18 mm.), and by its more robust and less dense sculpture. There are nine rather sharp inner tubercles and only twelve to thirteen ribs per half whorl (as compared to seventeen in the *forma typica*). The primary costae in the anterior part of this fragment run almost uninterruptedly and in a distinctly sigmoidal course across the sides, thus exhibiting the same strong development of ornamentation as specimen No. 8 of the typical form, though at a considerably smaller diameter.

Since a fragment of *Dipoloceras* (*rectangulare* ?) is wedged into this specimen the latter is obviously unseptate.

A much smaller fragment (No. 2, Pl. VII, fig. 13) agrees so well with the holotype that it also is referred to this variety.

REMARKS (AD *H. semilēve*, SENSU LATO).—Among those *Hysteroceras* of the present collection which are characterized by a persistent keel, this species is most closely related to *H. carinatum* and to *H. propinquum*. From the former it can be readily distinguished as it is more slender and has an umbilicus which is narrower than that of even the most involute forms of *H. carinatum*. It can also be distinguished by its more pronounced peripheric shoulders, flatter sides and more truncate venter and above all by its ornamentation which is restricted, up to a much later ontogenetic phase, to the innermost and the outer zones of the sides; this type of ornamentation, called "*Prohysteroceras* ornamentation" by Spath,[1] here still persists on the body chamber, thus causing even the adults to appear half smooth.

This species will be compared below (p. 46) with its next of kin, *H. propinquum*. Its intermediate position between *H. carinatum* and the latter is best seen in ventral view (see both the vertical and the horizontal rows of ventral views, as indicated in the explanation of Pl. v).

The writer found only one form in literature which seems to be related to both *H. semilēve* and *H. propinquum*, i.e., one of the North African examples included by Pervinquière (1907, pp. 237–239, text figs. 97, 98, Pl. XI, figs. 5–12; 1910, p. 66, Pl. XV, figs. 20–28) in "*Mortoniceras*" *proratum* Coquand, namely, the specimen depicted (1907) in fig. 10, which has "côtes fortes et peu nombreuses, limitées a la moitié externe des flancs," and which is certainly not conspecific with the original of fig. 5. In

[1] In the description of *Dipoloceras bouchardianum*, var. *alticarinata* (1931, p. 378), "i.e., outer crescents and faint umbilical nodes, but no distinct connecting ribs."

the absence of any illustration of Coquand's type, this species must be evaluated on the basis of this latter[1] figure. The specimen illustrated in Pervinquière's fig. 10 is, however, conspecific with neither *H. semilēve* nor *H. propinquum*, but it occupies an intermediate position between them. Its outer nodes agree in density and size with those of *H. semilēve* but in shape more with those of *H. propinquum*. At any rate the ventral view of this Tunisian *Hysteroceras* does not permit any doubt about its close relationship to both the above mentioned Angola species.

The inner whorls of *H. semilēve* up to diameters of about 10 mm. are even more difficult to distinguish from similar whorls of comparable size of *Dipoloceras rectangulare* than are the same ones of *H. carinatum*. The only difference seems to be that the ribs appear to be more regular, slightly stronger and perhaps projecting forward a little less in ventral views of *D. rectangulare*. Moreover, in some individuals of that species they reach farther down the sides.

The early half smooth stage of the inner whorls of some *Elobiceras* (e.g., *E. raymondi*) also has a striking resemblance to individuals of the same size (diameters from 15 to 20 mm.) of the species under discussion. However, they can be distinguished from those of the present form by their straighter and broader outer ribs which in ventral view appear to be perpendicular to the keel or but very slightly turned forward. The best distinctive character is provided by the suture lines of *Elobiceras* which are even at that early stage much more ramified and richly indented, exhibiting far deeper lobes and taller saddles. This distinctive feature, previously mentioned in the remarks on *H. intermedium*, serves also to distinguish *H. semilēve*, although that species has the most elaborate suture line among all the forms of *Hysteroceras* dealt with in the present paper.

Finally, the superficial similarities between *Prohysteroceras gracile* and the present species will be noted below (p. 128).

[1] Pervinquière asserts it agrees exactly with Coquand's type.

Hysteroceras propinquum,[2] new species

Pl. v, figs. 23a–d; Pl. vii, figs. 14a–c

A. M. N. H. No. 25121: seven specimens

Description.—The holotype is almost half a disc, of which only the unseptate outer whorl is well preserved. Specimen No. 2, also a half disc, is even better preserved, but it is considerably smaller, and its outer whorl is still septate. The inner whorls are unfortunately obscured by matrix. In addition to these specimens, there are: a whorl fragment (No. 4) which perfectly agrees with the holotype; another and somewhat smaller part of a whorl (No. 3); and three minor fragments (Nos. 5–7) bearing the characteristic external nodes of this species.

The conch is discoidal and moderately involute. The section (Pl. v, fig. 23d, Pl. vii, fig. 14c) is almost oblong, with the sides entirely flat and converging but very slightly from the umbilical edge to the latero-ventral one. Both these edges are very pronounced in nodal section. The umbilical wall is steep, almost perpendicular, and the venter is truncate.

There are from six to seven inner tubercles and from eleven to twelve outer nodes per half whorl. The former seem to be a little stronger on the smaller specimen (No. 2) than on the holotype, where they continue for a greater or less distance down the umbilical wall, whereas they are but very little elongated ventrad. The external nodes are confined to the outermost fifth, or fourth, of the sides; they are broad and separated from each other by equally broad interstices; on the venter they appear to be slightly slimmer than on the sides; here they run at an angle of about 45° toward the keel from which they remain separated by comparatively broad flat bands. They are slightly sharper in specimen No. 2 than in the holotype. These nodes differ from those of *H. semilēve* by crossing the peripheric shoulder in an almost straight line, not in a gentle curve as in that species. In shape, they are to a certain degree

Dimensions

Spec. No.	D	H	H′	W	W′	U
2	16.9 mm.	43	?	31	33	29½
Holotype: 1	ca. 27.0 mm.	ca. 42½	?	ca. 27?	ca. 28	ca. 29½

[2] Although Stoliczka (1865, p. 53, Pl. xxxi, figs. 1, 2) named an Indian *Prohysteroceras* "*Ammonites propinquus*," the writer does not hesitate to use this specific name for the form here dealt with, as it seems most unlikely that any author would in the future attempt to unite *Hysteroceras* and *Prohysteroceras* under the same generic name.

reminiscent of the apple seeds mentioned by Kossmat (1895, p. 188, Pl. XXII, fig. 7) in the description of his "*Schloenbachia*" *gracillima*, but they are much shorter.[1] As in some *Neokentroceras* their posterior slope is remarkably steeper than the anterior one. Very faint, straight, radial folds connecting the outer nodes with some of the inner ones can be seen from a diameter of about 14 mm. on, in oblique illumination only.

The keel is still rather sharp and considerably overtops the outer nodes at the rear end of the smaller specimen No. 2, but it is blunter, though still very distinct, and hardly higher than the external tubercles at its front end. This fading of the keel can be better observed in the holotype. At its rear end the keel is about as high and distinct as at the front end of the smaller individual, whereas at the front end only a very blunt ridge is visible.

The suture line of specimen No. 2 is too inadequate to be worth delineating. All that can be observed is a rather broad siphonal lobe with strongly diverging terminal points; a very broad, bifid external saddle; a first lateral lobe which seems to be very short and two-pronged; and on the umbilical shoulder and the umbilical wall two auxiliary lobes with the first auxiliary saddle between them. On the whole, this suture line seems to be more simplified than that of *H. semilēve*.

REMARKS.—Despite the fact that its keel has a decided tendency to vanish near and on the body chamber, this species must be referred to the second among the two groups of *Hysteroceras* distinguished in the present paper, since its outer ribs do not show any tendency toward uniting on the venter.

Within this group it is most closely related to *H. semilēve*, from which it can readily be distinguished by its being somewhat stouter, by its keel fading toward and on the body chamber and by its coarser and fewer outer nodes. This last distinctive feature is less obvious insofar as a comparison with the variety *sparsicostata* of *H. semilēve* is concerned, but the latter variety is not considered transitional between these species, since it shows some features very characteristic of *H. semilēve*. In that variety the ribs are distinctly sigmoidal on the sides, and the outer nodes are gently curved around the peripheric edge, whereas the folds replacing the ribs in *H. propinquum* are straight, and the external tubercles pass across the peripheric edge without any curve. Finally, the suture line seems to be less elaborate in *H. propinquum*.

This species differs from *H. intermedium* by its flatter sides, more truncate venter and its ribs which are considerably coarser, never rursiradiate, and are confined to the outermost zone of the sides; moreover, their ventral projections are turned decidedly forward, whereas they run almost perpendicularly toward the keel in *H. intermedium*. Finally, the keel is fine and rather sharp in that species but is much broader in *H. propinquum*, and it is decidedly fading in this form but not in *H. intermedium*.

The rectangular section and the dominance of both outer and inner nodes of the ornamentation relate this species more closely to *Neokentroceras* than any other *Hysteroceras* of the Albian of Angola, and it appears to be somewhat transitional between these two genera. The external tubercles, however, do not project beyond the outlines of the whorl section as they do in that genus; instead they cling to the peripheric shoulders as in other species of *Hysteroceras*. It was, therefore, left with the latter genus. Detailed comparison with those species of *Neokentroceras*, which it most closely resembles, i.e., *N. choffati* and *N. costatum*, will be made in the discussion of those species (pp. 51 and 53, respectively).

NEOKENTROCERAS SPATH

Spath, in discussing this genus established by him in 1921 (p. 306), reviewed in his Angola paper (1922, pp. 106, 107) the previously described forms which might be referred to his genus, which he diagnosed as "characterised by tuberculation of a special type, and a low keel." The genotype chosen in 1921 is *H. curvicornu* Spath.

In Spath's opinion "*Ammonites*" *tectorius* White (1887, p. 225, Pl. XX, figs. 6, 7; Maury, 1930, p. 297; 1936, p 239, Pl. XXIV, figs. 1, 2; *non:* Boule, Lemoine and Thevenin, 1907, p. 36, Pl. IX, fig. 2; *non:* Collignon, 1932a, p. 17, Pl. III, fig. 10) from the Middle Albian of the Sergipe Province of Brazil, "*Schloenbachia*" *inflata*, var. *spinosa* Pervinquière (1907, p. 230, Pl. XI,

[1] Cf. below under *Neokentroceras pseudovaricosum* (p. 59, footnote 1).

fig. 3) from the Vraconnian of Tunis, which he renamed *N. spinosum*, and perhaps *"Ammonites" corruptus* Stoliczka (1865, p. 58, Pl. xxxvi, fig. 2), *"Schloenbachia" gracillima* Kossmat (1895, p. 188, Pl. xxii, fig. 7 = *"Ammonites candollianus* Pictet" Stoliczka, 1865, p. 51, Pl. xxx, fig. 4) and *"Ammonites" ootatoorensis* Stoliczka (1865, p. 56, Pl. xxxii, fig. 2), all three of them from the Indian Ootatoor group, belong to the genus under discussion. Furthermore, he compared (*ibid.*, p. 143) the form described and figured by Krause (1902, p. 22, Pl. ii, fig. 9) under the name *"Schloenbachia* sp." from the Cretaceous of western Borneo with his *N. pseudovaricosum*. None of the forms mentioned above is sufficiently close to any of those dealt with in the present paper to require specific comparison.

Previous to Spath's Angola paper of 1922 only a single specimen had been described from this region which could be referred to this genus. That is the one figured by Choffat (1888) in fig. 3 of Pl. i of his first Angola paper, which Spath made the holotype of his new species *N. choffati*, well represented in this collection. Also, many individuals in the present collection could be referred with more or less certainty to the Angola species first described by Spath himself: *N. curvicornu*, *N. subtuberculatum* and *N. pseudovaricosum*. The forms of the Ansorge collection and those from Nigeria, repeatedly mentioned by Spath (1922), could not, however, be compared for lack of figures.

Not many forms among those published since Spath's paper of 1922 seem to belong to *Neokentroceras*. In the writer's opinion some of the specimens figured by Besairie under the name of *"Inflaticeras" varicosum* (1931, p. 633, *pro parte*, Pl. lv, figs. 4–6 only) belong to this genus and are here, though doubtfully, referred in part to *N. choffati* and in part to *N. costatum*. Those forms named by Collignon (1932a, pp. 16, 17, Pl. iii, figs. 1–10) *"Schloenbachia (Pervinquieria) varicosa* Sow., var. *pseudovaricosa* Spath" and *"Schloenbachia (Pervinquieria) tectoria* White" may also be referred here. As to their specific position, reference may be made to the later discussion (see pp. 53 and 60, respectively). Collignon's somewhat antiquated taxonomic conceptions have been alluded to in the Introduction to this paper (p. 6; cf. p. 66, footnote 2). Furthermore, Adkins (1928, p. 235, *cum synon.*, Pl. xx, figs. 4–6, Pl. xxi, fig. 9) has referred two forms from the Upper Albian of Texas under the names: *N.* n. sp. and *N. worthense*, respectively, to this genus. Thus its geographical range, restricted by Spath as late as 1932 (p. 472) to Angola, seems almost world wide, reaching from Texas and Brazil to Borneo.

When dealing in his Gault Monograph with the closely related genus *Hysteroceras*, Spath repeatedly mentioned the genus under discussion (1934, *passim*, espec. p. 472). Here he appears to be inclined to restrict it to the forms most closely related to his genotype, *N. curvicornu*, and to exclude others, e.g., *N. pseudovaricosum*, which he now refers to *Hysteroceras*. For the reasons set forth below (p. 61) the writer cannot follow Spath in this restriction.

That author mentions (*ibid.*, p. 489, footnote) that "abundant new material of this species [i.e., *"Hysteroceras" pseudovaricosum*] and of *Neokentroceras* has since been received" from Angola and that "it is hoped a description will be published in Portugal." The writer, however, has not succeeded in finding this paper.

The question might be raised as to whether this genus should be maintained at all as an independent genus since, as seen from Spath's remarks in his Gault Monograph,[1] the stratigraphic and phylogenetic surmises prevailing at the time of its creation are no longer valid. In the writer's opinion the high degree of specialization in its ornamentation, chiefly as far as its prominent, sometimes horn-like or even

[1] 1934, p. 472, "In Angola the beds with *Hysteroceras choffati* and *H. pseudovaricosum* and numerous *Neokentroceras* have now turned out to be at the base of the *Mortoniceras-Elobiceras*-bearing series, which brings even the extreme *Neokentroceras* into closer association with *Hysteroceras* than with *Mortoniceras*, of which it was at first taken to be a late offshoot. It thus appears that neither *Neokentroceras subtuberculatum*, Spath, nor the new, tritubercular, Angola species, previously discussed, or forms like *Neokentroceras choffati*, Spath, and *N.* ? *lemoinei*, Spath, are as closely related to the genotype of this genus (*Neokentroceras curvicornu*) as I myself previously held."

spinous outer tubercles are concerned,[1] justifies its generic separation from *Hysteroceras*.

It is worth noting that *N. curvicornu*, the genotype, is the most highly specialized among all those forms. There is a striking analogy to the genus *Elobiceras*, for the genotype of which, *E. elobiense*, the same is true (pp. 98, 124). Among all the species hitherto referred or referable to *Neokentroceras*, *N. curvicornu* is the only one developing true spines. It is, moreover, extremely rare even at Hanha, its type locality; among 117 specimens of this genus in the present collection only three fragments could be referred to this species and even those but doubtfully.

The close relationship between some *Pervinquieriae*, which Spath includes in his subgenus *Durnovarites*, and *Neokentroceras* has already been pointed out by that author, and it is confirmed to a high degree by the new species *N. magnum* (see below, p. 56). *"Inflaticeras" spathi* Haughton (1924, p. 91, Pl. 1, figs. 6–8) has been mentioned by that author as another connecting link between the present genus and some *Pervinquieriae* of the *"rostrata-meunieri* group"; but in this species the anterior edges of the external tubercles seem to be the more abrupt ones, whereas the opposite is the rule in *Neokentroceras;* moreover, Haughton's form is more distinctly ribbed across the sides than any species of the present genus.

When the writer began the present study not a single *Neokentroceras* was visible, and even after a few months' study and preparation only six specimens had been found, four of them incomplete fragments. Later, however, a few conchs and abundant pre-fossil fragments of this genus were observed, crowded together in certain pieces of rock, and by methodically splitting up and preparing them[2] 117 examples were secured, though mostly fragments, it is true. Thirty among those 117 individuals are too poorly preserved for specific determination.

The remaining eighty-seven specimens are assigned to fourteen different forms including nine species, one with two varieties, and three with one variety each. Five species and four varieties are new, although one of the five new species is but doubtfully referred to this genus and has not been named because of the poor preservation of the two examples representing it.

This assemblage of forms appears to be divisible into four or five natural groups. *N. choffati* Spath shows the distinctive characters of the genus very clearly and is a "neutral" type among the various species. One recognized group shows a trend toward distinct costation and increasing involution. It includes *N. costatum*, *N. costatum*, var. *tenuis*, *N. magnum* and *N.* cf. *subtuberculatum*. *N. choffati*, var. *crassinodosa*, is considered transitional between the *forma typica* of that species and this group.

Another group, the "chef de fil" of which is *N. pseudovaricosum*, is distinguished by a peculiar type of both outer and inner tubercles. This species, with its two varieties, *gracilis* and *compressa*, is very closely related to *N. choffati*, and there are also transitions between the variety *gracilis* and *N. costatum* of the first group.

A third group is represented by *N. speciosum* and its variety *rudis*. This species is at its earlier stages very similar to both *N. choffati* and the forms of the costate group. On the other hand, its variety *rudis* appears to be somewhat transitional to *N. curvicornu*, the genotype and the most highly specialized member of this genus.

The peculiar *N. singulare*, which is strongly reminiscent at its very latest stage of some *Hysteroceras* with ventrally coalescing ribs, can be readily connected with *N. speciosum*.

There are finally two tiny fragments mentioned above which seem to belong to this genus but to occupy a rather isolated taxonomic position within it.

[1] The objection might be made that horns, spines, flared ribs and the like occur in other genera as well, as for example in *Dipoloceras* (e.g., *D. cornutum*, *D. cristatum*); they seem, however, to be but occasional and additional sculptural elements in those forms, whereas the very prominent outer tubercles and horns are quite a regular feature of ornament in *Neokentroceras*.

[2] More than 90 per cent of the total of 117 specimens were prepared out of two blocks of matrix, none of which measured more than about 10 × 7 × 5 cm.

Neokentroceras choffati Spath

(A) **forma typica**

Pl. VII, figs. 15–18; Pl. IX, fig. 4; text fig. 6a
A. M. N. H. No. 25123: eight specimens

Schloenbachia Lenzi Szajn.; CHOFFAT, 1888, p. 65, *pro parte*, Pl. I, fig. 3 only.

Neokentroceras choffati SPATH, 1922, pp. 106, 124 (footnote §§), 140, 143.

Inflaticeras varicosum Sow.; BESAIRIE, 1930, p. 633, *pro parte*, Pl. LXV, figs. 4, 5 only.

Neokentroceras choffati, SPATH, 1934, p. 472.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1	8.8 mm.	36½	32	?	57	33
2	12.5 mm.	37	?	?	37½?	36
3	14.1 mm.	34	?	?	41	35

DESCRIPTION.—Only a few of the eight specimens, none of which is complete, are septate, and no septum could be found at a diameter greater than about 12 mm. (specimen No. 6). No individual in the present collection attains the size of Choffat's holotype which seems to be an extraordinarily large representative of this small species.

The conch is discoidal and rather evolute; the degree of involution decreases, and the impressed zone, therefore, becomes shallower in the course of development.[1] The section is very wide in the young (e.g., specimen No. 1, text fig. 6a) and later becomes more slender[2] (e.g., specimen No. 5, Pl. VII, figs. 18c, d). It seems to be quadratic on the whole; however, as seen in specimen No. 4 (Pl. VII, fig. 17c) at a diameter of about 12 mm., the internodal section proves to have a broad inverted heart shape, the nodal one a slightly trapezoidal shape, owing to the prominent umbilical tubercles marking the maximum whorl thickness. Thus both the umbilical and peripheric shoulders are very pronounced in the nodal section but are rounded in the internodal one; both sides and venter appear to be flat.

The keel is distinct, though not very strong; it does not betray any tendency to fade on the body chamber. It overtops but slightly the outer tubercles which are separated from it by broad, shallow furrows. In one specimen (No. 4, Pl. VII, fig. 17b) it is peculiarly distorted near the front end, apparently due to some pathological condition.

The ornamentation consists of small, dot-like, though comparatively sharp inner tubercles and strong outer ones; the former almost equal the latter in number; as a rule, from four to five inner and five outer tubercles can be counted per quarter whorl. As in *N. pseudovaricosum*, there is a checkered arrangement of the tubercles; a radius drawn from an inner tubercle joins the periphery at an interstice between two outer ones, and vice versa. The outer nodes are radially elongated across the outer third or in exceptional cases the outer half of the sides; but occasionally indistinct folds can be seen crossing the sides and connecting outer and inner tubercles, as indicated in Choffat's fig. 3a. The inner ones maintain their position at the umbilical edge throughout development, without moving toward the middle of the sides as in some other species of this genus. The outer tubercles look much larger in ventral than in side view; this feature, seen well in Choffat's fig. 3, appears to be most characteristic of this species. Another distinctive feature which may be mentioned is the fact that, although the interstices between the external nodes continue a little obliquely toward the keel, the nodes do not seem to be projected on the venter to such a degree as in other species, e.g., *N. pseudovaricosum*. Also, there is not the striking difference in the degree of slope between the anterior and posterior edges of the nodes such as that pointed out by Spath (1922, p. 142) in the description of the latter species. The peripheric tubercles thus appear in ventral view either as equilateral triangles with one corner pointing decidedly outward (see Choffat's fig. 3b) or they point but slightly backward. It seems that the former aspect gradually replaces the latter in the course of development, as seen in Pl. VII, figs. 16b, 17b, 18b. From a diameter of about 9 mm. on, a slight notch—as mentioned by Spath (1922, p. 140) in the description of *N.*

[1] U = 33 in specimen No. 1 (D about 9 mm.), 35 in specimen No. 3 (D about 14 mm.), 40 in Choffat's holotype at a diameter of about 29 mm.

[2] H:W′ = 3.2 mm.:5 mm. in specimen No. 1 (D = 8.8 mm.), 4.5 mm.:5.1 mm. in specimen No. 4 (D = 12 mm.), 4.8 mm.:5.8 mm. in specimen No. 3 (D = 14.1 mm.), 5.5 mm.:5.9 mm. in specimen No. 5 (D = 15 mm.), 6.9 mm.:8.1 mm. at rear end (D = 20 mm.), but 10 mm.:8.2 mm. at front end (D = 27 mm.) of Choffat's holotype.

curvicornu—can be more or less distinctly observed, preservation permitting, at the outermost point of the external nodes which are thus divided into ventral and lateral protuberances; the latter become stronger and sharper with the more distinct development of the notch (see the second tubercle from the end on left side in fig. 18b).

The ornamentation described above is observable, though less distinctly, from a diameter of about 5 mm. on in specimen No. 1.

The suture line could be studied best in specimen No. 6, at a diameter of about 10 mm. (Pl. IX, fig. 4). The siphonal lobe is rather broad, subdivided by a low, trapezoidal, median knob into two but little divergent terminal points. The external saddle is very broad and bifid, its inner stem being broader than the outer one. The first lateral lobe is hardly shorter than the siphonal one and is distinctly two-pronged, with two more points on both sides of the terminal ones. The first lateral saddle is only a little lower than the external one and is bifid, the outer stem being broader than the inner one. The second lateral lobe is about half as long as the first, triangular in shape and three-pronged. Between it and the umbilical seam the second lateral saddle and an auxiliary lobe are indistinctly visible. On the whole this suture line is but modestly indented and in its general plan strongly reminiscent of the one figured by Spath (1922, p. 141) in his fig. 7a.

(B) var. **crassinodosa**, new variety

Pl. VII, figs. 19a–d

A. M. N. H. No. 25124: one specimen

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	ca. 19 mm.	ca. 39½	ca. 36	ca. 39½	ca. 47½	38?

DESCRIPTION.—A single well preserved fragment, consisting of a little less than the half of an unseptate whorl, differs from the typical form by its coarser ornamentation, both outer and inner tubercles being considerably stronger. The latter, moreover, become radially elongated down the umbilical wall which is very high and steep, though not perpendicular. There are no more than four inner and four outer tubercles per quarter whorl, and the folds connecting the outer and inner nodes are a little more pronounced than in the *forma typica;* here and there they show a faint indication of a lateral tubercle.

These features indicate that this individual is transitional to both *N. costatum* and *N. magnum.* In other characters, however, especially in its outer tubercles which are indistinctly notched and in its section, it agrees with the typical *N. choffati* and was, therefore, attached to this species as a variety.

REMARKS (AD *N. choffati*, SENSU LATO).—Although all the individuals of this collection are much smaller than Choffat's type, the writer does not hesitate to refer them to Spath's species as its distinctive specific characters can be found, though perhaps less pronounced, owing to the smaller size of these specimens. Although Choffat's form was renamed by Spath in 1922, it has never been properly described, and the above description is, therefore, the first ever given for this species.

Choffat referred his specimen, along with quite different forms, to *Schloenbachia lenzi* Szajnocha, but none of them was subsequently found to be conspecific with Szajnocha's species.[1] As far as the present species is concerned, Choffat was misled merely by the interruption of the costation; this character, however, has since been recorded by Spath among very different forms, and it occurs, as a matter of fact, in almost all genera of sculptured Albian ammonites, as repeatedly pointed out in the present paper. Unfortunately the holotype of Szajnocha's species is crushed; moreover, his description lacks some important details, and no section has ever been published. He speaks of his form as a "small and elegant one," but he does not disclose whether or not his only specimen is septate throughout, and it cannot, therefore, be decided whether or not it is an adult or merely a nucleus. Spath (1922, p. 133)

[1] 1885, p. 234, Pl. II, fig. 4. Among the forms erroneously referred to that species by Choffat (1888) fig. 3 is the holotype of *N. choffati*, fig. 4 that of "*Inflaticeras*" *dombense* Spath (1922, p. 124), fig. 5 is *Elobiceras* cf. *lobitoense* (Crick, MS.), fig. 6 ("*Schloenbachia* cf. *Lenzi*") is *Pervinquieria arietiformis* (Spath), whereas the form described as "*Schloenbachia lenzi*" in Choffat's paper of 1905 (p. 37, Pl. III, fig. 2) has become the holotype of *Pervinquieria evoluta* (Spath).

mentions "what he considers to be the true '*Schloenbachia*' *lenzi* Szajnocha," but he does not disclose his conception of its characters, which cannot be learned from the original description and figure. At any rate, the fact that its ribs are distinctly crenulated both at their inner and outer ends seems to suggest that it is a true *Elobiceras* rather than one of the micromorphic ammonites referred to *Neokentroceras* or *Hysteroceras*.

On the other hand, I am very much inclined to believe that some of the individuals from the Upper Albian of Madagascar published by Besairie (*loc. cit. in synon.*) under the name of "*Inflaticeras*" *varicosum*, viz., those depicted in his figs. 4 and 5, are conspecific with *N. choffati;* their section is almost identical with that of this species. At any rate, Besairie's specimens, showing very prominent umbilical tubercles in both frontal and ventral view, cannot be conspecific, as that author believes, with "*Schloenbachia* (*Brancoceras*)" *laferrerei* Boule, Lemoine and Thevenin (1907, p. 45, Pl. IX, figs. 6, 6a, 6b) from the Lower Cenomanian of Madagascar, as that species has, according to the original description, but "de tubercles ombilicaux faiblement marqués" and loses its keel in maturity, the ribs from both sides coalescing on the venter. It seems, therefore, to be a genuine *Hysteroceras*.[1] As to Besairie's fig. 6, the reader is referred to the remarks on the following species, *N. costatum* (see p. 53).

It may be worth noting that Spath did not alter the generic position of this species in his Gault Monograph, still calling it *Neokentroceras choffati*, while repeatedly referring to his *N. pseudovaricosum* (*passim*, espec. pp. 472, 489) as a *Hysteroceras*. The writer agrees with Spath in leaving the present species with the genus *Neokentroceras*. But he cannot agree to referring *N. pseudovaricosum* to *Hysteroceras*, as that species is very closely related to *N. choffati* and is even more closely related to the genotype *N. curvicornu* than is the latter species.

It may be added that the Madagascar form referred to "*Schloenbachia*" *tectoria* White by Boule, Lemoine and Thevenin (1907, p. 36, Pl. IX, fig. 2) and by Collignon (1932a, p. 17, Pl. III, fig. 10) and renamed "*Inflaticeras*" (*Neokentroceras*?) *lemoini* by Spath (1925, p. 185) is obviously a *Neokentroceras*, though certainly not conspecific with White's Brazilian species or with the holotype of the present species, as Boule, Lemoine and Thevenin assert.

N. choffati is, on the one hand, rather similar to the most *Neokentroceras*-like species of *Hysteroceras*, *H. propinquum*, and, on the other, closely related to both the *costatum-magnum* group (transitional: *N. choffati*, var. *crassinodosa*) and the *pseudovaricosum*-group. By the former group it appears to be connected with *N.* cf. *subtuberculatum*, by the latter with *N. speciosum*, *N. singulare* and *N. curvicornu*. Thus the present species is obviously the best point of departure for the study of the various forms included in the genus *Neokentroceras*. It will be compared with those species in the remarks on the latter.

Neokentroceras choffati is similar to *Hysteroceras propinquum* (p. 46) in its rectangular section, its truncate venter and the small circumumbilical and much larger external tubercles, but it can be readily distinguished by the fact that it is much less involute, stouter and has more prominent inner and outer nodes, whereas these nodes hardly grow beyond the outlines of the section in *H. propinquum*. Moreover, the outer tubercles are bent obliquely forward on the venter of the latter species, and its keel is much blunter from the outset and fades on the body chamber.

Finally, the inner whorls of *N. choffati*, as seen in specimen No. 1, are not very different from those of *Dipoloceras rectangulare* and *Hysteroceras varicosum*, var. *angolana* (see pp. 14 and 21, respectively). They differ from the latter, however, by the fact that the section is wider and more quadratic, with more pronounced lateroventral shoulders and a more truncate venter. Also, there are fewer and stronger outer tubercles, which do not continue down the sides as they do in *H. varicosum*, var. *angolana*. They differ from *D. rectangulare* in being stouter with clumsier outer and more distinct inner tubercles.

[1] It can, however, certainly not be considered a synonym of *H. varicosum* (Sowerby), as it is by Venzo (1936, p. 97).

Neokentroceras costatum, new species

(A) forma typica

Pl. VII, figs. 20–25; Pl. IX, figs. 5a–c; text figs. 6b–d

A. M. N. H. No. 25125: eighteen specimens

? *Inflaticeras varicosum* Sow.; BESAIRIE, 1930, p. 633, *pro parte*, Pl. LXV, fig. 6 only.

? *Schloenbachia (Pervinquieria) varicosa* Sow., var. *pseudovaricosa* Spath; COLLIGNON, 1932a, p. 17, *pro parte*, Pl. III, figs. 6, 6a only.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	ca. 18 mm.	45	?	39	49	28½

DESCRIPTION.—Of the eighteen specimens referred to this form only the holotype could be properly measured, and it proves to be, for a *Neokentroceras*, comparatively slender and involute. Some of the other individuals, however, seem to be less involute than the holotype.

The holotype consists of somewhat less than half an outer whorl, belonging to a body chamber, as do five more fragments. Septa could be traced only in individuals not exceeding 10 mm. in diameter; this form thus must have been a small one.

The whorl section seems at first glance to be quadratic, both sides and venter appearing to be flat. Further examination, however, shows the internodal section to be almost elliptical, the nodal one trapezoidal with concave sides and sulcate top. The keel is distinct, though not high, but slightly overtopping the outer tubercles at the rear end of the holotype and just equaling them in height at its front end. It does not, however, show any trend toward fading.

The main features of the ornamentation of this form are, as usual in this genus, the umbilical and peripheral tubercles. There are from four to five of the former and from five to six of the latter per quarter whorl. The inner ones are just on the umbilical shoulder and are radially elongated down the high, moderately steep, umbilical wall. Although they are more prominent above the median plane than the outer tubercles, the latter are definitely stronger. No checkered arrangement of tubercles can be seen in side view as in other species, but both outer and inner ones are elongated toward each other and connected by distinct, though blunt, slightly sigmoidal ribs which are, of course, far less prominent on the middle of the sides than the tubercles on their inner and outer zones. Only one secondary rib can be seen on each side of the holotype; those secondary ribs end in the first third of the sides.

The outer tubercles appear as the dominant features in ventral view. They are rather close to each other and thick; they trend, regularly and parallel to each other, obliquely forward toward the keel, from which, however, they are separated by a comparatively broad shallow furrow. Their anterior and posterior edges are not parallel to each other; whereas the former form an angle of about 60° with the median line, the angle formed by the latter is more acute. The outer ends of these tubercles point in ventral view obliquely backward. In sectional view (text fig. 6c) their highest point appears to be about half way between the keel and the outer margin; it is connected by an oblique slope with the outer end of the tubercle. Thus there is an upper and a lateral protuberance which are, however, not separated from each other by a notch.

The character of ornamentation in fourteen more fragments referred to this species is the same as in the holotype. In the smaller ones (Nos. 2–4, 13), which are septate, at least near their posterior ends, the costae are even more distinct and continuous across the sides (Pl. VII, fig. 22). The whorl section seems to be considerably wider than high at that early stage (Pl. VII, fig. 21c).

Suture lines could be studied in specimens Nos. 6, 15 and 16 at diameters of about 8 mm. They exhibit the general outlines of the genus: a very broad, bifid, external saddle and a rather short, apparently two-pronged, first lateral lobe, but they are too poorly preserved for delineation. Some more details could, however, be observed in a scanty fragment (No. 18) which is but doubtfully referred to this species; they are shown in Pl. IX, figs. 5a–c, depicting: (a) the lower part of the siphonal lobe, (b) the top of the external saddle with a three-pronged lobule and (c) the bottom of the first lateral lobe.

Two specimens of the eighteen included in the typical form of this species deviate somewhat from its holotype. Specimen No. 11, with the following dimensions:

D	H	H′	W	W′	U
17.6 mm.	38½	?	?	45½	34½

is less involute and its outer tubercles are less regular, more prominent and pointed and are distinctly notched in the front part of the body chamber; it thus may be considered transitional to *N. magnum*. The other atypical example, No. 12, with the following dimensions:

D	H	H′	W	W′	U
16 mm.	39½	?	?	37½	32

is also less involute and considerably more slender than the holotype, and its outer tubercles are much less prominent. In these characters it rather closely approaches the variety *gracilis* of *H. pseudovaricosum;* on the other hand, its ornamentation is that distinctive of *N. costatum*, especially in the density and arrangement of the outer tubercles and in the continuity of its distinct costae connecting the outer and inner tubercles, though these weaken considerably on the mid-sides. This individual was. therefore, left with this species.

(B) var. **tenuis**, new variety

Pl. VII, figs. 26, 27; Pl. VIII, figs. 1a–c; text figs. 6e, f

A. M. N. H. No. 25126: five specimens

DESCRIPTION.—The fragments included in this variety deviate from the *forma typica* in being more slender; the height of the whorls just equals (H:W′ = 4.8 mm.:4.9 mm. in the paratype) or even slightly exceeds the width. The keel is also a little sharper and higher and overtops the less prominent outer tubercles more decidedly than in the typical form. The section of the whorls (text figs. 6e, f), quadratic at first, later resembles, except for the more pronounced peripheric shoulders, that of the variety *compressa* of *N. pseudovaricosum*, as depicted by Spath (1922, text fig. D, 6); the other characters of the form here dealt with, however, are those of *N. costatum*, whereas Spath's above mentioned variety must be assumed to be, as the typical *N. pseudovaricosum*, less involute and without a distinct costation.

The holotype (specimen No. 1) is about a third of an unseptate whorl of about 15 mm. in diameter; its left side is badly corroded. The paratype (specimen No. 4), consisting of a little more than a quarter whorl, is septate, at least in its rear part. There are, besides, three more fragments; two among them (Nos. 3 and 5, diameters 12 mm. and 7 mm., respectively) are septate. Measurements could not be taken of any of these fragments.

In the paratype only parts of the suture line are visible; it seems to agree with that of the typical form but it is also too poorly preserved for delineation.

REMARKS (AD *N. costatum*, SENSU LATO).—In the writer's opinion, Besairie's (*loc. cit. in synon.*) Madagascar example, which differs from this author's figs. 4, 5 by being more involute and slender, is likely to belong to *N. costatum*. This applies to Collignon's (*loc. cit. in synon.*) fig. 6 as well, although the venter is less truncate than in the holotype of the present species; this is, however, true of equally small individuals from Angola as well. As pointed out above (p. 51), none of the forms named "*Inflaticeras varicosum*" by Besairie can be justly identified, as he does, with *Hysteroceras laferrerei* (Boule, Lemoine and Thevenin, 1907, p. 45, Pl. IX, figs. 6, 6a, 6b).

Within the genus *Neokentroceras*, *N. costatum* is most closely related to *N. chofati*, *N. magnum*, *N. pseudovaricosum* and to the variety *gracilis* of the latter. From the first it can be readily distinguished as it is more involute and chiefly by some considerable differences of ornamentation; there is no checkered arrangement of tubercles, but outer and inner ones are connected by distinct, though blunt, fold-like ribs; moreover, the outer tubercles are slightly more dense in *N. costatum* and in ventral view always point obliquely backward, even at a later ontogenetic stage.

N. magnum, which is doubtless the next of kin to the former, will be compared below, as will *N. pseudovaricosum* and its variety *gracilis* and *N. speciosum*, the young of which may somewhat resemble those of *N. costatum*.

In ventral view there is also some resemblance between the most *Neokentroceras*-like *Hysteroceras*, e.g., *H. propinquum*, on the one hand and *N. costatum* and, even more so, its variety *tenuis* on the other. However, even the latter can readily be distinguished from *H. propinquum* by its stronger, persistent keel and especially by its much more prominent inner and outer tubercles.

Finally there must be mentioned a most remarkable similarity between the present species and the earlier developmental stages of some individuals doubtfully referred to *Prohysteroceras hanhaense*, new species; it will be discussed in detail below (p. 133).

Neokentroceras magnum, new species

Pl. VIII, figs. 2–6; Pl. IX, fig. 6; text fig. 6g

A. M. N. H. No. 25127: fourteen specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	ca. 35 mm.?	12.0 mm.	8.4 mm.?	11.6 mm.	ca. 13 mm.	?
2	ca. 20 mm.	7.5 mm.	?	7.5 mm.	8 mm.	?

DESCRIPTION.—This interesting form is represented by fragments only, some of which are, however, sufficiently well preserved to permit a full description. This applies particularly to the holotype (Pl. VIII, figs. 2a–d, text fig. 6g), consisting of a little more than a quarter of an unseptate outer whorl; the inner whorls could not be properly exposed. The larger individuals among the other fragments seem also to be unseptate, although septa could be traced in specimen No. 2 up to a diameter of about 18 mm.

The section (text fig. 6g) is, on the whole,

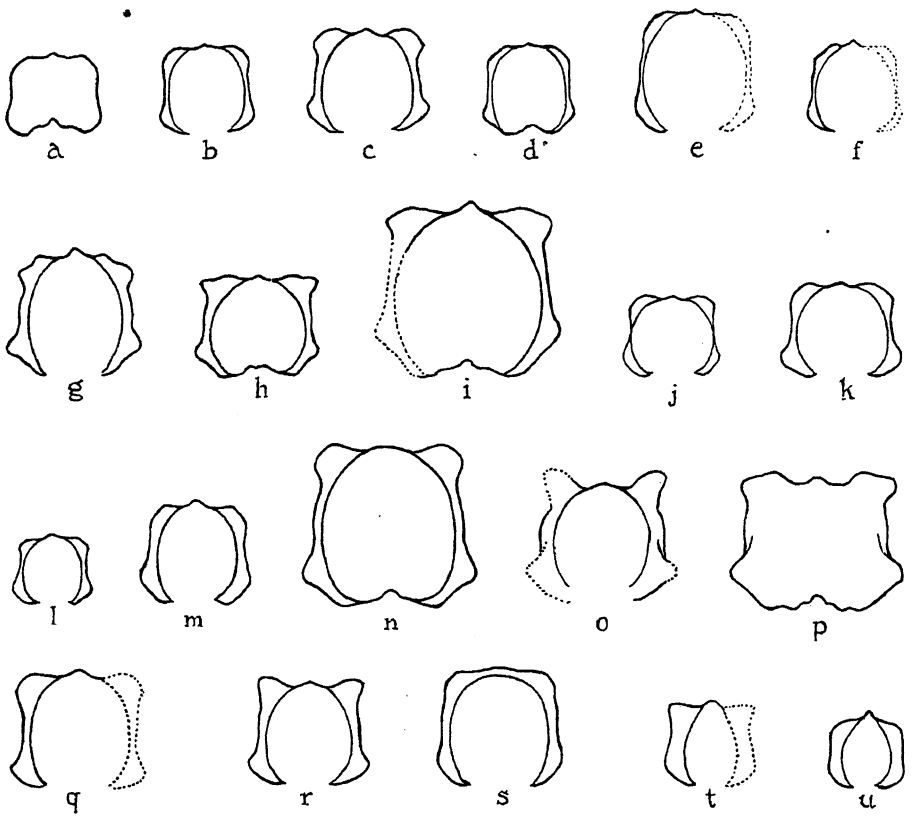

Fig. 6. Nodal and internodal sections of *Neokentroceras*.

(a) *N. choffati* Spath, A.M.N.H. No. 25123:1, at fracture, × 4.

(b–d) *N. costatum*, new species, (b, c) holotype, A.M.N.H. No. 25125:1, (b) at posterior, (c) at anterior end, both × 2; (d) A.M.N.H. No. 25125:12, at posterior end, × ca. 3.

(e, f) *N. costatum*, new species, var. *tenuis*, new variety, (e) holotype, A.M.N.H. No. 25126:1, × 3; (f) A.M.N.H. No. 25126:2, × 3.

(g) *N. magnum*, new species, holotype, A.M.N.H. No. 25127:1, at middle of fragment, × 3/2.

(h, i) *N.* cf. *subtuberculatum* Spath, A.M.N.H. No. 25128:1, (h) at posterior end, (i) near anterior end, both × 2.

(j, k) *N. pseudovaricosum* Spath, A.M.N.H. No. 25129:1, (j) at posterior end, (k) at anterior end, both × 3.

(l, m) *N. pseudovaricosum* Spath, var. *gracilis*, new variety, A.M.N.H. No. 25130:3, (l) at posterior end, (m) at anterior end, both × 3.

(n, o) *N. speciosum*, new species, (n) holotype, A.M.N.H. No. 25132:1, at anterior end, × 2; (o) A.M.N.H. No. 25132:3, at anterior end, × 3.

(p) *N. speciosum*, new species, var. *rudis*, new variety, A.M.N.H. No. 25133:2, near anterior end, × 3.

(q) *N. curvicornu* Spath?, A.M.N.H. No. 25134:2, in anterior part, × 3.

(r, s) *N. singulare*, new species, holotype, A.M.N.H. No. 25135, (r) at point of highest elevation of horns, (s) near anterior end, both × 2.

(t, u) *N.* (?), indeterminate new species, (t) A.M.N.H. No. 25136:1, at posterior end, × 3; (u) A.M.N.H. No. 25136:2, × 3.

Actual ratios of enlargement about 5 per cent less than indicated above.

almost quadratic; its corners are rounded in the internodal but are very accentuated by both inner and outer tubercles in the nodal section. As the inner nodes are just a little higher than the outer ones, the nodal section is but slightly trapezoidal. The keel is remarkably strong and higher than the tops of the external tubercles throughout development. In the body chamber it seems still to increase in both strength and height. The details of the ventral part of the section will be discussed below.

Although outer and inner tubercles are, as in all *Neokentroceras*, the dominant feature of sculpture, this form must be considered to be a costate one. In the holotype, the inner tubercles are sharp and radially elongated both dorsad and ventrad; on the one hand, they reach down the umbilical wall which is high, though not steep; on the other, they expand up the sides slightly beyond their middle. These elongated umbilical nodes cross the inner shoulder in a decidedly prorsiradiate sense and only then assume a radial direction, thus giving the costation a distinctly sigmoidal aspect. Occasionally they form high spines immediately above the umbilical edge which point outward in sectional view.

On the better preserved left side of the holotype the continuations of the inner tubercles do not meet those of the outer ones but terminate in the interstices between the latter, thus causing the costation to appear duplicated in the middle zone of the sides, a condition also observed by Spath (1922, p. 141) in *N. subtuberculatum*. On the right side of this example, the continuations of both inner and outer tubercles seem to coalesce into continuous ribs.

There are four inner and five outer tubercles per quarter whorl in the holotype as well as in the other specimens whose tubercles could be counted. The outer tubercles are strong, broad and distinctly notched. In side view they have a triangular aspect; in ventral view they look slightly mastoid and point obliquely backward at an angle of about 45°. The venter appears to be deeply intersected by the internodal areas. In sectional view the outer nodes are separated from the keel by distinct, though not very deep furrows; their highest point is about half way between the latter and the latero-ventral shoulder. The slope slanting from the peripheric point to the lateral one is decidedly concave, owing to the notch between them; that gives the ventral part of the sectional outline the undulate aspect, seen in text fig. 6g, which is most characteristic of this species.

Expanding dorsad, the outer nodes form gradually tapering ribs which are directed toward the inner tubercles but on the left side of the conch do not join them, whereas on the right one they seem to run continuously across the sides. Once on each side, though not directly opposite each other, ribs starting from two neighboring peripheric tubercles converge to one and the same umbilical one, thus causing the aspect of bifurcation.

At about the third fifth of the sides, the costae originating from the outer nodes carry a more or less vestigial, radially elongated, lateral tubercle.

The foremost outer tubercle on the left side of the holotype is much more prominent than the others and is very much elongated spirally; in sectional view (Pl. VIII, fig. 2d) it points outward and slightly upward. In ventral view (fig. 2c) this "horn" seems to have been formed by coalescence of two ventral tubercles; this surmise is strongly supported by the fact that ribs start from both the anterior and the posterior ends of this horn (see fig. 2a). The same type of double node seems to have been present on the damaged right side of the conch. This "flared tubercle" is strongly reminiscent of the flared ribs in some *Dipoloceras*, e.g., *D. cristatum*, whereas the "horns" of *D. cornutum* seem to arise out of single ribs.

The other fragments referred to this species do not exhibit all the sculptural characters to the same degree of distinctness as the holotype, and there is, furthermore, considerable variation in ornamentation among them. In some, e. g., specimens Nos. 12 (Pl. VIII, fig. 6) and 13, the ribs are very pronounced; in others they are far less developed. All of them, however, have in common the strong, slightly mastoid, more or less distinctly notched outer nodes which are, as a rule, pointing obliquely backward and are lower than the comparatively strong keel, with the internodals deeply intersecting the venter. Lateral tubercles can be but seldom observed in the earlier stages, e.g., as an extremely blunt knob just in the middle of the right side of specimen No. 4 (Pl. VIII, fig. 5a).

Parts of three suture lines could be studied in specimen No. 3 (Pl. IX, fig. 6). The siphonal lobe is rather deep, subdivided by a moderately high median knob into two slightly diverging points. The external saddle is just embracing the outer tubercle, very broad and bifid, its inner stem being broader than the outer one and bifid on its part. The first lateral lobe is considerably shorter than the siphonal one and ends in two long points. The first lateral saddle seems to be smaller and narrower than the external one, the second lateral lobe smaller than the first and three-pronged; the second lateral saddle is already on the umbilical wall; beyond it may be seen a first auxiliary lobe, a first auxiliary saddle and parts of a second auxiliary lobe. On the whole, this suture line agrees, in its outlines and in its degree of indentation, fairly well with Spath's (1922) text fig. D, 7a, taken from an individual of about the same size.

REMARKS.—Within the genus *Neokentroceras* this species must first of all be compared with *N. costatum* on the one hand and with *N. subtuberculatum* on the other. From the former, which is likewise costate and also very similar in section, it differs by

its considerably larger size and by its stronger, less dense and less regular, slightly mastoid and distinctly notched outer tubercles; moreover, lateral tubercles and the "doubling" of costation, as mentioned above, are never found in *N. costatum;* this may, however, be due merely to the small size of the latter species. From *N. choffati* the species under discussion differs in the same way as does *N. costatum.* It will be compared later with *N. subtuberculatum* Spath and with the form described below as *N.* cf. *subtuberculatum.*

There is also a most remarkable resemblance between *N. magnum* and some *Pervinquieriae* of the group of *P. perinflata* (Spath), for which that author established (1932, p. 380) his subgenus *Durnovarites.* This is especially true for *P. subquadrata* (Spath, 1933, p. 435, Pl. XXXVII, fig. 6, Pl. XLII, figs. 5, 9, Pl. XLIII, fig. 7, Pl. XLIV, fig. 6, Pl. XLV, fig. 5, Pl. XLVII, figs. 2–4, Pl. XLVIII, figs. 2, 4), whose close relationship to *Neokentroceras* did not escape Spath's observation. *N. magnum* might be considered, like the forms of that group, "quadrituberculate," if the faint lateral tubercle is taken into account and the doubled external one is considered as representing two tubercles. Also the whorl section varies from quadratic to broad-trapezoidal shape in both groups. Comparison of Spath's fig. 5 (Pl. XLV) of *P. subquadrata* with text fig. D, 7a of his Angola paper and with fig. 6 of Pl. IX of the present paper shows also the considerable similarity of the suture lines. The resemblance is most striking if the ventral views of Spath's holotype (Pl. XXXVII, fig. 6b) and of the holotype of *N. magnum* (Pl. VIII, fig. 2c) are compared; also the ventral aspect of a smaller specimen, as seen in Spath's fig. 7b (Pl. XLIII), is not very different from that of my specimen No. 2 (Pl. VIII, fig. 3b). There are, however, remarkable differences. Although Spath points out that in his *P. subquadrata* the peripheral tubercle is much more prominent than the three lateral ones, it is nevertheless not the dominant feature of sculpture that it is in *N. magnum.* As far as the latter is concerned, it seems to be more suitable to speak of one outer tubercle with a lateral and a peripheric point rather than of two distinct tubercles such as may be seen in the English form; also the lateral (second) tubercles are not so vestigial and the umbilical ones much less prominent in the latter than they are in *N. magnum.* Furthermore, the costation of the Gault species is more continuous, and its keel seems to be weaker than in the Angola form. All these differences seem to be fully sufficient for specific separation; moreover, the writer does not hesitate to include the present species in the genus *Neokentroceras,* not only because of its most close relationship to other species of this genus, particularly *N. subtuberculatum* and *N. costatum,* but also because it exhibits some characteristic features of this genus: the notch in the outer tubercles is not deep enough to divide them into two separate ones; the lateral tubercles are very faint and radially elongated; and the ribs originating from the outer nodes pass by those coming from the inner ones.

Neokentroceras cf. subtuberculatum Spath

Pl. VIII, figs. 7a, b; Pl. IX, fig. 7; text figs. 6h, i

A. M. N. H. No. 25128: six specimens

Cf. *Neokentroceras subtuberculatum* SPATH, 1922, p. 141, text figs. D, 8, 8a.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1	31.3 mm.	43½	ca. 38½	ca. 41½	48	27

DESCRIPTION.—Under this heading a single, relatively complete, though badly damaged example (No. 1) and some fragments (Nos. 2–6) are dealt with. Fragments of the inner whorls of the former are preserved, but they cannot be properly restored; the description has, therefore, to be restricted to the outer whorl, the last half of which belongs to the body chamber.

The conch is stout and rather involute for a *Neokentroceras,* with an internodal section which is broad, inverted heart-shaped to circular and a nodal section which is broader than high and a little trapezoidal,

with slightly concave sides and carinate-sulcate venter.

At the beginning of the preserved part of the outer whorl (text fig. 6h) the outer tubercles are fairly well developed and rather like those of *N. magnum* at the same diameter; the inner ones are sharp, though not very elongated radially. In the body chamber five inner and five outer nodes are seen on a little more than a quarter whorl. The inner ones are less sharp than at the rear end of the outer volution and radially elongated, a little on the sides, to a greater extent down the upper half of the umbilical wall, which is neither steep nor very high. In this form, too, the radially elongated inner tubercles cross the umbilical shoulder in a decidedly prorsiradiate direction. The outer tubercles are very broad and less pointed in the anterior than in the posterior part of the outer whorl. The internodals are shallower than those of *N. magnum*. These nodes appear but slightly directed backward both in ventral and in side views, their posterior slope being but little steeper than the anterior one. No notches are observable between their peripheric parts and the lateral ones; their outline appears, therefore, gently convex, not concave, in sectional view (text fig. 6i). They are separated by distinct and broad, though shallow furrows from the remarkably strong keel. At the rear end of the outer whorl the keel just equals the tops of the outer nodes in height, but it becomes considerably higher than the latter on the body chamber. Very blunt, almost vestigial, lateral nodes are visible just at the middle of the sides. There are no true ribs but only indistinct folds which seem to connect inner, lateral and outer tubercles.

A little whorl fragment (specimen No. 6) perfectly agrees, both in section and tuberculation, with the rear end of the outer whorl of specimen No. 1; also four more fragments (Nos. 2–5) can be recognized by some details of ornament or by the strength of the keel as being conspecific with No. 1.

Some details of two suture lines are perceptible at the posterior end of this specimen (Pl. IX, fig. 7). The siphonal lobe is about the same as in other species of this genus. The first lateral saddle is comparatively slender and intersected by a rather deep three-pronged lobule. The first lateral lobe is shorter than the siphonal one and ends in two but slightly diverging terminal points, which are three-pronged each and separated from each other by a slender, upright leaflet, and two lateral ones which are not very much shorter than the former. Also the first lateral saddle is rather slender and considerably lower than the external one. The second lateral lobe, which is halved by the umbilical edge, is less than half as deep as the first, points dorsad and is trifid. On the umbilical wall are seen a slender second lateral saddle, a rather broad, three-pronged, first auxiliary lobe which points ventrad and a first auxiliary saddle. This suture line exhibits a higher degree of indentation than those of the other *Neokentroceras* of this collection, probably owing to the greater diameter to which it corresponds. It shows, on the other hand, a remarkable resemblance to the suture lines of certain *Pervinquieriae*, a resemblance which is not unexpected, since this form is the next of kin to *N. magnum*, the close relations of which to the *Pervinquieriae* of the *perinflata*-group(=subgenus *Durnovarites* Spath) have been emphasized above.

Remarks.—Although Spath's side view of this species (*ibid.*, fig. 8) is inadequate since it does not show any details of the ornamentation, it can be seen from his sectional outline and from his description that the form here dealt with is, among the *Neokentroceras* discussed in the present paper, most closely related to this species of Spath's. It can, however, not be considered fully conspecific, as it is much more involute, stouter and has a stronger keel which considerably overtops the outer tubercles on the body chamber. Also it seems to be less distinctly costate and does not permit any observation of the peculiar doubling of ribs, as mentioned in Spath's description of *N. subtuberculatum* and noticed also in *N. magnum*, new species.

Within the present collection the form under examination must be compared with *N. magnum*. Up to diameters of about 18 mm. both are very similar; in the body chamber, however, *N.* cf. *subtuberculatum*

is much stouter and considerably more involute, its venter is broader, more truncate and not so deeply intersected by the internodals, and its keel seems to be a little stronger and higher. Also the outer tubercles are broader, less prominent and without notches, and its costation is less distinct. The above mentioned distinctive characters relative to the outer tubercles and to the shape of the venter seem to be valid also when Spath's holotype of *N. subtuberculatum* is compared with *N. magnum*.

The writer, dealing with a collection much richer in representatives of *Neokentroceras* than that available to Spath, cannot share the latter's opinion of a close relationship between *N. subtuberculatum* and *N. choffati*. The differences between both these species can be easily discerned by adding the gradual distinctive characters within the series: *choffati–costatum–magnum–*cf. *subtuberculatum–subtuberculatum* and by comparing the respective figures of the present paper.

Neokentroceras pseudovaricosum Spath

(A) **forma typica**

Pl. VIII, figs. 8, 9; Pl. IX, fig. 8; text figs. 6j, k

A. M. N. H. No. 25129: eleven specimens

Neokentroceras pseudovaricosum SPATH, 1922, p. 142, text figs. D, 4, 5.

Schloenbachia (Pervinquieria) varicosa Sow., var. *pseudovaricosa* Spath; COLLIGNON, 1932a, p. 17, *pro parte;* Pl. III, figs. 1–4,? figs. 5, 7, 8, *non* figs. 6, 9.

Hysteroceras pseudovaricosum (Spath); SPATH, 1932, *passim*, espec. pp. 472, 480, 489.

	Dimensions					
Spec. No.	D	H	H′	W	W′	U
11	10.0 mm.	ca. 40	ca. 35	?	ca. 50	33
3	11.5 mm.	38½	?	?	ca. 47	ca. 33
1	ca. 14.0 mm.	ca. 39	?	ca. 36?	ca. 50	ca. 36

DESCRIPTION.—A fragment (No. 1), consisting of about a third of a whorl which seems to be septate at least in its rear part, is most characteristic of this species in the present collection. The smaller specimens which have been measured, Nos. 11 and 3, the former almost complete, the latter more than half a disc, are septate throughout and so seem to be most of the other fragments, none of which exceeds 15 mm. in diameter, although in only one of them (No. 8) can septa actually be seen. Only the largest fragment (No. 10), corresponding to a diameter of about 20 mm., certainly belongs to a body chamber, whereas it cannot be stated with certainty whether or not the well preserved little fragment, No. 2, is still septate.

The conch is stout and but slightly involute. The section appears to be quadratic on the whole, but careful examination shows the internodal section to be almost circular, the nodal one to be subtrapezoidal with concave sides and shallowly sulcate venter. The width of the whorls increases faster than their height, thus causing the section to be decidedly thicker at the front ends of the fragments than at the rear ones. The keel of this species is weaker on the whole than that of *N. choffati* and *N. costatum* and loses strength in the course of growth. However, it does not entirely disappear in any of the examples under examination. The umbilical wall is high and rather steep, though far from being perpendicular.

Most characteristic of this species is its ornamentation, as seen best in Spath's fig. 5 and in figs. 8a, b and 9a, b in Pl. VIII of this paper. Its dominant features, as is the rule in this genus, are the outer and inner tubercles. Both of them are, however, of most peculiar shape. The umbilical ones are not very sharp but extremely broad and elongated, neither in a strictly radial nor in a strictly spiral sense but obliquely to both of them; their main axis trends sometimes prorsiradiately, sometimes strongly rursiradiately. Occasionally they assume an indistinctly triangular shape. There are per quarter whorl only three inner tubercles, but from four to five outer ones; thus the checkered arrangement of the nodes, as mentioned in the description of *N. choffati*, becomes even more distinct in this species.

The outer tubercles appear in side view as if some irregular beads had been glued

upon the peripheric part of the sides.[1] This aspect may be due to their being delimited by more or less abrupt slopes all around, although the posterior one is, as pointed out in Spath's (*loc. cit. in synon.*) description, considerably steeper than the anterior one. It is apparently for this reason that the outer tubercles, though rather clumsy, point slightly backward in side view. Their characteristic ventral aspect has been explicitly described by Spath; to his remarks it may be added that the outer nodes form rectangular triangles in ventral view, the right angle being at the lower corner next the keel. Slight notches are sometimes seen on their peripheric side, most oddly only in smaller individuals (e.g., No. 3), there being no trace of them in larger ones. In sectional view neither the keel nor the external tubercles, which equal each other in height, rise much above the venter, and the furrows between them are shallow.

Indistinct folds, observable in oblique illumination only, connect outer and inner nodes in a rather irregular way. Such a fold may connect the posterior slope of an outer one with a farther anterior, rursiradiately elongated, inner one, thus accounting for the "strongly rursiradiate undulations" as mentioned by Spath (see Pl. VIII, fig. 8a, on the anterior part of the whorl).

The suture line, visible in specimen No. 8 (Pl. IX, fig. 8), exhibits the characteristic features of this genus. The siphonal lobe is wider and, therefore, the external saddle, which is as usual bifid, is narrower than in other *Neokentroceras*. The first lateral lobe attains about two-thirds of the length of the siphonal one and is distinctly two-pronged. The second lateral lobe is far shorter than the first and three-pronged, the second lateral saddle very small, and already on the umbilical wall.

[1] The comparison with apple seeds, as used in Kossmat's (1895, p. 188, Pl. XXII, fig. 7) description of his "*Schloenbachia*" *gracillima* and quoted by Spath (1922, pp. 106–107), does not quite suit in this case, as apple seeds are extended more longitudinally.

(B) var. **gracilis**, new variety

Pl. VIII, figs. 10–13; Pl. IX, fig. 9; text figs. 6 l, m

A. M. N. H. No. 25130: six specimens

DESCRIPTION.—The holotype is an almost complete disc with only its last quarter whorl belonging to the body chamber. There is, in addition, a half disc (No. 3) which is septate throughout, and the same seems to be true for the smallest specimen (No. 2) and for two more whorl fragments (Nos. 4, 5), whereas a fourth (No. 6), consisting of half a whorl attaining nearly 15 mm. in diameter, is unseptate.

This variety deviates from the typical form in its section (text figs. 6 l, m), which is more slender, though not at all so compressed as that of Spath's variety *compressa* (see below).[2] The venter, which becomes slightly roof-shaped in the latter, is still distinctly truncate in the variety *gracilis*, the keel but slightly exceeding the outer tubercles in height.

Moreover, both outer and inner tubercles appear to be a little less prominent than in the *forma typica*, thus adding to the more graceful aspect of this variety, and the former are, as a rule, radially elongated as far as the middle of the sides. The number of tubercles, six inner and eight outer ones per half whorl both in the holotype and in specimen No. 3, and their checkered arrangement are the same as in the typical *N. pseudovaricosum*. In specimen No. 4 (diameter about 10 mm. only) some outer tubercles are distinctly notched, but such notches are in this variety as well as in the *forma typica* never found in larger examples.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
2	8.4 mm.	38	ca. 30	?	44	33½
3	12.6 mm.	36½	29½	ca. 34	ca. 40	35
Holotype: 1	13.6 mm.	37	?	?	40½	35½

The suture line, well visible, though corroded in specimen No. 3 (Pl. IX, fig. 9), exhibits in this variety also a broad siphonal lobe, subdivided by a low, trapezoidal, median knob into two but slightly diverging points, a rather broad, bipartite, external saddle and a bifid first lateral lobe, which is considerably shorter than the ventral one. The intersection of the first lateral saddle is still indistinct at this early stage. The second lateral lobe is bifid as usual. The second lateral saddle rides just on the umbilical shoulder. One auxiliary lobe is visible on the umbilical wall.

[2] H:W′ = 6.2 mm. : 5 mm. in Spath's (*loc. cit. in synon.*, fig. 6) section of the variety *compressa*, but 5 mm. : 5.5 mm. in the holotype of this variety.

(C) var. **compressa** Spath?

A. M. N. H. No. 25131: one specimen

Neokentroceras pseudovaricosum Spath, var. *compressa* SPATH, 1922, p. 142, text fig. D, 6.

DESCRIPTION.—A single fragment of a whorl attaining a little more than 10 mm. in diameter, exhibiting the periphery and the outer half of one side only, seems to have outer tubercles of the same type as *N. pseudovaricosum*, but it is much more slender than both the *forma typica* and its variety *gracilis*, and its keel, which runs very near the outer tubercles, overtops them distinctly.

The resulting section is very similar to that figured by Spath (*loc. cit. in synon.*). The present fragment, which is too poorly preserved for delineation, is, therefore, though doubtfully, referred to his variety *compressa*.

REMARKS (AD *N. pseudovaricosum*, SENSU LATO).—As to the synonymy, among the examples figured by Collignon (*loc. cit. in synon.*) only figs. 1–4 seem to the writer undoubtedly to belong to the species under discussion; it may be stressed that distinct notches can be seen in the outer nodes of his fig. 1a and also of figs. 3a and 4a, though to a less degree. All these specimens measure from 8 to 9.5 mm. in diameter and are of about the same size as the smaller individuals of both the typical form and the variety *gracilis* in the present collection in which notched outer nodes could be found. It seems rather doubtful whether the individuals depicted in Collignon's figs. 5, 7 and 8 belong to the typical *N. pseudovaricosum* from which they differ by denser tuberculation; they may represent another variety of this rather variable species. Figs. 6 and 9 are certainly not conspecific; the former was, though doubtfully, referred to *N. costatum* above (p. 53), whereas the latter is, owing to its roof-shaped venter, entirely different from all the other African forms of *Neokentroceras*. It seems more closely related to Krause's (1902, p. 22, Pl. II, fig. 9) "*Schloenbachia* sp." from Borneo, which has not yet been given a specific name, and it may be conspecific with it.

Within the present collection this species is closely related to *N. choffati* on the one hand and to *N. costatum* and to the earlier stages of *N. magnum* on the other. From the former it can be distinguished by its less truncate venter and especially by its ornamentation. The inner tubercles are much broader and blunter in the typical *N. pseudovaricosum*, not dot-like and pointed as in *N. choffati*, and are considerably fewer in number. Besides, there are always fewer inner than outer tubercles in the present species, whereas the former almost equal the latter in number in *N. choffati*. The outer tubercles are coarser and clumsier, less regular and delimited by steeper slopes all around and also slightly less in number in *N. pseudovaricosum*. In ventral view they appear as rectangular triangles, not as equilateral ones as in adults of *N. choffati*, and they always point more decidedly backward. Finally, notching of the outer tubercles occurs rather frequently in larger individuals of the latter species, whereas it seems to be confined to the earlier ontogenetic stages in *N. pseudovaricosum*.

On the other hand, this species can be readily distinguished from *N. costatum* by being less involute, by its less truncate venter and by its weaker keel which betrays some tendency toward fading. Most distinctive, however, is the ornamentation. Both outer and inner tubercles are considerably clumsier and less regular in *N. pseudovaricosum;* there are fewer of both of them, and the outer tubercles look like irregular beads in this species, whereas they appear to be reinforced outer ends of distinct ribs in *N. costatum*. In the present species, however, the ribs are replaced by indistinct, irregular folds. These differences are, it is true, less distinctive as far as the variety *gracilis* of *N. costatum* is concerned; an individual somewhat transitional between *N. costatum* and this variety was described above (p. 52). Moreover, there may also be some convergence between the variety *compressa* of Spath's species and the variety *tenuis* of *N. costatum*, as already pointed out in the description of the latter (p. 53).

N. pseudovaricosum also needs comparison with smaller individuals of *N. magnum*. Owing to their less prominent inner tubercles, the latter are less trapezoidal in sec-

tion; their keel is stronger and higher and does not indicate any trend toward fading, and their outer tubercles are more prominent and point more decidedly backward. Moreover, the costation which is so distinct in *N. magnum* is almost lacking in *N. pseudovaricosum*, and notched outer nodes are found in small specimens only of the latter species, whereas they persist in the former. Finally, lateral nodes are never found in the species here dealt with.

It will have to be compared with *N. speciosum* when the latter is discussed (below, p. 63).

In 1922 Spath included *N. pseudovaricosum* in his genus *Neokentroceras;* in 1932 (*loc. cit. in synon.*), however, he mentions it repeatedly as a *Hysteroceras*, having meanwhile changed his opinion on both its stratigraphical range and its phylogeny. In view of the extremely close relations between this species and other typical *Neokentroceras* of Angola, as explicitly discussed above, the writer cannot agree with Spath in these changes. This view is, moreover, strongly supported by the stratigraphical range of the different types of dwarf forms in the present collection. *N. pseudovaricosum* always occurs associated with other *Neokentroceras*, e.g., *N. speciosum* and *N. costatum*, though never with *Hysteroceras varicosum*, var. *angolana*. The latter and the various *Neokentroceras* seem to exclude and to replace each other in certain stratigraphic zones (see p. 139).

Collignon (1932a, p. 17) relegated this important species to the rank of a mere variety of *Hysteroceras varicosum*. In the writer's opinion no student really familiar with these micromorph Albian ammonites will ever agree with that procedure. However, there is, no doubt, some phylogenetic relation between both lineages, as witnessed also by the remarkable resemblance between the inner whorls of *N. pseudovaricosum* and *H. varicosum*, var. *angolana*. Those of the former can, however, readily be distinguished by their much more pronounced inner tubercles and much coarser and broader outer ones and by the lack of a lateral costation which is always distinct in those of the latter.

Neokentroceras speciosum, new species

(A) forma typica

Pl. VIII, figs. 14–17; Pl. IX, figs. 10a, b; text figs. 6n, o

A. M. N. H. No. 25132: nine specimens

DESCRIPTION.—The holotype, which was entirely hidden in matrix, had to be removed from it bit by bit, but eventually it was possible to restore it so as to represent a complete, though damaged specimen. The body chamber occupies almost two-thirds of the outer whorl. The aperture, though not fully preserved, is indicated by a slightly protracted and raised rostrum; its lateral margins seem to run parallel to the last ribs.

The innermost volution could be examined, at least in its peripheric parts, at a diameter of 8 mm. It differs from the equally small specimen, No. 2, of *N. pseudovaricosum*, var. *gracilis* (Pl. VIII, figs. 11a, b), solely in being decidedly stouter and perhaps less involute and in possessing more robust outer tubercles; the keel is distinct, though not strong.

	DIMENSIONS[1]					
Spec. No.	D	H	H′	W	W′	U
Holotype: 1	(a) 14.8 mm.	37	?	?	46	34
	(b) 31.7 mm.	36½	35½	29	35	41½
Paratype: 2	17.9 mm.	33½	30	39	45	30
3	23.6 mm.	32½	?	34	42½	37½

Measurements of the penultimate and of the outer whorl prove that both the degree of involution and the width decrease considerably in the course of growth, the last whorl being almost fully evolute and much thinner than the penultimate one. At first glance the nodal section appears to be transverse-oblong in adolescence and almost quadratic in maturity, but even in the adults the full width still exceeds the height of the whorl, if the horn-like tubercles are not taken into account. Owing to the prominence of the inner tubercles the nodal section always attains its maximum width immediately above the umbilical shoulder and is, therefore, slightly trapezoidal. The internodal section is almost circular, as seen in specimen No. 5, a little whorl fragment corresponding in development to about the middle of the body chamber of the holotype (Pl. VIII, fig. 17).

This species exhibits, next to *N. curvicornu* Spath, the most spectacular ornamentation

[1] D, H and H′ not including height of tubercles above level of venter.

among all the species of *Neokentroceras*. That of its penultimate whorl is very similar to that of smaller specimens of *N. magnum:* rather sharp, radially elongated inner tubercles and very strong, slightly notched outer ones which point in ventral view obliquely backward at an angle of 45° or a little less. They are separated from the equally high keel by broad, moderately deep furrows; the keel is distinct and broad throughout this whorl. There are eight outer and six or seven inner nodes per half whorl. Neither costae nor lateral tubercles can be seen on its sides.

On the outer whorl the external tubercles become spirally elongated and grow gradually above the level of the venter, attaining their maximum height in about the first third of the body chamber, i.e., half a whorl apicad of the aperture. Here these "horns" overtop the venter more than a fourth of the whorl height; they point steeply upward and but slightly outward in sectional view, strictly outward in side view (text fig. 6 o; Pl. VIII, figs. 14c, d, e). From here on toward the aperture they gradually decrease in height, simultaneously becoming blunter and pointing a little more outward in sectional view. In side view they generally appear to be semicircular in shape; occasionally the posterior margin is slightly more abrupt than the anterior one, thus causing an indistinct backward trend of the tubercle. No notches can be found in outer nodes of this whorl.

The keel is still very distinct at its beginning, but it gradually becomes more blunt on the body chamber until near the aperture only a broad, very blunt median ridge is left which is still decidedly overtopped by the horns, which have also become blunt. On the rostrum the keel seems to be rejuvenated, suddenly becoming more prominent again.

There are seven outer and seven inner tubercles on the anterior half of the last volution. The latter are sharp and elongated in a strictly radial sense; they culminate at the umbilical shoulder which marks about the first fifth of the distance between the umbilical seam and the latero-ventral edge, the umbilical wall having become less steep in the outer whorl and sloping at an angle of about 45°. Thus the highest point of the inner tubercle appears to be somewhat remote from the umbilicus, but it cannot be said to have moved toward the middle of the sides as in *N. curvicornu*, according to Spath's description (1922, p. 140). From that highest point the umbilical tubercles slope obliquely toward the umbilical seam, but very abruptly ventrad; they are, therefore, neatly distinct from the ribs which run in a straight, slightly prorsiradiate line toward the posterior edges of the outer nodes. These ribs are pronounced as such only in the last third of the outer whorl, whereas they appear as broad folds in its earlier parts. Throughout this whorl distinct, though very blunt, lateral nodes are visible at about the middle of the sides; they become more and more radially elongated in the foremost third of this volution where they occupy the middle part of the connecting ribs. They equal both outer and inner tubercles in number.

Details of the suture line could best be studied in the holotype at diameters from 9 to 18 mm. (Pl. IX, figs. 10a, b). The siphonal lobe is comparatively broad and subdivided by a low, trapezoidal, median knob into two slightly diverging terminal points; the knob is crenulated at the top by two minute notches. The external saddle is broad, just embracing the outer node and intersected by a distinctly three-pronged triangular lobule; its inner stem is broader than the outer one and in turn is subdivided by a three-pronged lobule. The first lateral lobe equals the siphonal one in length; it is comparatively broad and plainly two-pronged, whereas the second, which is considerably shorter, is, as usual, three-pronged and situated on the umbilical wall. There follow the rectangular second lateral saddle, which is indented at its top and about halved by the umbilical seam; and, in the impressed zone, a triangular, tongue-shaped lobe and a tall, slim saddle flanking the antisiphonal lobe. The latter exhibits two lateral points on each side and a strong three-pronged terminal one. As far as the outer suture line is concerned, the degree of indentation is about the same as in Spath's (1922) text fig. D, 7a, depicting a suture line which is but slightly larger.

The paratype (specimen No. 2, Pl. VIII, figs. 15a–c), consisting of about three-quarters of a septate whorl, shows an accelerated development of the sculpture. Here the horns rise above the venter at a diameter of about 12 mm., as compared to 18 mm. in the holotype. On the other hand, the paratype is up to its front end even more involute than the penultimate whorl of the holotype at a somewhat smaller diameter, and the width of the whorls is about the same; thus the trend toward a decrease, both in involution and thickness, appears to be somewhat retarded in the paratype. Moreover, the posterior edge of the outer tubercles is more abrupt than the anterior one so that the tubercles appear to point slightly backward in side view. All these differences may, however, be considered as merely individual variations which do not justify the separation of this form as a distinct variety.

In specimen No. 3 (Pl. VIII, fig. 16; text fig. 6 o), consisting of more than half a disc, only the foremost part may belong to the body chamber; except for its slightly more dense tuberculation (eight instead of seven outer nodes) this individual agrees very well with the holotype. Some distinct, though blunt, lateral nodes can be seen.

There are six more fragments (Nos. 4–9), the larger ones unseptate, the smaller ones septate, at least in their rear parts; all of them agree in all their observable characters either with the holotype or with the

paratype and are, therefore, considered as belonging to this species.

(B) var. **rudis**, new variety

Pl. VIII, figs. 18, 19; text fig. 6p

A. M. N. H. No. 25133: two specimens

DIMENSIONS[1]

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	23 mm.	34	?	37½	ca. 48	45

DESCRIPTION.—The holotype (Pl. VIII, figs. 18a, b) is an almost complete, though damaged disc; its outer whorl seems to belong to the body chamber, but its inner whorls are too poorly preserved for accurate examination. The maximum height of the "horns" is attained about a sixth of a whorl apicad of the front end. In its dimensions the holotype differs from the *forma typica* by being considerably stouter and more evolute, as seen best by comparison of the above measurements with those of specimen No. 3 of the typical form, which is of about the same size, and of the outer whorl of its holotype.

There are other varietal differences. Both inner and outer tubercles are coarser than in the *forma typica;* in the posterior part of the outer whorl the inner nodes are almost as strong as the outer ones, and the "horns" point more distinctly backward. There are only six outer and inner tubercles per half whorl, as compared to seven in the typical *N. speciosum*. The dorsad elongations of the umbilical tubercles almost disappear in the front part of the outer whorl, and the nodes themselves are shifted as far as, or even beyond, the first third of the distance between the umbilical seam and the latero-ventral edge, as compared to the first fifth in the typical form. This ventrad movement is accentuated by the fact that the umbilical shoulder becomes very indistinct in this variety. Furthermore, the folds connecting outer and inner tubercles remain rather faint up to the front end, and no lateral nodes can be observed.

In almost all of these distinctive features this variety decidedly approaches *N. curvicornu* Spath, to which it is transitional; but as it is more evolute and also a little stouter than Spath's species, and as the horns still remain blunt and broad at a diameter at which those of *N. curvicornu* have developed into spines which are curved sharply backward, it cannot be referred to the latter, but it is considered to be a variety of *N. speciosum* to which it seems to be most closely related.

An apparently unseptate fragment (No. 2, Pl. VIII, figs. 19a, b, text fig. 6p), consisting of less than a quarter of a whorl which may have attained 17 mm. in diameter, shows heavy outer tubercles, rising above the venter at a diameter of less than 15 mm. (cf. paratype of *forma typica*) and pointing backward also in side view, and very strong and prominent inner tubercles; it may, therefore, well be referred to this variety.

REMARKS (AD *N. speciosum*, SENSU LATO).—In maturity, this species, in which the "horns" rise considerably above the venter, can readily be distinguished from all the other known species of the genus except *N. curvicornu* and *N. singulare*, both of which will be compared in more detail below (pp. 64 and 65, respectively). The differences between *N. curvicornu* and the variety *rudis* of the present species have been pointed out above.

In the adolescent stage, however, *N. speciosum* closely resembles some related forms, especially *N. choffati*, *N. costatum*, *N. magnum* and *N. pseudovaricosum*. From the typical *N. choffati* the young of *N. speciosum* can be distinguished by their being somewhat stouter and by the slightly fewer and coarser outer tubercles, but *N. choffati*, var. *crassinodosa*, is distinguishable solely by its stronger and sharper keel. *N. costatum* is more distinctly costate at an early stage, and its ornamentation is more dense. Some young of *N. magnum* are hardly distinguishable from those of *N. speciosum* except for the fact that their outer nodes are as a rule more distinctly notched. Finally, *N. pseudovaricosum* can be distinguished, at the same size, by its less truncate venter and by the peculiar aspect of its outer tubercles in both side and ventral views.

Neokentroceras curvicornu Spath?

Pl. VIII, figs. 20–22; text fig. 6q

A. M. N. H. No. 25134: three specimens

? *Neokentroceras curvicornu* SPATH, 1922, p. 139, text figs. D, 1, 1a, 2.

? *Neokentroceras curvicornu;* SPATH, 1934, *passim*, espec. p. 472, text fig. 161p.

DESCRIPTION.—Three whorl fragments, all of which seem to be unseptate and the incompleteness of which does not permit proper measurements, do not reach the mature stage necessary for the observation of the distinctive characters of Spath's species, particularly its horns rising considerably above the venter and turning into sharp spines bent backward. However, they exhibit some features which induce the writer

[1] D and H not including the height of the outer tubercles above the level of the venter.

to refer them, though doubtfully, to this species.

In fragment No. 1, consisting of about a sixth of a whorl only, the same change in section occurs as seen between Spath's figs. 2 and 1a; in the first third of its length the section (Pl. VIII, fig. 20c) is very similar to that of the early stages of *N. magnum* or *N. speciosum*, and it also agrees fairly well with Spath's fig. 2, whereas in the second third of the length of this fragment, just 4 mm. farther orad, the outer tubercles point upward and considerably overtop the weak keel, thus approaching Spath's fig. 1a. In side view they point distinctly backward, thus betraying the trend toward forming the characteristic spines of the mature *N. curvicornu*. Also, the inner tubercles seem to be shifted a little ventrad from the umbilical edge. There are three outer and three inner nodes in this fragment, distinctly showing the checkered arrangement, as mentioned in the descriptions of *N. chofati* and *N. pseudovaricosum*. They are connected with each other by indistinct folds running obliquely across the sides. On the right side there seems to be a single very blunt lateral node.

Fragments Nos. 2 and 3, both of them about a quarter of a whorl long, have in common inner tubercles which are sharper and more dense (four to five per quarter whorl) than in No. 1 and are radially elongated dorsad. Ventrad, blunt folds originate from them and run across the sides. These folds are more or less straight and radial in specimen No. 3 but are peculiarly bent forward in No. 2. In both individuals the outer tubercles point outward and backward in both ventral and side views and can, preservation permitting, be seen to form a more or less sharp point (Pl. VIII, fig. 22). The section can be seen in fragment No. 2 only (text fig. 6q); it is comparatively slender and but slightly trapezoidal; in its anterior part the weak keel still slightly exceeds the outer nodes in height, whereas it equals them in the rear part of specimen No. 1 (Pl. VIII, fig. 20c).

REMARKS.—In spite of the peculiar aspect of Spath's fig. 1 (declared by this author himself to be "somewhat diagrammatic") *N. curvicornu* does not seem to be very different in its earlier stages from equally small individuals of various other species of *Neokentroceras*, and the fragments discussed above also show similar resemblances. There is a close affinity especially to examples of the same size of *N. magnum* and *N. pseudovaricosum*, and they can be distinguished, if at all, solely by the peculiarities of their outer tubercles.

In maturity, however, this species is the only one which develops sharp spines that are turned decidedly backward; this character is the main distinctive one also insofar as *N. speciosum*, the only other hitherto known *Neokentroceras* with "horns" rising high above the venter, is concerned. In the latter species these horns always remain blunt, also when they show some tendency to point backward, as they do, more distinctly than in the typical form, in the variety *rudis*, which is, as mentioned above, somewhat transitional between both species. Another difference, equally less pronounced in that variety than in the typical *N. speciosum*, may be found in the inner tubercles which are less coarse and more elongated radially and ride on the umbilical shoulder in the latter species, whereas they are clumsier and migrate toward the middle of the sides in *N. curvicornu*. Finally, Spath's species does not, even in maturity, become as evolute as the holotype of *N. speciosum*, which is but a little larger than that of *N. curvicornu*, and is as a rule (exception: No. C 21.119) slightly less thick than the paratype of *N. speciosum* and particularly its variety *rudis*.

Neokentroceras singulare, new species

Pl. IX, fig. 11; Pl. X, figs. 1a–c; text figs. 6r, s

A. M. N. H. No. 25133: one specimen

DIMENSIONS OF HOLOTYPE

D	H	H′	W	W′	U
23.8 mm.	35½	ca. 30	31½	37?	38

DESCRIPTION.—The single specimen (holotype) is a full, though incomplete disc; it cannot be decided with certainty whether or not it is septate throughout.

The conch is comparatively slender and but little involute. The nodal section (text fig. 6r) of the outer whorl is but slightly trapezoidal, as the inner tubercles rise only a little higher above the median plane than the outer ones;

the internodal section becomes almost elliptical toward the front end (text fig. 6s).

At the beginning of the outer whorl the keel is not weak and is as high as the outer nodes, but it gradually fades toward the front end (for its very last stage see below). In the first third of this whorl, the surface of which is in places badly corroded, the peripheric tubercles are of medium strength, blunt, dense and very regular; they point obliquely backward in ventral view, whereas they seem bead-like in side view. In the second third of this volution they become less dense and more prominent, gradually rising above the venter and forming blunt "horns" which point upward and outward in section and outward in side view. They reach their maximum height, which attains about a sixth of H, at about the second third of the length of the outer whorl; from there on they gradually lose height and cling more and more to the peripheric shoulder, running obliquely forward on the venter, until they are reduced near the front end of the specimen to reinforced peripheric ends of the distinct, slightly sigmoidal ribs which have meanwhile appeared on the sides, connecting inner and outer tubercles.

The inner tubercles are dot-like at the beginning of the outer whorl. Later they become stronger, though not very prominent, and on the last quarter whorl they are radially elongated, thus forming the inner parts of the continuous costae mentioned above. In the last third of this volution they move slightly ventrad from the umbilical edge, which is rounded throughout. There are eighteen outer and about twelve inner tubercles in the last whorl. There are four pairs of ribs near the anterior end of the holotype which gradually attempt to unite across the venter, as do, even more successfully, the intercostals. In the latter the vestigial keel gradually disappears; it persists as a blunt knob only between the outer tubercles, from which it is still separated by indistinct shallow furrows. Near the front end the latter tend to disappear, and the peripheric ends of the ribs tend to coalesce with the blunt median knob. However, since the conch is incomplete and, furthermore, is damaged ventrally just at its front end, it cannot be stated with certainty whether or not this coalescence is fully achieved (Pl. x, fig. 1c).

Three suture lines could be well studied (Pl. ix, fig. 11). On the whole, they seem to be a little more richly indented than those of other species of *Neokentroceras*. The siphonal lobe, owing to the somewhat more slender whorls of this species, is comparatively narrow and is two-pronged, the terminal points being separated from each other by a low, trapezoidal, median knob. The external saddle embraces the outer tubercle and is broad and bipartite. The first lateral lobe is rectangular in shape, with two terminal points and two very conspicuous lateral ones immediately above them. Whereas this lobe is still considerably shorter than the siphonal one in the two posterior suture lines among the four studied, both are equal in length in the next, and in the foremost suture line the first lateral lobe is even longer than the siphonal one. The first lateral saddle is as high as the external one and is bifid as well, but is much more slender. The second lateral lobe is only half as long as the first and is distinctly three-pronged. The second lateral saddle is low, triangular in shape, corresponding in site with the inner node. The first auxiliary lobe is still visible on the umbilical wall.

REMARKS.—In adolescence this interesting form is, except for being more slender and slightly less involute, very similar to individuals of the same size of *N. choffati*. It also agrees fairly well in its general habitus and in the dimensions of its outer whorl with some typical specimens (e.g., No. 3) of *N. speciosum*. It is, however, considerably more slender; its tuberculation is decidedly finer and more dense from the outset, and its "horns" do not grow so high. Both species have in common the occurrence of distinct lateral ribs on the body chamber, but they appear later in *N. singulare*. Its most distinctive feature is, however, the bridging of the venter by the intercostals and, though less definitely, by the costae themselves, as described above. The same trend is observable, though at a much larger diameter, at the very aperture of the holotype of *N. speciosum*, but here the ribs of both sides remain distinctly separated from each other up to the aperture.

This feature, unique among the *Neokentroceras* of the present collection and even among all hitherto known species of this genus, definitely suggests a relationship between this species and those of the first group of the Angolan *Hysteroceras*, in which the ribs coalesce on the venter, e.g., *H. varicosum*, var. *angolana*, or *H. orbignyi*, var. *minor*. Nevertheless, it is a genuine *Neokentroceras*, as shown by the pronounced inner and outer tubercles, the latter even developing, though weakly, into horns as in *N. speciosum;* tubercles of that kind are never found in the above mentioned group of *Hysteroceras*. Moreover, the forms belonging to the latter group are always costate throughout development, whereas ribs appear in *N. singulare* only at a very late ontogenetic stage.

The *Neokentroceras* and the "unkeeled"

Hysteroceras undoubtedly belong to different zones of the Albian of Angola; although this is far from certain, there is some reason to assume that the latter occur in the higher zone. Thus the hysteroceratoid characters appearing in maturity in the present species are phylogenetically to be interpreted as a first heralding of new characters which develop to a much greater degree in the offspring ("precursory characters") rather than as a recurrence of ancestral features (atavism).[1]

Neokentroceras (?), indeterminate new species

Pl. x, figs. 2, 3; text figs. 6t, u

A. M. N. H. No. 25136: two specimens

DESCRIPTION.—Two tiny whorl fragments, measuring 7.5 and 5 mm., respectively, in length but not permitting exact measurements, show peculiar features not found in any other *Neokentroceras* or in any other genus of the present collection; they are, therefore, described and depicted in spite of the unsatisfactory state of their preservation.

In both of them indistinct sutural elements can be traced, and they must in consequence be considered to be septate.

The intercostal section is oval and unusually compressed; the costal one is almost quadratic (W′ = H). The maximum width is at the umbilical shoulder, although no inner tubercles are present. There are, however, very broad blunt ribs, separated from each other by deep intercostals which are almost twice as broad as the ribs and cause the periphery to be deeply intersected between the strong sharp tubercles formed by the outer ends of the ribs (Pl. x, figs. 2, 3). These tubercles point outward in both ventral and side views, sideward and, in the larger fragment (No. 1) only, slightly upward in sectional view. The venter is distinctly fastigate and very narrow in the intercostals but broad and truncate where it is joined by ribs. Its median line is marked by a keel which appears to be sharper in the smaller example (No. 2) than in the larger one (No. 1). In the former, which may represent an earlier ontogenetic stage, it considerably overtops the outer tubercles; in the latter it only slightly overtops them; here it is separated from those tubercles by broad shallow furrows (text figs. 6t, u).

The suture lines, although traceable here and there, are too indistinct for description or for delineation. In its general plan the suture line visible at the front end of specimen No. 1 seems to show the generic characters of *Neokentroceras*.

REMARKS.—These curious minute fragments probably belong to some yet unknown species of *Neokentroceras*. However, they deviate from all the species of this genus hitherto described by the unusually broad intercostals deeply intersecting the whorls, by the fastigateness of the venter in the intercostals and by the lack of inner tubercles. Even at the earliest stages the known species of this genus are quite different and the present specimens, which look rather like a "miniature edition" of some horned *Pervinquieriae*, e.g., *P. perarmata* (see below, p. 74, Pl. xii, figs. 1a–c), are, therefore, doubtfully referred to the genus *Neokentroceras*.

[1] Cf. pp. 139, 141.

PERVINQUIERIA BÖHM

There can no longer be any doubts about the fact that this generic name, proposed in 1910 (p. 152) by J. Böhm for the group of *"Schloenbachia" inflata*, antedates and must, therefore, replace both its synonyms, *Inflaticeras* Stieler (1920, p. 346) and *Subschloenbachia* Spath (1921, p. 284; 1922, p. 100).[2]

Difficulties arise, however, from the existence of Meek's (1876, p. 448) generic name *Mortoniceras* proposed in 1876; as the genotype of this genus is the Albian *Ammonites vespertinus* Morton (1834, p. 40, Pl. xvii, fig. 1), it does not seem admissible to transfer the name *Mortoniceras* as many authors[3] have done to the Senonian group of *Ammonites texanus* Roemer (1852, p. 31, Pl. iii, fig. 1), for which Spath (1932, p. 379) created the generic name *Texanites*. When

[2] There is a strange reluctance of some authors to acknowledge these facts of priority as well as certain other features of taxonomic progress which should be beyond discussion, such as the necessity of the separation of the group of *Ammonites inflatus* (= genus *Pervinquieria*) from both the genus *Schloenbachia* in its restricted sense and the Senonian genus *Texanites* Spath. For example, Collignon uses as late as 1932 (1932a, pp. 14 ff.) the generic-subgeneric name *"Schloenbachia (Pervinquieria)"* including under it *Ammonites varicosus* Sowerby, the genotype of *Hysteroceras*, and considering *Neokentroceras pseudovaricosum*, which belongs to a fourth genus, a variety of the former species. Jayet in 1929 ignores the generic name *Pervinquieria*, using *"Inflaticeras"* instead, as do Besairie (1930, pp. 630 ff.), who also includes *Hysteroceras varicosum* in *"Inflaticeras"* and considers *Dipoloceras* and *Neokentroceras* to be subgenera of the former, and Douvillé as late as 1931 (pp. 19, 20). Likewise Renz (1936, pp. 8–10) ignores Spath's (1932) proposal of the generic name *"Texanites"* for the group of *Ammonites texanus* Roemer, although in the writer's opinion he should have either accepted or rejected it.

[3] E.g., Grossouvre, 1893, p. 66; Pervinquière, 1907, p. 227; Böhm, 1910, p. 152; Stieler, 1920, p. 346; Spath, 1925b, p. 199; Stanton, 1937, p. 457.

discussing the *inflatus*-group Spath (1932, pp. 379, 380) proposed to maintain the name *Mortoniceras* and to restrict *Pervinquieria* as a subgeneric name to "the *inflatum-rostratum*-group in the restricted sense" until Adkins had completed his investigations on the type of *Ammonites vespertinus* Morton.

As far as the writer is aware, Adkins has not yet published any result of those investigations. Meanwhile Stanton (1937) disclosed that he had examined the type of *Ammonites vespertinus* Morton many years ago; he characterized it as a "poorly preserved large fragment of an adult whorl," "the specific identity" of which "will probably never be satisfactorily established." Stanton believes it to be related to *Ammonites inflatus* and attaches *Ammonites leonensis* Conrad and "several other forms now known to be distinct species" as varieties to *Ammonites vespertinus*. According to Roman (1938, p. 461), who quotes Spath, Adkins has also found the holotype of *Ammonites vespertinus* to be "très incomplet"; Roman (1938, p. 367) also mentions that it is "en mauvais état." He, therefore, proposes (1938, pp. 367, 461) to "ne pas en tenir compte et supprimer purement et simplement le nom de *Mortoniceras* qui a donné lieu à tant de confusions."[1]

Restricting this generic name to Meek's unsatisfactory genotype, the writer is glad to accept for obvious reasons this proposal by Roman; in consequence the name *Pervinquieria* is used throughout this paper not in the restricted sense given to it in the Gault Monograph but in the circumference provisionally given by Spath in 1932 to the generic name *Mortoniceras* Meek, which is here entirely replaced by *Pervinquieria*. The genotype of *Pervinquieria, sensu lato*, is, of course, *Ammonites inflatus* J. Sowerby as proposed by Böhm in 1910, not *Ammonites vespertinus* Morton.

The writer, however, objects to the use of the different subgeneric names either created or admitted by Spath: *Angolaites* Spath (1932, p. 380) for the "*simplex*-group," *Cantabrigites* Spath (*loc. cit.* and 1933, p. 436) for the "*cantabrigensis*-group," *Durnovarites* Spath (*loc. cit.* and 1933, p. 429) for the "*perinflata*-group," *Deiradoceras* van Hoepen (1931, p. 52; Spath, 1932, p. 381) for the "*prerostrata-bispinosa*-group" and *Leonites* Spath (1932, p. 388) for the group of *P. leonensis* (Conrad), not only because he objects to the use of subgeneric names in principle, as specified in the Introduction (p. 5), but also for particular reasons referring to this genus. To the writer it would seem much more advisable to be satisfied with the mere distinction of groups within this genus, as Spath was in 1922, rather than to split it into so many subgenera,[2] particularly since all these groups have some generic features in common.

In the present collection this genus is represented by a greater number of forms than are found for any other genus. There are twenty different species, two with one variety each and one with three varieties, twenty-five different forms in all. They can easily be divided into several groups.

The first is that of the genotype *P. inflata* (= *Pervinquieria, sensu stricto*, according to Spath); it is represented in the collection by a typical specimen of *P. inflata*, var. *aequatorealis*. In addition to this variety there is the small *P. margaritata*, new species, which is without doubt closely related to the typical species of the genus; it is almost conspecific with a form figured by Szajnocha (1885, Pl. II, fig. 2) and resembles another Angola form, *P. meunieri* Spath; on the other hand, it appears to be transitional to "*Mortoniceras* (*Durnovarites*)" *quadratum* Spath.

The second group includes forms which might be called the "horned"[3] *Pervinquieriae*. *P.* cf. *stoliczkai*, still very close to the typical forms of this genus, may be considered as the "chef de fil" of this group. Other forms belonging here are: *P. romeri* and its variety *fastigata*, *P. perarmata*, *P. barbouri*, *P. howelli*, *P.* sp. indet. aff. *howelli* and *P. proteus*, all new forms.

[1] As to the unserviceableness of this name for the group of *Ammonites texanus* Roemer see Haas, 1942a, pp. 10, 11.

[2] For this reason van Hoepen's (1941) generic names "*Cechenoceras*," "*Deiradoceras*" and "*Mimoceras*" are also rejected (see p. 144).

[3] "Horn" is used here in the meaning of a horn-shaped, enlarged, outer tubercle, not of a raised rostrum in Stieler's (1922a, p. 322) sense.

Almost all of them are large types, attaining diameters up to 350 mm., with a vigorous sculpture. As far as the writer knows, such "horns" in Albian *Pervinquieriae* from Africa are recorded only in Spath's description of *P. stoliczkai*, as depicted in his text fig. C (1922, p. 120), and in Venzo's (1936, p. 91, Pl. VIII, fig. 5, Pl. XII, fig. 2) of his *P. curvatocostata* from the Upper Albian of Zululand. This feature is, however, developed to a much higher degree in Stoliczka's (1865, pp. 48, 49, Pl. XXVII, Pl. XXIX, fig. 2) Indian type of the former species and in the forms dealt with in the present paper. In the collections of The American Museum of Natural History were found three fragments from the Cretaceous of Texas (exact locality unknown) two of which proved to belong to the same specimen and which undoubtedly belong to the same group; either of them can be considered as being either conspecific with or at least closely related to one of the new Angola species described below.[1] A remarkable comment upon W. S. Adkins' knowledge of this group is furnished by the fact that after inspecting these specimens he left the following note dated "Jan. 1932": "All three *'Pervinquieria'*—outer whorls of probably *inflata* group, and indeterminate resemble *P. stoliczkai* Spath from Angola and *P.* new species from Texas."[2] *P. proteus*, new species, the last of the forms enumerated above, seems to be somewhat transitional to the group of *P. simplex* (= subgenus *Angolaites* Spath).

The third group is that of *P. evoluta* which is closely connected to the *inflata*-group. In this collection it is represented by *P. evoluta* itself and by another form considered to be a variety (variety *gracilis*) of a Madagascan species figured by Boule, Lemoine and Thevenin and renamed *P. montraynaudensis* in this paper.

The fourth group is the *simplex*-group on which Spath based his new subgenus *Angolaites*. In the present collection it is represented by the new variety *tenuis* of *P. simplex* and by a form figured by Spath (1922) and renamed in the present paper *P. vicina;* to the latter a variety *evoluta* is attached.

The group of *P. perinflata* (= subgenus *Durnovarites* Spath) is the fifth one present at Lobito Bay. To it belong the most *Arietites*-like new species, *P. bassleri*, and the peculiar *P. ferecostata*, new species, which is closely related to the former. There is, moreover, a single nucleus transitional between both these species.

Of the sixth group, that of *P. cantabrigensis* (= subgenus *Cantabrigites* Spath), there is but one representative, *P.*, indeterminate new species No. 1, in the present collection. On the other hand, the seventh group contains the largest number of specimens. This, the group of *P. arietiformis*, is without doubt transitional to the genus *Elobiceras*. To this group belong *P. arietiformis* with three new varieties (*compressa*, *lēvicostata* and *elegans*) and *P. vokesi*, new species. This group also produces big individuals, some of which even seem to exceed 350 mm. in diameter. Among its species, *P. vokesi* is distinguished by a very robust ribbing reminiscent of that of the horned *Pervinquieriae*, although entirely lacking the characteristic horns of the latter.

P. (?), indeterminate new species No. 2, holds a rather isolated position within this genus, and the generic reference itself appears to be doubtful.

Pervinquieria inflata (J. Sowerby), var. **aequatorealis** Kossmat

Pl. x, figs. 4a–c

A. M. N. H. No. 25138: one specimen

Ammonites inflatus Sow., *var. II;* Stoliczka, 1865, p. 49, Pl. XXVIII; Pl. XXIX, figs. 1, 3; Pl. XXX, figs. 1–3.

? *Ammonites inflatus* Sow.; Szajnocha, 1885, p. 232, *pro parte*, Pl. II, fig. 3 only.

Schloenbachia inflata Sowerby sp., var *aequatorealis* Kossmat, 1895, p. 187.

? *Schloenbachia inflata*, variété *aequatorealis* Kossmat; Boule, Lemoine and Thevenin, 1906, p. 40, *pro parte*, Pl. IX, fig. 8 only.

Inflaticeras aequatoreale Kossmat sp.; Spath, 1922, p. 121.

Inflaticeras aequatorealis Kossmat; Besairie, 1930, p. 630.

[1] One more such fragment from the Mt. Taylor country of New Mexico has quite recently been added to these collections.

[2] This apparently refers to the form described and depicted by Adkins (1928, p. 234, Pl. x, fig. 1) under the name of *Pervinquieria* n. sp. 4 and exhibiting, as Spath's above mentioned example, only the beginning of the development of horns.

? *Inflaticeras aequatorealis* Kossmat; AIRAGHI, 1931, p. 847, Pl. II, figs. 1, 2.
Mortoniceras (Pervinquieria) inflatum, var. *aequatorialis;* SPATH, 1932, pp. 386–388, text fig. 126d.

DIMENSIONS

D	H[1]	H′	W	W′	U
86.4 mm.	40	?	39	45½	35½

DESCRIPTION.—The only specimen is badly damaged. It seems to be septate almost up to the front end; the inner whorls, which seem to be crystallized, could not be properly examined.

The conch is moderately evolute and rather thick, the intercostal width of the whorls almost equaling their height. The intercostal section is trapezoidal, with the greatest width at the umbilical shoulder, flat sides and rounded latero-ventral edges. The venter is truncate and rather broad, crowned by a strong and broad, though low keel which has smooth bands on both sides.

The costation is coarse and comparatively stiff with seventeen almost straight ribs per half whorl along the periphery; some of them are simple, some bifurcate at the umbilical tubercles; such bifurcation occurs less frequently on the anterior part of the outer whorl than on the posterior one. On the latter area there is a peculiar crowding of ribs with intercalated secondary ribs which start at about the middle of the sides. They rapidly widen ventrad to such a degree that the primary ribs, which are rather broad on the inner zone of the sides, have to give way and to taper toward the periphery. On the outer whorl the ribs appear much broader where the test is preserved than on the cast. The intercostals which attain about half the width of the ribs in the cast are, as a rule, reduced to narrow deep furrows in the shelled parts of the conch.

There are three very distinct rows of tubercles: one around the umbilicus, a second slightly ventrad of the middle of the sides and a third row at the peripheric edge. The umbilical tubercles are the most prominent ones and are radially elongated to the extent that they occupy from a fourth to a third of the sides; the median row is composed of blunt tubercles which are less elongated than those of the umbilical row; the tubercles of the peripheral row are subdivided by a shallow notch into a ventral and a lateral protuberance; the latter is the sharper one and forms a distinct ridge on the ribs beneath the latero-ventral edge. The ventral ends of the ribs are not always strictly symmetrical on both sides of the conch; they run perpendicularly toward the keel in the first quarter of the whorl, but they are slightly projected orad on the body chamber.

In describing the spiral ornamentation, a sentence of Stoliczka's (p. 50, 4th to 6th lines) original description can be quoted literally, "sometimes the whole surface of the shell is spirally ribbed; these spiral ribbings being of course better seen on the tubercles." For the Angola specimen it need only be added that no spiral ridges can be traced in the intercostals and that on the ribs they are not only better visible but also tend to be concentrated on the tubercles. Among fifteen spiral ridges, four to five are on both the inner and outer tubercles, three to four on the lateral one and one to four only on the remainder of the rib. On the outer nodes they lose their sharpness ventrad, the innermost ridge being the strongest and the most prominent one.

No continuous suture lines could be studied.

REMARKS.—Spath (1932) doubts whether the specimen depicted in Stoliczka's Pl. XXVIII, considered by Spath the type of this variety, can be distinguished from the typical *P. inflata*, and he believes Stoliczka's fig. 1 on Pl. XXIX to be different from the former and to be identical with *P. kiliani* (Lasswitz). Nevertheless this variety is here taken in Kossmat's (*loc. cit. in synon.*) original sense, as Spath himself did, though not fully, in his Angola paper. The writer agrees with Spath (1932) in considering that this form is only a variety of that most variable species *P. inflata*, not an independent species as considered by Spath in 1922. He does not believe that Stoliczka's examples depicted on Pl. XXVIII on the one hand and on Pl. XXIX, fig. 1, on the other are too different from each other to be con-

[1] This ratio and the following ones measured at a diameter of 70 mm.

sidered conspecific, particularly since, to quote Spath's own words, "no two of these incomplete specimens are alike because the change in ornamentation sets in at different diameters," nor can he agree with Spath in assuming the identity of the latter specimen with *P. kiliani*. That species (see Lasswitz's holotype in Adkins, 1928, Pl. v, fig. 4, and Spath, 1932, text fig. 140) does not possess such distinct tubercles and up to a diameter of about 80 mm. has no lateral tubercles at all. Furthermore, its ribs are narrower, more sigmoidal and more numerous (thirty-eight on a whorl as compared to thirty-four in Stoliczka's form), and the spiral striation seems to be restricted to the venter.

On the other hand, the writer shares Spath's opinion that the specimen figured by Boule, Lemoine and Thevenin on their Pl. IX, fig. 10, and Pl. XI, fig. 1, cannot be referred to this variety, since its ornamentation is much finer, and there are no tubercles on the inner whorls. The example figured by the same authors in fig. 9 of Pl. IX seems to be a true *P. kiliani*, while the one shown in fig. 8 might belong to the variety *aequatorealis*, if the section, which is unfortunately not delineated, agrees with that of this variety.

It seems doubtful whether Airaghi's (*loc. cit. in synon.*) specimens really belong to this variety; their whorls seem to be higher and more slender and their ribs narrower and more numerous.

Kossmat believes that the two examples figured by Szajnocha (*loc. cit. in synon.*) are identical with Stoliczka's "var. II" but that too must be doubtful as long as their sections are unknown. Furthermore, Szajnocha's fig. 2 shows a much narrower umbilicus and much fewer ribs; it might be conspecific with, or at least closely related to, the next species, *P. margaritata*. His fig. 3,[1] wrongly referred to the variety *aequatorealis* by Boule, Lemoine and Thevenin, is much more evolute, has a denser costation and loses its tubercles at a very early stage, its ribs beginning simultaneously to turn decidedly forward. Both these specimens were quoted by Spath (1922, pp. 122, 123) as "*Inflaticeras* sp. cf. *aequatorialis*." The second may represent another variety of *P. inflata*.

The specimen here discussed agrees fairly well with Stoliczka's smaller one both in section and in measurements and there is only a slight difference in costation. The ribs turn forward a little more decidedly in the latter, but that may be due only to the fact that this feature develops a little later in the Angola form.

Within the present collection *P. margaritata*, and *P.* cf. *stoliczkai* are most closely related to the form under discussion and will be compared with it below (pp. 71 and 73, respectively). On the other hand it latter also shows considerable resemblance to *Elobiceras primordiale;* one of the lines connecting the genera *Elobiceras* and *Pervinquieria* seems to start here. For detailed comparison reference may be made to p. 101.

Pervinquieria margaritata, new species

Pl. x, figs. 5, 6a, b; Pl. XXII, fig. 1

A. M. N. H. No. 25139: two specimens

? *Schloenbachia inflata* Sow.; SZAJNOCHA, 1885, p. 232, *pro parte*, Pl. II, fig. 2 only.

DESCRIPTION.—Only the foremost part of the holotype belongs to the body chamber; the paratype seems to be septate throughout.

	DIMENSIONS					
Spec. No.	D	H	H′	W	W′	U
Paratype: 2	45.5 mm.	ca. 37	?	37?	41 1/2	38 1/2
Holotype: 1	47.0 mm.	39 1/2	?	38	41 1/2	36

The conch is moderately involute. The whorl section is subrectangular, with its maximum width at the umbilical shoulder. The sides are flat, with both umbilical and latero-ventral edges pronounced, though rounded. The um-

[1] Spath's (1922, p. 122) rectification, "fig. 1(= '3')," and his remark (*loc. cit.*, footnote††), "Both Kossmat and Boule, Lemoine and Thevenin, in referring to fig. 3 of Szajnocha's Pl. 2, mean the (wrongly numbered) fig. 1," are likely to increase confusion instead of removing it. As a matter of fact, the only error occurred in Szajnocha's Explanation of Plates, where the locality "Benguela" was added to fig. 3 instead of fig. 1 (see Choffat, 1888, p. 63, footnote 1; 1905, p. 35, footnote 1). To correct this error it is only necessary to interchange the figures "1" and "3" in the explanation of Pl. II.

bilicus is comparatively deep, the umbilical wall high and perpendicular. The venter is truncate and crowned by a strong keel. Where the latter is broken off the lower half of the siphuncular tube is visible and still contains here and there pieces of its cylindrical core.

The ornamentation is most characteristic of this species. The innermost whorls seem to be smooth. Between the diameters of 12 mm. and 35 mm. the sculpture consists merely of three rows of strong tubercles. The circumumbilical ones are first spinous, then they lose sharpness and begin at last to become radially elongated. The lateral ones, slightly above the middle of the sides, are rather prominent too, though never so sharp as the inner ones; they are pearl-like and, as a rule, remain circular in shape, but occasionally they become spirally elongated. The outer nodes, which strongly accentuate the peripheric shoulder, are comparatively large and become spirally elongated at an early stage (at diameters of less than 20 mm.). There are, per half whorl, seven umbilical tubercles in the holotype at a diameter of 19 mm. and nine in the paratype at a diameter of 30 mm. The total number of peripheric tubercles is about the same.

From a diameter of 35 mm. on, these tubercles begin to coalesce, thus forming broad, rather flat ribs which still show an umbilical prominence, a flat lateral node and a distinct outer one. The latter still remains very prominent for some time after the other tubercles have become flat. Toward the body chamber the ribs seem to flatten gradually, except for their innermost parts which remain sharp. There are fourteen ribs per half whorl. No spiral striation could be traced.

Suture lines could be examined in both specimens, best in the holotype (Pl. XXII, fig. 1), The siphonal lobe is moderately broad and subdivided by a rather low, trapezoidal, median knob into two slightly diverging terminal points, above which two main lateral branchlets are seen. The external saddle is high and intersected by a rather deep and large three-pronged lobule; its outer stem is broader and lower than the inner one and is richly indented. The first lateral lobe is somewhat deeper than the siphonal one and is rather broad; it ends in two terminal points and two lateral ones. The first lateral saddle is very like the external one in shape but not quite so high. The broad, distinctly trifid, second lateral lobe is only a little more than half as long as the first; the second lateral saddle is rather slender and distinctly intersected at its top; it rides just on the umbilical edge. On the umbilical wall follow a short two-pronged auxiliary lobe and a low, bifid, auxiliary saddle. The internal suture line consists of a slender and deep trifid lobe, a tall and slender, most richly indented, internal saddle and the anti-siphonal lobe, which is rather broad, though very much straitened at about its upper third, and ends in a comparatively short, three-pronged middle point.

REMARKS.—Szajnocha's fig. 2 of Pl. II, also showing pearl-like tubercles on its inner whorls and only later distinct ribs, is very similar to this new species and, except for the bifurcation of its ribs, it might be conspecific, if it proves to have the same section.

Moreover, *P. margaritata* closely resembles *P. meunieri* (Spath) (Meunier, 1888, p. 61, *pro parte*, Pl. I, fig. 2 only; Spath, 1922, p. 115) which, however, differs by showing distinct ribs at a very early stage (diameter: 16 mm.), but pronounced tubercles only later, whereas the opposite is the case in the present species.

It also may require comparison with *Mortoniceras* (*Pervinquieria*?) *nanum* Spath (1933, p. 411, text fig. 141, Pl. XLIII, fig. 6, Pl. XLVI, figs. 4, 5) and *Mortoniceras* (*Durnovarites*) *subquadratum* Spath (1933, p. 435, Pl. XXXVII, fig. 6, Pl. XLII, figs. 5, 9, Pl. XLIII, fig. 7, Pl. XLIV, fig. 6, Pl. XLV, fig. 5, Pl. XLVII, figs. 2–4, Pl. XLVIII, figs. 2, 4); both these species, however, have distinct costae at a much earlier stage; the former has internal and bituberculate outer nodes but no lateral ones; the latter, four rows of tubercles instead of three. Also, the suture line of the present species is not so much reduced as those of the two aforementioned ones (see text fig. 141e for *nanum* and Pl. XLV, fig. 5 for *subquadratum*), particularly as to the length of the first lateral lobe. The prevalence of tubercles on the inner whorls and their gradual replacement by ribs are seen also in Spath's (1932) Pl. XXXIX, fig. 4b, considered by him to be an adolescent form of *P. rostrata* (*ibid.*, p. 400).

Within the present collection *P. inflata*, var. *aequatorealis*, needs to be compared with this species. It can be readily distinguished by the development of its ornamentation which is more like that of *P. meunieri;* here, too, distinct ribs are seen at an earlier stage (e.g., in Stoliczka's Pl. XXIX, fig. 1, at a diameter of 17 mm.), and the rounded tubercles become pronounced only later, whereas the sequence of the sculptural development is just the opposite in *P. margaritata*.

Pervinquieria cf. stoliczkai Spath

Pl. x, figs. 7a–c

A. M. N. H. No. 25140: one specimen

Cf. *Ammonites inflatus* Sow., *var. I;* Stoliczka, 1865, pp. 48, 49, Pl. xxvii; Pl. xxix, fig. 2.[1]

Schloenbachia inflata Sowerby sp., Typische Form; Kossmat, 1895, p. 186; Pl. xxiii, fig. 2; Pl. xxiv, fig. 1.

Inflaticeras stoliczkai Spath, 1922, p. 119, text fig. C.

Inflaticeras stoliczkai Spath; Airaghi, 1931, p. 846.

Mortoniceras (Pervinquieria) stoliczkai; Spath, 1932, p. 385, text figs. 126e, f.

Mortoniceras (Pervinquieria) stoliczkai Spath; Collignon *in* Besairie, 1936, p. 195.

Dimensions

D	H	H′	W	W′	U
Ca. 200 mm.	31½[2]	?	25	27	41½

Description.—About three-quarters of the outer whorl of the single specimen seems to belong to the body chamber; thus it may be almost complete.

The conch is discoidal, the degree of its involution decreasing slightly in the course of growth, and there is a distinct egression of the spiral of involution, as observed also in other species of *Pervinquieria* and in other genera (*Elobiceras, Prohysteroceras*) within the present collection. The intercostal section is trapezoidal at the beginning of the last whorl, with the maximum width at the umbilical shoulder and with rather flat sides which converge ventrad. The section becomes more elliptical toward the front end, where the sides are more vaulted and most distant from each other slightly below their middle. At the beginning of the last whorl the umbilical shoulder is distinct, though rounded, and the umbilical wall is rather high and perpendicular, whereas on the body chamber the former becomes less distinct and the latter lower and less steep. The latero-ventral edges are pronounced, and the venter is decidedly truncate and rather broad in the first quarter of the outer whorl, but later on the edges almost disappear, and the venter becomes gradually more rounded in intercostal section. The keel is strong but is fully preserved only in a single spot, where it proves to attain 7 mm. in height and to overtop considerably the external tubercles.

The penultimate whorl is partly destroyed, partly badly worn; however, the ribs can be seen to be stiff and straight and to bifurcate almost regularly at rather inconspicuous, radially elongated, circumumbilical nodes. In addition, there seem to be lateral nodes at about the second third of the sides; the external tubercles are hidden by the outer whorl. On the outer volution thirty-eight stiff, almost straight, prominent ribs can be counted. Bifurcation continues regularly in its first quarter only and occurs but occasionally later on; now every second rib starts almost regularly at the first fourth of the sides only and is in their inner zone weaker than the primary ribs. Only on the latter are radially elongated inner tubercles present, whereas all the costae exhibit more or less distinct lateral nodes at about the second third of the sides; they too are radially elongated. The external tubercles have the shape of blunt rounded knobs in the first quarter of the outer whorl, but they assume that of horns in the last; these horns are rather blunt and in sectional view point outward and upward at an angle of about 45°.

The ribs seem to be covered throughout with spiral ridges which are distinct on the tubercles only. Preservation permitting, six can be counted on the umbilical tubercles, from five to six on the lateral ones and from three to four on the outer ones. Where the latter assume a horn shape these ridges seem to disappear.

Although septa could be traced, no suture line sufficiently adequate for detailed description or delineation could be studied.

Remarks.—This specimen is without doubt very closely related to, although not fully conspecific with, Stoliczka's "Var. I," believed by him, and also by Kossmat, to be the typical form of *P. inflata* but renamed *P. stoliczkai* by Spath. It agrees with Stoliczka's and Kossmat's examples—which slightly differ among each other, as pointed out by Spath—in sectional outline and in the character of costation, but it is a little more slender, its ribbing is more dense,

[1] Erroneously numbered "4a" in some copies of Stoliczka's paper (cf. Spath, 1932, p. 389, footnote 3).

[2] This ratio and the following ones measured at a diameter of 175 mm.

and its keel considerably exceeds the horns in height, whereas it is lower than the latter at the mature stage of the above mentioned specimens and also in the specimen figured by Spath (1922, text fig. C). For comparison between *P. stoliczkai* and *P. curvatocostata* Venzo (1936, p. 91, Pl. VIII, fig. 5, Pl. XII, fig. 2) the reader may be referred to Venzo's observations.

Within the present collection this individual differs from *P. inflata*, var. *aequatorealis*, in being, at the same diameter, less involute and much thinner and by its narrower, sharper, more prominent ribs; and from *P. evoluta* by the distinctive features as pointed out in the remarks on the latter (below, p. 80). The closely related various species of horned *Pervinquieriae* will be compared below.

Pervinquieria romeri,[1] new species

(A) forma typica

Pl. XI, figs. 1a–c, 2a–c; text fig. 7a

A. M. N. H. No. 25141: four specimens

"*Pervinguieria*" spec. indet.; *in schedis*, ADKINS, 1932, *pro parte*.

In the paratype there are four ribs, every second of which starts at some distance from the umbilical edge and lacks the inner tubercle. In the holotype there are five ribs, equal among each other, which run across the sides in a flat, orad concave arc, the chord of which is slightly prorsiradiate. They are not sharp but are prominent, especially around the umbilicus; there is also a second, though less prominent swelling at about their second third, distinct in the septate paratype but obsolescent on the body chamber of the holotype. On the latero-ventral shoulders the costae form strong, though blunt horns, pointing outward and but slightly upward in sectional view and forming isosceles triangles in ventral view. They rise considerably above the venter, resulting in a broad depression between them and the keel which exceeds them but slightly in height.

No spiral striation could be found, except on the single horn mentioned below.

Five or six suture lines are fairly well visible in the paratype (Pl. XI, figs. 2a, b; text fig. 7a). The external lobe is deep but not broad, with slightly diverging terminal points and a three-pronged, oblique branchlet, deeply intersecting the external saddle at about half its height, on each side. The external saddle is very broad, massive in its lower half but deeply intersected in the upper one by a stout trifid lobule, the middle point of which is distinctly three-pronged; both of the main stems are bifid; the inner one is much broader than the outer one, and its outer branchlet more than twice as broad as the inner one. The first lateral lobe is considerably deeper than the siphonal one; it is broad and subdivided by a tall triangular leaflet into two main branches which are both trifid; in addition, there are strong branchlets on both its sides. The first lateral saddle is higher and more slender than the external one and is also bifid. The second lateral lobe is much shorter than the first, is broad and trifid; all of its branchlets seem to be three-pronged. The second lateral saddle is subdivided into an upright inner and an oblique outer stem; the former is much higher and just touches the umbilical shoulder. On the umbilical wall there follow a short, bifid auxiliary lobe and an extremely broad and sturdy first auxiliary saddle, which is intersected by a short, though wide, three-pronged lobule; its outer stem is just halved by the umbilical seam. In the impressed zone are a comparatively large trifid lobe and a tall, richly indented, internal saddle, subdivided by a deep, three-pronged lobule into two stems, the inner one of which is much broader and higher than the outer one. The antisiphonal lobe is

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Paratype: 1	?	68 mm.	64 mm.	59 mm.	72 mm.	?
Holotype: 2	?	77 mm.	?	57 mm.	68 mm.	?

DESCRIPTION.—The holotype consists of about a quarter of a whorl and belongs, except for its rear end, to a body chamber, whereas the paratype, which is about a sixth of a whorl long, is septate throughout. The former is a fragment of a disc which must have attained 300–350 mm. in diameter; the conch, of which the paratype is a fragment, cannot have been much smaller.

The conch is rather evolute with an intercostal section which is almost inverted heart-shaped, attaining its maximum width in the first fourth of the sides, which are gently rounded and converge ventrad. The peripheric shoulders are distinct, though rounded. The truncate venter is raised only in its median part which is crowned by a broad strong keel; the latter is triangular in section. The umbilical shoulder is rounded with a steep, though not high umbilical wall. The costal section is trapezoidal with rounded corners at the bottom and slightly concave sides; within this concavity a faint swelling is visible at the place of the lateral nodes.

[1] Named in honor of Dr. Alfred S. Romer, Professor of Zoölogy and Curator of Vertebrate Palaeontology, Harvard University.

but a little deeper than the precedent one; it is narrow and ends in a rather short middle point.

A very worn fragment exhibiting only two ribs (specimen No. 3) and a single horn (specimen No. 4) seem also to belong to this species.

(B) var. **fastigata,** new variety

Pl. XIII, figs. 1a, b

A. M. N. H. 25142: one specimen

DIMENSIONS

	D	H	H′	W	W′	U
Holotype:	?	73.5 mm.	68.5 mm.	56 mm.	67 mm	

DESCRIPTION.—A septate whorl fragment measuring about 160 mm. in length and exhibiting five ribs deviates from the typical form in its decidedly gable-shaped venter which carries a sharp keel not neatly separated from it. Thus the keel considerably overtops the horns which point still more outward than in the *forma typica.* As in the paratype of the latter, every second rib starts only at the first third of the sides. Very distinct spiral ridges cover the ribs; four rather sharp ones are to be seen on their lateral parts and from three to four much weaker ones on the horns. A faint spiral striation is visible also in the intercostals.

Only parts of the suture line can be seen. They seem to agree with the corresponding parts of that of the typical form.

REMARKS (AD *P. romeri,* SENSU LATO).—One of the two Texas examples mentioned above (p. 68), an incomplete, partly worn, outer whorl whose anterior half is unseptate and which corresponds to a diameter of about 230 mm., can almost with certainty be considered conspecific with the *forma typica.*[1]

This species is without doubt closely related to *P. stoliczkai.* There is great similarity in the ribbing on the body chamber and in the suture line, which in its outlines very much resembles Stoliczka's (1865, Pl. XXVII) fig. 1c, and as far as the typical *P. romeri* is concerned also in section. On the other hand, *P. romeri* seems to have grown much larger than *P. stoliczkai,* and, moreover, it differs from the latter by the strong development of its horns, hitherto unknown among *Pervinquieriae,* though they are equaled, if not exceeded, in *P. perarmata.* The horns, which point more upward in *P. stoliczkai,* are outwardly pointed in the typical *P. romeri* and particularly in its variety *fastigata.*

The strong horns are so characteristic a feature of this species that hardly any further comparison appears to be necessary, except with the other horned *Pervinquieriae* of this collection, viz., *P. perarmata, P. howelli* and *P. barbouri* (see below, pp. 75, 77 and 76, respectively). It may be added that some superficial resemblance may be found between the present species, particularly its variety *fastigata,* and *P. vokesi;* however, the sides of *P. vokesi* converge more decidedly ventrad and its ribs are much more sinuous and carry blunt knobs instead of horns.

Pervinquieria perarmata, new species

Pl. XII, figs. 1a–c

A. M. N. H. No. 25143: one specimen

DESCRIPTION.—The holotype, a little less than a quarter of a whorl long, attains 220 mm. in length and belongs to a body chamber. The complete disc must have measured at least 300 mm. in diameter.

The conch is almost fully evolute, the impressed zone extremely shallow. The intercostal section is almost elliptic, reaching its maximum width at about the first third of its height. The sides are gently vaulted, changing without a distinct edge into the moderately broad venter which is raised only in its median part and carries a strong keel with a triangular section. The costal section is almost oblong with broad shallow depressions on both sides of the keel; the latter but slightly exceeds the horns in height.

There are on each side of the fragment five uniform, extremely prominent and sharp, radial and almost straight ribs, turning forward only at their external ends; they continue on the

DIMENSIONS[2]

	D	H	H′	W	W′	U
Holotype:	?	72 mm.	63.5 mm.	55 mm.	71 mm.	?

[1] Quite recently a fragment from Cebolletta, Mt. Taylor country, New Mexico, could be identified as *P.* cf. *romeri.*

[2] Measurements taken in about the middle of the fragment.

venter where they run at an angle of about 45° toward the keel. Only a slight swelling near the umbilical shoulder reminds one of the inner tubercles; only occasionally lateral nodes are present a little below the middle of the sides; if so, they are followed by a slight incurving of the outer half of the ribs. The horns are very strong and sharp; they overtop the "valleys" separating them from each other by 22 mm. They point outward in sectional view and obliquely backward in ventral one, and they appear to be much less distinctly separated from the lateral parts of the ribs than in other horned species. Their anterior slope is steeper than the posterior one. There seem to be obsolete traces of spiral ridges on the inner parts of the ribs.

REMARKS.—This new species is characterized by its high ribs and horns and by the fact that in sectional view the latter do not rise very high above the remainder of the ribs. By these distinctive features and by the fact that it is more evolute it can be readily separated from the precedent species, *P. romeri*. With *P. barbouri* it will be compared below (pp. 75, 76).

Pervinquieria barbouri,[1] new species

Pl. XII, figs. 2a–c

A. M. N. H. No. 25144: one specimen

Cf. "*Pervinquieria*" spec. indet. *in schedis*, ADKINS, 1932, *pro parte*.

crowned by a strong fastigate keel. The latter is in sectional view about as high as, or but slightly higher than, the horns and is separated from them by deep broad furrows.

There are seven ribs on each side of the present fragment. In ventral view they appear to alternate in position on the opposite sides of the whorl. Two of them begin at some distance from the umbilical edge, otherwise the costae are uniform, strong and prominent, though not sharp, radial and almost straight; beyond the horn they continue obliquely forward on the venter, ending at a rather considerable distance from the keel. The primary ribs originate from strong, radially elongated, umbilical tubercles. The outer tubercles are still stronger and point outward and very slightly upward in sectional view, outward and slightly backward in ventral view. In this species also the anterior slope of the horns is much steeper than the posterior one. Between the outer and inner tubercles the ribs are slightly incurved, but occasionally this incurving is interrupted by a hardly perceptible swelling of the rib which might be interpreted as the last vestige of a lateral node. No traces of spiral ornamentation can be seen.

No continuous suture line could be traced, but at the rear end of this fragment there can be perceived the outlines of a very broad external saddle, of a rather slender first lateral lobe, with two terminal points and two lateral ones immediately above them, and of a comparatively broad first lateral saddle which seems to be a little higher than the external one.

REMARKS.—The larger of the two Texas examples mentioned above (p. 68) differs from this new species merely by its less dense ribbing (five costae per quarter whorl, as compared to six in the latter) and by being a little less evolute, as indicated by its slightly less shallow impressed zone. It even exceeds the present form in size, as this Texas fragment, consisting of about a third of a whorl which is septate at its rear end only, belongs to a disc attaining almost 300 mm. in diameter.

P. barbouri is most closely related to both *P. romeri* and *P. perarmata*. From both these species it differs by being entirely evolute, by its much stouter whorls and by the fact that its ribs alternate in position on opposite sides of the conch. Furthermore, the ribs are stronger and more prominent, lack any spiral striation and, particularly, possess more prominent inner

DIMENSIONS

	D	H	H′	W	W′	U
Holotype:	?	63 mm.	58 mm.	59 mm.	73 mm.	?

DESCRIPTION.—This species is based on a third of an outer whorl. The fragment shows a septum (the last ?) at its rear end and seems to belong almost entirely to the body chamber of an individual which must have considerably exceeded 250 mm. in diameter.

Except for the impressions of the keel and of the horns of the penultimate whorl there is hardly any impressed zone; thus the conch must have been fully evolute. This species and *P. proteus* (below, p. 77) seem to be the most evolute forms among the horned *Pervinquieriae* of this collection.

The section is broad and is inverted heart-shaped between the ribs and almost quadratic on the ribs. The costal section, however, attains its maximum width a little above the umbilical shoulder, and it is slightly concave both on the sides and at the periphery on both sides of the keel. The umbilical edge is rounded, the umbilical wall neither high nor steep. The venter is truncate, comparatively broad and

[1] Named in honor of Dr. Thomas Barbour, Professor of Zoölogy and Director of the Museum of Comparative Zoölogy, Harvard University.

tubercles than those of *P. romeri*. The costation is less sharp than that of *P. perarmata*, and the ribs are much more incurved in their middle than are those of the latter species so that the horns appear to stand out more in sectional view; furthermore, these horns are higher in *P. barbouri*, and in consequence the furrows separating them from the keel appear to be deeper. Finally, the horns of this species point more upward in sectional view and less backward in ventral view than those of *P. perarmata*. *P. howelli* will be compared below (p. 77).

Pervinquieria howelli,[1] new species

Pl. XIII, figs. 2a–c, 3; text fig. 7b

A. M. N. H. No. 25145: two specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Paratype: 2	?	43.5 mm.	?	34 mm.	41 mm.	?
Holotype: 1	?	44.5 mm.	ca. 40 mm.	32 mm.	42 mm.	?

DESCRIPTION.—Both examples are fragments consisting of a little more than a quarter of a whorl and are septate throughout; the holotype attains about 130 mm., the paratype about 150 mm. in length.

The conch is very evolute. The intercostal section is oval and slightly tapering ventrad; both umbilical and peripheric shoulders are gently rounded, the sides almost flat, and the venter decidedly truncate. The costal section is thus almost rectangular, though slightly inflated in its lower part and considerably incurved beneath the horns.

There are six strong and prominent though not sharp ribs per quarter whorl. They are distinctly prorsiradiate and turn slightly forward near the periphery. On the holotype every second rib starts somewhat ventrad of the umbilical shoulder; on the paratype just one pair of ribs begins at the first third of the sides only. Except for these secondary ribs all the others carry strong, radially elongated, umbilical tubercles. However, lateral tubercles are distinct only on the secondary ribs. The costae are rather deeply incurved beneath the horns which are very prominent, comparatively sharp and point outward or occasionally also slightly upward in sectional view and exactly outward in ventral view. In the latter they resemble equilateral triangles. They hardly overtop the venter, forming almost one plane with it in the holotype, whereas in the paratype very shallow furrows appear between them and the keel.

The latter is strong but not high and but slightly, if at all, overtops the horns. In places it is broken off, disclosing the lower half and the core of the siphuncular tube.

Preservation permitting, from four to six spiral ridges can be seen on the costae, but none on the horns.

A continuous suture line could be traced in the holotype (text fig. 7b). The siphonal lobe is moderately broad, with two slightly diverging terminal points which are separated from each other by a triangular median knob, and with two lateral branchlets which deeply intersect the ventral borders of the external saddles at about the midpoint of their height. The external saddle is broad, subdivided by a deep, oblique, broad and trifid lobule into two unequal stems which are bifid as well; the outer one is inclined toward the median line and is much more slender and slightly lower than the inner upright one. The first lateral lobe is hardly shorter than the siphonal one and is broad and two-pronged; there is a tall and slender upright leaflet between both its terminal points which are almost perpendicular; immediately above them are two strong lateral branchlets. The first lateral saddle is considerably higher than the external one but is much more slender and is deeply intersected by a three-pronged lobule; here too the inner stem is much higher than the outer one which is inclined ventrad. The second lateral lobe attains about three-quarters of the length of the first, points slightly dorsad and is distinctly three-pronged. The second lateral saddle, beginning slightly ventrad of the rounded umbilical edge, is very broad and occupies the full width of the umbilical wall; it is subdivided by two secondary lobes, its outermost stem being the highest. There follow in the impressed zone a rather deep trifid lobe and a tall and slender, richly indented saddle, flanking the deep and narrow antisiphonal lobe which ends in a three-pronged middle point and has two lateral main points on each side.

As far as suture lines can be observed in the paratype, they seem to agree with those of the holotype.

The most characteristic features of the suture line described above are the broad solid bodies of the saddles which, as in the external saddle of *P. romeri* (p. 73), are deeply intersected only in their upper half. The lack of any auxiliary elements is also characteristic. Even the second lateral saddle is almost entirely shifted to the umbilical wall. The former character is found in Stoliczka's (1865) figs. 1c of Pl. XXVII and 1 and 1a of Pl. XXX, the latter in his fig. 2 of Pl. XXX, the first depicting a suture line of *P.*

[1] Named in honor of Dr. Benjamin F. Howell, Professor of Geology, Princeton University.

stoliczkai Spath, the others those of *P. inflata*, var. *aequatorealis* (Kossmat).

REMARKS.—This new species requires comparison especially with *P. romeri* and *P. barbouri*. It differs from both by its flatter venter, more prominent prorsiradiate ribs and more outstanding horns which point sideward in sectional view. Moreover, it is more evolute than *P. romeri* and more slender than both the above mentioned species, especially than *P. barbouri*. It will be compared below with *P. proteus* (p. 78).

Pervinquieria spec. indet. affin. **P. howelli,** new species

A. M. N. H. No. 25146: two specimens

DESCRIPTON.—A poorly preserved whorl fragment of a very evolute specimen (No. 1) is in ventral view very like *P. howelii*, except for some asymmetry between the horns of both sides. Moreover, there are distinct lateral nodes on the second third of every rib and the ribs are radial, not prorsiradiate.

Another badly worn whorl fragment (No. 2), the ventral part of which is not preserved, may be conspecific with No. 1.

Pervinquieria proteus, new species

Pl. XIV, figs. 1a–d

A. M. N. H. No. 25147: one specimen

DIMENSIONS

	D	H	H′	W	W′	U
Holotype:	260 mm.	29	?	22½	27	49½

DESCRIPTION.—The single specimen representing this new species is almost complete, including more than six whorls, about three-quarters of the outer one belonging to the body chamber.

The conch is discoidal and almost fully evolute. The section of the penultimate whorl seems to be trapezoidal with flat sides and venter; that of the last whorl is almost oval between the ribs and attains its maximum width in the first third of its height; the sides are gently vaulted and converge slightly ventrad; the umbilical shoulder is rounded, the umbilical wall not steep. The latero-ventral edges are rounded, the venter is truncate, moderately broad and is crowned by a strong keel which is, however, not high in the cast. The costal section of the last whorl is much broader than the intercostal one; due to the horns, it exhibits rectangular upper corners, and it shows distinct knobs at about the second third of the sides, corresponding to the lateral tubercles. The horns equal, or even exceed, the median keel in height and are separated from it by distinct, moderately deep furrows.

The innermost whorl is smooth; on the second whorl there are, at a diameter of less than 10 mm., fold-like ribs, carrying distinct, pearl-shaped tubercles at both the umbilical and peripheric shoulders. As far as the ornamentation can be studied on the third whorl, it consists of rather strong and sharp ribs with prominent circumumbilical tubercles. On the fourth volution the costation is very much like that of *P. inflata*, var. *aequatorealis*, as described above (p. 69), and consists of broad ribs with distinct, knob-like, inner, lateral and outer tubercles, the last of which become very prominent toward the end of this whorl. Only about a sixth of the fifth whorl is sufficiently well preserved to permit the examination of its sculpture. There are strong, sharp, straight ribs (about thirty-six of them per whorl) with very prominent umbilical, lateral and external tubercles, the last of which develop into sharp horns pointing sideways in sectional and outward in ventral view. This is exactly the ornamentation of *P. howelli* as described above (p. 76), and the venter also agrees perfectly with that of that species. The outer volution exhibits sixteen single, strong and rather sharp ribs per half whorl, which are as a rule almost straight, or only occasionally very slightly sigmoidal and are turned forward at the periphery only. They are a little more prominent at the umbilical edge; however, at about the second third of the sides there is a distinct and prominent swelling, and there are at the latero-ventral shoulder strong, though not sharp, spirally elongated horns which point upward in section and obliquely backward in ventral view.

Owing to the poor preservation of the ribs of the outer whorl faint traces only of apparently rather blunt spiral ridges can be observed; they seem to have been sharper and more pronounced on the penultimate whorl.

Septa can, of course, be traced throughout the inner whorls, but no suture lines could be found which were sufficiently adequate to permit detailed description or delineation.

REMARKS.—As seen from the above description, this interesting species passes through the sculptural stages of *P. inflata*, var. *aequatorealis*, and *P. howelli* successively and assumes in maturity a very peculiar type of ornamentation which approaches in the strong development of the lateral tubercles that of *P. orientalis* (Kossmat).[1] It differs, however, from the latter at a diameter of about 100 mm. (see Koss-

[1] Stoliczka, 1865, p. 50, Pl. XXIX, fig. 4 ("Var. III" of *Ammonites inflatus*); Kossmat, 1895, p. 186, Pl. XXIII, fig. 1 ("*Schloenbachia*" *inflata* var. *orientalis*); Spath, 1922, p. 120, Pl. IV, fig. 2 ("*Inflaticeras*" aff. *orientale*).

mat's figure) by its much coarser costation and its more pronounced horns, and at a diameter of about 250 mm. (see Stoliczka's figure) by its far less prominent lateral and external tubercles. From the variety *aequatorealis* of *P. inflata* it can be distinguished by its being more evolute; from *P. howelli*, at the same size, by a minor degree of involution and especially by its more dense and sharper costation, lacking the regular alternation of longer and shorter ribs, as seen in *P. howelli*. On the other hand, the single ribs of this new species result in a resemblance to species of the group of *P. simplex* (Choffat) (= subgenus *Angolaites* Spath, 1932), which also shows lateral tubercles; Choffat's form is, however, more slender and has denser costation and much less pronounced horns.

From *P. stoliczkai* Spath the present form can be readily distinguished as it is much more evolute and has more rounded sides and slightly more slender whorls and especially by the different development of the ornamentation; the "*howelli*-stage" is entirely missing in Spath's species. *P.* cf. *stoliczkai* as described above has denser ribbing and a higher keel. In maturity *P. proteus* differs from the other horned *Pervinquieriae* of this collection, already described above, mainly by its more rounded section, its much more distinct lateral tubercles and above all by its less prominent horns which cling to the peripheric shoulders and point upward, not outward, in sectional view.

P. proteus will be compared below (pp. 82 and 84, respectively) with the representatives of the *simplex*-group in the present collection, *P. simplex*, var. *tenuis*, and *P. vicina*.

Pervinquieria evoluta (Spath)

Pl. xv, figs. 1a, b; text fig. 7c

A. M. N. H. No. 25148: one specimen

Schloenbachia lenzi Szajn.; Choffat, 1905, p. 37, Pl. III, fig. 2.

Inflaticeras evolutum nov. nom., Spath, 1922, p. 124.

Dimensions					
D	H	H′	W	W′	U
140 mm.	32	?	30½	34½	44½

Description.—The foremost part, about one-eighth whorl, of the single specimen belongs to the body chamber.

The conch is evolute and robust. The section, on the whole, is almost quadratic, though with sloping external shoulders. In intercostal section the umbilical shoulder appears to be gently rounded and the umbilical wall neither high nor steep, and in the preserved part of the body chamber the latter becomes still less abrupt. The gently vaulted sides are most distant from each other a little below the middle. The external shoulder is rounded, the venter broad and slightly truncate. The costal section is much more gibbous than the intercostal one and has one distinct swelling above the umbilical edge and another at the middle of the sides, corresponding to the umbilical and lateral tubercles, respectively. There is a very prominent horn-like tubercle at the peripheric shoulder. These horn-like tubercles considerably overtop the strong, though rather low keel, thus causing the venter to appear to be concave with the keel immersed between them; it is separated from the horns by broad, rather deep furrows. The horns slope obliquely on their outer side but are almost perpendicular on the inner one; in consequence, they point upward and slightly inward in sectional view.

There are thirty-two prominent, rather sharp and slightly sigmoidal ribs on the outer whorl. They are distinctly triangular in section, whereas the section of the intercostals proves to be almost semicircular. Although all the costae are single, primary and secondary ones alternate; the former are distinguished by stronger umbilical tubercles and start at the umbilical seam, whereas the latter begin at the umbilical shoulder only or, rarely, still farther ventrad. Throughout the ribs of the first half of the last volution spiral ridges ("nodosités allongées dans le sens spiral," Choffat, *loc. cit. in synon.*) are seen. They are most distinct on the outer half of the ribs where from five to six can be counted. In the foremost part of this whorl they become more blunt and are much less distinctly spirally elongated. Three of these ridges are here particularly distinct in the outer

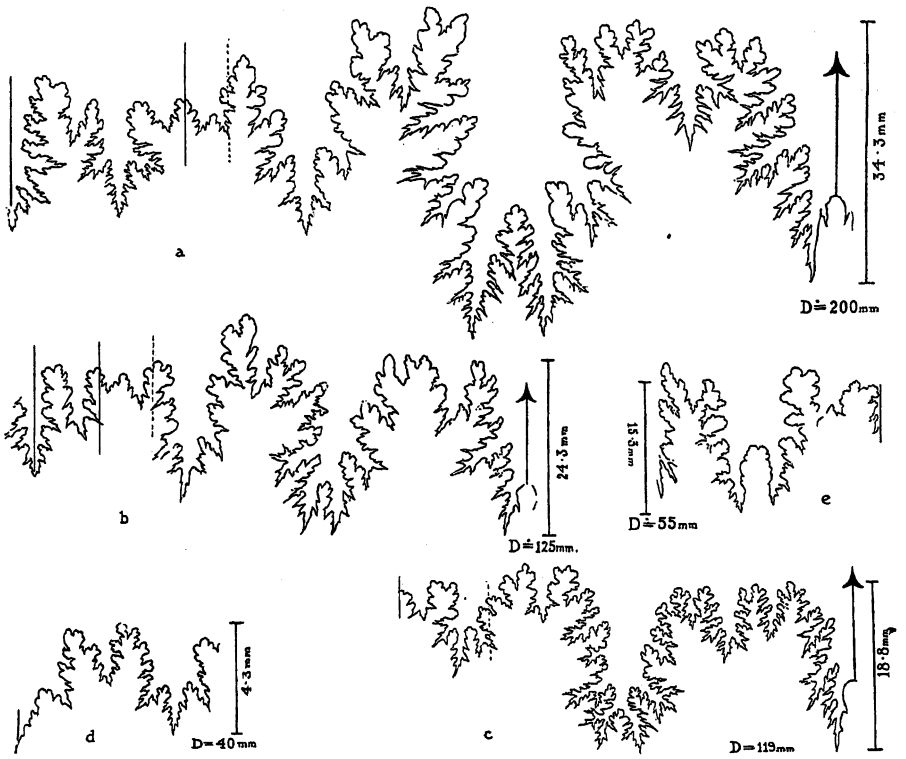

Fig. 7. Suture lines of *Pervinquieria*.

(a) *P. romeri*, new species, paratype, A.M.N.H. No. 25141:1.
(b) *P. howelli*, new species, holotype, A.M.N.H. No. 25145:1.
(c) *P. evoluta* (Spath), A.M.N.H. No. 25148.
(d) *P. montraynaudensis*, new name, var. *gracilis*, new variety, holotype, A.M.N.H. No. 25149, from inner part of first lateral lobe to second.
(e) *P. simplex* (Choffat), var. *tenuis*, new variety, holotype, A.M.N.H. No. 25150; siphonal lobe incomplete.
Scale and diameter of disc are indicated for every drawing.

zone of the ribs, that is, between the peripheric tubercle and the lateral one, as seen also in Choffat's (*loc. cit. in synon.*, Pl. III) sectional diagram fig. 2c.[1] In the very last intercostals faint spiral folds can be observed which connect the crenulations of neighboring ribs.

The outer part of the suture line could be studied in the last quarter of the outer whorl (text fig. 7c). The siphonal lobe is narrow, with a high, tongue-shaped, median knob which is slightly crenulated at its margins and just covers the median keel, and with two long, fine, almost perpendicular points embedded in the furrows accompanying the latter. The external saddle is extremely broad and rather low and is subdivided into two stems by a broad trifid lobule, all three points of which are three-pronged; both of the stems are intersected by three-pronged lobules, the outer one more deeply than the inner one, which is narrower than the former. The first lateral lobe equals the siphonal one in length and is subdivided by a triangular, richly indented leaflet into two three-pronged terminal points; above them a strong lateral branchlet is visible on each side of this lobe. The first lateral saddle is higher than the external one and is also

[1] The statement in the text "que les côtes sont privées latéralement de noeuds saillants" thus seems to be misleading.

broad, though less so than the latter; this saddle, too, is subdivided by a comparatively short, three-pronged lobule into two bifid stems, the inner one of which is broader than the outer one. The second lateral lobe is situated on the umbilical wall which is unusually high in this species; it is distinctly trifid and is considerably shorter than the first. The second lateral saddle is about half as deep as, and almost four times narrower than, the first and is bifid. There follow up to the umbilical seam the three-pronged first auxiliary lobe, which points slightly ventrad, and the first auxiliary saddle, which is only a little intersected at its top. This suture line is characterized by the fact that its main saddles are very broad and massive at their bases but are richly indented in their upper parts, a feature which is even more pronounced in the present species than in *P. howelli* (see p. 76).

REMARKS.—This species, made by Spath (*loc. cit. in synon.*) the "chef de fil" of his "*evoluta*-group," is characterized by robust, prominent, comparatively sharp and almost straight ribs which end in a tubercle that points upward and slightly inward. The name does not appear to be well chosen, as there are other forms of the same group and of closely related ones which are even more evolute, e.g., Spath's (1932, p. 384, Pl. XLIII, fig. 1) *P. inflata*, var. *aperta*, and the form from Madagascar described by Boule, Lemoine and Thevenin (1907, p. 40, Pl. IX, fig. 7) and renamed *P. montraynaudensis* below (p. 81), U equaling 44 1/2 in the present species, as compared to 47 in *P. inflata*, var. *aperta*, 48 in *P. montraynaudensis*, and 51 1/2 in the variety *gracilis* of the latter species.

Except for the fact that it is remarkably stouter, the example under discussion agrees fairly well with Choffat's holotype. Within the present collection *P. montraynaudensis*, var. *gracilis*, is most closely related to *P. evoluta* and will be compared with it below (p. 81). The present species differs from *P.* cf. *stoliczkai* (see p. 72) in being stouter and more evolute and in having horns which point upward and slightly inward, not upward and outward as in the latter. The suture line of *P. evoluta* resembles that of *P. stoliczkai*, as seen in Stoliczka's (1865, Pl. XXVII) fig. 1c, but in the latter species the outer stem of the external saddle is the broader one, whereas the opposite is true in the form here dealt with. From all the other *Pervinquieriae* described in the present paper *P. evoluta* can readily be distinguished by its costation, as described above.[1]

Pervinquieria montraynaudensis, new name,[2] var. **gracilis,** new variety

Pl. XIII, figs. 4a–c; text fig. 7d

A. M. N. H. No. 25149: one specimen

	Dimensions					
	D	H	H′	W	W′	U
Holotype:	100 mm.	27	24 1/2	23 1/2	28	51 1/2

DESCRIPTION.—A little more than a half of the last whorl of the holotype belongs to the body chamber. The conch is discoidal and very evolute. The inner whorls are considerably, and the outer one but slightly, broader than high. The intercostal section is subelliptic and attains its maximum width a little above the first third of the sides, which converge more decidedly ventrad than dorsad and are gently vaulted. The umbilical shoulder is rounded, and the umbilical wall almost perpendicular, though not high. The latero-ventral shoulder is not pronounced between the ribs, and the venter is comparatively narrow and crowned by a strong low keel. The costal section is much stouter than the intercostal one; its umbilical edge is accentuated by the inner tubercles and the peripheric edge by the high, though blunt external tubercles which point upward and slightly outward and considerably overtop the keel. Moreover, there are two rows of lateral tubercles, one about at the middle of the sides, the other about halfway between the first and the culminating point of the external node.

Except on the last half of the outer whorl the ribs bifurcate regularly at the umbilical tubercles which are very strong and seem to have been developed as spines on the penultimate and antepenultimate volutions. Only two secondary ribs can be seen in the anterior half of the outer whorl, one beginning at the middle, the other at the first third of the sides; all the ribs are single in that part of the conch. Fourteen umbilical tubercles per whorl can be counted in the inner volutions, and fifteen ribs at the periphery of the last half whorl. All the costae are prominent, sharp, triangular in section and much narrower

[1] As to the close resemblance of "*Cechenoceras*" *magnum* van Hoepen, see p. 144.

[2] For "*Schloenbachia* (*Mortoniceras*) *inflata* Sow., forme typique," Boule, Lemoine and Thevenin, 1907, p. 40, Pl. IX, figs. 7, 7a.

than the intercostals, the section of which appears to be semicircular. The four rows of nodes cause the ribs to look somewhat crenulated, and there is, in addition, a fine spiral striation, traceable also across the intercostals.

Some parts only of the last suture line could be examined on the outer whorl, viz., a rather broad, bifid, external saddle, a broad, bifid, first lateral lobe and a bifid first lateral saddle which is much narrower than the external one. This suture line is rather massive on the whole, though comparatively richly indented at its margins. Moreover, the first lateral saddle and the second lateral lobe of a suture line of the penultimate whorl proved to be well preserved (text fig. 7d). The former is broad and deeply intersected by a long three-pronged lobule which points slightly dorsad. The second lateral lobe is distinctly trifid. Even at this early stage the indentation is a comparatively rich one.

REMARKS.—Among all known forms that figured by Boule, Lemoine and Thevenin (1907, Pl. IX, fig. 7) agrees best with the present example in both the degree of evolution and the character of the ornamentation; in that form, strong umbilical tubercles and a regular bifurcation of ribs up to a diameter of almost 100 mm. can be seen also, and the ribs are in both specimens slightly sigmoidal at that size and become less dense in the outer whorl. On the other hand, the Hanha individual is much thinner (W′ = 28, as compared to 40½ in that from the Mont Raynaud), and its keel is less strong and is overtopped by the outer nodes, whereas the latter equal it in height in Lemoine's type. These differences, however, are considered to be merely varietal ones.

The much larger Madagascar form, to which the present specimen is referred as a variety, was believed by its authors to be the typical form of *P. inflata* Sowerby and identified by them with Stoliczka's (1865, p. 49, Pl. XXVII, Pl. XXIX, fig. 2) "Var. I" [= *P. stoliczkai* (Spath), 1922, p. 119, text fig. C] and with the example referred to the latter by Kossmat (1895, p. 185, Pl. XXIII, fig. 2, Pl. XXIV, fig. 1). In the writer's opinion, however, the form from the Mont Raynaud cannot be referred to these Indian types which are more involute and not so coarsely sculptured on their inner whorls. Spath mentioned the Madagascar form in 1921a (p. 284), comparing it with his "*Subschloenbachia*" *prerostrata* and with *P. stoliczkai*, but he has never discussed it more explicitly and did not include it in the synonymy of the true *P. inflata* (1932, pp. 381–383). The writer considers it to be entirely different from the typical form of Sowerby's species and in consequence had to give it a new specific name.

Within the present collection *P. evoluta* is most similar to the variety under discussion which is much more slender and more evolute; moreover, its costation is less dense and slightly more sigmoidal; its inner tubercles are stronger and even spinous on the inner whorls, and its ribs bifurcate regularly up to the beginning of the body chamber. As far as the other *Pervinquieriae* of this collection need comparison with it they will be compared below.

It may be added that the spinous development on the inner whorls of the umbilical tubercles seems to be an (atavistic) *Neokentroceras*-feature.

Pervinquieria simplex (Choffat),[1] var. **tenuis,** new variety

Pl. XVI, figs. 1a–c; text figs. 7e, 8a

A. M. N. H. No. 25150: one specimen

DESCRIPTION.—The preserved half of the outer whorl is unseptate; to judge by the fading of the costation on its anterior end, the aperture cannot have been far removed.

The conch is very slender and fully evolute. The intercostal section is oval; the sides are most distant from each other at the inner third and decidedly converge from there toward the narrow gable-shaped venter; the median keel seems to become sharper toward the aperture.

	DIMENSIONS					
	D	H	H′	W	W′	U
Holotype:	ca. 170 mm.	ca. 24	?	ca. 14	ca. 15	53½

Both the inner and outer shoulders are rounded. The costal section is subtrapezoidal, the upper corners of the trapezoid being accentuated by the external tubercles; the sides are, however, distinctly vaulted and, owing to the lateral tubercles, are almost as prominent at their outer third as at the inner one (text fig. 8a).

There must have been twenty-one or twenty-

[1] 1905, p. 35, Pl. IV, fig. 3.

two ribs on the anterior half of the last whorl; all of them are single, narrow and prominent. They are, as a rule, almost straight, though occasionally they form a flat, orad convex arc across the sides. An exceptional, almost imperceptible swelling of the umbilical ends of the costae is all that remains of the inner tubercles, but on all the ribs there are more or less distinct prominences at about the second third of the sides and also pronounced, horn-like outer tubercles, which point sideways and slightly upward in sectional view and outward and slightly backward in ventral one. At the rear end of the preserved part of the outer volution, they slightly overtop the keel, whereas the latter has become remarkably higher than the horns near the aperture. The costation is gradually fading on the anterior part of this whorl; the last rib is extremely weak and is followed by a space equaling from two to three intercostals in width which lacks all ribbing. No spiral striation can be seen; instead, distinct radial growth striae can be observed in the intercostals running parallel to the ribs.

The ornamentation of the penultimate whorl is but indistinctly visible. The total number of costae seems to be about the same as on the last whorl, and the ribbing appears, in consequence, to have been more dense; moreover, it seems to have been a little less stiff than on the outer volution. Also there may have been more lateral tubercles, but the state of preservation does not permit any definite statement.

A suture line of the penultimate whorl could be studied fairly well, except for the siphonal lobe (text fig. 7e). The external saddle is unusually slender and intersected by a three-pronged lobule, its outer stem being higher than the inner one. The first lateral lobe is broad and bifid; its two branchlets are separated from each other by an extraordinarily stout and high leaflet. The first lateral saddle is about as high as the external one and even more slender; it is but slightly intersected at its top by a short lobule. The second lateral lobe attains only about a third of the length of the first; it is broad, trifid and strongly points ventrad. There follow on the umbilical wall a remarkably broad, low, second lateral saddle, with two short intersections at its top, and the outer part of a slender auxiliary lobe which appears to be three-pronged.

REMARKS.—This specimen perfectly agrees with Choffat's holotype of the species in the degree of involution, in the ventrad tapering of its section and in its ribbing. That author's remark that the external tubercle "ne forme pas de forte saillie latérale" is interpreted by the writer in the sense that the "horns" do not stand out laterally to a high degree, and he does not hesitate, therefore, to refer both forms to the same species. The only difference seems to be that the section of Choffat's type is "subcarrée," whereas that of the present example is decidedly slim. In consequence, the latter has been separated from Choffat's species as its variety *tenuis*.

Spath recently[1] established the subgenus "*Angolaites*" for the section of *Pervinquieria* named the "*simplex*-group" in his Angola paper (1922, pp. 103, 127), but to the writer this subgenus appears to be superfluous, for the reasons specified above (pp. 5 and 67, respectively).

Within this collection the form under examination is so well characterized by its compressed evolute conch and by its single ribs that there is need for hardly any comparison with other species. It may be pointed out that *P. proteus* exhibits the same peculiar "clinging" of the horns to the peripheric edges, but otherwise it is entirely different owing to its more robust shape and sculpture. *P. vicina* will be compared below.

Pervinquieria vicina, new name

(A) **forma typica**

Pl. XVI, figs. 2a, b; text fig. 8b

A. M. N. H. No. 25151: two specimens

Inflaticeras sp. n. ? aff. *gregoryi* SPATH, 1922, p. 127, Pl. III, fig. 2.

DIMENSIONS

Spec. No.	D	H[2]	H′	W	W′	U
1	ca. 93 mm.	32	30?	26½	29	47

DESCRIPTION.—Less than a third of the outer whorl of specimen No. 1 belongs to the body chamber which, in addition to being non-septate, is recognizable by the fading of the costation.

As in *P. gregoryi*, considered by Spath to be the form that is most closely related to the present species, the section attains its maximum width a little below the middle of the sides; the umbilical edge is rounded and the umbilical wall almost perpendicular. On the other hand, the gently rounded sides converge toward the venter which is slightly truncate and crowned by a rather strong keel.

There are seventeen ribs per half whorl (as compared to nineteen in Spath's side

[1] 1932, p. 380; see also p. 429.

[2] This ratio and the following ones measured at D = 86 mm.

view); all are single, strong, straight or slightly sigmoidal and widen ventrad. In the preserved part of the outer whorl no umbilical tubercles are visible, but there are more or less distinct lateral ones at about the second third of the sides; they are, however, never so strongly developed as in Spath's sectional diagram (fig. 2c). The external tubercles, however, are prominent. In ventral view they trend as a rule exactly perpendicularly toward the keel; only on the last quarter of the outer whorl do they turn obliquely forward. They stop at a little distance from the keel which they equal or slightly exceed in height. On the lateral nodes there are but faint traces of spiral ridges, but on the external ones they are more distinct; here, preservation permitting, six ridges can be counted. On the anterior part of the outer volution the ribbing fades rather suddenly; the costae are replaced by dense, flat, decidedly sigmoidal and prorsiradiate folds.

A small part only of a suture line could be traced in the penultimate whorl; it exhibits a rather broad, two-pronged, first lateral lobe; the adjacent first lateral saddle, which is bifid as usual, seems to be slightly lower than the external one.

Another, very poorly preserved, specimen (No. 2) may be conspecific with the first and also has been referred, though with doubt, to this species.

(B) var. **evoluta**, new variety

Pl. XVI, figs. 3a–c; text fig. 8c

A. M. N. H. No. 25152: one specimen

	DIMENSIONS					
	D	H[1]	H′	W	W′	U
Holotype:	ca. 90 mm.	27½	?	22	25	53½

DESCRIPTION.—The single specimen which seems to be almost fully septate deviates from the typical *P. vicina* by being considerably more evolute and slender. Moreover, the umbilical wall is less steep and the keel, which is triangular in section, somewhat sharper.

As to costation, there are fewer ribs (sixteen instead of seventeen per half whorl), bearing up to the last quarter of the outer whorl distinct, radially elongated umbilical tubercles. The lateral tubercles stand out further than on the *forma typica*, thus causing the sectional outline to be similar to that delineated in Spath's (1922, Pl. III) fig. 2c, and are more horn-like than on the former. In sectional view they point outward. No traces of spiral ornamentation could be found even in the well preserved parts of the surface.

No suture lines could be traced without damaging the single example by removing its shell.

REMARKS (AD *P. vicina*, SENSU LATO).—Spath (1922) stated that without examination of the inner whorls it could not be decided whether or not his *Inflaticeras gregoryi* (*ibid.*, p. 127, Pl. III, fig. 1) and his *Inflaticeras* sp. n.? aff. *gregoryi* were conspecific. But in the writer's opinion the differences in their ornamentation even in

[1] This ratio and the following ones measured at D = 86 mm.

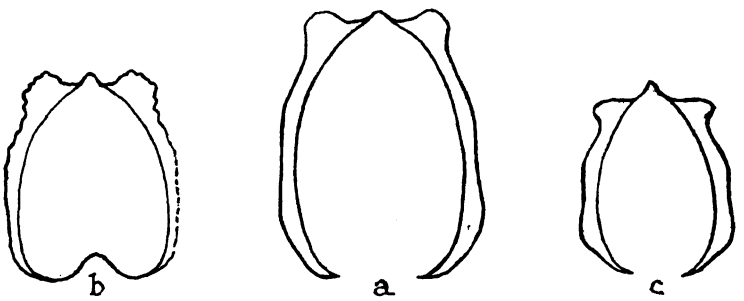

Fig. 8. Costal and intercostal sections of *Pervinquieria*.
(a) *P. simplex* (Choffat), var. *tenuis*, new variety, holotype, A.M.N.H. No. 25150.
(b) *P. vicina*, new name, A.M.N.H. No. 25151:1.
(c) *P. vicina*, new name, var. *evoluta*, new variety, holotype, A.M.N.H. No. 25152.
All natural size.

maturity justify the separation of the latter as an independent species, and the specimen figured and described by Spath (*loc. cit. in synon.*) is here considered as its holotype. The ribs of the true *P. gregoryi* are on the outer volution broad and fold-like; those of the new species are narrower and apparently more prominent. To the latter specimen No. 1 of the *forma typica* discussed above may well be referred, as it agrees fairly well with it, except for being slightly more evolute and for its less prominent lateral tubercles; also the various differences by which the variety *evoluta* is distinguished from the typical form, as enumerated above, would not justify its specific separation.

On the other hand, the variety *evoluta* shows exactly the same degree of evolution as *P. simplex* Choffat; the latter can, however, readily be distinguished from both that variety and from the typical *P. vicina* by its rather sharp and narrower ribs. The variety *tenuis* of *P. simplex* is, also, considerably more slender.

P. proteus differs from *P. vicina* by its more robust conch; and, moreover, its ornamentation has at the same diameter (of about 90 mm.) a quite different character, being similar to that of *P. howelli.*

It may be added that with *P. gregoryi P. vicina* belongs to the *simplex*-group of the genus *Pervinquieria* (= *Angolaites* Spath).

Pervinquieria bassleri[1] Haas

Pl. XIII, figs. 5a–e; Pl. XV, figs. 2a–d

A. M. N. H. No. 25153: five specimens

Pervinquieria bassleri, HAAS, 1942b, pp. 645, 648, Pl. XCIV, figs. 2a, b.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
4	10.2 mm.	39	?	?	46	36½
Holotype: 1	(a) 30.5 mm.	33	31	42½	46	41
	(b) 43.0 mm.	30	29	40½	45½	46½

DESCRIPTION.—The holotype seems to be almost complete; its last septum could be located at a diameter of about 30 mm. If its front end is, as it seems, near the aperture, the length of the body chamber was a little less than three-quarters of a volution. As seen in the above table, the degree of involution decreases in the course of development.

Another specimen (No. 2), which attains only 18.5 mm. in diameter, seems to be entirely septate, but as it was recovered from a piece of very soft matrix it was not possible to restore it properly, and exact measurements are not feasible. Another poorly preserved fragment (No. 5) belongs to a conch of about the same size. A still smaller nucleus (No. 4) could, however, be measured (see above). There is, in addition, about half an unseptate whorl (No. 3) which seems to be conspecific with these individuals.

The conch of the holotype is wheel-shaped and almost fully evolute in maturity. The whorl section is transversely rectangular, always considerably wider than high, with the W′:H ratio gradually increasing in the course of growth. Both the sides and the venter are flat, and both the umbilical and the latero-ventral edges are pronounced, though rounded; the umbilical wall, particularly during the earlier stages, is high and steep, though not perpendicular. The sides are almost parallel at the beginning of the body chamber, but there is a slight ventrad convergence at the anterior end which causes the section to appear to be trapezoidal rather than rectangular. The venter is crowned by a strong keel which is accompanied on both its sides by distinct, rather broad furrows.

Except for the smaller degree of depression of the whorl, almost the same section is found also in specimens Nos. 2 and 4 at diameters of 11.5 mm. and 10 mm., respectively.

The ornamentation consists of ribs which are, as a rule, single on the last one and a half whorls of the holotype and even on the last quarter whorl of the small specimen No. 2. Occasional bifurcation of ribs

[1] Named in honor of Dr. Ray S. Bassler, Head Curator of Geology, U. S. National Museum, and Professor of Geology, George Washington University, Washington, D. C.

occurs, not only on the innermost, but once in a while also on the outermost zone of the sides.[1] Sometimes there are intercalated secondary ribs which begin at some distance from the umbilical edge. The ribs are strong and prominent throughout development, especially on the body chamber. Up to a diameter of about 10 mm. they run radially across the sides, forming a shallow, orad concave arc. Then rather suddenly they become sharp and irregular, turning, here and there, abruptly backward at the umbilical shoulder. At a later stage, as observed in the holotype, the costae are decidedly bent backward, this feature becoming more and more pronounced toward the aperture, and they pass across the sides in a flat, orad convex arc. They always cross the latero-ventral edge and continue on the venter without losing strength and prominence. Here they trend, as a rule, strictly perpendicularly toward the keel. At diameters between 12 and 18 mm., however, the costation also becomes irregular on the venter, where, in three individuals examined (specimens Nos. 1, 2 and 5), the ribs suddenly begin to turn decidedly forward or even backward; and in specimen No. 2 they also become peculiarly curved. These are features which are even more strikingly developed in *P. ferecostata*. In both species they seem to coincide with a dissymmetry of the conch which is (e.g., in specimen No. 2) at that stage much stouter and much more vaulted on its right side than on the left. In specimen No. 5 the ventral costation itself becomes most dissymmetric at one place; here the ribs at the right of the keel are turned slightly backward, whereas those at its left, which are also thinner and a little more numerous, trend sharply forward. The ribs always stop at the furrows accompanying the keel. On specimen No. 2 and on the inner whorls of the holotype their position is, as seen in ventral view, symmetrical on both sides. On the body chamber of the latter, however, it becomes dissymmetric. There are from thirty-four to thirty-six ribs per whorl.

[1] Up to a diameter of about 10 mm., however, bifurcation seems to occur regularly near the umbilical shoulder, as seen in specimen No. 2.

At the earlier ontogenetic stages only indistinct umbilical tubercles can be seen, but they become more prominent on the body chamber. They are, of course, missing on the secondary ribs. In addition there are external tubercles at the latero-ventral edge which point upward in sectional view. Occasionally one or two lateral protuberances can be observed, but no regularity can be observed as to their arrangement such as may be seen, for example, in the section of *P. depressa* (Spath) (1922, p. 114, text fig. B, 2). The anterior ribs on the right side of the holotype show in section (Pl. xv, fig. 2b) six prominences including the external tubercle, three hardly perceptible nodes on, and immediately beneath, the latero-ventral shoulder, a very flat lateral node at about the first third of the sides and, finally, a distinct umbilical tubercle. It may be that the minor prominences seen here are but reinforced spiral ridges, for a very fine spiral striation can be found, preservation permitting, throughout the ribs on the body chamber of the holotype. It is best visible where remnants of the shell are preserved; on these about ten spiral ridges can be counted on each rib.

One of the last suture lines of the holotype could be studied, though it is too poor for delineation. There are: a rather broad siphonal lobe, ending in two strongly diverging points which are separated from each other by a low median knob which rides just on the keel; a broad, bifid external saddle, intersected by a moderately long three-pronged lobule; a first lateral lobe, which is considerably shorter than the siphonal one, with two strong terminal points and two lateral ones somewhat above them; a bifid, comparatively slender first lateral saddle; a triangular, three-pronged second lateral lobe which is considerably shorter than the first; a second lateral saddle reaching with its inner part beyond the umbilical edge; and, on the umbilical wall, the first auxiliary lobe, a low auxiliary saddle, slightly intersected at its top, and a second auxiliary lobe which seems to be trifid.

REMARKS.—To judge by the apparently mature holotype, this species must be con-

sidered to be one of the most specialized forms of the genus *Pervinquieria* (*sensu lato*). Furthermore, it seems to be the most *Arietites*-like of all the hitherto known *Pervinquieriae*, much more so than the species named *arietiformis* by Spath (see p. 90). In its strongly depressed section it closely approaches *P. depressa* Spath (1922, p. 114, text fig. B, 2), and it may, therefore, also be included in this author's *perinflata*-group for which he later (1932, p. 380; 1933, p. 429) proposed the subgenus *Durnovarites* (subgenotype: *P. subquadrata*). *P. depressa* can, however, readily be distinguished from *P. bassleri* by its more rounded sigmoidal ribs, each provided with four tubercles, whereas no such regularity as to tubercles can be found in the present species. *P. recticostata* (Spath, 1925, p. 184, Pl. XXVIII, figs. 2, 3, 5–7) from Portuguese East Africa is perhaps even more similar to the latter than is *P. depressa*, since in that form also the "ribs meet the keel at right angles, without the slightest forward projection," ventral views of both species are very similar. The East African form, however, has decidedly rectiradiate ribs which are less sharp and a little less numerous, and, furthermore, the conch is more slender.

Detailed comparisons with the other *Pervinquieriae* of the present collection, except *P. ferecostata* and *P.*, indeterminate new species No. 1, which will be compared below, do not seem to be necessary since the present species differs from them by the extremely depressed section of its whorls, by its evolute conch and by its peculiar costation.

There is, however, considerable convergence between the inner whorls of this species and those of *Dipoloceras symmetricum*, var. *obesa* (see p. 18). This is caused chiefly by the almost straight course of the costae on both the sides and the venter. They can readily be distinguished from those of the latter variety since they are more evolute and particularly since they have more pronounced peripheric shoulders, a broader venter and much wider furrows between the keel and the outer ends of the ribs.

Pervinquieria ferecostata, new species

Pl. XVII, figs. 1a–c, 2a, b; text fig. 9a

A. M. N. H. No. 25154: two specimens

DESCRIPTION.—The holotype, consisting of about half a disc, is badly crushed and distorted, and the above measurements cannot, therefore, be depended upon. The front part of the outer whorl belongs to the body chamber. There is, in addition, a small example (No. 2) which also consists of about half a disc; it cannot be stated with certainty whether or not it is septate throughout.

The conch of the holotype is very dissymmetrical, its right half being thicker than the left one. The venter is seen to be broad and almost flat, and the sides, too, seem to have been rather flat, while the umbilical wall must have been comparatively high. The same features of the section can be found even more distinctly developed in specimen No. 2, for despite the smallness of that specimen, it exhibits neatly rectangular peripheric shoulders and a broad flat venter which is crowned by a strong sharp keel; the latter is accompanied by two shallow furrows.

The ornamentation of this example is comparatively neat and regular. There are sixteen ribs per half whorl. On the sides they are prominent, almost straight, and more or less radial; they regularly bifurcate at the moderately sharp, radially elongated, circumumbilical tubercles and are separated from each other by deep, furrow-like intercostals. On the venter they continue as far as the furrows accompanying the keel, running toward the latter first obliquely forward, then perpendicularly and soon afterward slightly backward; at that last stage, they become strangely curved on the venter and somewhat dissymmetrical on both its sides (Pl. XVII, fig. 2b).

About the same type of costation is also found at the posterior end of the holotype, except for the fact that the ribs have become, on the whole, decidedly rursiradiate. Soon afterward, however, the sculpture becomes extremely coarse and irregular. There are, at the periphery, eighteen prominent, strong and sharp ribs per half whorl. All of them trend radially in the inner third of the sides but trend decidedly backward in their outer zone. There are umbilical and external tubercles; the former are most

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
2	19.2 mm.	42½	?	ca. 36[1]	43½[1]	33½
Holotype: 1	49.5 mm.	40½	?	31½	38½	37½

[1] Measured at D = 16.7 mm.

pronounced on the anterior part of the present half whorl, and the latter, which are strong and sharp, accentuate the latero-ventral edge. Moreover, occasionally there seem to be lateral tubercles also. The irregularity of sculpture outlined above is also remarkable with regard to the position of the tubercles. The umbilical ones are at times shifted ventrad as far as the first third of the sides, and the lateral ones may coalesce with the peripheric ones so that the latter seem to expand down to the second third of the sides. The ribs may either bifurcate at the inner tubercles, or secondary ribs may be intercalated at the first third or at the middle of the sides. On the venter the costae continue almost up to the keel which gradually becomes thin and low on the body chamber. On the posterior part of the holotype the ribs run perpendicularly toward the keel or they may even be curved slightly backward on the venter, whereas on the body chamber they again turn more and more forward, running in a shallow, orad concave arc as far as the rudimentary keel whose accompanying furrows have, meanwhile, entirely disappeared (Pl. XVII, fig. 1c). In this part of the conch three to four spiral ridges can distinctly be seen on the peripheric continuations of the ribs; much weaker ones may have been present also on their lateral parts.

No suture lines could be examined.

By way of an appendix to this species one specimen transitional between *P. bassleri* and *P. ferecostata* (A. M. N. H. No. 25155, Pl. XVII, figs. 3a, b), consisting of about half a whorl and seemingly septate throughout, may be dealt with.

	Dimensions				
D	H	H′	W	W′	U
Ca. 17 mm.	37½	?	?	49	38

Description.—As may be seen from these figures, it is intermediate between both species in its dimensions and particularly in the degree of involution, in the width of the umbilicus and in the height of the whorls. In the thickness of the whorls it agrees better with *P. bassleri*, in the number of ribs (about sixteen per half whorl) better with the young of *P. ferecostata;* otherwise its costation is very similar to that of the smaller examples of both species, except that at diameters from 12 to 17 mm. bifurcation occurs only occasionally. The aspect of the ventral ribbing resembles that of *P. bassleri*, the outer ends of the ribs trending first perpendicularly, then with a slight forward turn toward the keel. In addition there is a peculiarity of ornamentation which is only occasionally slightly indicated in the individuals of the two above mentioned species but which is much more distinctly visible on the present transitional specimen. In several places on both sides of the conch two ribs coalesce, thus forming flat protuberances superimposed on the middle part of the sides.[1] (Such protuberances account for the remarkably high amount of W′ in the above table.)

No suture lines could be traced.

Remarks (ad *P. ferecostata*).—Within the present collection this curious form is without doubt most closely related to *P. bassleri*. Both have in common the strength and the peculiar backward bending of the ribs, which continue uninter-

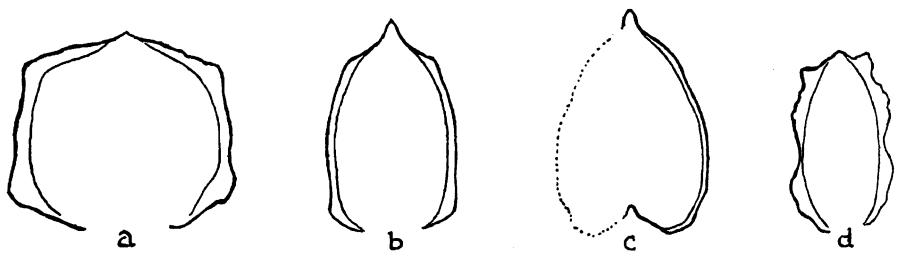

Fig. 9. Costal and intercostal sections of *Pervinquieria*.
(a) *P. ferecostata*, new species, holotype, A.M.N.H. No. 25154:1, × 3/2.
(b) *P. arietiformis* (Spath), var. *lēvicostata* Haas, holotype, A.M.N.H. No. 25159, × 1/2.
(c) *P. arietiformis* (Spath), var. *elegans*, new variety, holotype, A.M.N.H. No. 25160, × 1/2.
(d) *P.* (?), indeterminate new species No. 2, A.M.N.H. No. 25162, × 3.

[1] Cf. Stieler, 1922b, pp. 300–320 ("ausgezeichnete Rippen").

ruptedly beyond the external shoulder, and the truncate and broad venter. The irregularity of costation on the latter, which is so remarkable in *P. ferecostata*, is also indicated in *P. bassleri*. At first the writer was in some doubt as to whether the striking coarseness and irregularity of the sculpture of the former, together with the remarkable dissymmetry of the conch, might not be due to a pathological condition. Later, however, small individuals of both species were found which differed from each other in exactly the same way as the adults; thus these differences seem to be of specific importance. They also go too far to be considered as being of merely varietal significance. The ornamentation is comparatively regular, though strong, in *P. bassleri*, whereas it becomes extremely irregular and coarse on the body chamber of *P. ferecostata*. The keel is quite persistent and always separated by rather deep broad furrows from the external ends of the ribs in the former species, whereas it almost fades and is nearly reached by the ventral continuations of the costae in the latter. Throughout development, *P. ferecostata* is also much less evolute than *P. bassleri*, and its whorls are considerably less stout. Thus it seemed advisable to separate the former as an independent species in spite of the presence of the clearly transitional individual described above.

On the other hand, *P. ferecostata* shows also some affinity to *P. spathi* (Haughton, 1924, p. 91, Pl. I, figs. 6–8), which also exhibits a coarse costation, a flat venter and, in ventral view, the characteristic indentation of the peripheric shoulder as seen in that author's fig. 8. The examples here dealt with, however, considerably differ from Haughton's form in the coarseness and irregularity of their ornamentation and in their wider section.

P. spathi has been considered to be of extreme importance by Thiele (1933, espec. p. 116) from both stratigraphical and palaeontological-phylogenetic points of view. To the writer, however, it appears to be simply another one of the almost innumerable types produced by the inexhaustible variability of the group of *Ammonites inflatus*, perhaps a rather degenerate one, represented by one corroded cast measuring 33 mm. in diameter. It seems as if that author might have reached quite different conclusions had he dealt with all the problems involved after, instead of before, he had worked out his Angola material in detail. His conclusions have already been declined by Spath (1934, pp. 473, 494; 1934b, p. 201).

P., indeterminate species No. 1, will be compared below (p. 89). From all the other *Pervinquieriae* of the present collection *P. ferecostata* is easily distinguishable by the coarseness and irregularity of its costation. There is a superficial resemblance to the inner whorls of *Elobiceras hexagonum* which will be discussed in the remarks on the latter (p. 119). Finally, it may be added that flaring ribs such as are found in *P. ferecostata* and, still more distinctly, in the transitional specimen described above occur more frequently in some species of *Dipoloceras*.[1] In fact, the transitional specimen can be distinguished from some individuals of about the same size of *Dipoloceras rectangulare* (see p. 14) only by its stouter, more evolute conch and by its broader, less sinuous ribs.

Pervinquieria, indeterminate species No. 1

Pl. XVII, figs. 4a–d, 5

A. M. N. H. No. 25156: three specimens

"*Pervinquieria* nova spec. indet. No. 1," HAAS, 1942b, Pl. XCIII, figs. 4a, b.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1	36 mm.	34½	ca. 30½	32	41½	39

DESCRIPTION.—About one-half of the outer whorl of the only complete specimen (No. 1, Pl. XVII, fig. 4) seems to belong to the body chamber. Its conch is rather evolute and the impressed zone very shallow. The intercostal section is almost quadratic, the sides being rather flat, both the umbilical and the latero-ventral edges rounded-rectangular, the umbilical wall rather high, though not too steep, and the venter truncate, carrying a strong keel ac-

[1] See footnote 1, on preceding page.

companied by two comparatively broad shallow furrows.

There are sixteen broad strong ribs on the last half whorl which run nearly straight across the sides. They bifurcate almost regularly at the strong, sharp, umbilical tubercles. The latter become very prominent on the body chamber, thus accounting for the great difference between W and W′ in the above table. The costae widen ventrad and swell at the peripheric shoulder, though without forming pronounced tubercles; beyond that edge, they continue on the venter, running almost perpendicularly or with a slight forward projection toward the keel, from which they remain neatly separated by the furrows. No lateral tubercles can be seen. Here and there faint traces of spiral ornament can be found.

Only some details of suture lines can be traced, particularly the bottom of a rather broad, distinctly two-pronged, first lateral lobe; to judge by its position, the external saddle must be very broad. However, no continuous suture line could be found which was adequate for delineation.

A little fragment (No. 2, Pl. XVII, fig. 5) seems to exhibit the ventral part of an inner whorl of this form and another small whorl fragment (No. 3) is also, though doubtfully, referred to this species.

REMARKS.—Within the present collection this form (which does seem to be an adult one) is most closely related to *P. bassleri*, but it is a little more involute and much less stout; it has fewer, broader and blunter ribs and more pronounced umbilical, no lateral and weaker external tubercles. Also the spiral ornamentation is still less distinct than in *P. bassleri*. From *P. ferecostata* the present species can readily be distinguished by its regular costation, its less truncate venter and its persistent keel.

This form hardly needs comparison with any other *Pervinquieria* from Angola, but it closely resembles, particularly in side view, the specimen from the Upper Albian of Portuguese East Africa which was described and figured by Spath (1925b, p. 184, Pl. XXVIII, fig. 7) as being transitional between *P. recticostata* and *P. haughtoni;* the latter is, however, considerably thicker, more evolute and has broader ribs and apparently less pronounced umbilical tubercles. The typical *P. recticostata* (Spath) (1925b, p. 184, Pl. XXVIII, figs. 2, 3, 5–7) is stouter than the Angola examples and has a coarser, less regular ribbing, but the fragment from the Upper Albian of Zululand referred to Spath's species by Venzo (1936, p. 96, Pl. VII, fig. 7, Pl. XI, fig. 6) is, in its general habitus, very similar to the present form, from which it differs merely by a more trapezoidal section and a slightly less dense costation.

Spath (*loc. cit.*) has drawn attention to the striking similarity between *P. recticostata* and *Hysteroceras choffati* Spath (see p. 29, *cum synon.*). The present form also very much resembles some *Hysteroceras;* specimen No. 1 is in side view hardly distinguishable from the example of *H. orbignyi* from the Perte du Rhône depicted in Spath's (1934, p. 485) text figs. 167b, c. Except for the much wider umbilicus of the latter, both individuals seem to agree in every detail, especially as far as the ornamentation is concerned. This similarity is, however, due merely to convergence, as the present form retains its strong keel to its front end without any tendency toward fading, and the outer ends of the ribs are always neatly separated by distinct, though shallow furrows from the keel, whereas the latter is lost and the ribs tend to coalesce across the venter on the outer whorl of the Perte du Rhône example.

Within the genus *Pervinquieria* (*sensu lato*) this form might belong to the *cantabrigensis*-group for which Spath recently (1932, p. 380; 1933, p. 436) created the subgeneric name *Cantabrigites*. Of the species referred by him to this subgenus that which most closely resembles the form under discussion is *P. minor* (Spath, 1933, p. 440, text fig. 152, Pl. IV, figs. 1, 2, Pl. XLIII, fig. 4, Pl. XLIV, fig. 2, Pl. XLVI, fig. 11). However, it can readily be distinguished by its wider umbilicus, its coarser ribbing and especially by its more prominent external tubercles and by the presence of three lateral ones.

Pervinquieria arietiformis (Spath)

(A) **forma typica**

Pl. XVIII, figs. 1–4; Pl. XIX, figs. 1, 2; Pl. XX, figs. 1, 2; Pl. XXII, figs. 2–7

A. M. N. H. No. 25157: twelve specimens

Schloenbachia cf. *lenzi*, Szajnocha; CHOFFAT, 1888, p. 65, Pl. I, fig. 6.

Schloenbachia sp., CHOFFAT, 1905, p. 34.

Elobiceras arietiforme SPATH, 1922, p. 137, Pl. II, fig. 6.

Elobiceras arietiforme Spath; AIRAGHI, 1931, p. 850, Pl. II, fig. 4.

Elobiceras ? arietiforme, SPATH, 1933, p. 418.

rather broad venter are almost flat. The latero-ventral edges, which become more and more accentuated by the external nodes, are pronounced up to a diameter of about 110 mm. Meanwhile the sides, which are most distant from each other at or immediately above the umbilical shoulder, have begun to converge ventrad. The section at that stage (specimen No. 4, D = 100 mm.) is depicted in Pl. XVIII, fig. 3c. Later the venter gradually assumes

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1	63.5 mm.	38	33	23 1/2?	29 1/2	36
2	72.5 mm.	39 1/2	36	25	30	37
3	120.0 mm.	35 1/2	33	17 1/2?	21 1/2	38
4	135.0 mm.	37	33 1/2	20	22	37 1/2
5	ca. 270.0 mm.	26 1/2	23 1/2	18	20	48
6	ca. 310.0 mm.	26 1/2	ca. 24 1/2	16 1/2	19 1/2	49

DESCRIPTION.—Five of the twelve specimens show the last septum at diameters of from 180 to 250 mm.; none of them is, however, preserved up to the aperture. The body chamber must have been half a whorl in length or may have been even longer. Therefore, fully adult individuals must have attained at least 350 mm. in diameter.

The degree of involution first increases up to a diameter of the conch of about 80 mm., then gradually decreases; thus the largest individuals exhibit the widest umbilicus. Also the width of the whorls first increases, then decreases during the course of growth. At the earliest stage, examined in specimen No. 2, W′ is about four-fifths of H at a diameter of 17 mm. (Pl. XVIII, fig. 2d), but at a diameter of about 20 mm. (same specimen) it slightly exceeds H. At a diameter of about 30 mm., however, the whorl is again higher than wide, and eventually the conch becomes slender in the adults (see the above table).

At the earliest stages the section is first rectangular, then for a short period almost quadratic; subsequently, the intercostal section becomes elliptic, and the costal one, owing to the strong development of the umbilical tubercles, trapezoidal with rounded corners (Pl. XVIII, figs. 2b, c, 3a–c, 4c; Pl. XIX, figs. 1b, c; Pl. XX, figs. 1, 2). Throughout these stages the sides and the roof shape, and on the body chamber it becomes more and more fastigate and the sides more and more rounded until eventually the intercostal section has become lancetiform and the costal one inverted heart-shaped, though still exhibiting latero-ventral edges produced by the external knobs of the ribs (Pl. XIX, figs. 1b, c; Pl. XX, fig. 1; cf. Choffat, 1888, fig. 6b). The keel is triangular in section, high and sharp, and even at the earliest ontogenetic stages there are no furrows accompanying it; in maturity it is no longer distinctly separated from the sharpened venter.

The sculpture also undergoes thorough changes in the course of its development. At the earliest stage which could be examined (specimen No. 2 at diameters from 7 to 17 mm.) the ribs are broad and blunt, and there are fourteen of them per half whorl. They slightly swell at the latero-ventral edge without forming a prominent tubercle and continue on the venter almost perpendicularly toward the keel which they almost reach, though remaining neatly separated from it. The ornamentation of the inner zone of that whorl could not be examined.

In the further course of growth (same specimen, diameters from 20 to 75 mm.) the costae become gradually narrower and sharper and trend more and more forward on the venter, ending at the base of the

keel. Up to a diameter of about 150 mm. the costae either regularly bifurcate at the umbilical tubercles, which are at first small and pointed and become later prominent and radially elongated, or secondary ribs, beginning at the inner third of the sides and lacking the umbilical tubercles, are intercalated between the primary ones. At the later ontogenetic stages this differentiation of primary and secondary ribs becomes less regular and entirely disappears at a diameter of about 220 mm. During the earlier stage the ribs are comparatively dense and rather stiff, though at first more or less distinctly sigmoidal. From a diameter of 120–150 mm. on they become again broader and blunter, crossing the sides in a flat, orad concave arc. On the body chamber they become quite uniform, very blunt, almost straight and are much more distant from each other than at the earlier stages.

The costae always carry external nodes which are most prominent between the diameters of 40 and 110 mm. and later gradually become more blunt. Toward and particularly on the body chamber, they form broad rounded knobs at the peripheral edges and then, though reduced to flat folds, continue obliquely forward toward the keel; these folds gradually disappear during the last ontogenetic stage. Lateral nodes, as mentioned by Airaghi (*loc. cit. in synon.*), occur only occasionally as slight protuberances on the middle of the sides, causing the outer zone of the sides to appear slightly concave between the external and lateral nodes. Even in very well preserved individuals, spiral ridges can only occasionally be observed on the ribs, and they seem to withdraw to the outer nodes in the course of growth. On none of the specimens could they be observed at any diameter exceeding 200 mm.

From a diameter of about 40 mm. on there are at the periphery from forty-two to forty-six, occasionally only thirty-eight to forty-two ribs per whorl. Although the costation appears to be much less dense on the outer whorls of the large discs, the total number of ribs proves to be here, if at all, but slightly smaller than on the penultimate ones.

Suture lines, some of them excellently preserved, could be studied in most of the individuals of this species at diameters from 13.6 to 220 mm. Figures 2a, b, 4a, b, 3, 7, 6 and 5a, b (Pl. XXII) show the suture lines, or parts of them, of specimens Nos. 2, 8, 4, 12, 9 and 6, respectively; in three of them (Nos. 2, 8 and 4; figs. 2b, 4a, 3) the internal suture lines could be depicted also.

All these suture lines exhibit a higher degree of indentation than those of the *Pervinquieriae* hitherto discussed in this paper; the saddles are not so sturdy as in the former, but are tall and much more straitened near their bases, and the lobes, too, are longer and more ramified. Thus this species proves to be, also in its sutural characters, transitional between the more typical *Pervinquieriae* and the next genus, *Elobiceras*.

Two types of suture lines can be distinguished in this species. In the majority of individuals (including Nos. 2, 8, 4 and 6) the first lateral lobes are bifid and the second ones trifid, as is the rule not only in this genus but also in all the related genera discussed in this part of the present paper; in two examples (Nos. 12 and 9), however, the first lateral lobes are trifid and the second ones bifid.[1] Occasionally indications of transitions between these two sutural types can be found, particularly at earlier ontogenetic stages.

The siphonal lobe is always narrow. The amount of the divergence of its long sharp terminal points decreases with the increase of the diameter of the disc, and in the largest suture line examined (specimen No. 6, fig. 5b, D = 220 mm.) they are almost vertical and parallel to each other, as in the typical *Elobiceras*. The strongest lateral branchlets of this lobe occur at about half its depth. These branchlets deeply intersect the external saddles at their ventral borders and each ends in a long three-pronged point. The external saddle is but moderately broad and is subdivided by a

[1] To judge by his figure, Airaghi's (*loc. cit. in synon.*) specimen seems to belong to the second sutural type.

large trifid lobule, the three branchlets of which are also three-pronged; both main stems of this saddle are bifid on their parts; the outer one is inclined toward the median line and is lower than the inner one; this difference in height increases in the course of development. The best examples of bifid first lateral lobes are seen in figs. 4b (specimen No. 8) and 5a (specimen No. 6); the best example of a trifid one is seen in fig. 7 (specimen No. 12). In both types of these lobes all the terminal points are, as a rule, three-pronged, and two pairs of lateral branchlets are present, the lower ones of which most deeply intersect the adjacent saddles. The first lateral saddle is as high as, or just a little lower and not much narrower than, the external one and is also deeply intersected by a three-pronged lobule; its two main stems are each bifid; the inner one seems to be higher than the outer one. It may be worth noting that this saddle becomes taller and more slender in the course of development (cf. figs. 2, 3, 7 and 5a). A typical trifid second lateral lobe is seen in fig. 3 (specimen No. 4), a bifid one in fig. 7 (specimen No. 12). In specimen No. 8 (fig. 4a), however, this lobe assumes the peculiar strictly symmetrical shape of a dagger with two lateral points on both its sides. In all examples it attains from two-thirds to three-fourths of the length of the first lateral lobe. The second lateral saddle repeats the outlines of the first, although on a smaller scale. The remainder of the external suture line consists of a short, ventrad oblique, first auxiliary lobe which is three-pronged in most individuals but is decidedly subdivided into two three-pronged branchlets in the largest suture line (specimen No. 6, fig. 5a); a leaf-shaped first auxiliary saddle; a still shorter, distinctly three-pronged second auxiliary lobe; and a simple second auxiliary saddle. In the smaller examples (up to a diameter of 100 mm.) the latter is bisected by the umbilical seam; in the largest suture line the half of a third auxiliary lobe is still visible beyond that saddle. The umbilical edge passes across the second lateral saddle in the smallest suture line examined (specimen No. 2, fig. 2a), whereas in all others the first auxiliary saddle rides more or less exactly on this edge.

Wherever the internal suture line could be studied, it was found to consist of a rather low saddle, intersected by a three-pronged lobule, immediately dorsad of the umbilical seam; of a deep lobe, which, as a rule, is trifid and points slightly dorsad; it is intermediate in size between the second lateral lobe and the first auxiliary one. There follow a tall and slender bifid internal saddle and a very deep antisiphonal lobe. The body of the latter is extremely narrow and ends in a very long three-pronged point; the middle prong is in its turn three-pronged; furthermore, there are three pairs of lateral branchlets decreasing in size orad; the lowest are much the strongest and almost meet the lobes on the opposite sides of the internal saddles in straitening the latter at their bases.

(B) var. **compressa**, new variety

Pl. xx, figs. 3a, b

A. M. N. H. No. 25158: three specimens

?*Schloenbachia* sp. indet., Choffat, 1888, p. 67, Pl. II, fig. 1 only.

Dimensions

Spec. No.	D	H	H′	W	W′	U
2	ca. 180 mm.	60 mm.	51 mm.	29 mm.	34 mm.	?
Holotype: 1	ca. 210 mm.	70 mm.	60 mm.	33 mm.	36 mm.	?

Description.—Three whorl fragments agree with the typical form of this species except for their more compressed section (Pl. xx, fig. 3b). Whereas the ratio W′:H is at the front ends 0.63 in specimen No. 6 of the *forma typica* (D = 310 mm.), 0.74 in its specimen No. 5 (D = 270 mm.) and 0.855 in its specimen No. 10 (D = 255 mm.), it amounts to only 0.54 in the holotype of this variety at a diameter of not more than 210 mm. and to 0.59 at the rear end of specimen No. 2 at a diameter of approximately 160 mm. These individuals are, therefore, referred to a separate variety.

The outer whorl of the holotype is unseptate, and it cannot be stated with certainty whether or not the two other examples are septate.

A part of the penultimate volution also is preserved, though crushed, in the holotype. This individual is the only one of the specimens referred to *P. arietiformis* (*sensu lato*) in which the

apertural margin and a slight indication of a rostrum can be seen (Pl. xx, fig. 3a). The former runs parallel to the last ribs; the latter does not seem to rise above the normal level of the venter.

(C) var. lēvicostata Haas

Pl. xx, figs. 4a–c; text figs. 9b, 10

A. M. N. H. No. 25159: one specimen

Pervinquieria arietiformis (Spath), var. *lēvicostata*, Haas, 1942b, pp. 645, 647, Pl. xciii, figs. 19a, b.

	Dimensions					
	D	H	H′	W	W′	U
Holotype:	ca. 160 mm.	34	29	21	24	43½

Description.—This variety is represented by a single individual, the last half whorl of which belongs to the body chamber. It differs from the typical form merely by the costation on the body chamber where the ribs remain comparatively narrow and the ribbing is rather dense (forty-five costae on the outer whorl). Bifurcation of ribs does not occur beyond the diameter of 110 mm., and from a diameter of 80 mm. on the ribs are no longer sigmoidal but run in an extremely flat, orad concave arc across the sides. In spite of the excellent preservation of this beautiful example only occasional very faint traces of spiral striation can be seen on the external knobs.

Fig. 10. Suture line of *Pervinquieria arietiformis* (Spath), var. *lēvicostata* Haas, holotype, A.M.N.H. No. 25159.

The suture line is also richly indented in this variety at diameters from 65 mm. to 80 mm. As in the majority of the individuals referred to the typical *P. arietiformis*, the first lateral lobe is bifid, the second trifid and the latter points distinctly ventrad.

(D) var. elegans, new variety

Pl. xx, figs. 5a, b; Pl. xxii, fig. 8; text fig. 9c

A. M. N. H. No. 25160: one specimen

Description.—This variety had to be based on another single individual. It deviates from the *forma typica* by being a little more involute than specimens of the latter of about the same size, by its higher and perpendicular umbilical wall, its higher and sharper keel and by its less prominent and slightly more dense costation (twenty-four ribs per half whorl).

Except for its considerably narrower umbilicus and its higher outer whorl the example under examination is most similar to the variety *lēvicostata* of this species. Also in the variety *elegans* spiral striation is indistinctly developed and is found only occasionally on the outer parts of the ribs, especially on their external knobs.

Parts of the suture lines could be studied at a diameter of about 120 mm. (Pl. xxii, fig. 8) and prove as elaborate as in the typical *P. arietiformis* at that size. There is a broad, bifid, first lateral lobe, the terminal points of which are separated from each other by a rather broad, elaborate, upright leaf, and a shorter and narrower second lateral lobe which is trifid; its median branchlet is extraordinarily long and three-pronged at its end. The second lateral saddle is bifid, with a remarkably strong lateral branch near the base on its outer side. There follow the short bifid first auxiliary lobe, which is similar to that of specimen No. 6 of the *forma typica* in that it is very oblique ventrad; the slender, low, second lateral saddle bordering the umbilical shoulder; and on the umbilical wall the second auxiliary lobe, the inconspicuous second auxiliary saddle, a third auxiliary lobe which is a little longer than the second, and parts of a third auxiliary saddle.

	Dimensions					
	D	H	H′	W	W′	U
Holotype:	150 mm.	39	36½	ca. 26	ca. 27	36½

Remarks (ad *P. arietiformis*, sensu lato).[1]—Spath established this species in 1922 on one fragment described and figured by Choffat in 1888 and two more from Gregory's collection. It is true that Airaghi described and depicted the first complete specimen in 1931, but never before has such a large amount of material been available, particularly one which includes such large examples and permits a

[1] For a fourth variety of this species, var. *recurvicostata* (= "*Deiradoceras*" *recurvicostatum* van Hoepen, 1941), see below, pp. 144, 145.

thorough study of the ontogenetic development of the species. As a result the detailed redescription of this interesting species was given above.

As to its generic position, Spath, when creating the specific name, referred it to *Elobiceras*. He was apparently induced to do so by the spiral striation present on both Choffat's type and his own specimens. He emphasized, however, the close affinity between this species and "*Schloenbachia* (*Mortoniceras*)" *inflata*, var. *angolaensis* Boule, Lemoine and Thevenin (1907, p. 41, text fig. 21), renamed "*Inflaticeras*" *angolaense* by Spath. So far as the writer knows, Spath has not formally altered his first generic determination of *P. arietiformis*, but he obviously no longer agrees with it. This may be inferred from his mention (1934, p. 418) of "those large fragments that were *formerly* taken to belong to *Elobiceras* ('*arietiforme*-group')" and from his considering (1934, p. 446) "the single, straight, club-shaped ribs, widening toward the periphery" to be distinctive of the typical forms of *Elobiceras*. Furthermore, Choffat, who in 1888 had referred the form here dealt with to "*Schloenbachia*" *lenzi*, believed also to be possibly an *Elobiceras* by Spath, admitted in 1905 that it belongs to a separate group of "espèces à région siphonale en forme de toit." The writer, too, hesitates to refer this species to *Elobiceras*, and he prefers to leave it with *Pervinquieria*. It does not show the characters of costation recently considered by Spath (see above) to be characteristic of *Elobiceras* nor does it have pronounced spiral ornamentation, and certainly this ornamentation is not equivalent in strength to the radial one, a feature which is in the writer's opinion another distinctive character of that genus. Furthermore, the forms most closely resembling *P. arietiformis* are without doubt true *Pervinquieriae*, which no author ever thought of referring to *Elobiceras*, e.g., *P. kiliani*, *P. cunningtoni*, *P. geometrica* (for details see below).

On the other hand, there cannot be any doubt that *P. arietiformis* is one of several transitional forms between the genera *Pervinquieria* and *Elobiceras;* examples of medium size, though lacking prominent spiral ridges on their ribs and different also in other sculptural features, are rather similar in general habitus to *Elobiceras intermedium*, and larger ones are equally similar to *Elobiceras browni*.

The differences between the typical form of this species and its three varieties, on the one hand, and of those varieties among each other, on the other, have been pointed out above. Some other species of the present collection, *P. vokesi*, *Elobiceras intermedium* and *E. browni*, will be compared below (pp. 96, 112, 121, respectively) with the typical *P. arietiformis* and two more, *E. spathianum* and *E. irregulare*, var. *rigidecostata*, with its variety *lēvicostata* (see below, pp. 106 and 104, respectively). Among other forms of the Albian of Angola that depicted by Choffat (1888) in fig. 1 of his Pl. II under the name of "*Schloenbachia*" sp. indet. (*ibid.*, p. 67)[1] and said to be still more compressed than fig. 6b of his Pl. I (type of *P. arietiformis*) might be identical with the variety *compressa* described above; the greater density of costation may be due merely to its smaller size (cf. the penultimate whorl of the holotype of that variety, as seen in Pl. XX, fig. 3a). The other form figured under the same name by Choffat (*ibid.*, fig. 2) also resembles in section the variety *compressa*, but its costation is still more dense and delicate and lacks the external knobs. Furthermore, Choffat's sectional diagram does not show any distinct keel in the impressed zone, whereas in that variety the penultimate whorl has a strong high keel (see Pl. XX, fig. 3b). It may be added that Stoliczka's (1865, p. 52, Pl. XXX, fig. 5) form, compared by Choffat with his, is stouter than the variety *compressa* of *P. arietiformis*, and its costation is much more dense and sigmoidal. Spath (1922, p. 133; 1934, pp. 443–444) refers both Choffat's and Stoliczka's forms to *Prohysteroceras* (*sensu lato*), but the writer would rather refer them to *Neoharpoceras* (see p. 137).

Among non-African *Pervinquieriae*, *P. kiliani* (Lasswitz, 1904, p. 25, text fig. 6, Pl. VII, fig. 1; Adkins, 1928, p. 233, Pl. V, fig. 4;

[1] Referred to as "*Schloenbachia*" (aff. *Roissyana*) in the author's second Angola paper (1905, p. 34) and compared by Spath (1922, p. 133) to his *Elobiceras flexicostatum*.

Spath, 1932, p. 408, Pl. XXXVIII, figs. 1, 2, Pl. XLII, fig. 1, Pl. XLVII, fig. 1, text fig. 140) is very similar to *P. arietiformis;* Lasswitz's holotype, as reproduced by Adkins,[1] is in side view exactly like individuals of the same size of the present species, and it agrees with the latter in every detail of ornamentation. Lasswitz's species, however, appears to be thicker, its venter is flat and its keel is accompanied, even at a diameter of almost 100 mm., by distinct furrows; moreover, there is no trace of any tendency toward the fastigation of the periphery. The Wordham example depicted by Spath (*ibid.*, Pl. XXXVIII, fig. 1) deviates from Lasswitz's type by its coarse, less dense costation (thirty-four instead of forty ribs on the last whorl). It must be kept in mind that all hitherto figured individuals of *P. kiliani* are septate throughout and that none of them exceeds 130 mm. in diameter; it would be interesting to compare larger conchs which have their body chambers preserved with adults of *P. arietiformis* to see whether they, too, get more slender and fastigate in maturity and whether their costation assumes the same characteristic features as that of the latter species or of the large specimen with body chamber of "*Mortoniceras* (*Deiradoceras*)" *cunningtoni* Spath depicted in Pl. XLVIII, fig. 1, of the Gault Monograph (1933). The resemblance between this figure and full grown individuals of *P. arietiformis* is a striking one and the specimens themselves must be even more like each other, since Spath emphasizes in the explanation of this plate that "the tubercles at the outer terminations of the ribs are prominent throughout"; the only difference seems to be provided by the smaller number of ribs (thirty-six instead of forty-four per whorl) in the Dorset example. Smaller individuals of *P. cunningtoni* (e.g., the holotype, *ibid.*, Pl. XLI, fig. 6, Pl. XLII, fig. 7), can, however, readily be distinguished from those of the present species of about the same size by their coarser, less numerous and slightly rursiradiate ribs which end rather abruptly at some distance from the keel, and by their more truncate venter. Finally, *Mortoniceras* (*Pervinquieria*) *geometricum* Spath (1932, p. 395, Pl. XLIV, fig. 1) from Folkestone resembles in side view the larger specimens of *P. arietiformis*. The only distinction which can be made from Spath's figure is that there are fewer ribs in that species (thirty-eight instead of forty-four per whorl). Unfortunately no sectional view is given, but since *P. geometrica* is said to be like *P. pricei* and the latter has a rather truncate venter, this feature may be assumed also to distinguish the former from the species under discussion.

[1] It may be worth noting that Adkin's figure does not show the "Reihe starker Knoten, an denen sich alternirende Rippen ansetzen, in der Mitte der Flanken," as mentioned by Lasswitz.

Pervinquieria vokesi,[2] new species

Pl. XXI, figs. 1a–e; Pl. XXII, fig. 9

A. M. N. H. No. 25161: one specimen

DESCRIPTION.—The single specimen, which corresponds to a diameter of about 280 mm., consists of almost a third of the outer whorl which belongs to the body chamber, and of about a quarter of the penultimate whorl which is septate and embraces a small part of an inner whorl; only the ventral part of the latter is preserved.

The conch is rather evolute, and the impressed zone, except for the mold of the strong keel, is rather shallow. The sides seem to be rather flat in the inner whorl, later they become rounded and converge ventrad; the venter is roof-shaped on the penultimate whorl and sharply fastigate on the outer one, whereas the periphery of the inner one is still rather truncate (fig. 1e). Thus there results an almost quadratic section of the inner whorl, a rectangular-elliptic section of the penultimate one and an inverted heart-shaped one of the last; the latter attains its maximum width at about the first fourth of the sides. The umbilical shoulder is rounded, the umbilical wall rather high and almost perpendicular.

The costation is coarse, but rather regular. There are, per quarter whorl, ten ribs on the penultimate volution and eight on the last. The former almost regularly bifurcate at a strong, radially elongated, umbilical tubercle;

DIMENSIONS

	D	H	H′	W	W′	U
Holotype: (a) penultim. whorl:	?	ca. 55 mm.	49 mm.	31 mm.	40 mm.	?
(b) last " :	?	ca. 80 mm.	ca. 70 mm.	58 mm.	62 mm.	?

[2] Named in honor of Dr. H. E. Vokes, Associate Curator of Fossil Invertebrates, The American Museum of Natural History.

one rib only is single and starts at some distance from the umbilical shoulder. The costation of this whorl is rather stiff, whereas the ribs on the outer one are single, arched and slightly rursiradiate; at the latero-ventral edge they end in strong, though blunt knobs from which weak undulations trend obliquely forward, gradually vanishing toward the keel. The latter is triangular in section, strong and rather sharp; on the outer whorl it is less neatly separated from the venter than on the inner ones. No spiral ornamentation can be seen.

On the whole, the suture line is traceable in its general outlines only, save for a part of a siphonal lobe which is well preserved (Pl. XXII, fig. 9); this agrees fairly well in degree of indentation and in the general arrangement of its elements with that of *P. arietiformis* at the same size (cf. Pl. XXII, fig. 3), but the median knob is much broader at its base, and the most prominent lateral branch is also much broader and ends in two strong points rather than in one. The first lateral lobe is apparently bifid.

REMARKS.—This new species is without doubt most closely related to *P. arietiformis* from which, however, it can readily be distinguished by its more rapidly increasing, stouter whorls, by its much more gibbous sides and by its coarser costation. The ribs on the penultimate whorl still regularly bifurcate at a size at which they are usually single in *P. arietiformis*, those of the outer volution are more sinuous than in the latter; moreover, there are considerably fewer costae (forty on the penultimate whorl, thirty-two on the ultimate one, as compared to forty-two to forty-six in Spath's species).

Among forms of other faunas the two specimens from Queensland named "*Schloenbachia rostratus* J. Sby." by Etheridge (1909, p. 237) and figured in Pl. LXV and in Pl. LXVI, fig. 1, especially the latter, appear to resemble the species here dealt with. In the former, however, the ribs of the penultimate whorl stop bifurcating at an earlier stage, and those of the outer one are sharper and more sigmoidal, and their external knobs show spiral striation. In the latter umbilical nodes are seen still on the outer whorl, the costation of which is otherwise very similar to that of *P. vokesi*, and its sides seem to be much flatter, as far as this can be determined without a sectional view.

Pervinquieria (?), indeterminate new species No. 2

Pl. XVII, fig. 6, text fig. 9d

A. M. N. H. No. 25162: one specimen

DIMENSIONS

D	H	H′	W	W′	U
ca. 23.5 mm.	38½	ca. 30	25½	ca. 30	38½

DESCRIPTION.—In spite of its being crushed and distorted this specimen is discussed at length because it differs from all the other costate forms of the present collection. It consists of a little less than half a disc and is apparently septate throughout.

The conch is rather evolute and seems to have been slender even before crushing. The section is lancetiform, the venter fastigate and crowned by a rather sharp keel.

The costation consists of twelve to thirteen strong and rather sharp ribs per third whorl. They are prorsiradiate on the inner zone of the sides, radial or slightly rursiradiate on the outer one and turn decidedly forward at the latero-ventral shoulder; thus their course is a slightly sigmoidal one. Three ribs out of twelve bifurcate at about the middle of the sides. The costae carry three tubercles each: a radially elongated umbilical one, a rather sharp lateral one located at about the outer third of the sides, and a prominent, almost horn-like, external one. Moreover, they appear to be crenulated, particularly on the nodes. Between the inner tubercles and the lateral ones the ribs are, as a rule, deeply notched; in consequence, the costation on the whole seems to be interrupted on both the penultimate and the outer whorls.

No suture lines could be traced.

REMARKS.—The generic position of this form cannot be determined with certainty, particularly since it lacks the body chamber. The interruption of costation on the mid-sides cannot be considered a generic character, as it occurs in different genera, particularly at earlier ontogenetic stages. In its small size and in the nodose nature of the costation this form seems to approach *P. spathi* (Haughton, 1924, p. 91, Pl. I, figs. 6–8) and some micromorphic *Pervinquieriae* of the English Gault, e.g., "*Mortoniceras* (*Pervinquieria*?)" *nanum* Spath,[1] "*Mortoniceras* (*Durnovarites*)" *subquadratum* Spath,[1] "*Mortoniceras* (*Cantabrigites*)" *cantabrigense* Spath (1933, p. 438, Pl. XLI, figs. 3, 4, Pl. XLV, fig. 4, Pl. XLVI, fig. 8) and "*Mortoniceras* (*Cantabrigites*)" *minor* Spath (1933, p. 440, text fig. 152, Pl. XLI, figs. 1, 2,

[1] For references see above, p. 71, under heading *P. margaritata*.

Pl. XLIII, fig. 4, Pl. XLIV, fig. 2, Pl. XLVI, fig. 11), but all of them are entirely different in section, and all except *P. cantabrigensis* have a coarser ornamentation than the form under discussion. Even *P. cantabrigensis* and its variety *gracilis* (*ibid.*, Pl. XLVI, fig. 8), which is the thinnest and most finely ribbed of the Gault forms mentioned above, differ from the present form by their pronounced latero-ventral shoulders.

The latter is, therefore, doubtfully referred to the genus *Pervinquieria*. Owing to its peculiar ornamentation it does not require further comparison with any of the forms of the present collection.

APPENDIX TO THE GENUS *Pervinquieria*

Pervinquieria cf. **lampasensis**
(Choffat)

Pl. XXI, figs. 2a, b; Pl. XXIII, figs. 1a, b

A. M. N. H. No. 25192: two specimens

Cf. *Schloenbachia inflata* (Sowerby), var. *Lampasense*, CHOFFAT, 1886, p. 3.

Schloenbachia inflata (Sow.), var. *Lampasense*, CHOFFAT, 1898, p. 79, Pl. IV, fig. 1.

Inflaticeras ? *lampasense* Choffat; SPATH, 1922, p. 103.

"*Schloenbachia inflata*, var. *lampasensis*" Choffat; SPATH, 1923, p. 145.

not high, considerably overtops the outer nodes.

There are at the periphery from eleven to twelve ribs per quarter whorl; some of them bifurcate at about the first third or at the middle of the sides. Where bifurcation does not occur, secondary ribs are intercalated, several of which seem to originate even farther ventrad. The ribs run in a radial or even slightly prorsiradiate direction across the sides; on the venter the outer nodes continue perpendicularly toward the keel, from which they are, however, separated by broad, rather shallow furrows. There are moderately strong, blunt, umbilical tubercles at the inner ends of the primary ribs; in addition, there are more or less indistinct lateral nodes situated at about the middle of the sides in the smaller fragment but at about their second third in the larger one. These tubercles seem to correspond to the third row mentioned in Choffat's (1898) description; the preservation of the fragments does not permit any decision as to whether or not Choffat's second row of tubercles, stated by him to be hardly visible, is also present. At any rate, there are strong tubercles at the outer ends

	DIMENSIONS					
Spec. No.	D	H	H′	W	W′	U
1	?	29 mm.	25.5 mm.	30.0 mm.	32 mm.	?
2	ca. 140 mm.	32 mm.[1]	30.0 mm.[1]	31.5 mm.[1]	35 mm.[1]	ca. 72 mm.?

DESCRIPTION.—The two worn whorl fragments may belong to the same individual. The smaller (specimen No. 1), about 90 mm. long, is septate throughout; the larger (specimen No. 2) measures about 120 mm. in length and seems to belong to the body chamber.

The conch must have been very evolute, as the impressed zone is very shallow. The intercostal section is inverted heart-shaped, and its width about equals its height. The costal section is broader than wide and is trapezoidal in its outlines. The latero-ventral edges are distinct, though rounded, and in costal section they are accentuated by the external tubercles. The keel is broad and strong and, though

[1] Measured at posterior end.

of all the ribs. The ribs on the right side of the smaller fragment look as if they were crenulated, a condition which may be due to corrosion only.

Although occasional single prongs and leaflets can be located on specimen No. 1, no continuous suture line could be traced. It can, however, be seen from the septum at the posterior end of this fragment that there was a broad, bifid, external saddle; a comparatively narrow first lateral lobe; a first lateral saddle, exceeding the external one in height; and a second lateral lobe, the inner margin of which seems to be at the umbilical shoulder.

PALAEONTOLOGICAL REMARKS.—This form closely resembles, in its general habitus, the outer whorl of Choffat's variety

lampasensis of *P. inflata*, raised to the rank of an independent species by Spath (*loc. cit. in synon.*). Some minor differences, however, seem to exclude full conspecificity. The section appears to be a little wider than in the Portuguese form, the ribs are not rursiradiate as in the latter but are radial or even slightly prorsiradiate, and the umbilical tubercles persist on the outer whorl. Also, it is doubtful whether or not two rows of lateral nodes are present on the Angolan form.

Choffat's (1905, p. 36, Pl. III, fig. 4) "*Schloenbachia* sp. indet." from Lobito Bay, compared by that author with his variety *lampasensis* but renamed "*Mortoniceras* (?)" *rotundum* by Spath (1922, p. 103; 1933, p. 437), is believed by the writer to be identical with *Prohysteroceras wordiei* Spath (see p. 125).

Within the genus *Pervinquieria* both the true *P. lampasensis* and the form here dealt with are assigned to Spath's (1922, pp. 103, 115) *perinflata*-group, for which he later (1932, p. 380; 1933, p. 429) established his subgenus *Durnovarites*.

Among the Albian forms of the present collection *P. proteus* (p. 77) has outer whorls somewhat resembling those of the present form; however, they can readily be distinguished by their more vaulted sides and their single, less dense and sharper ribs and more prominent lateral and external tubercles.

OCCURRENCE; STRATIGRAPHICAL REMARKS.—According to the field label the fragments under discussion were collected south of Cabo Ledo, forty kilometers south of the mouth of the Cuanza River, from the "Itombe,[1] Upper Albian–Basal Cenomanian." They, therefore, are from a somewhat higher horizon than the Upper Albian (= Vraconnian of Choffat, 1905) of Hanha. *P. lampasensis* Choffat, to which they are most closely related, is recorded by that author from the "Bellasien inférieur" of S. Joao-das-Lampas, Portugal. This stage is considered by Choffat (1885, pp. 37–39; 1886, p. vi) to be either at the base of the Cenomanian or immediately beneath it. This would agree fairly well with the age indicated for the fossils under discussion.

[1] "Itombe" is a formation name used on the field labels of Dr. Chester A. Washburne, but, so far as the writer knows, it has not appeared in the literature except in the data given by Haughton (1924, p. 101) on the occurrence of his new species *Epiaster angolensis*.

ELOBICERAS SPATH

Since Szajnocha (1885) described and figured some new, peculiarly sculptured ammonites from the Elobey Islands (now identified as *E. szajnochai*, *E. lenzi* and *E. elobiense*), our knowledge of this interesting genus has been greatly increased. Although Choffat published some new types, the greatest progress in our knowledge of this genus is to be credited to Spath. When creating it in 1921 (p. 306) he did not give a generic diagnosis, merely naming *E. elobiense* as the genotype. This species has, however, proved to be a rather highly specialized offshoot, deviating widely from the average representatives of this genus. When discussing it in greater detail in 1922 (p. 103), Spath again failed to publish a formal diagnosis of this genus, but he characterized it as "distinguished by compressed discoidal shells, with elevated or acute periphery and delicate ornament of quite a peculiar type."[2] In his more recent papers, however, this author seems inclined to some restriction of the range of *Elobiceras*. He points out (1934, p. 418) that "the single, straight, club-shaped ribs, widening towards the periphery" are most characteristic of this genus and he excludes, though not explicitly, the group of *Pervinquieria arietiformis* which he had referred to *Elobiceras* in 1922.[3]

The writer shares the view that the character of costation is a most serviceable generic feature, but it must be kept in mind that it changes, especially in this genus, very quickly even on the same individual[4]; the ribs are, for example, very straight in one part of the conch and decidedly sigmoidal only a quarter of a whorl later. Another distinctive character of this genus is, despite Douvillé's skepticism (1931, p. 20), the presence of a spiral ornamentation which is, as a rule, expanded throughout the

[2] This diagnosis quoted also by Adkins (1928, p. 234).

[3] See p. 94.

[4] Cf. Spath (1922, p. 137) with regard to *E. lobitoense* and *E. neuparthi*.

shell, whereas it is usually less conspicuous and restricted to a part of it, particularly to the outer zone, in other genera, e.g., *Dipoloceras*, *Pervinquieria*, *Prohysteroceras*, *Neoharpoceras* and occasionally also *Hysteroceras*. As Spath (1922, pp. 103, 146) pointed out repeatedly, "spiral ornament alone" is not sufficient to indicate a relationship with *Elobiceras;* Adkins (1928, p. 234) also emphasizes that "this feature alone is not diagnostic of *Elobiceras*, but occurs in other Albian or even Coniacian genera." On the other hand, even in some forms which the writer refers without doubt to this genus, the spiral ornamentation becomes obsolete in parts of the shell or at certain ontogenetic stages even throughout the sides. In the most characteristic representatives of this genus, however, the spiral ornamentation is equivalent in distinctness and prominence to the radial one.

At any rate it must be recognized that there is a broad transitional zone between the genera *Pervinquieria* and *Elobiceras*, and the boundary between them will always be a more or less arbitrary one. For example, *Pervinquieria arietiformis*, referred to *Elobiceras* by Spath in 1922 (cf. above, p. 94), is considered a *Pervinquieria*, though very closely approaching *Elobiceras*, in the present paper. On the other hand, *E. irregulare* was referred to "*Inflaticeras*" by Spath (1922, p. 125), whereas it is considered by the writer to be a primitive representative of *Elobiceras*.

It may be added that Spath formerly (1922, p. 104) believed this genus to be probably "a specialized offshoot of *Inflaticeras*," and in 1931 (p. 374) derived it from *Dipoloceras cristatum*, var. *moniliformis*, via "*candollianus*-like forms and the Pervinquierids."

As to its geographic range, Spath, despite the fact that Pervinquière had fifteen years earlier (1907, p. 233) recorded "*Mortoniceras*" *neuparthi* from the Cenomanian, perhaps "Gault," and "*Mortoniceras elobiense*" from the Upper Gault of Tunis, declared in 1922 (pp. 103, 155) that it was an "apparently quite local lineage," restricted to the Elobey Islands, Angola and Nigeria, "isolated in the West African Bay of the Tethys." In 1925 (p. 196), however, he said that it was "now known from practically all round Africa,[1] not to mention Europe." He seems to have adhered to this conception of *Elobiceras* as a wholly African genus in 1934 when he refrained from referring his "*Prohysteroceras*" *pseudoelobiense* (1934, p. 445, Pl. LV, fig. 1) to *Elobiceras*. The writer, on his part, does not hesitate to consider that species a true *Elobiceras*, since its ribs are crenulated throughout and since both the "irregular branching of the ribs" which continues even on the body chamber and the absence of any decidedly straight ribs also occur in some of the undoubted *Elobiceras* of Angola (e.g., *E. raymondi*, *E. browni*).

The above restriction cannot further be maintained, since Maury (1925, p. 577, Pl. XX, fig. 15; 1930, p. 271) has described a genuine *Elobiceras* (*E. bahiaense*) from the Upper Albian of Algodoes, near Marahu, Bahia, Brazil, and Adkins (1927, pp. 53, 55, Pl. IV, fig. 3; 1928, p. 234, Pl. VI, fig. 3) recorded four different representatives of this genus from the Kiamichi Series of the Albian of Texas. The geographic range of this genus in Albian times is thus proved to have reached from Texas and Brazil, on the one hand, as far as Portuguese East Africa (*E. newtoni* Spath, 1925, p. 186, Pl. XXIX, fig. 3, Pl. XXX, fig. 1) and Zululand (van Hoepen, 1931, 1941), and probably also England (*E. pseudoelobiense*, see above), on the other.

Today, as in the past, Angola and the Elobey Islands may, nevertheless, still be considered as being the "classical" region for the development of this genus. Within the present collection, *Elobiceras*, although outnumbered in forms by *Pervinquieria* and *Hysteroceras* and in individuals by the latter genus and by *Puzosia*, appears to be, along with the *Pervinquieriae* of the *arietiformis* group, the most spectacular genus. Leaving out of account two natural molds and twenty-eight more or less small fragments, which are either too incomplete or too poorly preserved for specific identification, there are fifteen species, three among them with one variety each, or al-

[1] A fragment named "*Elobiceras* sp." has since been figured, though not described, from the "Albien terminal–Cénomanien basal" of the Mont Raynaud, Madagascar, by Besairie (1936, Pl. XXI, fig. 17).

together eighteen different forms represented at Hanha. It is obvious that an attempt must be made to divide them into natural groups.

The first group consists of species ornamented with lateral nodes or tubercles. It includes *E. primordiale* whose three rows of tubercles attach it rather closely to *Pervinquieria inflata*, var. *aequatorealis*, and *E.*, indeterminate new species No. 1.

A second group is characterized by a sculpture which is extremely coarse in adolescence but becomes more regular in maturity; it includes *E. irregulare* with its variety *rigidecostata*, and *E. spathianum*. This group too is very closely related to some *Pervinquieriae*, viz., *P. arietiformis*, its variety *lēvicostata*, and *P. vokesi*.

In the opposite direction *E. spathianum* proves to be transitional to the third group, including more involute forms with very regular, more or less dense costation, less pronounced crenulation of the ribs and a fastigate venter. This group includes *E.* cf. *flexicostatum* and *E. oxytropidoceratoides* with its variety *minor*. The latter species appears to be a highly specialized type, becoming extremely slender in maturity; it exhibits a most remarkable homeomorphy with the genus *Oxytropidoceras* and seems, moreover, to be transitional to *Neoharpoceras*.

The fourth group comprises the forms believed by the writer to be the most characteristic representatives of this genus: *E. intermedium*, *E. lobitoense*, *E. subelobiense*, *E. angustum*?, *E. raymondi* and *E. hexagonum*. The last named, showing traces of an interruption of costation in the middle of the sides, seems to be transitional to the group of *E. lenzi*. *E. raymondi*, on the other hand, may be intermediate between the fourth group and another, not yet found in Angola, characterized by a robust sigmoidal ribbing, which has been recorded from Zululand and was superfluously raised to the rank of an independent genus, "*Rhytidoceras*," by van Hoepen (1931, p. 42). The latter group is considered by Spath (1932, p. 381, footnote 5) to be transitional between *Pervinquieria* and *Elobiceras*, but the writer would prefer to include it in the latter genus. This might even be true, likewise, of van Hoepen's (1931, p. 46) other genus "*Drepanoceras*," which also shows a very pronounced spiral ornamentation but is considered by Spath (1933, p. 415), with some "*Rhytidoceras*" (e.g., "*R.*" *elegans*, variety *crassicostata*), to include passage forms between *Dipoloceras* and *Pervinquieria* and to be closely allied to the *pricei*-group of the latter genus and to its "subgenus *Deiradoceras*." In the writer's opinion, however, these more robustly sculptured Zululand forms referred by van Hoepen partly to "*Rhytidoceras*" and partly to "*Drepanoceras*"[1] are, despite the remarkable difference in the degree of involution, very similar to *E. newtoni* Spath (1925, p. 186, Pl. XXIX, fig. 3, Pl. XXX, fig. 1) from Portuguese East Africa. Spath points out that the latter is close to *E. intermedium* and *E. lobitoense*, both considered characteristic *Elobiceras* in the present paper.[2] All of these coarsely sculptured forms seem to belong to the above mentioned group which is somewhat connected with *E. irregulare*. It may be added that only the outer whorls of these forms exhibit the characteristic robust ornamentation, whereas the inner ones have a remarkably finer ribbing, both in Spath's species and in the different forms figured by van Hoepen.

The fifth group is also closely related to the fourth and is characterized by a rectangular section with flat sides and venter and by some degeneration of the ribbing on the body chamber. Its "chef de fil" seems to be *E. neuparthi* (Choffat, 1905, p. 38, *pro parte;* Pl. II, figs. 1a,b, Pl. III, fig. 1c, *non* Pl. IV, fig. 4). In this collection this group is represented by *E. browni*, new species. It seems doubtful whether the fragment distinguished by its absolutely straight ribs and named *E.*, indeterminate species No. 2, belongs to this group or to the precedent one.

E. elobiense, the genotype, hitherto known only from the Elobey Islands but described and figured in the present paper from the mainland of Angola, occupies,

[1] I agree with Spath (1931, p. 347–8) in finding that both "genera" are not sufficiently distinct to be separated from each other.

[2] See also p. 144.

owing to its extreme slenderness, its sharpened periphery and its extraordinarily broad flat ribs lacking any save very weak umbilical tubercles, an isolated taxonomic position, forming a sixth "group" of its own.

Elobiceras primordiale, new species

Pl. XXIII, figs. 2a–c

A. M. N. H. No. 25163: six specimens

keel, ending at some distance from it. The intercostals appear to be reduced to narrow furrows between these knobs. A shallow, though distinct spiral depression of the sides can be seen between the peripheral nodes and the lateral ones.

On the umbilical tubercles there are about five spiral ridges of which the outermost is the strongest; about three of them are present on the lateral nodes and there are two or three faint ones on the outer knobs. No such ridges can distinctly be seen on the remainder of the

	Dimensions					
Spec. No.	D	H	H′	W	W′	U
Holotype: 1	54.1 mm.	44	41	ca. 26½	27½	30½

Description.—The holotype consists of about half a disc, of which the outer whorl belongs to the body chamber. The conch is discoidal and rather involute. Although the inner whorls are crystallized, the section of both the outer and the penultimate whorls can well be seen (fig. 2b). The latter is only slightly higher than wide and has gently rounded sides which converge ventrad from the umbilical shoulder; the external edges are pronounced, and the venter is flat, broad and crowned by a comparatively strong keel. The whorls rapidly increase in height, the outer one being much more slender than the penultimate one. It reaches its maximum width immediately above the pronounced, though rounded umbilical shoulder. The umbilical wall is high and almost perpendicular. The sides, which converge ventrad, are flat, as is the comparatively broad truncate venter which is separated from the sides by rounded edges. The median keel is triangular in section, strong, moderately high and is accompanied by smooth bands on both its sides.

There are eighteen ribs on the preserved half of the outer whorl which start slightly beneath the umbilical shoulder. They are rather narrow around the umbilicus and run perfectly straight across the sides, quickly widening and flattening toward the periphery, thus assuming the club shape characteristic of *Elobiceras*. Among the eighteen ribs there are three pairs which bifurcate, the point of bifurcation moving gradually ventrad from the umbilical shoulder as far as the first third of the sides. There is one single rib which also begins there. On the outer zone of the sides the ribs are uniform. On the penultimate quarter of the outer whorl there are radially elongated umbilical tubercles, culminating at about the innermost sixth of the sides, but on the anterior quarter of this whorl they are indicated solely by the prominence of the corresponding parts of the ribs. Moreover, the costae exhibit a slight swelling on the middle of the sides forming very flat lateral nodes. They also swell more distinctly at their peripheral ends, producing broad, relatively inconspicuous knobs which continue on the venter and are directed obliquely forward toward the ribs or in the intercostals, but there may be traces of spiral striation.

Owing to the crystallization of the inner whorls no suture lines could be traced.

Five small fragments (specimens Nos. 2–6) with club-shaped ribs which are broader than the intercostals may represent an earlier ontogenetic stage of this species and are, though doubtfully, referred to it.

Remarks.—The holotype, permitting the observation of important and characteristic features, occupies such an interesting position in the Albian fauna of Hanha that the creation of a new species for it seemed justifiable. Within the present collection it is closely related to *Pervinquieria inflata*, var. *aequatorealis;* its outer whorl is much more slender, but the inner one is not very different from that of Kossmat's variety. Its ribs are flatter but they show, though less distinctly, the same three rows of tubercles and the same concentration of the spiral ridges on these tubercles, at least on those of the two inner rows. As stated above (p. 70), *E. primordiale* is believed to be one among several connecting links between *Pervinquieria* and *Elobiceras* (see also *P. arietiformis*—*E. irregulare*).

Among the known species of *Elobiceras*, *E. subelobiense* Spath (1922, p. 132, Pl. II, fig. 2; see p. 113, this paper) resembles the new species in the relatively broad and straight ribs, in the degree of involution and in section. Nevertheless they cannot be considered to be conspecific, for Spath's species apparently attains a much larger size and is much stouter; its ribs are slightly inflected in the inner zone of the sides and they are equally ridged through-

out, without showing at the same diameter any trace of the three rows of tubercles which are clearly visible in *E. primordiale*. The latter has in common with *E. elobiense*, on the other hand, the flatness and the width of the ribs and will be compared with it in more detail below (p. 124), as it will with the next form, *E.* indeterminate new species No. 1.

Elobiceras, indeterminate new species No. 1

Pl. XXIII, figs. 3a, b; text fig. 12a

A. M. N. H. No. 25164: four specimens

DESCRIPTION.—Four specimens, of which the largest consists of about a quarter of a disc which may have attained 40–45 mm. in diameter (specimen No. 1), are described, though too imperfect to be worthy of a formal name. On the largest specimen only the apparently septate outer whorl could be examined.

The section (text fig. 12a) is almost rectangular, with both umbilical and latero-ventral edges distinct, though a little rounded, and the sides but slightly vaulted and converging ventrad. The venter is truncate and comparatively broad, the keel strong, sharp and high.

There are eight ribs per quarter whorl; on the right side of the conch two pairs among them bifurcate near the umbilical shoulder, whereas on the left side all the costae appear to be single. The ribs are sigmoidal and decidedly prorsiradiate in the outer zone of the sides. In their two inner thirds they are rather sharp and narrow; there are umbilical tubercles which only occasionally become prominent, and smaller, though distinct lateral tubercles at about the middle of the sides, marking the spot where the ribs turn forward. Then on the outermost part of the sides they widen rather suddenly, decidedly swelling on the peripheral edges. They continue on the venter, trending obliquely forward at an angle of about 60° almost as far as the keel from which they remain, however, neatly separated. Spiral ornamentation can be seen throughout the ribs. It is most distinct on the inner and lateral tubercles where rather prominent ridges occur, whereas there is only a fine striation on the outer swellings.

No suture lines could be traced in this example.

There is another whorl fragment (No. 2), exhibiting but one secondary and one primary rib together with parts of two others. All of them are spirally ridged, similar to those of specimen No. 1. A little fragment (No. 3), showing the outer part of the right side of a whorl with parts of three ribs, appears to be conspecific with the specimens described above. A fourth fragment (No. 4) of an individual somewhat larger than specimen No. 3, showing two incomplete ribs, is, owing to their characters, referred to this species.

REMARKS.—This form has lateral nodes similar to those of *E. primordiale*, from which, however, it can readily be distinguished by its broader venter, sharper and higher keel and narrower, sigmoidal, prorsiradiate ribs which are more inclined to be projected on the periphery. On the other hand, this form leads to those with sigmoidal costation which are among the most characteristic *Elobiceras* of this collection, e.g., *E. raymondi;* the latter differs from the present form by its broader, more closely set ribs, which lack lateral tubercles, and by its lower keel.

There is, also, due to the high keel and the sigmoidal ribs, some superficial resemblance to *Dipoloceras bouchardianum* (see p. 14), but the latter has more rounded sides and more numerous, narrower and sharper ribs which do not widen ventrally and only occasionally show lateral tubercles and are less distinctly crenulated.

Elobiceras irregulare (Spath)

(A) **forma typica**

Pl. XXIII, fig. 4; Pl. XXIV, figs. 1a–d, 2; Pl. XXXV, fig. 1

A. M. N. H. No. 25165: six specimens

Inflaticeras irregulare SPATH, 1922, p. 125, Pl. IV, fig. 7.

DESCRIPTION.—The largest specimen (No. 2) is septate up to a diameter of about 160 mm., whereas the last septum seems to be at diameters of 115 mm. in specimen No. 3 and of 75 mm. in specimens Nos. 1 and 5.

The conch is discoidal; both the degree of involution and the height of the whorls first increase and then decrease, while the width of the whorls decreases in the course of development. Therefore, large examples

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1	115 mm.	42	?	?	?	33½
2	ca. 190 mm.	40[1]	38½	21	24½	37

[1] This ratio and the following ones measured at D = 158 mm.

appear to be more evolute and slender than the smaller ones.[1]

The intercostal section (Pl. XXIV, fig. 1d) is subrectangular with flat sides which but slightly converge ventrad; the umbilical wall is steep, though not high, and the umbilical shoulder is rounded. The venter is at first rather truncate, later it is roof-shaped and in maturity slightly fastigate. But even at the later stages the latero-ventral edges are distinctly marked in costal section by the external nodes. The keel is high and sharp.

Spath, although he had only one fragment, which did not exceed 90 mm. in diameter, perfectly divined the most characteristic features of this peculiar species: the extreme irregularity of its sculpture and "the gradual fading of the outer portion of the ribs." The description of the ornamentation as given by this author is valid up to a diameter of about 100 mm.; it need only be added that the ribs not only bifurcate quite irregularly, sometimes even at the latero-ventral edge, but occasionally two or three of them, starting independently from the umbilical shoulder, coalesce at the middle or even at the outer third of the sides, forming a single extremely broad rib. The costae are at that stage either slightly sigmoidal or they form a shallow, orad concave arc. The sculptural details of that stage, including the strong umbilical and lateral tubercles and the distinct spiral ridges, are best seen in specimen No. 4 (Pl. XXIV, fig. 2).

Between the diameters of 100 and 120 mm., however, the character of ornamentation changes, suddenly becoming very regular. The umbilical tubercles, so strong in adolescence, now become, as a rule, much less prominent; the ribs originating at the umbilical edge alternate quite regularly with others which start at the innermost fourth of the sides only, but all of them become uniform on the outer half of the sides. Here they form a flat, orad convex arc across the sides and turn sharply backward just at the latero-ventral edge, thus accentuating the external nodes, which are otherwise less pronounced and more radially elongated than they are in adolescence. The ribs continue on the venter, forming a short, orad concave arc, the terminal part of which trends at an angle of about 30°, and gradually fades toward the high, sharp keel. The lateral nodes have disappeared.

Throughout development there are from thirty-six to forty-two ribs per whorl. All of them are spirally ridged throughout, but no traces of spiral ornamentation can be found in the intercostals.

The outer part of the suture line could be well studied in specimen No. 5 at diameters of from 35 to 70 mm. (Pl. XXXV, fig. 1). Although this species must be considered as being a primitive *Elobiceras*, its suture line is rather richly indented, although not to the high degree observed in the more advanced species of this genus, e.g., *E. raymondi*. The siphonal lobe is rather deep; its terminal points are long and slender and diverge at an angle of about 30°; there are also two principal lateral branchlets on each side, the upper ones being the strongest; they are three-pronged and almost horizontal. The external saddle is deeply intersected at its top by a three-pronged lobule, a condition which is also true of both its stems; the main stem, owing chiefly to the strong development of the above mentioned upper lateral branchlet of the siphonal lobe, is very much straitened at about half its height. The first lateral lobe is considerably shorter than the siphonal one and is decidedly bifid; both of its terminal points are three-pronged and are separated from each other by a strong upright leaflet. The first lateral saddle is a little higher and narrower than the external one and also is intersected by a deep three-pronged lobule. Also the second lateral lobe, like the first, is bifid, but is much shorter and narrower. The second lateral saddle, much smaller than the first, is intersected at its top and rides on the umbilical shoulder. There follow on the umbilical wall a two-pronged auxiliary lobe and a slender auxiliary saddle, which is about halved by the umbilical seam.

A poorly preserved fragment (No. 6)

[1] For that reason W′ = 30 in Spath's holotype, as compared to 24½ in my specimen No. 2 which is more than twice its size.

with a similar coarse ornamentation is also, though with doubt, referred to this species.

(B) var. **rigidecostata**, new variety

Pl. xxv, figs. 1a–c; Pl. xxxv, fig. 2

A. M. N. H. No. 25166: one specimen

	Dimensions					
	D	H	H′	W	W′	U
Holotype:	145.7 mm.	38	36½	22½	25	40

Description.—The single specimen agrees perfectly with the typical form of the species in most of its characters, and especially in the very coarse and irregular ornamentation of its inner whorls. It is, however, somewhat stouter, and the costation, though it also suddenly becomes regular in this individual, is quite different from that of the former on the anterior half of the outer volution, which apparently belongs to the body chamber. The primary and secondary ribs do not alternate regularly; there are but three intercalated ribs on the third quarter of the outer whorl and but one on the last. The costae run in a flat, orad concave arc across the sides of the posterior part of the body chamber and become almost straight on the anterior part. The external knobs are much less pronounced than in the *forma typica*, causing the latero-ventral edges to be less conspicuous, and they are but slightly projected toward the keel, without forming another short arc on the venter as in the typical form. The umbilical tubercles, which are still very strong and prominent on the first half of the outer whorl, almost disappear on its anterior quarter. There are twenty-two ribs on its anterior half, where the costation is slightly denser than on the septate part of the conch (thirty-eight ribs per whorl) or on the typical *E. irregulare*. As in the latter and in other species of *Elobiceras* the spiral ridges become less distinct on the body chamber.

The suture line of this variety (Pl. xxxv, fig. 2) agrees with that of the *forma typica* except for the much greater differences in length between the first lateral lobe and the siphonal one and in height between the external and the first lateral saddles. The second lateral lobe is relatively deeper than in the typical form, and the degree of indentation of the minor sutural elements is considerably greater (compare the terminal points of the first lateral lobes in figs. 1 and 2 of Pl. xxxv).

Remarks (ad *E. irregulare*, sensu lato).—Spath (*loc. cit. in synon.*) referred this species to the "*evoluta*-group" of *Inflaticeras* (= *Pervinquieria*), although admitting that the forms of this group, particularly "*Inflatic.*?" *ambiguum* which he stated to be very similar to *E. irregulare*, are transitional to *Elobiceras* and considering (*ibid.*, p. 146) the possibility of referring the present species to the latter genus. The writer, however, believes this species to be a genuine *Elobiceras*, since its ribs are crenulated throughout their length and throughout their development, and also since its suture line exhibits some distinctive features of this genus, including the slight amount of divergence of the terminal points of the siphonal lobe and the straitening of the main stems of the principal saddles. Some support for this generic reference may be found in Adkins' (1927, p. 55, Pl. iv, fig. 3; 1928, p. 234, Pl. vi, fig. 3) reference to the genus *Elobiceras* (as *E. serratescens*), of Cragin's (1893, p. 241) "*Schloenbachia*" *leonensis*, var. *serratescens*, from the Kiamichi formation of Texas. In side view that species closely resembles the present one, but it differs by its "strongly compressed .... tall cross section."

Within this collection *E. irregulare* shows considerable affinity to the *Pervinquieriae* of the *arietiformis* group, on the one hand, and to some forms referred to *Elobiceras*, on the other. Its typical form differs from *P. arietiformis* by its more rectangular section and especially on the inner whorls by its coarser, irregular and less dense costation and by its much more distinct spiral crenulation. There is even more similarity between the variety *rigidecostata* of *E. irregulare* and the variety *lēvicostata* of. *P. arietiformis*. The latter, however, is much more evolute and has a much finer and more regular costation, not only on the inner volutions but also on the body chamber. It also lacks spiral ornamentation. *Pervinquieria vokesi* has, at the same diameter, a section similar to that of *E. irregulare* and also possesses a very robust sculpture, but its ribs are less numerous throughout. They bifurcate regularly on the inner whorls and are more sinuous, forming but one, orad concave arc, and on the outer whorl are quite uniform; furthermore, they show no trace of spiral crenulation.

The other species of *Elobiceras* in the present collection which appear to be most closely related to *E. irregulare* are *E. intermedium* and *E. spathianum*, the latter particularly resembling the variety *rigide-*

costata; it will be compared with both that variety and the typical form (p. 106).

"*Inflaticeras*" *ambiguum* Spath (1922, p. 126, Pl. IV, fig. 6) is in its earlier stages rather similar to the present species and particularly to its variety *rigidecostata* in both section and ventral view; they can, however, readily be distinguished from it by their coarser ribbing and by the projection of the external ends of the ribs. Spath, although repeatedly stressing the close affinity of that species to some *Elobiceras*, decided to separate it from this genus to which, in the writer's opinion, it should also be referred.

ter is truncate at a diameter of about 30 mm.; then the former becomes gradually lancetiform, the latter roof-shaped. This section in the posterior part of the outer volution (diameter: 65 mm.) is seen in text fig. 11a. Later the intercostal section becomes wider again, assuming an inverted heart shape (text fig. 11b, diameter: about 80 mm.), but in the body chamber it rather suddenly becomes for the second time lancetiform and even decidedly compressed, the venter having become fastigate (text fig. 11c). The sides, most distant from each other at about their inner third, are gently vaulted and converge ventrad in adolescence, but they become almost flat and parallel in the body chamber. The costal section at any stage differs from the intercostal one by its greater width, and particularly by the fact that the latero-ventral and

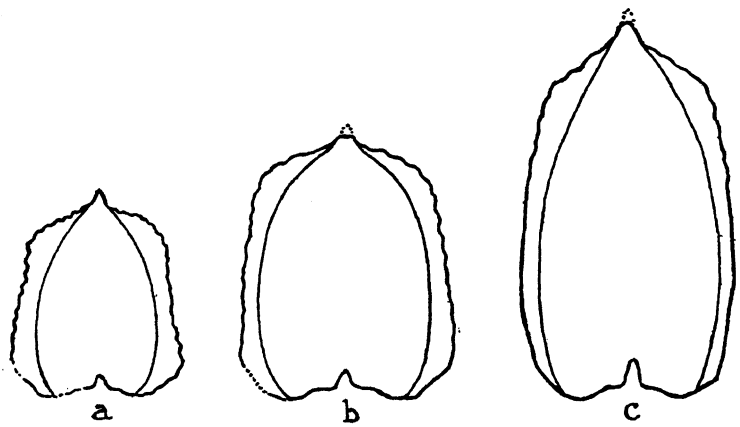

Fig. 11. Development of section in *Elobiceras spathianum*, new species, holotype, A.M.N.H. No. 25167. Costal and intercostal sections at diameters of (a) ca. 65 mm., (b) ca. 80 mm., (c) ca. 135 mm., all natural size.

Elobiceras spathianum, new species

Pl. XXV, figs. 2a, b; Pl. XXXV, fig. 3; text figs. 11a–c

A. M. N. H. No. 25167: 1 specimen

	Dimensions					
	D	H	H′	W	W′	U
Holotype:	ca. 137.5 mm.	37½[1]	34	19	21	37

Description.—The left side of the anterior part of the single specimen was crushed and crumbled off in the course of preparation; about a third of its outer whorl, as seen in fig. 2a, belongs to the body chamber.

The conch is discoidal and slender. In this species, also, the degree of involution apparently first increases, then decreases. The intercostal section is subrectangular, and the ventral edges are accentuated by the external and internal nodes, respectively. The umbilical shoulder is pronounced, though rounded, and the umbilical wall is steep but not high.

The sculpture up to a diameter of 75 mm. consists of sharp coarse ribs, bifurcating almost regularly at prominent, radially elongated, umbilical tubercles. Both these tubercles and the tendency toward bifurcation gradually disappear later in the development. The ribs are single on the anterior half of the outer whorl, and a few of them are a little longer than the others and a little higher near the umbilical shoulder. All are at first rather sharp, but on the outer zone of the sides they become gradually broader and blunter.

On the penultimate whorl the costae are rather stiff, only slightly sigmoidal, and a little rursiradiate. Later they become almost straight on the sides, but on the anterior part of the outer volution they are again slightly sigmoidal. In maturity there is only a distinct swelling of the ribs at the peripheral shoulders, instead of the

[1] This ratio and the following ones measured at D = 128.8 mm.

rather sharp external tubercles which are present up to a diameter of about 75 mm. On the venter the costae turn decidedly orad and continue, gradually vanishing, up to the base of the sharp, moderately high keel. It is neatly separated from the venter in the penultimate whorl but not in the ultimate one. The ribs join the keel alternately from each side. There are forty-two costae on the last whorl.

On the penultimate volution the ribs are crenulated throughout, and about ten spiral ridges can be counted on the sides and from five to seven considerably finer ones on the ventral projections of the ribs. On the body chamber the spiral ornamentation is indistinct on the inner two-thirds of the costae but is more visible on the outer third.

Suture lines, which are almost complete, could be studied between the diameters of 70 and 80 mm. (Pl. XXXV, fig. 3). They are similar to those of the preceding species, agreeing best as to degree of indentation with its variety *rigidecostata*, although here the external saddle and the first lateral one are of equal height, and the second lateral one is much lower than the first. However, these suture lines are more similar to those of *E. raymondi*, one of the characteristic species of the genus, in that they show a distinctive sutural feature of the latter, that is, the long, sharp terminal points of the siphonal lobe are almost perpendicular and parallel to each other. Furthermore, those of the first lateral lobe, which is but a little shorter than the siphonal one, also diverge less than in *E. irregulare*. Both the first and the second lateral lobe are bifid. The latter is followed by a bifid second lateral saddle and on the umbilical wall by the three-pronged first auxiliary lobe, the narrow, low, bifid, first auxiliary saddle, and the short, two-pronged, second auxiliary lobe which just touches the umbilical seam. In the impressed zone there can be observed a narrow saddle; a comparatively slender, trifid lobe with a distinctly three-pronged middle point; the elaborate, tall and slender internal saddle; and the very narrow, deep and trifid anti-siphonal lobe.

REMARKS.—Within the present collection this species holds an intermediate position between *E. irregulare* and its variety *rigidecostata* and *E.* cf. *flexicostatum*, by which it is also linked to *E. oxytropidoceratoides*. In general habitus and in the ornamentation of the inner whorls it is very similar to *E. irregulare* and particularly to the variety *rigidecostata* of that species, though the ornamentation is less coarse and irregular in *E. spathianum*. This species is also more slender and in the body chamber more lancetiform in section than the variety *rigidecostata* or the typical *E. irregulare*. Furthermore, it is slightly less evolute than the former and has on its outer volution less pronounced tubercles than the latter. Minor differences in costation and in sutural characters also exist. These may be observed by a comparison of the detailed descriptions, side views (Pl. XXIV, fig. 1a, Pl. XXV, figs. 1a, 2a) and sutural drawings (Pl. XXXV, figs. 1, 2, 3) of the three forms here discussed.

E. cf. *flexicostatum* and *E. oxytropidoceratoides* will be compared below (pp. 107 and 109, respectively).

As in the case of *E. irregulare* and its variety *rigidecostata* this species is still closely related to *Pervinquieria arietiformis* (*sensu lato*). Equally large specimens of the *forma typica* of the latter (e.g., No. 4) almost exactly agree with the holotype of *E. spathianum* in their measurements. The present species, however, differs from the former by its more fastigate venter, by its ribbing which is coarser and sharper on the inner whorls but finer and weaker in maturity, and by the greater degree of indentation and the more straitened saddles of its suture line. Furthermore, it does not nearly attain the large size of *P. arietiformis*. The latter's variety *lēvicostata* can readily be distinguished from the species under discussion by the same differences in suture line and costation and, furthermore, by the fact that on the outer whorl its ribs form a flat, orad concave arc across the sides, whereas they are straight or slightly sigmoidal in *E. spathianum*, and they almost entirely lack spiral ornamentation. Also the external knobs and latero-ventral shoulders are more distinct in *P. arietiformis*, var. *lēvicostata*, and the latter is more evolute and somewhat stouter than the present species.

Elobiceras cf. **flexicostatum** Spath

Pl. XXVI, fig. 1

A. M. N. H. No. 25168: one specimen

Cf. *Elobiceras flexicostatum* SPATH, 1922, p. 133, Pl. II, fig. 5.

DESCRIPTION.—A single fragment, which measures 93.5 mm. in length and 74.5 mm. in height and seems to belong to a body chamber, agrees fairly well, both in section and costation, with Spath's holotype. However, it has less dense ribbing. Seven

ribs are to be seen on the present fragment, indicating that there were about ten of them per quarter whorl, as compared to fourteen per quarter whorl on Spath's form. Also, every second rib arises at some distance from the umbilical shoulder, whereas all costae on Spath's holotype seem to be equally long. From ten to twelve rather blunt spiral ridges can be counted throughout the length of every rib on the present specimen.

REMARKS.—The latter feature proves that this form is a true *Elobiceras*. Spath (*loc. cit. in synon.*) has discussed the differences by which *E. flexicostatum* may be distinguished from other species of this genus. Among the forms of the present collection *E. spathianum* differs from the fragment under examination by its much denser, sharper costation, which is of a quite different design. *E. oxytropidoceratoides* and *E.*, indeterminate species No. 2, will be compared below (pp. 109 and 122, respectively), as will *Neoharpoceras angolanum*, new species, which shows a superficial resemblance to this specimen (see p. 135).

Elobiceras oxytropidoceratoides, new species

(A) forma typica

Pl. XXVI, figs. 2–5; Pl. XXVII, fig. 1; text fig. 13a

A. M. N. H. No. 25169: eight specimens

they are crushed, but they seem to have been particularly subject to crushing owing to their slenderness. At the diameter of 24 mm. the section, as seen in specimens Nos. 3 and 4 (Pl. XXVI, figs. 4b and 5), is perfectly rectangular, both the sides and the venter being quite flat. The sides are still flat at a somewhat larger diameter (of about 30 mm.); later, the latero-ventral edges become less pronounced and gradually rounded, and the sides become gently vaulted, as seen in the penultimate whorl of the holotype (Pl. XXVI, fig. 2c). At that stage (diameter about 45 mm.) the section attains its maximum width at about the inner third of the sides, and the venter is still rather broad and slightly truncate. The umbilical shoulder is rounded and the umbilical wall almost perpendicular but moderately high. In the outer whorls of both the holotype and specimen No. 3 the umbilical wall has become perpendicular or even overhanging and the umbilical edge more pronounced, even sharp. The sides have again become almost flat; they are most distant from each other slightly above the umbilical shoulder and have a decidedly ventrad convergence; the external shoulders are still distinct, and the venter is roof-shaped. The relative thickness of the whorls seems to decrease rapidly, and simultaneously the venter becomes more and more sharpened. The keel is sharp and extraordinarily high, being almost 4 mm. in height at the anterior end of the outer volution of the holotype.

The section of the largest individual (No. 2) is distorted throughout by crushing (Pl. XXVI, fig. 3b), but there cannot be any doubt that it was even before that considerably more slender than that of the holotype.

The ornamentation could be well studied throughout development. At a diameter of about 25 mm. the ribs bifurcate regularly at umbilical tubercles which are at that stage still sharp and prominent. Later, between the diameters of 35 and 42 mm., the latter become gradually more blunt and are radially elongated, and several single ribs appear between the bifurcating ones; the point of bifurcation has meanwhile been shifted a little ventrad, occasionally as far as the inner third of the sides. At a diameter of about 60 mm. (specimen No. 8, Pl. XXVII, fig. 1) primary ribs, starting from distinct, though blunt, radially elongated tubercles at the umbilical shoulder, alternate almost regularly with secondary ones which begin at the innermost fifth of the sides. At this stage the costation is not very different from that of other species of this genus; the ribs are narrower,

DIMENSIONS

Spec. No.		D	H	H′	W	W′	U
Holotype: 1	(a)	43.5 mm.	48	41 1/2	34 1/2	39	28 1/2
	(b)	106.0 mm.	41	36 1/2	22 1/2	23 1/2	30 1/2
2		ca. 170.0 mm.	?	?	9 1/2?[1]	10 1/2?[1]	32 1/2?

DESCRIPTION.—About a quarter of the outer whorl of the holotype may belong to the body chamber and a sixth only of that of specimen No. 3; both these specimens are very similar to each other, and both are partly crushed. The largest example (No. 2) is still more crushed. Its outer volution is certainly unseptate, and the inner ones are almost entirely destroyed. A little fragment of an inner whorl (specimen No. 4) agrees perfectly with the same stage of No. 3. The best preserved (No. 8) among four more fragments (Nos. 5–8) seems to be unseptate at a diameter of about 60 mm.

The conch is discoidal and becomes extremely slender in maturity. The examples mentioned above do not appear slender merely because

[1] Specimen very crushed.

weaker and less distinctly crenulated than those on the inner whorls of *E. intermedium* and rather like those of the same stage of *E. raymondi*, though less sigmoidal. There are forty of them per whorl. On the penultimate volution of the holotype a fine, dense crenulation can be seen on the ribs only where preservation permits. It can be much better observed on specimen No. 8, where about fourteen transverse ridges, which become gradually longer, finer and more dense ventrad, can be counted on every primary rib.

On the outer whorl of the holotype the costation is much more dense than on the penultimate one; there are twenty-eight rather narrow and elevated ribs per half whorl, running in a wide, shallow, orad concave arc across the sides, widening and swelling near the external shoulder and continuing on the venter obliquely forward up to the base of the keel. Occasional bifurcation still may be seen. There are from fifteen to seventeen spiral ridges on every rib, these being crowded on the external swellings.

In the largest disc (specimen No. 2) there are thirty-two ribs per half whorl. Their course is about the same as on the outer volution of the holotype except for their more pronounced projection near the periphery. The ribs, which are rather elevated on the posterior part of the whorl, gradually flatten toward the aperture. The bifurcation of ribs or the intercalation of secondary ones occurs only occasionally, and several more or less vestigial umbilical tubercles can still be seen. The spiral ornamentation is much less prominent now than at earlier stages, and it appears to be reduced to five or six transverse striae on the peripheric ends of the ribs and to obsolete spiral ridges in the other parts of the conch.

The suture line could best be studied in the holotype at diameters between 30 and 40 mm. (text fig. 13a). Unfortunately the siphonal lobe and the adjacent portions of the external saddle could not be examined in this example, as they are either covered by the outer volution or corroded. Although the finest details appear to be lost due to weathering, the degree of indentation can be recognized as having been a rather rich one, though less so than in *E. intermedium* or *E. raymondi*. Other features, also, are decidedly those of an *Elobiceras* suture. The lateral saddles are tall and slender, the lobes rather deep. The first lateral one is bifid, the second trifid; the latter attains a length which is about three-quarters of that of the former. Almost all the terminal points of both these lobes seem to be three-pronged. The first lateral saddle is deeply intersected at its top by a three-pronged lobule, and its main stem is much straitened at about the first third of its height. The second lateral saddle resembles the first in shape, but it does not seem to be straitened to the same degree. There follow on the umbilical shoulder the three-pronged first auxiliary lobe which points slightly ventrad; and, on the umbilical wall, the low and broad, deeply bifid, first auxiliary saddle, the small, three-pronged, second auxiliary lobe and a second auxiliary saddle which borders the umbilical seam. An earlier stage of the suture line could be studied in specimen No. 4 at diameters between 15 and 20 mm.; the general outlines seem to be about the same, if allowance is made for the smaller size. Here the external part of the suture line also is accessible for examination. The siphonal lobe is considerably deeper than the first lateral one and ends in the two long, almost perpendicular points characteristic of this genus. The external saddle is comparatively broad and seems to be deeply intersected at its top.

Three fragments, Nos. 5–7, all of which exhibit only the inner zones of the flat sides, somewhat deviate in costation from the holotype. The ribs, the inner, straight parts of which are seen, are, as a rule, single. These specimens are, therefore, though doubtfully, referred to the present species.

(B) var. **minor**, new variety

Pl. XXIII, figs. 5a–c

A. M. N. H. No. 25170: one specimen

DIMENSIONS

	D	H	H′	W	W′	U
Holotype:	87 mm.	43½	?	17	19½	29½

DESCRIPTION.—A single specimen, consisting of almost three-quarters of an outer whorl, apparently represents an accelerated development of this species and, therefore, had to be separated from the typical form. It agrees with the latter in the general shape of the conch, in the section and in costation. But the whorl, the anterior half of which seems to belong to the body chamber, is very thin, the periphery is decidedly roof-shaped and the ribs have attained characters indicative of maturity at a diameter of about 48 mm., whereas in the *forma typica* it is still rather stout, its venter almost flat and its ribbing very similar to that of other, more typical *Elobiceras* at a diameter of 43.5 mm. Furthermore, the venter becomes fastigate in the anterior half of the preserved volution, viz., between the diameters of 50 and 87 mm.

The swelling of the ribs near the periphery seems to be slightly more pronounced than in the typical form; on the right side of the conch the row of costal swellings is accompanied dorsad by a shallow furrow. Bifurcation or even trifurcation of ribs occurs occasionally; secondary ribs are, in the outer half of the side, only rarely intercalated on the body chamber. Distinct spiral ridges can be found in this variety only on the external, swollen parts of the ribs; on other parts of the shell obsolete traces of spiral ornamentation can occasionally be observed.

No continuous suture lines could be traced.

REMARKS (AD *E. oxytropidoceratoides*, SENSU LATO).—There is a striking similarity between this form and some species of the genus *Oxytropidoceras* Stieler (1920,

p. 346; genotype: *O. roissyanum* [d'Orbigny, 1841, p. 302, Pl. LXXXIX]), especially abundant in the Comanche Series of Texas and in the upper horizon of the Middle Albian of Madagascar, e.g., *O. acutocarinatum* (Shumard) (Lasswitz, 1904, p. 20, *cum synon.*, Pl. V, fig. 1; Collignon *in* Besairie, 1936, p. 179, *cum synon.*, figs. 12h, i, Pl. XVIII, fig. 1, Pl. XIX, fig. 4, Pl. XX, fig. 2) and its variety *multifida* Steinmann (Lasswitz, 1904, p. 22, Pl. V, fig. 2; Collignon *in* Besairie, 1936, p. 181, Pl. XX, fig. 1), *"Sonneratia" supani* Lasswitz (1904, p. 22, Pl. IV, fig. 3), *O. chihuahuense* (Böse, 1910, p. 73, Pl. V, figs. 3, 4, Pl. VII, figs. 3, 4, Pl. VIII, figs. 1, 2; Adkins, 1928, p. 227, Pl. VI, fig. 5), *O. belknapi* (Marcou)[1] (Adkins, 1928, p, 226, *cum synon.*, Pl. IV, fig. 3, Pl. VII, figs. 1, 4, the latter representing the holotype). The sutural characters, however, are entirely different. Whereas the saddles are sturdy and indented just at their margins in *Oxytropidoceras*, they are tall, rather narrow and deeply intersected and straitened in the present species. The above resemblance thus appears to be due merely to convergence. Moreover, the close similarity between the inner whorls of this species and those of undoubted *Elobiceras*, e.g., *E. intermedium*, *E. raymondi*, does not permit any doubt concerning the generic position of *E. oxytropidoceratoides*.

Within the genus *Elobiceras*, *E. spathianum*, *E. flexicostatum* Spath (1922, p. 133, Pl. II, fig. 5) and *E.* cf. *flexicostatum* of the present collection (p. 106) seem to be most closely related to this species. All have in common the forward turning of the ribs toward the periphery, the relatively slender section and the high keel. The costation is, however, much more dense, and the whorls are much thinner at the same diameter in the present species which is, furthermore, much more involute than *E. spathianum*.

The specimen illustrated by Choffat (1888) in fig. 2 of his Pl. II is similar to the species under discussion in costation but quite different in section, since its sharpened venter lacks any distinct keel. As pointed out by Spath (1922, p. 133), it is related to the form figured by Stoliczka (1865, p. 52, Pl. XXX, fig. 5) as *"Ammonites*, sp. indet.," and to other species of *Neoharpoceras*. Also the present species approaches, by the degree of its involution, by its slender section, by its dense costation and in its sutural characters the representatives of that genus in the present collection, *Neoharpoceras angolanum* and *N. conditum* (for detailed comparison see pp. 135 and 137, respectively).

There is also considerable resemblance in section between the inner whorls of *E. oxytropidoceratoides* and *Dipoloceras rectangulare* Spath (see p. 14), but the former can readily be distinguished from the latter by the absence of sharp umbilical tubercles and by its much more elaborate suture line. The resemblance of the inner whorls of this species to those of *Prohysteroceras decipiens* will be discussed below (p. 130).

Finally, it may be noted that the similarity between *E. oxytropidoceratoides* and *E. elobiense* is apparently confined to the slenderness of the section, to the sharpness of the venter and to the degree of involution; the latter species, however, is already very slender at a much smaller size, its costation, consisting of broad flat ribs, is entirely different, and its keel is lower.

Elobiceras intermedium Spath

Pl. XXVII, figs. 2–5; text figs. 12b, 13b, α, β

A. M. N. H. No. 25171: twelve specimens

Schloenbachia elobiensis Szajn.; CHOFFAT, 1888, p. 66, *pro parte*, Pl. I, fig. 8 only.

Elobiceras intermedium SPATH, 1922, p. 134, Pl. I, fig. 1.

Elobiceras elobiensis Choffat; AIRAGHI, 1931, p. 849, Pl. II, fig. 3.

DESCRIPTION.—The four largest specimens (Nos. 1–3, 6) attain a diameter of about 130 mm. each; in all of them the body chamber is partly preserved, in two (Nos. 1, 2) almost as far as the aperture. Its length includes from a half (in specimen No. 2) to more than three-quarters (in specimen No. 1) of a whorl. The apertural margin is not preserved, but its proximity is indicated by the beginning of a rostrum (Pl. XXVII, figs. 2a, 3). Specimens Nos. 4 and 11 (for dimensions see above) represent

[1] This species has since been made by Spath (1931, p. 350) the genotype of his genus, *Adkinsites*.

Spec. No.	D	Dimensions H	H′	W	W′	U
11	22.5 mm.	42	?	?	39?	31
4	41.0 mm.	44½	40	32½	35½	27
1	(a) 103.0 mm.	40	36	30	34½	33½
	(b) 130.0 mm.	36½	32½	26	28	34½

earlier ontogenetic stages; there are, in addition, fragments of individuals of various sizes.

In this species, as in others of this genus and of other genera, both the height and width of the whorls and the degree of involution first increase, then in the body chamber again decrease. There is, furthermore, a very remarkable egression of the spiral of involution in the outer whorl, causing the conch to appear to be peculiarly elliptic.

The intercostal section is slender and elliptic, almost oblong, in the young (text fig. 12b, Pl. XXVII, fig. 5b), inverted heart-shaped in adults, the maximum width then being at the first fourth of the sides (Pl. XXVII, fig. 2c). The umbilical shoulder is more pronounced and the umbilical wall much higher and steeper in the septate part of the conch than in the body chamber. The sides converge slightly ventrad and are gently vaulted. In the anterior part of the body chamber they become much more rounded. The venter is truncate at the earliest stages but roof-shaped in maturity. The costal section (Pl. XXVII, fig. 2c), however, exhibits at that stage flat sides, but slightly converging ventrad, and a truncate periphery. The keel (which is fully preserved at a single place on specimen No. 1 only, see Pl. XXVII, fig. 2a) is high and sharp and but moderately broad at its base.

The sculpture consists at the earliest stage (diameters from 12 to 15 mm.) of strongly prorsiradiate, circumumbilical folds and eighteen broad, strong, though rather blunt ribs per half whorl on the outer half of the sides; the inner one is almost smooth. Later the number of ribs increases to forty per whorl, but again decreases to thirty-six on the outer volution. Up to a diameter of 35 mm. strong umbilical folds

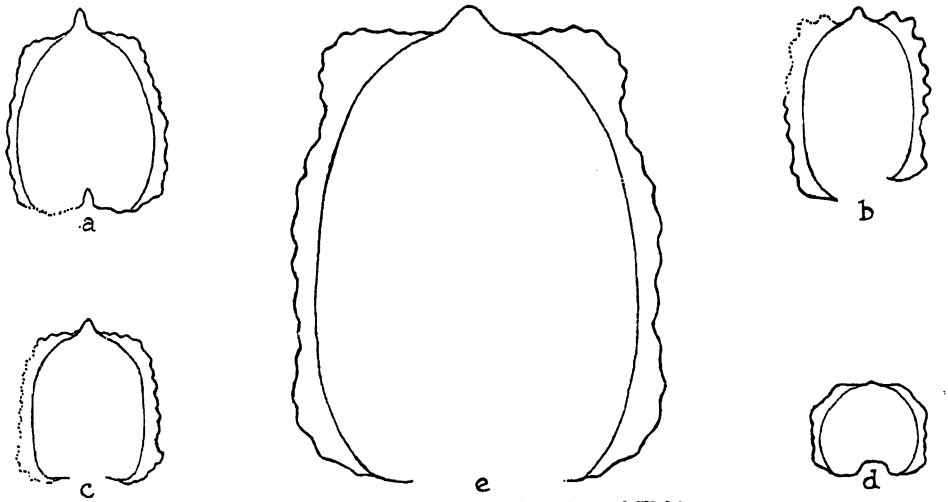

Fig. 12. Costal and intercostal sections of *Elobiceras*.
(a) *E.*, indeterminate new species No. 1, A.M.N.H. No. 25164:1, × 3/2.
(b) *E. intermedium* Spath, A.M.N.H. No. 25171:4, × 3/2.
(c) *E. raymondi*, new species, A.M.N.H. No. 25175:2, × 3/2.
(d) *E. hexagonum*, new species, A.M.N.H. No. 25177:4, × 4.
(e) *E. browni*, new species, holotype, A.M.N.H. No. 25178:1, at anterior end, natural size.

are present, and a bifurcation of ribs or an intercalation of secondary ones at the inner third or at the middle of the sides is found occasionally. The costae are distinctly sigmoidal. At a diameter of about 50 mm., however, they assume the distinctive generic characters which are, in the writer's opinion, most pronounced in this species. They become prominent, almost straight and club-shaped; they are now always single, uniform and broader than the interventral view, they run perpendicularly toward the keel, stopping at a distance of about 1 mm. from it. As observed by Spath, the external ends of the ribs are not exactly opposite each other on both sides of the keel but alternate in position.

Crenulation of ribs begins at diameter from about 15 mm. On the outer whorl th costae are distinctly crenulated throughout and from thirteen to fifteen conspicuou spiral ridges can be counted on each of

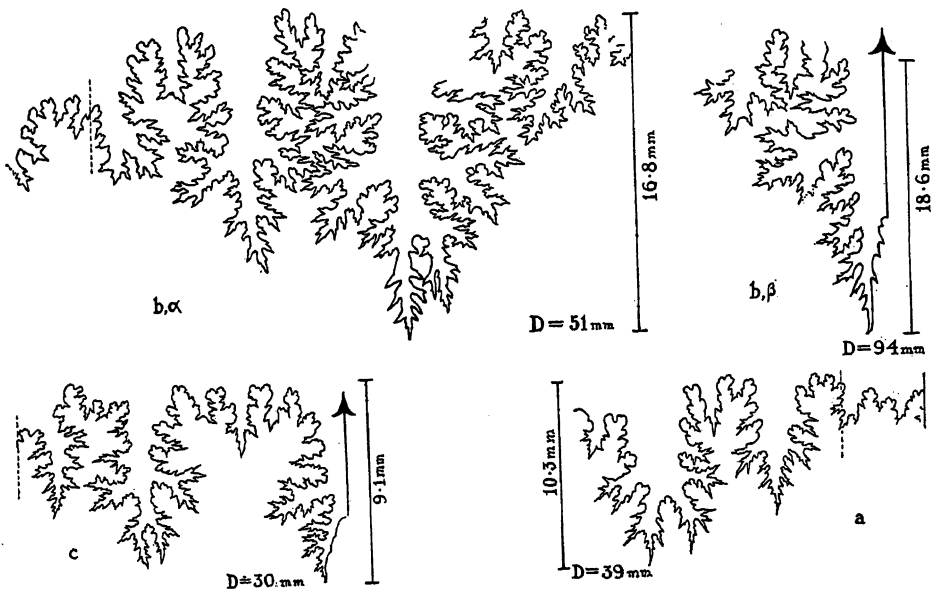

Fig. 13. Suture lines of *Elobiceras*.

(a) *E. oxytropidoceratoides*, new species, holotype, A.M.N.H. No. 25169:1.
(b) *E. intermedium* Spath, A.M.N.H. No. 25171:6, α, penultimate whorl (combined from two neighboring suture lines); β, left half of a siphonal lobe of outer whorl.
(c) *E. hexagonum*, new species, A.M.N.H. No. 25177:3.
Scale and diameter of disc are indicated for every drawing.

costals. The costation between the diameters of 55 and 105 mm. appears to be slightly less dense than at both the earlier and the later stages. On the anterior part of the body chamber there is another change in the character of the ribbing, for although remaining club-shaped, the costae become narrower and sharper in the inner zone of the sides and more and more prorsiradiate orad and are for a second time slightly sigmoidal. The external knobs are very strong, particularly on the posterior half of the body chamber; in them. They decrease ventrad in prominence and sharpness.

The very elaborate suture line could best be studied in the penultimate whorl of specimen No. 6 at a diameter of about 50 mm. (text fig. 13b, α). Both lobes and saddles are greatly elongated in the spiral sense. At this stage the siphonal lobe is comparatively broad, but it narrows remarkably on the outer whorl (text fig. 13b, β); its two long, slender, terminal points diverge but very slightly; there is a strong, trifid, main lateral branchlet on each side.

The external saddle, which cannot be fully examined, seems to be rather broad; it is deeply intersected at its top by a strong, dorsad oblique, trifid lobule and is much straitened at about half its height. The first lateral lobe seems to be a little shorter than the siphonal one; it is rather narrow, as far as its main body is concerned, and very deep; both its long and narrow terminal points are three-pronged; the inner one is considerably longer than the outer one, and they are almost parallel and separated from each other by a tall, slender, deeply indented upright leaf. In addition, there are two pairs of main lateral branches; the lower ones are the strongest and decidedly bifid, the upper ones are shorter, almost horizontal, and trifid. The first lateral saddle is tall, deeply intersected in its upper part by a trifid lobule and in its upper half straitened three times to the extent that it is almost excised. The second lateral lobe attains a little more than two-thirds of the length of the first; it is also narrow and decidedly trifid, with a long three-pronged middle point. The second lateral saddle resembles the first in shape, but it is much lower and not narrowed to such a degree. The comparatively broad, short, trifid, first auxiliary lobe is strongly oblique ventrad; it is still in the innermost zone of the sides, whereas the extremely broad, low, bifid, first auxiliary saddle is almost entirely on the umbilical wall, where also a second auxiliary lobe is visible.

REMARKS.—Although the examples in the present collection agree fairly well with Spath's original description and figures, my abundant material permitted the more detailed description given above. The fragment described and figured by Airaghi (*loc. cit. in synon.*) under the name of "*E. elobiensis*" is, in my opinion, referable to the present species; its costation agrees perfectly with that of my specimen No. 4, particularly as to the sharp transverse ridges on the ribs. Airaghi was not unaware of the differences between his specimen and the true *E. elobiense*, but he provisionally referred it to that species because of its strong resemblance to Choffat's (*loc. cit. in synon.*) fig. 8, overlooking the fact that Spath (1922) had repeatedly discussed the latter which he considered to be a nucleus of a form similar to *E. intermedium* or *E. subelobiense*. As Choffat's fig. 8 agrees fairly well with the inner whorls of specimen No. 1, the writer does not hesitate to refer it to the present species, whereas he believes that Choffat's fig. 9 is probably a nucleus of *E. raymondi*, new species.

As to the distinction between *E. intermedium* and its nearest congeneric relatives, *E. lobitoense*, *E. angustum* and *E. subelobiense*, here a general reference to Spath's Angola paper may suffice, though it should be borne in mind that the succession of three (or at least two) distinct types of ribbing is not, as that author assumes, a peculiarity of *E. lobitoense* and *E. neuparthi* but is found in several other species of *Elobiceras*, e.g., *E. intermedium* and *E. browni*, and in *Pervinquieria arietiformis* as well.

Within the present collection *Pervinquieria arietiformis* resembles the present species in section; the latter, however, differs greatly from the former in its costation which is, even on the inner whorls, not at all as coarse and is, on the whole, that which is characteristic of *Elobiceras*. In maturity the ribs are broader and less sinuous; the external knobs are much stronger and continue perpendicularly, not obliquely, toward the keel from which they always remain neatly separated. Also the spiral ridging of the ribs is much more distinct in *E. intermedium*. Medium sized individuals of *P. arietiformis* resemble those of the present species in general habitus but can readily be distinguished by their ribs, which are decidedly projected near the periphery, less prominent, not club-shaped and much less distinctly crenulated, as well as by their much weaker external knobs.

This species does not require detailed comparison with the very different *E. elobiense*.

Finally, there must be mentioned a remarkable resemblance between the earliest stages (specimen No. 11) of *E. intermedium* and examples of the same size of *Dipoloceras rectangulare* (above, p. 14); the latter may, however, be distinguished by their

stronger, stiffer, more elevated ribs, which do not fade in the inner zone of the sides and do not show any crenulation, and by their whorls which are stouter even at an early stage.

Elobiceras lobitoense (Crick MS) Spath

Pl. XXVIII, figs. 1, 2

A. M. N. H. No. 25172: three specimens

Elobiceras lobitoense (Crick MS. sp.), nov.; SPATH, 1922, p. 136, Pl. I, fig. 2.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1	ca. 115 mm.	ca. 38½	?	?	?	37

DESCRIPTION.—The principal representative of this beautiful species in the collection is a mold which does not exhibit the periphery but which perfectly permits its reference to Crick's form. Figure 1 shows the artificial cast of this mold.

The conch is moderately involute, and the umbilicus rather wide. The sides are rather flat on the penultimate whorl and gently rounded on the outer one; they are most distant from each other at about their first third. The umbilical shoulder is rounded, and the umbilical wall is moderately high and not very steep.

The ribs are straight and radial in direction[1] up to a diameter of about 90 mm.; they occasionally bifurcate near the umbilical shoulder. Although widening ventrad, they are on the anterior half of the outer whorl narrower than the intercostals; the costation is much denser at the earlier stages. The costae are conspicuously crenulated throughout; from eleven to twelve spiral ridges can be counted on each rib from the umbilical shoulder ventrad as far as the mold extends. There must have been at least fifteen of these ridges, not nine as Crick stated in his description (cf. Spath's fig. 2a). These ridges continue between the ribs as fine, though distinct spiral striae. There are eighteen costae on the anterior half of the penultimate whorl and only twenty-eight on the last; the latter figure agrees with the density of costation on the part of the whorl marked "A-B" in Spath's side view.

The details of ornamentation can be excellently observed on a whorl fragment (No. 2, fig. 2) exhibiting three ribs which are rather distant from each other and covered with sharp and strong spiral ridges; there are eleven of them on the middle rib which is almost complete. A little fragment (No. 3), consisting just of the external knob of a very large rib, seems also to belong to this species.

REMARKS.—This species can readily be distinguished from the preceding one by its more rounded section and its less dense costation; furthermore, its ribs do not become so prominent toward the periphery as on the former. *E. lobitoense* is also closely related to *E. subelobiense*, *E. angustum*, *E. raymondi;* with all of them, as well as with *E. browni* and *E. elobiense*, it will be compared below.

Elobiceras subelobiense Spath

Pl. XXVIII, figs. 3a–c

A. M. N. H. No. 25173: five specimens

Elobiceras subelobiense SPATH, 1922, p. 132, Pl. II, figs. 2.

Elobiceras subelobiensis Spath; AIRAGHI, 1931, p. 849.

? *Elobiceras subelobiense* Spath; VENZO, 1936, p. 96, Pl. XII, fig. 7.

DESCRIPTION.—A septate fragment (No. 1) agrees fairly well, both in section and in costation, with Spath's holotype. The venter is broad and truncate. The ribs are broad and club-shaped, widen rather quickly and are close to each other and densely crenulated. Suture lines can be traced, but they are too poorly preserved for description or delineation.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
1	?	39.2 mm.	?	27.3 mm.	28.5 mm.	?

Four much smaller fragments (Nos. 2–5) exhibit the same type of costation and are, therefore, also referred to this species.

REMARKS.—Spath (*loc. cit. in synon.*) proposed this species as a new name for

[1] In the holotype they are strictly radial on the first half of the outer whorl, and they begin to turn forward only on its anterior part.

the form figured, under the name "*Schloenbachia elobiensis*," by Choffat (1905) in Pl. IV, fig. 5, but the writer doubts whether that form is really conspecific with Spath's, as it has stiffer, narrower and more outstanding ribs. It is also doubtful whether Venzo's (1936, p. 96, Pl. XII, fig. 7) specimen from the Upper Albian of Zululand really belongs to the present species, as its section, said in the description to be "subplana nella regione sifonale," is seen in the diagram to be not at all so truncate as in Spath's type.

E. subelobiense has been compared above (p. 101) with *E. primordiale*. In addition, *E. intermedium*, *E. lobitoense*, *E. raymondi*, *E. browni* and *E. elobiense* appear to be closely related to the species under discussion. It differs from *E. intermedium* by its more ventrad tapering section and by its less prominent, broader and more dense ribs. The same difference in section is also found in the comparison of the present species with *E. lobitoense* which also has straighter ribs and much broader intercostals. The other species enumerated above will be compared below.

Elobiceras cf. angustum Spath

A. M. N. H. No. 25174: one specimen

Cf. *Elobiceras angustum* SPATH, 1922, p. 134, Pl. II, fig. 1.

Elobiceras angustum Spath; AIRAGHI, 1931, p. 850.

DESCRIPTION.—The single, poorly preserved example exhibits the outer parts of four ribs and half the venter. In costation and in the peripheral part of the section, which shows a slightly depressed outer zone of the sides and very pronounced external shoulders, it agrees with Spath's form, but it differs from it by its high keel which considerably exceeds the external shoulders in height. Although it may be doubted whether the "sunk keel" seen in Spath's fig. 1b is not merely due to crushing, the present fragment cannot, because of that difference, fully be identified with this species. No suture lines could be traced.

REMARKS.—The validity of this species, which is based on a single crushed fragment, may seem doubtful. But Spath's type differs from *E. subelobiense* by being more slender, by having higher latero-ventral shoulders, a low keel and slightly sigmoidal ribs. By the same characters and, in addition, by its less prominent costation it can also readily be distinguished from *E. intermedium* and *E. lobitoense*. Except for its higher keel, the present fragment can also be distinguished by the same features from these three species. Both Spath's form and that here dealt with will be compared below with *E. raymondi*, *E. browni* and *E. elobiense* (pp. 117, 124 and 121, respectively).

Elobiceras raymondi,[1] new species

(A) forma typica

Pl. XXVIII, figs. 4–6; Pl. XXIX, figs. 1–3; Pl. XXX, figs. 1a–b; Pl. XXXV, figs. 4–10; text fig. 12c

A. M. N. H. No. 25175: twenty-eight specimens

? *Elobiceras elobiense* Szajn.; CHOFFAT, 1888, p. 66, *pro parte*, Pl. I, fig. 9 only.

DESCRIPTION.—If mere fragments and poorly preserved individuals are disregarded, the site of the last septum was found, at diameters of from 16 mm. on, in eleven of the thirteen specimens which could be examined. Not all of these individuals, however, are mature. In the holotype and in the largest specimen (No. 5) which attain diameters of about 120 and 150 mm., respectively, and seem to be adults, the last septa may have been between the diameters of 65 and 95 mm. Although these two examples are preserved up to the apertural margin, the length of the body chamber cannot be accurately determined since the last septum is missing in the first specimen and cannot be located in the second. In both of them the apertural margin seems to be parallel with the last rib; both ex-

DIMENSIONS

Spec. No.		D	H	H′	W	W′	U
1		31.0 mm.	50	?	32½?	38½?	26
18		36.0 mm.	45½	ca. 39	32½	35	27½
Holotype: 4	(a)	36.5 mm.	50½	?	33	35½	?
	(b)	65.5 mm.	46	39½	30	31	30
	(c)	ca. 120.0 mm.	ca. 38[1]	ca. 36[2]	25½	26½	38½

[1] Named in honor of Dr. Percy E. Raymond, Professor of Palaeontology, Harvard University.

[2] Disregarding the rostrum.

hibit parts of distinct rostra and an egression of the spiral of involution, as observed also in other species, e.g., *E. irregulare*. The conch is discoidal and in the adolescent stage comparatively involute; however, in maturity the umbilicus widens to a high degree.

The development of the section is seen in Pl. XXVIII, figs. 4, 5c, 6; Pl. XXIX, figs. 1b, c, d; Pl. XXX, fig. 1b; text fig. 12c. Up to a diameter of 17 mm. (specimen No. 1, Pl. XXVIII, fig. 4) it is rather slender and elliptic with rounded lateroventral edges, flat sides and a flat, comparatively narrow venter. At a diameter of from 25 to 30 mm. (specimens Nos. 2, text fig. 12c, and 8, Pl. XXVIII, fig. 6) the section has become stouter and almost rectangular in shape; the sides are but slightly vaulted, the venter is broad and truncate; and the umbilical edge is, at least in some individuals (e.g., No. 2, text fig. 12c), accentuated by umbilical tubercles. At a diameter of not quite 40 mm. (specimen No. 6, Pl. XXVIII, fig. 5c, and holotype, Pl. XXIX, fig. 1b), the section has not greatly changed, as compared to the preceding stage. The venter is still broad and almost flat, the external shoulders are still distinct, though rounded, and the sides more (Pl. XXVIII, fig. 5c) or less (Pl. XXIX, fig. 1b), though always gently, vaulted; however, the section again approaches a more oval shape. The latter persists in the holotype up to a diameter of about 65 mm. (Pl. XXIX, fig. 1c). The section of the body chamber of specimen No. 5 is at a diameter of about 130 mm. more lanceti-form (Pl. XXX, fig. 1b); here the sides are more vaulted and converge more decidedly ventrad, the venter is narrow and fastigate and the lateroventral edges are clearly visible only in costal section. At the apertural end of the holotype the rostrum causes a pronounced sharpening of the periphery (Pl. XXIX, fig. 1d); the sides now appear to be slightly concave in their outer third. The same is true of a fragment (No. 11) which represents approximately the same ontogenetic stage. Throughout all the development the sides are most distant from each other at about their inner third, and the umbilical shoulder is well rounded; the umbilical wall is rather high, perpendicular or even overhanging in the inner whorls, but it gradually loses its steepness on the anterior part of the body chamber. The median keel is always distinct; it is strong and comparatively high on the inner whorls, sharp and high on the outer one.

Up to a diameter of about 10 mm. the conch is almost smooth (specimen No. 24). Then broad blunt nodes appear around the umbilicus, and simultaneously broad, short, straight ribs develop which are confined at first to the outer third, then to the outer half of the sides (specimens Nos. 23–26). At diameters of from 20 to 25 mm. some of them begin to become connected by very faint undulations with the now more prominent inner tubercles and to assume a slightly sigmoidal course. At diameters between 25 and 30 mm. the ribs become continuous across the sides, crenulated and more distinctly sigmoidal, and the umbilical tubercles begin to be elongated in a slightly prorsiradiate sense (specimen No. 18, Pl. XXIX, fig. 2a). From that stage on this species is distinguished by its regular and graceful ornamentation. Throughout its further development the ribs are decidedly sigmoidal and directed radially on the whole, although, as is usual in this genus, they become prorsiradiate toward the aperture. There are fourteen ribs per half whorl at a diameter of 21 mm. (specimen No. 17), seventeen at a diameter of 31 mm. (specimen No. 1) and eighteen at a diameter of 36 mm. (specimen No. 18). Later the costation becomes more dense, being most dense at a diameter of about 80 mm.; the penultimate whorl of the holotype has forty-two ribs, twenty-three of them on its anterior half; in specimen No. 3 there are twenty-four, in specimen No. 9 even twenty-five ribs per half whorl. At later stages the density of costation again decreases slightly. On the anterior quarter of the holotype's outer volution there are only ten ribs, and there are only a few more (twenty-one per half whorl) on the outer volution of the largest specimen (No. 5).

The costae are rather flat and distinctly widen ventrad, forming at an early stage marked knobs at the external shoulder and assuming on the body chamber the characteristic club shape of this genus, although retaining their sigmoidal course. Here they become prominent and rather sharp in the innermost zone of the sides. With this exception they are much broader than the intercostals which are reduced to relatively narrow furrows. Up to a diameter of 40 mm. there is, as a rule, regular differentiation between primary and secondary ribs; the former arise from strong folds or even from radially elongated tubercles around the umbilicus; the latter begin, either by bifurcation or by intercalation, between the first third and the middle of the sides. Bifurcation and intercalation of secondary ribs persist on some individuals (e.g., No. 27, Pl. XXIX, fig. 3a) up to a diameter of 65 mm. and occasionally recur even on the anterior part of the body chamber (holotype, Pl. XXIX, fig. 1a), where the ribs are single as a rule. The external knobs are pronounced only on the body chamber and always remain neatly separated from the keel. In ventral view the costae are perfectly symmetrical on both sides in specimen No. 5 but slightly dissymmetrical on the anterior part of the holotype (Pl. XXIX, fig. 1e).

In the innermost whorls spiral striation seems to be limited to the outer parts of the ribs. From diameters between 25 and 30 mm. on, however, the costae are crenulated throughout. The stage at which this spiral ornamentation reaches its full development varies. In specimen No. 27 (Pl. XXIX, fig. 3a) nineteen transverse ridges can be counted on each rib at a diameter of about 35 mm., whereas this density occurs, as a rule, only beyond the diameter of 60 mm. These spiral elements are more ridge-shaped on the inner parts of the ribs, but, as the latter widen, they assume toward the periphery

more and more the shape of elongated riblets which become thinnest and most dense on the outer knobs. In specimen No. 27 mentioned above, the two outermost spiral riblets are much finer than the others and continue almost unweakened across the intercostals. In addition, a secondary riblet, which is still finer than these, is intercalated dorsad of them (fig. 3b).

Suture lines could be studied in specimens Nos. 22–26, 28, 18, 8 and in the penultimate whorl of the holotype. From a very early stage on (e.g., specimen No. 28, D = 12 mm., Pl. xxxv, fig. 4; specimen No. 24, D = 17 mm., Pl. xxxv, fig. 6) they are elaborate and typical of this genus. The siphonal lobe is deep and narrow and ends in two long, sharp, strictly vertical points which are separated from each other by a slender, rather tall, rectangular median knob; there are, in addition, three main lateral points on each side of this lobe. The external saddle is high and very broad and is divided into two bifid, richly indented stems by a deep, trifid lobule with a distinctly three-pronged middle point. In the holotype this lobule points very obliquely dorsad. The first lateral lobe is deep, and, as a rule, narrow; on the right side of the last suture line of specimen No. 8 (Pl. xxxv, fig. 9a), however, it is much broader, and the external saddle much narrower, than on the left, or in any other suture lines of this species which have been examined. This lobe is bifid and has three pairs of lateral branchlets, which deeply intersect the adjacent saddles, and two terminal points which are but little divergent; in the holotype they are parallel. Here the inner ones considerably exceed the outer ones in size, particularly in length; both these points are three-pronged, and the middle prong of the inner one is extraordinarily sharp and long. Normally, this lobe is as long as the siphonal one in the adolescent specimens, but it is remarkably longer in the holotype. The latter is apparently the best example of the trend of the suture lines of *Elobiceras* to develop very tall saddles and deep lobes, both of which are extremely straitened by intersecting elements. The first lateral saddle slightly exceeds the external one in height; twice, once at about half its height and again at its second third, the main stem is straitened to such a degree that its width appears to be reduced almost to zero. At its top it is deeply intersected by a three-pronged lobule pointing obliquely dorsad. The second lateral lobe attains about two-thirds of the length of the first, but it seems to be slightly less straitened. It is distinctly trifid, its middle point three-pronged, and there are two lateral branchlets on each side. The second lateral saddle is a reduced repetition of the first. There follow the first auxiliary lobe bordering the umbilical shoulder, with a three-pronged middle point; on that shoulder, the first auxiliary saddle; and on the umbilical wall the distinctly three-pronged second auxiliary lobe; a second auxiliary saddle; a third auxiliary lobe, still recognizably three-pronged; and a third auxiliary saddle which is just halved by the umbilical seam. The last five of these sutural elements are observable in the holotype only. The inner part of the last suture line could be examined in specimen No. 8 (Pl. xxxv, fig. 9b). There is a rather broad anti-siphonal lobe which ends in a long, sharp, median point and has three lateral branchlets on each side, the lowermost of which is the strongest and is bifid. This lobe is flanked by two richly indented internal saddles which are much straitened at their bases. Each is followed by a rather slender trifid lobe which attains about two-thirds the length of the anti-siphonal one. The interior part of this suture line is decidedly dissymmetric.

(B) var. **tenuis**, new variety

Pl. xxx, figs. 2–4

A. M. N. H. No. 25176: five specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	77 mm.	44½	40½	23	25	28½

DESCRIPTION.—A few examples agree with the typical form in costation, but they differ from it by being slightly more involute and much more slender, and by assuming at a much earlier stage a more elliptic, almost lancetiform section with equally and gently vaulted sides and a narrower, roof-shaped venter, such as is found in the *forma typica* only at a diameter of about 130 mm. Thus this variety appears to be represented by individuals whose development has been accelerated.

A half disc crushed on its left side was chosen as the holotype (Pl. xxx, fig. 2); the anterior quarter-whorl may belong to the body chamber. In addition, an apparently septate fragment (No. 2, Pl. xxx, fig. 3) which is very much like the holotype and another poorly preserved fragment (No. 3) were referred to this variety. The latter is slightly stouter than the holotype and may be transitional between the variety *tenuis* and the typical form. A much smaller fragment (No. 4, Pl. xxx, fig. 4), exhibiting broad, finely crenulated ribs which are separated from each other by very narrow interstices and turn decidedly forward on the venter, and another very poorly preserved one seem to represent an earlier stage of this variety.

The suture lines, which can be well observed in specimen No. 3 only, seem to agree with those of the *forma typica*.

REMARKS (AD *E. raymondi*, SENSU LATO).—Within the Albian fauna of Angola this beautiful species is most closely related to *E. intermedium*. Adults of both species

can, however, readily be distinguished from each other by the fact that those of *E. raymondi* are more involute and have gently rounded sides and a less truncate venter, which even becomes fastigate on the living chamber, and especially a less prominent, regular, sigmoidal costation. Also, the ribs are broader in *E. raymondi* and have pronounced external knobs only on the body chamber. The differences in section are still more obvious in the variety *tenuis* than in the *forma typica* of this species. It is less easy to distinguish the young of both species from each other. They have in common the slender, elliptic-rectangular section, the distinct, prorsiradiate, circumumbilical folds and the interruption of costation in the inner zone of the sides; those of *E. intermedium* are, however, less involute, and their ribbing seems to be a little more coarse and at that early stage a little more sinuous than in *E. raymondi*. The latter differs even more from *E. irregulare* both in the character of the costation, which is elegant and regular even on the inner whorls, and in the slenderness of its section.

There is, at the same size, some resemblance between *E. raymondi* and *E. angustum* Spath (1922, p. 134, Pl. II, fig. 1); both have in common the broad, moderately prominent, sigmoidal ribs and the vaulted sides which converge ventrad and are slightly concave in their outer zones. However, the section of Spath's species is much more slender (W′:H = 0.48, as compared to 0.67 in the typical *E. raymondi* and 0.56 in its variety *tenuis*), and its periphery is comparatively broad and truncate; also, its keel hardly overtops the outer knobs, whereas it considerably overtops them in *E. raymondi*. In this latter character the fragment described above (p. 114) as *E.* cf. *angustum* agrees better with the present species than with Spath's type, but it can readily be distinguished from the former by its more pronounced external shoulders and its more truncate venter. Another rather involute *Elobiceras*, *E. subelobiense* (p. 113), differs by its flat venter and its straight ribs. Choffat's (1905, Pl. IV) fig. 5, the reference of which to *E. subelobiense* is questioned above (p. 114), differs by its straight and narrower ribs which bifurcate up to a diameter of 90 mm. *E. raymondi* is easily distinguishable from *E. lobitoense* (p. 113) by its more slender section, which tapers distinctly ventrad, and by its much more dense sigmoidal costation. *E.*, indeterminate new species No. 1, has been compared above; for comparison with *E. browni* and *E. elobiense* reference may be made to the remarks on the latter.

Nuclei of the species here dealt with often cannot easily be distinguished from micromorphic forms of other genera. There is some resemblance to equally small (D = 20 mm.) examples of *Dipoloceras rectangulare* which can, however, be distinguished by their greater thickness and their stronger and slightly stiffer ribs whose obsolescence in the inner zone of the sides is confined to a much earlier stage. Almost the same distinctive features can be relied upon for distinction between the inner whorls of *E. raymondi* and certain more pronouncedly costate types of *Hysteroceras carinatum*. The former, however, at the smooth or half smooth stage, with ribs still stiff, broad, uncrenulated and restricted to the outer zone of the sides, are almost indistinguishable from equally small specimens of some other species of *Hysteroceras*, particularly *H. intermedium* and *H. semilēve*, unless the suture lines, which are more elaborate and, even at that early stage, have a genuine *Elobiceras* character in the former, can be examined.

Among other African forms, the typical "*Rhytidoceras*" *elegans* van Hoepen (1931, p. 43, *pro parte*, text figs. 4, 7, only), though not its variety *crassicostata* (*ibid.*, text figs. 5, 6),[1] resembles *E. raymondi* by its distinctly sigmoidal ribbing. Van Hoepen's form, unfortunately depicted in side views only, seems, however, to be slightly more evolute and to have a more robust and a little more dense costation, the single ribs being narrower than in the present species. As to the generic position of van Hoepen's species reference is made to the discussion under the heading *Elobiceras* (p. 100).

[1] Subsequently raised to the rank of an independent species by van Hoepen (1941, p. 67, text figs. 19, 20, Pls. IX, X).

Finally, the variety *tenuis* of the present species resembles *E. bahiaense* (Maury, 1925, p. 577, Pl. xx, fig. 15; 1930, p. 271) which, according to the description, is laterally compressed. The Brazilian species, however, differs from both that variety and the typical *E. raymondi*, as well as from all the other African forms of this genus, by being much more involute and by the fact that the spiral ridges (called "nodules" by Maury) are, to judge from her drawing, much broader than the interstices between them, whereas the opposite relation prevails in all the *Elobiceras* of the present collection.

Elobiceras hexagonum, new species

Pl. xxx, figs. 5–8; Pl. xxxi, fig. 1; text figs. 12d, 13c

A. M. N. H. No. 25177: nine specimens

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
4	9.0 mm.	44	?	?	40	36½
5	21.2 mm.	39	35	39	44½	37
Holotype: 3	26.5 mm.[1]	46?	?	?	ca. 45½	ca. 32½

DESCRIPTION.—The holotype is preserved, though incompletely, up to a diameter of about 55 mm., but as only the anterior part of its outer whorl seems to be unseptate, it must have grown considerably larger. The individual of which fragment No. 2 is about a quarter whorl seems to have attained about the same size. There are, in addition, four fragments of whorls (Nos. 1, 5, 6, 7), corresponding to diameters of between 20 and 25 mm., and a tiny disc (specimen No. 4) which seems to be an inner nucleus of this species.[2]

The conch is moderately involute, with a section which is characteristic of this species throughout its development. Disregarding the impressed zone, the intercostal section appears more or less elliptic, and the costal one somewhat hexagonal (text fig. 12d; Pl. xxx, figs. 5b, 6c, 7c, 8b). More exactly speaking, the costal section may be described as resembling a transverse rectangle with a low trapezoid on its top. This is due chiefly to sharp angulations at about the second third of the height of the whorl caused by the prominent lateral tubercles. From these angles the sides converge toward the periphery which is delimited laterally by angulations as distinct as the lateral ones. The sides slope from the former to the latter at an angle of about 45°. The venter is truncate, moderately broad and crowned by a sharp, though not very high keel which is accompanied by relatively shallow furrows on both its sides. Below the lateral angulations the sides run parallel to each other toward the distinct, though rounded umbilical shoulder; the umbilical wall is high, almost perpendicular at earlier stages, but less steep in the body chamber. On both sides of the lateral angle the costal section is slightly concave owing to the prominence of the three rows of tubercles (umbilical, lateral and external ones) and to the obsolescence of costation on the middle of the sides of smaller specimens.

The inner whorl of specimen No. 1 seems to be smooth; this may, however, be due to corrosion only. But the ornamentation could be studied in specimen No. 4 (Pl. xxx, figs. 5a, b) at about the same diameter, 9 mm. There are thirteen to fourteen slightly sigmoidal ribs per half whorl. These are distinct and comparatively strong only on the outer half of the sides. Every second rib, though obsolescent in the inner zone of the conch, reaches the marked, though blunt umbilical tubercles, six of which can be counted per half whorl; the others end at the middle or at the first third of the sides. On the venter the ribs continue in a decidedly forward direction, stopping at some distance from the keel. Both lateral and ventral angulations are marked on the ribs by distinct nodes which cause their outer parts to resemble the broad, notched, external tubercles of some *Neokentroceras*. In addition, traces of spiral ridges can be found on these outer parts of the ribs.

At diameters of between 20 and 30 mm. (specimens Nos. 5, 1, 3, Pl. xxx, figs. 6a, b, 7a, b; Pl. xxxi, fig. 1) the primary ribs arise at the umbilical wall, forming at the umbilical shoulder strong tubercles, which are sharp or even pointed in specimen No. 5, whereas they have the shape of strongly prorsiradiate folds in specimens Nos. 1 and 3 which represent a somewhat later stage. In specimens Nos. 5 and 6 the primary ribs are continuous across the sides, whereas they weaken (specimen No. 3) or almost vanish (specimen No. 1) in their middle zone on the others. In all of them, however, secondary ribs originate at the inner third of the sides, either by intercalation, or, less frequently, by bifurcation. The ribs run in a more (specimen No. 1) or less (specimen No. 5) rursiradiate sense up to the lateral angle where they form a prominent or even pointed tubercle; then they continue, turning gently forward, across the roof-shaped peripheral part of the sides, where they become again prominent and broad, assuming the club shape characteristic of this genus. The above mentioned changes in direction cause the ribs

[1] Measured about half a whorl apicad of anterior end.

[2] Subsequently, two more fragments have been found in the body chamber of *Turrilitoides*, indeterminate new species (described in Part III), which in size as well as in the other characters agree best with specimen No. 2.

to appear decidedly sigmoidal or, in specimen No. 1 (fig. 7a), even sickle-shaped. On the external shoulders they form another tubercle which is, as a rule, less prominent than the lateral one. They do not continue beyond the terminal tubercles on the venter; the intercostals, however, can be followed as fine furrows gradually vanishing toward the base of the keel. From seven to eight costae can now be counted at the periphery on each quarter whorl, and there are also four tubercles at the umbilical edge. Except in their obsolescent parts the ribs are covered with spiral ridges which are most distinct between the two angulations, where from four to five of them are seen. Preservation permitting, fourteen to seventeen spiral ridges can be counted on each rib; they become gradually finer ventrad, being most prominent on the lateral nodes. Both these and the external ones are each marked by a pair of spiral ridges which are closer to each other than the others.

The latest observable stage of the ornamentation was studied on the anterior part of the holotype (Pl. XXXI, fig. 1) and more completely on fragment No. 2 (Pl. XXX, fig. 8a). On the former the costation is in the inner zone of the sides not greatly different from that of *E. raymondi* at the same stage. There are eight ribs per quarter whorl along the umbilical edge; bifurcation occurs but twice in this quarter of a volution. No more fading of the costation can be observed, but the zone on the sides where this fading occurred in the earlier stages of growth is marked by the presence of a larger interstice between the spiral ridges. In the outer half of the whorl, preserved in specimen No. 2 only, the ribbing exhibits the same features as in the precedent stage, but it is coarser on the whole. Both lateral and external tubercles are more pronounced, and in consequence the concavities of the ribs between them and dorsad of the lateral nodes are more distinct than in the smaller examples. Also the spiral ridges are slightly increased both in sharpness and number. In this individual the ribs are much sharper and narrower and also less dense (eight per quarter whorl) than in *E. raymondi*.

The external part of the suture line could be studied in the posterior part of the holotype at a diameter of about 30 mm. (text fig. 13c). The siphonal lobe ends in two long and rather slender points diverging at an angle of not quite 60° and has a strong, trifid, main lateral branchlet on each side. The external saddle is for this genus extraordinarily broad and sturdy and is divided by a long, three-pronged lobule into two main stems, both of which are bifid. The first lateral lobe is shorter than the siphonal one and rather narrow; it has two long, perpendicular, terminal points and slightly below half its length a pair of strong lateral branchlets which are distinctly bifid, each of their points being three-pronged. The first lateral saddle is bifid and, in its dorsad part, slightly higher than the external one but less than half as wide; it is somewhat straitened at about half its height; its inner stem is higher, though narrower than the outer one. The narrow second lateral lobe attains about two-thirds of the length of the first and is, as usual, trifid. Up to the umbilical edge about half the second lateral saddle is visible which is considerably lower, though hardly more slender, than the first. On the whole, this suture line appears, chiefly owing to its sturdy external saddle, to represent a less advanced evolutionary stage than those of *E. intermedium* and *E. raymondi*. It may be worth noting that it agrees best with suture lines of specimens of the latter species of a much smaller diameter (e.g., A. M. N. H. No. 25175:24; compare fig. 6 of Pl. XXXV with text fig. 13c). However, the comparatively high degree of indentation and particularly its first lateral lobe give evidence of its *Elobiceras* character.

REMARKS.—Although the trinodosity of this interesting species accounts for its resemblance in general habitus to some species of *Neokentroceras*, e.g., *N. magnum* (p. 53), and also to some *Pervinquieriae* of the English Gault belonging to the *perinflata*-group (= subgenus *Durnovarites* Spath), e.g., *P. subquadrata* Spath (for reference see p. 56), the pronounced spiral ornamentation of its ribs proves it to be a genuine *Elobiceras*. It can, however, readily be distinguished by both its peculiar section and its prominent lateral tubercles from all other species of this genus, including *E. raymondi*, which it resembles at a later ontogenetic stage in the sculpture of the inner zone of the sides, and *E. lenzi* (Szajnocha, 1885, p. 234, Pl. II, fig. 4; see also remarks on *Neokentroceras choffati*, p. 50), which has in common with it the weakening of the costation on the same part of the conch.

From all the other forms of this collection referred to various genera which also exhibit the latter character, *E. hexagonum* is easily distinguished by its spiral ornamentation. Its similarity to the holotype of *Pervinquieria ferecostata* (p. 88), particularly obvious in specimen No. 2, is merely superficial, due chiefly to the coarseness of the ribbing. The latter can, however, readily be distinguished by the fact that it is more evolute in maturity, by its more truncate venter and much coarser and less regular costation with strong inner tubercles, and by the less dis-

tinct transverse striation which is, furthermore, confined to the outer parts of the ribs.

Finally, the earliest stage of *E hexagonum*, as represented in this material by the little disc No. 4, is distinguishable from equally small *Dipoloceras*, e.g., *D. rectangulare*, var. *elegans* (above, p. 15), solely by the bituberculate aspect of the outer parts of the ribs and the hexagonal costal section.

Elobiceras browni,[1] new species

Pl. XXXI, figs. 2, 3; Pl. XXXII, figs. 1a–c; text fig. 12e

A. M. N. H. No. 25178: five specimens

? *Schloenbachia Lenzi* Szajn.; CHOFFAT, 1888, p. 65, *pro parte*, Pl. I, fig. 5 only.

? *Elobiceras* cf. *lobitoense* (Crick MS.); SPATH, 1922, pp. 124 (footnote §§), 137.

DESCRIPTION.—The holotype consists of a little more than half of an outer whorl and about a third of the penultimate whorl; the former seems to belong to the body chamber. The paratype is half an outer whorl which is without doubt unseptate; thus the body chamber must have measured at least half a volution in length.

The conch is discoidal and rather evolute. Both the degree of involution and the width of the whorls decrease in the course of growth.

The intercostal section is elliptic; in the holotype (text fig. 12e) the costal one is trapezoidal and has its maximum width immediately above the umbilical shoulder; the sides are flat on the whole, but there is a distinct swelling at about their middle, and an equally distinct concavity between it and the external nodes. The umbilical shoulder is marked, though rounded, the umbilical wall high and perpendicular, or, in the posterior part of the outer whorl, even overhanging. The pronounced latero-ventral edges are accentuated by the external knobs of the ribs. The venter is flat and comparatively broad.

The section of the paratype agrees at its posterior end with that of the holotype at its anterior one, the diameters being about the same. In the anterior part of the paratype, however, the sides gradually become more vaulted and the venter less truncate, rather slightly roof-shaped. Thus an inverted heart-shaped section results at the front end of the paratype (Pl. XXXII, fig. 1c) instead of the high trapezoidal one seen toward its rear end (fig. 1b) and in the holotype (text fig. 12e). Even in the costal section of the anterior part of the paratype the peripheral shoulders are much less distinct than at the earlier stage represented by the holotype. In both examples the venter is crowned by a very strong, but moderately high keel.

There are eighteen ribs per half whorl on both of them. Primary ones arising on the umbilical wall and secondary ones originating at some distance only from the umbilical shoulder alternate almost regularly on the holotype; in the paratype, however, intercalation of secondary ribs or rather bifurcation of primary ones occurs only very rarely. In both individuals all the ribs are uniform in the outer two-thirds of the sides. They are rather sharp and narrow around the umbilicus, but they widen on the sides, gradually assuming a club shape, independently of their course which is decidedly prorsiradiate and slightly sigmoidal on the holotype as well as on the posterior third of the paratype. But it becomes rursiradiate on the body chamber of the latter, where the ribs form a strongly orad convex arc. Orad, the density of costation decreases remarkably on the paratype; only eight ribs can be counted on its last quarter whorl, as compared to ten on the preceding quarter.

The elevated, sometimes sharpened, innermost parts of the primary ribs of the holotype must be considered as being elongated umbilical tubercles. Moreover, all the ribs end at the external shoulders in large, though blunt and rounded knobs which, however, weaken toward the aperture in the paratype. They are, as seen best in the ventral view of the holotype (Pl. XXXI, fig. 2b), almost symmetrical on both sides of the keel from which they remain neatly separated by a smooth band. The interstices between them continue as shallow furrows trending obliquely forward toward the median line, though without interrupting those smooth bands.

From eighteen to twenty spiral ridges can be counted in the holotype on every primary rib and about fifteen on every secondary one. As is usual in this genus, they become denser and finer toward the periphery where six to seven of them are concentrated on the external knobs. Very fine striae can still be seen beyond them, but the smooth bands on both sides of the keel lack even that striation. It continues, however, though less distinctly than on the ribs, across the intercostals. In the anterior part of the paratype the spiral striae gradually become obsolescent on the ribs and appear, therefore, to run more equally and continuously across both the costae and the intercostals.

Three smaller fragments (Nos. 3–5) obviously represent an earlier ontogenetic stage than does

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	ca. 160 mm.	33 1/2	32?	27 1/2	32	38 1/2
Paratype: 2	ca. 220 mm.	31 1/2	27 1/2	23	25	42 1/2

[1] Named in honor of Dr. Barnum Brown, formerly head of the Department of Palaeontology, The American Museum of Natural History.

the holotype. Two of them (Nos. 3, 4), consisting of about a sixth of a disc each, correspond to diameters of 50 and 70 mm., respectively; the third (No. 5), which is about a third of an outer whorl, is terminated posteriorly by the last septum. All of them show approximately the same high trapezoidal section and the same features of venter and keel as the holotype which they also resemble, except for their less distinct external knobs, in ornamentation. In specimens Nos. 3 and 4, as in the holotype, a slight concavity may be observed in the outer third of the sides. The upper part only of the suture line can be seen in specimen No. 5; in its general character it seems to agree with other suture lines of this genus, but it is too incomplete for detailed description or for delineation.

REMARKS.—The fragment figured by Choffat (*loc. cit. in synon.*) and compared by Spath (*loc. cit. in synon.*) to *E. lobitoense*, in the writer's opinion, most likely belongs to this new species. At about the same diameter it agrees fairly well with the holotype of the latter, except for its slightly finer ribs. As recognized by Choffat and mentioned also by Spath, Choffat's form closely resembles *Pervinquieria arietiformis* (p. 94), and the same is true of *E. browni*, as described in the present paper. Adults of both species have in common the decrease in degree of involution and in thickness and the tendency of the venter, which is first truncate, to become fastigate later. Spath's species is, however, more slender in adolescence and becomes much more compressed in maturity, its periphery is, throughout development, less truncate, its sides are less flat and converge more decidedly ventrad; furthermore, its costation is more dense and slightly less sigmoidal, its external knobs are weaker, and the spiral ornamentation is less distinct in the young and is almost entirely lost in maturity. All these differences, however, become less obvious on the body chamber, as is also true of those distinguishing *P. arietiformis* from other *Pervinquieriae* which can be separated during their earlier stages (e.g., *P. cunningtoni*, *P. geometrica;* for references see p. 95).

Among the other *Elobiceras* of this collection *E. intermedium* (p. 109) appears to be most closely related to *E. browni*, but it can at the same size easily be distinguished by its stronger, more prominent, radial and straight ribs, the external ends of which almost touch the sharper and higher keel and alternate in position on the opposite sides of it. The much narrower venter is also particularly distinctive. *E. angustum* Spath (see p. 114) differs from the species under discussion by its more slender section and by its low or even "sunk" keel, but both are not very different in costation. The fragment described above (p. 114) as *E.* cf. *angustum* is also more slender than *E. browni* and has, besides, much broader ribs which are separated from each other by narrow interstices. *E. subelobiense* Spath (p. 113) resembles the present species in section, but the inner parts of its sides are more inflated, thus causing the section to converge more decidedly ventrad, and its ribs are considerably broader and less sigmoidal. *E. lobitoense* (p. 113) can be readily distinguished from the species under discussion by its more rounded section and by its straight ribs which are more distant from each other, while *E. raymondi* (p. 117) can be distinguished by its elliptic section, narrower venter, higher and sharper keel and much broader and more sigmoidal ribs.

Among all the species of this collection *E. browni* most closely approaches "*Schloenbachia*" *neuparthi* Choffat (1905, p. 38, *pro parte*, Pl. II, figs. 1a, b, Pl. III, fig. 1c, *non* Pl. IV, fig. 4; Pervinquière, 1907, p. 232 ?), left provisionally with "*Inflaticeras*" by Spath (1922, p. 103) but referred to *Elobiceras* by the writer, with regard to the fact that it has spiral ornamentation throughout its ribs up to a diameter of 150 mm. It exhibits about the same measurements as *E. browni* and has a very similar section, but its ribs are more numerous, they lose the spiral striation on the body chamber and turn decidedly forward in the foremost part of the latter, and their external knobs are less prominent.

Elobiceras, indeterminate new species No. 2

Pl. XXXI, fig. 4

A. M. N. H. No. 25179: one specimen

Cf. *Elobiceras* sp. ind.; SPATH, 1922, p. 134, Pl. I, fig. 3.

DESCRIPTION.—A fragment of a large conch which may have attained almost 300 mm. in diameter exhibits eight straight ribs, every second of which begins at about the first third of the sides only. There are twelve to fourteen spiral ridges on the primary ribs and eight to ten on the secondary ones. This fragment is apparently unseptate.

REMARKS.—This is the only *Elobiceras* of the present collection whose ribs are perfectly straight even at such a great diameter. It has this feature in common with the example from Enyiba, southern Nigeria, figured by Spath (*loc. cit. in synon.*). In that specimen, however, all the ribs apparently begin at the umbilical edge. The same difference serves to distinguish the large specimens of *E. szajnochai* Spath (1922, p. 132 *cum synon.*) and *E. elobiense* (see below), figured by Szajnocha (1885) in Pls. I and IV, respectively, from the form under examination. From *E.* cf. *flexicostatum* (p. 107) the latter can readily be distinguished by its more distinctly crenulated ribs, which are much more distant from each other and are not projected in the outer half of the whorl, as well as by the more remarkable difference in both length and strength between the primary and the secondary ones.

Elobiceras elobiense (Szajnocha)

Pl. XXVI, fig. 1; Pl. XXXIII, figs. 1a–d

A. M. N. H. No. 25180: five specimens

Schloenbachia Elobiensis, SZAJNOCHA, 1885, p. 235, Pl. IV, fig. 1.

Not *Schloenbachia Elobiensis*, Szajnocha; CHOFFAT, 1888, p. 66, Pl. I, figs. 7–9.

Not *Schloenbachia Elobiensis*, Szajnocha; CHOFFAT, 1905, p. 37, Pl. IV, fig. 5.

? *Mortoniceras Elobiense* Szajnocha; PERVINQUIÈRE, 1907, p. 232, *pro parte*.

Not *Elobiceras elobiensis* Choffat; AIRAGHI, 1931, p. 849, Pl. II, fig. 3.

DIMENSIONS

	Spec. No.	D	H	H′	W	W′	U
Cond. neotype:	1	65.7 mm.	43½	?	18?[1]	18½?[1]	27

DESCRIPTION.—Specimen No. 1 is an almost complete disc of which the anterior quarter of the outer whorl may be unseptate. The conch is discoidal, very slender and rather involute. The section (Pl. XXXIII, fig. 1d) is almost elliptic, though slightly tapering ventrad, its maximum width being at about the inner third. The sides are gently vaulted; the umbilical shoulder is distinct, though rounded, and the umbilical wall perpendicular but low. The most characteristic feature of this species is its periphery, described by Szajnocha as follows, ". . . Externseite, wo der Rückenkiel von den Rippen berührt wird und dieselben mit dem Rückenrand allmählig verschwimmen." This also applies to the present specimen. The external edges are indistinct, and the ventral area is extremely narrow; the outer ends of the ribs are greatly projected, causing the fine intercostals to form an acute angle with the keel. The latter is sharp and rather high[2] (1.5 mm. at a diameter of about 65 mm.) and despite the narrowness of the venter always remains neatly separated from the outer ends of the ribs; it is somewhat stronger than the outermost spiral ridges which run parallel to it.

As far as the penultimate whorl is visible, the surface seems to be smooth, but that may be due to corrosion. On the outer whorl there are about thirty-six ribs along the periphery. All are flat and broad, reducing the intercostals to narrow, shallow furrows. They are club-shaped and are covered from the umbilical seam to the periphery with many parallel spiral ridges. At the anterior end of the outer whorl nineteen of these ridges can be counted on each rib. The fourth and the fifth (from the umbilicus) are very close to each other, forming a twin ridge, and the four nearest to the keel are remarkably closer to each other, finer than the others, and are sometimes slightly sinuous. The third and the fourth from the keel, however, appear to be sharper than their neighbors, thus indicating a latero-ventral edge which otherwise would hardly be perceptible. No trace of spiral striation can be observed between

[1] Measured at D = 63.2 mm. Results uncertain, as specimen is partly crushed.

[2] In fig. 1a the keel appears to be low. This, however, is due to the fact that its top is broken off. The full height is visible in Pl. XXXIII, fig. 1b, which shows the artificial cast of the mold of this specimen.

the ribs, even where the surface is excellently preserved (Pl. XXXIII, fig. 1b).

On the posterior half of the outer whorl the innermost parts of the ribs are fold-like and rather prominent, resembling umbilical tubercles, and are decidedly prorsiradiate. Here the costae bifurcate almost regularly at the first third of the sides, where they also assume a more radial course, running in an orad concave arc across the remainder of the sides. Thus, on the whole, they appear distinctly sigmoidal. On the anterior half of the outer whorl, however, the ribs become almost straight, and bifurcation occurs but twice. On the foremost part of this volution a slight swelling of the outer ends of the ribs is observable as the only remaining vestige of the external tubercles. In ventral view the ribs appear to be strictly symmetrical in position on both sides of the conch.

Septa can be traced in the posterior half of the outer whorl, but no continuous suture lines could be studied. In addition to the specimen just described, there are two fragments which can be referred without doubt to Szajnocha's species. One (No. 2) immediately adjacent in the matrix to the former specimen shows a part of the sides with six ribs; they agree with those of specimen No. 1 at the same diameter (30–35 mm.). The other (No. 3), which may belong to a disc measuring about 80 mm. in diameter, exhibits the blunt external ends of three ribs, agreeing with those at the front end of the penultimate whorl in Szajnocha's drawing.

There are two other fragments (Nos. 4, 5), however, which are but doubtfully referred to this species. The sides of the former (No. 4, Pl. XXVI, fig. 1) are flat as in specimen No. 1, and the character of the costation also is the same, except that the ribs are almost straight at an earlier stage, but the venter, though narrow, seems to be slightly truncate.[1] The latter (No. 5) shows the inner and middle parts of four flat broad ribs which seem to have the general habitus of those of *E. elobiense* but to be straighter and less densely crenulated than in specimen No. 1.

REMARKS.—Spath was correct when he stated in 1922 (p. 134), "that the typical *E. elobiense* . . . has not, so far, been found in Angola." Hardly any of the forms hitherto referred in literature (see synon.) to this species is really conspecific with Szajnocha's type. Choffat's (1888, *loc. cit. in synon.*) fig. 7 was compared by Spath (1922, p. 134) to his *E. angustum*, while his (*ibid.*) fig. 8 is considered by Spath (1922, p. 135) to be closely related to *E. intermedium* or *E. subelobiense* and is referred above (p. 112) to the former species, together with Airaghi's (*loc. cit. in synon.*) nucleus. Choffat's (*ibid.*) fig. 9 represents in the writer's opinion (p. 114) the inner whorls of an example of *E. raymondi*, whereas that author's (1905, *loc. cit. in synon.*) fig. 5 has become the type of Spath's (1922, p. 132) *E. subelobiense*.

The second of the specimens from the Tunisian Cretaceous referred by Pervinquière (*loc. cit. in synon.*) to *"Mortoniceras" elobiense* belongs, to judge by his description, to *E. szajnochai* Spath (1922, p. 132 = *Schloenbachia inflata* Szajnocha, 1885, p. 232, *pro parte*, Pl. I only). Whether the specimen discussed first by Pervinquière (*loc. cit.*) is really a true *E. elobiense* must be considered to be doubtful, for almost every Albian ammonite with spirally ridged ribs was referred to this species until Spath's Angola paper initiated the more careful distinction of the various species of *Elobiceras*.

It may be worth noting that for that very reason this species became in the course of time an almost legendary one, even being chosen by Maury (1930, correlation table, p. 53; 1936, correlation tables between pp. 34 and 35) as the index fossil for the top horizon of the Upper Albian of West Africa (*"Elobiceras elobiense* zones"). This author was, however, certainly quite unaware of the fact that, up to the present paper, Szajnocha's holotype from the little Elobey Islands off the West African coast was the only described and figured specimen which was truly referable to this species.

[1] The much more inflated fragment with three ribs, seen in fig. 1 (Pl. XXVI) adjacent to the flat-sided one, belongs in the writer's opinion to another individual.

It was only after most careful consideration that the writer decided that his examples were conspecific with Szajnocha's type. This decision is based both on the fairly good agreement in side view as to measurements and ornamentation[1] between the above described specimen No. 1 and the penultimate whorl, as seen in Szajnocha's drawing,[2] and particularly on his description. The characters of the periphery quoted above, as well as the "extreme flatness" of the conch, are also found in the form from Hanha. It is true that specimen No. 1, although the foremost part of its outer whorl apparently belongs to the body chamber, does not attain even half the size of the holotype; this cannot, however, negate this identification. Thus a genuine *E. elobiense*, this time from the African continent, can be described and figured for the first time since 1885[3] and the section of this species, enigmatic since its creation except for Szajnocha's statement concerning its "extreme flatness," can be shown (Pl. XXXIII, fig. 1d) together with a ventral view (fig. 1c). As seen from these figures, *E. elobiense* is indeed very slender, even if the crushing of the right side of specimen No. 1 is taken into account. Thus this feature seems also in Szajnocha's type not to be due merely to the "very strong crushing" emphasized by that author. As with *E. oxytropidoceratoides* (cf. p. 107) the present species also seems to have been, more than others, exposed to crushing owing to its slenderness rather than to appear to be slender because of this crushing.

The broad, club-shaped ribs and the full development of the spiral ornamentation leave no doubt but that the species under discussion is a thoroughbred *Elobiceras;* and it has, for purely historical reasons, become the genotype of this genus, though it is one of its most highly, if not the most highly, specialized representatives. It differs from all the other species of this genus by its compressed shape, by the absence of any pronounced tubercles and by its narrow sharpened venter.

Among these species, *E. subelobiense* Spath (see p 113.) and *E. angustum* Spath (see p. 114) may be the least dissimilar ones; both of them, however, can be readily distinguished by their thicker whorls and their truncate periphery; the same is true also of the form described above (p. 114) as *E.* cf. *angustum.* There is, at least in side view, some resemblance between *E. elobiense,* on the one hand, and *E. raymondi* (p. 114) and especially its variety *tenuis* (p. 116) on the other, as seen best by comparing Pl. XXXIII, figs. 1a, b, with Pl. XXX, fig. 2a. That variety has the dense and flat costation in common with the present species; in the latter, however, the ribs are still broader, even around the umbilicus, less sigmoidal and much less numerous and it is much more slender and has a still narrower and more fastigate venter, crowned by a finer keel which is far less distinctly separated from the external ends of the ribs. In general shape, degree of involution and character of the periphery *E. elobiense* somewhat resembles *E. oxytropidoceratoides* which has been compared with it above (p. 109).

Furthermore, the costation of the inner whorls of *E. lobitoense* (p. 113) is in side view not very different from that of the present species at the same size; however, the former species can be most easily distinguished from the latter by its much stouter whorls, its inflated sides and its much more prominent ribs which are more distant from each other. As mentioned above (p. 102), one of the most primitive *Elobiceras* of this assemblage, *E. primordiale*, has the flatness and width of the costae in common with the most highly specialized *E. elobiense;* the former is, however, much stouter than the latter, its venter is distinctly truncate and is by no means sharpened as in *E. elobiense*, and its

[1] It must, however, be noted that there are only twenty-eight ribs on the penultimate whorl in Szajnocha's figure, as compared to about thirty-six in my specimen No. 1.

[2] The most peculiar detachment of the right half of the outer volution from the penultimate one might arouse some suspicion as to whether they belong together at all. On the other hand, the contact of both farther left in the figure seems to be quite natural. Also such a suspicion, if substantial, would have been voiced by the author himself.

[3] It may be added that no indication as to the repository of his types can be found in Szajnocha's paper. Should it prove impossible to locate them, specimen No. 1, described above, might be chosen as the neotype of this species.

ribs, straighter and sharper near the umbilical edge, have much less distinct spiral ornamentation.

PROHYSTEROCERAS SPATH[1]

When establishing this genus in 1921 Spath considered it a "forerunner" of *Hysteroceras*, as indicated by the generic name. This conception is, however, no longer maintained in his Gault Monograph (1933, p. 442), where this genus is considered "to be no more than a convenient group to accommodate the finely ribbed and compressed Mortoniceratids, differing from *Neoharpoceras* merely in their wide umbilicus, and, like the more or less parallel development *Elobiceras* (with specialized ornamentation) connected with *Mortoniceras* by too many transitions to form a single lineage."

The writer agrees with this later opinion of Spath's; he does not question the serviceableness of a separate genus comprehending the *candollianum-goodhalli*-groups, but he doubts whether Spath's selection of *P. wordiei* as its genotype was a fortunate one. This genus was destined to include shells which deviate from *Pervinquieria* by a higher degree of involution, a flat and compressed shape and an increasing whorl height; *P. wordiei* is, however, in maturity not at all less evolute than many typical *Pervinquieriae* and hardly less so than the genotype, *Pervinquieria inflata*. (U varies, according to Spath, 1932, p. 384, in the latter from 34 to 52; average 43. In the holotype of *P. wordiei* U amounts at a diameter of 105 mm. to 40, but in the larger specimens described below, attaining diameters of 130 and 150 mm., respectively, U = $46^1/_2$ and $43^1/_2$, respectively.) Furthermore, *P. wordiei* exhibits distinct spiral striation, which, according to Spath (1922, p. 133), does not generally occur in this genus. This species must, therefore, be considered as being transitional between *Pervinquieria* and *Prohysteroceras* and still rather close to the former genus; as a matter of fact, its outer whorls are hardly distinguishable from those of some *Pervinquieriae*.[2]

In the present collection this is one of the less prolific genera both in the number of species and of individuals. It is represented by nineteen specimens only, which are referred to six different species, one among them not formally determined. Together with the genotype, *P. wordiei*, and another of Spath's Angolan species, *P. decipiens*, both of which contribute to the present collection examples which are far larger than their holotypes, there occur a specimen closely related to a third Angola species of Spath's, *P. dubium*, some which belong to *P. gracile*, a newly named species detached from *P. wordiei*, and *P. hanhaense*, new species. This species, represented by the largest number of individuals, is the most interesting of all the forms here referred to this genus, owing to the phylogenetically significant factors disclosed by the study of its ontogenetic development.

For the general reasons stated above (p. 5) Spath's subgeneric names *Prohysteroceras, sensu stricto*, and *Goodhallites* are not used in the present paper. On the other hand, *Neoharpoceras*, recently reduced to the rank of another subgenus of *Prohysteroceras* by Spath, is here maintained as a separate genus which will be separately dealt with (p. 134).

Prohysteroceras wordiei Spath

Pl. XXXI, fig. 5; Pl. XXXIII, figs. 2a–d, 3

A. M. N. H. No. 25184: three specimens

? *Schloenbachia* sp. ind., CHOFFAT, 1905, p. 36, Pl. III, fig. 4.

Prohysteroceras wordiei SPATH, 1922, p. 143, Pl. III, figs. 4–6.

? *Inflaticeras roundum* SPATH, 1922, p. 103.

Prohysteroceras wordiei Spath; HAUGHTON, 1924, p. 92.

? *Mortoniceras* (?) *rotundum;* SPATH, 1933, p. 437.

Prohysteroceras wordiei; SPATH, 1933–1934, pp. 441, 443, 444, 461, text fig. 158g.

DESCRIPTION.—Whereas in Spath's holotype the last septum is visible, according to his description, at the beginning of the last

[1] 1921a, p. 286, 2d footnote; see also 1922, p. 104, and 1933, p. 441–1934, p. 445. In the last paper this genus is subdivided into three subgenera, *Prohysteroceras (sensu stricto)*, *Goodhallites* and *Neoharpoceras;* the last had been previously (1921a, p. 282) created as an independent genus.

[2] As far as the *inflatiformis*-group of "*Inflaticeras*" is concerned, Spath (1922, p. 145) admits this fact, though emphasizing that "the inner whorls are quite different in the two stocks."

		Dimensions				
Spec. No.	D	H	H′	W	W′	U
2	130 mm.	30½	26	22½	24	46½
1	150 mm.	28	23½	24	25½	43½

whorl, i.e., at a diameter of about 60 mm., specimen No. 2 of this collection is septate throughout and specimen No. 1 up to a diameter of about 137 mm. As Spath asserts that the body chamber occupied at least one complete whorl, these specimens must have attained a diameter of more than 200 mm.; this species thus seems to have grown to a much larger size than could be assumed from the holotype. In both specimens (Nos. 1 and 2) the inner whorls are crystallized (see Pl. XXXIII, fig. 2d).

Spath observes that his largest example is more evolute than the others he measured; this is, however, due merely to the decrease in the degree of involution in maturity, a feature found also in many species of other genera in this collection.

Both the present specimens exhibit the specific characters described by Spath: the evenly rounded sides, the very thick keel, accompanied by two furrows, which, however, become less distinct in maturity, and the character of the costation. Sixty-four ribs can be counted along the periphery of the outer whorl in specimen No. 1 and almost sixty in specimen No. 2. The rapid decrease in the density of the costation in the course of growth is responsible for the difference between these figures and those given by Spath; of the sixty-four ribs counted on specimen No. 1, thirty-eight belong to the posterior half of the outer whorl, only twenty-six to the anterior one. Not only do the ribs become more distant from each other on the outer volution, but they also are more sigmoidal and, in addition, assume a distinctly rursiradiate direction on the anterior half of the whorl. This direction, however, changes rather suddenly into a decidedly prorsiradiate one on the body chamber of specimen No. 1. Blunt circumumbilical tubercles can be observed only occasionally; they disappear entirely near the front end. The external knobs become broader and more distinct on the outer volution, but they too remain blunt. As a rule, only every second rib originates at the umbilical shoulder, whereas the others begin at the first or even the second third of the sides. Moreover, some ribs bifurcate at the middle or, as seen also on the holotype, sometimes even at the second third of the sides. This occurs, however, more and more rarely on the anterior part of the outer whorl. Trifurcation of ribs recorded by Spath could not be observed in the examples here dealt with, although secondary ribs are seen to bifurcate as well as primary ones.

Spiral ornamentation is particularly distinct on specimen No. 1 where from four to six fine ridges can be observed on the outer ends of the ribs, and from five to seven on their inner parts. Here and there spiral striation is perceptible also in the intercostals.

A quarter whorl (specimen No. 3), corresponding to a diameter of about 45 mm., represents an earlier ontogenetic stage. Here the sides are but gently vaulted; the broad, though blunt primary ribs prevail throughout the inner two-thirds of the sides; the secondary ones are intercalated at their outer third only. This character of the costation is recorded by Spath only for his variety *compressa;* the fragment under discussion is, however, not slender enough to be referred to that variety. In the outer third of the sides all the ribs are uniform and broad, separated from each other by much narrower intercostals and provided with a fine, though distinct spiral striation. Seven ribs are counted around the umbilicus and fifteen at the periphery.

Although many suture lines could be traced, no continuous ones could be studied.

Remarks.—As to the position within the genus of this species, its genotype, reference may be made to the precedent heading. As to its synonymy, the writer strongly suspects that the specimen described and figured by Choffat (*loc. cit. in synon.*) under the name "*Schloenbachia sp.*

ind." and renamed *Inflaticeras*—later *Mortoniceras* (?)—*rotundum* by Spath is conspecific with *P. wordiei*, with which it agrees very well in costation and especially in section; the "very thick keel, rounded on the cast" which is, according to Spath, so characteristic of this species is clearly visible also in Choffat's diagram. The absence of spiral striation mentioned by that author is most likely due to the worn condition of that specimen, stressed both in the text and the explanation of plates. Haughton's description (*loc. cit. in synon.*) rouses some doubt as to whether his example is really conspecific with Spath's type.

P. gracile and *P. decipiens* will be compared below (this page and page 130) with the present species. Its outer whorls, it is true, superficially resemble those of some *Pervinquieriae* of this collection; it can, however, readily be distinguished from all of them by its more rounded section, its extraordinarily thick keel and its more sigmoidal ribbing.

Prohysteroceras gracile, new name

Pl. XXXI, figs. 6a, b, 7

A. M. N. H. No. 25185: four specimens

Prohysteroceras wordiei, var. *compressa*, SPATH, 1922, p. 144, *pro parte*, Pl. III, fig. 6 only.

DESCRIPTION.—As only fragments could be examined, no exact measurements were feasible. In the largest fragment (No. 1), however, the relation W′: H was found to be 0.655, as compared to 0.58 in Spath's (*loc. cit. in synon.*) fig. 6b and 0.77 in specimen No. 3 of *P. wordiei*. Both these specimens are but a little larger than No. 1, which attains 28 mm. in length and consists of a little more than a quarter of a whorl of a diameter between 30 and 35 mm. It is certainly septate in its posterior part, probably throughout.

The sides are almost flat and most distant from each other at about their first fourth. The latero-ventral edges are pronounced, though rounded, and the venter is nearly flat, moderately wide and neatly separated from the strong, comparatively sharp and not very broad keel. The ribs are fold-like, though distinct, and are decidedly prorsiradiate on the inner third of the sides; they flatten in their middle and bifurcate there or more frequently at the outer third. On the outer zone of the sides the ribs are uniform, broad and comparatively flat; they turn slightly forward and continue on the venter, ending at some distance from the keel. There are, per quarter whorl, five primary ribs around the umbilicus and twelve ribs altogether at the periphery. There they show a distinct, though fine spiral striation.

In addition, there is one more fragment (No. 2) exhibiting the venter and two others (Nos. 3, 4) consisting of parts of the sides of other individuals. All of them agree very well with No. 1.

No continuous suture lines could be examined.

REMARKS.—The examples here dealt with are certainly conspecific with Spath's form, referred to in the synonymy. The passage in the latter's description stating that the ribs "run, almost straight, up to the . . . keel" might easily be misunderstood; for, as seen from Spath's fig. 6a as well as in the present specimens, this is true only of the outer ends of the costae which, on the whole, are distinctly sigmoidal. The species comprising Spath's fig. 6 and the examples here dealt with differ from the true *P. wordiei* not only by being more slender and much smaller, but also by lacking the "very thick keel, rounded on the cast," particularly distinctive of Spath's species. These same differences, except the first, also distinguish this new species from Spath's fig. 5 of his Pl. III, which is considered to be the holotype of his variety *compressa* of *P. wordiei*. In consequence, the present form has been separated from the latter as an independent species with the example figured by Spath in his fig. 6 as its holotype.

For its comparison with *P. decipiens* reference is made to the remarks on the latter (p. 130).

There is an apparently striking homeomorphy between *P. gracile* and some specimens of *Hysteroceras carinatum* of about the same size, which is due especially to the fold-like aspect of the ribs around the umbilicus and to their flattening in the middle region of the sides which are, moreover, almost flat in both forms. They can,

however, though not easily, be distinguished from each other. The venter is broader and more truncate and the outer ends of the ribs are broader, flatter and less distinctly projected in *P. gracile;* besides, the latter shows a fine, but distinct spiral striation which is only rarely found in *H. carinatum.*

Equally large individuals of *Hysteroceras semilēve* and *H. propinquum,* though also resembling those of *P. gracile,* can be readily distinguished by their more pronounced peripheral shoulders, more truncate venter and still flatter sides and chiefly by their costation, which is much more obviously obsolescent on the sides in those species of *Hysteroceras* whose sides are, as a rule, almost smooth, whereas both the costae and the intercostals can, in spite of considerable attenuation, be traced throughout the sides in *P. gracile.* Moreover, the ribs of the former species are more elevated and narrower at the periphery, and the intercostals are broader than in *P. gracile;* also, there is no trace of spiral striation in *H. semilēve* and *H. propinquum* and, in particular, they show in ventral view distinct nodes which are entirely lacking in *P. gracile.* The variety *elegans* of *H. semilēve* is, in addition, much more slender than the latter.

Hysteroceras is, however, not the only genus of this assemblage whose members need delimitation from the present species. Some forms of *Dipoloceras* are at a small size rather similar, but they can be distinguished by their much more prominent and sharper ribs which equal the intercostals in width, whereas in *P. gracile* the costae are flat and much broader than the intercostals. The fine spiral striation observed in the latter is not found in individuals of *Dipoloceras* of the same size, and the keel seems to be always sharper and higher in the latter genus. *D. rectangulare* also differs by its much more pronounced peripheric shoulders and its more truncate venter.

Finally, there is also a remarkable homeomorphy between *P. gracile* and the inner whorls of some *Elobiceras,* especially *E. intermedium* and *E. raymondi.* They may, however, be distinguished by their slightly more vaulted sides and by their costation, which is, from a diameter of about 25 mm. on, a little more sigmoidal; moreover, the ribs are more prominent in *Elobiceras,* and their spiral ridges reach as far as the middle or even the inner third of the sides at diameters between 20 and 25 mm., and they are sharper, more elevated and less dense than in the present species, whose fine and dense spiral striation appears to be restricted to the peripheral parts of the ribs.

Prohysteroceras decipiens Spath

Pl. xxxi, figs. 8a–c; Pl. xxxii, figs. 2a, b; Pl. xxxiv, figs. 1a–d; Pl. xxxv, fig. 11; text figs. 14a–d

A. M. N. H. No. 25186: three specimens

Prohysteroceras decipiens Spath, 1922, p. 145, Pl. iv, fig. 13.

Prohysteroceras decipiens; Spath, 1934, p. 447.

Dimensions

Spec. No.	D	H	H′	W	W′	U
2	ca. 61.0 mm.	41	33½	25½	31	ca. 38
1	86.5 mm.	ca. 42	?	ca. 20	ca. 22	ca. 33½

Description.—Specimen No. 1, though somewhat incomplete, is about 70 per cent larger than Spath's holotype. Since the two-thirds of its outer whorl which is preserved is apparently unseptate, its anterior end may be assumed to coincide with the apertural margin, especially since there is a slight indication of a rostrum (Pl. xxxiv, fig. 1a). Although much larger, this example permits the recognition of all the specific characters pointed out in Spath's original description; a smaller one (specimen No. 2), which consists of half an outer whorl, septate in its posterior part only, together with remnants of the penultimate one, likewise agrees with Spath's description. A still smaller fragment (No. 3) consists of about a third of an outer whorl, corresponding to a diameter of not quite 30 mm., together with a fragment exhibiting only the ventral region of the penultimate one. The well preserved part of the outer volution seems to be septate throughout.

Careful preparation of specimen No. 1 made the penultimate and the ventral part of the innermost whorl accessible for examination. The former shows a compressed rectangular section (at its anterior end H = 11.5 mm., W′ = ca. 9 mm.) and strong umbilical tubercles which gradually elongate in a prorsiradiate sense, thus causing the ribs to appear to be slightly falciform. There are from twenty-one to twenty-two ribs per half whorl; longer and shorter ones alternate regularly. On the venter they continue obliquely forward toward the keel, stopping at a short distance from it. The venter is flat and the keel not yet high. The ventral aspect of the innermost whorl is about the same, except for the comparatively broader outer ends of the ribs.

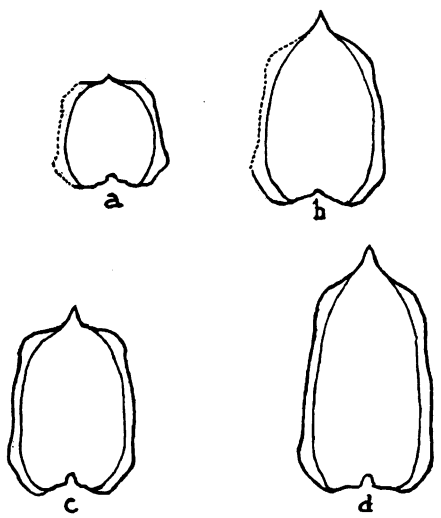

Fig. 14. Development of section in *Prohysteroceras decipiens* Spath.

(a, b) A.M.N.H. No. 25186:2, costal and intercostal sections (a) at posterior, (b) at anterior end of fragment.

(c, d) A.M.N.H. No. 25186:1, costal and intercostal sections (a) at posterior, (b) at anterior end of preserved part of outer whorl.

All natural size.

The last whorl increases rapidly in height but decreases even faster in width. The venter is truncate at the beginning of this volution but fastigate at its end. Thus the section changes from a rectangular shape to a lancetiform one and, besides, it becomes much more slender. The ribs are straight up to the latero-ventral edge, then they turn decidedly orad and continue on the anterior part of the conch, gradually vanishing, toward the sharp and high keel. As there is no increase in the number of ribs from that observed on the penultimate whorl (twenty-two per half whorl), the costation appears to be less dense.

Prominent, radially elongated, umbilical tubercles and occasionally the bifurcation of ribs at these tubercles or the intercalation of shorter secondary ribs occur on the outer whorls in specimen No. 1 up to a diameter of about 70 mm., and in specimen No. 2 up to its anterior end. Thus the presence of single, non-tuberculate ribs from a diameter of about 40 mm. on seems to be an individual feature of the holotype. In specimen No. 1 rather obsolete transverse ridges are perceptible on the outer ends of the ribs, particularly near the aperture; here the outer portions of the costae are club-shaped, as in typical *Elobiceras*.

As far as it is preserved, the inner whorl of specimen No. 3 agrees perfectly with the innermost one of specimen No. 1. The preserved part of its outer volution just bridges the ontogenetic gap between the inner whorl of specimen No. 1 on the one hand and the outer ones of both specimens Nos. 1 and 2 on the other. It seems, however, to represent an individual of somewhat accelerated development, for the section at its front end (Pl. xxxi, fig. 8c) is already rather lancetiform in shape, whereas that of its rear end is still rectangular. But for the slightly smaller number of ribs (from nineteen to twenty instead of twenty-two per half whorl), the outer whorl of this fragment agrees in costation fairly well with those of the other examples. The outer ends of the ribs appear to be broader than in the latter, a feature which may, however, be due to the fact that they are still covered with the shell.

The suture line, though traceable also on the penultimate whorl of specimen No. 1, could be studied best in specimen No. 2 at a diameter of about 40 mm. (Pl. xxxv, fig. 11). The siphonal lobe ends in two points which diverge at an angle of about

60° and are separated from each other by a trapezoidal, comparatively low, median knob; most remarkable are two almost horizontal, two-pronged lateral points at about half the height of this lobe, which deeply intersect the external saddles. They are very similar to those seen in Pictet's (1847, Pl. XI, fig. 1c) drawing of the suture line of *P. candollianum*. The external saddle is tall and broad; it is in its upper part subdivided by two three-pronged lobules into three stems (cf. Spath's—1934, text fig. 158a—drawing of the suture line of *P. goodhalli*), the middle one of which is the highest and broadest. The first lateral lobe is shorter than the siphonal one and is subdivided by a tall, broad, triangular, middle leaf into two long terminal points. The first lateral saddle is about as high as the external one and is bifid. The second lateral lobe is not much shorter than the first and is also two-pronged. The second lateral saddle is somewhat lower than the first and is slender, bifid and just halved by the umbilical edge. There follow a narrow, two-pronged, first auxiliary lobe, a first auxiliary saddle and at least one more auxiliary lobe. The last mentioned sutural elements are remarkably slender. On the whole, this suture line appears to be hardly less elaborate than that of any other species of this genus.

REMARKS.—The adult stage of this species is so well characterized by its straight stiff ribbing and by the rapid decrease of its whorls in thickness that it can be readily distinguished from the other *Prohysteroceras* of this collection. From *P. wordiei* it differs, besides, by being far more involute, by the rapid increase of the height of its whorls and by its much narrower and sharper keel. Approximately the same differences apply to the distinction of the present species from *P. gracile* which is, moreover, much smaller. *P.* cf. *dubium* and *P. hanhaense* will be compared below (pp. 131 and 133, respectively).

These same specific features serve to distinguish easily adults of *P. decipiens* from species in this collection which are referred to other genera. Its adolescent stage (diameter about 30 mm.), however, is not so readily distinguishable from some of the latter. The close similarity of the earlier stages of this species to *Dipoloceras* did not escape Spath (*loc. cit. in synon.*); within the present collection, also, there is a remarkable resemblance to *Dipoloceras rectangulare* (p. 16), from which the inner whorls of *P. decipiens* can be distinguished merely by their broader ribs, which are more decidedly projected on the venter, by their more developed umbilical tubercles and by their lower and blunter keel. Also, some individuals of *Hysteroceras carinatum* (e.g., No. 19) are very similar to nuclei of the present species; they differ only by their less sharp ribbing, which is obsolescent on the inner zone of the sides, and by the less pronounced peripheral shoulders. Furthermore, the inner whorls of *Elobiceras oxytropidoceratoides* are distinguishable solely by their less sharp costation, slightly thicker whorls and, of course, by the different character of the suture line.

Prohysteroceras cf. **dubium** Spath

Pl. XXXIV, fig. 2; text fig. 15a

A. M. N. H. No. 25187: one specimen

Cf. *Prohysteroceras dubium* SPATH, 1922, p. 146, Pl. IV, fig. 11.

DESCRIPTION.—The single fragment, consisting of less than a quarter of a whorl which is apparently unseptate, did not permit exact measurements.

The section is similar to that of Spath's (*loc. cit. in synon.*) fig. 11b, except for its more distinct peripheric shoulders. There are also some differences in costation. In the present fragment the ribs are less sigmoidal and not sharp and high as in Spath's type, but are rather low, though prominent, and are broad and swell distinctly in the outer third of the sides. Every second rib is marked at the umbilical edge by high, rather sharp, radially elongated nodes. The secondary ribs originate either from the primary ones by bifurcation immediately ventrad of the umbilical tubercles, or they are intercalated independently. All the costae, however, become uniform in the two outer thirds of the sides. The latero-ventral edge is marked by a row of small, though prominent tubercles with faint traces of spiral striation. Another row of vestigial

nodes may be observed at about the second third of the sides. In the innermost zone of the sides there are only very indistinct traces of spiral ridges on the ribs. The keel is high and sharp.

No suture lines could be traced.

REMARKS.—Although so similar to *Neoharpoceras angolanum* that it was at first, though doubtfully, referred to that species, the sharp umbilical tubercles, lacking in *Neoharpoceras*,[1] proved that this example is a true *Prohysteroceras*. Its differences from the typical *P. dubium* have been pointed out in the description. Within the present collection it may need comparison with *P. decipiens*, which can be readily distinguished by its stiff straight ribs, and with *P. hanhaense*, which will be compared below (p. 133).

It also resembles inner whorls of *Pervinquieria arietiformis* of about the same size, but its latero-ventral shoulders are less distinct, and its ribs, which are less sharp and slightly more sigmoidal, lack the pronounced terminal knobs of *P. arietiformis* and continue on the venter toward the keel, whereas they end abruptly at the external edge in the latter species.

Prohysteroceras hanhaense, new species

Pl. XXXII, figs. 3–5; Pl. XXXIV, figs. 3–5; Pl. XXXV, figs. 12a–c, 13; text figs. 15b, c

A. M. N. H. No. 25188: eight specimens

gently vaulted, the venter is fastigate, and the latero-ventral edges are much less distinct; the keel is now distinctly triangular in section, high and rather sharp.

The costation also shows remarkable change in character. Whereas on the penultimate whorl the ribs run almost straight across the sides, turning but slightly forward on the venter, they become strongly flexuous on the outer volution, where they run sharply forward from about the middle of the sides up to the very base of the keel, thus forming a moderately deep arc the chord of which is very prorsiradiate. There are ten ribs per quarter whorl, as compared to seven on the penultimate volution. Every second rib reaches the umbilical tubercles, of which four can be counted per quarter whorl on the penultimate whorl, as compared to six on the outer one. They seem to be blunt on the former but become more and more elongated radially in the latter; eventually they cause the innermost parts of the ribs to be sharply raised and to slope down almost perpendicularly toward the umbilical seam (Pl. XXXIV, fig. 3b). The secondary ribs are either intercalated between the primary ones, or they originate from the latter by bifurcation In the outer half of the sides all costae are uniform, rather broad, blunt and distinctly swollen at their outer ends on the penultimate whorl but prominent (though by no means as sharp as in *Dipoloceras*) on the outer one. No traces of spiral striation are perceptible.

The suture lines could be studied in both the innermost and the penultimate whorls of the holotype (Pl. XXXV, figs. 12a, b). The siphonal lobe is rather broad, ending in two terminal points which do not diverge to a very high degree and exhibiting an oblique lateral branchlet on each side at about the second third of its length. The median knob is trapezoidal and moderately high. The external saddle is very broad and rather deeply intersected by a three-pronged lobule; its two stems are about equal in both width and height. The first lateral lobe, which is considerably shorter than the siphonal one, ends in two long points separated from each other by an upright triangular leaf. The first lateral saddle, much lower than the external one, is rather slender and bifid. The second lateral lobe is three-pronged and points slightly dorsad. The second lateral saddle is a reduced repetition of the first. This is also true of the first auxiliary lobe, as compared to the second lateral one; this lobe is already on the umbilical wall. Up to the umbilical seam follow the first auxiliary saddle, a second auxiliary lobe and a second auxiliary saddle. Considering the small size of this suture line (diameter 14 mm.) it is rather remarkable for the high degree of indentation, particularly of its siphonal lobe.

DIMENSIONS

Spec. No.	D	H	H′	W	W′	U
Holotype: 1	ca. 34 mm.	ca. 40½	ca. 37	?	ca. 32½	ca. 33½

DESCRIPTION.—The holotype consists of not quite half a whorl, embracing about a third of the inner ones; all of them are septate throughout.

The section at the anterior end of the penultimate whorl (text fig. 15b) is almost rectangular, a little higher than wide and having pronounced umbilical and peripheral shoulders and almost flat sides. The umbilical wall is perpendicular; the venter is truncate, though not quite flat, and considerably overtopped by the keel. Half a whorl later, at the posterior end of the preserved part of the outer volution, the section is still about the same, except that the venter has assumed a distinct roof shape. At the anterior end of this whorl, however, the section has become decidedly lancetiform. The sides are

[1] Cf. Spath's (1934, p. 459) subgeneric diagnosis of *Neoharpoceras*.

In the outer whorl of this example the suture line could be examined in the impressed zone only (Pl. xxxv, fig. 12c); there is a comparatively broad, two-pronged, antisiphonal lobe, flanked on each side by a tall and slender, bifid, internal saddle. The latter is separated by a three-pronged lobe from another much lower saddle.

Another septate whorl fragment (specimen No. 2) agrees fairly well with the holotype except in being slightly more slender. The fact that its ribs seem to be less prominent and its inner tubercles less sharp may be due to corrosion only. Its suture line (Pl. xxxv, fig. 13) also agrees fairly well with that of the holotype.

A smaller specimen (No. 3), consisting of about three-quarters of an outer whorl, may represent an accelerated development. Here the stage represented in the holotype by its penultimate whorl is immediately followed at a diameter of 22 mm. (as compared to more than 30 mm. in the holotype) by rapid changes in both section and costation similar to those described above. The suture line of this example is the same as in the penultimate whorl of the holotype. Also in another fragment (No. 4) both section (text fig. 15c) and ribbing seem to reach the final stage, far earlier than in the holotype, at a diameter of about 25 mm. Finally, a little fragment (No. 5), exhibiting the innermost part of one side only, seems also to belong to this species.

Some other individuals, however, can be referred but doubtfully to it. Half a whorl (specimen No. 6, Pl. xxxii, figs. 4a–c), attaining a little more than 30 mm. in diameter, is quite similar to specimen No. 3 in its badly damaged anterior part, but the posterior one is almost indistinguishable from *Neokentroceras costatum* (see p. 52). The main features of both section and costation are the same as in the penultimate whorl of the holotype and in the posterior part of specimen No. 3, but a much stronger development of both the inner and the outer tubercles causes the nodal section to become decidedly trapezoidal, with distinct furrows between the outer nodes and the low keel. Thus the ornamentation becomes perfectly *Neokentroceras*-like, whereas at that stage in the typical forms of this species it is rather reminiscent of some forms of *Hysteroceras carinatum* (see p. 37). If only the posterior part of specimen No. 6 were present, the writer would not in the least hesitate to refer it to *Neokentroceras costatum;* its anterior part, however, is by no means *Neokentroceras*-like but is fully identical with that of specimen No. 3. The same peculiar development is seen in a very poor fragment (No. 7) mentioned here solely because at the top of a section already becoming lancetiform there is still a strong low keel between two distinct furrows. Another whorl fragment (No. 8, Pl. xxxii, figs. 5a–c), corresponding to a diameter of about 20 mm., exhibiting a quadratic section and having a rather sharp keel and strong broad ribs which are obsolescent on the middle of the sides, so resembles the posterior part of specimen No. 6 that it is also, though doubtfully, referred to the present species.

Remarks.—The generic position of this interesting species was not easily determined, but since the most advanced ontogenetic stage that could be studied is that of a *Prohysteroceras* (though strongly reminiscent also of *Dipoloceras*) it was eventually referred to that genus. Its earlier stages, however, are, as seen from the above description, *Hysteroceras*-like in the typical individuals and *Neokentroceras*-like in some others.

The mature stage can, though not too easily, be distinguished from both *Dipoloceras bouchardianum* and *D. rectangulare* by the more vaulted sides, by the fastigate venter and by the less sharp and coarse, more regular, more flexuous and more prorsiradiate costation; neither flared ribs nor spiral ridges can be found in the form under discussion which also has more distinct and sharper inner tubercles. The resemblance of its earlier stage to *Dipoloceras symmetricum* is restricted to the side

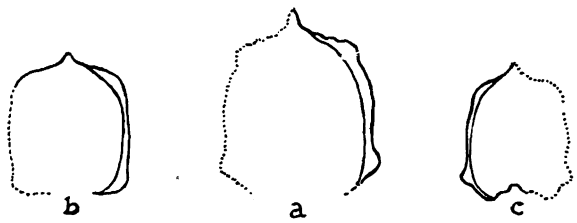

Fig. 15. Costal and intercostal sections of *Prohysteroceras*.
(a) *P.* cf. *dubium* Spath, A.M.N.H. No. 25187, natural size.
(b, c) *P. hanhaense*, new species, (b) holotype, A.M.N.H. No. 25188:1, at anterior end of penultimate whorl, × 3; (c) A.M.N.H. No. 25188:4, × 2.

views, whereas in ventral view the latter is easily distinguished by the rapidly increasing thickness of its whorls.

Inner whorls of *P. hanhaense* are distinguishable from the more strongly ribbed forms of *Hysteroceras carinatum* solely by their being still septate at a far greater diameter, by their slightly stronger keel and by differences in the suture lines (cf. Pl. VI, figs. 12–14, and Pl. IX, fig. 2, with Pl. XXXV, figs. 12b, 13). Both the siphonal lobe and the external saddle are broader in the present form; the former has more diverging terminal points and a pair of long lateral ones, and the first lateral saddle is considerably lower than the external one, whereas it is even higher in *H. carinatum*.

On the other hand, the distinction of the posterior part of specimen No. 6 from some individuals of *Neokentroceras costatum* appears to be even more difficult (cf. Pl. XXXII, figs. 4a–c, with Pl. VII, figs. 20a–c, and text figs. 6b–d). Here again only the fact that the specimens of *P. hanhaense* are still septate at a much larger size can be entirely relied upon for their separation; furthermore, the external shoulders are slightly less raised in this species, and its keel is a little sharper. Specimen No. 8, however, can more easily be distinguished from *N. costatum* by its less prominent outer tubercles and by its far higher and sharper keel.

It may be added that a similar ontogenetic passage through a *Neokentroceras*-stage has been recorded by Spath for various forms of other genera, e.g., *Pervinquieria recticostata*, *Pervinquieria prerostrata*, the Madagascar form renamed *Pervinquieria montraynaudensis* above (1925, p. 185), and *Hysteroceras choffati* (*ibid.*, p. 188; 1934, p. 486). Even more interesting in the present connection is Spath's mentioning that the "Bellegarde type" of *Pervinquieria prerostrata* and *Pervinquieria montraynaudensis* "also have [like the species here dealt with] *Hysteroceras* or *Neokentroceras* costation on the inner whorls." The phylogenetic significance of this feature will be discussed in the Palaeontological Résumé (pp. 142 ff.).

There is a striking similarity in ventral view between specimen No. 8 (Pl. XXXII, fig. 5b) and the inner whorls of *Pervinquieria cunningtoni* Spath, var. *flexuosa* Spath (1933, p. 417; 1932, Pl. XXXVII, fig. 2b), which is, however, a much larger form.

Within the genus *Prohysteroceras*, the present species has in common with *P. decipiens* (p. 130) the quick change from a rectangular section to a lancetiform one and from a rather stiff costation to a more sigmoidal one. This change occurs, however, at a much earlier stage in *P. hanhaense* which is, furthermore, considerably smaller. The individuals doubtfully referred to this species which go through a *Neokentroceras*-stage resemble, particularly in section, the penultimate whorl of specimen No. 1 of *P. decipiens;* they have, however, a far less dense costation and much stronger inner and outer tubercles. Among the other Angola species of *Prohysteroceras* *P. dubium* Spath (1922, p. 146, Pl. IV, fig. 11) to a certain degree resembles the present species, but it has much sharper, higher and more sigmoidal ribs and is considerably larger, as is also the form described above (p. 130) under the heading *P.* cf. *dubium*. The costation of the latter differs, however, less from that of *P. hanhaense* than that of the true *P. dubium*, but the ribs are broader and less prorsiradiate. *P. gracile* seems to be as small as the present species, but it can be easily distinguished by its flat sides, its truncate venter and its flat, broad ribs which are obsolescent in the inner zone of the sides.

Prohysteroceras (?), indeterminate species

A. M. N. H. No. 25189: one specimen

DESCRIPTION.—A single badly deformed fragment measuring about 25 mm. in length cannot be attached to any other form of the present collection. The conch must have been very involute and its sides rather flat; the venter, separated from the sides by very pronounced shoulders, is truncate and carries a strong keel. There are nine broad ribs per quarter whorl; two pairs originate by bifurcation at or even beyond the middle of the sides. The others start at the umbilical seam and run

almost straight across the sides, then swelling and turning sharply forward on the latero-ventral edge; they continue on the venter obliquely forward but do not reach the keel. Vestigial lateral nodes seem to be visible on the costae at about the middle of the sides and perhaps faint traces of spiral ornamentation there and around the umbilicus.

No suture lines could be traced.

REMARKS.—While this fragment is apparently referable to *Prohysteroceras*, it cannot be referred to any of the known species of this genus. The possibility of the presence of spiral striation throughout the ribs is such that its reference to *Elobiceras* cannot be excluded. On the other hand, its vigorous costation is reminiscent of some forms of the group of *Dipoloceras bouchardianum* which are, however, far less involute and have a much sharper keel.

NEOHARPOCERAS SPATH

Spath (1921, p. 282, 1st footnote) established this genus with *Ammonites hugardianus* d'Orbigny (1840–42, p. 291, Pl. LXXXVI, figs. 1, 2) as its genotype and compared it with his genus *Pseudophacoceras* (= *Oxytropidoceras* Stieler). Later (1922, p. 105) he discussed it more explicitly in his Angola paper. In his Gault Monograph (1934, p. 459), however, he "relegated" it "to the rank of a subgenus of *Prohysteroceras*." The writer, though certainly not favoring the creation or the maintenance of new genera of such a small size, cannot agree with Spath in making this change. There may be transitional forms between both genera, but as *P. wordiei* is the genotype of the latter, the forms of the *hugardianus*-group, which are entirely different, cannot be left with *Prohysteroceras*. *Neoharpoceras* differs from the former chiefly by its more sigmoidal costation and by the lack of any distinct outer tubercles. As to the writer's general objections to the use of subgeneric names, reference is made to the Introduction (p. 5).

Neoharpoceras is in consequence here treated as an independent genus. It is true that up to the present time very few species belonging to it have been described. Spath (1934, p. 460) mentions a specimen (No. C 36030 B.M.) from Angola which he believes to be transitional between *Prohysteroceras wordiei* and *N. obtusum* Spath (1934, p. 463, new name for "*Ammonites hugardianus*" Pictet and Roux, 1847, p. 364, *pro parte*, Pl. x, fig. 4 only), but no typical *Neoharpoceras* have hitherto been recorded from Angola. The present collection, however, includes two new species which apparently belong to this genus: *N. angolanum*, strongly reminiscent of *Pervinquieria arietiformis* at its earlier stages and of some *Elobiceras* in maturity, and *N. conditum*, looking in every respect except the suture line like a liassic *Grammoceras*.

The superficial resemblance of this genus to *Oxytropidoceras* (for references see p. 109) has already been pointed out by Spath (1921, *loc. cit.*); both genera can, however, readily be distinguished from each other by their entirely different suture lines. The lobes and saddles are rather stout and little indented in *Oxytropidoceras* but are richly ramified and intersected and much straitened in *Neoharpoceras*. This sutural difference appears to be most pronounced in the first lateral saddle.

Whether or not van Hoepen's (1931, p. 40) new genus *Lophoceras* should be united with the genus under discussion can hardly be decided without examination of the holotype of his genotype, *L. umsinense* (*ibid.*, p. 41, text figs. 1, 2), particularly because of the remarkable dissymmetry of both sides of that specimen. It also would require a careful examination of its suture lines, which are not properly visible in text fig. 2, to decide whether "*Lophoceras*" is more closely related to, or even identical with *Neoharpoceras* on the one hand or to *Oxytropidoceras* and *Venezoliceras* on the other; the suture lines of both of these genera are compared by van Hoepen with those of his "*Lophoceras*."

Neoharpoceras angolanum, new species

Pl. XXXIV, fig. 2; Pl. XXXVI, figs. 1a, b; text fig. 16

A. M. N. H. No. 25190: three specimens

DESCRIPTION.—The holotype (specimen No. 1, Pl. XXXVI, figs. 1a, b) is a fragment of the left

side of a body chamber; it measures about 80 mm. in length, the height of the whorl amounts to 57 mm., its intercostal width to 25 mm.

The section is subelliptical and slender. The sides are gently vaulted and most distant from each other at about half their height. The umbilical shoulder is pronounced, though rounded, the umbilical wall comparatively high and almost perpendicular. The latero-ventral edge is distinct only in costal section, and even there it is gently rounded. The venter is roof-shaped and crowned by a strong high keel which is neatly separated from it.

The ornamentation consists of about twelve distinctly sigmoidal, though but gently inflected ribs per quarter whorl. Among ten of them three bifurcate at very blunt, almost vestigial, radially elongated, umbilical nodes. The costae are not very prominent; ventrad they become broader and blunter and continue on the venter, gradually vanishing, at an angle of about 45°

Fig. 16. Diagrammatic section across the ribs and intercostals of the largest fragment of *Neoharpoceras angolanum*, new species, A.M.N.H. No. 25190:3, natural size.

toward the keel. From eight to ten rather indistinct elements of spiral ornamentation can be counted on the outer two-thirds of the ribs; they have the shape of blunt ridges in the middle zone of the sides but assume the character of striae on the outer ends of the costae.

There are two other, apparently unseptate fragments: specimen No. 2 belongs to a somewhat larger disc than the holotype with which it is certainly conspecific, specimen No. 3 is a fragment of a much larger conch measuring about 200 mm. in diameter. No. 3 exhibits just three ribs which have at this stage become very flat, broad and fold-like, being about twice as wide as the shallow intercostals (text fig. 16). The ribs show no traces of any spiral striation. However, they still maintain the characteristic gently sigmoidal course of this species.

REMARKS.—As to its generic position, the crenulation of the ribs gives an *Elobiceras*-like aspect to the present species, which the writer, however, prefers to assign to *Neoharpoceras*, chiefly on account of its distinctly sigmoidal costation and its comparatively high degree of involution. It will be compared below (p. 137) with the other species of the present collection referred to this genus, *N. conditum*.

The example described above (p. 130) as *Prohysteroceras* cf. *dubium* so greatly resembles *N. angolanum* in both costation and character of the keel that it was first believed to represent an earlier ontogenetic stage of this species, but it differs by its sharp inner tubercles which seem to exclude its reference to this genus.

Furthermore, some *Elobiceras* in this collection, viz., *E. spathianum*, *E.* cf. *flexicostatum* and *E. oxytropidoceratoides*, are rather similar to the form under discussion. It differs, however, from all of them in that the maximum width of its section is about at its middle rather than in its lower half and especially in that its costation is gently sigmoidal; from *E. spathianum* in particular by its much finer ornamentation, by the lack of terminal knobs of the ribs and by the more neatly separated keel; from *E.* cf. *flexicostatum* by its denser and finer costation and the much weaker crenulation of its ribs, a difference which is also true in a comparison with *E. oxytropidoceratoides* which has, furthermore, a more dense ribbing.

Neoharpoceras conditum[1] Haas

Pl. XXXVI, figs. 2a–c; text fig. 17
A. M. N. H. No. 25191: one specimen
Neoharpoceras conditum HAAS, 1942b, pp. 646, 648, Pl. XCIV, figs. 12a–d.

DIMENSIONS

	D	H	H′	W	W′	U
Holotype:	ca. 71 mm.	ca. 49½	ca. 43½	ca. 24½	ca. 25½	ca. 21?

DESCRIPTION.—The single specimen, a cast, consists of about a third of a whorl which is septate throughout; it was quite surprisingly discovered in a small piece of matrix crowded with ammonites of different genera and with gastropods.

The conch is discoidal, slender and rather involute. Its whorls increase rapidly in height (from 25 mm. at the posterior end of the fragment to 35 mm. at the anterior one) but far more slowly in width (from 15.5 mm. to 18 mm. only). The section is

[1] *Conditus* = hidden.

lancetiform and high and attains its maximum width at about its first fourth. Hence the sides, which are almost flat, converge gently ventrad. The umbilical shoulder is pronounced, though rounded, and the umbilical wall is perpendicular, though not high. The latero-ventral shoulders are perceptible but are not very distinct; the venter has the shape of a flat gable and is crowned by a strong high keel neatly separated from the periphery; the siphuncular tube is just at its base, being exposed where the keel is broken off. The sides exhibit at their outermost fourth a narrow and shallow depression running concentrically with the periphery.

Twenty-eight flat ribs can be counted along the periphery of the preserved third of a volution; thus there must have been about eighty-five of them per whorl. Some bifurcate near the umbilical shoulder, and some secondary ribs are intercalated at about the middle of the sides; in consequence, there are only sixteen ribs at the umbilical shoulder compared with the twenty-eight at the external one. The ribs are broad, reducing the intercostals to narrow furrows, and are distinctly sigmoidal; they swell slightly at the latero-ventral edge, continue in an obliquely forward direction on the venter and stop at a little distance from the keel. Obsolete spiral ridges are perceptible in oblique illumination only on their external swellings and in the depression accompanying the external shoulder.

The complete suture line of this specimen could be studied (text fig. 17). It is reminiscent of that of the genotype, *N. hugardianum* (d'Orbigny), as delineated by Spath (1934, p. 461, text fig. 158f). The narrow siphonal lobe ends in two long, sharp, almost vertical points which are separated from each other by a tall and very slender, triangular, median knob; it has, in addition, two main lateral branchlets on each side at about the first and the second third of its length. The external saddle is high and broad; its main stem is, however, very much narrowed at about the first third of its height; its upper part is subdivided by a deep trifid lobule, which points slightly dorsad, into two main branches, each of which is bifid; the outer one is inclined toward the median line, as is a strong lateral branch beneath it. The first lateral lobe is shorter than the external one and is deep, narrow and bifid; its two terminal branchlets are three-pronged and separated from each other by a tall upright leaf, flanked at its base by secondary leaflets; there are two main lateral branchlets on each side of this lobe. The first lateral saddle is somewhat higher than the external one and is similar in shape. The second lateral lobe attains a little more than two-thirds of the length of the first and is distinctly trifid; its three branchlets are each three-pronged. The second lateral saddle repeats the outlines of the first at a reduced scale. The first auxiliary lobe is less than half as long as the second lateral one and is bifid; both its terminal branchlets are three-pronged and point slightly ventrad. The first auxiliary saddle rides just on the umbilical edge. There follow on the umbilical wall

Fig. 17. Suture line of *Neoharpoceras conditum*, Haas, holotype, A.M.N.H. No. 25191.

the short, three-pronged, second auxiliary lobe and the beginning of the second auxiliary saddle, most of which belongs to the internal part of the suture line. Its next elements are a rather deep and narrow, trifid lobe and the upright, tall and slender internal saddle. The latter flanks the narrow and deep anti-siphonal lobe, which ends in a long, three-pronged, middle point and has two more main branchlets on each side.

REMARKS.—Although not the only *Neoharpoceras* within the present collection, this form occupies a rather isolated position owing to its decidedly grammoceratoid habitus. By the latter, manifested particularly in the density and the design of its costation, it can readily be distinguished even from the congeneric *N. angolanum* which is still somewhat transitional between *Prohysteroceras* and *Neoharpoceras;* other distinctive features are provided by the flatness of the sides and the broader venter.

For comparison with the more involute and more densely ribbed forms among the *Elobiceras* of the Angola fauna, especially with *E. oxytropidoceratoides*, reference may be made to the remarks on *N. angolanum*, just adding that the costation of the present species is much denser than even that of *E. oxytropidoceratoides*.

Another densely ribbed form from the Albian of Angola is described and figured by Choffat (1888, p. 67, Pl. II, fig. 2) under the name "*Schloenbachia* sp. ind." and compared by that author to "*Schloenbachia*" *hugardiana* (d'Orbigny), the genotype of *Neoharpoceras*. In his later paper (1905, p. 34) Choffat included that form in a group of "espèces à région siphonale en forme de toit," headed by the type on which later the species "*Elobiceras*" *arietiforme* was based by Spath. It may be added here that the latter species and, even more so, some *Elobiceras*, especially *E. irregulare*, var. *rigidecostata*, show a remarkable similarity not only in the general plan and in the degree of indentation of the suture lines, but also in some sutural details, with the present species (cf. below, p. 143). Choffat's above mentioned form differs from the latter by its fastigate venter which lacks a distinct keel, by its more vaulted sides and by its sharp, narrow, less sigmoidal ribs.

The sigmoidal course of the ribs is found also in another species from Angola, *Prohysteroceras dubium* Spath (1922, p. 146, Pl. IV, fig. 11); the latter, however, differs from *N. conditum* even more than from *N. angolanum* by its sharp high ribs and by its marked umbilical tubercles; moreover, its costation is much less dense, and its whorls are thicker. Except for the more blunt ribs, the same differences serve to distinguish the form described above (p. 130, Pl. XXXIV, fig. 2, text fig. 15a) as *Prohysteroceras* cf. *dubium* from that under discussion. Also *Prohysteroceras gracile*, new name (p. 127), exhibits sigmoidal costation, but the latter is less dense and quite different in other features, and that form, furthermore, has stouter whorls and a truncate venter.

The fragment from southern India described and figured by Stoliczka (1865, p. 52, Pl. XXX, fig. 5) as "*Ammonites sp. indeter.*" and compared by Choffat with his above mentioned form has wider whorls than the present species; furthermore, its sides are less flat, its ribs narrower and separated from each other by broader intercostals and its keel is lower. These differences, however, are considered as being of merely specific importance, and both Stoliczka's and Choffat's forms are referred by the writer to *Neoharpoceras*, but not to *Prohysteroceras* as they are by Spath (1922, p. 133).

Ammonites boghariensis Coquand (1880, p. 35), first identified by that author (1862, p. 172, Pl. II, figs. 3, 4) with *Ammonites favrei* Ooster and later recorded by Pervinquière (1907, p. 240, Pl. XI, fig. 16; 1910, p. 67, Pl. XV, figs. 29–38) from the Cenomanian of both the original Algerian locality and a Tunisian one, also has grammoceratoid costation and belongs in the writer's opinion to *Neoharpoceras* despite the umbilical tubercles which are faintly indicated at a diameter of 17 mm.

Finally there is a striking similarity in side view between the present species and *Muniericeras boulei* Basse (1931, p. 42, Pl. V, fig. 4, Pl. XIII, figs. 6a, b; Collignon,

1932b, p. 31, Pl. IV, fig. 2). The costation of Basse's type at diameters from 100 to 140 mm.[1] closely resembles that of *N. conditum*, but it is much finer and more dense and seems to be slightly more sigmoidal in the inner zone of the sides. Moreover, the Madagascar example, when as large as the Angolan one, still has distinct tubercles, and its section, unfortunately not figured by that author, seems to be different, and its suture line[2] certainly is.

Oxytropidoceras Stieler[3]

Subsequent to the completion of this manuscript there was found a ribbed fragment which cannot be referred to any of the dipoloceratid genera discussed so far, but which seems to be referable to the above genus.

Oxytropidoceras (?), indeterminate species

A. M. N. H. No. 25385: one specimen

Description.—The single worn fragment consists of about a third of a septate whorl which at its anterior end corresponds to a diameter of the disc of a little more than 20 mm. Its section is narrow, lancetiform and decidedly fastigate, the ventral portion of the conch being sharpened, though unkeeled. About twelve ribs can be seen only on the outer two-thirds of the sides, the inner third being too much corroded. Where observed, they form a wide, orad concave arc whose cord is directed radially, and they gradually vanish before reaching the median crest.

Although many prongs and leaflets can be traced, they can unfortunately not be connected to form a continuous suture line worthy of description or delineation; by etching, things became worse instead of better. What is visible, however, is at least not inconsistent with the general outlines of the suture lines of smaller specimens of *Oxytropidoceras*, as seen in Collignon's (*in* Besairie, 1936) text fig. 12.

Remarks.—This fragment must, though with every reservation, be referred to Stieler's genus; its poor preservation, however, seems to forbid further comparisons.

Palaeontological Résumé of the Dipoloceratidae

An appreciation of the ammonite fauna of the Albian of Hanha as a whole, from both palaeontological and palaeoecological points of view, cannot be made in advance of the completion of the study of this fauna, nor can the stratigraphic results be discussed earlier.

However, for the present attempt to make a palaeontological and as far as possible phylogenetic evaluation of the sculptured forms here discussed it is of supreme importance to examine the evidence concerning the nature of any zonal differentiation which may be found among these forms. As no field data were available (see p. 2), the only observations to be relied upon were those made in the laboratory in the course of the preparation of the collection. A few of them may be mentioned here:

(1) In one small block of matrix, containing a medium-sized *Puzosia*, were found many *Neokentroceras*, among them the holotypes of *N. magnum* and *N. speciosum*, var. *rudis*, but not a single *Hysteroceras*.

(2) From another small piece of rock, containing the holotype of *Hamitoides angolanus*, new species (described in Part III), were prepared from fifty to sixty *Neokentroceras*, among them the holotype of *N. speciosum*, some *Hysteroceras semilēve* (typical form and variety *elegans*) and *H. propinquum*, some *Dipoloceras rectangulare*, several small *Elobiceras* fragments and a few of *Hamites*, together with numerous gastropods and some more fragmentary fossils.

(3) On the other hand, the matrix adhering to specimen No. 4 of *Pervinquieria arietiformis* has yielded some beautiful

[1] These figures are based on fig. 4 of Basse's Pl. V, said in the explanation of this plate to be reduced × 1/2; however, they do not agree with her text, recording the diameter of her type as being only 88 mm.

[2] The statement in the description that suture lines could not be disclosed can hardly be harmonized with figs. 6a, b of Pl. XIII depicting two complete external ones.

[3] 1920, p. 346.

examples of *Hysteroceras varicosum*, var. *angolana*, and a few small *Puzosiae*, together with many gastropods and bryozoans, but not a single *Neokentroceras*. Also the largest discs of *Pervinquieria arietiformis* (specimens Nos. 5, 6) were crowded with little *Hysteroceras* of the *varicosum*-group, but no *Neokentroceras* were found on them.

(4) In the rock connecting the holotypes of *Elobiceras irregulare*, var. *rigidecostata*, and of *E. spathianum*, embedded beside each other, were found, in addition to many gastropods, about six specimens of *Hysteroceras varicosum* (typical form and var. *angolana*), a few fragments of *H. orbignyi*, var. *minor*, one of *H. falcicostatum*, a single fragment of *Dipoloceras rectangulare*, a poorly preserved *Pervinquieria bassleri* and five little fragments of *Elobiceras raymondi* and *E. hexagonum*, but not a single *Neokentroceras*.

From these observations it can be inferred with some certainty that there is, in spite of the small total volume of rocks in which the Hanha fossils were embedded, some zonal differentiation within this deposit.[1] The *Neokentroceras* and the *Hysteroceras* with ribs not coalescing on the venter ("keeled" *Hysteroceras*), on the one hand, and the "unkeeled" ones, as represented chiefly by *H. varicosum* and *H. orbignyi* and their varieties, on the other, appear to be mutually exclusive. Furthermore, the latter are apparently associated with *Pervinquieria arietiformis* and with some species of *Elobiceras* closely related to the former species. However, small representatives of *Elobiceras* occur with *Neokentroceras*.

There was no indication within the dismembered blocks of rock which the writer examined in the laboratory as to the order of superposition of these two assemblages. On the basis of Spath's statement (1934, p. 472), "In Angola the beds with *Hysteroceras choffati* and *H.*[2] *pseudovaricosum* and numerous *Neokentroceras* have now turned out to be at the base of the *Mortoniceras*[3]-*Elobiceras* bearing series," the *Neokentroceras* zone (examples 1 and 2) would have to be considered the lower one, while that with *Hysteroceras varicosum* and *H. orbignyi* and *Pervinquieria arietiformis* (samples 3 and 4) the upper one. The phylogenetic interrelations between the genera discussed so far will, therefore, have to be examined, though with reservations, under the surmise of this order of superposition.

First, however, let us consider the relations between the genera here dealt with from a merely morphological point of view. As seen in the "Remarks" following the description of every species, similarities occur not only between congeneric species, but no less frequently between species belonging to different genera. How frequently is shown best by the chart (text fig. 18) which, it may be reiterated, endeavors to illustrate only purely morphological resemblances between non-congeneric forms. Many, if not most, of these similarities occur between the adolescent stages of both forms concerned or between the young of one form and the adults of the other. No better illustration of Spath's (1934, p. 443) statement referring to the same group of Albian ammonites, that "they are all closely allied and all derived from the same root-stock," could be found than that furnished by text fig. 18. This diagram is inserted here to dispense with the necessity for a recapitulation of the intergeneric relations, as noted in the descriptive portion of this paper. Each of these relations is indicated by a straight line connecting the similar forms with each other, while merely sutural resemblances are indicated by a dotted line. The details on which these connections are based are discussed in the "Remarks," mentioned above.

In any attempt to place a phylogenetic significance on these intergeneric resemblances, two principles should be kept in mind:

(1) Groups of extinct beings of very

[1] This zonal differentiation may also account for the fact pointed out by Spath (1922, p. 154, that "one locality, namely, 295 ('shore at landing-place near Hanha'), is characterised by the presence of the genera *Neokentroceras*, *Torneutoceras*, and *Aniosceras*, and the absence of the typical large *Subschloenbachia* and *Elobiceras*."

[2] Referred to *Neokentroceras* in this paper.

[3] = *Pervinquieria* in the usage of this paper.

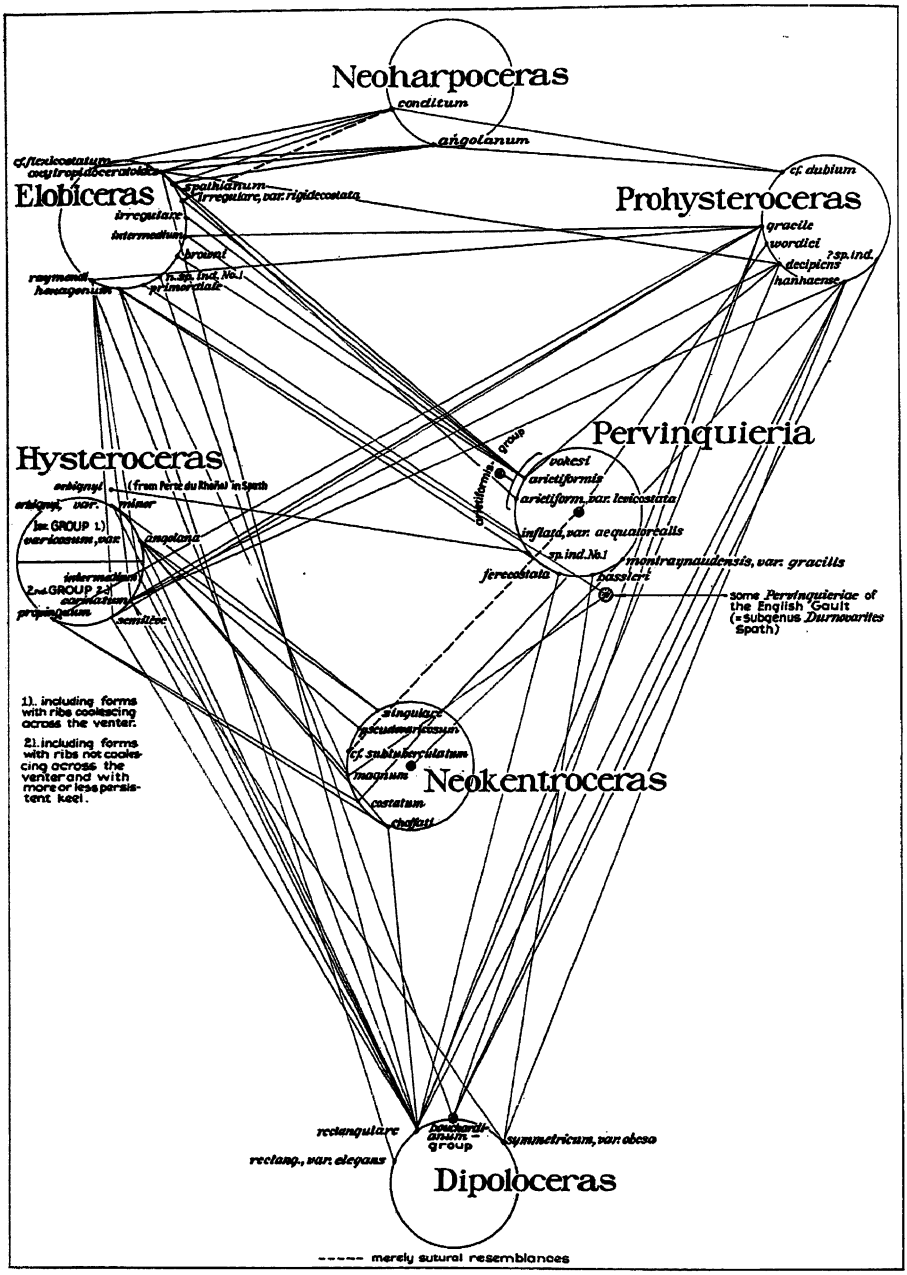

Fig. 18, INTERGENERIC RESEMBLANCES OF THE DIPOLOCERATIDAE

different evolutionary stages can live within the same faunal assemblage. This fact never excludes the establishment of phylogenetic relations, for it is the date of the first appearance of a lineage that is of importance, regardless of the duration of its survival.[1]

(2) A single fauna and even a chronological sequence of faunas in the same palaeogeographic province should, in the tracing of phylogenetic relations, never be examined *per se*, particularly if animals having as wide a geographic range as ammonites are concerned. The results yielded by a certain living space must, therefore, most carefully be checked as to whether or not they are consistent with those based on others.

The latter point needs to be stressed, as every author is usually and naturally inclined to overrate the importance of his own field. This is another reservation which must be made before proceeding with this investigation. Although fully aware of this, I believe that the Albian fauna of Angola may once more, by the present paper, be proved to be of much greater importance for the elucidation of intergeneric and phylogenetic relations among the ammonites of that period than could be expected at the time of the appearance of Choffat's papers of 1888 and 1905.

Dipoloceras, occurring in Beds IV–VIII of the English Gault, seems to be one of the oldest genera in the present assemblage; however, the group of *D. bouchardianum*, represented in this fauna by this species itself, its variety *alticarinata* and by the closely related *D. rectangulare* (= *D. bouchardianum*, var. *rectangularis* Spath), seems to be restricted in England to Bed VIII. It is sometimes almost impossible to distinguish some forms of *Hysteroceras carinatum* from *Dipoloceras rectangulare*, and there are, furthermore, close relations between the latter species and other *Dipoloceras* on the one hand and various forms of *Hysteroceras*, *Neokentroceras*, *Prohysteroceras* and the inner whorls of some *Elobiceras* on the other. Also the smaller *Pervinquieriae* bear some resemblance to *Dipoloceras*.

Thus at least one section of *Hysteroceras*, the group of *H. carinatum*, may be derived from *Dipoloceras*, as may some *Prohysteroceras*.

Although there are not many lines connecting *Dipoloceras* with *Neokentroceras* in the chart, future collections may show that the latter may also be traceable back to some late *Dipoloceras*.

Neokentroceras was first assumed by Spath (1922, p. 154; 1923, p. 140) to occur in Bed XIII of the English Gault and to be the latest in appearance of all the genera under discussion. To Thiele (1933, p. 118) it was "one of the last representatives of an old lineage dying out." The spinosity of its genotype, *N. curvicornu*, may have favored this conception, as spines and the like are conventionally considered to be symptoms of degeneration. However, this genus turns out to be apparently older than those of which it was hitherto thought to be the degenerate late offshoot. This, of course, involves also the inversion of some phylogenetic concepts.

Nothing in the present collection would cause any objection to the derivation of the typical *Hysteroceras* from *Neokentroceras*. As shown by the suture lines, both genera are undoubtedly most closely related. *Neokentroceras*, although once considered to be a highly specialized, dead-end side branch of *Hysteroceras*, appears first, at least earlier than the genotype, *H. varicosum*, and its allies, included in the present paper in the first group of this genus. It is, therefore, quite probable that this group originated from some *Neokentroceras;* one connection may be found in *N. singulare* which heralds in maturity the coalescence of ribs across the venter, the characteristic feature of the *varicosum*-group. There is also a close relationship between some forms of the latter group and *N. choffati* and between *H. varicosum* itself and *N. pseudovaricosum*. Also, the *Hysteroceras* of the second group, the "keeled" *Hysteroceras*, or at least some of them, can be easily connected with *Neokentroceras*,

[1] It would not make much difference in the present investigation, should the common occurrence of all these forms at Hanha be due to "taphonomic" (Efremov, 1940) reasons only, or, in other words, if it be merely a thanatocoenosis, not a biocoenosis. This issue will be discussed explicitly in the final conclusions.

e.g., along the line *N. costatum-H. propinquum-H. semilēve*. The latter is very close to *H. carinatum* which in turn is so very similar to *Dipoloceras rectangulare* that it might be derived from that species as well. All this seems to suggest the polyphyletic origin of *Hysteroceras* from various lineages of both *Dipoloceras* and *Neokentroceras*. At any rate, it seems as if *Neokentroceras* and *Hysteroceras*, or at least the *varicosum*-group of the latter, would have to change places in the role of a specialized "decadent." The loss of the keel coincidental with the amalgamation of the costae from the sides across the venter characteristic of the latter group does not seem to continue in any immediate successors, whereas several important lines of descent seem to originate from the little known, comparatively rare and micromorphic *Neokentroceras*.

Hysteroceras does not seem to be the only lineage which may be derived from it; some small *Pervinquieriae*, particularly those included by Spath in his subgenus "*Durnovarites*," show a striking resemblance to some *Neokentroceras*, e.g., *N. magnum;* thus the possibility cannot be excluded that *Pervinquieria* also may have to be derived, at least in part, from *Neokentroceras*. It is, for instance, most striking to see that the inner whorls of *P. montraynaudensis*, var. *gracilis*, bear umbilical tubercles developed as true spines, a feature which can be traced back to *Neokentroceras* only. All this does not mean that other *Pervinquieriae* may not descend from *Dipoloceras* but merely that a polyphyletic origin is most likely for *Pervinquieria* also. Certainly its derivation is not so simple as was imagined by Thiele (1933, espec. p. 120), who misunderstood both the different forms and their stratigraphic sequence (cf. Spath, 1934, p. 473). Furthermore, the ornamentation of some specimens doubtfully referred to *Prohysteroceras hanhaense*, almost indistinguishable from that of *Neokentroceras costatum*, seems to indicate that some *Prohysteroceras* also may be derived, directly or indirectly via *Hysteroceras*, from *Neokentroceras*.

The above opinions are strongly supported by some observations of Spath, who found, at a time when he still considered *Neokentroceras* to be a late, dead-end offshoot, that the inner whorls of various forms belonging to other genera are "*Neokentroceras*-like," e.g., those of *Pervinquieria recticostata*, *P. prerostrata* and *P. montraynaudensis* (the ribbing of the last two forms being called a "*Hysteroceras*-or *Neokentroceras* costation," 1925b, p. 185) and of *Hysteroceras choffati* (*ibid.*, p. 188; 1934, p. 486).[1]

Elobiceras and *Pervinquieria* occur together in Angola, but that must not necessarily be considered an objection[2] to the derivation of the former from the latter, as attempted by Spath. In the present collection transitions from *Pervinquieria* to *Elobiceras* could be followed along several lines, e.g., *P. inflata*, var. *aequatorealis*—*E. primordiale*, or *P. arietiformis* and varieties—*E. irregulare* and varieties, *E. spathianum* and *E. intermedium*. However, nuclei of some *Elobiceras* show also close affinities not only with some *Hysteroceras*, but also with some *Dipoloceras*. For example, the inner whorls of *E. oxytropidoceratoides* are hardly distinguishable from *Dipoloceras rectangulare*, and there is also much resemblance between those of *E. raymondi* and some keeled *Hysteroceras* (e.g., *H. intermedium*, *H. carinatum*, *H. semilēve*). Thus *Elobiceras* seems to require polyphyletic derivation no less than any of the genera discussed so far; it even looks as if the peculiarity of its ornamentation, consisting of spiral riblets throughout the ribs and sometimes even in the intercostals, would be due to some "signature of time" (Dacqué).

The writer also fully shares Spath's (1933, p. 442) belief in the polyphyletic origin of *Prohysteroceras*, but owing to his observations on the inner whorls of some species of this genus he cannot restrict that polyphyletic origin to ancestors belonging to *Pervinquieria*, but rather expands it to *Dipoloceras* (e.g., *D. rectangulare—P. dubium*) and to the "keeled" *Hysteroceras*

[1] The same statement made by him (1934, p. 480) with regard to "*Hysteroceras*" *pseudovaricosum* must be left out of account, as this species is considered a true *Neokentroceras* in the present paper.

[2] See pp. 139, 140.

(e.g., *H. carinatum* and *H. semilēve*-*P. gracile* and *P. hanhaense*). The possibility of the derivation of the latter species even from *Neokentroceras* has been discussed above.

There can be hardly any doubt concerning the derivation of *Neoharpoceras* from *Prohysteroceras*, a subgenus of which it is now considered by Spath. There is, however, also a close affinity between *Neoharpoceras* and *Elobiceras*, which becomes particularly obvious by comparison of the suture lines, e.g., of *N. conditum* and *E. irregulare*, var. *rigidecostata*. It cannot be excluded that this affinity also might be of some phylogenetic significance.

Summarizing the above observations:

(1) "The elasticity or fluidity of phylogenetic implications which I always plead" (Spath, 1938b, p. 3) seems to be confirmed, perhaps more than ever, by the present analysis of the sculptured, regularly coiled ammonites of the Albian fauna of Hanha;

(2) And so seems his belief (*ibid.*, p. 14) in the polyphyletic origin of "all our ammonite families," which might even be extended down to the genera.

(3) On the other hand, no observations made in the present study support the preference repeatedly given by Spath (1933, p. 442; 1933b, p. 448; 1934, p. 490; 1938b, Introduction, espec. p. 12[1]) to caenogenesis over palingenesis. In agreement with the law of recapitulation, characters which a form has in common with older[2] ones were found at an early ontogenetic stage of the former, and features which it has in common with younger[2] forms were found at a late one. This does not, however, imply any doubt concerning the correctness of Spath's observations and conclusions or of those of Schindewolf (1936), which, though recorded under the different name of "proterogenesis," amount practically to the same. It just means to say that both palingenetic and caenogenetic phenomena occur, but only most careful observation based on reliable stratigraphic data can decide which are prevailing in any specific example. It may be added that Ruzhencev (1939, p. 31) also found, in his investigations on some groups of Upper Paleozoic ammonites, "the concept of recapitulation . . . brightly exemplified" and "the meaning attached by Schindewolf to the phenomenon of proterogenesis" to have "not been justified."

(4) Should the phylogeny assumed above prove to be correct, the Albian fauna of Hanha would furnish another example of some general anagenetic trends which, in the writer's opinion,[3] reiterate themselves in the evolutionary history of certain groups[4] of ammonites throughout the Mesozoic.[5] The conchs become gradually more involute and more discoidal, the whorls higher and more slender; the sculpture, robust and stiff at first, gradually becomes finer and more sigmoidal; the suture lines become more and more elaborate. Some of these trends, for example, the refinement of ornamentation and the increase of sutural indentation, are found also in ontogenetic development; in other regards, however, the latter takes just the opposite trend to that of phylogeny, e.g., the degree of involution decreases at maturity in almost all the genera examined.[6]

According to the conception that taxonomy has primarily to be based on morphology pointed out above (p. 5), the writer, agreeing with Pia (1921, p. [147]) and Schindewolf (1927, pp. 138 ff.), does not believe that the assumed polyphyletic origin of almost all the genera discussed so far necessitates their taxonomic dissolution.

Finally, a few examples of homeomorphy

[1] I did not succeed in finding the wording of this conception, as given by Jaworski (1940, p. 246), "The inner whorls foreshadow the successor rather than recapitulate the ancestors," in the Introduction of Spath's Monograph on the Liparoceratidae.

[2] In spite of the forms concerned being contemporaneous or almost contemporaneous in the present collection, the words "older" and "younger" are here used in the sense of "appearing earlier" and "appearing later," respectively.

[3] Haas, 1942b, p. 647.

[4] No general validity is claimed for these evolutionary trends; e.g., within the Liparoceratidae involute forms precede more evolute ones.

[5] See Haas, 1912–13, p. 139; 1942b, p. 647.

[6] I am well aware that this fact might be interpreted as supporting Schindewolf's "proterogenetic" conception that new characters first occur in adolescence and are displaced in maturity by ancestral ones and that it requires some time for them to push through. It may, however, be doubted whether such a general feature can be correctly interpreted in so specialized a sense.

(cf. Schindewolf, 1940, p. 230), observed in the study of the genera examined, may be listed: *Hysteroceras binum*, var. *lobitoensis*, very much resembles *Stoliczkaia africana* Spath; *Elobiceras oxytropidoceratoides*, some true *Oxytropidoceras; Prohysteroceras hanhaense*, the inner whorls of *Pervinquieria cunningtoni* (Spath); and *Neoharpoceras conditum*, *Muniericeras boulei* Basse. No phylogenetic relations, however, are inferred from these merely superficial similarities.

Appendix to Part I

Van Hoepen's second paper on the keeled ammonites of the South African Gault, published on March 29, 1941, came to the writer's knowledge only after the closing of the manuscript of Part I of the present paper. As it deals with Albian forms similar to those from Angola and as both its taxonomic and phylogenetic conceptions provoke contradiction, some remarks which must be made may be concentrated here. Footnotes referring to them are added to the discussions of the genera and species concerned.

First, van Hoepen's abundant creation of generic names gives new evidence of the well known fact that the narrower an author's survey of forms both in collections and in literature (see his list of literature[1]), the more will he be inclined to consider his own to be most peculiar and solitary. Thus almost every form becomes a genotype.

As to "*Rhytidoceras*" and "*Drepanoceras*," I still adhere, after examination of the more complete descriptions and figures found in van Hoepen's new paper, to the opinion voiced above (p. 100) that both are only stout *Elobiceras*. "*Cechenoceras*," "*Deiradoceras*" (whether or not acknowledged, as it is by Spath, as a subgenus of *Pervinquieria*) and "*Mimoceras*" are *Pervinquieriae* throughout. In consequence, van Hoepen's new families "*Drepanoceratidae*" and "*Cechenoceratidae*" must be considered invalid. It may be added that he apparently assigns much taxonomic value to the presence or absence and to the shape of old apertural margins. I do not believe, however, that they can be considered generic characters; it can be seen from Stieler's (1922b) careful investigations, which seem to have escaped van Hoepen, that such periodically occurring abnormal apertures are found in very different genera. There is, furthermore, no sound reason whatsoever to split off a new genus "*Ricnoceras*" from *Dipoloceras*, merely on account of the occurrence of umbilical nodes in the former, as they are found also in various forms of the group of *D. bouchardianum*, especially in *D. rectangulare* from Angola. For this reason van Hoepen also includes, though doubtfully, *D. bouchardianum* and *D. quadratum* Spath, which is most closely related to *D. rectangulare*, in his genus "*Ricnoceras*." In that case, however, *D. bouchardianum* d'Orbigny, established just a century earlier than "*Ricnoceras*" *pandai* van Hoepen, should be, instead of the latter, the genotype of this genus, were it to be considered a valid one. It is striking that, according to van Hoepen, *D. bouchardianum* occurs in Zululand earlier than *D. cristatum*, the genotype of *Dipoloceras*, and *D. cornutum*, whereas the opposite seems to be true in the English Gault.

Only two of van Hoepen's new species need be dealt with here. "*Cechenoceras*" *magnum* is, to judge by its costation, most closely related to, if not merely a somewhat stouter variety of, *Pervinquieria evoluta* Spath (cf. the latter's type in Choffat, 1905, Pl. III, fig. 2, with van Hoepen's, 1941, Pl. VIII). At least some "*Cechenoceras*" may, therefore, be referable to Spath's *evoluta*-group. "*Deiradoceras*" *recurvicostatum*, although figured only in side view by van Hoepen (1941, Pl. XV), can, by the decrease of its degree of involution in the course of development, by its fastigate outer whorl, by its costation, which becomes much less sharp and dense in maturity, and by the characteristic, blunt,

[1] In which even Venzo's (1936) important paper, dealing in part with the same fauna, is omitted.

external knobs of its ribs, clearly be recognized as a *Pervinquieria arietiformis*. It is true that such strongly rursiradiate ribs (confined also in van Hoepen's single example to the inner whorls) are not found in any of the specimens of this species from Angola; the former may, therefore, be taken as the type of a variety *recurvicostata* of this species.

Van Hoepen's preliminary conclusions (pp. 87–90) and his genealogical tree (text fig. 55) lose much of the importance given them by that author if it is kept in mind that his "*Cechenoceratidae*" are merely a group of the genus *Pervinquieria* and that both "*Rhytidoceras*" and "*Drepanoceras*" together form a group of the genus *Elobiceras*. The branching off of the latter from *Pervinquieria*, as seen in van Hoepen's diagram, is no unusual conception, but derivation of the whole family of the "Pervinquieridae" (= "*Mortoniceratidae*" Spath ?) from the "Cechenoceratidae" late in Albian times becomes understandable only if the former family name is restricted to those *Pervinquieriae* which incidentally have not yet been discussed by van Hoepen. On the other hand, derivation of the whole family of the *Dipoloceratidae* from "*Cechenoceras*," that means to say, from one group within the genus *Pervinquieria*, seems rather strange, particularly since the opposite relationship was hitherto inferred from all the data available. Altogether, van Hoepen's phylogeny strongly confirms my statements above (p. 141) that every author is inclined to overrate the importance of his own material, and that no single fauna nor sequence of faunas should in the tracing of phylogenetic relations ever be examined *per se*. Furthermore, it does not seem easy to agree with this author's opinion that a monophyletic conception is that of the younger generation. It might be much more convenient to science if all lineages we have to deal with could be derived from each other in a purely monophyletic sense; unfortunately, however, things have gradually turned out to be not quite so simple as they were expected to be. The trend prevailing in modern ammonitology is, therefore, that toward polyphyletic, not monophyletic, derivation of families and, as repeatedly shown above, even of genera.

PART II: PHYLLOCERATIDAE, DESMOCERATIDAE, LYTOCERATIDAE

This part of the present paper includes those ammonites from Hanha which might at first glance be called the smooth, normally coiled forms, in contradistinction to the sculptured ones dealt with in Part I. However, the ammonites here described are, as a rule, not entirely smooth. Even if the varices and constrictions occurring in most of the Desmoceratidae, and the ridges which usually accompany the constrictions and in some forms, e.g., *Puzosia spathi*, become quite prominent are not considered a part of the ornamentation, there are still distinct striae, riblets and folds in *Phylloceras velledae* and *Gaudryceras aenigma* as well as in many *Puzosiae*.

Numerically the three above families contribute to a very different extent to the ammonite fauna of Hanha. The "stenothermal" families of the Phylloceratidae and Lytoceratidae, whose apparent absence from the Albian of Angola was stressed by Spath in 1922 (p. 155),[1] are represented only by one form each of the three genera *Phylloceras*, *Gaudryceras* and *Tetragonites*, with from one to three specimens; but nine out of twelve forms described and 187 out of 192 specimens studied belong to the Desmoceratidae. Within the latter family, the genera *Beudanticeras* and *Aconeceras* (?) are again represented by one form with only one or two specimens each, whereas the great majority of forms (seven out of nine) belong to *Puzosia*, which is, with one hundred eighty-four individuals, by far the most abundantly represented genus discussed in this part.

[1] A single Albian *Phylloceras* has since been recorded, and given the specific name *angolense*, by Haughton (1924, p. 85, Pl. 1, figs. 1,2) from a locality south of Benguela Velha.

Phylloceratidae Zittel

PHYLLOCERAS SUESS

This most persistent of all Mesozoic ammonite genera, hitherto unknown from the Albian of the Lobito region, is represented in this collection by three specimens referred to the following almost ubiquitous species.

Phylloceras velledae (Michelin)

Pl. XXXVII, fig. 1a, b; Pl. XLIV, fig. 1; text figs. 19a, b

A. M. N. H. No. 25386: three specimens

Ammonites Velledae Michelin; D'ORBIGNY, 1841, p. 280, Pl. LXXXII.

?*Ammonites Velledae* Michelin; PICTET AND ROUX, 1848, p. 286, Pl. II, fig. 1.

Ammonites Velledae, Michelin; PICTET AND CAMPICHE, 1860, p. 268, Pl. XXXVI, fig. 8.

?*Ammonites Velledae*, Michelin; STOLICZKA, 1865, p. 116, Pl. LIX, figs. 1–4.

Phylloceras Velledae Mich.; YOKOYAMA, 1890, p. 177, *cum synon.*, Pl. XIX, figs. 1a, b.

?*Phylloceras Velledae* Michelin sp.; KOSSMAT, 1895, p. 108, Pl. XV, fig. 3.

Phylloceras Velledae Michelin; BOULE, LEMOINE AND THEVENIN, 1906, p. 7, *cum synon.*, Pl. I, figs. 6, 11, *non* fig. 10.

?*Phylloceras Velledae* (?Michelin, sp.), Stoliczka sp.; CRICK, 1907, p. 166, Pl. X, figs. 10, 11.

Phylloceras velledae, Michelin sp.; SPATH, 1921, p. 273.

Phylloceras velledae Michelin; SPATH, 1923, p. 18.

Phylloceras velledae Michelin; BÖSE, 1923, p. 119, *cum synon.*, Pl. VII, figs. 15–17.

Phylloceras velledae (Michelin); SPATH, 1925b, p. 180.

Phylloceras velledae Michelin; COLLIGNON, 1929, p. 6, Pl. I, fig. 1.

Phylloceras velledae Mich.; BESAIRIE, 1930, pp. 616, 617.

Phylloceras Velledae Michelin; COLLIGNON, 1932a, p. 8.

Phylloceras Velledae Mich.; COLLIGNON, 1933, p. 60.

Phylloceras velledae Michelin; BESAIRIE, 1936, p. 164, Pl. XVI, fig. 1.

Phylloceras velledae (Michelin); VENZO, 1936, p. 66, Pl. V, fig. 4.

Phylloceras Velledae Mich.; ROMAN, 1938, p. 15.

DIMENSIONS

Spec. No.		D	H	H′	W	U
1	(a)	83.5 mm.	59½	?	34	6
	(b)	140.0 mm.	56	38½	36	ca. 5

DESCRIPTION—A rather large specimen (No. 1), which is partially crushed, is septate up to a diameter of 130 mm.; only its foremost part belongs to the body chamber. Taking the length of the latter into account, this disc, when complete, may have reached a diameter of about 200 mm.

The conch is discoidal and almost fully involute, the umbilicus being very narrow (Pl. XXXVII, fig. 1a). The whorls increase rather rapidly in both height and width. At a diameter of about 70 mm. the section (text fig. 19a) is slender and elliptic; the sides are but very gently vaulted and most distant from each other at about their

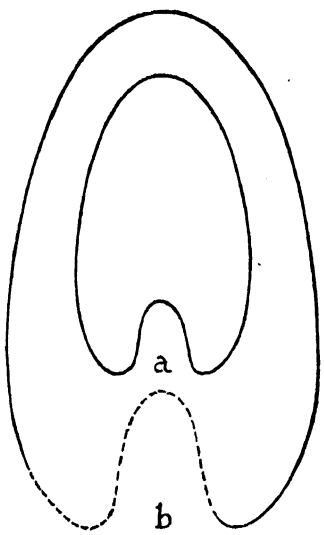

Fig. 19. Sections of *Phylloceras velledae* (Michelin), A.M.N.H. No. 25386: 1, at diameters of (a) 70 mm., (b) ca. 130 mm.

first third; the venter is rather narrow, though rounded. Its median line is marked on the cast by a narrow (width about 0.5 mm.) and rather shallow, but sharply engraved groove (Pl. XXXVII, fig. 1b); however, this groove appears to be too fine to represent the siphonal tube (cf. de Grossouvre, 1893, pp. 165, 166). In the anterior part of the disc at diameters from 120 to 140 mm. the section (text fig. 19b) is somewhat stouter; the sides seem to converge more decidedly ventrad, and the

boundary between them and the venter has become slightly more distinct, but no latero-ventral shoulders can be recognized.

The ornamentation, which is faintly visible even on the cast, consists of fine striae which markedly increase ventrad in strength; whereas they are on the inner half of the sides as wide as the interstices between them, they are considerably wider on the outer one as well as on the venter, where from seven to eight of them can be counted on a length of 10 mm., as compared with seventeen to twenty on the inner zone of the sides. The striation seems to be less dense on the anterior part of the outer whorl than it is farther apicad. Bifurcation of these striae around the umbilicus can occasionally be observed. Here and there they seem to be slightly imbricated. They are gently sigmoidal on the sides and cross the venter in a very shallow, orad convex sinus.

The external suture lines are visible throughout the septate part of the outer whorl, best between the diameters of 45 and 80 mm. (Pl. XLIV, fig. 1). The siphonal lobe attains only about two-fifths of the length of the first lateral one; it has two almost parallel, three-pronged, terminal points separated from each other by a rather slender median knob whose shape might best be defined as rectangular with a blunt point superimposed on the rectangle; furthermore, there are two lateral branches on each side of this lobe. The external saddles are inclined dorsad under an angle of about 60° and divided by a moderately deep three-pronged lobule; the outer stem is upright, the inner one oblique and slightly lower than the outer; both are bifid, their leaves ending, as all those of the saddles of this suture line, in the phylloid manner distinctive of this genus. The first lateral lobe has a narrow trunk but expands the more at its bottom; it is trifid, the outer branch is much broader and longer than the inner one and approaches the median line so closely that its outermost points are just beneath the terminal one of the siphonal lobe; all three branches of the first lateral lobe are trifid, and all their points are three-pronged; the leaf separating the middle branch from the outer one is markedly lower than the opposite one. The first lateral saddle is slender, very much straitened both at its base and at about half its height, and is bifid; its inner stem is higher than the outer one and marks the highest point of the line connecting the tops of the saddles, which from here on follows an almost radial direction. The second lateral lobe is somewhat shorter than the first and resembles it very much, also in that the outer branch is more developed, so less markedly so than in the former, and that the inner leaf is higher than the outer. The bottoms of all lateral and auxiliary lobes can also be connected by a straight radial line, as can the tops of the corresponding saddles. The second lateral saddle is a slightly reduced repetition of the first except for both its stems being equal in height. Six auxiliary lobes and five auxiliary saddles can be counted up to the umbilical seam; these lobes gradually decrease in size but are otherwise very like each other; the same is true of the auxiliary saddles, except that only the first can be recognized to be bifid, while the others are not. The third auxiliary saddle rides just on the umbilical edge.

Two small, poorly preserved fragments (Nos. 2, 3) of discs measuring less than 30 mm. in diameter show the same section and striation and, as far as No. 3 is concerned, also the same suture line as the full disc described above; they are, therefore, also referred to the present species.

REMARKS.—The striking resemblance in side view between my specimen No. 1 and the equally large one from the upper horizon of the Middle Albian of Madagascar depicted by Besairie (*loc. cit. in synon.*) appears to be worth noting. Another example of about the same size is recorded by Venzo (*loc. cit. in synon.*) from the Upper Albian of Zululand; it differs from that from Hanha merely by being a little stouter and by its slightly less fine striation.

As to the synonymy of this species reference may be made to the papers of Boule, Lemoine and Thevenin and of Spath, quoted above. It may, however, be doubted whether the differences between

Ph. seresitense Pervinquière (1907, p. 52; Spath, 1923, p. 18, Pl. I, fig. 3, Pl. II, fig. 1), to which Spath (*loc. cit.*) also refers Pictet's Greensand form, here doubtfully included in the synonymy of *Ph. velledae*, and the present species are not merely varietal ones, as Pervinquière thought them to be. Stoliczka's Indian form, recorded also by Kossmat and from Zululand by Crick (*loc. cit. in synon.*), might also belong to Pervinquière's variety or to another variety slightly differing from the former by its stiffer and rursiradiate striation. The wide geographic range of this species has been emphasized by Boule, Lemoine and Thevenin.

The only *Phylloceras* hitherto recorded from the Albian[1] of Angola, though from a locality (south of Benguela Velha) almost two degrees farther north, *Ph. angolense* Haughton (1924, p. 85, Pl. I, figs. 1, 2), has about the same measurements as *Ph. velledae*, but it can readily be distinguished by its flatter, "sub-parallel" sides and its broader, slightly truncate venter; also it is thicker at an early stage.

Desmoceratidae Zittel

This family, carefully discussed by Spath in his Gault Monograph (1923, pp. 31–39), is represented at Hanha by two of its Albian genera, *Puzosia* and *Beudanticeras*. The rather intricate taxonomic issues involved in the delimitation, particularly of *Desmoceras* and *Beudanticeras*, will be discussed in the heading dealing with the latter genus. Furthermore, the genus *Aconeceras* (group of *Ammonites nisus* d'Orbigny), for which Spath (1923, p. 35) established a separate family Aconeceratidae, is, due to its close relationship to *Beudanticeras*, here tentatively included in this family, to which it has also been attached by both Hyatt (1903, footnote b, pp. 100–101) and Roman (1938, pp. 153, 417).

Puzosia Bayle[2]

The circumscription of the present genus, as here interpreted, is the same as that of Jacob (1908a, pp. 24–27) and Spath (1923, pp. 31–39) who, since the beginning of this century, have studied it most carefully; the former author considered it a subgenus of *Desmoceras* Zittel. According to Douvillé (1879, p. 91) *Puzosia planulata* Bayle (1878, Pl. XLVI, fig. 1) *non* Sowerby (= *Ammonites subplanulatus* Schlüter, 1871, p. 4, Pl. II, figs. 5–7) must be considered the genotype (cf. Spath, 1923, p. 42).[3]

Among the "smooth," or almost smooth, genera from Hanha discussed in this part of the present paper *Puzosia* by far outnumbers all the others; being represented by 184 specimens in this collection, it is exceeded in the total number of specimens only by the genus *Hysteroceras* discussed in Part I. It is true that most of these 184 specimens are fragments, eighty-six of which are too poor for specific identification. The remaining ninety-eight specimens are assigned to seven different forms.

Among them two groups can clearly be distinguished. One is the group of *P. mayoriana* d'Orbigny (1841, p. 267, Pl. LXXIX, figs. 1–3),[4] to which undoubtedly the Gault specimens figured by Quenstedt as early as 1849 under the name of *Ammonites planulatus* but later separated by Parona and Bonarelli under the name of *P. quenstedti*, have to be referred. The latter species is represented in Angola chiefly by a new variety *angolana*, which has yielded by far the greatest number of specifically determinable specimens. There is also another, much less abundant new variety of the same species, the variety *applanata*. To this group belong, furthermore, a new form, *P. tenuis*, and another new species which was, however, thought to be too poorly preserved to be given a specific

[1] The two Angolan localities from which Haughton (1924, p. 86, Pl. I, figs. 3, 5) records *Ph. surya* Forbes belong undoubtedly to a higher horizon.

[2] 1878, explanations of Pls. XLV, XLVI.

[3] Jacob (1908a, p. 27) and Roman (1938, p. 407), however, choose *P. mayoriana* d'Orbigny for the genotype.

[4] Jacob (1908a, pp. 38–41, text figs. 13, 23, 24, Pl. VI, figs. 1–4) has most thoroughly studied this species, particularly as to its ontogenetic development, but his interpretation is in Spath's (1923, p. 43) words a "comprehensive" one. By his scale of circumscription of species almost all the various forms of this genus encountered at Hanha might be included in *P. mayoriana* as well.

name, together with some specimens referable to Meunier's hitherto inadequately known species *P. cuvervillei*, and to a new variety *flexisulcata* of the latter. The other group, that of *P. planulata* (Sowerby) (and *P. subplanulata* Schlüter), differs from the first by attaining a much larger size and particularly by its much more elaborate suture line with an oblique external saddle; it is represented at Hanha by some large discs of a form repeatedly reported from Zululand but named *P. stoliczkai* Kossmat, var. *spathi*, only some years ago by Venzo (1936) and here raised to the rank of an independent species. The first group seems to be the older one, still exhibiting close affinities to the Upper Barremian-Aptian *P. melchioris* Tietze, made by Spath (1923, p. 33) the genotype of a separate genus *Melchiorites*, whereas the Angola forms of the second group, which apparently represents the younger lineage, perfectly agree both in size and in sutural character with the Cenomanian *P. planulata* (and *P. subplanulata*).

In distinguishing within the present material the two above groups the writer relied chiefly on the suture lines. Within the first group, however, the distinction between species and varieties is based on dimensions and sections rather than on the number and shape of the constrictions, since the latter are not always observable and are, moreover, very subject to individual variation.

Puzosia quenstedti (Parona and Bonarelli)[1]

(A) var. angolana, new variety

Pl. XXXVII, figs. 2–9; Pl. XLI, figs. 1–6, text figs. 20a–g

A. M. N. H. No. 25387: forty-six specimens

?*Puzosia* cfr. *planulata* Sow.; CHOFFAT, 1905, p. 39.

DESCRIPTION.—The holotype (specimen No. 4) seems to be septate at its posterior end only, having the last septum at a diameter of a little more than 15 mm. In the two largest specimens (Nos. 15, 16), both attaining a diameter of about 35 mm., the body chamber seems to begin at a diameter of about 25 mm. Specimens Nos. 5 and 9, however, whose greatest diameters amount to 26.7 and 31 mm., respectively, are septate throughout. As no specimen is really complete, nothing can be stated about the length of the body chamber.

The conch is rather involute; the whorls increase faster in height than in width. Whereas their thickness equals the height in the smallest of the measured examples (No. 11), the ratio W:H gradually decreases from 0.98 in specimen No. 1 to 0.84 in specimen No. 5; in the paratype (No. 3) and in the holotype (No. 4) this ratio amounts to 0.865 and 0.855, respectively, as compared to 0.81 in the holotype of the typical form of this species (according to Breistroffer, *loc. cit.*, Quenstedt's fig. 13b). Thus the section (Pl. XXXVII, figs. 2c, 4c, 5c, 7; text figs. 20a–g) is circular in the earliest stages and becomes oval later, having its maximum width at about the first third of its height, whence the sides converge ventrad. The venter is comparatively broad but well rounded, not truncate. The umbilical shoulder is marked, though rounded, the umbilical wall perpendicular, or almost so, and, at least at a greater diameter, rather high.

Constrictions appear as early as at a diameter of less than 4 mm. (specimen No. 11, Pl. XXXVII, figs. 2a, b); here three of them can be counted per half whorl. They are less distinct on the inner zone of the sides than on the outer one; however, they can be recognized to be slightly sinuous on the sides and to cross the venter in a very shallow, orad convex arc. In specimen No. 1, at diameters of from 5 to 8 mm., this arc becomes slightly more distinct, but otherwise the characters of the constrictions are still the same; here six can be counted on three-quarters of the whorl and four per half whorl in specimen No. 2 at diameters of from 8 to 11 mm. In this individual their ventral sinus is again extremely shallow and hardly perceptible, but a slight sinuosity of the furrows is recognizable on the sides. In the holotype as well as in the very similar specimen No. 5 there are three distinct constrictions on less than half a whorl, corresponding to a total per whorl of from six, as in the holotype of the typical *P. quenstedti*, to seven, as in Parona and Bonarelli's (1896, Pl. XI, fig. 3) figured specimen. In the holotype, a cast, these constrictions start at the umbilical seam, rise up the umbilical wall and run in a somewhat prorsiradiate, very slightly sigmoidal line across the sides; in the outermost zone of the latter they turn decidedly

[1] Synonymy of the typical form:
Ammonites planulatus Sow.; QUENSTEDT, 1849, p. 221, Pl. XVII, figs. 13a–d.
Desmoceras Quenstedti PARONA AND BONARELLI, 1896, p. 81, Pl. XI, fig. 3.
Puzosia quenstedti (Parona and Bonarelli); SPATH, 1923, *passim*, particularly pp. 43, 44.
Puzosia quenstedti (Parona and Bonarelli); BREISTROFFER *in* Besairie, 1936, pp. 172, 176 (note "(L)").
The specimens figured by Bayle (1878, Pl. XLV, figs. 6–8) under the name "*P. Mayori*" are referred to *P. quenstedti* by both Spath (1923, p. 43) and Breistroffer (*ibid.*, note "(L)," as the metatype of the latter species), but the distinctly orad convex course of their constrictions seems to indicate that they are much closer to *P. provincialis* (Parona and Bonarelli, 1896, p. 81, Pl. XI, fig. 4), "considered by Kilian to be identical with his *P. mayoriana*, var. *africana*" (Spath, 1923, p. 44).

DIMENSIONS

Spec. No.	D	H	H′	W	U
11	6.2 mm.	45	?	45	27 1/2?
1	8.0 mm.	46	?	45	33 1/2
2	10.2 mm.	ca. 45	36 1/2	43	32 1/2
Paratype: 3	20.9 mm.	43	34	37 1/2	30
Holotype: 4	26.3 mm.	44 1/2	35 1/2	ca. 38	28
5	26.7 mm.	44 1/2	37 1/2	37 1/2	26

forward and on the venter they form a distinct, gently rounded, orad convex sinus. These furrows are comparatively broad and are slightly narrower and deeper on the venter and on the inner zone of the sides than on the outer one. The same characteristics of the constrictions can also be observed in the other specimens examined, although there is some individual variation. For example, in the fragments Nos. 21 (Pl. XXXVII, fig. 8), 22 and 39 (Pl. XXXVII, fig. 9) their projection at the latero-ventral shoulders and, in consequence, also their ventral sinus are more pronounced.

Faint folds running parallel to the constrictions appear in specimen No. 1 as early as at a diameter of about 6 mm. They are slightly more distinct in specimen No. 2 at diameters of from 8 to 10 mm. but are still extremely flat. At a larger size of the conch the ornamentation can be studied only where preservation permits, best in the holotype. Here it consists of fine folds which are much too blunt to be called riblets or even ribs; here as well as in specimen No. 2 from three to four of them are intercalated between two constrictions. They run parallel to the latter and are least indistinct in the ventral area, but they become clearly visible only in the foremost part of the whorl where fine striae of growth can also be observed on and between these folds.

Suture lines were, or could be made, visible in the holotype and in many other specimens, best in Nos. 6–10 and 23. The earliest stages of external sutural development could be studied in specimen No. 6 at diameters of about 3 and 5 mm., respectively (Pl. XLI, figs. 1a, b). Both suture lines examined show a broad siphonal lobe with two but slightly diverging terminal points; they are separated from each other by a triangular median knob whose margins are indented even at these early stages; there are, furthermore, two almost horizontal lateral points; all these points appear to be three-pronged. The external saddles are bifid at the top and rather deeply intersected at their outer margins by the lateral points of the siphonal lobe, less so at their inner margins by the outer branches of the first lateral lobes. The latter are somewhat deeper than the siphonal lobe, remarkably broad and distinctly trifid; the outer branch is markedly stronger than the inner one; all branches are three-pronged. The first lateral saddle is lower than the external one, bifid at its top and somewhat straitened at the first third of its height. The second lateral lobe is shorter than the first and at this early stage even a little shorter than the siphonal one; it points slightly ventrad and is also decidedly trifid; all its three points seem to be three-pronged. The second lateral saddle, attaining less than two-thirds of the height of the first and bifid as well, is followed by the oblique, trifid, first auxiliary lobe and the low, bifid, first auxiliary saddle. A distinctly three-pronged second auxiliary saddle and the outer half of a third auxiliary lobe are visible in the larger suture line (D = 5 mm.) only. Here the umbilical edge just cuts off the innermost part of the first auxiliary saddle. It is important to note that a line connecting the tops of the saddles drops rather steeply dorsad.

The next stage could be studied at a diameter of about 8 mm. in specimen No. 7 (Pl. XLI, fig. 2). The general plan remains the same as in the preceding one, but both lobes and saddles have become narrower and deeper or taller, respectively. Furthermore, the second lateral lobe can now also be recognized to have its outer terminal branch more strongly developed than the inner one, and a fourth auxiliary lobe is visible at the umbilical seam. The median knob is now strikingly tall and slender, filling more than half the depth of the siphonal lobe, and the lobules intersecting the main saddles have become deeper. The steep dorsad slope of the auxiliary lobes is even more conspicuous.

The same ontogenetic trends can be further pursued in the next stage, as represented by the external suture lines of specimens Nos. 8 and 23 (Pl. XLI, figs. 3, 6) at diameters of 18 and 20 mm., respectively. Here the lobules intersecting the three main saddles are still narrower and deeper, attaining from a third to a half of the height of these saddles; their main stems are, on their part, subdivided by three-pronged lobules. The difference in depth between siphonal and first lateral lobes has become much more conspicuous (about 2:3), and also the second lateral lobe now exceeds the siphonal one in depth. The general degree of indentation has, of course, considerably increased. There is, however, some individual variation. The external saddle is broader in No. 8 than it is in No. 23; on the other hand, the first lateral one is broader in No. 23. Furthermore, the difference in depth between siphonal lobe and first lateral one is more pronounced in No. 23, where the former attains only 63.5 per cent of the length of the latter, as compared to 68 per cent in No. 8; and the siphonal lobe and, even more so, the lower half of its median knob are considerably broader in the former example than in the latter. Also the difference between both specimens as to the richness of indentation is

much greater than could be accounted for by the slight difference in size. There is in specimen No. 23, one more deviation from the general sutural plan of this form, insofar as its second lateral lobe points slightly dorsad (as does that of d'Orbigny's, 1847, Pl. LXXIX, fig. 3, suture line of *P. mayoriana*) instead of ventrad. However, the general outlines are in these two suture lines the same as in those previously discussed and in that of the latest stage examined (specimen No. 9, D = 25 mm., Pl. XLI, fig. 4). Here the degree of indentation has, of course, still increased, but even in this most advanced stage there is no trace of the extreme straitening of the main stem of the external saddle, such as may be seen in the group of *P. planulata* (compare *P. spathi*, Pl. XLI, figs. 14, 15), nor does the outer branch of the first lateral lobe so closely approach the median line, causing the external saddle to appear more inclined dorsad.

It may be worth noting that in the smallest specimen (No. 6), whose suture lines have been studied, the siphuncular tube shows as a double line on the cast (Pl. XLI, figs. 1a, b,) and the narrowed upper part of the median knob approximately coincides with it in width. Also in the next stage, represented by specimen No. 7 (Pl. XLI, fig. 2), a lower trapezoidal part of this knob and an upper one can clearly be distinguished; the latter is sagittate, as it is in some *Gaudryceras* (compare *G. aenigma*, Pl. XLIV, fig. 2), and consists of a lower heart-shaped part and an upper still narrower one. In the larger specimens (Nos. 8, 9, 23, Pl. XLI, figs. 3, 4, 6) the lower, more or less trapezoidal part of the median knob appears to be separated by a crenulated line from its narrower orad continuation; it must, therefore, be inferred that there is a septum dividing the secondary saddle which appears on the surface as the median knob. Its upper part, matching in width the siphuncular tube, might correspond to some collar or sheath accompanying the latter for a short distance; it seems, however, to be closed at its top, although in specimen No. 8 the lateral margins of this upper part of the median knob continue beyond its ceiling, slightly pointing outward, so as to look like the antennae on a beetle's head.

The internal suture line could best be studied in specimens Nos. 23 and 10 (Pl. XLI, figs. 6, 5) at diameters of 20 and 23 mm., respectively. The anti-siphonal lobe is deep and narrow, with three lateral points on each side which decrease orad in size with the two lower points being distinctly three-pronged, and with a strong, three-pronged terminal point. The latter is slightly dissymmetrical in specimen No. 10 (fig. 5), but here also it can be recognized to be trifid, although its lateral prongs are only a little shorter than the median one. This lobe is flanked on both sides by tall, slender, internal saddles, which are bifid on their top and somewhat straitened at about the first third of their height. Ventrad they are followed by narrow trifid lobes which are considerably shorter than the anti-siphonal one and point slightly dorsad. The next element is a slender saddle, lower than the internal one and rather deeply intersected by a three-pronged lobule. There follow three more trifid lobes with two bifid saddles between them. The last of these lobes is separated by a low trapezoidal knob from the last auxiliary lobe of the external suture line. All the aforementioned lobes and saddles of the internal one become more and more inclined ventrad, thus causing it to slope steeply toward the umbilical seam. This descending branch forms, together with the opposite one of the external suture line, the "suspensive" or "umbilical" lobe characteristic of this genus, as seen best in Kossmat's (1898, Pl. XVI, fig. 4) drawing of a complete suture line of *P. planulata*, var. *odiensis* (reproduced by Spath, 1923, text fig. 2) and also in Quenstedt's (1847, Pl. XVII, fig. 13d) drawing of that of the holotype of the typical *P. quenstedti*. The internal suture line seen in the latter drawing agrees almost perfectly with that here described.

(B) var. **applanata**, new variety

Pl. XXXVII, figs. 10, 11; Pl. XLI, figs. 7, 8; text figs. 20h–j

A. M. N. H. No. 25388: four specimens

DESCRIPTION.—The four specimens referred to this variety differ from those included in the preceding one by their flattened sides, and, except the paratype (No. 2), also by being slightly more involute. Otherwise they agree with the variety *angolana* in the oval shape of the section, which attains its maximum width at about the inner third of its height, and in the density and course of the constrictions. Faint traces of an ornamentation similar to that described in the holotype of the variety *angolana* can be perceived in specimen No. 3.

Both the holotype and the paratype are casts exhibiting beautiful suture lines (Pl. XLI, figs. 7, 8) which agree fairly well with those of the precedent variety at about the same diameters. As an example of individual variation it may be noted that the suture line of the paratype (fig. 7), although taken at a slightly smaller diameter than that of the holotype (fig. 8), shows a somewhat richer indentation, which is, however, restricted just to the margins of the lobes and saddles, without affecting their shape in general. Furthermore, the second lateral lobe points de-

DIMENSIONS

Spec. No.	D	H	H′	W	U
Paratype: 2	16.3 mm.	43 1/2	?	40	29
Holotype: 1	ca. 18.0 mm.	ca. 46 1/2	?	ca. 40	ca. 25 1/2
3	ca. 23.0 mm.	ca. 49	?	ca. 42	ca. 25

cidedly ventrad in the holotype, whereas it is not inclined at all in the paratype.

REMARKS (AD *P. quenstedti*, SENSU LATO).—Although the holotype of this species (for synonymy see p. 149, footnote 1) was originally referred by Quenstedt to *Ammonites planulatus* Sow., it belongs to the group of *P. mayoriana* (d'Orbigny, 1841, p. 267, Pl. LXXIX, figs. 1–3)[1] rather than to the group typified by Sowerby's species. It differs from *P. mayoriana* by its more numerous (six instead of four per whorl) and less sinuous constrictions, which do not form a pronounced chevron on the venter as do those of d'Orbigny's type, and by its much less distinct ribbing. That the latter is more slender may be due merely to its much greater size, as all the forms of this group tend to decrease in thickness in the course of development (cf. Jacob, 1908a, p. 39). *P. mayoriana*, var. *furnitana* Pervinquière (1907, p. 158, Pl. VI, figs. 27, 28), raised to the rank of an independent species by Spath (1923, p. 45), differs from *P. quenstedti* merely by being a little more involute and by its broader, slightly truncate venter; it may be doubted whether it should not better be attached as a variety to the latter species. "*P. planulata*," var. *natalensis* Crick (1907, p. 213, Pl. XIV, fig. 4; Spath, 1923, p. 45; Venzo, 1936, p. 68, Pl. V, fig. 9), quoted by both Spath and Venzo as a variety of *P. mayoriana*, differs from *P. quenstedti* by its more slender whorls, its slightly wider umbilicus and the more distinct ventral chevrons of its constrictions, but also these differences are but slight ones.

The same distinctive characters serve in general also to distinguish the variety *angolana* of *P. quenstedti* from the forms compared above. This variety had to be separated for being at the same diameter more involute and also a little less inflated; it also lacks the fine, but distinct costation seen in Quenstedt's figure. Also the variety *bonarellii*, based by Breistroffer (*in* Besairie, 1936, p. 171, fig. 10e) on Jacob's

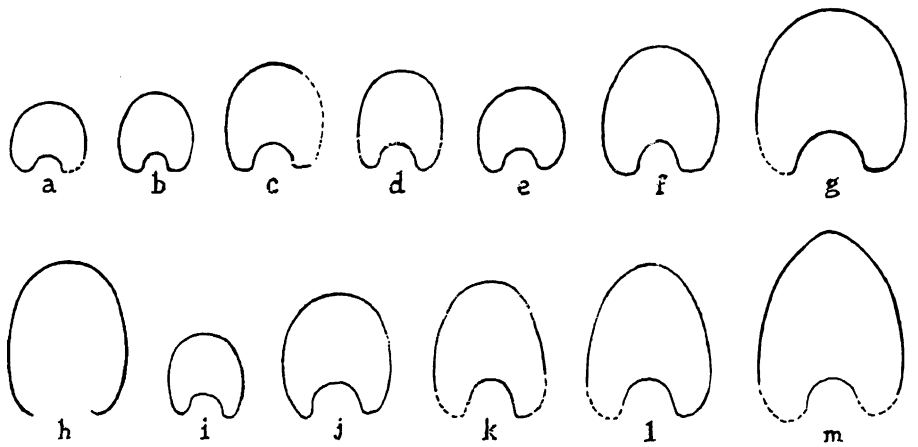

Fig. 20. Sections of *Puzosia*.

(a–g) *P. quenstedti* (Parona and Bonarelli), var. *angolana*, new variety, (a) A.M.N.H. No. 25387: 12, at posterior end; (b, c) A.M.N.H. No. 25387:13, at both ends; (d, e) A.M.N.H. Nos. 25387:14, 17, both at posterior ends; (f) A.M.N.H. No. 25387:18, at anterior end; (g) A.M.N.H. No. 25387: 19, at posterior end; all × 2.

(h–j) *P. quenstedti* (Parona and Bonarelli), var. *applanata*, new variety, (h) holotype, A.M.N.H. No. 25388:1, at anterior end; (i, j) paratype, A.M.N.H. No. 25388:2, (i) at first, (j) at second fracture; all × 3.

(k) *P. tenuis*, new species, holotype, A.M.N.H. No. 25389:1, at anterior end, × 3.

(l, m) *P.*, indeterminate new species, A.M.N.H. Nos. 25390:1, 2, both at posterior ends, both × 2.

[1] For further references see Pictet and Roux, 1847, p. 293, Pl. II, fig. 5; Kossmat, 1898, p. 122; Pervinquière, 1907, p. 157, Pl. VI, figs. 25, 26, 29, 30; Jacob, 1908a, p. 38, Pl. VI; Spath, 1923, p. 42, *cum synon.*, text fig. 10, Pl. I, figs. 9, 10.

(1908a, p. 39, Pl. VI) fig. 1, is less stout than the typical form; it differs, however, from the variety *angolana* by being more evolute and slender and by its dense and fine, but rather distinct costation. The variety *applanata* established above for a few specimens from Hanha somewhat different from the former variety can readily be distinguished from the typical *P. quenstedti* by being more involute and by its flattened sides. Its differences from the variety *angolana* have been pointed out in the description. The variety *applanata* is, no doubt, transitional to *P. tenuis*, new species, and in some ways also to *P. cuvervillei* (Meunier). Both these species will have to be compared later with *P. quenstedti* as well as with its two varieties occurring at Hanha, and so will *Puzosia*, indeterminate new species, from the same locality.

It may be added that the specimen from the Upper Barremian or Aptian of Tunis referred by Pervinquière (1907, p. 147, text fig. 55, Pl. VI, fig. 15) to "*Puzosia* (*Latidorsella*)" *melchioris* Tietze very much resembles in side view the paratype of *P. quenstedti*, var. *applanata;* it can, however, be distinguished by its more slender whorls, its narrower venter, and above all by its suture line, which is at about twice the diameter less elaborate and does not slope so distinctly dorsad. Tietze's (1872, p. 135, Pl. IX, figs. 9, 10) type of *Ammonites melchioris* is, owing to its much more evolute conch, its almost triangular whorl section and the great number of its prorsiradiate constrictions, clearly distinct from Pervinquière's form and, even more so, from *P. quenstedti*, var. *applanata*. It may, however, be doubted whether the differences between the typical *Puzosiae* of the Albian and Tietze's older form suffice to justify the creation by Spath (1923, p. 33, footnote 12) of the genus *Melchiorites* for the latter. Still another form of Pervinquière's (1907, p. 155, Pl. VI, fig. 21, text fig. 61) from the same Tunisian horizon, his "variété plate" (text) or "variété mince" (explanation of Pl. VI) of *P. angladei* Sayn, is similar to the present varieties of *P. quenstedti*, but it differs from them at about the same diameter by having more constrictions and by being a little thicker and more involute and by its much more simplified suture line. The type of Sayn's species (1891, p. 43, Pl. II, figs. 13a–c), which is wider than high, deviates even more from *P. quenstedti* and its Angola varieties.

Puzosia tenuis, new species

Pl. XXXVII, figs. 12, 13; Pl. XXXVIII, figs. 1, 2; Pl. XLI, figs. 9, 10; text fig. 20k

A. M. N. H. No. 25389: thirteen specimens

DESCRIPTION.—Since the last septum appears to be between diameters of 12 and 16 mm. in the holotype (specimen No. 1) and in specimen No. 2, at a diameter of about 22 mm. in specimen No. 9 and of about 25 mm. in the paratype (specimen No. 4), it seems fair to assume that this species was a rather small one, hardly exceeding 45 mm. in diameter.

The conch is discoidal and involute; as seen best in the paratype (Pl. XXXVII, figs. 13a, c), the whorls increase in a later stage rapidly in height, less so in width. Up to a diameter of about 18 mm. the section, well seen in specimens Nos. 1–4, 5, 7–9 (Pl. XXXVII, fig. 12c, Pl. XXXVIII, figs. 1c, 2) is compressed oval, attaining its maximum width immediately above the umbilical shoulder, whence the gently vaulted sides converge steadily toward the comparatively narrow rounded venter. At a later ontogenetic stage, best observed at the anterior ends of the holotype (text fig. 20k) and the paratype, the sides become flat and converge less decidedly, thus allowing the venter to become broader. The latter is, however, still rounded, and the sides are still most distant from each other slightly above the umbilical edge. The latter is well rounded throughout development. The umbilical wall tends to become perpendicular at

DIMENSIONS

Spec. No.	D	H	H′	W	U
3	14.1 mm.	ca. 50	ca. 35	36	18½
5	16.9 mm.	50	?	30?	22½
2	18.2 mm.	47½	38	38	22
Holotype: 1	19.5 mm.	48½	?	ca. 34	20
9	24.0 mm.	49	39	31	20½
Paratype: 4	ca. 30.0 mm.	ca. 46	ca. 40	ca. 33	ca. 21

an early stage (Pl. XXXVIII, figs. 1c, 2) and increases rather rapidly in height (compare figs. 12c and 13c in Pl. XXXVII).

Constrictions can be seen well in some casts only; they are, as a rule, rather faint. Even where they are clearly visible, as in specimen No. 2 (Pl. XXXVIII, figs. 1a, b), they are shallow, particularly in the middle zone of the sides. They run in a slightly sinuous, almost straight line of radial direction across the sides; on the venter they unite in a shallow, orad convex sinus. There are three constrictions per half whorl in the holotype.

A faint ornamentation, very similar to that described in the holotype of *P. quenstedti*, var. *angolana*, can be seen only on the holotype (Pl. XXXVII, fig. 12b). There are about ten obsolete folds per quarter whorl, and, apparently, also fine striae of growth on the test. Both folds and striae run parallel to the constrictions.

Suture lines could be studied in about six specimens, best in Nos. 13 and 2 (Pl. XLI, figs. 9, 10) at diameters of about 9 and 13 mm., respectively. They agree, in general, so well with those of *P. quenstedti* that no detailed description appears to be necessary. However, the second lateral lobe tends in some specimens (e.g., No. 2, fig. 10) to remain considerably shorter than the siphonal one up to a far larger diameter than it does in both the variety *angolana* and the variety *applanata* of the former species. Also there is some individual variation in other sutural characters as well. The second lateral lobe points slightly ventrad in specimen No. 13 (fig. 9), but not in No. 2 (fig. 10). The main lobes and saddles appear to be broadest in specimen No. 2, narrowest in No. 13. A secondary septum between the lower and upper parts of the median knob is indicated only in specimen No. 2, which also exhibits the internal suture line (fig. 10).

REMARKS.—Despite its discoidal conch, which might suggest a relationship to the *planulata*-group, the suture line proves that this elegant little species belongs to the group of *P. mayoriana* and is particularly close to *P. quenstedti* from which it can, however, readily be distinguished by being much more involute, by its remarkable slenderness, even at an early stage, by its section, which is widest immediately above the umbilical edge and shows, at least in adolescence, a narrow venter and a very pronounced umbilical edge, as well as by its shallow, often faint or even absent, constrictions. These differences serve to distinguish the present form from the typical *P. quenstedti* as well as from its varieties *bonarellii* and *angolana*. The variety *applanata*, with its flattened sides and its slightly narrower umbilicus, is apparently transitional between the variety *angolana* and the present species; but the latter can be distinguished even from the variety *applanata* by being more slender and involute, by its section, which has its maximum width farther dorsad and converges in the earlier stages more decidedly ventrad, and by the weakness, or even the absence, of constrictions. The distinctive characters pointed out above also serve to separate *P. tenuis* from *P. mayoriana* and its variety *natalensis* and from *P. furnitana* (for references see remarks on *P. quenstedti*).

P. androiavensis Breistroffer (*in* Besairie, 1936, p. 173, text fig. 11, Pl. XVI, fig. 3) is a similarly slender form, but it can be easily distinguished from *P. tenuis* not only by being less involute and by its larger size, but also by its sutural characters which, according to Breistroffer's description, refer it to the *planulata*-group. The last two differences serve to distinguish the present species from other forms of that group as well.

Puzosia, indeterminate new species

Pl. XXXVIII, figs. 3, 4; text figs. 20 l, m

A. M. N. H. No. 25390: four specimens

DIMENSIONS

Spec. No.	D	H	H′	W	U
2	54.2 mm.	42	?	ca. 33	ca. 32

DESCRIPTION.—All the fragments present, except the smallest one (No. 1), are worn and in part crushed. The largest specimen (No. 2), consisting of a half a whorl, is septate in its posterior part, apparently up to a diameter of about 40 mm. It cannot be determined whether or not the two other fragments are septate and, if so, up to which size.

The conch is discoidal and rather evolute. In addition to the wide umbilicus the ogival section, best seen at the posterior ends of specimens Nos. 1 and 2 (text figs. 20 l, m), is most characteristic of this form. It decidedly tapers from the zone of its maximum width, which is immediately above the umbilical edge, toward the narrow, slightly fastigated venter; the sides are gently vaulted, the umbilical edge is rounded, the umbilical wall perpendicular, though low.

Four, or even five, constrictions per half whorl are visible in specimen No. 2, a cast. They are shallow on the sides, where they form a markedly prorsiradiate, orad concave arc. On the venter they are projected in a comparatively acute, tongue-shaped sinus and accom-

panied apicad by a strong ridge which makes them appear here much more pronounced than on the sides and which is, on its turn, followed apicad by a slight concavity of the periphery. This ridge appears, however, only on the anterior part of this specimen, believed to belong to the body chamber. No trace of it can be found on the smallest but best preserved fragment, No. 1 (Pl. XXXVIII, figs. 3a, b). The poorly preserved surfaces do not show any ornamentation.

Although suture lines can be traced here and there, it proved to be impossible to examine the sutural characters more exactly.

REMARKS.—This form is believed to represent a new species, but it is too incompletely known, particularly as to sutural characters, to be given a new name.

It supposedly belongs to the *mayoriana*-group. In its measurements it agrees fairly well with both the typical *P. mayoriana* (for references see p. 148) and *P. sharpei* Spath (1923, p. 46, *cum synon.*, text fig. 11b, Pl. I, figs. 11, 12 = *Ammonites planulatus* Sowerby *in* Sharpe, 1854, p. 29, *pro parte*, Pl. XII, fig. 4 only) from the English Gault; with the latter it has in common the linguiform ventral sinus of its furrows and their prorsiradiate course on the sides. However, it can readily be distinguished from both those species by its narrow, slightly fastigated venter, causing its section to be decidedly ogival even at an early stage,[1] and by its more numerous constrictions.

The same distinctive features and, moreover, its comparatively wide umbilicus and the course of its furrows on both venter and sides clearly separate the present form from the *Puzosiae* of this collection hitherto dealt with and from the following species, *P. cuvervillei*. From the latter as well as from *P. quenstedti* and its varieties it deviates also by being more slender. It will be compared below with *P. spathi*.

Among all the *Puzosiae* encountered at Hanha the present one seems most closely to approach the form described and figured by Choffat (1888, p. 67, Pl. II, fig. 3) as "*P.* sp. aff. *difficilis* d'Orb." No section is figured by Choffat, but from his description it may be inferred that it is also slender and ogival. However, his form is much more involute than the present one and cannot, therefore, be considered conspecific. It is also not conspecific with *Ammonites difficilis* d'Orbigny (1841, p. 135, Pl. XLI, figs. 1, 2); Kilian has since made this species the type of his genus *Barremites* (see Roman, 1938, pp. 402, 403).

Puzosia cuvervillei (Meunier)

(A) forma typica

Pl. XXXVIII, figs. 5, 6; Pl. XXXIX, figs. 1a, b; Pl. XLI, figs. 11–13; text figs. 21a–e

A. M. N. H. No. 25391: eleven specimens

Desmoceras Cuvervillei MEUNIER, 1888, p. 62, Pl. I, fig. 3.

Desmoceras Cuvervillei, Stan. Meunier; CHOFFAT, 1888, p. 68.

Desmoceras Cuvervillei, Stan. Meunier; CHOFFAT, 1905, p. 39.

Puzosia cf. *mayoriana*, d'Orbigny sp.; SPATH, 1922, p. 153, *pro parte* (*fide* Spath, 1923, p. 45).

Puzosia cuvervillei (Meunier); SPATH, 1923, p. 45.

DIMENSIONS

Spec. No.	D	H	H′	W	U
6	9.6 mm.	49	?	43	22
8	25.9 mm.	48½	37½	42½	25½
2	ca. 30.0 mm.	ca. 42½	?	ca. 37½	ca. 30½
Condit. neotype: 1	35.9 mm.	47½	36	42½	25½

DESCRIPTION.—The largest full disc, specimen No. 1, on which this description is chiefly based, is septate almost up to its anterior end; only its foremost part seems to belong to the body chamber. In specimens Nos. 8 and 7 the last septum is found at diameters of about 25 and 16 mm., respectively. The two fragments representing the largest sizes (Nos. 9, 10) certainly belong to body chambers.

The conch is rather involute and sturdy. Some irregularities of coiling, manifested in "humps" of the peripheral outline, seem

[1] E.g., in *P. austeni* (Sharpe, 1854, p. 28, Pl. XII, figs. 1, 2) an ogival whorl section is assumed only at a diameter of almost 400 mm.

to occur more frequently in this species than in other *Puzosiae;* they are seen in specimen No. 1 (Pl. XXXIX, fig. 1a) as well as in Meunier's protograph and in specimen No. 4 of the variety *flexisulcata* (Pl. XXXVIII, fig. 9), to be described below.

As seen in the table of dimensions, specimen No. 2 is considerably less involute and also thinner than Nos. 8 and 1 whose diameters are but a little smaller and greater, respectively. Should more such less involute individuals be found in the future, this specimen might be made the type of a separate variety; meanwhile it is considered merely an individual variation.

strictly radial on the sides and form a very shallow, orad convex sinus on the venter. They are deepest on and near the umbilical wall and gradually become shallower ventrad. It is worth noting that here the ridges accompanying the furrows on their orad side are more pronounced than those on the apicad one. The same characters of the constrictions are also found in other examples.

Ornamentation can be observed in specimen No. 5 only; it consists of a fine striation running parallel to the constrictions but restricted to the ventral portion of the conch; about twenty such striae can be counted on a sixth of a whorl.

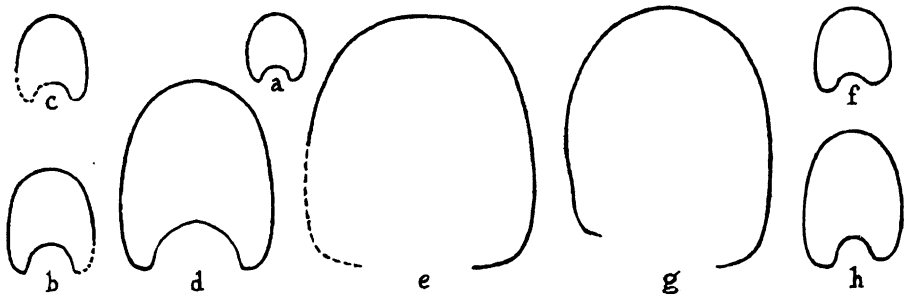

Fig. 21. Sections of *Puzosia*.

(a–e) *P. cuvervillei* (Meunier), (a) A.M.N.H. No. 25391:6, at anterior end; (b, c) A.M.N.H. No. 25391:4, at both ends; (d) A.M.N.H. No. 25391:8, at anterior end; (e) conditional neotype, A.M.N.H. No. 25391:1, at anterior end; all × 2.

(f, g) *P. cuvervillei* (Meunier), var. *flexisulcata*, new variety, A.M.N.H. Nos. 25392:1, 6 (holotype), at anterior ends, showing dissymmetry of sides, both natural size.

(h) *P. spathi* Venzo, A.M.N.H. No. 25393:7, at anterior end, natural size.

Most characteristic of this species throughout development is its section, well seen in specimens Nos. 2, 6, 4, 8 and 1 (Pl. XXXVIII, fig. 5c, text figs. 21a–e). The umbilical wall is almost perpendicular and markedly high, the umbilical edge pronounced, though rounded. The sides are decidedly flat and most distant from each other a little beneath their middle, whence they converge but very slightly ventrad; practically they are almost parallel, thus causing the section to appear rectangular with a rounded top, corresponding to the broad, gently vaulted venter. The ratio W:H varies from 0.85 in specimen No. 7 to 0.88 in Nos. 2 and 4 and 0.895 in No. 1.

Specimen No. 1 shows six constrictions per whorl; these are almost straight and

The suture lines could well be studied in several specimens, best in Nos. 6, 7 and 8 at diameters from about 8 to 15 mm. (Pl. XLI, figs. 11, 13, 12). They seem most to resemble those of *P. tenuis;* here also the second lateral lobe remains shorter than the siphonal one up to a diameter of 12.5 mm. In specimen No. 7 (D = 15 mm., Pl. XLI, fig. 13) the former lobe is dissymmetric, so that it should be called subtrifid rather than trifid; its outer terminal point is not only stronger but also situated much higher than the inner one. In this specimen, which seems to represent an individual variation, this lobe points distinctly dorsad, while it is perpendicular in the others. There is, in this species also, some variation in the degree of indentation. As

in *P. tenuis*, a septum separating the top of the median knob from its trunk is seen only in a single specimen (No. 8, Pl. XLI, fig. 12). The internal suture line, studied in the same example, deviates from that of the other forms of this group merely by the fact that the curve formed by the tops of the saddles declines much less steeply toward the umbilical seam, thus causing the "umbilical lobe" to be considerably shallower.

(B) var. **flexisulcata,** new variety

Pl. XXXVIII, figs. 7–10; Pl. XXXIX, fig. 2; text figs. 21f, g

A. M. N. H. No. 25392: eight specimens

DIMENSIONS

Spec. No.	D	H	H′	W	U
1	24.1 mm.	46	37½	38½	30
Paratype: 2	26.2 mm.	50	34½	42½	25
4	52.8 mm.	49	?	39½	21
Holotype: 6	70.4 mm.	49½	?	37½	25

DESCRIPTION.—By far the largest specimens referred to *P. cuvervillei, sensu lato*, belong to this variety, which agrees fairly well with the typical form in its measurements and even more perfectly in its section, well seen in specimens Nos. 5 and 1 (text fig. 21f), in the paratype (specimen No. 2, Pl. XXXVIII, fig. 7b) and in the holotype (specimen No. 6, text fig. 21g). It differs, however, in its constrictions, which are sinuous on the sides and form a slightly more pronounced forward sinus on the venter (Pl. XXXIX, fig. 2). As this course of the furrows can clearly be observed also in the smaller specimens, measuring from about 15 mm. to 30 mm. in diameter, the above difference cannot be considered to be merely an ontogenetic one. Also in this variety the anterior ridge bordering the furrows is more pronounced on the sides, but it is just the opposite on the venter, where the posterior ridges are rather strongly developed, particularly so in the holotype. There are six constrictions per whorl, as in the typical form.

The same fine striation as in specimen No. 5 of the latter is well seen in the holotype of this variety and in specimen No. 7, and, though less distinctly, also in specimen No. 8. In this variety, too, it is distinct only on the venter and it gradually vanishes on the sides. In both the holotype and specimen No. 7 about thirty such striae can be counted per quarter whorl, corresponding, as in the typical form, to a total of about 120 per whorl. Moreover, there are in the foremost part of the holotype flat folds, which also run parallel to the constrictions; from five to six of them can be counted between two constrictions, or on a sixth of a whorl.

These folds seem, however, to appear only on the body chamber, which apparently begins in the holotype at a diameter of about 60 mm., whereas the last septum seems to be at a much smaller diameter in the paratype. The two largest fragments (Nos. 7, 8) apparently belong to body chambers, but it cannot reliably be decided whether or not the other specimens (Nos. 1, 3–5) are septate throughout.

No continuous suture lines could be traced.

REMARKS (AD *P. curvervillei*, SENSU LATO).—Meunier's (*loc. cit. in synon.*) description and figure have justly been censured as entirely insufficient by Choffat as early as 1888 (p. 68) and again in 1905 (p. 39); indeed the former's specific name could not claim any validity if it had been established after 1930. In his attempt to revive this name the writer is encouraged by the following facts:

(1) Meunier's figure shows about the same habitus, particularly as to the course of the constrictions, as do the forms referred above to the typical form.

(2) The "humps" occurring in some specimens from Hanha can be found also in Meunier's.

(3) Insofar as measurements can be taken of Meunier's figure, viz., for H, amounting to 45½, and for U, amounting to 23½,[1] they agree fairly well with those of my specimens.

(4) As Meunier gives neither a ventral view nor a sectional one, W cannot be made out. However, he compares his form with *Ammonites involvulus*[2] Stoliczka (1865, p. 150 Pl. LXXV, fig. 1), whose whorl width amounts to thirty-six, without mentioning his form to be thinner than Stoliczka's. It thus seems fair to assume that Meunier's type is also rather stout.

(5) Finally, Stoliczka's species resembles the present specimens also in section, whence it may be inferred that the same is true of the former and that Meunier was induced also by this resemblance to compare it to *Ammonites involvulus*.

The safest way to solve this problem would be, of course, to secure, if possible, Meunier's specimen for comparison. This

[1] I cannot agree with Spath's (1922, p. 153) figure of 26.

[2] Meunier, repeating the error occurring in Stoliczka's explanation of plate, quotes this form as "*Desmoceras involutus.*" As seen from its suture line (Stoliczka, 1865, fig. 1b), it is not even a *Desmoceras* but a *Gaudryceras* (cf. Kossmat, 1895, p. 128).

way is, however, impracticable under present world conditions, and the writer cannot but operate for the time being on the above assumptions. Should the specimens here referred to *P. cuvervillei* later turn out to be not conspecific with Meunier's, they would have to be given a new specific name. On the other hand, in case Meunier's specimen should prove to be unavailable or insufficient as a type, specimen No. 1 from Hanha is here proposed as the neotype of this species.

According to Spath (1923, p. 45) some of the unfigured examples from Angola previously (1922, p. 153) referred by him to *P. mayoriana* and, still earlier (1921, p. 276), referred to as "forms of the *planulata*-group, with straight constrictions," should be included in the present species, and the others in the closely related *P. welwitschi* Choffat (1888, p. 68, Pl. II, fig. 4). The latter resembles *P. cuvervillei* in section, but it differs by its lower whorls and particularly by the course of its constrictions which, although said in Choffat's description to be "presque droits," form an orad concave, flat arc on the sides and cross the venter in a straight line. It seems to be worth noting that among more than 180 *Puzosiae* studied in this collection not a single specimen could be referred even approximately to Choffat's species.

The differences between the variety *flexisulcata* and what is believed to be the typical *P. cuvervillei* have been pointed out in the description of the former. Within the present collection this species can readily be distinguished from *P. quenstedti* and its varieties and from *P. tenuis*, as well as from *P. spathi*, by its sturdy whorls, its broad venter and its almost rectangular section, and, as far as the typical form is concerned, by its constrictions being almost straight on the sides. It is true that the sides are also flat in the variety *applanata* of *P. quenstedti*, but the section of the latter is elliptic rather than rectangular and its venter is not so broad. Larger specimens of the variety *flexisulcata* are in side view similar to those of about the same size of *P. spathi*, but the latter can be distinguished not only by their more slender and elliptic section, but also by their more elaborate suture lines which follow the pattern of the *planulata*-group, whereas those of *P. cuvervillei* are of the type of the *mayoriana*-group.

Finally, Pervinquière's (1907, p. 148, *cum synon.*, text figs. 56, 57, Pl. VI, figs. 10–14) *P. paronae* Kilian[1] from the "Vraconnian" of Tunis may require comparison with the present species. It has a similar section and about the same measurements, but its constrictions are indistinct, as a rule, and, where visible, as in Parona and Bonarelli's original figure, more sinuous; also there is no ornamentation visible on the Tunisian form and it has a much less elaborate suture line at about the same diameter; particularly its siphonal lobe is considerably deeper than the first lateral one, whereas the opposite is true of the present species (compare Pervinquière's text figs. 56, 57 with my drawing Pl. XLI, fig. 13).[2]

Puzosia spathi Venzo

Pl. XXXIX, figs. 3–5; Pl. XL, figs. 1a, b; Pl. XLI, figs. 14, 15; Pl. XLII, fig. 1; text figs. 21h, 22

A. M. N. H. No. 25393: thirteen specimens

?*Puzosia Stoliczkai* F. Kossmat; CRICK, 1907, p. 216.

?*Uhligella* ? sp. nov. aff. *stoliczkai*, Kossmat sp.; SPATH, 1921, p. 275, *cum synon.*

Cf. *Desmoceras Toucasi*, Jacob; DOUVILLÉ, 1931, p. 40, Pl. II, figs. 6a, b.

Puzosia Stoliczkai Kossmat var. *spathi* nov. var.; VENZO, 1936, p. 69, Pl. VI, fig. 1, Pl. XI, fig. 2.

DESCRIPTION.—In the two largest full discs (specimens Nos. 2 and 3) as well as in the largest fragment but one (No. 12) the last septum is at a diameter of about 150 mm., and in the half disc No. 4, equal in diameter to No. 3, at about 175 mm. The largest fragment (No. 13), which corresponds in size to the foremost part of No. 4, belongs to a body chamber, whereas specimen No. 1 and some of the smaller fragments are septate throughout. In specimen No. 3, which seems to be almost complete although it does not show the aper-

[1] Based on Parona and Bonarelli's (1895, p. 80, *pro parte*, Pl. XI, fig. 2 only) "*Desmoceras* cfr. *Emerici* Rasp."

[2] The essential sutural differences between *P. paronae* and *P. mayoriana* have been emphasized by Pervinquière (1907, p. 150).

tural margin, the body chamber occupies two-thirds of the outer whorl. Specimen No. 4, in which only a third of the former belongs to the body chamber, may thus easily have attained a diameter of about 300 mm.; at its anterior end it is just a little larger than Venzo's biggest specimen "C."[1] Thus the Angola examples confirm the evidence previously given by those from Zululand indicating that this form reaches a considerable size.

The conch is discoidal, more so in the larger specimens than in the young; in adolescence it is remarkably involute, but it becomes less so and simultaneously also becomes considerably thinner and flatter on the sides in the course of growth.[2] However, individual variations are observable which occasionally involve some deviations from this course of development, e.g., the largest specimen (No. 4), which is at a diameter of about 100 mm. considerably less involute and thinner than is the smallest measured example (No. 1) at about half this diameter, becomes half a whorl later (D = 150 mm.) again a little more involute and slightly thicker. At the diameter of 240 mm., however, it has almost exactly the same measurements as No. 3 (see table of dimensions).

At the smallest diameters at which the section could be studied, viz., about 35 mm. (fragments Nos. 7, text fig. 21h, and 8) and 46.5 mm. (No. 1, Pl. XXXIX, fig. 3c), it is oval, with more or less, but always gently, vaulted sides and a well rounded venter. The later development of the section is best seen in the sectional diagram (text fig. 22) of the largest individual, the half disc No. 4. The same retardation can be seen in the development of its section as was recognized in that of its measurements (see above). The sides of the penultimate whorl, both in the middle and at the anterior end, corresponding to diameters of about 65 and 100 mm., respectively, are no less vaulted than those of specimen No. 1 at the far smaller diameter of less than 50 mm., and the section is, therefore, exactly as oval. However, the outer whorl of the half disc shows very well the way in which the sides become flatter and converge ventrad and how, consequently, the venter tends to become narrower. This is exactly the development described by Venzo[3] and depicted in his Pl. XI, figs. 2b-c. The umbilical shoulder is well rounded also in this species; the umbilical wall is almost perpendicular even in the earliest stages and is remarkably high in the later ones.

DIMENSIONS

Spec. No.		D	H	H′	W	U
1		ca. 60.0 mm.	50[5]	36[5]	39[5]	23 1/2[5]
2		215.0 mm.	43	ca. 35 1/2	ca. 25?	27
3		240.0 mm.	ca. 41	ca. 32 1/2	ca. 25?	27 1/2
	(a)	97.5 mm.	45 1/2	ca. 33	ca. 33	28 1/2
4	(b)	150.0 mm.	46 1/2	36 1/2	33 1/2	26
	(c)	240.0 mm.	40 1/2	34	25 1/2	28

Four shallow constrictions per half whorl are seen in specimen No. 1, a cast; they are directed radially and are slightly sigmoidal on the sides and form a linguiform forward sinus on the venter. On the body chambers of the large specimens (Nos. 2, 3, 4, 13) these constrictions are much more strongly developed, particularly in the outer zone of the sides and on the venter; they are now almost falciform and slightly prorsiradiate on the sides; the ventral sinus has become "Λ" shaped. They are bordered on their apicad side[4] by distinct ridges which form on the venter a strong "bourrelet," attaining its maximum height at the apex of the Λ-shaped sinus (Pl. XXXIX, fig. 4a,b). On the body chamber

[1] Should the section of the siphuncular tube in Venzo's fig. 2c be correct, this would mean that his specimen is still septate at a diameter of almost 240 mm., in which case it would when complete have attained a still much larger size than my specimen No. 4.

[2] Cf. Jacob's (1908a, p. 39) description of *P. mayoriana*, ". . . le tour ayant cependant une tendance à devenir moins involute, à s'aplatir latéralement et à devenir moins épais par rapport à sa hauteur."

[3] *Ibid.*, p. 70, ". . . i fianchi divenendo sempre più piatti e più inclinati verso l'esterno."

[4] Cf. d'Orbigny's (1840, p. 268) original description of *Ammonites mayorianus*, ". . . sillons profondément marqués, bordés en avant et en arrière, mais surtout en arrière, d'un fort bourrelet."

[5] Measured at D = 46.5 mm.

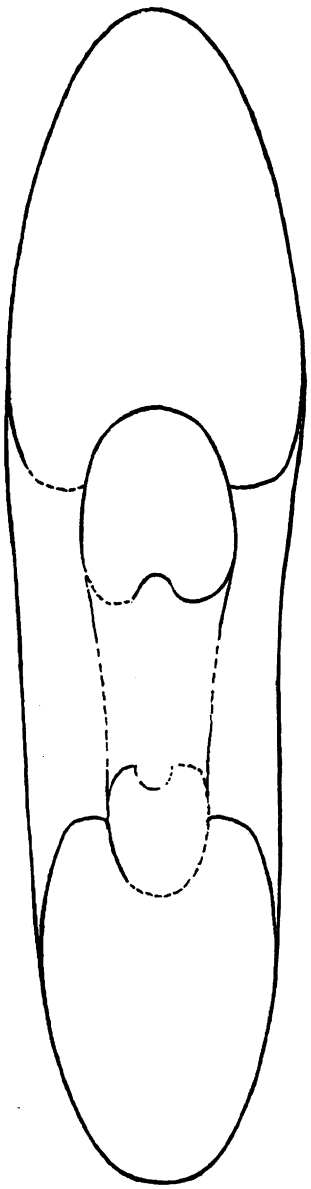

Fig. 22. Sectional diagram of *P. spathi* Venzo, A.M.N.H. No. 25393:4, at fracture, × 2/3.

the constrictions follow each other at closer intervals so that as many as three of them can be counted per quarter whorl. The final portion of the preserved part of specimen No. 3 (Pl. XL, fig. 1a) is particularly interesting. Here no less than five varices are crowded together on about a sixth of a whorl; they are marked by the "bourrelets" mentioned above, which give a coxcomb-like aspect to the periphery. This accumulation of varices undoubtedly indicates a slowing down of the growth immediately preceding its final stopping. A similar development has been recorded by Jacob (1908a, p. 40, Pl. VI, fig. 2) on his largest disc of *P. mayoriana* from the Albian of the Balme de Rencurel, but in his example the stage described above is followed by another in which strong ribs develop on the sides and form horn-like tubercles on both sides of the median line. The latter stage, however, seems not to be missing but to be entirely absent in specimen No. 3 from Hanha, whose body chamber occupies two-thirds of the outer whorl and which, therefore, must be almost complete.

A faint striation parallel to the constrictions is indicated on the ventral area of the small fragments Nos. 5 and 8. Among the large specimens only No. 2 shows some ornamentation on the body chamber (Pl. XXXIX, fig. 4a); it consists of blunt folds similar to those observed in the holotype of *P. cuvervillei*, var. *flexisulcata*. They are distinct only around the umbilicus where about ten of them can be counted per quarter whorl. In addition, there are fine striae of growth on and between these folds. Both folds and striae run parallel to the constrictions.

This is the only *Puzosia* present at Hanha in whose suture line the characters of the *planulata*-group (see *P. planulata* in Kossmat, 1898, Pl. XVI, fig. 4; *P. subplanulata* in Schlüter, 1871, Pl. II, fig. 7) are recognizable. The suture line could be examined in eight out of thirteen specimens, best in Nos. 1 (Pl. XLI, fig. 14), 2, 3 (Pl. XLI, fig. 15) and 11. The high degree of indentation, which is one of its distinctive features, is by no means due merely to the size of the discs. This is seen best by a comparison, on Pl. XLI, of fig. 14, taken at a diameter of no more than 43 mm., with fig. 4 (*P. quenstedti*, var. *angolana*), taken at a diameter of about 25 mm. This difference in

size is certainly not sufficient to account for that in elaborateness. Although the general plan of the suture lines is the same in *P. quenstedti* and *P. spathi*, there are nevertheless some remarkable differences. The main saddles are much more straitened in the latter, both from the sides and from above, their main lobules, which are extremely deep and narrow, attaining about half their height, or even more, in depth. Laterally all three main saddles are straitened at two points, near the bases and at about the second fifth of their height or, as far as the second lateral saddle is concerned, at about half of it. Furthermore, the difference in length between the two lateral branches at the bottom of the first lateral lobe is much more pronounced in this suture line than even in the most advanced sutural stages that could be observed in the forms of the *mayoriana*-group. This feature causes the first lateral lobe to become greatly widened and to reach, with its outer branch, much nearer to the median line; in consequence, the axis of the external saddle becomes inclined dorsad at an angle of about 60°, as it is also in *Phylloceras velledae* (cf. Pl. XLIV, fig. 1).

The siphonal lobe is rather narrow, the median knob is rectangular in outline and richly indented both on its sides and at its top; its height amounts to about two-thirds of the depth of this lobe; there is no top part superimposed on it, as found in many of the other *Puzosiae* of this collection. Both branches of the siphonal lobe are divided by a high, oblique, triangular leaf into two branchlets, the outer ones of which are subdivided by another, lower, triangular leaflet into two points; all the points are three-pronged. The outer stem of the external saddle is markedly higher and broader than the inner oblique one; both are subdivided by rather deep three-pronged lobules. The first lateral lobe is about one and one-half times as deep as the siphonal one; its lateral branches have been described above; the middle one is very long and trifid. In the first lateral saddle the outer stem is oblique and lower than the inner one; the latter equals the outer stem of the external saddle in height; thus the four stems of the two main saddles appear to be arranged symmetrically around the axis of the first lateral lobe; also those of the first lateral saddle are intersected by three-pronged lobules. The second lateral lobe is much shorter than the first but considerably longer than the siphonal one; its middle branch is extraordinarily broad, and the leaflet separating its outer point from the middle one is much more developed than the opposite one; of its two lateral branches the outer one is somewhat stronger and longer than the inner. From the highest point of the first lateral saddle the curve connecting the tops of the saddles slopes rapidly, though equally, toward the umbilical seam. The second lateral saddle resembles the external one rather than the first and is somewhat lower than both. The first auxiliary lobe is rather broad, trifid and points decidedly ventrad. There follow three auxiliary saddles and three more auxiliary lobes; the umbilical edge passes between the first auxiliary saddle and the second auxiliary lobe. All the auxiliary elements are strongly inclined dorsad. The "umbilical lobe" is, in depth, just intermediate between the two lateral ones; its middle line, coinciding with the umbilical seam, is marked by an upright leaf, which is richly indented at its sides and not unlike the median knob in some siphonal lobes.

The internal suture line shows the same general plan as in *P. quenstedti*, var. *angolana;* in the internal part of the suture line of the present species the indentation seems to be even richer than in the external one. There is a strong, trifid, antisiphonal lobe, about as deep as the first lateral one. It is flanked by two extremely slender, tall, internal saddles which are slightly bent away from the median line. There follow a narrow, decidedly bifid lobe, then a saddle which is much broader but a little lower than the internal one; it is deeply intersected by a narrow trifid lobule. Then there is a strong trifid lobe with a bifid middle branch, a bifid saddle and three more trifid lobes with two saddles between them; only the first of these saddles is bifid. All these elements rapidly decrease in size and are, except for the very

last lobe which is perpendicular, strongly inclined toward the umbilical seam, as are those on the opposite side of the "umbilical lobe." Its internal branch apparently slopes more steeply than the external one. It is particularly interesting to compare this internal suture line with that of *P. planulata*, as seen in Kossmat's drawing (1898, Pl. XVI, fig. 4). The anti-siphonal lobes are very similar in both, but otherwise there are considerable differences. The slope toward the umbilical seam is steeper in Kossmat's drawing, and the internal saddle is broader and much more deeply intersected; it seems functionally to replace both the internal saddle and the following one of *P. spathi*, the lobe between them having been reduced in *P. planulata* to a deep and narrow lobule, and the following saddle seems to be homologous with the third from the median line rather than with the second of the present species.

For comparison with the suture line of specimen No. 1 that of No. 3 taken at a diameter of about 110 mm. has also been drawn in part (Pl. XLI, fig. 15). The general plan is quite the same in both examples, but owing to the much greater diameter of No. 3 its suture line is much more richly indented. Also the difference in length between the outer and the inner branch of the first lateral lobe is still more pronounced, the outermost ramifications of the former reaching even beneath the siphonal lobe. Furthermore, the high leaf separating the middle branch of the first lateral lobe from the outer one shows slight indications of curvature and distortion, as seen much more distinctly in Venzo's (1936, Pl. XI, fig. 2a) drawing of the suture line of this species, corresponding to a still greater diameter, and, though less markedly, also in his (*ibid.*, fig. 1) and Kossmat's (1898, Pl. XVIII, fig. 6) drawings of the suture line of *P. stoliczkai*. The most remarkable difference, however, between the two suture lines of the present species depicted in Pl. XLI is that the siphonal lobe, the external saddle and even the first lateral lobe, along with all the minor elements belonging to them, have become much narrower, or more slender, respectively, in fig. 15, which corresponds to a much more advanced ontogenetic stage. This is undoubtedly due to the changes in section pointed out above which cause the venter to become narrower and the sides to become flatter in the course of growth.

REMARKS.—Only a single specimen which can certainly be referred to this interesting form has ever been illustrated by photography: Venzo's example "A," shown in side and frontal view in figs. 1a, b of his Pl. VI, whereas in Pl. XI only sectional diagrams and a sutural drawing of his much larger example "C" are given. The average specimens of about the same size from Angola agree in their measurements fairly well with Venzo's smaller one, except for being thicker and having less flattened sides. However, there are also among the examples from Hanha some with thinner whorls and flatter sides than the others, e.g., No. 7 (text fig. 21h), in which the ratio W:H amounts to 68.5, that is even less than in Venzo's specimen "A" (0.7), as compared to 0.78 in my specimen No. 1. These slight differences can, therefore, be considered to be merely individual variations. On the other hand, there is so close an agreement of the sections and suture lines in the largest specimens (Nos. 2–4 from Angola, "C" from Zululand) that the writer does not hesitate to identify his form with that of Venzo.

This species seems to have been repeatedly recorded from Zululand before that author. To judge by Crick's (1907) and Spath's (1921) descriptions, their specimens might, as Venzo believes, well be conspecific with his, although both are, at about the same diameter, even more slender, and Spath's has, moreover, a wider umbilicus, at least at an early stage. However, in the absence of any figures no certainty can prevail as to their conspecificity. Besairie's (1930, p. 620) mention of Spath's form, included by Venzo in his synonymy, is insignificant, as it is made merely in a résumé of Spath's previous paper.

Venzo named the present form *P. stoliczkai*, var. *spathi;* the typical *P. stoliczkai* Kossmat (1898, p. 119, Pl. XVIII, fig. 6), was based on Stoliczka's

(1865, p. 142, Pl. LXXI, figs. 2–4, Pl. LXXII, figs. 1, 2) "*Ammonites Beudanti*" and was referred by Spath (1923, p. 37) to the genus *Beudanticeras*, whereas Jacob (1908a, p. 32) emphasized its close relationship to his *Uhligella walleranti*. However, the suture line of Stoliczka's large specimen (1865, Pl. LXXII, fig. 2) does not leave any doubt but that it is a *Puzosia* of the group of *P. planulata*. Venzo (1936, pp. 69, 70) points out the following differences between his variety *spathi* and the typical *P. stoliczkai*. The sides of the latter are, at the same diameter, a little more vaulted and more convergent; the venter is consequently narrower; the whorls are said to be a little thicker,[1] and the umbilical wall to be vertical instead of "inclined"; while the umbilicus itself is a little narrower (22 as compared to 24 in Venzo's specimen "A"). The same author particularly emphasizes the sutural differences, as Kossmat's species is stated to have sturdier lobes with larger branches which more or less "intersect" each other and more slender and graceful saddles. To this enumeration it may be added that there are in the true *P. stoliczkai* a few more constrictions and that they are more prorsiradiate and form a more pronounced ventral sinus at a comparatively early stage (see Stoliczka's Pl. LXXI, figs. 3, 3a); and that the umbilicus remains narrow even at a very large size (U = 21 at D = 515 mm. in Stoliczka's giant specimen figured in Pl. LXXII), whereas it widens in the course of growth in Venzo's large specimen, and even more so in those from Hanha, in which U amounts to from 27 to 28 at diameters between 215 and 240 mm.

Be this as it may, Venzo's form seems to differ from Kossmat's species (which is apparently also somewhat younger) to a degree sufficient to justify raising it to the rank of an independent species, particularly since it is so well represented by spectacular examples in Angola.

Another Angola form, the single specimen from Salinas identified by Douvillé (*loc. cit. in synon.*) as *Desmoceras toucasi* Jacob, is believed by the writer to be a *Puzosia* of the *planulata*-group and to be very closely related to, if not fully conspecific with, the present form. At about the same diameters (53 and 46.5 mm., respectively) its measurements (according to Douvillé's description: H = 51, W = $41^1/_2$, U = $22^1/_2$) agree fairly well with those of specimen No. 1; the shape of the conch is the same, as seen also by comparison of Douvillé's figs. 6a, b with figs. 3 a, b, in Pl. XXXIX of the present paper. Also Douvillé's remarks on the suture line, said to be characterized by the strong development of the first lateral lobe and its ramifications and to have a siphonal lobe remarkably shorter than that of the typical "*Desmoceras*" *toucasi* Jacob (1905, p. 405, text fig. 2, Pl. XII, figs. 4, 5), are quite consistent with the sutural characters of *P. spathi*. Furthermore, the ornamentation and the furrows, as described by Douvillé, are in good agreement with those of the present species, except for the greater number of constrictions in the Salinas example (thirteen as compared to eight to twelve), which might perhaps justify its varietal separation from the typical *P. spathi*. The former certainly differs from the true "*Desmoceras*" *toucasi* from Clansayes by being less involute, by its narrower venter, by its more pronounced constrictions and chiefly, as may be inferred from Douvillé's incomplete indications, particularly from his comparison of the "profondes découpures du premier lobe latéral" with those of *Uhligella walleranti* Jacob (1908a, p. 31, text figs. 17, 18, Pl. III, figs. 1–4), by its more elaborate suture line; that of Jacob's species, which is included by that author (1908a, p. 26) in his subgenus *Uhligella* but which might be a *Puzosia* of the older type as well, is much more simplified. It may be added that Douvillé (1931, p. 41) refers his specimen to the Albian[2]; should this prove to be correct, there would be even

[1] This seems, however, to be inconsistent with Stoliczka's (1865, p. 142) measurements of his largest specimen which has at D = 80 mm. a thickness of 29, and with his fig. 3a (Pl. VII) of another individual, in which it amounts at about the same size to 32, as compared to 34 in Venzo's specimen "A" of *P. spathi* at D = 50 mm. Kossmat's (1898, p. 120) figure of 33 for W, measured at D = 126 mm., may easily correspond to a thickness above 34 at the smaller diameter of 50 mm.

[2] In his Résumé (p. 44), however, he lists this orm, adding a "cf.," among the Vraconnian ones.

less reason to question its conspecificity with the present form; Spath (1931, p. 316), however, believes it to be from the Cenomanian.[1]

Another *Puzosia* from Zululand, described and figured by Etheridge (1907, p. 88, Pl. VI) as "*Desmoceras* sp.," has been compared by both Spath (1921) and Venzo (1936) with the present form, from which it differs chiefly by its much more pronounced costation. If Spath's (1922) Angola specimens are, as he stated in 1923 (p. 45), referable to *P. cuvervillei* and *P. welwitschi*, the writer cannot share Spath's (1921, p. 276) belief in their relationship to Etheridge's form, whose constrictions are not quite so straight but are slightly sigmoidal.[2]

Another African form, *P. androiavensis* Breistroffer (*in* Besairie, 1936, p. 173, text fig. 11, Pl. XVI, fig. 3) from the Middle Albian of Madagascar, resembles the present one in section and, to judge by the description and the side view, also in the sutural characters, but it is markedly more evolute.

Within the present collection *P.*, indeterminate new species, and the variety *flexisulcata* of *P. cuvervillei* require comparison with *P. spathi*. The latter has been compared above; the former can readily be distinguished as it is much more evolute and by its decidedly ogival whorl section. Furthermore, neither of these forms exhibits the sutural characters of the *planulata*-group, as does *P. spathi*.

The same feature also serves to distinguish the latter from the true *P. mayoriana* (d'Orbigny, 1847, p. 267, Pl. LXXIX, figs. 1–3), which has a similar whorl section and whose constrictions have a similar course; they are, however, less numerous, and d'Orbigny's type (measurements at D = 120 mm.: H = 41; W = 31; U = $32^1/_2$) is, moreover, more evolute and thinner and has a much more pronounced costation.

[1] As to the most intricate problem of the age of the ammonite assemblage of Salinas, see Haas, 1942a, p. 21.

[2] Venzo's (1936, p. 70) reference in his quotation of Spath's (1921) above opinion to "big" types of the *planulata*-group from Angola is certainly erroneous, as none of the examples described by Spath in 1922 seems to exceed 39 mm. in diameter.

Beudanticeras Hitzel

Before using the above generic name one must settle the problem as to which of the five rather diversified "Formenreihen" originally included by Zittel (1884, pp. 465, 466) in his genus *Desmoceras, sensu lato*, must be considered as *Desmoceras, sensu stricto*. Opinions have been largely divided among students. Whereas de Grossouvre (1893, p. 166) and, following him, Boule, Lemoine and Thevenin (1906, p. 15) proposed to restrict Zittel's generic name to the group of *Ammonites latidorsatus*, whose suture line is depicted in his text fig. 648, Jacob (1908a, p. 25; 1908b, p. 75), quoting Kilian and Sayn, claimed that the group of *Ammonites beudanti* ranks first in Zittel's enumeration and that consequently his generic name should be reserved to this group, while he proposed the generic name *Latidorsella* for the group of *Ammonites latidorsatus*. This conception has also been accepted by Douvillé (1916, p. 371), while Pervinquière (1907, pp. 128, 129, 139) suggested the restriction of the genus *Desmoceras* to the groups of *Ammonites beudanti* and *Ammonites difficilis* (since made the genotype of *Barremites* Kilian) and accepted Jacob's genus *Latidorsella* as a subgenus "a l'intérieur du genre *Puzosia*."

However, as Zittel failed to designate explicitly or tacitly any genotype of *Desmoceras*, de Grossouvre was free to select the typical group. Spath (1923, pp. 35–38, 39) stated that, "according to the laws of priority," de Grossouvre's procedure must be followed and Jacob's proposal be rejected, and formally designated *Ammonites latidorsatus* Michelin as the genotype of *Desmoceras* Zittel, *sensu stricto*. The writer adheres, despite Roman's (1938, p. 403) opinion to the contrary, to Spath's conception and in consequence accepts Hitzel's (1905, p. 875) generic name *Beudanticeras* for the group of *Ammonites beudanti* (cf. Spath, 1923, pp. 37, 49).

This genus is here for the first time recorded from the Albian of Angola, where it is, however, represented only by a single specimen, here referred to the genotype, *B. beudanti* (Brongniart).

Beudanticeras beudanti (Brongniart)

Pl. XLII, figs. 2a–c; text fig. 23a

A. M. N. H. No. 25395: one specimen

Ammonites Beudanti BRONGNIART, 1822, pp. 95, 99, 394, Pl. VII, fig. 2.

Ammonites Beudanti Brongniart; D'ORBIGNY, 1842, p. 278; Pl. XXXIII, figs. 1–3; Pl. XXXIV, figs. 1–3.

Ammonites Beudanti Brongniart; PICTET AND ROUX, 1847, p. 289, Pl. II, fig. 3.

Ammonites Beudanti Brongniart; QUENSTEDT, 1849, p. 222, Pl. XVII, fig. 10.

Ammonites Beudanti, Al. Brongniart; PICTET AND CAMPICHE, 1860, pp. 277, 360, Pl. XL, figs. 1–4.

?*Cleoniceras Beudanti* Brongn.; PARONA AND BONARELLI, 1896, p. 86, Pl. XI, fig. 6.

Desmoceras Beudanti Brongniart sp.; JACOB, 1908a, p. 27, text fig. 14.

Beudanticeras beudanti (Brongniart); SPATH, 1923, p. 49, *cum synon.*, Pl. II, figs. 4a–d, text fig. 12.

Cf. *Desmoceras* cf. *Beudanti* Brongniart; COLLIGNON, 1929, p. 19, Pl. II, figs. 1, 1a.

Desmoceras (*Beudanticeras*) *Beudanti* d'Orb.; ROMAN, 1938, pp. 401, 403, Pl. XLI, fig. 389.

DESCRIPTION (INCLUDING DIMENSIONS).—The only specimen consists of about a third of a disc which is septate throughout. Its anterior end corresponds to a diameter of about 70 mm. It did not allow proper measurements, but it can be seen that the conch is slender (W:H = 0.42) and rather involute (U = 15). The umbilicus appears to be wider on the right side than on the left.

The section (text fig. 23a) is compressed and ogival; it attains its maximum width at about the second fifth of the gently vaulted sides, whence they converge more decidedly ventrad than dorsad. The venter is fastigate, though not sharp, but narrowly arched. The umbilical shoulder is distinct, though rounded; the umbilical wall is perpendicular.

On the right side of this fragment three shallow, slightly sigmoidal constrictions are seen, which are on their orad side accompanied by indistinct broad ridges. They are a little rursiradiate, whereas the two ridges visible on the left side are rather prorsiradiate. These ridges cross the venter in an acute, orad convex sinus. More ridges can indistinctly be perceived, between and parallel to those mentioned above, in oblique illumination only on the ventral area. They are least indistinct in the posterior part of the fragment, where six of them can be counted between two primary ridges.

Isolated prongs and leaflets can be traced here and there, but no continuous suture lines worthy of description or delineation were found. What is visible seems to agree in general character with the known suture lines of this species.

REMARKS.—The section of the present fragment, although not so decidedly triangular as in Brongniart's fig. 2b and in d'Orbigny's (Pl. XXXIII) fig. 1, agrees fairly well with that at the beginning of the outer whorl of the typical Folkestone specimen figured in Spath's (*loc. cit. in synon.*) fig. 4b. On the other hand, ridges similar to those on the Hanha example can, although at an earlier ontogenetic stage, also be seen on Pictet and Roux' (1847, Pl. II, fig. 3a) specimen from the Perte du Rhône, which Spath believes to be a true *B. beudanti;* the former is, therefore, referred to this species without reservation.

As to its synonymy and to its delimitation from its closest allies, *B. laevigatum* (Sowerby; Spath, 1923, p. 55, *cum synon.*, text fig. 13, Pl. III, fig. 2) and *B. ligatum* (Newton and Jukes-Browne; see Spath, 1923, p. 58, *cum synon.*, Pl. III, fig. 3) reference may be made to Spath's Gault Monograph.

ACONECERAS HYATT

Two small fragments are doubtfully referred to this rather rare genus, based by Hyatt (1903, pp. 100, 101) on *Ammonites nisus* d'Orbigny (1840, p. 184, Pl. LV, figs. 7–9) and referred to the Oppelidae by Sarasin (1893). Spath (1921, p. 312; 1923, pp. 35, 38), however, derives his family Aconeceratidae from the Desmoceratidae, and Roman (1938, pp. 417, 418, Pl. XLII, fig. 406) deals with this genus in his appendix to the latter family, among the forms thought by him to be *incertae sedis*.

Aconeceras (?), indeterminate species

Text fig. 23b

A. M. N. H. No. 25396: two specimens

DIMENSIONS

Spec. No.	D	H	H′	W	U
1	21.3 mm.	60½	?	24	12½

DESCRIPTION.—The larger specimen (No. 1), a poorly preserved half disc, is septate throughout. Only its outer whorl could be studied. Its anterior part is somewhat bulged on the right side, thus causing the section to be dissymmetrical.

The conch is involute, very flat and slender; the outer whorl increases rapidly in height. The umbilicus is remarkably narrow, with an apparently perpendicular wall and a pronounced edge. At the anterior end of the outer whorl the section[1]

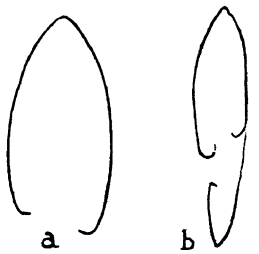

Fig. 23. Sections of (a) *Beudanticeras beudanti* (Brongniart), A.M.N.H. No. 25395, at anterior end, natural size; (b) *Aconeceras* (?), indeterminate species, A.M.N.H. No. 25396, at fracture, × 3/2.

is compressed lancetiform and attains its maximum width between the second fifth and the middle of the sides. The venter is decidedly sharpened, though not keeled. The same slender, triangular, ventrally sharpened section is also seen in the middle of this whorl, as shown in the lower half of the diagram.

The surface appears to be smooth on the whole, as it is in d'Orbigny's (1840, Pl. xv, fig. 7) and Sarasin's (1893, Pl. iv, fig. 9a) side views of *Ammonites nisus*. The poor preservation does not permit any certain decision as to whether or not some faint irregularities of the surface of this specimen are to be interpreted as ridges and furrows, respectively, nor can the fold-like ribs visible in Sarasin's enlarged side view, fig. 9c (Pl. vi), on the inner half of the sides be recognized.

A tiny, poorly preserved septate fragment (No. 2) is also tentatively referred to this genus because of its lancetiform section and sharpened venter.

Some prongs and leaflets can occasionally be seen in both examples, but no continuous suture line could be traced.

REMARKS.—Among the species of this genus figured by Sarasin (1893) *A. nisus* most resembles in both sectional and side views the fragments under examination, but owing to their poor preservation no specific identification could be ventured. With regard to the impossibility of studying the ornamentation, should any be present, and the suture lines, even the generic determination can be but a tentative one. Should it prove to be correct, the present form would have to be considered an Albian straggler of this genus which has hitherto been known only from the Upper Aptian. However, Spath (1923, p. 38) mentions an example from the *tardefurcata*-zone [upper zone of the Lower Albian (see his revised Table, 1941, p. 668)] of England, though doubting whether it might not be "derived or perhaps merely a homoeomorphous or accidentally keeled development of the contemporary *Beudanticeras*." Should it prove to be a true *Aconeceras*, it would stratigraphically connect the Upper Aptian forms with the present one.

Lytoceratidae Neumayr (Sensu Stricto)

Although the two genera of this family encountered at Hanha, *Gaudryceras* and *Tetragonites*, are each represented only by a single specimen, the writer has briefly to discuss its circumscription from two points of view:

(1) Whether or not to accept Spath's (1927a, pp. 66, 67) families Gaudryceratidae and Tetragonitidae, including the above genera and their respective closest allies. The writer shares Roman's (1938, pp. 28,[2] 42–45) opinion that generic

[1] The right side of the sectional diagram (text fig. 23b), corresponding to the left side of the conch, is believed to be the undistorted one.

[2] As Roman mentions a total of eight families (including the four subfamilies left with the Lytoceratidae proper by Spath, 1927a, pp. 64, 65), the omission of the Tetragonitidae in his enumeration is obviously erroneous.

separation of *Gaudryceras* and *Tetragonites* from *Lytoceras* is sufficient.

(2) Whether or not to include abnormally coiled ammonites in the Lytoceratidae, as J. P. Smith (*in* Zittel-Eastman, 1927) did for his subfamilies Macroscaphitinae and Turrilitinae and Zittel-Broili (1924) for some genera, e.g., *Hamites*, *Turrilites*, *Baculites*, etc.—Roman (1938) on his part makes a distinction between "formes à enroulement anormal" which he includes in the Lytoceratidae, e.g., *Pictetia*, *Costidiscus*, *Macroscaphites*, and "formes aberrantes pouvant se rattacher aux Lytoceratidés," e.g., *Hamites*, *Hamulina*, *Anisoceras*, *Baculites*, *Baculina*. The writer, however, shares Spath's (1927a, p. 66) conception that the "uncoiled stocks . . . are distinct enough to be definitely separated from the unmodified parent stock"; to which it might be added that the parent stocks of all the various aberrant forms are still far from being definitely cleared up. In consequence, the abnormally coiled ammonites are separately dealt with (Part III) in the present paper.

Gaudryceras de Grossouvre, emend. Kossmat, emend. Jacob

This genus is here interpreted in Jacob's (1908a, p. 13) circumscription, viz., including only Kossmat's (1895, pp. 113, 119) "Group of *Lytoceras* (*Gaudryceras*) *sacya* Forbes," Kossmat's (1895, pp. 118, 130) second group, that of "*Lytoceras* (*Gaudryceras*)" *agassizianum* (Pictet), having been given the subgeneric name *Kossmatella* by Jacob.

It is true that Spath (1923, p. 22) was free, according to the laws of priority, to choose a genotype of *Gaudryceras*, since both Kossmat and Jacob had omitted to do so. The fact that de Grossouvre when establishing this genus (1893, pp. 225–227) described *G. mite* (von Hauer, 1866, p. 7, Pl. II, figs. 3, 4) first (*ibid.*, p. 227, Pl. XXVI, fig. 4, Pl. XXXIX) may have induced Spath to select von Hauer's species for the genotype. On the other hand, Kossmat, whose conception of this genus is explicitly accepted by Spath, chose *G. sacya* (Forbes, 1846, p. 113, Pl. XIV, fig. 10)[1] for the "chef de fil," and since Jacob's restriction of Kossmat's interpretation, equally accepted by Spath, *Gaudryceras* exactly coincides in its circumscription with Kossmat's "Group of *G. sacya*." As the latter species is of Cenomanian age (Kossmat, 1895, p. 115),[2] Spath's (1927a, p. 67) speaking of the "true *Gaudryceras* (*sensu stricto*) of the Senonian" might be questioned. Moreover, Spath's (*loc. cit.*) opinion, that "the external lobe is deeper" than the first lateral one "in the true *Gaudryceras*," is inconsistent with Kossmat's (p. 113) statement, that "der lange und schmale Externlobus . . . dem ersten Laterallobus an Tiefe gleichkommt." It may be doubted whether the groups of *G. numidum* (Coquand; Sayn, 1891, p. 144, Pl. I, figs. 3, 4) and of *G. leptonema* (Sharpe, 1854, p. 32, Pl. XIV, fig. 3) really require the creation of separate genera (*Eogaudryceras* and *Mesogaudryceras*, respectively), as proposed by Spath (1927a, pp. 66, 67). *G. leptonema* will be discussed in the remarks on the only *Gaudryceras* of the present collection, described below.

Gaudryceras aenigma, new species

Pl. XLII, figs. 3a–d; Pl. XLIV, figs. 2a, b; text figs. 24a–d

A. M. N. H. No. 25397: one specimen

Dimensions of Holotype

D	H	H′	W	U
58.3 mm.	48½	38	41½	24

Description.—Except for a small part of the surface of the outer whorl the only specimen was hidden in a block of matrix; it was difficult to remove it from there, since not only the inner whorls but also parts of the outer one are crystallized.

The holotype is septate throughout, and consequently its full size cannot be inferred. The outer whorl increases very rapidly in height, less so in width; this fact accounts for its becoming comparatively more slender toward the front end as well as for an increase in the degree of involution.

A fragment of the penultimate whorl which broke loose in the course of preparation shows most surprisingly a slender ogival section with a decidedly sharpened, almost keel-like periphery (text fig. 24a). It even looks as if the

[1] *G. buddha* (Forbes, *ibid.*, p. 112, Pl. XIV, fig. 9) is considered by both Stoliczka (1865, p. 154) and Kossmat (1895, p. 119) a synonym of *G. sacya*.

[2] *G. sacya* has since been recorded by Venzo (1936, p. 78, Pl. V, fig. 1, Pl. VI, fig. 5) from Zululand, where it has been found at an Upper Albian locality as well as at a Cenomanian one.

antepenultimate whorl would carry a distinct keel; this, however, cannot be said with certainty, as aspects seen, or supposedly seen, in crystallized portions of fossils may easily be deceptive. However, there is the less reason to doubt the sharpened venter of the penultimate whorl, since in the first quarter of the outer one the section is still inverted heart-shaped and decidedly fastigate with a distinct, almost keel-like median ridge (text fig. 24b). This ridge disappears at a diameter of about 30 mm., and the section is now (text fig. 24c) oval to subcircular; its height exceeds its width but slightly; the venter is evenly rounded. At the anterior end of the outer volution the section has become higher and more slender, but otherwise it is unchanged (text fig. 24d). Throughout this whorl both umbilical and latero-ventral edges are fully rounded. The umbilical wall is high, though not perpendicular.

The ornamentation consists chiefly of numerous fine riblets, about forty-five of which can be counted per quarter whorl on the periphery of the anterior part of the conch. They start on the umbilical wall where they are slightly rursiradiate; beyond the umbilical shoulder they turn a little orad and cross the sides, increasing in number by bifurcation or intercalation, in a faintly sigmoidal elegant arc; on the venter they form a broad, very shallow, orad convex sinus. Very faint folds, visible in oblique illumination only, appear to coincide with every tenth or fifteenth of the riblets; these folds are less indistinct on the posterior half of the outer whorl than on the anterior one. It cannot be recognized whether or not they correspond to shallow constrictions of the cast, as observed in other species of this genus. Occasionally the riblets look somewhat "fimbriate," as they are in another lytoceratid lineage, but this aspect may be due merely to irregular corrosion of the thin test. As seen best on the venter, one or two extremely fine threads are intercalated between the riblets of the anterior part of the outer volution.

The dark median line seen in both ventral views (Pl. XLII, figs. 2b, c) and in the suture line drawings (Pl. XLIV, figs. 2a, b) is apparently due to the deposition of crystallized calcite in the siphuncular tube.

The unusual preservation, in which some chambers are filled with crystallized calcite while the adjacent ones with but ordinary matrix, cause the suture lines to show, without any previous preparation, most distinctly on two places of the outer whorl. In the side view (Pl. XLII, fig. 3a) the crystallized chambers appear dark and the others light, while in transparent light it is just the reverse (Pl. XLII, fig. 3d).

The suture line (Pl. XLIV, figs. 2a, b) is very elaborate. The siphonal lobe is narrow and divided by a slender, richly indented, median leaf into two terminal points, which are each bifid. The sagittate shape of the median leaf noted by Kossmat (1895, p. 113) is more pronounced at the first quarter of the outer whorl (fig. 2a) than at the third (fig. 2b); this may be due to the venter still being slightly sharpened at the former place but not at the latter. The height of this leaf amounts in both places to about two-fifths of the length of the siphonal lobe. There are, on both sides of the latter, three main lateral branchlets which gradually decrease in length orad. The first lateral lobe is about as long as the siphonal one; the second and the third[1] decrease gradually in length. All three of these lateral lobes are very like each other; all are divided by a tall upright leaf, most strongly developed in the first lobe, half the length of which it equals in height, into two bifid main stems; above those, there are two main lateral branchlets on each side. The external saddle and the first and second lateral ones also greatly resemble each other; all are decidedly bifid and symmetrical; only in the second lateral saddle the inner stem is remarkably broader than the outer one and somewhat inclined dorsad. The external saddle stands out, being by far the broadest, with an extremely strong middle lobule whose length equals (fig. 2a) or even exceeds (fig. 2b) half the height of this saddle; of the secondary lobules intersecting both its main stems, the outer one is a little deeper than the inner one and attains about a third of the height of the external saddle in depth, whereas of the four stems of this saddle the second from the median line slightly overtops the others. The first lateral saddle is equal in height to the external one; also in this saddle the inner stem of the outer half marks the topmost point. From this point on, the curve connecting the saddle tops slopes dorsad, first gradually, then much more abruptly, thus forming one side of the wide "suspensive lobe" distinctive

[1] Most of the textbooks and important ammonitological monographs (e.g., d'Orbigny, 1840, p. 103; Zittel, 1881–1885, p. 400; usual nomenclature, as quoted by Hyatt, 1900, pp. 538–539, footnote, and *in* Eastman, 1927, p. 619; Roman, 1938, p. 5; Moret, 1940, p. 432) know of no more than *two* lateral lobes (and saddles). However, Hyatt (1900, p. 540; cf. Eastman, 1927, p. 621) defines the auxiliaries as "the inflections added to the sides after the first two or *three* saddles and lobes appear," and Buckman (1909, vol. I, p. IX) explicitly mentions, under the designation "L^3," a "*third* lateral," though adding, "often first of a series of auxiliaries." The writer adheres to von Buch's old conception as quoted by Diener (1916, p. 553) and supported by Mojsisovics (see Zittel, *loc. cit.*), that the boundary between lateral and auxiliary sutural elements is determined by the projection of the peripheral outline of the precedent whorl. This boundary may sometimes be exceeded where the second lateral lobe, or parts of it, come to lie beyond it, but it should certainly be respected where there are more than two lateral lobes ventrad of it. In the suture line under examination this is obviously true of the third lobe and of almost all of the following saddle. They must for this very reason be called the third lateral lobe and saddle, respectively. This view is strongly supported by the perpendicular course of the third lobe and by its complete analogy in shape with the first two laterals and, moreover, by the fact that the following saddle is undoubtedly homologous in every respect with the second lateral saddle in other *Gaudryceras;* compare, e.g., Stoliczka's (1865, Pl. LXXVI) fig. 3b of a specimen of *G. sacya* with the drawing (Pl. XLIV, fig. 2b) of the present suture line.

of this lytoceratid group. In all three main saddles the lobules end in two two-pronged points, whereas the secondary lobules are three-pronged. The third lateral saddle is in its character just intermediate between the precedent saddles and the auxiliary ones; its broad outer stem, which marks the site of the umbilical edge, is still upright, but the inner one is much inclined dorsad, as are the following auxiliary saddles; both these stems are separated from each other by an extremely strong trifid lobule which is inclined in the same way. Five auxiliary lobes are recognized; all of them are very oblique, owing to the steep slope of the suture line across the umbilical wall. The first stands out by being strong and broad and is divided into two bifid branches. The first auxiliary saddle imitates in shape the inner stem of the third lateral one; the second and the third are rather inconspicuous, but the fourth seems to be higher than both.

REMARKS.—Leaving the rather unusual presence of a third lateral lobe and saddle out of account the suture lines just described show all the distinctive features of this genus: the symmetrical bifidity of all main lobes and saddles; the equal length of siphonal lobe and first lateral one; the considerable number of auxiliary elements; the steep decline of the external suture line across the umbilical wall; and, last not least, the extremely high degree of indentation. Also in the shape of the conch and in ornamentation this form agrees so well with the typical *Gaudryceras* that there cannot be any doubt as to its reference to this genus.

On the other hand, the sharpness of the periphery in the penultimate and in the posterior part of the outer whorl is in a Lytoceratid a most unusual feature, found, as far as the writer knows, in only one *Gaudryceras* described and figured in literature, viz., in Pervinquière's (1910, Pl. x, fig. 10b) frontal view of one of the two specimens from the Algerian Cenomanian referred by him to *G. vatonnei* (Coquand). Here also the outer whorl is at its beginning so decidedly sharpened as almost to carry a keel, but most peculiarly no mention whatsoever of this strange feature is found in Pervinquière's otherwise very careful description, nor does his second specimen (*ibid.*, fig. 9) or Coquand's (1862, p. 173, Pl. I, figs. 9, 10) type of this species show any indication of it.[1] Neither older nor younger forms of this stock are known to the writer which might yield a palingenetic or cenogenetic explanation of this character which apparently occurs so sporadically, and it is indeed a riddle to him; hence the name of this species. From Spath's (1927, p. 67) generic diagnosis of *Mesogaudryceras*, stressing its "compressed and flattened . . . inner whorls," it might be thought that the present form might belong to it; however, Sharpe's (1855, p. 32, Pl. XIV, fig. 3) protograph shows a quite different development of the section of Spath's genotype *G. leptonema*. Here the outer whorl has at its beginning a decidedly truncate, flatly rounded venter, and the whorl section becomes lancetiform only later. Also the tiny *G. dozei* (Fallot, 1885, p. 235, Pl. IV, figs. 3, 3a, 3b; Jacob, 1908a, p. 16, text fig. 4, Pl. XII, fig. 12; Pervinquière, 1910, p. 14, Pl. x, figs. 11–18), although exhibiting a thin, discoidal, flattened conch,

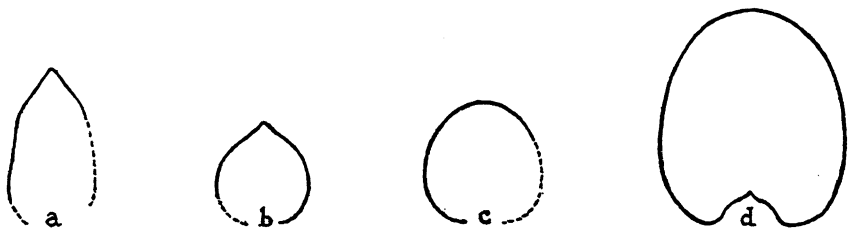

Fig. 24. Development of section in *Gaudryceras aenigma*, new species, holotype, A.M.N.H. No. 25397. Sections of (a) penultimate whorl at D = ca. 15 mm., × ca. 3; (b–d) outer whorl at diameters of (b) ca. 25 mm., (c) ca. 33 mm., (d) 58 mm.; all natural size.

[1] It may be added that *G. vatonnei* has the rapid increase in height of the outer whorl stressed by Pervinquière, and the shape of its section in common with the present species, but it is remarkably less involute, and its costation seems to be much less distinct.

is a quite different type with a blunt periphery. The same is also true of a little *Gaudryceras* from the Ootatoor Group of southern India, *G. odiense* Kossmat (1895, p. 129, Pl. XVIII, fig. 1, Pl. XIX, fig. 3)[1] which is, according to Kossmat, the most involute *Gaudryceras*. [The measurements (H = 45, U = 24) of Stoliczka's (1865, p. 111, *pro parte*, Pl. LVIII, fig. 1) specimen, figured under the name *Ammonites varuna* but included by Kossmat in his *G. odiense*, are almost exactly the same as in the present form.]

Be that as it may, neither the presence of a third lateral lobe and saddle nor the sharply fastigate venter in the adolescent stage seems to the writer to be a sufficiently distinctive character to justify a generic (or subgeneric) separation of this species from *Gaudryceras*, as the former is believed to be due merely to the exceptional height of the outer whorl, which allows for the formation of a third main lobe and saddle on the sides, and the latter, sporadically occurring also in another true *Gaudryceras* (*G. vatonnei*), fully disappears in maturity.

There are, in addition, some minor distinctive features of the new species. Except in the case of *G. odiense* mentioned above, so high a degree of involution occurs in the typical *Gaudryceras* only at a much greater size, e.g., in the large specimen of *G. mite*, figured by de Grossouvre (1893) on Pl. XXXIX, at a diameter of 188 mm. Furthermore, the backward trend of the riblets on the umbilical wall cannot be found in any known form of this genus,[2] whereas it can be recognized in some Jurassic lineages of the Lytoceratidae. It may be a somewhat archaic character of this species which is, no doubt, one of the oldest *Gaudryceras* (cf. Spath, 1923, p. 21).

Thus no detailed comparison of *G. aenigma* with any other *Gaudryceras* seems to be necessary, unless an exception is made for the larger one of the two Japanese forms described under the name "*Lytoceras* sp." by Yokoyama (1890, p. 180, Pl. XIX, fig. 3); it strongly resembles the Angola form in its general habitus and also has accidentally exactly the same size, without, however, sharing the former's distinctive features emphasized above.

[1] The front view (fig. 1a) of Stoliczka's specimen referred by Kossmat to this species shows a slightly fastigate venter, but Kossmat's fig.1b is believed to be more reliable.

[2] De Grossouvre's (1893, p. 225) statement, "que les stries, au lieu d'arriver sur le bord d'ombilic normalement ou obliquement vers l'avant, se rejettent, au contraire, en arrière," obviously proceeds dorsad instead of ventrad; it thus describes just the reverse of the feature found in the present form.

TETRAGONITES KOSSMAT

This lytoceratid genus, established as a subgenus of *Lytoceras* by Kossmat in 1895 (p. 131), is also represented at Hanha only by a single specimen, here referred as a new local variety to *T. jurinianus*, a species closely related to the genotype *T. timotheanus*.

Tetragonites jurinianus (Pictet),[3] var. angolana, new variety

Pl. XLIV, fig. 3; Pl. XLV, figs. 1a, b; text figs. 25a, b

A. M. N. H. No. 25398: one specimen

DIMENSIONS OF HOLOTYPE

	D	H	H′	W	U
(a)	62.8 mm.	ca. 51	?	54½	?
(b)	104.6 mm.	53½	42½	48½	16

DESCRIPTION.—Despite its size the single specimen (holotype) is septate throughout; with its body chamber it must have attained a diameter of at least 150 mm.

The conch is much less inflated than in the typical form of this species. The inner whorls are filled with crystallized calcite; the outer one increases more rapidly in height than in width; while slightly wider than high in its posterior part, it is higher than wide in the anterior one (see table of dimensions). In the former the section has the shape of a rectangle, with moderately rounded sides and venter; near the front end, however, the sides are more distinctly vaulted and the venter becomes remarkably narrower, the rectangular sectional outline thus giving way to a rather triangular one (cf. text figs. 25a and b). The umbilicus is deep, surrounded with a perpendicular wall which is separated from the sides by a well rounded edge.

Near the posterior end of the preserved part of the outer whorl a constriction is seen on the left side only (therefore visible neither in the right side view, fig. 1a, nor in the ventral view.

[3] Synonymy of typical form:

Ammonites Jurinianus Pictet; PICTET AND ROUX, 1847, p. 297, Pl. III, fig. 3.

Ammonites Timotheanus (Mayor), Pictet; PICTET AND CAMPICHE, 1860, p. 289, *cum synon., pro parte.*

Ammonites Jurinianus, PICTET, 1860, *ibid.*, p. 362.

Lytoceras (*Tetragonites*) *Jurinianum* Pictet sp.; JACOB, 1908a, pp. 19–20, Pl. I, fig. 12.

Tetragonites Jurianus Pict.; ROMAN, 1938, p. 43.

fig. 1b); its course seems to be slightly sinuous and a little prorsiradiate. The test is preserved in part, but corroded, and does not show any trace of ornamentation.

The external suture line could be studied at a diameter of about 50 mm. (Pl. XLIV, fig. 3). Its most outstanding features seem to be the following: except for the auxiliary elements situated on the umbilical wall, all lobes and saddles are upright; the main lobes are equal in length; the line connecting the saddle tops slopes most gently dorsad. The siphonal lobe is rather narrow and divided by a tall and slender, sagittate median leaf, which attains almost three-fifths of the length of this lobe in height and is richly indented on its sides;[1] both its terminal branchlets are strong and bifid, their points being each three-pronged; there are, moreover, on each side a strong, trifid, lateral branchlet and farther orad another weaker one.

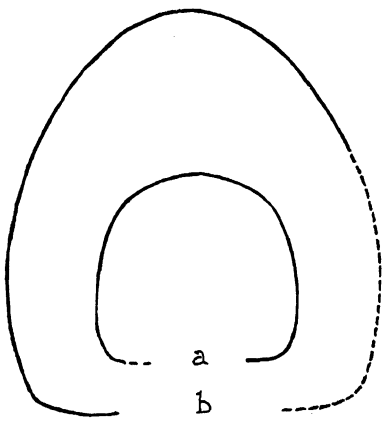

Fig. 25. Sections of *Tetragonites jurinianus* (Pictet), var. *angolana*, new variety, holotype, A.M.N.H. No. 25398, (a) at posterior, (b) at anterior end of preserved part of outer whorl, both natural size.

The first lateral saddle is very much straitened at its base as well as somewhat below half its height; its upper part is divided by a strong and deep, ventrad pointing lobule into a much stronger outer main stem and a weaker, dorsad inclined, inner one; the former is almost symmetrically subdivided by another deep lobule into two upper branches, each of which is about as strong as, or even a little stronger than, the inner main stem of this saddle; there is, in addition, a minor branch at the outer side of this main stem. The arrangement of the upper stems, as described, causes the saddle as a whole to appear "trifurcated." The first lateral lobe is broad and comparatively short; it is symmetrically divided by a strong middle leaf into two broad, bifid, main branches; the outer one is a little longer than the inner one; furthermore, there is a strong lateral branch on each side. The first lateral saddle is slightly lower than the external one and "trifurcated" in a similar way, but here the inner main stem is the stronger and bifid one. The second lateral lobe is even slightly deeper than the first and irregularly trifid; the outer and the middle branch are about equally strong, the former is bifid, the latter trifid and twisted dorsad; the inner branch is by far the weakest, much shorter than the two others, and bifid; some of the points of all three branches are three-pronged, others are two-pronged; the leaf separating the outer branch from the middle one is very like the middle leaf of the first lateral lobe and is higher and less inclined than its opposite, separating the middle branch from the inner one. The second lateral saddle is remarkably lower than the first and is bifid at its top. The next lobe, being situated mostly within the projection of the peripheral outline of the precedent whorl (footnote, p. 168), must be considered the first auxiliary one, although it is, for an auxiliary lobe, extraordinarily broad and large; but it is, of course, shorter than the second lateral lobe. In its general plan it imitates the first lateral lobe rather than the second; of its two bifid branches the inner is the stronger, but shorter. The first auxiliary saddle is a reduced repetition of the second lateral one and is crossed a little dorsad of its middle by the umbilical edge. On the umbilical wall there follow the well developed, trifid, second auxiliary lobe, the slender second auxiliary saddle, the narrow third auxiliary lobe, the rather simplified third auxiliary saddle and half a fourth auxiliary lobe. The last four sutural elements are somewhat inclined dorsad, though much less so than in *Gaudryceras aenigma* or in the *Puzosia* suture lines studied above.

REMARKS.—Were it not for its suture line, this form would have been taken for one of the involute, less inflated varieties of *Desmoceras latidorsatum* (Michelin); in the shape of its conch and in its measurements it is indeed indistinguishable from Boule, Lemoine and Thevenin's (1906, p. 17, Pl. II, fig. 5) "variété comprimée a petit ombilic" from the "Cenomanian" of the Mont Raynaud, Madagascar.[2] However, the suture line of the present specimen is

[1] The siphonal saddle appears much lower, blunter and lacking indentations in Pictet and Roux' (1847, Pl. III, figs. 1c, 3c) suture line drawings of both *T. timotheanus* and *T. jurinianus;* this seems, however, to be due to poor preservation.

[2] This variety has been doubtfully united by Breistroffer with his *D. collignoni* (*in* Besairie, 1936, p. 170, text fig. 10d, Pl. XVI, fig. 2) from the upper horizon of the Middle Albian of Madagascar; however, as seen from his description and figures, his holotype possesses distinct constrictions, whereas it is the absence of constrictions in their variety that is stressed by Boule, Lemoine and Thevenin. The latter should, therefore, rather be left, as a separate "var. **angusteumbilicata,** new variety," with *D. latidorsatum* than included in the synonymy of *D. collignoni.*

decidedly lytoceratid, not desmoceratid, as is that of the Madagascar example, recognizable in its side view (fig. 5); moreover, it shows the characteristic features of *T. timotheanus* and *T. jurinianus*. The three main lobes are about equal in length; the first lateral lobe is bifid, the second asymmetrically trifid; the main saddles are "trifurcated"; and up to the umbilical edge all sutural elements are upright. The almost[1] perfect agreement of my drawing (Pl. XLIV, fig. 3) with Kossmat's (1895, Pl. XVII) fig. 11, which depicts the suture line of an Indian specimen of *T. timotheanus* and which is much more complete and accurate than Pictet and Roux' (1847, Pl. III) figs. 1c and 3c, is striking indeed. It may be added that the strong resemblance between the later ontogenetic stages of *T. jurinianus* and *Desmoceras latidorsatum* was pointed out in the original description of the former species (1847, p. 298) and later (1908a, p. 20) by Jacob as well.

It is true that there is, at least in the outer whorl of the present form, no trace of the trapezoidal section characteristic of the genotype, *T. timotheanus* (Mayor, MS; Pictet and Roux[2]); the inner whorls can, unfortunately, not be examined, as they are crystallized. However, the posterior part of the outer whorl still shows a rectangular section. On the other hand, *T. jurinianus* is, as seen from both Pictet's and Jacob's observations, so closely allied to *T. timotheanus* that there can be no doubt but that they are congeneric.

As to distinction between both these species reference may be made to the authors just cited, since little can be added to their remarks referring to this comparison. The present variety deviates from the typical *T. jurinianus* in the same direction as does the latter from *T. timotheanus*. The variety *angolana* is still more involute and less stout than the typical form; furthermore, its venter is even more rounded, and its outer whorl increases even more rapidly in height. Since the Angola form grows considerably larger than the examples from the Saxonet (Pictet and Roux) and from the Balme de Rencurel (Jacob), the question might arise whether the above differences are not merely due to development; however, the African form is apparently much more slender from the outset and is, therefore, here considered a distinct local race of *T. jurinianus*.

It has the rounded venter in common with the much younger *T. epigonus* Kossmat (1895, p. 135, Pl. XVII, figs. 4, 5; = *Ammonites timotheanus* Stoliczka, 1865, p. 146, *pro parte*, Pl. LXXIII, fig. 5 only), which is, however, much less involute and also different in its sutural characters, as pointed out and illustrated by Kossmat.

Finally, it may be added that there is also almost perfect agreement in measurements with, and considerable resemblance in the shape of the conch to, the Upper Senonian *Pseudophyllites Indra* (Forbes; Kossmat, 1895, p. 137, *cum synon.*, Pl. XVI, figs. 6–9, Pl. XVII, figs. 6, 7, Pl. XVIII, fig. 3), which can, however, readily be distinguished from the present form by the distinctive characters of Kossmat's subgenus *Pseudophyllites* and by its steep, but not perpendicular umbilical wall.

PART III: HAMITIDAE, ANISOCERATIDAE, TURRILITIDAE

This part of the present paper deals with the abnormally coiled ammonites from Hanha together with some others, apparently also of Albian age, collected by Dr. C. A. Washburne from two localities south of Benguela Velha. Eighteen different forms referable to seven genera are recognized in the collections from Hanha, while a new variety (var. *spinosa*) of *Anisoceras saussureanum* (Pictet) and three forms of *Idiohamites* are described from south of Benguela Velha.

The taxonomy of families and genera is discussed below only insofar as essential for

[1] It must be admitted that in Kossmat's suture line the siphonal lobe is the deepest of the principal lobes, while they are about equally deep in the specimen from Hanha.

[2] 1847, p. 297, Pl. III, fig. 3; Kossmat, 1895, p. 133, *cum synon.*, Pl. XVII, figs. 11, 13; Boule, Lemoine and Thevenin, 1906, p. 14, Pl. II, figs. 3, 3a, b; Pervinquière, 1907, p. 74, text figs. 13, 14, Pl. III, figs. 24–26; Jacob, 1908a, p. 19, Pl. I, fig. 12; Spath, 1923, p. 25, *cum synon.*, text fig. 6, Pl. I, figs. 5, 6; Collignon, 1929, p. 18, *cum synon.*, Pl. I, figs. 18, 18a.

the scope of this paper. Much more fascinating is the problem of from which lineages of normally coiled ammonites the various groups of abnormally coiled ones might be derived. This problem, however, could not be studied at this time.

The symbols used in the tables of dimensions throughout Parts I and II of this paper (see p. 8) proved to be unserviceable for abnormally coiled forms. The difference between "W" and "W'" is, for practical reasons, no longer maintained in this part. Both "H" and "W" are measured over, not between, the ribs. Furthermore, a modified method of measurement had to be applied to all forms with straight shafts of the families Hamitidae and Anisoceratidae: "L" means the full length of the fragments under examination, "H" and "W" mean their dorsal-ventral and transverse diameters, respectively; where these have been measured at or near the posterior or anterior ends of the fragments, a "p," or "a," respectively, is added, whereas "H" or "W" plainly refers to these diameters at about the middle of the measured fragment. In most of the tables of dimensions the ratio W:H is indicated; all the other figures are expressed in millimeters.

Hamitidae Hyatt, emend. Spath

This family, which was established by Hyatt in 1900 (p. 586), has been interpreted recently in quite a different way by Spath (1939, pp. 603–605). In the present paper it is used to include the following genera occurring in the Albian of Angola: *Hamites* Parkinson, *Ptychoceras* d'Orbigny and *Hamitoides* Spath, although Spath (1939, pp. 605–606 and 600–601, respectively) no longer considers *Ptychoceras* as an independent genus and doubtfully refers *Hamitoides* to the Labeceratidae. The genera *Anisoceras* and *Idiohamites*, although undoubtedly also closely related to *Hamites*, are here included in Hyatt's family Anisoceratidae (see p. 189).

Although Hyatt (*loc. cit.*) stated that all the members of his family Hamitidae have "no tubercles at any stage," this does not hold true of all the genera included in this family by him, since tubercles certainly occur in some species usually referred to the genus *Helicoceras* d'Orbigny. In the present paper, however, only non-tuberculate forms are included in this family.

Hamites Parkinson

This old genus is here interpreted in about the circumscription recently given to it by Spath (1939, pp. 603–607), viz., excluding *Hamitoides* and *Idiohamites* but including *Torneutoceras* Hyatt, previously (1922, pp. 147–149) separated by Spath from *Hamites*. *H. attenuatus*, once chosen by Hyatt (1900, p. 586) as the genotype of *Torneutoceras* and referred to the latter genus also in Spath's (1922, p. 148) Angola paper, has now been made by him (1939, p. 605) the genolectotype of *Hamites*. In his recent circumscription this genus would also include *Helicoceras* and *Ptychoceras*, now held by Spath (1939, p. 605; 1941, p. 656) to be a subgenus of *Hamites*. The relationships of *Helicoceras* need not be investigated in the present study; *Ptychoceras*, however, is here maintained as an independent genus (see p. 185). Breistroffer's (1940, p. 85; *fide* Spath, 1941, p. 634) subgeneric name "*Stomohamites*," created to include *H. virgulatus*, *H. venetzianus* and *H. duplicatus*, all of which are represented in this collection, is considered superfluous and, therefore, not used in the present paper. This is due not only to the writer's general aversion to the use of subgeneric names but also to the following considerations. It is true that "apertures with two collars, separated by a deep constriction," as seen in Spath's (1941, p. 641) text fig. 232, have hitherto been observed only in the aforementioned species of *Hamites*, whereas in others the apertures are believed to be plain. It must, however, be kept in mind how imperfectly known are almost all the forms of this genus, represented, as a rule, only by fragments. This may be the reason why Spath (1941, p. 634) does not even mention this apertural character in his sub-

generic diagnosis. Furthermore, those characters there listed do not establish a sufficient basis for a thorough distinction between the two sections of *Hamites*, since there are numerous transitions between them, as repeatedly emphasized by Spath himself. He believes the bifid second lateral lobe to be a distinctive feature of the *virgulatus*-group; however, according to the evidence furnished by the *Hamites* from Angola, this lobe can in the forms of this group be subtrifid or even plainly trifid as well as bifid. The characters mentioned by Spath thus do not seem to the writer to justify Breistroffer's separation of a subgenus, but reluctantly accepted by Spath. No forms referable to that author's (1941, pp. 654–655) subgenus *Psilohamites* have been found in Angola, but as Spath thought its creation necessitated merely by "the adoption of Breistroffer's *Stomohamites* (for the *virgulatus*-group)," it may here be rejected as well as the latter.

The abundance of little fragments of *Hamites* in the Albian of Angola has been recorded since the earliest days of its scientific palaeontology, particularly by Meunier (1888, p. 62) and Choffat (1888, p. 72), who referred most of those fragments to *H. virgulatus;* however, only the former's paper contains a poor figure of that species; the other figures of "*Hamites*" found in these two papers depict forms now referred to *Anisoceras*. The same is certainly true of one of the two fragments of abnormally coiled ammonites in Choffat's second Angola paper (1905, p. 41, Pl. I, fig. 6) and, to judge by that author's description (p. 40), probably also of the other (Pl. III, fig. 5), identified by Choffat merely as "*Hamites* sp. nov." In his classical paper on Cretaceous Ammonoidea from Angola Spath (1922, pp. 148, 149) discusses a few *Hamites* fragments identified by him as "*Torneutoceras* cf. *attenuatum* (Sowerby), d'Orbigny" and as "*Torneutoceras virgulatum* Brongniart," but he unfortunately gives no figures. As far as these earlier reports refer to forms dealt with in the present paper or to closely related ones, their synonymy will be discussed below.

The present collection includes sixty-two more or less fragmentary specimens of *Hamites;* thus Meunier's and Choffat's previous statements on the abundance of *Hamites* fragments in the matrix of the Albian fossils from Angola have been fully verified. Ten of these fragments are too poorly preserved to allow specific identification, but fifty-two others, although mostly rather poor and scanty, could be referred, at least approximately, to known species and varieties.

Hardly a group of Cretaceous ammonites can be found whose specific taxonomy is as confused as was, until lately, that of *Hamites*. It is true that the valuable work of Pictet and his co-authors many decades ago did much to disentangle the classification of *Hamites* (see particularly Pictet and Roux, 1847, pp. 371–372, 385–394; Pictet and Campiche, 1861–1864, pp. 77–102); however, they did not fully take into account that almost all characters thought to be distinctive of the various forms of *Hamites* are based on mere fragments, that is to say, on certain ontogenetic stages, and may not apply to earlier or later ones as well. For instance, Pictet attaches great weight to the direction of obliqueness of the ribs, whether they are projected ventrally (= on his "dorsal" side) or dorsally (= on his "ventral" side); however, some of the types of Sowerby (e.g., *H. attenuatus*, 1812, p. 137, Pl. LXI, fig. 4 = text figs. 218a, c, in Spath, 1941) as well as of Pictet (e.g., *H. attenuatus*, 1847, Pl. XIV, fig. 5e) show the ribs running in opposite directions on either shaft of U-shaped specimens. What makes things even worse is the fact that Pictet repeatedly substituted d'Orbigny's spectacular, but, according to Spath, not always quite dependable drawings for the true types of Sowerby's English species. Thanks to Part XIV of Spath's Gault Monograph, published quite recently, many of the taxonomic issues concerned can now be considered to be clarified.

In the classification of the *Hamites* from Angola the writer relies, as does Spath, more on characters of the ornamentation and of the section than on the manner of coiling which not only is but rarely observable but is very subject to individual variation.

Hamites compressus J. Sowerby

(A) forma typica

Pl. XLIII, figs. 1a–e

A. M. N. H. No. 25399: five specimens

Hamites compressus J. SOWERBY, 1814, p. 138, Pl. LXI, figs. 7, 8.

Hamites compressus, J. Sowerby; SPATH, 1941, p. 617, *cum synon.*, text fig. 222, Pl. LXVIII, figs. 10, 11.

DIMENSIONS

Spec. No.	L	Hp	Wp	Ha	Wa
1	14.2 mm.	5.3 mm.	3.9 mm.	5.9 mm.	4.1 mm. (=0.7 Ha)

DESCRIPTION.—The least incomplete specimen (No. 1) is a short, perfectly straight, septate fragment. Its section (fig. 1e) is elliptical. Twelve ribs can be counted along the full length of this fragment, six of them on a length equal to the whorl height. The ribbing is perfectly regular, all the ribs being uniform and strictly parallel to each other. Despite the corrosion of the surface they appear rather sharp. Narrower than the intercostals and but slightly oblique, being projected dorsally, they are strongest on the venter and weakest on the dorsum where they disappear almost entirely, thus causing it to appear smooth.

Isolated prongs and leaflets can be found here and there, but no continuous suture line could be traced.

There are four other incomplete fragments, among them a portion of another straight shaft (specimen No. 2), which is only 4 mm. long and in every respect exactly like specimen No. 1, and a thin slice of a somewhat thicker shaft (specimen No. 3), which can be identified by its slightly compressed section and by its sharp, rather distant ribbing.

(B) var. gracilis Spath

Pl. XLIII, figs. 2–4; text figs. 26a, b

A. M. N. H. No. 25400: nine specimens

?*Hamites virgulatus* (Brong.?) d'Orb.; PICTET AND CAMPICHE, 1861, p. 85, *pro parte* ("variété à côtes fines et rapprochées"); Pl. LIV, fig. 9 only.

?*Hamites* aff. *compressus* Sow.; COLLIGNON, 1932a, p. 24, Pl. IV, figs. 18, 19.

Hamites compressus, J. Sowerby, var. *gracilis* SPATH, 1941, p. 619, Pl. LXVIII, figs. 12, 13.

DESCRIPTION.—The largest fragment (specimen No. 1, Pl. XLIII, figs. 2a–c, text figs. 26a, b) is septate throughout and has about the shape of a hockey stick; it consists of the anterior part of a hook and of a part of the adjacent shaft. Its coiling is slightly twisted, as shown in text fig. 26 by juxtaposition of the sections at the posterior and anterior ends, drawn before and after rotating the specimen in one plane. The intercostal section is, at both ends of this fragment, oval (tapering ventrad); the costal one is almost elliptic. The costation is very dense. About six ribs can be counted on a length equal to the dorsal-ventral diameter on the hook, and seven near the anterior end of the fragment. These ribs are about as broad as the intercostals; they are strongest on the venter and disappear almost entirely on the dorsum, which is nearly smooth except for some ribs on the anterior part of the straight shaft which can be traced in oblique illumination even across the dorsal median line. On the sides the costae gradually widen ventrad; they are just slightly sigmoidal on the hook but straight on the shaft. In its posterior part they are still slightly projected dorsally, but they gradually become horizontal on the anterior one. Owing to the dissymmetry of the specimen, mentioned above, they cross the venter in a slightly oblique, though straight line, rising from the left side to the right.

A smaller fragment (No. 3, fig. 4) exhibits the final part of the shaft preceding the hook and also the beginning of the latter, thus supplementing the information given by specimen No. 1. It is remarkable by the rapid increase of its whorl height, but it is too crushed to allow a satisfactory study of its section. The costation is like that of specimen No. 1, except for the fact that there are slightly fewer (five and a half on the length of H) and stiffer ribs. Specimen No. 2 (figs. 3a, b), with about the same measurements as No. 3, however, shows the same fine and slightly sinuous costation as the posterior part of No. 1, but

Spec. No.	L	Hp	Wp	Ha	Wa
			DIMENSIONS		
1	ca. 40.0 mm.	5.8 mm.	4.7 mm. (=0.81 Hp)	7.0 mm.	5.8 mm. (=0.83 Ha)
2	15.7 mm.	4.8 mm.	3.5 mm. (=0.73 Hp)[1]	5.0 mm.	3.9 mm. (=0.78 Ha)[1]
3	ca. 16.0 mm.	4.6 mm.	?[2]	5.7 mm.	?[2]

some ribs are sigmoidal from the opposite direction. Its section seems to be a little more slender, but this fragment also is slightly crushed. Five more small fragments (Nos. 4–7, 9) and the mold of a hook (No. 8) agree in their ribbing so well with Nos. 1–3 that they are also referred to this variety.

No suture lines worthy of description or delineation could be traced.

REMARKS (AD *H. compressus*, SENSU LATO).—Many of the older authors (e.g., d'Orbigny, 1842, p. 533; Pictet and Roux, 1847, p. 388) united this species of Sowerby's with his *H. attenuatus*, but it has recently been reëstablished as a distinct species by Spath. However, he admits that there are transitions to other contemporary species, e.g., *H. tenuicostatus* (see Spath, 1941, p. 615), *H. incurvatus* (*ibid.*, pp. 619–620), *H. gardneri* (*ibid.*, p. 625) as well as to *H. attenuatus* itself (Spath, 1939, p. 607, *cum synon.*, 1941, text fig. 218, Pl. LXVII, figs. 1–13, 19, Pl. LXVIII, figs. 4, 5), from which the present species differs chiefly by its more compressed section and its sharper, more distant ribs which tend to be slightly projected dorsally, instead of ventrally, as they do in *H. attenuatus*. The distinction between the present species and other similar *Hamites*, particularly those mentioned above, is discussed in Spath's Gault Monograph.

Spath (1922, p. 148) has recorded a "*Torneutoceras* cf. *attenuatum* (Sowerby), d'Orbigny sp." from Angola; however, no specimen truly referable to that species has been found in the present collection, nor is there any individual which could be thought to be conspecific with Spath's form, which that author describes as having very oblique costae and as being closely comparable to Pictet's (1847) fig. 5.

On the other hand, the writer has no doubt about the reference of the present specimens to *H. compressus*. Those referred to its typical form show about the same degree of compression as Spath's lectotype (W:H = 0.7, as compared to 0.67 in his text fig. 222c) and also possess the distinctive features of its ornamentation. Those here referred to Spath's variety *gracilis* are, it is true, less compressed than his type (W:H = 0.55 in Pl. LXVIII, figs. 12b, as compared to from 0.73 to 0.83 in my specimens Nos. 1 and 2), but their fine dense ribbing accounts for their very similar habitus, although the flexuosity of the ribs is much more pronounced in the curved parts of the Angola examples than in those from the English Gault.

Spath excluded from the synonymy of Sowerby's species, without giving reasons, Collignon's (1932a, p. 24, Pl. IV, figs. 18, 19) small, very finely ribbed *H.* aff. *compressus* Sowerby from the Albian of Madagascar, but in the writer's opinion it might well be identified with its variety *gracilis* with which it perfectly agrees in density of costation, though being less compressed. The same character of ribbing as in the variety *gracilis* is also found in some of the forms referred by Spath (1941) to *H. attenuatus*, particularly in those figured in his Pl. LXVII, figs. 10–12, but they differ from this variety by their more circular sections (Spath considers them to be transitional to *H. rotundus*) and by their ribs crossing the dorsum uninterruptedly. Pictet and Campiche's (1861, p. 88, Pl. LIV, fig. 13) "variété à côtes fines" of *H. attenuatus*, which was only doubtfully included by Spath (1939) in the synonymy of that species, shows about the same degree of compression and the same fine ribbing as the variety under discussion, but it differs in that its ribs are projected ventrally (a character emphasized by Pictet, p. 89, as distinctive of *H. attenuatus*) and are not weakened on the dorsum. Pictet and Campiche's (1861, p. 86, Pl. LIV, fig. 5) "variété à côtes fines et rapprochées" of *H.*

[1] Specimen slightly crushed.
[2] Specimen too crushed to be measured.

virgulatus, included in the synonymy of that species by Spath (1941, p. 635), does not, however, show these two differences in ornamentation and might, in the writer's opinion, perhaps be referred to *H. compressus*, var. *gracilis*. Finally, a type of ribbing similar to that of the latter is also found in the Mexican examples determined by Böse (1923) as *H.* aff. *charpentieri* (p. 131, Pl. IX, fig. 42) and *H.* aff. *attenuatus* (p. 132, Pl. IX, figs. 43–45), but as both are badly crushed, no statement as to their relationships can be ventured.

The differences between the typical *H. compressus* and its variety *gracilis* have been pointed out above; with the other forms requiring comparison within the present collection, *H. tenuis* and its variety *subacuaria*, *H. virgulatus*, *H. venetzianus*, and *H. duplicatus*, both will be compared below.

Hamites tenuis J. Sowerby

(A) forma typica

Pl. XLIII, figs. 5–7; text figs. 26c–e

A. M. N. H. 25401: seven specimens

Hamites tenuis J. SOWERBY, 1814, p. 136, Pl. LXI, fig. 1.

Hamites tenuis, J. Sowerby; SPATH, 1941, p. 628, *cum synon.*; text figs. 228a–h, m–o; Pl. LXVIII, fig. 14, Pl. LXX, figs. 2, 16, 17.

in the anterior part of specimen No. 3. As a rule, they vanish on the dorsum which appears to be smooth. On the anterior part of specimen No. 2, however, the costae, although very weakened on the dorsum, remain perceptible in oblique illumination. It seems to be worth noting that they become very slightly sigmoidal in the front part of specimen No. 3 on the right side only, as seen also in Spath's (1941) text fig. 228m and in fig. 14 of his Pl. LXVIII.

Three more fragments (Nos. 4–6) agree, in both section and ornamentation, well enough with the above described ones to be referred to the same form. A seventh, gently curved fragment (No. 7), about 10 mm. long, exhibits the same character of costation as those hitherto discussed, but it differs from them by its decidedly circular section (W=H) and is, therefore, only doubtfully referred to the present species.

No suture lines are visible in any of the specimens.

(B) var. subacuaria Spath

Pl. XLIII, figs. 8a, b; text fig. 26f

A. M. N. H. No. 25402: five specimens

Hamites tenuis J. Sowerby, var. *subacuaria* SPATH, 1941, p. 630, text figs. 228i–l.

DIMENSIONS

Spec. No.	L	Hp	Wp	Ha	Wa
1	8.5 mm.	2.4 mm.	1.9 mm. (=0.8 Hp)	2.7 mm.	2.1 mm. (=0.77 Ha)
2	13.0 mm.	2.7 mm.	2.2 mm. (=0.8 Hp)	3.3 mm.	2.8 mm. (=0.75 Ha)
3	15.0 mm.	3.3 mm.	2.6 mm. (=0.8 Hp)	4.0 mm.	3.0 mm. (=0.75 Ha)

DESCRIPTION.—Two slightly curved fragments (Nos. 1, 2) and an almost straight one (No. 3) are the best preserved specimens; the degree of increase in the height and width of their whorls can be seen from the above measurements. All seem to be septate up to their anterior ends.

The section is elliptical, only slightly compressed. From four to five blunt, though distinct ribs, about as wide as the intercostals, can be counted on a length equal to the whorl height. They are somewhat projected ventrally, running obliquely across the sides; they cross the venter in a straight line which is, however, seen to rise a little from the left to the right

DESCRIPTION.—Five straight, apparently septate fragments are referred to this variety. The measurements of the largest one are given above; the others are considerably shorter.

All agree in section with the typical form, but they deviate by their radial or but slightly oblique ribbing which is a little less dense (four ribs on the length of H) and "rather feeble all round the whorl." Also the rate of increase in thickness of the shaft is slower than in the typical form, as seen by comparison of the ratio Ha:Hp in specimen No. 3 of the latter with that of the measured specimen of this variety, both fragments being about equally long. Also a comparison of figs. a, b, d, e, f, m, n and

Spec. No.	L	Hp	Wp	Ha	Wa
		DIMENSIONS			
1	16 mm.	2.7 mm.	2.2 mm. (=0.8 Hp)	3 mm.	2.4 mm. (=0.8 Ha)

o of Spath's (1941) text fig. 228 with figs. i, j and l clearly shows this difference.

No suture lines could be traced.

REMARKS (AD *H. tenuis*, SENSU LATO).—This truly delicate species, which has been refused the status of an independent species by d'Orbigny (1842, p. 533, synonymy of *H. attenuatus*) and most subsequent authors, has only recently been revived by Spath. It is well recognizable at Hanha, both in its typical form and in its needle-like variety; the differences between both have been discussed explicitly above.

This species can be readily distinguished from both the typical *H. compressus* and its variety *gracilis* by its smaller size, its less compressed section and its weaker and less dense costation. For its distinction from other related forms, particularly from the variety *recta* of *H. maximus*, reference may be made to Spath (1941, pp. 629, 630).

Its remarkable delicacy makes unnecessary any further comparisons with the other forms of this collection as well as with previously known ones. Among the latter an exception may be made for the tiny fragment from the Vraconnian of Mexico described and figured by Böse (1923, p. 132, Pl. IX, figs. 47–49) under the name of *H.* aff. *intermedius* Sowerby, which is, it is true, rather poorly preserved but might be referable to the present species.

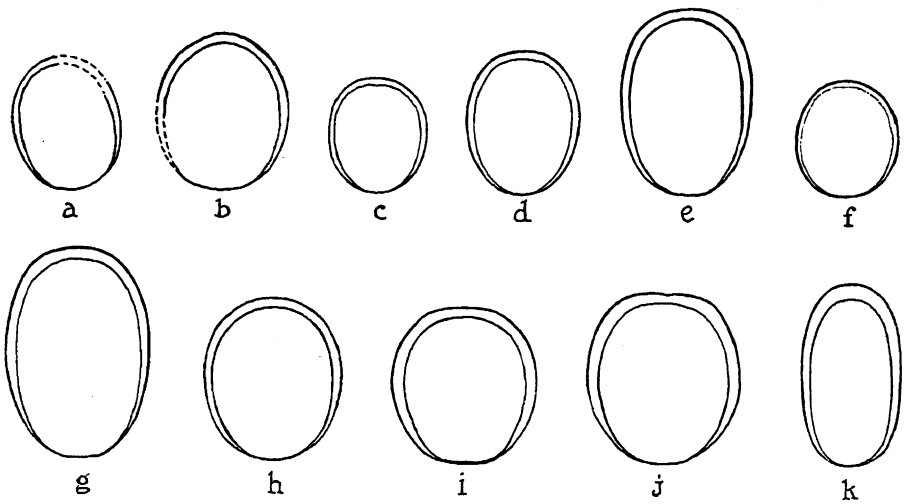

Fig. 26. Costal and intercostal sections of *Hamites*.

(a, b) *H. compressus* Sowerby, var. *gracilis* Spath, A.M.N.H. No. 25400:1, (a) near posterior, (b) near anterior end, both × 3; showing twisted coiling.
(c–e) *H. tenuis* Sowerby, A.M.N.H. Nos. 25401:1, 2, 3, at anterior ends, all × 3.
(f) *H. tenuis* Sowerby, var. *subacuaria* Spath, A.M.N.H. No. 25402:1, near anterior end, × 5.
(g) *H. virgulatus* (Brongniart?), Pictet and Campiche, A.M.N.H. No. 25403:1, near anterior end, × 5.
(h) *H. subvirgulatus* Spath?, A.M.N.H. No. 25404, at posterior end, × 3.
(i, j) *H. venetzianus* Pictet, A.M.N.H. No. 25405:2, at both ends, × 5.
(k) *H.* (?) cf. *nokonis* Adkins and Winton, A.M.N.H. No. 25407, at anterior end, × 2.

Hamites virgulatus (Brongniart?) Pictet and Campiche

Pl. XLIII, figs. 9, 10; Pl. XLIV, fig. 4; text fig. 26g

A. M. N. H. No. 25403: five specimens

Hamites virgulatus BRONGNIART, 1822, Pl. O, fig. 6.

Hamites virgulatus Brongniart; PICTET AND ROUX, 1847, p. 391, *pro parte*, *non* Pl. XIV, figs. 7–10.

Hamites virgulatus Brongniart; PICTET AND

CAMPICHE, 1861, p. 85, *pro parte*, Pl. LIV, figs. 6, 7 only.

Hamites virgulatus Brongniart; MEUNIER, 1888, p. 62, Pl. I, fig. 4.

Hamites virgulatus Brongniart; CHOFFAT, 1888, p. 71.

Hamites virgulatus Brongniart; CHOFFAT, 1905, p. 39.

Torneutoceras virgulatum, Brongniart; SPATH, 1922, p. 148.

Torneutoceras virgulatum (Brongn.); HAUGHTON, 1924, p. 94.

Hamites (Stomohamites) virgulatus (Brongniart?) Pictet and Campiche; SPATH, 1941, p. 635, *cum synon.*, text fig. 230, Pl. LXXI, figs. 7–10; Pl. LXXII, fig. 11.

narrower than the first; as this suture line is slightly dissymmetrical, this lobe is shown on both sides: on the right it might be called subtrifid, on the left it is irregularly bifid; here also the terminal points seem to be three-pronged. The lateral saddle is considerably higher than the external one; both are subdivided by deep lobules; that of the lateral saddle attains almost half its height in depth and is trifid; the inner stem of this saddle is higher than the outer one. The internal saddles, which

DIMENSIONS

Spec. No.	L	Hp	Wp	Ha	Wa
1	10.6 mm.	4.6 mm.	?	5.0 mm.	4.5 mm. (=0.9 Ha)
2	15.0 mm.	3.9 mm.	3.1 mm. (=0.8 Hp)	4.4 mm.	3.4 mm. (=0.77 Ha)

DESCRIPTION.—Most typical of this species seem to be a straight fragment (No. 1), which is septate throughout, and a much shorter and smaller one (No. 5). The section is but slightly compressed in the former (Wa = 0.9 Ha; text fig. 26g), a little more in the latter (Wa = 0.8 Ha). In both fragments the ribs are comparatively sharp and rather distant from each other, straight, moderately oblique, being projected ventrally, and effaced on the dorsum. On the length of the dorsal-ventral diameter five costae can be counted in specimen No. 1 and four in No. 5.

Although this index does not exceed five in the longest fragment (No. 2), its ribs appear to be a little more closely spaced than in No. 1, which is apparently due to its being part of a thinner shaft. The degree of compression is here the same as in specimen No. 5 (W = 0.8 H). The two remaining fragments (Nos. 3, 4) most closely resemble No. 2; owing to their smaller size, only four ribs can here be counted on a length equal to H.

Although isolated prongs and leaflets can be traced in fragments Nos. 3 and 4, only specimen No. 1 exhibits a suture line worthy of detailed description and delineation (Pl. XLIV, fig. 4). The siphonal lobe is unfortunately missing; the first lateral lobe is broad and almost symmetrically bifid; both its branches are subdivided into two three-pronged terminal points. The second lateral lobe is but a little shorter and equal the external ones in height, are also bifid: they embrace a distinctly trifid anti-siphonal lobe which is about half as deep as the second lateral one.

REMARKS.—Except for the much less pronounced bifidity and symmetry of the second lateral lobes and for the relative heights of the main saddles, this suture line agrees in its general plan fairly well with that seen in Pictet and Campiche's fig. 6d (= Spath's, 1941, text fig. 230g) and to be considered, according to Spath (1941, p. 637), as that of the type of this species; particularly the first lateral lobes and the anti-siphonal ones with the adjacent saddles agree very well in both specimens. Since the other specific characters of *H. virgulatus*, recently pointed out by Spath, also are present in the specimens here discussed, the writer does not hesitate to refer them to this species.

Within the present collection they very much resemble those referred to the typical *H. compressus*, which are, however, readily distinguishable by their more compressed section and their more numerous ribs, projected dorsally instead of ventrally. The variety *gracilis* of *H. compressus* differs particularly by its dense, slightly flexuous costation. The present form is most closely related to *H. subvirgulatus* and *H. venetzianus;* with both these species as well as with *H. duplicatus* it will be compared below.

Hamites subvirgulatus Spath?

Pl. XLIII, figs. 11a–d; text fig. 26h

A. M. N. H. No. 25404: one specimen

?*Hamites (Stomohamites) subvirgulatus* SPATH, 1941, p. 645, text fig. 234.

DESCRIPTION.—The single specimen had to be recovered bit by bit from the matrix, but eventually it could be restored fairly well. It is a comparatively long, gently curved fragment which seems to be septate throughout.

The section (text fig. 26h) is elliptic, slightly flattened ventrally; its width attains about four-fifths of its height. The costation is comparatively dense; five ribs can be counted on a length equal to the dorsal-ventral diameter in the posterior part of the fragment and six in the anterior one. The costae are about as broad as the intercostals and are distinct, though not particularly sharp. They are absent on a comparatively broad area of the dorsum which is decidedly smooth. They run in a straight line or in a very flat, orad convex arc across the sides and are markedly projected dorsally, the degree of this obliqueness gradually decreasing orad. Whereas in the posterior third of the fragment they cross the venter in a slightly orad concave sinus without losing anything of their distinctness, they later become, almost regularly, effaced on the venter as well as on the dorsum. On the right side only of the foremost part of the fragment two ribs can be seen to join before disappearing ventrally; however, in this part of the specimen the ornamentation seems to have been disturbed by some lesion of the shell, as may also be inferred from a peculiar scar along the median line of the periphery.

Sutural elements can be traced here and there, but no continuous suture lines can be found.

REMARKS.—In most of its characters, particularly in the vanishing of the ribs also on the venter, this fragment agrees well with Spath's description and figures of *H. subvirgulatus;* but whereas he states the ribbing of his specimens to be "straight or very slightly oblique," and his figures show it to be prorsiradiate, it is decidedly rursiradiate in the present form. Although the sense of obliqueness often varies within the species and changes on even one and the same conch, particularly on and next to its curved portions, it was thought best to refer this specimen only doubtfully to Spath's new species.

According to its author the latter differs from *H. simplex* d'Orbigny (1842, p. 550, Pl. CXXXIV, figs. 12–15) by the direction of the ribs, by their sharpness and by their being only slightly attenuated on the dorsal area.[1] The first distinctive character does not hold true for the form under discussion, in which the costae are rursiradiate, as they are in d'Orbigny's fig. 12, but the others do; the present specimen is, therefore, thought to be distinct from *H. simplex.*

Within the present collection it appears to be most closely related in its general habitus to *H. virgulatus*, from which it can, however, readily be distinguished by its more closely spaced and slightly broader ribs, which are oblique in the opposite direction as in Brongniart's species and tend to vanish also on the venter. *H. venetzianus* and *H. duplicatus* will be compared below.

DIMENSIONS

L	Hp	Wp	Ha	Wa
34 mm.	7.2 mm.	6 mm. (=0.82 Hp)	8.7 mm.	7 mm. (=0.8 Ha)

Hamites venetzianus Pictet

Pl. XLIII, figs. 12–15; Pl. XLIV, fig. 5; text figs. 26i, j

A. M. N. H. No. 25405: eleven specimens

Hamites venetzianus Pictet; PICTET AND ROUX, 1847, p. 390, Pl. XIV, fig. 6.

Hamites venetzianus Pictet; PICTET AND CAMPICHE, 1861, p. 98.

Hamites Venetzi Pictet; COLLIGNON, 1932a, p. 23, text fig. 30, Pl. IV, fig. 16.

Hamites venetzianus Pictet; SPATH, 1941, p. 638, *cum synon.*, text fig. 231, Pl. LXXI, figs. 11–13.

DESCRIPTION.—A graceful, perfectly straight, septate fragment of a cast is by far the best preserved specimen (No. 2); its section (text figs. 26i, j) is but slightly

[1] Best visible in d'Orbigny's dorsal view, fig. 15.

higher than wide and a little flattened ventrally. The costal section exhibits even a little notch in the middle of the ventral area; thus in oblique illumination a hardly perceptible groove appears along the siphonal line (cf. Spath, 1941, p. 646, in description of *H. subvirgulatus*). There are three and one-half ribs to a length equal to the whorl height; they are moderately projected ventrally and slightly wider than the intercostals. They are not sharp but are very distinct, broadest on the venter, which they cross in a straight line and where they show the median notch mentioned above. They run in an oblique, almost imperceptibly sinuous line across the sides and vanish before reaching the dorsum which remains smooth. Except for the last character and for its ribs being a little blunter, the specimen under examination most closely resembles in the ventral and lateral aspects of its costation Spath's (1941) Cambridge Greensand fragment figured in his text figs. 231h–k. Five tiny fragments (Nos. 1, 3–5, 11) agree fairly well with No. 2.

DIMENSIONS

Spec. No.	L	Hp	Wp	Ha	Wa
1	6.2 mm.	?	?	2.9 mm.	2.4 mm. (=0.83 Ha)
2	11.9 mm.	3.7 mm.	3.2 mm. (=0.87 Hp)	3.8 mm.	3.3 mm. (=0.87 Ha)
6	18.3 mm.	6.2 mm.	5.7 mm. (=0.91 Hp)	?	?
7	15.0 mm.	5.8 mm.	4.8 mm. (=0.83 Hp)	?	?

There are five more straight, or almost straight, fragments of somewhat larger specimens (Nos. 6–10). They agree on the whole with that described above; in four of them (Nos. 6, 7, 9, 10) the costation is slightly denser (from four to four and one-half ribs on the length of the larger diameter) and perhaps a trifle less oblique. In one fragment (No. 8) the ribbing is horizontal and perfectly straight, as in Pictet's type, and of the same density as in No. 2.[1] Preservation permitting, the flattening of the venter can be seen also in these fragments of thicker shafts.

In specimen No. 2 the best suture lines shown by any *Hamites* of the present collection can be studied all around the whorl (Pl. XLIV, fig. 5), though they are here and there a little coarsened by corrosion. The tiny fragment No. 3, limited by a septum at either end, shows the same sutural characters as No. 2. In the latter, there is a rather broad siphonal lobe subdivided by a triangular, crenulated, median knob into two main points, both of which are two-pronged. The external saddles are sturdy and intersected in their uppermost fourth by rather broad lobules which seem to be three-pronged; both their stems are about equally high, but the outer ones are a little wider than the inner ones. The first lateral lobes are only a little deeper than the siphonal one and on their turn are almost symmetrically bifid; both their main branches, separated from each other by a low knob, are bifid; some of the terminal points are distinctly three-pronged. The lateral saddles are but slightly lower but are markedly narrower than the external ones, and also bifid. The second lateral lobes are about as deep as the first, decidedly trifid and are slightly oblique ventrally; some of their terminal points can be recognized to be three-pronged. There follow rather broad, bifid, internal saddles, which attain only about two-thirds of the height of the lateral ones, and between them the distinctly three-pronged antisiphonal lobe, which is considerably smaller and shorter than the siphonal one. As seen in the drawing, this suture line exhibits, as do almost all those of this genus, minor dissymmetries which are, however, so slight that they could be neglected in the above description.

This suture line agrees, except for its stouter external saddles, fairly well with that of Pictet's (1847) fig. 6e (reproduced in Spath's, 1941, text fig. 231e), corresponding to a diameter about twice as great as that of the present specimen.

[1] The appearance in fig. 15, suggesting that some of the ribs continue across the dorsum of this fragment, seems to be deceptive and due merely to the presence of some ridges of matrix which could not entirely be removed in the course of preparation.

REMARKS.—In their survey of the various species of *Hamites* Pictet and Campiche (1862, p. 98) stated this species to be "très voisine du *virgulatus*, caracterisée par des côtes plus obtuses et par le lobe latéral inférieur plus oblique." The latter difference cannot well be verified in the present material, as the second lateral lobe might be considered even more oblique in my suture line of *H. virgulatus* (Pl. XLIV, fig. 4) than in that of the present species (Pl. XLIV, fig. 5). The first difference, however, is well shown in the Angola examples of both species, as is the greater width of the costae of *H. venetzianus*, which exceeds that of the intercostals, and their being a little more widely spaced; both these differences from *H. virgulatus* were emphasized by Pictet in his earlier paper (1847, pp. 390, 392), but were thought to be of minor serviceableness by Spath (1941, p. 638). In the writer's opinion, however, they can well be utilized for the separation of these two closely allied species.

As to the synonymy of *H. venetzianus*, the writer agrees with Spath in questioning the conspecificity of Böse's (1923, p. 134, Pl. XIX, figs. 50–53) specimens from the Mexican Vraconnian, but he has no doubt about that of Collignon's (*loc. cit. in synon.*) Madagascar example, whose ventral view (fig. 16a) shows quite distinctly the faint median notch of the ribs. It is true that the suture line depicted in Collignon's text fig. 30 deviates from both Pictet's and my own drawings by the presence of an auxiliary lobe and by the small size of the anti-siphonal one, but these differences may be merely individual ones.

In addition to *H. virgulatus* compared above, the following forms of the present collection may require comparison with *H. venetzianus: H. compressus* and its variety *gracilis*, from both of which the former differs by being less compressed and by its less dense ribbing which is, if at all, oblique in the opposite sense; and *H. subvirgulatus* ?, which is readily distinguishable by its narrower and more closely spaced rursiradiate ribs which tend to vanish on the venter, whereas those of the present species are just slightly notched along the siphonal line, but remain, nevertheless, distinct also across the periphery. *H. duplicatus* will be compared below.

Hamites duplicatus Pictet and Campiche

Pl. XLIII, figs. 16–19; Pl. XLIV, fig. 6

A. M. N. H. No. 25406: eight specimens

Hamites virgulatus Brongniart; PICTET AND ROUX, 1847, p. 391, *pro parte*, Pl. XIV, figs. 7, 9, 8?, *non* 10.

Hamites duplicatus PICTET AND CAMPICHE, 1861, pp. 87, 98.

Hamites virgulatus Brongniart; PICTET, 1872, p. 35, Pl. LVI, fig. 4.

Hamites (*Stomohamites*) *duplicatus* Pictet and Campiche; SPATH, 1941, p. 640, *cum synon.*, text fig. 232, Pl. LXXII, figs. 12–16.

DIMENSIONS

Spec. No.	L	Hp	Wp	Ha	Wa
1	11.3 mm.	?	?	6.1 mm.	5.7 mm. (=0.93 Ha)

DESCRIPTION.—This species is represented at Hanha only by more or less scanty fragments, all of which are straight or almost straight; however, its distinctive features could clearly be recognized.

The section of the only measured fragment (No. 1) is but slightly compressed, the width of the whorl attaining 93 per cent of its height. The otherwise poorly preserved fragment No. 4 (Pl. XLIII, fig. 19) exhibits at its anterior end what must be considered the two apertural "collars, separated by a deep constriction," seen in Pictet and Roux's figs. 9a, b (reproduced by Pictet, 1872, Pl. LVI, fig. 4, and by Spath, 1941, text figs. 232c, d) and mentioned by Spath among the specific characters. On the other hand, a deep furrow between two ribs near the anterior end of another fragment (No. 5) cannot be homologous to this constriction, as this fragment is septate throughout.

The costation is but slightly oblique (projected ventrally), fine, and considerably denser than in the other species of this group represented at Hanha. In all fragments examined seven ribs can be counted on the length of the whorl height. Only in two of them (Nos. 2 and 3, Pl. XLIII,

figs. 17 and 18) can the duplication of the ribs on the dorsum be observed. In the former the duplicated ribs are very much weaker than the primary ones and perceptible only in oblique illumination, whereas in the latter the contrast between both kinds of ribs is less marked; here seven duplicated ribs can be counted on the dorsum on a length equal to half the height of the whorl, exactly corresponding to the above ratio for the primary ribs.

The remaining fragments (Nos. 6–8) agree in ornamentation so well with the one or the other of those hitherto discussed that there cannot be any doubt concerning their conspecificity.

In specimen No. 1 the suture line could be studied (Pl. XLIV, fig. 6). The siphonal lobe is subdivided by a tall, richly indented median leaf into two but slightly diverging terminal points which are each followed orad by three lateral ones. The external saddles are tall and comparatively slender; they are intersected by a deep, rather narrow, trifid lobule up to almost half their height; the inner main stems are broader than the outer ones and slightly inclined dorsad; all the main stems are, on their turn, subdivided by three-pronged lobules. The first lateral lobe is only a little deeper than the siphonal one, remarkably broad and asymmetrically subdivided by a tall, slightly oblique leaf into two main branches, each of which is bifid; the outer one is a little deeper and broader than the inner one. The lateral saddle almost equals the external one in height; it is inclined ventrad and also halved in its upper part by a deep, narrow, three-pronged lobule; its inner stem is a little wider than the outer one. The second lateral lobe attains not quite two-thirds of the length of the first and is broad and almost symmetrically trifid. Two slender, bifid, internal saddles, which are as high as the lateral ones, flank the very short, broad, trifid, anti-siphonal lobe. This suture line differs from the incomplete one of a Cambridge Greensand example figured by Spath (1941, text fig. 232e), which is, as far as the writer knows, the only one ever depicted of this species, merely by its higher median knob and by the deeper lobules of the main saddles; the more advanced ontogenetic stage may account for its higher degree of elaboration.

REMARKS.—The synonymy of this species and its relations to others, especially to *H. charpentieri* Pictet (1847, p. 387, Pl. XIV, figs. 2–4; Spath, 1941, p. 642, *cum synon.*, text fig. 233, Pl. LXXII, figs. 17–22) have recently been discussed by Spath.

Within the present collection it can readily be distinguished from the other species of the *virgulatus*-group discussed above, *H. virgulatus*, *H. subvirgulatus* and *H. venetzianus*, by its finer and denser costation, duplicating itself on the dorsum. The only other *Hamites* represented at Hanha, whose ribbing is nearly as dense as that of *H. duplicatus*, *H. compressus*, var. *gracilis*, has a much more compressed section and more distant ribs which occasionally become slightly sigmoidal and projected, if at all, dorsally instead of ventrally; the same distinctive characters hold true also for comparison of the present species with the typical *H. compressus* which is, moreover, less densely ribbed.

Hamites (?) cf. **nokonis** Adkins and Winton

Pl. XLIII, figs. 20a, b; text fig. 26k

A. M. N. H. No. 25407: one specimen

Cf. *Hamites nokonis* ADKINS AND WINTON, 1919, p. 39, Pl. VI, figs. 5, 6.

Hamites nokonis Adkins and Winton; ADKINS, 1928, p. 208, Pl. XII, fig. 2.

DIMENSIONS

L	Hp	Wp	Ha	Wa
25.3 mm.	11.3 mm.	5.8 mm. (=0.51 Hp)	12.3 mm.	6.3 mm. (=0.51 Ha)

DESCRIPTION.—The slightly curved, somewhat crushed fragment has a strongly compressed, elliptical section (text fig. 26k); it is septate throughout. Its ornamentation consists on either side of eleven ribs; only one of them is markedly weaker than the others, so as to look like an intercalated secondary rib. Five ribs can be counted on a length corresponding to the whorl height. All these ribs run all around

the whorl, but they are strongest and broadest on the venter, weakest and narrowest on the dorsum where they can be perceived in oblique illumination only. They are, as a rule, twice as broad as the intercostals. They cross the venter in a straight, but slightly oblique line. This obliqueness as well as the difference in the course of the costae on both sides of the whorl may, however, be due to crushing. Whereas on the left side they are almost straight and radial or but slightly prorsiradiate, on the right they form, particularly in the anterior part of the fragment, a shallow, orad convex arc and become more and more decidedly prorsiradiate orad. No lateral tubercles are present, nor can any tubercles be seen on the venter which is, it is true, somewhat corroded.

No continuous suture lines could be traced.

REMARKS.—The absence of tubercles pleads for the reference of this fragment to the genus *Hamites*, but the writer could find only one closely comparable representative of this genus in literature. *H. nokonis* from the basal Duck Creek, Upper Albian, of Texas is similarly, though somewhat less (W = 0.59 H) compressed and its ribs, though slightly less numerous, are also twice as broad as the intercostals and slightly flexuous. Their course is not quite the same as in the Angola fragment, but it is well known that such details of ornamentation quickly change in the course of development. Both "strongly compressed species of untuberculate *Hamites* in the Lower Gault" (Spath, 1941, p. 618) of England, *H. compressus* J. Sowerby (see above, p. 175) and *H. incurvatus* Brown (Spath, 1941, p. 619, *cum synon.*, text fig. 223, Pl. LXVIII, figs. 18, 19) are not compressed to the same degree as the present form and have much sharper and narrower, straight ribs. In the variety *gracilis* of *H. compressus*, some fine examples of which have been described above (p. 175), the ribs also become sometimes slightly flexuous, but also this variety is readily distinguishable by its much denser and finer costation, and it is also far less compressed. By the latter difference also the Upper Albian *H. virgulatus* (p. 178) can be distinguished from the form under examination; it has also much narrower and sharper straight ribs.

However, even the generic assignment of this fragment can be but a tentative one, for it also resembles to a certain extent some forms of *Idiohamites*, in which the tubercles become indistinct or even disappear, e.g., the large specimens of *I. turgidus* (J. Sowerby), aff. var. *robusta*, depicted in Spath's (1941) figs. 7 and 8 of Pl. LXVI, show on their inner shafts a similar habitus of costation; it must, however, be kept in mind that the variety *robusta* is stated by Spath (1941, p. 588, text figs. 209h, i, Pl. LXV, fig. 5) to have a more rounded whorl section than the compressed typical form of *I. turgidus*. There is also some superficial resemblance in ornamentation between the present fragment and that of *I. subspiniger* Spath (see below, p. 197) figured in that author's (1941) text fig. 208a, but the ribs of the latter are rursiradiate not prorsiradiate as in the former, and exhibit distinct, both lateral and ventral tubercles; also the section of *I. subspiniger* decidedly tapers ventrad, whereas that of the present fragment is plainly elliptic.

PTYCHOCERAS D'ORBIGNY,[1]

The single representative of this genus in the Vernay Collection undoubtedly belongs to the group of *P. gaultinum* Pictet (1847, p. 395, Pl. XV, figs. 5, 6); according to Spath (1925b, p. 189) it would, therefore, have to be referred to his genus *Hemiptychoceras*. The writer, however, agrees with Roman (1938, p. 49) in not acknowledging *Hemiptychoceras* as an independent genus; the differences between *P. gaultinum* and the genotype of *Ptychoceras*, *P. emericianum* d'Orbigny (1840–1842, p. 555, Pl. CXXXVII, figs. 1–4) do not seem sufficient to justify generic separation. Spath mentions as a difference merely the sharpness of the ribs in "*Hemiptychoceras*," but also those of *P. emericianum* cannot be called blunt, as seen in d'Orbigny's side view (Pl. CXXXVII, fig. 1).

In the revision of the Hamitidae attempted in his Gault Monograph Spath

[1] 1840–1842, p. 554.

(1939, p. 605) mentions *Ptychoceras* in quotation marks; from this and from his (1941, p. 656) reference to *"Hamites (Ptychoceras)" glaber* Whiteaves it must be inferred that he now prefers to include *Ptychoceras* as a subgenus in *Hamites, sensu lato*. For the purpose of this paper, however, it seemed advisable to maintain this genus in d'Orbigny's circumscription.

Ptychoceras fauncei,[1] new species

Pl. XLV, figs. 2a–c; text figs. 27a, b

A. M. N. H. No. 25409: one specimen

DIMENSIONS OF HOLOTYPE

	L	Hp	Wp	Ha	Wa
(a) thinner shaft:	10.0 mm.	?	?	ca. 3.5 mm.	4.5 mm. (=1.29 Ha)
(b) thicker shaft:	21.8 mm.	4.3 mm.	5.7 mm. (=1.32 Hp)	?	?

Maximum distance between venters of both shafts: 9 mm.

DESCRIPTION.—The only specimen (holotype) is septate throughout and consists of a shorter apicad shaft and a much longer orad one, both of which are connected by a semicircular hook allowing for an eye-like empty space. To this "eye" correspond outer curvatures of both shafts, particularly of the thicker one; thus the specimen assumes a somewhat crosier-like shape. The shorter shaft slightly tapers apicad, but it is far from complete.

The section (text figs. 27a, b) is in both shafts wider than high, slightly more so in the thicker one than in the thinner one and shows in both of them a slight concavity dorsally which is, however, not due to any contact with the other shaft, as both sections are taken from their free parts. Immediately apicad of the vertex of the hook a shallow contriction is visible on the ventral side of the whorl.

The ornamentation consists of transverse ribs which are stronger on the thicker shaft than on the thinner one and almost entirely disappear on the hook. There are ten costae on the ribbed part of the thinner shaft, which is 7 mm. long, and seventeen on the thicker one, on a length of 17 mm. On a length corresponding to the dorsal-ventral diameter six ribs can be counted on the thinner shaft and five on the thicker one. On the venter, which they cross in a straight line, the costae are about as broad as the intercostals; the dorsum seems to be smooth also in the straight parts of the conch.

Isolated prongs and leaflets can be traced throughout the holotype but no continuous suture line worthy of description or delineation; on the other hand, further etching might delete the ornamentation of the single specimen.

REMARKS.—The presence of a distinct costation also on the thinner shaft refers this form to the group of *P. gaultinum* Pictet (= *Hemiptychoceras* Spath). It differs, however, from Pictet's species and from all the others of this group by the above mentioned "eye" and by the corresponding outer curvature of the hook, which is not strictly U-shaped as in most of the *Ptychoceras*. The only species of this genus showing a similar "eye" seems to be *P. pseudo-gaultinum* Yokoyama (1890, p. 181, Pl. xx, figs. 1–3) from Japan, but the outer curvature of its hook is nevertheless U-shaped; moreover, the Japanese form can easily be distinguished from the present one by its strictly circular, not depressed whorl section, by its less dense and less regular costation and by the obliqueness of its ribs on the thinner shaft. From Pictet's type of *P. gaultinum* from the Grès Verts of the Saxonet and the Perte du Rhône the present form deviates not only by its "eye," but also by being much smaller, by its depressed whorl section and by the nearly uniform strength of the ribbing on both limbs. Both forms agree, on the other hand, in the attenuation of the costation on the hook, whereas in *P. tropicum* Kossmat (1895, p. 150, = *P. gaultinum in* Stoliczka, 1865, p. 195, Pl. xc, fig. 10) from the Ootatoor Group of India the ribbing persists unweakened across the hook. The

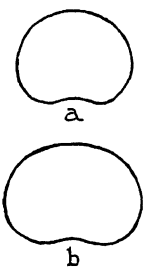

Fig. 27. Sections of *Ptychoceras fauncei*, new species, holotype, A.M.N.H. No. 25409, (a) between thinner shaft and hook, (b) in posterior part of thicker shaft, both × 3.

[1] Named in honor of Mr. Wayne M. Faunce, Vice-Director, The American Museum of Natural History.

small form from Madagascar referred to *P. gaultinum* by Boule, Lemoine and Thevenin (1907, p. 56, Pl. XIII, figs. 1, 1a) rather resembles *P. fauncei* in costation, but it differs, as do almost all the forms compared, by the fact that the inner sides of both its shafts are strictly parallel and close to each other, thus causing the conch to be U-shaped. Collignon (1929, p. 56, Pl. VII, figs. 6, 7) believes his *Hamites* (*Ptychoceras*) cf. *gaultinum* from the same locality to be closely related to Pictet's species or to *P. pseudo-gaultinum;* this can, however, be checked neither from his description nor from his figures, and, for the same reasons, his fragment cannot well be compared with the present form.

Whether or not the only *Ptychoceras* hitherto recorded from the Albian of Angola, Spath's (1922, p. 150) "? *Ptychoceras gaultinum*, Pictet," is conspecific with the former cannot reliably be decided for lack of illustrations. Spath mentions that the "coarsely ornamented thicker and terminal straight arm is missing," but from his precise description of both the inner and outer curvatures it must be inferred that his fragment lacks the "eye" distinctive of *P. fauncei.*

HAMITOIDES SPATH

Since Spath (1925b, p. 191) established this genus for the forms described and figured by Pictet (1847, p. 393, Pl. XV, figs. 1–4) from the Perte du Rhône and the Saxonet under the name *Hamites studerianus*, simultaneously splitting them into three different species, *H. studerianus* (*sensu stricto*), *H. flexicostatus* and *H. compressus*, few more forms have been referred to this group, most of them only doubtfully, *Hamites* aff. *studerianus* from the glauconitic limestone of the Polish Tatra by Passendorfer (1930, p. 664); *Hamites studeri* by Collignon (1932a, p. 22, Pl. IV, figs. 11–13), *H. madagascariensis* Breistroffer by that author (*in* Besairie, 1936, p. 174, text fig. 10i, Pl. XX, figs. 6–9), and another specimen figured, though not described, in the same paper (Pl. XVII, fig. 8), all three from the Albian of Madagascar; *Hamites studeri* from the Upper Albian of Zululand by Venzo (1936, p. 111, ? Pl. IX, fig. 8); finally, *H.* (?) *rusticus* Spath and five doubtful fragments, all of them from the English Gault, by Spath (1939, pp. 602, 603; 1941, Pl. LXV, fig. 7, Pl. LXVI, figs. 2–5).[1]

In discussing this genus it must, therefore, be kept in mind that it includes only a few forms some of which (e.g., *H. flexicostatus* Spath, *H. compressus* Spath, *H.* [?] *rusticus* Spath and the new species described below) are based on a single specimen each. However, this group seems to be clearly characterized by some distinctive features of its ornamentation, particularly by the bi- or even trifurcation of the ribs near and on the venter, although this character is frequently restricted to a comparatively small zone of the conch, especially on and near the hook. It may be added that no two of the figured specimens referred to this group really agree in ornamentation and that almost all of them have been made separate species on account of these differences, which are often but slight ones. Whether or not such splitting of species is really justified remains to be seen from future studies of a more complete material.

Spath's generic diagnosis seems to require emendation in that the dorsum is not really smooth either in his genolectotype, according to Pictet's original description,[2] or in the Madagascar forms studied by Breistroffer, or in the only representative of this genus in the Albian of Angola, described below.

As to the family relationship of this genus, Spath (1925b, p. 191; 1939, pp. 600–601) includes it in his family Labeceratidae, as it shows some analogy in ornamentation with *Labeceras* (Whitehouse MS.) Spath. However, the latter genus as well as the closely related *Myloceras* (Whitehouse MS.) Spath (1925b, p. 192) never seems to develop two decidedly straight, parallel shafts connected by a hook as does *Hamitoides*. Although Spath is certainly right in pointing out that the mode of coiling should not be overrated taxonomically in the "aberrant" ammonites but be considered merely one among several

[1] For some more references from Switzerland and Savoy see Breistroffer (*in* Besairie, 1936, pp. 174, 175).

[2] "Dans le moule ces côtes disparaissent sur le ventre, mais lorsque le test existe, elles s'y subdivisent aussi en des lignes minces . . ."

distinctive features, the above character seems to me to be sufficiently important to leave the present genus with the Hamitidae. On the other hand, there cannot be any doubt about its being transitional between this family and the "Labeceratidae" and "Myloceratidae" (Spath, 1939, p. 601, footnote 1).

Hamitoides angolanus, new species

Pl. XLV, figs. 3a–e; text figs. 28a, b

A. M. N. H. No. 25410: one specimen

?*Hamites Studeri* Pictet; COLLIGNON, 1932a, p. 22, Pl. IV, figs. 10–13.

?*Labeceras plasticum* Spath; VENZO, 1936, p. 114, Pl. IX, fig. 8.

DIMENSIONS OF HOLOTYPE

	L	Hp	Wp	H	W
(a) thinner shaft: ca. 20 mm.[1]		11 mm.	11.2 mm. (=1.02 Hp)		
(b) thicker shaft: ca. 40 mm.[1]				12.5 mm.	11.1 mm. (=0.89 H

Distance between venters of both shafts: ca. 34 mm.

DESCRIPTION.—The single specimen (holotype) consists of a shorter and thinner shaft preceding the hook and a longer and thicker one which follows it, thus forming an incomplete U. It is septate throughout and partly crushed and damaged.

The section (text figs. 28a, b) is almost quadratic, flattest on the dorsum, hardly vaulted on the sides and flatly rounded on the venter. It attains its maximum width slightly below the middle of the sides; as a rule, the height slightly exceeds the width, but in exceptional cases (see table of dimensions) the latter may equal, or even surpass, the former.

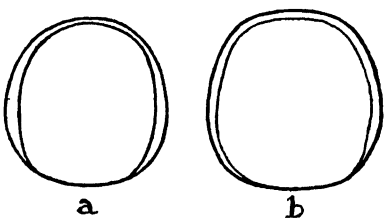

Fig. 28. Sections of *Hamitoides angolanus*, new species, holotype, A.M.N.H. No. 25410, (a) between thinner shaft and hook, (b) of thicker shaft, both × 2.

Strong ribs arise at the latero-dorsal edge; they crowd together on and near the hook but are less closely spaced on the straight shafts; their distance from each other, measured at about the first third of the sides, varies from 1.5 mm. in some parts of the hook up to 5.4 mm. on the longer shaft. These ribs are decidedly prorsiradiate on the preserved part of the thinner shaft, more or less radial on the hook, and, to a gradually decreasing degree, rursiradiate on the thicker shaft, becoming almost horizontal near its anterior end. Altogether twenty-one of these primary ribs can be counted. Except in the anterior part of the longer limb, there are from one to three secondary ribs on the outer zone of the sides in the intervals between the primary ones, originating either by bifurcation of the latter or by independent intercalation. Thus twenty-two ribs along the periphery of the hook correspond to only nine of them on the inner half of its sides. On the venter, which they cross in a straight line, all the ribs become uniform. The zone of intercalation of secondary ribs is gradually shifted dorsad, until, in the anterior two-thirds of the thicker shaft, secondary ribs as well as primary ones begin at the latero-dorsal edges; simultaneously the difference in strength between both kinds of ribs decreases also on the sides. At first glance the dorsum seems to be smooth; careful examination, however, proves that the primary ribs continue, though much attenuated, across the dorsum in a very flat, orad convex arc. As seen best in the mold (fig. 3d), they are, in the median part of the dorsum, hardly stronger than the fine striae of growth (or secondary ribs), which are intercalated, at a rate of from one to three, between, and run parallel to them. This refers to the hook and the adjacent part of the shorter shaft; on the longer one, however, the primary ribs remain prominent in the middle of the dorsum (fig. 3e). Occasionally about four fine thread-like striae can be observed between two ribs on the venter. Before bifurcating, the primary ribs swell, as a rule, at about the middle or later at the first third of the sides, but to the writer it would seem an exaggeration to call these swellings radially elongated tubercles.

At the anterior end of the longer limb two ribs are separated from each other by a narrow and exceptionally deep intercostal which may be caused by a constriction of the whorl.

Although prongs and leaflets can be recognized here and there, no continuous suture lines could be traced; thus the present paper can make no contribution toward our knowledge of the sutural characters of this genus, the incompleteness of which has been deplored by all its students.

REMARKS.—As pointed out above, the distinction of several species among the various forms referred or referable to this genus is based chiefly on differences in ornamentation. The same is also true of

[1] Not including parts connecting with hook.

the writer's motive for giving a new specific name to the present form. Among the four examples originally figured by Pictet and Roux (1847, p. 393, Pl. XV, figs. 1–4) under the name of *Hamites studerianus*, Spath's lectotype (fig. 2) most resembles the Angola specimen, but it differs from it by the more regular bi- and trifurcation of the primary ribs, taking place almost at the latero-dorsal edge. The two other forms of Pictet, named *H. flexicostatus* (fig. 3) and *H. compressus* (fig. 4) by Spath, deviate, as indicated by his specific names, farther from the form under examination; *H. compressus* shows, moreover, a much denser and finer ornamentation. Collignon's form from the Mont Raynaud, which differs from Pictet's type in the same way as *H. angolanus*, seems to be most closely related to the latter, and, although it is very much smaller, might even be conspecific. The same is also true of the Zululand example figured by Venzo (1936) in fig. 8 of his Pl. IX; according to the explanation of the plate this figure would represent a specimen of *Labeceras plasticum* Spath, but no reference is made to it in the text dealing with that species (p. 114), nor does it show any particular resemblance to both Spath's and Besairie's figures quoted in Venzo's synonymy of *Labeceras plasticum*. On the other hand, this figure by Venzo very much resembles, except for its greater size, the Madagascar form of Collignon mentioned above, which Venzo (p. 111) also includes in his synonymy of *Hamites Studeri* Pictet. I, therefore, doubt whether fig. 8 of Venzo's Pl. IX, which seems to me to be an unquestionable *Hamitoides*, does not depict the latter species rather than *Labeceras plasticum* from the same locality.

H. (?) *madagascariensis* Breistroffer (*in* Besairie, 1936, p. 174, text fig. 10i, Pl. XX, figs. 6–9), besides being much larger than *H. angolanus*, also seems to be slightly more densely costate, and its primary ribs carry, according to the description, small tubercles where they bifurcate.[1] The fragment from the Upper Albian of Madagascar figured by Collignon in Pl. XXI, fig. 12, of the same paper (p. 197) under the name "*Labeceras*" *spathi* seems to differ from Breistroffer's specimen merely in that the bifurcation occurs at the first third of the sides; to judge by its shape, it seems to be a *Hamitoides* rather than a *Labeceras*. From the present form it certainly differs by the presence of two rows of tubercles. On the other hand, the undescribed specimen from the Upper Middle Albian of Androiavy, Madagascar, figured in Pl. XVII, fig. 8, of the same paper under the name "*Hamitoides* ? sp." does not seem to belong to this genus, its costae showing no trace of the characteristic bifurcation.

In *H.* (?) *rusticus* Spath (1939, p. 602; 1941, Pl. LXVI, fig. 2), which is apparently a much larger form, the bifurcation is restricted to a small section of the hook, and even there never more than one rib is intercalated between two primary ones. Also the other fragments from the English Gault doubtfully referred to this genus by Spath (1939, pp. 602, 603; 1941, Pl. LXV, fig. 7, Pl. LXVI, figs. 3–5) but rarely exhibit bifurcation or intercalation of ribs; where they occur the secondary ribs are from the outset as strong as the primary ones, whereas they are remarkably finer than the latter in the present species; also the ornamentation of all of Spath's fragments is coarser, and this may hold true of his unfigured "gigantic fragment" from the Malmstone of Devizes.

Finally, attention may be drawn to the striking similarity in ornamentation between the longer limb of the specimen under discussion (Pl. XLV, figs. 3a, b) and the "crushed final shaft" of an *Anisoceras armatum* from the English Gault figured by Spath (1939) in Pl. LIX, fig. 6. This resemblance seems to give further evidence of the close interrelationship between the genera *Anisoceras*, *Hamitoides* and *Hamites* and to support the writer's doubts as to whether all of them should not be included in one family (see below).

[1] It is worth noting that the fragment figured in Breistroffer's fig. 7 shows on its venter an abnormal furrow strongly reminiscent of that of the "*Anisoceras* monstrueux" figured by Pictet and Campiche (1861, p. 75) in Pl. LII, fig. 4.

Anisoceratidae Hyatt,[1] emend. Spath[2]

Within the scope of the present paper it is difficult to decide whether this family should be maintained as a separate entity or whether the three genera included in it by Spath, *Anisoceras*, *Prohelicoceras* and *Protanisoceras*, should not be united with those here referred to the Hamitidae in one great family of that name. It may be mentioned that Roman (1938, p. 51), more cautious than Spath, merely enumerates the genus *Anisoceras* along with many others among the "formes aberrantes pouvant se rattacher aux Lytoceratidés."

Certainly Spath's circumscription of this family appears to be too narrow; at least the genus *Idiohamites*, closely related to and connected by several transitional forms with *Anisoceras*, should be included (see p. 194).

Both these genera are represented in the collections of The American Museum of Natural History from the Albian of Angola by a few specimens, some from Hanha, some from the localities "R 28" (= "3041") and "R 30," south of Benguela Velha.[3]

Anisoceras Pictet[4]

This genus, here taken in the rather narrow circumscription recently given to it by Spath (1938, p. 540; 1939, pp. 541–542), is represented in the Vernay Collection merely by the mold of a large "crosse" and by two tiny fragments. Two of these specimens could be identified specifically, at least tentatively, whereas even the generic assignment of the second little fragment is doubtful. Four more specimens in the Washburne Collection from locality "3041," south of Benguela Velha, doubtless belong to the genotype *A. saussureanum*, but they had to be referred to a new variety of this species.

The forms from the Albian of Angola recorded in previous papers which are, or might be, referable to this genus are discussed in the following headings, except the fragment from Lobito Bay described, though not figured by Choffat (1905, p. 41) under the name "*A.* cfr. *subundulatum* Yokoyama," whose reference to *Anisoceras* seems altogether doubtful, as well as that of Yokoyama's (1890, p. 183, Pl. xx, figs. 6, 7, 7a) species itself, for it does not show any of the sculptural features distinctive of this genus.

Anisoceras armatum (J. Sowerby)

Text fig. 29

A. M. N. H. No. 25411: one specimen

Hamites tropicalis Meunier, 1888, p. 62, Pl. i, fig. 5.

?*Anisoceras armatum* Sow.; Choffat, 1905, p. 41, Pl. i, fig. 6.

?*Anisoceras* cf. *oldhamianum* Stoliczka; Spath, 1922, p. 151.

?*Anisoceras* cf. *oldhamium* Stoliczka; Haughton, 1924, p. 93.

Anisoceras armatum (J. Sowerby); Spath, 1939, p. 543, *cum synon.*, text fig. 191; Pl. lix, fig. 6; Pl. lx, fig. 1; Pl. lxi, figs. 9–11; Pl. lxii, fig. 5.

Description (including Dimensions).—The above identification refers to a mold found on the reverse side of the holotype of *Pervinquieria vokesi* (p. 95). An artificial cast of this mold is here described. It is U-shaped and consists of two straight, almost parallel shafts, the thicker of which seems to be the final one, and of a semicircular hook connecting them. It is about 110 mm. long; the distance between the dorsa of the shafts varies from about 30 mm. to about 40 mm. The whorl height may be about 30 mm. in the thinner shaft and about 35 mm. in the thicker one.

On the shaft preceding the hook twenty-one more or less radial, rather weak ribs can be counted; they correspond to four strong lateral tubercles, the site of which seems to have been at, or somewhat above, the middle of the sides. Two of the ribs coalesce in one tubercle, whereas two or

[1] 1900, p. 587.
[2] 1938, p. 540; 1939, pp. 541–542.
[3] All the forms from the above localities have turned out to be conspecific with, or at least closely related to Upper Albian ones; they can, therefore, roughly be considered to be of the same age as those from Hanha.
These localities have been referred by Dr. C. A. Washburne, according to the field labels, to his "Itombe" formation (cf. p. 98, footnote 1). However, this formation name is thought to lack stratigraphic significance, as it has been used not only for the above localities but also for that of *Pervinquieria* cf. *lampasensis*, apparently belonging to a somewhat higher horizon than Hanha (see p. 98), and even for locality "3095" which has yielded forms as young as Santonian (see Haas, 1942a, pp. 11, 20).
[4] 1854, p. 705.

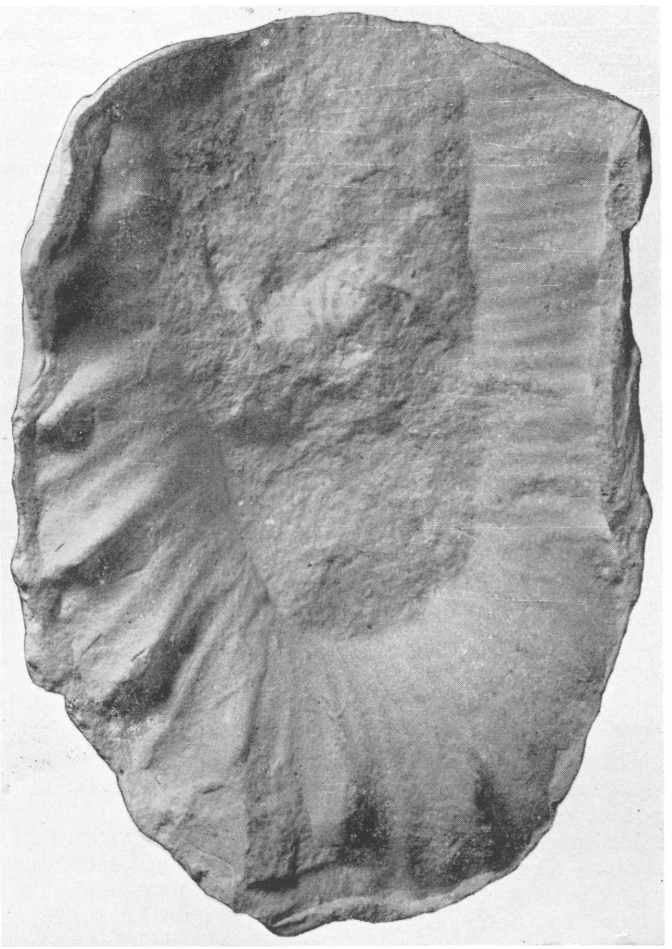

Fig. 29. *Anisoceram armatum* (J. Sowerby), A.M.N.H. No. 25411, left side view of plaster cast of mold, natural size.

three others are intercalated between two tubercles. On the hook the costae suddenly become decidedly rursiradiate and slightly stronger. The tubercles are here much sharper than on the precedent shaft and radially elongated; they mark the point of the maximum width of the whorl. Twenty-two ribs and six tubercles can be counted on this part of the conch. From one to three ribs are intercalated between two tubercles; most of the tubercles are here riding on single ribs; only occasionally two ribs merge in a tubercle. Except for being less crowded, the ornamentation remains about the same on the final shaft; in its posterior part the costae are still very much rursiradiate,[1] but they gradually become less so toward the anterior end. Three or four strong tuberculate ribs can be counted here; two much weaker ones are intercalated between two of the former.

REMARKS.—The identification of this specimen is based on its great resemblance to Spath's (1939, Pl. LX) fig. 1.

[1] Cf. Spath, 1939, p. 547, ". . . on the early part of the final shaft the ribs may be strongly oblique."

As to the synonymy of this species, in general, reference is made to Spath's Gault Monograph (1939, pp. 543–545). As far as the forms from the Albian of Angola are concerned, in the writer's opinion Meunier's specific name *Hamites* (= *Anisoceras*) *tropicalis* (*e*) should definitely be cancelled. As Spath (1939, p. 546) justly emphasizes, the species of this group can by no means be separated from each other on account of "insufficient or badly preserved material"; this applies particularly to the poor fragment described and figured by Meunier, which certainly is not qualified to be the holotype of a species. Furthermore, Meunier's figure shows so much resemblance to Sowerby's protograph (reproduced in Spath's, 1939, text fig. 191) that it can easily be included in the synonymy of *A. armatum*, as tentatively suggested by Choffat (1905, p. 41). It is true that Spath (1939, p. 558) considers Meunier's form to be perhaps closely related to *A. pseudo-elegans* Pictet and Campiche, but he admits that "its whorl section agrees more with *A. armatum*"; also the holotype of *A. pseudo-elegans* does not show in ventral view any secondary ribs intercalated between the tuberculate ones, whereas there are almost regularly three of them in Meunier's fragment. Choffat's (*loc. cit. in synon.*) form from Lobito Bay, included by Spath only doubtfully in the present species, is certainly closely related to it. The same seems to hold true of the only *Anisoceras* recorded from Angola, but not figured, by Spath himself (1922, p. 151) under the name of *A.* cf. *oldhamianum* Stoliczka, to which, in the writer's opinion, Spath's (1939) quotation in his synonymy of *A. armatum* of a form dealt with on p. 151 of his Angola paper has to be referred,[1] and of the fragment recorded by Haughton (*loc. cit. in synon.*) under the same name from Cabo Ledo. Haughton's (1924, p. 94) "*Anisoceras* cf. *armatum* (Sow.)," however, said by that author to be abundant south of Benguela Velha, seems (to judge by the description) to belong to *A. saussureanum* (Pictet), var. *spinosa*, new variety, described below (p. 192) from the same region, rather than to Sowerby's species.

As far as their size permits, the other *Anisoceras* discussed in the present paper will be compared below.

Anisoceras perarmatum Pictet and Campiche ?

Pl. XLV, fig. 4

A. M. N. H. No. 25412: one specimen

?*Anisoceras perarmatum* PICTET AND CAMPICHE, 1861, p. 65, Pl. LXVIII, figs. 7, 8, Pl. XLIX, figs. 1–8.

? *Anisoceras perarmatum* Pictet and Campiche; SPATH, 1939, p. 548, *cum synon.*, text fig. 192; Pl. LIX, figs. 1–3; Pl. LXI, figs. 3–7.

DESCRIPTION.—Despite its extreme smallness the fragment here dealt with shows some characteristic features of this genus. It is believed to exhibit the left side of a shaft whose section seems to have been hexagonal and which may have measured about 6 mm. in both height and width. Four straight transverse ribs are visible, the third of which seems to be simple, whereas the others show the beginning of a loop, as they duplicate themselves between the lateral and the ventral tubercles. There is an indication of a ventral tubercle also on the third rib. From the row of lateral tubercles the ribs descend toward the dorsum, where they seem to be uniform. All the tubercles are circular in shape and rather blunt.

REMARKS.—The above details of ornamentation are strongly reminiscent of that of the small fragments of *A. perarmatum* figured by Pictet and Campiche (1861, Pl. XLIX, figs. 6, 7) and by Spath (1939, Pl. LIX, fig. 3, Pl. LXI, figs. 4, 5); this fragment is, therefore, though doubtfully, referred to Pictet and Campiche's species. As to its distinction from *A. armatum*, which is certainly not easy, the reader may be referred to Spath's Gault Monograph. Owing to the enormous difference in size, the present fragment cannot well be compared with the mold referred above to *A. armatum;* it will be compared below with the following form.

Anisoceras (?), indeterminate species

Pl. XLV, fig. 5

A. M. N. H. No. 25413: one specimen

[1] The specific name "*A. armatum*" itself does not appear there.

DESCRIPTION.—Another tiny fragment exhibits an almost flat lateral surface with five straight, slightly diverging ribs, every second of which is stronger than the precedent one and carries a pronounced, though not high, slightly radially elongated tubercle. These tubercles seem to be lateral, not ventral ones; should this prove to be correct, their site would seem to be extraordinarily shifted ventrad.

REMARKS.—Although showing quite a distinct ornamentation, this fragment is too incomplete to allow, even generically, a definite assignment. It might be an *Idiohamites* of the group of *I. spiniger* (see p. 195) as well as an *Anisoceras*. Within the latter genus the juvenile form figured by Spath (1939) in fig. 12 of his Pl. LXI under the name "*A.* sp. juv. (aff. *saussureanum*, Pictet or *armatum*, J. Sowerby sp.)" seems most to resemble the present fragment, particularly with regard to the high position of its lateral tubercles, but it differs by having almost regularly two secondary ribs intercalated between the tuberculate ones.

From the precedent form the present one can be readily distinguished by its flatter sides, by its much finer ornamentation and by the high position of its lateral tubercles. It represents a much too early stage to be compared with the mold referred above to *A. armatum* or with the specimens described below as *A. saussureanum*, var. *spinosa*.

APPENDIX TO THE GENUS *Anisoceras*

Anisoceras saussureanum (Pictet),[1] var. spinosa, new variety

Pl. XLVI, figs. 1–3; text figs. 30a–e

A. M. N. H. No. 25414: four (five?) specimens

Anisoceras cfr. *Armatum* Pictet; BÖSE, 1923, p. 143, Pl. x, figs. 22–24.

Anisoceras cf. *armatum* (Sow.); HAUGHTON, 1924, p. 94.

DESCRIPTION.—All the fragments referred to this variety are peculiarly leached and eaten out at both ends, while No. 3 is similarly affected on one side. The specimens Nos. 1 (holotype, figs. 2a, b) and 2 seem to be parts of the conch transitional between its initial spiral and its less curved part; the holotype is curved in two planes,[3] as is Pictet's (1847) fragment "3" (compare his fig. 3b with my fig. 2b), and so is, though to a lesser degree, specimen No. 2. Specimen No. 3 (figs. 3a, b), corresponding in shape to the posterior part of Pictet's (*loc. cit.*) fragment "2," consists of a part of an almost straight shaft, which begins to be curved at its anterior end only, whereas specimen No. 4 (fig. 1), corresponding in shape exactly to Pictet's fragment "3," is almost semicircular.

The intercostal section is circular or transversely subelliptic, its width but slightly exceeding its height; occasionally (anterior end of specimen No. 4) the opposite ratio may prevail. Particularly where the conch is twisted, slight dissymmetries of the section occur.

Most characteristic of this form is its "button-and-loop" ornamentation, which is very robust, at least on the larger specimens. No. 4, representing the earliest stage, shows on its left side (the right one is corroded) twenty strong, slightly rursiradiate ribs, every second of which is stronger than the intercalated ones, and carries an indistinct lateral tubercle a little above the latero-dorsal edge and a much stronger ventral one at the latero-ventral shoulder. The ventral tubercles are slightly elongated longitudinally and seem to have developed spines, at least in the anterior part of the fragment. Between the lateral and ventral tubercles the tuberculate ribs duplicate themselves on the sides, thus forming the loops distinctive of this species. Toward the anterior end of this fragment three tuberculate, loop-forming costae follow each other immediately, without intercalation of simple ribs. Occasionally also one of the latter carries a weak tubercle at the latero-ventral edge. The ornamentation of the venter cannot properly be studied in this specimen owing to its poor preservation; however, both tuberculate and non-tuberculate ribs are seen to cross it in a straight line, the former forming, at least in the anterior part of the fragment, another loop connecting the ventral tubercles of both sides.

DIMENSIONS

Spec. No.	L	Hp	Wp	Ha	Wa
Holotype: 1	83.5 mm.	ca. 15.0 mm.	15.3 mm. (=1.02 Hp)	19.5 mm.	19.7 mm. (=1.01 Ha)
2	73.0 mm.	12.6 mm.	13.7 mm. (=1.09 Hp)	14.2 mm.	ca. 17.0 mm. (=ca. 1.2 Ha?)
3	62.5 mm.	?	?	?	?
4	63.5 mm.[2]	11.4 mm.	11.8 mm. (=1.04 Hp)	15.7 mm.	14.3 mm. (=0.91 Ha)

[1] For synonymy of the typical form see Spath, 1939, pp. 551–552.

[2] Refers to chord of almost semicircular arc formed by this specimen.

[3] Cf. Pictet's (1854, p. 705) generic diagnosis of *Anisoceras*, "à tours disjoints, ayant tous une double courbure, et ne pouvant pas être compris dans un plan."

In the holotype the sculpture is much coarser. Here it is dominated by ten ventral and ten lateral tubercles on each side, all of which are elongated in the longitudinal sense and developed as sharp spines which, when complete, must have attained 4 or even 5 mm. in height; the ventral ones are stronger than the lateral ones. The latter occupy a higher position on the right side than on the left. The distance between the two ventral rows is markedly greater than that between the ventral and the lateral ones. On both sides as well as across the venter the tubercles are connected by loops formed by the tuberculate ribs, which duplicate or in exceptional cases even triplicate themselves between the tubercles. In the posterior part of this specimen there are single ribs intercalated between two loops, unless they are, in the case of median line of the dorsum. In the arrangement of the tubercles there is a remarkable dissymmetry between both sides. Whereas on the left the lateral tubercles are situated at the laterodorsal edge, they are shifted almost to the lateroventral one on the right so as to be quite close to the right ventral tubercles, which appear here to be somewhat reduced. In this fragment the distance between both rows of ventral tubercles is much smaller than that between the ventral and lateral ones of the left side of the conch. Dorsad of the right row of lateral tubercles this specimen shows an ornamentation very similar to that of Pictet's fragment "2." From three to four fine secondary ribs converge irregularly toward the lateral tubercles or toward the intercostals between the outer ribs. Others among these dorsal secondary ribs are the continuations

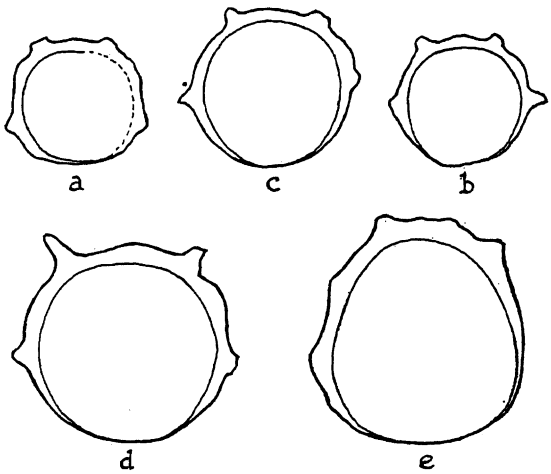

Fig. 30. Costal and intercostal sections of *Anisoceras saussureanum* (Pictet), var. *spinosa*, new variety, (a, b) A.M.N.H. Nos. 25414:4, 2, both at posterior ends; (c, d) holotype, A.M.N.H. No. 25414 : 1, (c) at posterior, (d) near anterior end; (e) A.M.N.H. No. 25414:3, a strongly dissymmetrical specimen; all × 3/2.

triplication, included in them; in the anterior part, however, these secondary ribs appear to be missing. The primary ribs continue, though reduced to hardly perceptible folds, across the dorsum which seems to be smooth at first glance. As seen, however, in specimen No. 4, it is covered with fine striae of growth. Otherwise the latter specimen agrees in ornamentation with the holotype, except for the fact that the loops are much less pronounced in the ventral portions of the tuberculate ribs.

The most advanced stage of ornamentation which can be studied in the present material is seen in specimen No. 3. The tuberculate ribs are very coarse, and the non-tuberculate ones, intercalated, as a rule, between the former, are robust and rather sharp on the venter and on the adjacent parts of the sides; on the left side they reach, hardly weakened, down almost to the of either tuberculate or non-tuberculate ventral ribs. Altogether fourteen fine costae of the dorsal zone correspond to four outer ones, two of which are tuberculate.

No suture lines could be traced in any of the above specimens.

A short corroded fragment (No. 5) shows about the same ornamentation as the posterior end of specimen No. 4, with which it also corresponds in size; however, as no differentiation between tuberculate and non-tuberculate ribs can be seen, it is but doubtfully referred to this variety.

REMARKS.—As seen from the above description, the Angola specimens exhibit such striking similarities with Pictet's original figures of this species in both the

manner of coiling and in the ornamentation that there cannot be any doubt about their conspecificity. There is, however, a remarkable difference. Whereas in Pictet's very accurate drawings all the tubercles are shown to be smooth and rounded so that they can by no means be considered to be merely the bases of broken spines, they are decidedly developed as sharp spines and elongated in the longitudinal sense in the forms here dealt with. Varietal separation thus seemed to be necessary. Furthermore, not more than one simple rib is intercalated between two tuberculate ones in the variety *spinosa*, as compared to regularly two in the typical form.

Haughton (*loc. cit. in synon.*) records many specimens of his "*A.* cf. *armatum* (Sow.)" from south of Benguela Velha; although he does not give any figures, his description proves this form to belong to *A. saussureanum, sensu lato*. The features pointed out by Haughton agree exactly with those observed in the present specimens; the spinous character of the tubercles is, it is true, not explicitly mentioned, but he emphasizes the full agreement between one of his specimens and that figured by Böse (*loc. cit. in synon.*), which shows distinct tubercles elongated in the spiral sense. The writer, therefore, does not hesitate to include Haughton's form as well as Böse's Mexican one in the synonymy of this new variety. The preservation of Böse's examples is rather poor, so, in consequence, are his figures, but his accurate description proves his specimen to be fully conspecific with those from Angola.

Of other forms previously recorded from the Albian of that country "*Hamites*" *angolaensis* Choffat (1888, p. 72, Pl. III, fig. 2; 1905, p. 70) is, no doubt, most closely related to *A. saussureanum*, but it is specifically different from both its typical form and the present variety, having loops only between both rows of ventral tubercles but only simple ribs between the latter and the lateral ones. The other differences in ornamentation should not be overrated, as it is, particularly in the forms of the present group, subject to much change throughout development.

Collignon's (1932a, p. 20, Pl. IV, figs. 2–4) "*Hamites* (*Anisoceras*) *Saussurei* Pictet" from the Upper Albian of the Mont Raynaud is certainly closely related to, if not fully conspecific with Pictet's type; the same is also true of his specimen of the same age recorded (*in* Besairie, 1936, p. 187, Pl. XXI, fig. 13) under the same name from Maniamba-amba.

For delimitation of *A. saussureanum* from its closest allies, *A. armatum* and *A. perarmatum*, reference may be made to Spath's careful observations in Part XIII of his Gault Monograph.

From all the other forms of *Anisoceras*—and of *Idiohamites*—discussed in this paper the present one is readily distinguishable by its coarse spinous ornamentation.

OCCURRENCE.—The holotype is marked "3041," south of Benguela Velha (a locality which is sometimes also indicated as "R 28"); although the four other specimens are not marked, their mode of preservation does not permit any doubt but that they come from the same locality. For its stratigraphic correlation see p. 189, footnote 3.

IDIOHAMITES SPATH

This genus, established by Spath (1925a, p. 189) in 1925 and explicitly discussed in Part XIII of his Gault Monograph (1939, pp. 578–582), is here included in the family Anisoceratidae on account of its "intimate relationship" to the precedent genus, emphasized also by Spath (1939, p. 579), who admits that his inclusion of *Idiohamites*, along with *Algerites* Pervinquière (1910, p. 96), in the family Algeritidae Spath (1925, p. 190) is only provisional.

Two specimens previously recorded from the Albian of Angola might be referable to this genus. In the case of that from Lobito Bay described and figured by Choffat (1905, p. 40, Pl. III, fig. 5) under the name "*Hamites* sp. nov.," this might be inferred from its comparison by Choffat with *Hamites alternatus* Pictet *non* Mantell (= *Idiohamites dorsetensis* Spath, 1939, p. 596), but the section seen in Choffat's fig. 5b shows no indication of ventral tubercles. The other, "*Anisoceras* sp. ind.," recorded by Airaghi (1931, p. 851, Pl. II, fig. 5) from Lobito, is very similar to *I.*

spiniger described on this page, but it might also be an *Anisoceras*.

Only a scanty fragment from Hanha can doubtfully be referred to this genus, but at some localities south of Benguela Velha, in beds which also seem to be of Upper Albian age, it is represented by three less incomplete specimens, one of which could be fully identified as *I. spiniger* (J. Sowerby), a species closely related to the genotype *I. tuberculatus* (J. Sowerby).

Idiohamites (?), indeterminate species

Pl. XLV, fig. 6

A. M. N. H. No. 25415: one specimen

DESCRIPTION.—The unseptate final shaft of the large specimen, of which the present fragment is only a short segment, must have attained a dorso-ventral diameter of almost 50 mm. The side, which seems to be the left one, is but gently vaulted. At the anterior end of the fragment there is a strong elevated rib carrying at its ventrad end a short, though sharp spine which points obliquely outward and backward. Somewhat behind that rib there is another, less strong one which is slightly curved backward on the outer half of the side; a third, still weaker rib, which seems to begin only at about the first third of the side, is intercalated between them.

REMARKS.—Even the generic determination of this poor fragment can be but a tentative one. It is, however, believed to belong to an *Idiohamites* rather than to an *Anisoceras*, since spines of this kind are occasionally found on the body chambers of some *Idiohamites*, e.g., on the final shaft of the large specimen of *I. spiniger* figured by Spath (1939) in Pl. LXIV, fig. 10, whereas the tubercles of *Anisoceras* seem always to be perpendicular to the periphery, so as to point strictly outward in side view.

APPENDIX TO THE GENUS *Idiohamites*

Idiohamites spiniger (J. Sowerby)

Pl. XLVI, figs. 4a–c; text figs. 31a, b

A. M. N. H. No. 25416: one specimen

?*Anisoceras* sp. ind., AIRAGHI, 1931, p. 851, Pl. II, fig. 5.

Idiohamites spiniger (J. Sowerby); SPATH, 1939, p. 584, *cum synon.*, text figs. 206i, 207; Pl. LXIV, figs. 10, 11; Pl. LXV, fig. 12.

DESCRIPTION.—The single specimen is a gently curved septate fragment, strikingly similar in shape to Spath's (1939, text figs. 207a, d, g) lectotype; it might correspond to the end of the initial spiral and the beginning of the straight shaft of his large typical example depicted in Pl. LXIV, fig. 10.

As seen in the table of dimensions, this fragment is slightly more compressed at its anterior end than at the posterior one. The internodal section (text figs. 31a, b) is oval, attaining its maximum width at about the second fifth of its height, from where it tapers ventrad. The venter is slightly truncate, the sides are gently vaulted, the venter is well rounded.

Three elements of ornamentation can be distinguished: broad blunt folds reaching from one latero-dorsal edge around the sides and the venter to the other but not crossing the dorsum; lateral and ventral tubercles riding on these folds; and closely spaced fine ribs which go all around the whorl and cover the folds as well as the intervals between them. Two to three of these fine ribs can be counted on every fold and from three to four in the intervals between them; thus there are from five to six ribs for each fold, the total being in the fully preserved part of this specimen thirty-two ribs and six folds.[1] The ribs run straight and radially across both sides and venter; on the dorsum, where they are, of course, finest, they form, only in the posterior part of the fragment, a hardly perceptible, orad convex sinus (seen also in Spath's text fig. 207g). The ventral tubercles are rather closely spaced on both margins of the venter; the position of the lateral ones is markedly higher on the right side of the fragment (about first third of whorl height) than on the left (about first

DIMENSIONS

L	Hp	Wp	Ha	Wa
55.3 mm.	11.1 mm.	9.2 mm. (=0.83 Hp)	13.9 mm.	11 mm. (=0.8 Ha)

[1] To judge by Spath's (1939) text fig. 207d, the same ratio (not 28:6, as said in his description) prevails also in his lectotype.

quarter of whorl height). The tubercles are circular in shape and comparatively small; careful examination proves them to be remnants of spines which are, however, nowhere preserved throughout the length of the fragment.

Sutural prongs and leaflets can be seen on many places, but all attempts to make them more clearly visible failed owing to the fact that once the test is removed the suture lines tend to vanish on the cast which is crystallized throughout. The only sutural elements which could be made visible, at least in their outlines, by careful preparation are some antisiphonal lobes and right internal saddles at about half the length of the specimen. However, it cannot reliably be decided whether the internal lobe is two- or three-pronged; the latter seems to be more likely.

REMARKS.—Considering the striking resemblance of the present specimen to Spath's lectotype of Sowerby's species, the writer does not hesitate to refer it to the latter, although it is somewhat less compressed (W = 0.72 H in the lectotype) and although its suture line could not properly be studied.

It also closely resembles the Gault specimen figured in Spath's (1939) Pl. LIX, fig. 5, and referred by him to *Anisoceras pseudo-elegans* Pictet and Campiche (Spath, 1939, p. 556, *cum synon.*, text figs. 196a–d, Pl. LIX, fig. 5, Pl. LX, figs. 2, 3, Pl. LXIII, fig. 12), and, even more so, the Cenomanian species *Anisoceras plicatile* (J. Sowerby) (see Spath, 1939, p. 557, text figs. 196e–h); both these forms can, however, readily be distinguished from the corresponding stage of *I. spiniger* by their slightly coarser and less dense costation (about twenty-five ribs, as compared to thirty-two in the present species, corresponding to six tubercles), and particularly by their much clumsier tubercles. *Anisoceras plicatile* differs, moreover, by its circular section, the much higher position of its lateral tubercles and by its ribs projecting more decidedly on the dorsum. The close similarity between *Anisoceras pseudo-elegans* and *I. spiniger* did not escape Spath (1939, p. 559); however, the distinctive characters he mentions are not quite consistent with his figures. Several intermediate ribs are visible between the outer tubercles in his fig. 5 (Pl. LIX) of *A. pseudo-elegans* as well as in *I. spiniger;* the inner nodes are in a lower, not in a higher position in the lectotype of the latter than in that of the former (compare the sections text figs. 207h and 196d in Spath, 1939), and the projection of the ribs on the dorsum is very slight in *I. spiniger* but much more pronounced in *A. plicatile*, whose close relationship to *A. pseudo-elegans* is not questioned by Spath. Although the former species appears later, and in spite of the differences pointed out above, it is, at the corresponding stage, so similar in side view to *I. spiniger* that it seems difficult to believe in the reference of both species to different genera, all the more so since no essential difference can be found between the suture lines of the group of *Anisoceras armatum* (to whose suture line that of *A. pseudo-elegans* is said to be similar by Spath, 1939, p. 557) on the one hand, and of *I. spiniger* on the other (compare Spath's, 1939, text figs. 193d, *A. saussureanum*, and 206i, *I. spiniger*).

Airaghi's (*loc. cit. in synon.*) "*Anisoceras* sp. ind.," from Lobito is certainly very similar to, and perhaps conspecific with the present form; but unfortunately both Airaghi's description, which does not even mention the tubercles clearly visible in the photograph, and his figure are insufficient to decide whether this form is closer to *I. spiniger* or to *Anisoceras pseudo-elegans* (or *A. plicatile*). Still another African form, *Hamites* (*Anisoceras*) *raynaudi*[1] Boule, Lemoine and Thevenin (1907, p. 56, Pl. XIII, figs. 12, 13) from the "Cenomanian" of the Mont Raynaud, Madagascar, since recorded also by Venzo (1936, p. 112) from the Upper Albian of Zululand, closely resembles both *A. pseudo-elegans* and *A. plicatile* and, therefore, also the present species; it can, however, readily be distinguished from the latter by its section, said to be "assez arrondie" in the description, by its still finer costation and above all by its very big and blunt tubercles[2] which do not seem to have been the bases

[1] Erroneously quoted as *A. "raymondi"* by Spath (1939, pp. 546, 558).

[2] It is pointed out in the text that they are "gros," "large," and of "forme mousse" (= blunt).

of spines, as they do in the Angola specimen.

The two other examples of this collection referred to *Idiohamites* will be compared below and on p. 198.

OCCURRENCE.—No locality is given for this specimen, but it is so similar in its mode of preservation to the following one that it is rather fair to assume that it was also collected at the locality "R 30." It may even have come from Hanha, but since the other ammonites from the localities south of Benguela Velha, indicated as "R 28" (= "3041") and "R 30" on the field labels, are apparently of about the same age as those from Hanha (see p. 189, footnote 3), this slight doubt is without stratigraphic significance.

Idiohamites, indeterminate species

Pl. XLV, figs. 7a, b; text fig. 31c

A. M. N. H. No. 25417: one specimen

DIMENSIONS

L	Hp	Wp	Ha	Wa
41.1 mm.	?	?	15 mm.	13.1 mm. (=0.875 Ha)

DESCRIPTION.—A single poorly preserved fragment resembles the precedent form in its dense costation and in the presence on the latero-ventral edges of small tubercles, which are apparently the bases of broken spines. It differs, however, by being less compressed, by a slight trend toward helicoid coiling, causing the section (text fig. 31c) to be somewhat dissymmetrical, and by the fact that the folds carrying the tubercles are much less distinct, being hardly perceptible. Furthermore, the ribs form a shallow, orad convex sinus on the sides instead of being straight as in *I. spiniger*, but they cross the venter in a straight line in both forms. About thirty-five ribs and eight pairs of ventral tubercles can be counted, or their presence inferred, on the whole length of this fragment. The difference of this ratio from that found in the precedent form (32:6) is due to the fact that the distance between the tubercles is about the same, but in the fragment under examination the ribs are markedly broader, though equally close to each other. The dorsum, which is covered by matrix, cannot be examined, nor can it reliably be decided whether or not any lateral tubercles are present.

The specimen, which is crystallized throughout, is septate up to its anterior end, but only faint traces of sutural elements are observable which do not allow any dependable description of the suture line or of parts thereof.

REMARKS.—The character of ornamentation, particularly the presence of small tubercles on the latero-ventral edges, assigns also this form to the genus *Idiohamites*. Its differences from *I. spiniger* have been pointed out above, and it will be compared below with *I.* aff. *subspinigero*. Its poor state of preservation does not allow any further comparisons.

OCCURRENCE.—Locality "R 30," south of Benguela Velha[1]; for stratigraphic correlation see p. 189, footnote 3.

Idiohamites aff. subspinigero Spath

Pl. XLVI, fig. 5; text figs. 31d, e

A. M. N. H. No. 25418: one specimen

Aff. *Idiohamites subspiniger* SPATH, 1939, p. 586, text fig. 208.

DESCRIPTION.—The slightly curved fragment is crystallized throughout and seems to be septate. Unfortunately both its ventral and dorsal areas are damaged. The section (text figs. 31d, e) is oval and attains its maximum width at about the first third of its height. It is a little more compressed at the posterior end of the fragment than at the anterior one.

There are indistinct folds carrying very flat, hardly perceptible tubercles at about the first fourth of the sides and at the latero-

DIMENSIONS

L	Hp	Wp	Ha	Wa
43.7 mm.	ca. 11.5 mm.	8.9 mm. (=0.78 Hp)	ca. 13 mm.	10.8 mm. (=0.83 Ha)

[1] This datum is found on a slip bearing the locality number "3041," but it apparently refers to "R 30" also, as the present specimen was found in the same tray with this slip.

ventral edges; owing to poor preservation, only a few of the ventral tubercles are traceable. There are also rather flat and broad ribs, which are decidedly rursiradiate and slightly sigmoidal, forming an orad concave arc in the inner zone of the sides and an orad convex one in the outer zone. Two such ribs are seen on every fold; they coalesce in the lateral tubercle but are separated dorsad as well as ventrad of it. The number of intermediate ribs between two folds varies from one to three or, seems to be intermediate between both of them.

Its ornamentation, consisting of folds, lateral and ventral tubercles and ribs, justifies its reference to the genus *Idiohamites*. Among the known species of this genus, *I. subspiniger* Spath, which could, according to that author, be considered a robust variety of *I. spiniger* as well, seems most to resemble the present fragment. In Spath's species, however, the ribs are sharper and less broad and do not show the slightly

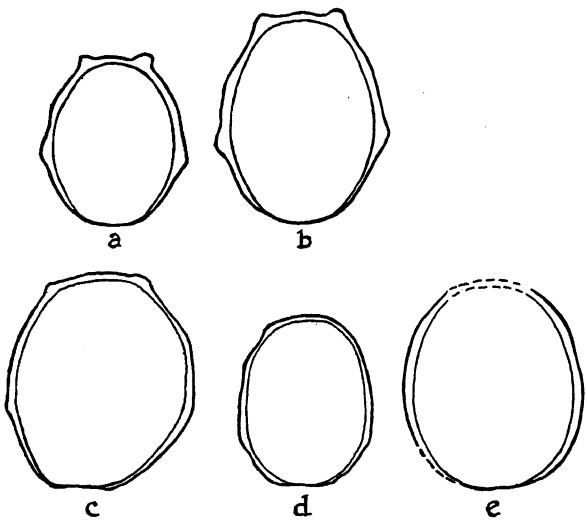

Fig. 31. Nodal and internodal sections of *Idiohamites*.

(a, b) *I. spiniger* (Sowerby), A.M.N.H. No. 25416, (a) in posterior, (b) in anterior part of fragment.
(c) *I.* (?) indeterminate species, A.M.N.H. No. 25417, near anterior end.
(d, e) *I.* aff. *subspinigero* Spath, A.M.N.H. No. 25418, at both ends.
All × 2.

rarely, even five. Altogether twenty-four ribs correspond to six tubercles. The costae are about as wide as the intercostals and seem to cross the venter in a straight line. The ornamentation on the dorsum cannot be examined.

No suture lines could be studied.

REMARKS.—This form is closely related to the two precedent ones, but it differs from both by its less dense costation, the single ribs being broader and slightly sigmoidal. In its degree of compression it sigmoidal course and the regular coalescence of two of them in the lateral tubercles, as observed in this fragment. Also in *I. subspiniger* never more than one or two simple ribs are intercalated between the tuberculate ones. On account of these differences in ornamentation the present example was not fully identified with Spath's species.

OCCURRENCE.—Locality "R 28" (= "3041"), south of Benguela Velha; for stratigraphic correlation see p. 189, footnote 3.

Turrilitidae Meek, emend. Hyatt,[1] emend. Spath

Spath (1937, pp. 507–509) includes in this family the genera *Turrilites* Lamarck, *Turrilitoides* Spath, *Pseudhelicoceras* Spath, *Mariella* Nowak, emend. Spath, *Hypoturrilites* Shimizu, *Carthaginites* Pervinquière, *Ostlingoceras* Hyatt, and, though not definitely, *Hyphantoceras* Hyatt. Of these genera only *Mariella*, *Ostlingoceras*, *Turrilitoides* and *Pseudhelicoceras* occur in the English Gault, but only the two last of these are represented at Hanha, the former by a large fragment and a doubtful tiny one, the latter by three little ones. There is, therefore, no immediate reason to study within the scope of this paper the full circumscription of this family, but it may briefly be mentioned that the writer prefers, as does Stephenson (1941, p. 407), to include the turrilitid genera of the Senonian and Maestrichtian, e.g., *Nostoceras* Hyatt, and perhaps also the late "*Helicoceras*" in the Turrilitidae, all the more so since Hyatt (1894, p. 568) himself admits his family Nostoceratidae to be "probably a more or less artificial group." For some interesting Upper Cretaceous turrilitids of the genus *Nostoceras* from Angola the reader is referred to a short separate paper now in preparation.

Turrilitoides Spath

This Albian genus, created by Spath (1923c, p. 75) for *Turrilites hugardianus* d'Orbigny (1842, p. 588, Pl. CXLVII, figs. 9–11; Spath, 1937, p. 526, *cum synon.*, text figs. 184a–i, Pl. LVIII, figs. 12–20) and its closest allies, is represented in this collection by one unseptate fragment of an unusually large new form; in addition, a tiny septate fragment is doubtfully referred to this genus.

Turrilitoides, indeterminate new species

Pl. XLVI, fig. 6; text fig. 32

A. M. N. H. No. 25419: one specimen

Description.—The single fragment apparently belongs to a body chamber of a sinistral conch; it is not preserved up to the aperture; two fragments of *Elobiceras hexagonum*[2] are embedded at its anterior end.

The whorl section (text fig. 32) shows on its outer side a convex upper surface, changing, by a rounded edge, into the slightly convex outer surface, which is separated by a clearly visible edge from the lower one. The latter at first slopes rather steeply dorsad, then forms a convex zone separated by a well rounded shoulder from the inner surface which is conical and in section but very little convex.

Thirty-one rather sharp ribs, which are a little narrower than the intercostals, can be counted on the present fragment; this corresponds to from eighty to eighty-five ribs per whorl. All costae are single; about nine out of thirty-one are outstanding in strength, but no rule can be established as to their distribution. Sometimes two such ribs follow each other immediately, between others from one to three finer ribs are intercalated. All the costae are flexuous, forming a very shallow, orad concave sinus on the upper surface and an equally shallow, orad convex one on the outer surface. They seem to pass the lower umbilical shoulder in a straight line. The inner surface has been damaged by grinding (in a vain search for suture lines); its mold, however, shows that there were faint traces of costation even there. On the above mentioned edge which separates the lower surface from the outer one the ribs swell very slightly, forming what might be called an indication of transversally elongated tubercles. A faint crenulation of the ribs can occasionally be

Dimensions

D	H	W	U[3]
ca. 90 mm.	ca. 37 mm.	ca. 45 mm.	ca. 37 mm.

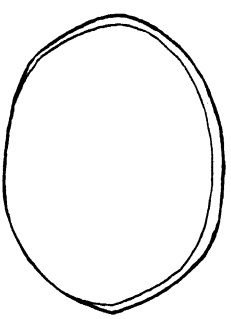

Fig. 32. Costal and intercostal section of *Turrilitoides*, indeterminate new species, A.M. N.H. No. 25419, near posterior end, natural size.

[1] 1900, p. 587.

[2] See p. 118, Pl. XXX, figs. 5–8, Pl. XXXI, fig. 1, text figs. 12d, 13c.

[3] Measured at base of whorl; at its top U = ca. 30 mm.

observed, best on the upper surface, as seen also in Spath's (1937, Pl. LVIII) fig. 7 of a specimen of *T. densicostatus*.

REMARKS.—This form, which seems to be the largest *Turrilitoides* hitherto known, most closely resembles by the density of its costation *T. densicostatus* Passendorfer (1930, p. 673, Pl. IV, fig. 70) from the Polish Tatra, found, according to Spath (1937, p. 529, *cum synon.*, text fig. 186, Pl. LVIII, figs. 5–7) also in the English Gault. On account of its much greater size and its still far denser ribbing it can, however, not be considered conspecific. On the other hand, it seems too incomplete to be given a new specific name. The above differences hold also true for its distinction from the genotype *T. hugardianus* (d'Orbigny), which has, moreover, lower whorls. The great difference in size is best illustrated by the fact that Spath (1937, p. 526) calls the examples depicted in figs. 15 and 17 of his Pl. LVIII large ones.

At first glance the present fragment might also be taken for a representative of the Upper Senonian genus *Bostrychoceras* Hyatt (1900, p. 588; type: *B. polyplocum* [Römer] *in* Schlüter, 1872, p. 112, Pl. XXXIII, fig. 4; see also Boule, Lemoine and Thevenin, 1907, p. 61, Pl. XIV, figs. 1, 2 and, for the very similar *B. indicum* [Stoliczka], particularly Kossmat, 1895, p. 143, *cum synon.*, Pl. XX, figs. 5, 6). Hyatt's genus has, however, more convex and more equally rounded whorls. It may be added that also the "parephebic substage with single costae and no tubercles" of another Upper Cretaceous form, *Emperoceras beecheri* Hyatt (1894, p. 575, Pl. XIV, figs. 15–17), as seen in Hyatt's fig. 15, is rather similar to the fragment under discussion, but that stage is reached by Hyatt's species only at about twice the size of the former.

Turrilitoides (?), indeterminate species

A. M. N. H. No. 25420: one specimen

DESCRIPTION.—A tiny poorly preserved fragment, measuring between 6 and 7 mm. in length and even less in its two other dimensions, would have been taken for a part of a small pelecypod or capulid gastropod were it not for distinct suture lines visible on its surface.

Thus it must be considered to be a fragment of some abnormally coiled ammonite; as two or three untuberculate transverse costae are perceptible, it is, though doubtfully, referred to the genus *Turrilitoides*. Fine thread-like striae seem to be present on and between the aforementioned ribs.

No continuous suture lines could be studied.

PSEUDHELICOCERAS SPATH

This genus, based by Spath (1922, p. 112) on *Turrilites robertianus* d'Orbigny, seems to be fairly well characterized by its sculptural features, as pointed out in Spath's (1937, p. 530) generic diagnosis. At Hanha it is represented by three small fragments, only two of which could be identified specifically.

Pseudhelicoceras cf. **quadrituberculatum** Spath

Pl. XLIV, fig. 7; Pl. XLV, fig. 8; text fig. 33a

A. M. N. H. No. 25421: two specimens

Cf. *Pseudhelicoceras quadrituberculatum* SPATH, 1937, pp. 531, 534, text figs. 190d–f.

DESCRIPTION.—Both fragments present consist of about half a whorl each and seem to be septate throughout. Despite their poor preservation the ornamentation can well be studied in the smaller one (specimen No. 1), and the sutural characters in the larger one (specimen No. 2).

DIMENSIONS

Spec. No.	D	H	W	U
1	ca. 14 mm.	ca. 6½ mm.	ca. 6½ mm.	?

Both are coiled sinistrally and apparently rather loosely. The whorl section (text fig. 33a) has on its ventral side the shape of half a regular hexagon, the three corners being marked by the tubercles of the first, second and third rows, respectively, whereas its dorsal side is rather semicircular.

The ornamentation consists of almost straight ribs which run obliquely from the

upper left to the lower right. Every second of them is considerably stronger than the others and carries four tubercles, all of which are slightly elongated transversely. Closer examination proves some of these tubercles to be scars left by fine spines. The tubercles of the second row, marking the most projecting point of the whorl section, appear to be the strongest, those of the first and the third, marking the upper and lower edges of the whorl, are but slightly weaker. Both are about equally distant from the second row. The tubercles of the fourth row, which runs around the basal opening of the conch, are somewhat closer to those of the third than are those of the second; they are much weaker than the others and not equally well developed on all tuberculate ribs. From four to five such ribs and as many simple ones can be counted per quarter whorl. Also some of the latter show faint indications of tubercles, corresponding in site to those of the former. In one interval between two tuberculate ribs there is a slight indication of a thread-like rib accompanying the single intercalated one.

The siphuncle is, as in the genotype *P. robertianum* (see Spath's, 1937, p. 533, specific diagnosis), situated between the second and the third row of tubercles, somewhat below the peripheral edge.

The suture line of specimen No. 2 (Pl. XLIV, fig. 7) is but slightly dissymmetric. Its right half is altogether shorter than the left and the right external saddle is lower than its pendant. The siphonal lobe is the deepest and rather broad; it ends in two comparatively long, almost perpendicular points, separated from each other by a club-shaped median knob whose margins are rather richly indented, and in two equally strong, oblique, three-pronged ones. The external saddles are each subdivided by a large trifid lobule which is as deep as the second lateral lobe on the left side of the suture line and even slightly deeper on the right. Both main stems of these saddles are bifid; the inner ones are much higher than the outer ones which are inclined ventrad. The first lateral lobe, attaining about three-quarters of the depth of the siphonal one, is very broad and bifid; both its main branches are subdivided into two points, all of which are three-pronged. The lateral saddle is extraordinarily broad and intersected by a strong three-pronged lobule; both its main stems are bifid; the outer one is higher than the inner one and equals (left side) or even slightly exceeds (right side) the inner stem of the external saddle in height. On both sides the top of the suture line slopes equally dorsad from its highest point, marked by the inner stem of the external saddle. The second lateral lobe is only half as deep as the first and also bifid; its points seem to be three-pronged. There is one more saddle, looking like a diminished repetition of the inner stem of the first lateral one, on each side, and between them the antisiphonal lobe which is deeper than the second lateral ones and has two terminal points and two rather strong lateral ones.

REMARKS.—Its ornamentation certainly refers this form to *Pseudhelicoceras* Spath. Within this genus, *P. quadrituberculatum*,[1] one of the two species incidentally established by him when discussing the genus, resembles it most. It has about the same character and density of ribbing, the same number and about the same general arrangement of the tubercles which he calls in one place (p. 534) even "sharper spines" (as compared to those of the genotype, *P. robertianum*). The only difference which seems to the writer to exclude full identification is that in Spath's holotype the distance between the first row of tubercles and the second is notably less than that between the second and the third, whereas in the present form all three are equally distant from each other. As these rows of tubercles coincide in position with the edges which give the outer part of the conch its angular shape, this difference necessarily also affects the section (compare my text fig. 33a with Spath's 196f). No suture line of *P. quadrituberculatum* has ever been figured; Spath states it to be "rather symmetrical, as in *P. bituberculatum* (d'Orbigny)." Also that of the Angola form shows but slight dissymmetry, but

[1] Possibly a synonym of d'Orbigny's (1850, II, p. 127, no. 108) older name "*Helicoceras*" *tuberculatus*, based, as is Spath's species, on a specimen from Clar (Var).

otherwise it widely differs from that of d'Orbigny's (1842, Pl. CXLI, fig. 10) species, which has an extraordinarily short siphonal lobe and narrower saddles.

Two forms very similar to that under discussion are Collignon's (1932a, p. 18, text fig. 23, Pl. I, fig. 21) "*Turrilites* (*Helicoceras* ?) *Roberti* d'Orbigny" from the Upper Albian of the Mont Raynaud, Madagascar, whose suture line agrees fairly well with that of the former, and Spath's (1937, p. 533, Pl. LVIII, fig. 34) variety *ornata* of *P. robertianum*. Both seem to me to be even closer to *P. quadrituberculatum* than to the typical *P. robertianum*. That they are dextral instead of sinistral would hardly be an obstacle to identification, as both dextral and sinistral coiling are well known to occur even within the same species. However, the present form agrees in some ornamental characters better with Spath's type of *P. quadrituberculatum* than with *P. robertianum*, and, as far as the variety *ornata* of the latter is concerned, also in size.

"*Helicoceras*" *madagascariense* Collignon (1932a, p. 18, text fig. 22, Pl. I, figs. 17–20) from the Mont Raynaud differs from all the other forms here discussed not only by the wider intervals between its tuberculate ribs, pointed out by Spath, but even more so by its more widely opened base, emphasized by Collignon. However, this species also seems to belong to *Pseudhelicoceras*, as seen from the almost perfect analogy between its suture line and that of "*Turrilites* (*Helicoceras* ?) *Roberti*" from the same locality (compare Collignon's, 1932a, text figs. 22 and 23).

Pseudhelicoceras, indeterminate species

Text figs. 33b, c

A. M. N. H. No. 25422: one specimen

DESCRIPTION (INCLUDING DIMENSIONS). —A poorly preserved, apparently septate, semicircular whorl fragment of a dextrally coiled turrilitid is separately described, as it differs specifically from the precedent form. The diameter of the conch amounts to about 12 mm., its central opening is about 4.5 mm. wide. The section changes rather rapidly. The intercostal one shows throughout the half whorl an almost horizontal, slightly convex upper surface, separated by a rather sharp edge from the more or less perpendicular outer one. In the posterior part of the fragment (text fig. 33b) this outer surface is very low and delimited by a second edge from an almost horizontal lower surface; the latter is here nearly as wide as the upper one and changes almost imperceptibly into the inner surface, which forms in section a flatly convex arc. In the middle of the fragment (text fig. 33c), however, the outer surface, forming an angle of a little more than 90° with the upper one, is much higher and the lower one much narrower; the latter is separated from the inner surface by another edge.

There are about five tuberculate ribs per quarter whorl which run a little obliquely from the upper right to the lower left; the tubercles of the uppermost row are small and situated on the inner zone of the upper surface; those of the second, immediately above or on the first edge, are stronger, and those of the third and fourth are the strong-

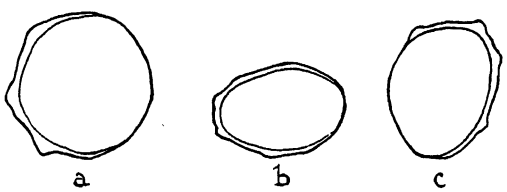

Fig. 33. Costal and intercostal sections of *Pseudhelicoceras*.
(a) *P.* cf. *quadrituberculatum* Spath, A.M.N.H. No. 25421:1, near anterior end.
(b, c) *P.*, indeterminate species, A.M.N.H. No. 25422, (b) in posterior part, (c) in middle of fragment.
All × 3.

est. The third row runs along, or slightly below the first edge; the position of the fourth varies with the section. In the posterior part of the fragment the tubercles of this row are on the inner zone of the lower surface and are radially elongated; in the middle of the fragment, however, they are just at the second edge, and these tubercles as well as those of the fourth row appear to be blunt and circular. The distance between these two rows always exceeds that between the second and the first. Simple ribs seem to be intercalated between the tuberculate ones.

No suture lines could be traced.

REMARKS.—Its peculiar ornamentation, described above, clearly refers this fragment to the group of *P. robertianum*. Its differences in coiling, section and ornamentation from the precedent form have already been pointed out. Its poor preservation does not justify further comparisons.

CONCLUSIONS

THE AMMONITE FAUNA OF HANHA AND OF SOME OTHER ALBIAN LOCALITIES OF ANGOLA

As earlier noted (p. 3), the faunal assemblage from Hanha by no means consists of ammonites alone; the latter do not even constitute the majority of the fossils in the present collection. However, as the rather abundant brachiopods and bryozoans have not as yet been studied, the following discussion will have to be restricted to the ammonites.

The ammonite fauna from Hanha, except those too poorly preserved for specific identification, includes the following forms:[1]

		Meunier, 1888	Choffat, 1888	Choffat, 1905	Spath, 1922	Haughton, 1924	Airaghi, 1931	Douvillé, 1931
1.	*Dipoloceras bouchardianum*	....	....	....	....	....	....	....
2.	" " , var. *alticarinata*	....	....	....	....	....	....	....
3.	" *rectangulare*	....	....	....	....	....	....	....
4.	" " , var. *elegans*	....	....	....	....	....	....	....
5.	" *symmetricum*, var. *obesa*	....	....	....	....	....	....	....
6.	*Hysteroceras varicosum*	....	....	=?	....	....	....	....
7.	" " , var. *angolana*	....	....	ssp.?	....	....	....	....
8.	" " , " *rarecostata*	....	....	var.?	....	....	....	....
9.	" *orbignyi*, var. *minor*	....	....	....	....	....	....	....
10.	" " , " *evoluta*	....	....	....	....	....	....	....
11.	" *choffati*	....	....	=	....	....	....	....
12.	" cf. *choffati*	....	....	cf.	....	....	....	....
13.	" *binum*, var. *lobitoensis*	....	....	....	....	....	....	....
14.	" " , cf. var. *lobitoensis*	....	....	....	....	....	....	....
15.	" " , var. *angusteumbilicata*	....	....	....	....	....	....	....
16.	" cf. *subbinum* ?	....	....	....	....	....	....	....
17.	" *falcicostatum*	....	....	....	....	....	....	....
18.	" *intermedium*	....	....	....	....	....	....	....
19.	" " , var. *compressa*	....	....	....	....	....	....	....
20.	" *carinatum*	....	....	....	....	....	....	....
21.	" " , var. *robustecostata*	....	....	....	....	....	....	....
22.	" " , " *exigua*	....	....	....	....	....	....	....
23.	" *semilēve*	....	....	....	....	....	....	....
24.	" " , var. *elegans*	....	....	....	....	....	....	....
25.	" " , " *densicostata*	....	....	....	....	....	....	....

[1] Descriptions, or at least mentions, of the forms listed below or of similar forms in the previous literature on the Cretaceous of Angola are annotated in chronological order; for explanation of signs see p. 213.

		Meunier, 1888	Choffat, 1888	Choffat, 1905	Spath, 1922	Haughton, 1924	Airaghi, 1931	Douvillé, 1931
26.	*Hysteroceras semilēve var. sparsicostata*	....	....	....	....	....	....	....
27.	" *propinquum*	....	....	....	....	....	....	....
28.	*Neokentroceras choffati*	....	=	....	....	....	....	....
29.	" " , var. *crassinodosa*	....	var.	....	....	....	....	....
30.	" *costatum*	....	....	....	....	....	....	....
31.	" " , var. *tenuis*	....	....	....	....	....	....	....
32.	" *magnum*	....	....	....	....	....	....	....
33.	" cf. *subtuberculatum*	....	....	....	cf.	....	....	....
34.	" *pseudovaricosum*	....	....	....	=	....	....	....
35.	" " , var. *gracilis*	....	....	....	var.	....	....	....
36.	" " , var. *compressa* ?	....	....	....	=?	....	....	....
37.	" *speciosum*	....	....	....	....	....	....	....
38.	" " , var. *rudis*	....	....	....	....	....	....	....
39.	" *curvicornu* ?	....	....	....	=?	....	....	....
40.	" *singulare*	....	....	....	....	....	....	....
41.	" (?) indet. spec.	....	....	....	....	....	....	....
42.	*Pervinquieria inflata*, var. *aequatorealis*	....	....	....	=	....	=?	....
43.	" *margaritata*	aff.	....	....	....	....	....	....
44.	" cf. *stoliczkai*	....	....	....	cf.	....	cf.	....
45.	" *romeri*	....	....	....	....	....	....	....
46.	" " , var. *fastigata*	....	....	....	....	....	....	....
47.	" *perarmata*	....	....	....	....	....	....	....
48.	" *barbouri*	....	....	....	....	....	....	....
49.	" *howelli*	....	....	....	....	....	....	....
50.	" spec. indet. aff. *howelli*	....	....	....	....	....	....	....
51.	" *proteus*	....	....	....	....	....	....	....
52.	" *evoluta*	....	....	=	=	....	....	....
53.	" *montraynaudensis*, var. *gracilis*	....	....	....	....	....	....	....
54.	" *simplex*, var. *tenuis*	....	....	var.	....	....	....	....
55.	" *vicina*	....	....	....	=	....	....	....
56.	" " , var. *evoluta*	....	....	....	var.	....	....	....
57.	" *bassleri*	....	....	....	....	....	....	....
58.	" *ferecostata*	....	....	....	....	....	....	....
59.	" transitional between #57 & #58	....	....	....	....	....	....	....
60.	" indet. n. spec. #1	....	....	....	....	....	....	....
61.	" *arietiformis*	....	=	....	=	....	=	....
62.	" " , var. *compressa*	....	=?	....	var.	....	var.	....
63.	" " , " *lēvicostata*	....	var.	....	var.	....	var.	....
64.	" " , " *elegans*	....	var.	....	var.	....	var.	....
65.	" *vokesi*	....	....	....	....	....	....	....
66.	" (?) indet. n. spec. #2	....	....	....	....	....	....	....
67.	*Elobiceras primordiale*	....	....	....	....	....	....	....
68.	" indet. n. spec. #1	....	....	....	....	....	....	....
69.	" *irregulare*	....	....	....	=	....	....	....
70.	" " , var. *rigidecostata*	....	....	....	var.	....	....	....
71.	" *spathianum*	....	....	....	....	....	....	....
72.	" cf. *flexicostatum*	....	....	....	cf.	....	....	....
73.	" *oxytropidoceratoides*	....	....	....	....	....	....	....
74.	" " , var. *minor*	....	....	....	....	....	....	....
75.	" *intermedium*	....	=	....	=	....	=	....
76.	" *lobitoense*	....	....	....	=	....	....	....
77.	" *subelobiense*	....	....	....	=	....	=	....
78.	" cf. *angustum*	....	....	....	cf.	....	cf.	....
79.	" *raymondi*	....	=?	....	....	....	....	....
80.	" " , var. *tenuis*	....	var.?	....	....	....	....	....
81.	" *hexagonum*	....	....	....	....	....	....	....
82.	" *browni*	....	=?	....	....	....	....	....
83.	" indet. n. spec. #2	....	....	....	....	....	....	....

		Meunier, 1888	Choffat, 1888	Choffat, 1905	Spath, 1922	Haughton, 1924	Airaghi, 1931	Douvillé, 1931
84.	*Elobiceras elobiense*	....	....	....	....	....	....	....
85.	*Prohysteroceras wordiei*	....	....	=?	=	=	....	....
86.	" *gracile*	....	....	....	=	....	....	....
87.	" *decipiens*	....	....	....	=	....	....	....
88.	" cf. *dubium*	....	....	....	cf.	....	....	....
89.	" *hanhaense*	....	....	....	....	....	....	....
90.	" (?) spec. indet.	....	....	....	....	....	....	....
91.	*Neoharpoceras angolanum*	....	....	....	....	....	....	....
92.	" *conditum*	....	....	....	....	....	....	....
93.	*Oxytropidoceras* (?) spec. indet.	....	....	....	....	....	....	....
94.	*Phylloceras velledae*	....	....	....	....	....	....	....
95.	*Puzosia quenstedti*, var. *angolana*	....	....	....	....	....	....	....
96.	" " , " *applanata*	....	....	....	....	....	....	....
97.	" *tenuis*	....	....	....	....	....	....	....
98.	" indet. n. spec.	....	....	....	....	....	....	....
99.	" *cuvervillei*	=	....	....	=	....	....	....
100.	" " , var. *flexisulcata*	var.	....	....	var.	....	....	....
101.	" *spathi*	....	....	....	....	....	....	cf.
102.	*Beudanticeras beudanti*	....	....	....	....	....	....	....
103.	*Aconeceras* (?) spec. indet.	....	....	....	....	....	....	....
104.	*Gaudryceras aenigma*	....	....	....	....	....	....	....
105.	*Tetragonites jurinianus*, var. *angolana*	....	....	....	....	....	....	....
106.	*Hamites compressus*	....	....	....	....	....	....	....
107.	" " , var. *gracilis*	....	....	....	....	....	....	....
108.	" *tenuis*	....	....	....	....	....	....	....
109.	" " , var. *subacuaria*	....	....	....	....	....	....	....
110.	" *virgulatus*	=	=	=	=	=	....	....
111.	" *subvirgulatus* ?	....	....	....	....	....	....	....
112.	" *venetzianus*	....	....	....	....	....	....	....
113.	" *duplicatus*	....	....	....	....	....	....	....
114.	" (?) cf. *nokonis*	....	....	....	....	....	....	....
115.	*Ptychoceras fauncei*	....	....	....	....	....	....	....
116.	*Hamitoides angolanus*	....	....	....	....	....	....	....
117.	*Anisoceras armatum*	=	....	=?	=?	=?	....	....
118.	" *perarmatum*	....	....	....	....	....	....	....
119.	" (?) indet. spec.	....	....	....	....	....	....	....
120.	*Idiohamites* (?) indet. spec.	....	....	....	....	....	....	....
121.	*Turrilitoides* indet. n. spec.	....	....	....	....	....	....	....
122.	" (?) indet. spec.	....	....	....	....	....	....	....
123.	*Pseudhelicoceras* cf. *quadrituberculatum*	....	....	....	....	....	....	....
124.	" indet. spec.	....	....	....	....	....	....	....

In addition, one form from south of Cabo Ledo:

125.	*Pervinquieria* cf. *lampasensis*	....	....	....	....	....	....	....

and the following forms from the localities "3041" (= "R 28") and "R 30," both south of Benguela Velha:

126.	*Anisoceras saussureanum*, var. *spinosa*	....	....	....	....	=	....	....
127.	*Idiohamites spiniger*	....	....	....	....	....	=?	....
128.	*Idiohamites* indet. spec.	....	....	....	....	....	....	....
129.	*Idiohamites* aff. *subspinigero*	....	....	....	....	....	....	....

are described in the present paper.

As seen from the above list, the 124 forms found at Hanha are referred to twenty-one genera, which differ greatly in the totals, both of forms and of individuals, as shown by the following:

AMMONITE GENERA FROM HANHA, ANGOLA

	Number of Forms		Number of Individuals	
1.	*Pervinquieria*	25	*Hysteroceras*	303
2.	*Hysteroceras*	22	*Puzosia*	185
3.	*Elobiceras*	18	*Elobiceras*	131
4.	*Neokentroceras*	14	*Neokentroceras*	117
5.	*Hamites*	9	*Dipoloceras*	74
6.	*Puzosia*	7	*Hamites*	62
7.	*Prohysteroceras*	6	*Pervinquieria*	52
8.	*Dipoloceras*	5	*Prohysteroceras*	20
9.	*Anisoceras*	3	*Neoharpoceras*	4
10.	*Neoharpoceras*	2	*Phylloceras*	3
11.	*Turrilitoides*	2	*Anisoceras*	3
12.	*Pseudhelicoceras*	2	*Pseudhelicoceras*	3
13.	*Oxytropidoceras* (?)	1	*Aconeceras* (?)	2
14.	*Phylloceras*	1	*Turrilitoides*	2
15.	*Beudanticeras*	1	*Oxytropidoceras* (?)	1
16.	*Aconeceras* (?)	1	*Beudanticeras*	1
17.	*Gaudryceras*	1	*Gaudryceras*	1
18.	*Tetragonites*	1	*Tetragonites*	1
19.	*Ptychoceras*	1	*Ptychoceras*	1
20.	*Hamitoides*	1	*Hamitoides*	1
21.	*Idiohamites* (?)	1	*Idiohamites* (?)	1
	Total	124		968[1]

[1] As compared to seventy-seven originally visible in the material before preparation.

For the number of specimens included in each of the listed forms, or determined merely generically, the reader is referred to the descriptive sections of this report.

Before entering upon the discussion of this assemblage, the problem as to whether or not it represents a stratigraphical and palaeontological unit must be considered. As earlier stated (p. 3), the whole collection seems to have been embedded in a mass of rock not exceeding a few cubic feet in volume; nevertheless, the problem of zonal differentiation again occurs. Its clarification appears to be particularly desirable, since the standard fauna for comparison, that of the English Gault, has been divided, particularly as a result of the investigations of Dr. Spath, so meticulously into zones and subzones (beds). However, since no zonal collecting has been done in the field, the writer must depend solely on his observations made in the laboratory, some of which have been recorded (pp. 138, 139). A few more have been made subsequently. The following forms have been found in association in one piece of matrix:

(1) *Dipoloceras rectangulare*, *Puzosia quenstedti*, var. *angolana*, and *Anisoceras* (?), indeterminate species.

(2) *Dipoloceras rectangulare* and *Hamites compressus*, var. *gracilis*.

(3) *Dipoloceras rectangulare*, *Hysteroceras varicosum*, var. *angolana*, *Elobiceras irregulare*, *Neoharpoceras angolanum*, *Neoharpoceras conditum*, and *Puzosia cuvervillei*.

(4) *Hysteroceras* of the group of *H. semilēve*, *Neokentroceras* sp., *Elobiceras* sp., and *Puzosia* sp.

(5) *Pervinquieria vokesi* and *Anisoceras armatum*.

(6) *Elobiceras primordiale* and *Puzosia cuvervillei*, var. *flexisulcata*.

(7) *Elobiceras hexagonum*, *Elobiceras*, indeterminate species, and *Phylloceras velledae*.

(8) *Elobiceras hexagonum* and *Turrilitoides*, indeterminate new species.

From all these observations, as well as from those referred to above, it can be seen that some genera, e.g., *Dipoloceras*, *Elobiceras*, *Puzosia* and *Hamites*, are associated with almost all the other genera repre-

sented in this fauna; it is particularly worth noting that they occur together with the keeled *Hysteroceras* and the *Neokentroceras* as well as with the *Hysteroceras* of the group of *H. varicosum*, although these two groups are apparently mutually exclusive (p. 139). The above genera thus seem to have persisted throughout the time of deposition of the rock which has yielded the present collection. Other genera, or groups, however, are associated with the *Hysteroceras* of the *varicosum*-group but not with the keeled ones or with the *Neokentroceras*. This appears to hold true for the most advanced group of *Pervinquieriae*, that of the group of *P. arietiformis*, and for *Neoharpoceras*. That *Pervinquieria vokesi*, belonging to the *arietiformis*-group, occurs together with *Anisoceras armatum* would fit into this picture, as *Anisoceras* is considered to be restricted to the Upper, and Uppermost, Albian by Spath. On the other hand, the single representative of the genus *Hamitoides* was associated with *Neokentroceras* and keeled *Hysteroceras* (and furthermore with some *Dipoloceras*, *Elobiceras* and *Hamites*, all of which seem to be zonally indifferent).

However, it must be stressed that all these inferences are made solely from observations in the laboratory, are necessarily incomplete and, therefore, but tentative; definite and reliable conclusions must await future careful zonal collecting in the field. For this reason no suggestion is ventured for those *Pervinquieriae* which do not belong to the *arietiformis*-group and for the genera *Phylloceras* and *Turrilitoides*. No observations have been made on the association of the genera *Prohysteroceras*, *Oxytropidoceras* (?), *Beudanticeras*, *Aconeceras* (?), *Gaudryceras*, *Tetragonites*, *Ptychoceras*, *Idiohamites* and *Pseudhelicoceras*.

Despite the slight indications of zonal differentiation noted above, the writer believes that the Hanha assemblage can be considered to represent a stratigraphical and palaeontological unit, in other words, one fauna; not only because it seems to have been collected from a very small space, but also because it appears to have been entombed in rock resulting from continuous sedimentation and because some of the genera contributing to this assemblage seem to have persisted throughout the period of the deposition of that sediment (see above).

Here it may be noted that the genera *Dipoloceras*, *Neoharpoceras*, *Oxytropidoceras* (?), *Beudanticeras*, *Aconeceras* (?), *Gaudryceras*, *Tetragonites*, *Hamitoides*, *Idiohamites*, *Turrilitoides* and *Pseudhelicoceras*, or eleven out of twenty-one here discussed, are recorded for the first time from the Albian of Angola. No references to previous literature are found in the above list for the genera *Phylloceras* and *Ptychoceras*, but it should be pointed out that forms of these genera other than those here described have been recorded by Haughton (1924) and by Spath (1922), respectively. *Pervinquieria vicina*, *Elobiceras raymondi*, *E. browni*, *Prohysteroceras gracile* and *Anisoceras saussureanum*, var. *spinosa*, which are definitely or doubtfully listed as previously known from Angola, have merely been given new specific or varietal names in the present paper.

Summary of Palaeontological Results

The most important palaeontological results may be summarized as follows:

(1) The genus *Dipoloceras* is found to be represented not only by *D. bouchardianum*, known for about a century from the European Gault, but also, and chiefly, by another form, *D. rectangulare*, which is closely related to, and was considered by Spath to be a variety of, the former. In the present collection *D. rectangulare* is the third most abundant species. In addition to the varieties accompanying these two species, which are represented by only a few individuals each, there is also *D. symmetricum*, "variety" *obesa*, to be mentioned as a subspecies[1] representing in Angola a known species of the English Gault.

[1] Merely in conformity with hitherto prevailing ammonitological usage the writer has in Parts I–III refrained from differentiating between subspecies and varieties. He is, however, fully aware of the

(2) The genus *Hysteroceras*, hitherto only quite sporadically recorded from the Albian of Angola (Choffat, 1905), is now known to be represented by a rich array of both forms and individuals. Among the former, *H. varicosum*, subspecies *angolana*, and *H. orbignyi*, subspecies *minor*, with sixty-four and fifty-nine specimens, respectively, are the two most abundant forms in this assemblage; they may well be considered index fossils of the Albian of Angola. In addition, there are *H. carinatum* with two varieties, a species first recorded from the Gault of France and England which ranks at Hanha fifth in abundance, and a regional subspecies *lobitoensis* of the English species *H. binum*, accompanied by a variety. It seems worth noting that almost all the Angolan forms replacing, or referable to European species appear to be more or less dwarfed, and the new forms peculiar to Angola are also small. Among the latter the graceful *H. falcicostatum*, *H. intermedium* with a variety, *H. semilēve* with three varieties, and the rare *H. propinquum* are particularly interesting. The last three species are "keeled" *Hysteroceras* belonging to the group characterized and hitherto almost exclusively represented by *H. carinatum* Spath.

(3) The genus *Neokentroceras*, carefully studied in Angola by Spath (1922), is represented in this collection by some forms fully or tentatively referable to his species *N. choffati*, *N. subtuberculatum*, *N. pseudovaricosum* and *N. curvicornu*, as well as by some particularly interesting new ones: *N. costatum*, *N. magnum*, *N. speciosum* with a variety, and *N. singulare*. The latter is an extremely rare but phylogenetically remarkable form.

(4) Within the genus *Pervinquieria*, which also includes "*Schloenbachia*" *inflata* considered since Meunier's and Choffat's days as being an index fossil of the strata concerned, no species, except *P. arietiformis*, *sensu lato*, with seventeen specimens, is represented by more than five individuals. There is, however, a rich diversity of forms. In addition to some close allies of *P. inflata*, there is the interesting group of the "horned" *Pervinquieriae* known through some specimens from Zululand, southern India and (*in schedis*) from Texas,[1] but hitherto represented from Angola by a single fragment only. The present collection contains eight forms of this group; seven of them are new and almost all attain a considerable size. On the other hand, four small forms of this genus are particularly interesting; three of them, *P. bassleri*, *P. ferecostata* and the peculiar *P.* (?), indeterminate new species No. 2, are quite new; the fourth, listed as *P.*, indeterminate new species No. 1, appears to be closely related to a form described by Spath (1925b) from Portuguese East Africa and, even more so, to one of Venzo's (1936) specimens from Zululand. Among the remaining *Pervinquieriae* from Hanha a good example of the previously known *P. evoluta*

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fact that the latter term is used there in two different meanings. According to the modern conception of subspecies (see Huxley, 1938, pp. 6 ff.; Merriam, 1941, pp. 61, 62; McAtee, 1941, pp. 368–371; Davis, 1941, pp. 49–52) forms like *Dipoloceras symmetricum*, "variety" *obesa*, *Hysteroceras varicosum*, "variety" *angolana*, *H. orbignyi*, "variety" *minor*, *H. binum*, "variety" *lobitoensis*, *Puzosia quenstedti*, "variety" *angolana*, *Tetragonites jurinianus*, "variety" *angolana*, *Anisoceras saussureanum*, "variety" *spinosa*, which—except for the first and the two last—are abundantly represented in the present fauna and replace more or less exclusively the typical forms of these species described from other far distant parts of the globe, should be considered as being geographically differentiated forms or regional races rather than mere varieties, and should, therefore, better be referred to as subspecies. In consequence, the abbreviation for subspecies ("ssp.") has been chosen to indicate, in the annotations to the faunal list and tables, the relationship of these forms to the typical ones of their species; in all the lists themselves, however, the term "var." has been kept for the sake of conformity with the systematic parts of this paper.

The difference between subspecies and varieties is well illustrated by the fact that some of the forms enumerated above are accompanied at Hanha by others which belong to the same species, but which deviate from the leading "variety" in one character or the other and are as a rule much less abundant. *Hysteroceras varicosum*, "variety" *angolana* (64 specimens) is accompanied by the variety *rarecostata* of the same species (1); *H. orbignyi*, "variety" *minor* (59), by variety *evoluta* (7); *H. binum*, "variety" *lobitoensis* (17), by variety *angusteumbilicata* (9); *Puzosia quenstedti*, "variety" *angolana* (46), by variety *applanata* (4). These accompanying forms seem to be genuine varieties of those subspecies in the meaning of modern taxonomy as are also the varieties of species represented in Angola by their typical forms, which occur elsewhere as well, and of species which are, whether previously known or new, peculiar to the Albian of Angola. In these groups are found two species (*Hysteroceras semilēve* and *Pervinquieria arietiformis*) with three varieties each, two (*Hysteroceras carinatum* and *Neokentroceras pseudovaricosum*) with two varieties each, and fourteen more (*Dipoloceras bouchardianum*, *D. rectangulare*, *Hysteroceras intermedium*, *Neokentroceras choffati*, *N. costatum*, *N. speciosum*, *Pervinquieria romeri*, *P. vicina*, *Elobiceras irregulare*, *E. oxytropidoceratoides*, *E. raymondi*, *Puzosia cuvervillei*, *Hamites compressus* and *H. tenuis*) with one variety each.

[1] Quite recently also from New Mexico; see p. 68, footnote 1, p. 74, footnote 1.

and the beautiful variety *gracilis* of *P. montraynaudensis*, a form recorded from the Mont Raynaud, Madagascar, may deserve special mention. However, the most spectacular representatives of this genus at Hanha are those belonging to the group of *P. arietiformis*, which is one of the most characteristic among the groups of macromorphous ammonites of the Albian of Angola. It is represented in this collection by the largest and most complete discs of the typical form of this species ever recorded, by three new varieties of it and by a closely related, large new species named *P. vokesi*.

(5) Among all the genera studied *Elobiceras* may be considered the most spectacular; it also is, along with *Neokentroceras*, the most distinctive of the Albian fauna of Angola. In addition to some forms which can fully or approximately be referred to species of Spath (1922), *E. irregulare*, *E. flexicostatum*, *E. intermedium*, *E. lobitoense*, *E. subelobiense*, some new species and varieties have been recognized. *E. primordiale* and *E.*, indeterminate new species No. 1, are thought to represent a primitive stage of this genus; a new variety *rigidecostata* is associated with the typical form of *E. irregulare*, represented in this collection by some large and particularly characteristic specimens; *E. oxytropidoceratoides* represents, along with its variety *minor*, a rather peculiar type of *Elobiceras; E. raymondi*, accompanied by a variety *tenuis*, is a particularly elegant form and by far the most abundant *Elobiceras* at Hanha, ranking among all the forms present sixth in abundance; *E. hexagonum* deserves special mention for its being phylogenetically linked to some *Neokentroceras* and *Dipoloceras;* and *E. browni* appears to be an interesting representative of the group hitherto known only by *E. neuparthi* (Choffat). Finally, some specimens could be referred to the genotype *E. elobiense*, which seems to have been found hitherto only once, although various finds have been so named; the best of these examples is conditionally proposed for the neotype of this species.

It may be added that the suture lines of *Pervinquieria arietiformis* as well as of the genus *Elobiceras* have hitherto been very imperfectly known, but a considerable number of them are shown in the present paper, particularly those of *E. raymondi* which proved to be surprisingly elaborate.

(6) Spath's genus *Prohysteroceras*, of a younger rather than older habitus than *Hysteroceras*, contributes to this collection three species previously known from Angola: *P. wordiei* and *P. decipiens*, both now represented by specimens much larger and more complete than Spath's types, and *P. gracile*, new name; a form closely comparable to another species of Spath's, *P. dubium;* and a new species, *P. hanhaense*. The latter, closely related to *P. decipiens*, is of special interest because of the *Hysteroceras-* or *Neokentroceras*-like ornamentation of its earlier ontogenetic stages.

(7) The genus *Neoharpoceras* is represented only by four more or less incomplete specimens on which, however, two new species, *N. angolanum* and *N. conditum*, could be based. The latter is of particular interest because of its decidedly grammoceratoid habitus and also because its suture line closely resembles those of some *Elobiceras*.

(8) The scanty fragment doubtfully referred to the genus *Oxytropidoceras* is here mentioned merely for the sake of completeness.

(9) Among the smooth or almost smooth genera dealt with in Part II of this paper *Puzosia* is the only one represented by more than one form and is also the most abundant as to number of individuals. Most of the specimens capable of specific identification proved to be closely related to *P. quenstedti* from the French Gault; the majority of them are referred to a subspecies *angolana*, which is thought to replace that species in Angola and which ranks in this material fourth in abundance; it is accompanied by a variety *applanata*. There are, furthermore, two new species, *P. tenuis* and an unnamed one. Second in number of individuals among the *Puzosiae* of this fauna is a species believed to be the *P. cuvervillei* which was most inadequately described and figured from Lobito Bay by Meunier (1888); it is represented by its typical form and by a variety *flexisulcata*. The latter, attaining a medium size, seems,

on account of this character and others, to be somehow transitional between the small *Puzosiae* of this fauna mentioned above and the large ones. The latter differ also by their much more elaborate suture lines and are here referred under the name *P. spathi* Venzo to a form previously recorded from the Upper Albian of Zululand and, perhaps though under a determination believed by the writer to be wrong, also by Douvillé (1931) from Salinas, southern Angola.

(10) The two other desmoceratid genera present at Hanha, *Beudanticeras* and *Aconeceras* (?), are represented only by more or less scanty fragments. These are the only genera described in Part II which did not disclose perfect suture lines.

(11) The two "stenothermal" families of the Phylloceratidae and Lytoceratidae, whose absence from the Albian of Angola was emphasized by Spath (1922), are represented by good specimens: the former by the almost ubiquitous *Phylloceras velledae*, the latter by one individual each of the genera *Gaudryceras* and *Tetragonites*. The *Gaudryceras*, deserving special interest for its ventrally sharpened inner whorls, has been named *G. aenigma;* the *Tetragonites* has been attached as a subspecies *angolana* to *T. jurinianus* from the Albian of France. The occurrence of these stenothermal ammonites at Hanha will be discussed more explicitly in the palaeoecological observations (p. 212).

(12) Among the irregularly coiled genera treated in Part III *Hamites* is by far the most abundant in the number both of forms and of individuals. Except for a single specimen doubtfully referred to this genus which is closely comparable to *H. nokonis* from the Upper Albian of Texas, all the *Hamites* present at Hanha could be referred to species which were first described from the Gault of England and France; among them are *H. compressus* and its variety *gracilis*, *H. tenuis* and its variety *subacuaria*, *H. virgulatus*, *H. venetzianus* and *H. duplicatus;* a single specimen is doubtfully referred to *H. subvirgulatus*.

(13) Two other hamitid genera, *Ptychoceras* and *Hamitoides*, are present in the collection, each represented by only a single specimen. Both had to be given new specific names, *P. fauncei* and *H. angolanus*, respectively.

(14) The family of the Anisoceratidae contributes to the Albian fauna of Angola two genera, *Anisoceras* and *Idiohamites;* both are but poorly represented at Hanha, better so south of Benguela Velha. Here occurs a characteristic subspecies *spinosa* of the French and Swiss Gault species *A. saussureanum*, which in the writer's belief has previously been recorded from Angola, under another name, by Haughton (1924) as well as from the Vraconnian of Mexico by Böse (1923), together with a few specimens of *Idiohamites* referable, or at least related to *I. spiniger* and *I. subspiniger* of the Upper Gault of England.

(15) The Turrilitidae are represented in this collection by a few fragments only; one of them, *Turrilitoides*, indeterminate new species, stands out by its size among the forms of this genus. The other fragment referred to the same genus is much too tiny and problematic to be discussed here. Three more fragments, however, can readily be recognized as belonging to Spath's genus *Pseudhelicoceras*.

The intergeneric relations within the Dipoloceratidae have been discussed from both morphological and phylogenetic points of view at the end of Part I; the families dealt with in Parts II and III, however, are much less richly represented at Hanha and do not allow a similar evaluation.

Palaeoecological Observations

The first question here to be examined is whether the Hanha material really represents a faunal unit. It does not seem quite logical to ask whether it is a "thanatocoenosis" or a "biocoenosis," since every assemblage of fossil molluscs necessarily is a community of shells entombed in the sediment after the death of the animals.

The issue is rather whether or not this "thanatocoenosis" is a more or less faithful image of the "biocoenosis" from which it is derived, or, to use a modern term (Efremov 1940), whether or not the association of shells found in a certain bed is due merely to taphonomic reasons.

In solving any such problems, especially as far as shelled cephalopods are concerned, the much discussed factor of the flotation of empty shells is involved. The writer shares in general Scott's (1940b, p. 302) opinion "that flotation was not an important factor in the distribution of the fossil shells" of ammonites, and he further believes that the significance of this factor often has been overrated. Moreover, there is in the present material some circumstantial evidence to support the idea that it is a fairly true image of a living fauna. The same forms of smaller ammonites (and other fossils) are found within the body chambers of larger ones as were found in the matrix about them; since the filling of the cavities of empty shells with mud, as can be observed on recent shores, is accomplished rather rapidly,[1] the above observation strongly suggests that the forms buried together also had lived together. The fact pointed out in the Introduction (p. 3), that many conchs seem to have been broken before fossilization, and the accumulation of so many fossils in a comparatively small volume of rock might "indicate that they may have floated into a bay or eddy, or were swept there by currents, tides or storms" (Scott, 1940b, p. 302); however, even should this be the case, these events can well be considered to have been of purely local significance and need, therefore, not cast doubt on the conclusion that the shells discussed in this paper were buried, (a) soon, if not immediately after the death of their owners, and (b) not far from the places where they lived.

No modern palaeoecological study on ammonites can overlook Gayle Scott's (1940b) excellent report on the palaeoecology of the Cretaceous ammonites in the Texas area, to which the reader is referred for the terms hereinafter used. With the exception of some of the *Elobiceras*, the *Neoharpoceras* and the poor fragment doubtfully referred to *Oxytropidoceras*, all the Dipoloceratidae belong to Scott's palaeoecological group 4. These forms contribute at least 650 specimens, or two-thirds, to a total of about 975; about eighty more, the irregularly coiled ammonites, belong to Scott's group 7, most of them to subgroup 7c, including the genus *Hamites*. All these forms, representing three-fourths of all the specifically determined specimens are, according to Scott, typical denizens of the infraneritic subzone, the most seaward one of the neritic zone. Thus in the Albian of Angola as well as in Texas "the various types of uncoiled ammonoids . . . show an overwhelming preference for association with the ammonites characterized by robust sculpture and quadrate whorl sections (group 4)" (Scott, 1940b, p. 315). This is about the same association as is also found, according to the same paper (p. 312), in some formations of the Upper Albian Washita group, e.g., in the Fort Worth and in the Weno. In both these formations abundant gastropods are associated with the ammonites as they are at Hanha; there is a further analogy with the Weno in that among the gastropods large, thick-shelled forms are "not found or rare." In the Fort Worth formation, however, some of the gastropods are moderately large and thick shelled. In both those formations of the Washita group pelecypods, which are rather rare at Hanha, are abundant, whereas brachiopods, whose unsociability with the ammonites is repeatedly stressed for Texas by Scott, are by no means rare in the present material.

The comparatively few *Elobiceras* which, like *E.* cf. *flexicostatum*, *E. oxytropidoceratoides*, *E.* cf. *angustum*, *E. raymondi* and, even more so, its variety *tenuis*, and *E. elobiense*, are distinguished by a higher degree of involution, by slender whorls with more or less elliptic section and by finer ornamentation, might be referred to Scott's

[1] It seems that crystallization of the inner whorls of ammonites occurred only where the shell remained intact so far as not to allow the mud to penetrate into the gas chambers, which then were filled by calcareous solutions after fossilization.

group 5 rather than to his group 4[1]; the same applies also to the few *Neoharpoceras* and to the poor fragment determined as *Oxytropidoceras* (?), indeterminate species. Group 5 is thought by Scott to be restricted to the epineritic subzone bordering the infraneritic one to shoreward. However, at the most there are only a little over fifty individuals of this collection which might be assigned to this subzone. The fact that some forms of this palaeoecological group occur in the present material should, therefore, not be overrated, especially since some of the forms concerned are, within the genus *Elobiceras*, most closely related to others which undoubtedly belong to group 4.

Numerically much more important are the 185 *Puzosiae* of this collection, to which must be added a single *Beudanticeras* and two poor fragments doubtfully referred to *Aconeceras*. According to Scott, these genera would belong to his group 3, including "smooth, moderately involute shells with ovate or subquadrate whorl sections, as *Desmoceras*, *Uhligella*, *Beudanticeras*,[2] *Latidorsella*,[2] *Puzosia*," which are considered to be the typical inhabitants of the epibathyal subzone, adjacent seaward to the infraneritic one. However, the admixture of a considerable number of epibathyal forms in an assemblage which is chiefly infraneritic is not likely to bring into question the general result of the present investigation. A similar association occurs, though in inverse proportion, in the lower half of the Duck Creek, the lowest formation of the Washita group, where "the large, smooth, moderately evolute shell with ovate to subquadrate whorl section exemplified by *Desmoceras*, *Uhligella*, etc." is "the dominant type," but associated with "numerous other species belonging principally to quadrate-whorled, robustly sculptured types such as *Mortoniceras*, *Prohysteroceras*, *Hamites*" (Scott, 1940b, p. 311).

Finally, there are five or—if two little fragments of *Phylloceras* are here left out of account—just three shells, each representing one of the three "stenotherm" genera *Phylloceras*, *Gaudryceras* and *Tetragonites*. It is true that the only *Tetragonites*, according to its degree of involution and to its whorl section which changes in the course of development from rectangular to rounded-triangular, would have to be referred to Scott's group 3 rather than to his group 2,[3] but as it belongs to the Lytoceratidae, as does *Gaudryceras aenigma*, it is here better treated together with the latter. The lytoceratid stock constitutes Scott's group 2, the phylloceratid one his group 1, and both are thought to have lived in the infrabathyal subzone beyond and below, respectively, the 100 fathom line. This makes the three specimens under discussion, despite their extremely small number, most important for the present investigation. As mentioned above, Spath (1922) emphasized the total absence from the Albian of Angola of "the . . . stenothermal . . . Phylloceratidae and Lytoceratidae, that are found in North Africa, but that did not migrate into the shallow water regions of the temporary transgression." Haughton (1924, pp. 82, 85) has since recorded a single *Phylloceras* found south of Benguela Velha some 150 kilometers to the north from Hanha. The presence of three good specimens (plus two fragments) belonging to these two families can by no means be considered to refute Spath's above conception, as the admixture of altogether five infrabathyal individuals with more than 970 others certainly cannot invalidate the infraneritic character, with epibathyal elements, of the present fauna. It might, however, slightly modify Spath's hypothesis inasmuch as the presence of some, though very few phylloceratids and lytoceratids seems to prove that the pelagic sea was not so far away as previously thought (for palaeogeographic inferences, see p. 215).

[1] Scott does not mention *Elobiceras* in his general enumeration (pp. 303, 304), but in discussing the Kiamichi fauna (p. 311) he characterizes this genus as one having "quadrate whorls with robust sculpture." This does, however, not even hold true for all the forms of Texas, as most of those listed by Adkins (1928, p. 234) in the Kiamichi are rather involute, compressed and more or less finely costate.

[2] As seen from the heading on the genus *Beudanticeras* (p. 164), "*Beudanticeras*" and "*Latidorsella*" cannot be quoted simultaneously as generic names, as either of them must be considered a synonym of *Desmoceras, sensu stricto*.

[3] Cf. p. 4, footnote 1.

TABLE I

AMMONITES FROM ANGOLA RELATED TO FORMS OF SOME OTHER AFRICAN FAUNAS	"Middle Cretaceous," Elobey Islands (I)[1]	Enybia, Southern Nigeria (II)	Cenomanian, Algeria, (III)	—TUNISIA (IV)— Upper Gault, Upper Albian	Gault-Cenomanian Boundary	Vraconnian	Upper Albian, Zululand (V) (VII) (VIII) (IX)	Upper Albian, Cafuana, Portuguese East Africa (X)	—MADAGASCAR— Upper Middle Albian, Borambo, Androiavy (XI)	Upper Albian, Mtge. des Français (VIII); Mont Raynaud, Maniamba-amba (XII)	"Lower Cenomanian," Mont Raynaud (XIII); Cenomanian, Diego, Antsatrambavelona (XIV)
FROM HANHA											
Dipoloceras bouchardianum	....	....	....	=?	....	....	=	....	....	....	=?
" " , var. *alticarinata*	....	....	....	var.?	....	....	var.	....	....	....	var.?
Hysteroceras orbignyi, var. *minor*	....	....	....	....	....	....	ssp.	....	....	ssp.	....
" " , " *evoluta*	....	....	....	....	....	....	var.	....	....	var.	....
" *choffati*	....	....	....	....	....	....	=	=	....	....	....
" cf. "	....	....	....	....	....	....	cf.	cf.	....	....	....
" *binum*, var. *lobitoensis*	....	....	....	....	....	....	....	....	....	ssp.?	....
" " , cf. var. *lobitoensis*	....	....	....	....	....	....	....	....	....	var.?	....
" *binum*, var. *angusteumbilicata*	....	....	....	....	....	....	....	....	....	var.?	....
" cf. *subbinum* ?	....	....	....	....	....	....	cf.	....	....	....	....
" *carinatum*	....	....	....	....	....	....	=	....	....	....	....
" " , var. *robustecostata*	....	....	....	....	....	....	var.	....	....	....	....
" " , " *exigua*	....	....	....	....	....	....	var.	....	....	....	....
" *semilēve*	....	....	....	....	....	aff.	....	....	....	....	....
" " , " *elegans*	....	....	....	....	....	aff.	....	....	....	....	....
" " , " *densicostata*	....	....	....	....	....	aff.	....	....	....	....	....
" " , " *sparsicostata*	....	....	....	....	....	aff.	....	....	....	....	....
" *propinquum*	....	....	....	....	....	aff.	....	....	....	....	....
Neokentroceras choffati	....	....	....	....	....	....	....	....	....	=	....
" " , var. *crassinodosa*	....	....	....	....	....	....	....	....	....	var.	....
" *costatum*	....	....	....	....	....	....	....	....	....	=?	....
" " , " *tenuis*	....	....	....	....	....	....	....	....	....	var.?	....
" *pseudovaricosum*	....	....	....	....	....	....	....	....	....	=	....
" " , var. *gracilis*	....	....	....	....	....	....	....	....	....	var.	....
" " , " *compressa* ?	....	....	....	....	....	....	....	....	....	var.	....
Pervinquieria inflata, var. *aequatorealis*	=?	....	....	var.	....	var.	=	....	....	=	=
" *margaritata*	=?	....	....	....	....	....	....	....	....	....	....
" cf. *stoliczkai*	....	....	....	....	....	....	....	....	....	cf.	....
" *evoluta*	....	....	....	....	....	....	var.	....	....	....	....
" *montraynaudensis*, var. *gracilis*	....	....	....	....	....	....	....	....	....	....	var.
" indet. n. spec. #1	....	....	....	....	....	....	cf.	aff.	....	....	....
" *arietiformis*	....	....	....	....	....	....	var.	....	....	....	....
" " , var. *compressa*	....	....	....	....	....	....	var.	....	....	....	....
" " , " *lēvicostata*	....	....	....	....	....	....	var.	....	....	....	....
" " , " *elegans*	....	....	....	....	....	....	var.	....	....	....	....
Elobiceras subelobiense	....	....	....	....	....	....	=?	....	....	....	....
" indet. n. spec. #2	....	cf.	....	....	....	....	....	....	....	....	....
" *elobiense*	=	....	?	....	....	....	....	....	....	....	....
Phylloceras velledae	....	....	....	....	....	var.	=	=	=	=	=
Puzosia quenstedti, var. *angolana*	....	....	....	....	....	var.?	....	....	var.	....	....
" " , " *applanata*	....	....	....	....	....	var.?	....	....	var.	....	....
" *spathi*	....	....	....	....	....	....	=	....	....	....	....
Beudanticeras beudanti	....	....	....	....	....	....	....	....	....	....	cf.
Hamites compressus, var. *gracilis*	....	....	....	....	....	....	....	....	....	=?	....
" *virgulatus*	....	....	....	....	=	....	....	....	....	....	....
" *venetzianus*	....	....	=	....	=	....	....	....	....	=	....
" *duplicatus*	....	....	....	....	....	....	....	aff.	....	....	....
Hamitoides angolanus	....	....	....	....	....	....	=?	....	....	=?	....
Anisoceras armatum	....	....	=?	....	....	=	....	aff.	....	=	=
" *perarmatum*?	....	....	....	....	....	....	....	aff.	....	....	=?
Pseudhelicoceras cf. *quadrituberculatum*	....	....	....	....	....	....	....	....	....	aff.	....
FROM LOCALITY "3041" (= "R 28"), SOUTH OF BENGUELA VELHA											
Anisoceras saussureanum, var. *spinosa*	....	....	....	....	....	....	....	....	....	ssp.	....

[1] REFERENCES (see Bibliography): I = Szajnocha, 1885. II = Spath, 1922. III = Pervinquière, 1910. IV = Pervinquière, 1907. V = Crick, 1907. VI = Spath, 1921. VII = Besairie, 1930. VIII = Venzo, 1936. IX = van Hoepen, 1941. X = Spath, 1925b. XI = Breistroffer, 1936. XII = Collignon, 1932a, 1936. XIII = Boule, Lemoine and Thevenin, 1906–07. XIV = Collignon, 1929, 1931b, 1933.

EXPLANATION OF SIGNS: Forms compared are: =, equal; cf., comparable to, aff., closely related to, var., a variety of, ssp., a subspecies of each other.

Summarizing, the Albian fauna of Angola is recognized to have been chiefly infraneritic, with some forms of epineritic but much more of epibathyal character, and infrabathyal forms washed in only quite sporadically; it thus can be assumed to represent the seaward part of the infraneritic subzone.

Not many observations could be made on the mode of life of the ammonites studied, but most of them must be thought to have lived on, or near the sea bottom, swimming but occasionally. This is certainly true of all the forms with a more or less sturdy conch, particularly of all those which tend to form a rostrum or at least to assume a ventrally fastigate whorl section at maturity.[1] It seems that the rostrum, or the fastigate periphery, served to be let down like a spur into the sea bottom in order to facilitate keeping balanced in upright position, as the conch had become heavier in the last stages of growth (cf. Stieler, 1922b, pp. 320–330, 333–338, text figs. 6–8; Spath, 1932, p. 403, text fig. 137).

Finally, attention may be drawn to the fact that there are in this fauna on the one hand some large forms (certain *Pervinquieriae* and *Elobiceras* together with *Puzosia spathi*) tending to attain when complete a diameter of about 300 mm., or even 350 mm. On the other hand, the diameter of complete specimens of all the *Hysteroceras* and *Neokentroceras*, of most of the *Dipoloceras*, of many of the small *Puzosiae* and of some *Prohysteroceras* hardly ever exceeds 30 mm. As far as the *Hysteroceras* and *Neokentroceras* are concerned, this fauna might be considered a dwarfed one. In addition to these small sized, regularly coiled ammonites most of the irregularly coiled ones, viz., those of the genera *Hamites*, *Ptychoceras* and *Pseudhelicoceras*, are also small. All these forms together include almost three-fourths of the total number of individuals. Medium sized forms, however, are much less abundant than even the large ones. It is difficult not to assign some ecological significance to these observations. Ammonites are believed, as a rule, not to have fed upon each other, but there may have been some other, still unknown reasons of faunal economy for associating hosts of very small creatures with others about ten times as large and with comparatively few of intermediate sizes.

Relations to Other Faunas; Palaeogeographical and Stratigraphical Results

For comparison of the present fauna with more or less contemporary ones the reader is referred to the Tables I and II and to some of the following notes. The signs used in the tables as well as in the faunal list indicate that the form described in the present paper is thought to be identical with (=) the form described elsewhere or that both are comparable (cf.) or closely related (aff.) to, or a variety (var.) or a subspecies (ssp.)[2] of each other. To avoid further complication, the sign "var." also is used in those cases where a form described in this paper is thought to be a variety not immediately of the typical form of the species recorded from elsewhere but of its Angolan subspecies.

The list of faunas compared in the Tables and in the following notes is by no means complete, nor could completeness be aspired to, as it would have been technically impossible as well as superfluous to include all existing quotations of species often recorded from all over the world, as e.g., *Hysteroceras varicosum*, *Pervinquieria inflata*, *Phylloceras velledae*, *Beudanticeras beudanti*, *Hamites virgulatus* or *Anisoceras armatum*. Emphasis was rather laid on listing the Albian (and Lower Cenomanian ?, see below) assemblages of Africa on the one hand (Table I) and the classical faunas of the Gault and Greensand of Europe (Sainte Croix, France, England) on the other (Table II) as carefully as possible and, furthermore, on making differentiations among the latter stratigraphically as far as possible; in the English Gault, in particu-

[1] The simultaneous trend toward decrease of the degree of involution ("egression of the spiral") seems to be closely connected with the above tendency.

[2] See p. 207, footnote 1.

lar, this subdivision goes as far as Spath's subzones.

Another factor important for the evaluation of the data found in the Tables is the recognition of the extent to which they are influenced by the narrow limitation of species, subspecies and varieties in contemporary usage. It must be kept in mind that only a few decades ago most of the genera listed would have been as many species. It seems to be significant that fourteen (or fifteen ?) of the twenty-one genera discussed appear to be restricted to the Albian.[1]

The effects of this narrow limitation of taxonomic units can best be seen in a comparison of the present fauna with that of the Cretaceous of Texas. Although nine out of twenty-one genera present in the Angolan Albian, viz., *Dipoloceras*, *Neokentroceras*, *Pervinquieria*, *Elobiceras*, *Prohysteroceras*, *Oxytropidoceras*, *Tetragonites*, *Hamites* and *Anisoceras*, are also recorded from the Fredericksburg and Washita groups of Texas, there are surprisingly few identical or closely related species common to the two areas. As far as previous literature is concerned, only one form from Hanha, *Hamites* (?) cf. *nokonis*, was found to be comparable to a Texas species; on the other hand, there occurs in Texas an "*Anisoceras* sp. aff. *armatum*," whereas the true *A. armatum* is present at Hanha. One Texas form thought to be conspecific with *Pervinquieria romeri* and another comparable to another horned *Pervinquieria* from Angola (*P. barbouri*) were encountered in the collections of The American Museum of Natural History, where they had been studied by Adkins. This result seems to be the poorer if compared with the great similarity between the *Oxytropidoceras* of the upper horizon of the Middle Albian of Madagascar, as described by Collignon (*in* Besairie, 1936, pp. 176–188, Pls. XVIII–XX), and those of the Kiamichi formation of Texas, or with that between the Maestrichtian irregularly coiled ammonites from Angola, described in a separate paper (in preparation) and some of the Navarro group of Texas (Stephenson, 1941). However, the diversity of the Upper Middle Albian faunas of Angola on the one hand and of Texas on the other is in part due to facies differences; for example, the almost complete absence from the present fauna of the genus *Oxytropidoceras*—which is also extremely rare in the English Gault (cf. Spath, 1931, pp. 348–351)—must be explained by the fact that the former is chiefly infraneritic, whereas the *Oxytropidoceras*, according to Scott (1940), favor the epineritic habitat.

As seen from the Tables, the present fauna shows the closest affinities to those of the "Vraconnian" of Tunis, of the Upper Albian of Zululand, of the Upper Albian (and "Lower Cenomanian") of Madagascar, of the Upper Greensand of Sainte Croix, Switzerland, of the Upper Albian of France, particularly of the Perte du Rhône and of Savoy, and of the English Gault. Less close relations prevail with the fauna of the Lower Ootatoor group of southern India.[2] However, we must not overlook the fact that these faunal analogies depend to a great extent on the degree of our knowledge of the faunas concerned; it is certainly for this reason that the Tables show, on the one hand, far fewer analogies between this fauna and that of the comparatively nearby Elobey Islands than must certainly exist and, on the other, so many with that of the English Gault which has so thoroughly been studied by Dr. Spath. But even where there are the closest faunal relations, they do not comprehend all the genera to the same degree. Especially *Neokentroceras* and *Elobiceras*, although recorded more or less sporadically also from other parts of the world (see pp. 47, 99), are still dominantly South African genera, and *Neokentroceras* can even be considered as chiefly an Angolan one. In the positive sense, however, the conspecificity of so many Albian forms from Angola, particularly in the genera *Hysteroceras*, *Hamites*, *Anisoceras* and *Idiohamites*, with

[1] Only *Phylloceras*, *Aconeceras*, *Gaudryceras*, *Tetragonites*, *Ptychoceras*, *Idiohamites* and possibly *Hamites* are not.

[2] This fauna (Stoliczka, 1865; Kossmat, 1895–8) has *Pervinquieria inflata*, var. *aequatorealis*, and *Anisoceras armatum*, perhaps also *Phylloceras velledae* and *Anisoceras perarmatum*, in common with the Albian of Angola; furthermore, a form comparable to the Indian *Pervinquieria stoliczkai* and *Puzosia spathi*, which is closely related to the Indian *Puzosia stoliczkai*, a variety of which it was considered by Venzo, occur at Hanha.

forms of the Gault of England and France seems to be one of the most interesting results of the present paper.

This fact as well as the admixture of the few phylloceratids and lytoceratids decidedly indicates an open sea connection during Albian times between the basins of deposition of the European Gault, on the one hand, and that of the Albian of Angola, on the other, around or perhaps intersecting the supposed Brazilio-Ethiopian continent. One cannot here attempt to redraw the Albian palaeogeographic map of the west Atlantic and adjacent regions of Europe and Africa, but it can be said that the worm-like arm of the Tethys, reaching from Tunis about 2000 miles south to Angola, as seen in Gregory's (1922, p. 161) map, looked most improbable from the outset and is certainly inconsistent with the palaeogeographic results of the present study.[1]

Before entering upon the stratigraphic evaluation of Tables I and II, it might be advisable to point out the interpretation here given to some terms used by previous authors:

(1) Szajnocha's (1885) "Middle Cretaceous"[2] of the Elobey Islands, tentatively correlated by that author with Stoliczka's Ootatoor Group, on the one hand, and with "the limestone facies of the Departments Yonne and Aube in the Paris Basin" (Albian?), on the other, but called by him "Cenomanian," is for faunistic reasons believed to be Upper Albian.

(2) Pervinquière's (1907) "Vraconnian" of Tunis is thought to be of the same age, as is also

(3) Böse's (1923) "Vraconnian" of Zacatecas, Mexico.[3]

(4) At least some of the forms described by Boule, Lemoine and Thevenin (1906–07) from the "Lower Cenomanian" of the Mont Raynaud, Madagascar, are here believed to be of Upper Albian age, as may be assumed from the close affinity of that fauna to that of the neighboring Montagne des Français, described as Upper Albian by Besairie (1930); this also seems to be admitted, though indirectly, by Collignon (1932a, p. 5).[4]

(5) Kossmat (1898, p. 30) states that the Lower Ootatoor group of southern India is equivalent to the boundary horizons between Gault and Cenomanian in Europe. The occurrence of fully or almost identical or closely related forms in Angola is, therefore, not surprising.

Keeping all this in mind, one cannot have the slightest doubt concerning the Albian age of the present fauna, a fact which was soundly established by Spath in 1922. There remains only the more precise correlation of the fauna within the Albian. Spath (1922, p. 157) had thought it to be probably equivalent to his beds XI–XIII of the English Gault, i.e., the four uppermost subzones (*auritus* to *dispar-perinflatum*) of the Upper Gault (= Upper Albian). However, the abundance of *Hysteroceras*, particularly of subspecies and varieties of *H. varicosum* and *H. orbignyi*, makes it necessary to include also the *varicosum*- and *orbignyi*-subzones corresponding to beds X and IX, while the similar abundance of *Dipoloceras rectangulare* and the presence of a subspecies of *D. symmetricum* require also the inclusion of the *cristatum*-subzone (= bed VIII) within the range of the Angolan Albian. Thus its lower boundary has to be shifted into the Lower Gault (= Middle Albian). However, *Dipoloceras* is not the only genus requiring this shift. Since both *Hysteroceras orbignyi* and H. *varicosum* are associated with *Pervinquieria arietiformis* and with some large *Elobiceras* (see pp. 138, 206) and since, according to Spath (1934, p. 472), "the *Mortoniceras-Elobiceras* bearing series" is above the beds with *Neokentroceras* which in turn never occurs together with *Hysteroceras orbignyi*

[1] Cf. Spath (1922, p. 155), "That this bay, however, was open, and not a narrow arm. . . ."

[2] The writer follows Spath's (1941b) example in believing that the Lower Cretaceous should include the Albian and the Upper Cretaceous the Cenomanian and that no term "Middle Cretaceous" should be admitted.

[3] This fauna has *Phylloceras velledae* and *Anisoceras saussureanum*, var. *spinosa*, and perhaps also *Hamites tenuis* in common with the Albian of Angola; in addition, it includes a *Hysteroceras* ("*Brancoceras* aff. *varicosum*") and some *Hamites* (*H.* "aff. *carpentieri*" and *H.* "aff. *attenuatus*") which are more or less closely related to forms occurring at Hanha, viz., *Hysteroceras varicosum* and its varieties and *Hamites compressus*, var. *gracilis*, respectively.

[4] Spath (1922, p. 151) also quotes the "Cenomanian" of Boule, Lemoine and Thevenin in quotation marks.

TABLE II

AMMONITES FROM ANGOLA RELATED TO FORMS OF SOME EUROPEAN FAUNAS	STE. CROIX (I)[1] (SWITZERLAND)	FRANCE					
	(Lower ?), Middle Gault	Upper Greensand	Lower Albian, Balme de Rencurel, Isère (II)	Middle Albian, Escragnolles, Clar (III) (IV) (V)	Gault, various localities (III)	Upper Albian, Haute Savoie: Mtge. des Fiz, Reposoir. (III) (VI)	Upper Albian, Perte du Rhône, Ain (III) (IV) (VI)
FROM HANHA							
Dipoloceras bouchardianum	....	....	....	....	=	=	=
" " , var. *alticarinata*	....	....	....	....	var.	var.	var.
" *rectangulare*	....	....	....	....	....	....	....
" *symmetricum*, var. *obesa*	....	....	....	....	....	....	....
Hysteroceras varicosum	....	=	....	....	=	=	....
" " , var. *angolana*	....	ssp.	....	....	ssp.	ssp.	....
" " , " *rarecostata*	....	var.	....	....	var.	var.	....
" *orbignyi* , " *minor*	....	....	....	....	ssp.	ssp.	....
" " , " *evoluta*	....	....	....	....	var.	var.	....
" *binum* , " *lobitoensis*	....	....	....	....	....	....	....
" " , cf. " "	....	....	....	....	....	....	....
" " , " *angusteumbilicata*	....	....	....	....	....	....	....
" cf. *subbinum* ?	....	....	....	....	....	....	....
" *carinatum*	....	....	....	....	=	....	....
" " , var. *robustecostata*	....	....	....	....	var.	....	....
" " , " *exigua*	....	....	....	....	var.	....	....
Pervinquieria inflata, " *aequatorealis*	....	....	....	....	var.	var.	var.
Phylloceras velledae	....	=	....	....	=	=?	=?
Puzosia quenstedti, var. *angolana*	....	....	var.	ssp.	....	....	ssp.
" " , " *applanata*	....	....	var.	var.	....	....	var.
Beudanticeras beudanti	=	....	=	=?	=	=	=
Tetragonites jurinianus, var. *angolana*	....	....	ssp.	....	....	ssp.	....
Hamites compressus	....	....	....	....	....	=	=
" " , var. *gracilis*	....	=?	....	....	....	var.	var.
" *tenuis*	....	....	....	....	....	....	....
" " , var. *subacuaria*	....	....	....	....	....	....	....
" *virgulatus*	....	=	....	....	=	=	=?
" *subvirgulatus* ?	....	....	....	....	....	....	....
" *venetzianus*	....	....	....	....	....	....	=
" *duplicatus*	....	....	....	....	....	=	....
Anisoceras armatum	....	=	....	....	=?	=	=
" *perarmatum*?	....	=?	....	....	....	=?	....
" (?) indet. sp.	....	....	....	....	....	....	....
Idiohamites (?) " sp.	....	....	....	....	....	....	....
Pseudhelicoceras cf. *quadrituberculatum*	....	....	....	cf.	....	....	....
FROM LOCALITIES SOUTH OF BENGUELA VELHA							
Anisoceras saussureanum, var. *spinosa*	....	ssp.	....	....	....	ssp.	ssp.
Idiohamites spiniger	....	....	....	....	....	....	=
" aff. *subspinigero*	....	....	....	....	....	....	....

[1] REFERENCES (see Bibliography): I = Pictet and Campiche, 1858–64. II = Jacob, 1908a. III = d'Orbigny, 1840–42. IV = Quenstedt, 1849. V = Parona and Bonarelli, 1896. VI = Pictet and Roux, 1847–53. VII = Spath, 1923–41.

TABLE II (*Cont.*)

ENGLISH GAULT[1] Folkestone and other localities (VII)											
LOWER (= MIDDLE ALBIAN)										UPPER (= UPPER ALBIAN)	
dentatus		*lautus*				zones / subzones	*inflatus*			*dispar*	
intermedius	*niobe*	*subdelaruei*	*lautus-nitidus*	*daviesi*	*cristatum*	*orbignyi*	*varicosum*	*auritus*	*aequatorealis*	*substuderi*	*dispar-perinflatum*
....	....	....	....	....	=	=	....	....	....	....	....
....	....	....	....	....	var.	=	....	....	....	....	....
....	....	....	....	....	=	....	....	....	....	....	....
....	....	....	....	....	ssp.	....	....	....	....	....	....
....	....	....	....	....	....	....	=	....	....	....	....
....	....	....	....	....	....	....	ssp.	....	....	....	....
....	....	....	....	....	....	....	var.	....	....	....	....
....	....	....	....	....	ssp.	ssp.	ssp.	ssp.	....	....	....
....	....	....	....	....	=?	=?	....	....	....	....	....
....	....	....	....	....	....	....	ssp.	....	....	....	....
....	....	....	....	....	....	....	var.	....	....	....	....
....	....	....	....	....	....	....	var.	....	....	....	....
....	....	....	....	....	....	cf.?	cf.	cf.	....	....	....
....	....	....	....	....	....	=?	=	=	=	....	....
....	....	....	....	....	....	var.?	var.	var.	var.	....	....
....	....	....	....	....	....	var.?	var.	var.	var.	....	....
....	....	....	....	....	....	....	....	var.	=	....	....
....	....	....	....	....	....	....	....	....	....	var.	var.
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	=	=	=	=	=	....	....
....	....	....	....	....	....	....	....	....	....	....	....
=	=	=	=	=	=	....	....	....	....	....	....
=	=	=	=	=	=	....	....	....	....	....	....
....	....	....	=	=	=	....	....	....	....	....	....
....	....	....	=	=	=	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	=?	=	....
....	....	....	....	....	....	....	....	....	=?	=?	....
....	....	....	....	....	....	....	....	....	=	=	....
....	....	....	....	....	....	....	....	....	....	=	=
....	....	....	....	....	....	....	....	=?	=	=	=
....	....	....	....	....	....	....	....	....	=?	=	=
....	....	....	....	....	....	....	aff.	aff.	....	....	....
....	....	....	....	....	....	aff.	aff.	aff.	....	....	....
....	....	....	....	....	....	aff.	aff.	aff.	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	=	=	....	....	....	....
....	....	....	....	....	....	aff.	aff.	....	....	....	....

[1] Subdivided according to Spath's (1941, p. 668) last table.

EXPLANATION OF SIGNS: Forms compared are: =, equal; cf., comparable to, aff., closely related to, var., a variety of, ssp., a subspecies of each other.

or *H. varicosum*, we must place *Neokentroceras* beneath the subzones of these two species and, therefore, refer this genus also to the uppermost zones of the Lower Gault. Furthermore, *Hamites compressus* and *H. tenuis* and their varieties, present in this collection, are restricted in England to the *subdelaruei-*, *lautus-nitidus-*, *daviesi-* and *cristatum*-subzones corresponding to beds IV–VIII of the Lower Gault. From all these facts it can well be inferred that *the Albian of Angola is equivalent to the upper part of the Lower Gault* (= *Middle Albian*) *and to the Upper Gault* (= *Upper Albian*). How much of the Lower Gault must be included in its stratigraphic range cannot be determined with any exactitude, but it might be cautious to think of from two to three of its subzones.

On the other hand, neither the occurrence of the widely spread *Beudanticeras beudanti* in bed VIII of the English Gault and in the Middle and even Lower Albian of France nor that of *Puzosia quenstedti* at Escragnolles (Middle Albian) and of its variety *bonarellii* Breistroffer at the Balme de Rencurel (Lower Albian) nor that of the typical *Tetragonites jurinianus* at the latter locality would necessitate the correlation of the lower horizons of the ammonitiferous limestones of Angola with the Middle or even Lower Albian, as *Beudanticeras beudanti* ranges up to the *aequatorealis*-subzone of the Upper Gault and is also found in the Upper Albian of the Perte du Rhône, together with *Puzosia quenstedti*, and of Savoy, together with *Tetragonites jurinianus*.

As to the indications of zonal differentiation within the ammonite fauna of Hanha reference is made to pp. 138–140, 206, 207.

Some doubt might arise as to whether rocks as thin as those which have furnished the present collection (cf. p. 3) are likely to represent the comparatively wide stratigraphic range arrived at above. However, the manner in which the fossils are crowded together, sometimes almost to the exclusion of barren rock, strongly suggests a very slow rate of deposition of sediment; its thinness might thus well be consistent with the length of time corresponding to the assumed stratigraphic range.

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[1] The complete paper (Fortschr. Geol. u. Palaeont., 1940, XII, Fasc. 41, vii + 104 pp., 33 text figs., 1 pl.) has not as yet arrived in the United States.

[2] "Spath 1923"—"Spath 1941" without small letters refer to parts I–XIV of this Monograph, according to their years of appearance.

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PLATES I–XLVII

Unless otherwise indicated, the figures are natural size in Plates XXXVII–XLVI, and about ninety-five per cent of natural size in Plates I–XXXVI. Also where a ratio of enlargement or reduction is indicated in the explanations of Plates I–XXXVI, the actual size of the figures concerned is about five per cent smaller.

In the suture line plates the scale and the diameter of the conch ("D") or, for the *Hamites*, the dorso-ventral diameter ("H") are indicated for every drawing.

Unless otherwise indicated, the specimens are from the Albian of Hanha, near Lobita, Angola.

Plate I

Figs. 1, 2. *Dipoloceras bouchardianum* (d'Orbigny). Fig. 1: A.M.N.H. No. 25095:1, (a) right side view, (b) section of outer whorl, (c) ventral view. Fig. 2: A.M.N.H. No. 25095:3, right side view, showing a flared rib.

Fig. 3. *Dipoloceras bouchardianum* (d'Orbigny), var. *alticarinata* Spath; A.M.N.H. No. 25096, (a) right side view, (b) ventral view.

Figs. 4–14. *Dipoloceras rectangulare* Spath. Fig. 4: A.M.N.H. No. 25097:1, (a) right side view, (b) ventral view. Fig. 5: A specimen with coarser ribbing, A.M.N.H. No. 25097:3, left side view. Fig. 6: A.M.N.H. No. 25097:4, (a) left side view, (b) ventral view. Fig. 7: A.M.N.H. No. 25097:5, (a) left side view of inner whorl (× 2), (b) right side view, (c) ventral view, (d) sectional view (× 3/2). Fig. 8: A specimen with flared ribs, A.M.N.H. No. 25097:6, (a) left side view, (b) ventral view. Fig. 9: A.M.N.H. No. 25097:7, (a) left side view, showing flared ribs, (b) ventral view. Fig. 10: A.M.N.H. No. 25097:8, (a) right side view, showing flared ribs, (b) ventral view. Fig. 11: A.M.N.H. No. 25097:10, (a) ventral view of inner whorl (× 2), (b) right side view, (c) ventral view, (d) section, all of outer whorl. Fig. 12: A.M.N.H. No. 25097:11, whorl section (× 2). Fig. 13: A.M.N.H. No. 25097:12, whorl section (× 2). Fig. 14: A.M.N.H. No. 25097:19, whorl section.

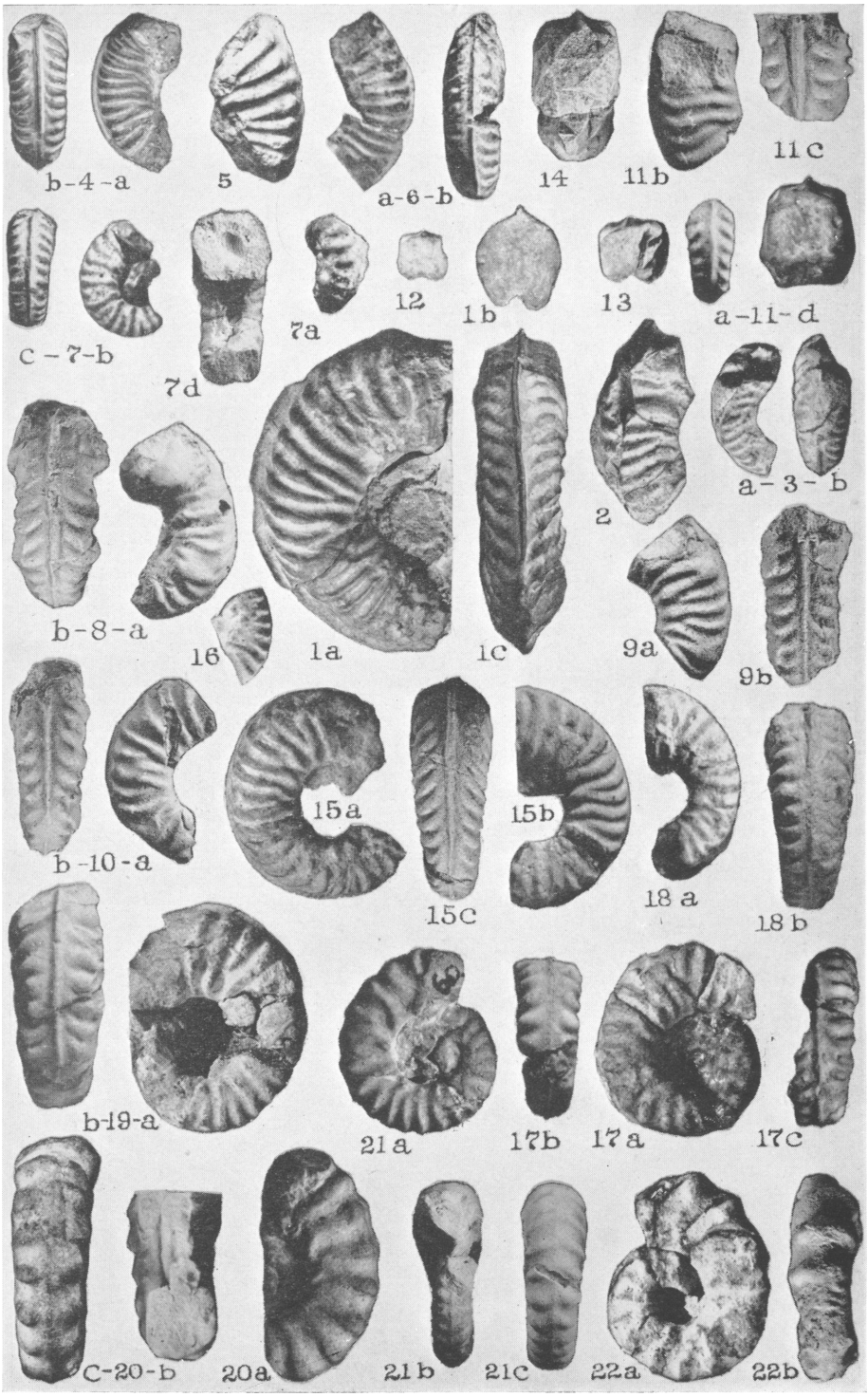
Figs. 15, 16. *Dipoloceras rectangulare* Spath, var. *elegans*, new variety. Fig. 15: Holotype, A.M.N.H. No. 25098:1, (a) right, (b) left side view, (c) ventral view (all × 3/2). Fig. 16: Fragment, A.M.N.H. No. 25098:2, left side view.

Figs. 17–19. *Dipoloceras symmetricum* (Sowerby), var. *obesa*, new variety. Fig. 17: Holotype, A.M.N.H. No. 25099:1, (a) right side view, (b, c) ventral views of outer whorl (all × 3/2). Fig. 18: A specimen with slightly denser costation, A.M.N.H. No. 25099:3, (a) left side view, (b) ventral view (both × 3/2). Fig. 19: A.M.N.H. No. 25099:4, (a) left side view, (b) ventral view (both × 3/2).

Fig. 20. *Hysteroceras varicosum* (Sowerby); A.M.N.H. No. 25100:1, (a) left side view, (b) sectional view, (c) ventral view (all × 3/2).

Fig. 21. *Hysteroceras varicosum* (Sowerby), var. *angolana* Haas; A.M.N.H. No. 25101:60, (a) right side view, (b) frontal view, (c) ventral view (all × 3/2).

Fig. 22. *Hysteroceras varicosum* (Sowerby), var. *rarecostata*, new variety; holotype, A.M.N.H. No. 25102, (a) left side view, (b) ventral view (both × 3/2).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1c
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18a
18b
15c
b-19-a
21a
17b
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C-20-b
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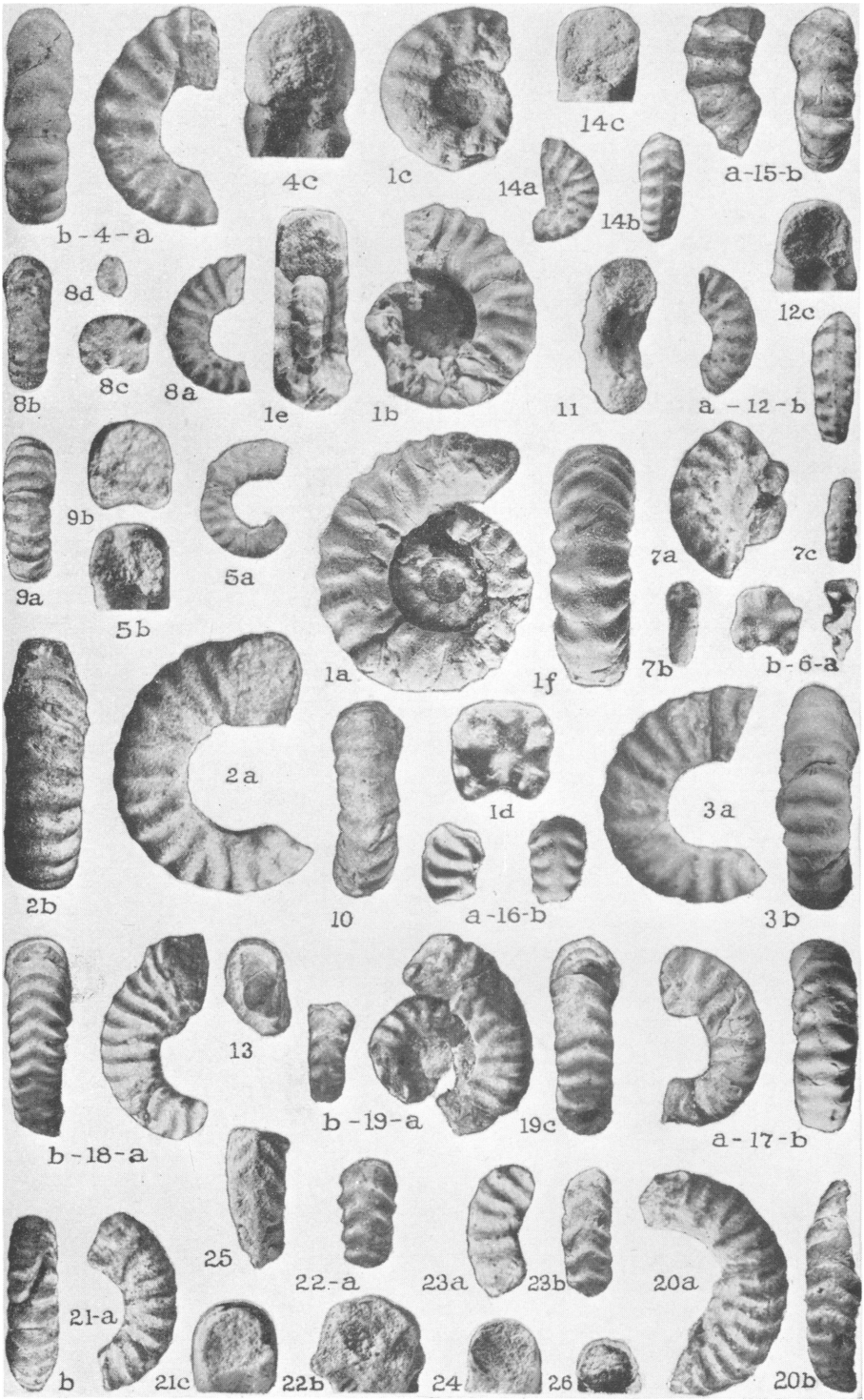
22b

Plate II

Figs. 1–17. *Hysteroceras varicosum* (Sowerby), var. *angolana* Haas. Fig. 1: Holotype, A.M.N.H. No. 25101:1, (a) right side view (× 2), (b) left side view (× 3/2), (c) right side view of inner whorls (× 3), (d) section at beginning of outer whorl (× 7/2), (e) ventral view of penultimate whorl and sectional view of outer whorl (× 2), (f) ventral view of outer whorl (× 2). Fig. 2: Paratype, A.M.N.H. No. 25101:2, (a) right side view, (b) ventral view, showing apertural margin (both × 3/2). Fig. 3: A.M.N.H. No. 25101:14, (a) right side view, (b) ventral view (both × 3/2). Fig. 4: A.M.N.H. No. 25101:13, (a) left side view, (b) ventral view (both × 3/2), (c) section at posterior end (× 3). Fig. 5: A.M.N.H. No. 25101:12, (a) right side view (× 3/2), (b) section at anterior end (× 3). Fig. 6: A.M.N.H. No. 25101:11, (a) side view, (b) sectional view of a single camera (both × 3). Fig. 7: A.M.N.H. No. 25101:15, (a) right side view, (b) frontal view, showing smooth innermost whorls (both × 3), (c) ventral view (× 3/2). Fig. 8: A.M.N.H. No. 25101:16, (a) right side view of outer whorl, (b) ventral view (both × 3/2), (c) section at posterior end of outer whorl, (d) section of inner whorl, showing open siphuncular tube (both × 3). Fig. 9: A.M.N.H. No. 25101:21, (a) ventral view (× 3/2), (b) section at posterior end (× 3). Fig. 10: A.M.N.H. No. 25101:22, ventral view (× 3/2). Fig. 11: A.M.N.H. No. 25101:26, sectional view of a septate inner whorl (× 3). Fig. 12: A.M.N.H. No. 25101:30, (a) left side view, (b) ventral view (both × 3/2), (c) section at posterior end (× 3). Fig. 13: A whorl fragment, A.M.N.H. No. 25101:56, sectional view of posterior end, showing a gastropod squeezed into the body chamber (× 3/2). Fig. 14: Specimen transitional to *Hysteroceras choffati* Spath, A.M.N.H. No. 25101:53, (a) left side view, (b) ventral view (both × 3/2), (c) section at anterior end (× 3). Fig. 15: Specimen with less dense and slightly coarser costation, A.M.N.H. No. 25101:52, (a) right side view, (b) ventral view (both × 3/2). Fig. 16: A specimen transitional to *Hysteroceras orbignyi* (Spath), A.M.N.H. No. 25101:54, (a) right side view, (b) ventral view (both × 3/2). Fig. 17: Another specimen transitional to *Hysteroceras orbignyi* (Spath), A.M.N.H. No. 25101:55, (a) left side view, (b) ventral view (both × 3/2).

Figs. 18–26. *Hysteroceras orbignyi* (Spath), var. *minor*, new variety. Fig. 18: Holotype, A.M.N.H. No. 25103:4, (a) right side view, (b) ventral view (both × 3/2). Fig. 19: Paratype, A.M.N.H. No. 25103:10, (a) left side view, (b, c) ventral views of posterior quarter and of anterior third, respectively, of outer whorl (all × 3/2). Fig. 20: A.M.N.H. No. 25103:1, (a) left side view, (b) ventral view (both × 3/2). Fig. 21: A.M.N.H. No. 25103:12, (a) left side view, (b) ventral view (both × 3/2), (c) section at posterior end (× 3). Fig. 22: A.M.N.H. No. 25103:14, (a) ventral view (× 3/2), (b) section at anterior end (× 3). Fig. 23: A.M.N.H. No. 25103:13, (a) right side view, (b) ventral view (both × 3/2). Fig. 24: A.M.N.H. No. 25103:23, section at posterior end (× 3). Fig. 25: A.M.N.H. No. 25103:27, ventral view (× 3). Fig. 26: A.M.N.H. No. 25103:47, section at fracture (× 3).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19c
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22-a
23a
23b
20a
21-a
b
21c
22b
24
26
20b

Plate III

Suture lines of:

Fig. 1. *Dipoloceras bouchardianum* (d'Orbigny); A.M.N.H. No. 25095:1, left external saddle and adjacent parts of lobes.

Fig. 2. *Dipoloceras bouchardianum* (d'Orbigny), var. *alticarinata* Spath; A.M.N.H. No. 25096, inner whorl.

Figs. 3–6. *Dipoloceras rectangulare* Spath. Fig. 3: A.M.N.H. No. 25097:6. Fig. 4: A.M.N.H. No. 25097:9, inner whorl. Fig. 5: A.M.N.H. No. 25097:10, right external saddle and adjacent lobes. Fig. 6: A.M.N.H. No. 25097:15.

Fig. 7. *Dipoloceras rectangulare* Spath, var. *elegans*, new variety; holotype, A.M.N.H. No. 25098:1.

Fig. 8. *Dipoloceras symmetricum* (Sowerby), var. *obesa*, new variety; holotype, A.M.N.H. No. 25099:1.

Fig. 9. *Hysteroceras varicosum* (Sowerby); A.M.N.H. No. 25100:1, penultimate whorl.

Figs. 10–12. *Hysteroceras varicosum* (Sowerby), var. *angolana* Haas. Fig. 10: A.M.N.H. No. 25101:60, parts of two subsequent suture lines. Fig. 11: A.M.N.H. No. 25101:31. Fig. 12: A.M.N.H. No. 25101:18, two subsequent suture lines.

Figs. 13, 14. *Hysteroceras orbignyi* (Spath), var. *minor*, new variety. Fig. 13: A.M.N.H. No. 25103:41. Fig. 14: A.M.N.H. No. 25103:31.

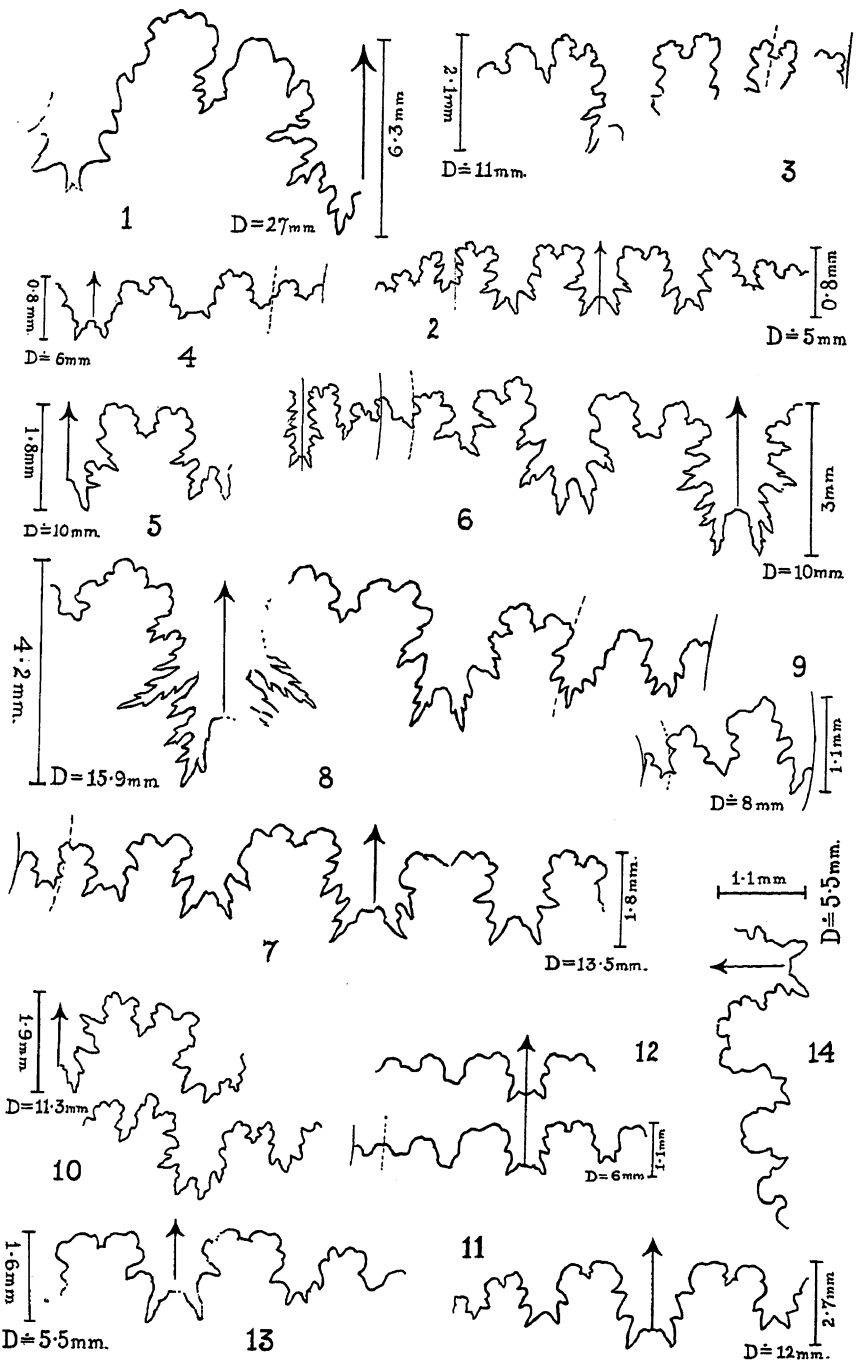
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Plate IV

Figs. 1–5. *Hysteroceras orbignyi* (Spath), var. *minor*, new variety. Fig. 1: A.M.N.H. No. 25103:20, (a) right side view, (b) ventral view (both × 3/2). Fig. 2: A.M.N.H. No. 25103:29, right side view of inner whorl (× 3). Fig. 3: A.M.N.H. No. 25103:37, left side view of inner whorl (× 3). Fig. 4: Fragment of an inner whorl, A.M.N.H. No. 25103:39, (a) right side view, (b) ventral view (both × 3). Fig. 5: A.M.N.H. No. 25103:50, (a) right side view, (b) ventral view (both × 3/2), (c) section at posterior end (× 3).

Figs. 6, 7. *Hysteroceras orbignyi* (Spath), var. *evoluta*, new variety. Fig. 6: Holotype, A.M.N.H. No. 25104:1, (a) left side view, (b) ventral view (both × 3/2). Fig. 7: A.M.N.H. No. 25104:7, right side view (× 3/2).

Figs. 8, 9. *Hysteroceras choffati* Spath. Fig. 8: A.M.N.H. No. 25105:1, (a) ventral view (× 3/2), (b) section of ventral part of whorl at its anterior end (× 2). Fig. 9: A.M.N.H. No. 25105:9, left side view (× 3/2).

Figs. 10, 11. *Hysteroceras choffati* Spath? Fig. 10: A.M.N.H. No. 25105:2, (a) right side view, (b) ventral view (both × 3/2). Fig. 11: A.M.N.H. No. 25105:3, (a) right side view, (b) ventral view (both × 3/2), (c) section at anterior end (× 2).

Fig. 12. *Hysteroceras* cf. *choffati* Spath; A.M.N.H. No. 25106, section at posterior end (× 2).

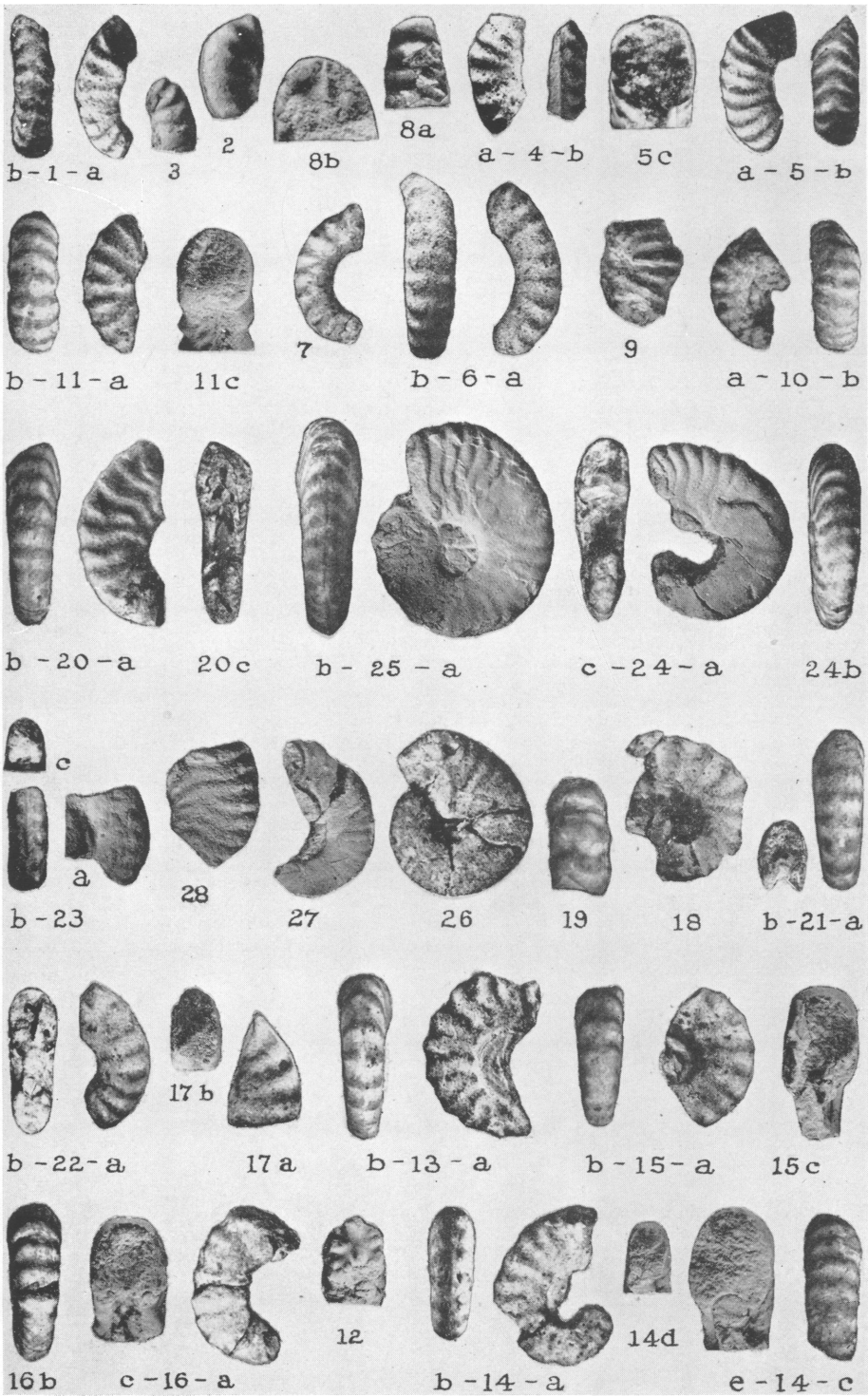
Figs. 13–18. *Hysteroceras binum* (Sowerby), var. *lobitoensis*, new variety. Fig. 13: Holotype, A.M.N.H. No. 25107:1, (a) right side view, (b) ventral view (both × 3/2). Fig. 14: Paratype, A.M.N.H. No. 25107:5, (a) right side view, showing beaded ribs (× 3/2), (b) ventral view of posterior part of outer whorl, showing gradual fading of keel (× 2), (c) ventral view of anterior part of outer whorl (× 3/2), (d, e) sections at posterior and anterior ends (both × 2). Fig. 15: A.M.N.H. No. 25107:4, (a) left side view, showing smooth inner whorls, (b) ventral view (both × 3/2), (c) section at anterior end (× 2). Fig. 16: A.M.N.H. No. 25107:7, (a) right side view, (b) ventral view (both × 3/2), (c) section at fracture, showing impression of penultimate whorl and of its high keel (× 2). Fig. 17: A.M.N.H. No. 25107:13, (a) left side view, (b) section at posterior end (both × 5/2). Fig. 18: Specimen transitional to var. *angusteumbilicata*, new variety, A.M.N.H. No. 25107:8, left side view (× 3/2).

Fig. 19. *Hysteroceras binum* (Sowerby), cf. var. *lobitoensis*, new variety; A.M.N.H. No. 25108, ventral view (× 3/2).

Figs. 20–22. *Hysteroceras binum* (Sowerby), var. *angusteumbilicata*, new variety. Fig. 20: Holotype, A.M.N.H. No. 25109:1, (a) left side view, (b) ventral view, (c) sectional view (all × 3/2). Fig. 21: A.M.N.H. No. 25109:2, (a) ventral view (× 3/2), (b) section at anterior end (× 2). Fig. 22: A.M.N.H. No. 25109:7, (a) left side view, (b) sectional view (both × 3/2).

Fig. 23. *Hysteroceras* cf. *subbinum* Spath ?; A.M.N.H. No. 25110, (a) left side view, (b) ventral view, (c) section at posterior end (all × 3/2).

Figs. 24–28. *Hysteroceras falcicostatum*, new species. Fig. 24: Holotype, A.M.N.H. No. 25111:1, (a) left side view, showing outline of apertural margin, (b) ventral view, (c) sectional view (all × 3/2). Fig. 25: Paratype, A.M.N.H. No. 25111:3, (a) left side view, (b) ventral view, showing vestigial, thread-like keel (both × 3/2). Fig. 26: A.M.N.H. No. 25111:5, left side view, showing late beginning of costation (× 3/2). Fig. 27: A.M.N.H. No. 25111:6, left side view, showing apertural margin (× 3/2). Fig. 28: A.M.N.H. No. 25111:11, left side view, showing details of costation (× 3/2).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14d
b-14-a
e-14-c

Plate V

Figs. 1–5. *Hysteroceras intermedium*, new species. Fig. 1: Holotype, A.M.N.H. No. 25112:1, (a) left side view, (b) ventral view (both × 3/2). Fig. 2: Largest specimen, A.M.N.H. No. 25112:2, (a) right side view, (b) ventral view, (c) sectional view (all × 3/2). Fig. 3: A specimen with distinct costation and vestigial lateral nodes, A.M.N.H. No. 25112:3, (a) right side view, (b) ventral view (both × 3/2). Fig. 4: A.M.N.H. No. 25112:4, section at anterior end (× 3/2). Fig. 5: A.M.N.H. No. 25112:7, section at posterior end (× 3/2).

Fig. 6. *Hysteroceras intermedium*, new species, var. *compressa*, new variety; holotype, A.M.N.H. No. 25113:1, ventral view (× 3/2).

Figs. 7–17. *Hysteroceras carinatum* Spath. Fig. 7: A nucleus, A.M.N.H. No. 25114:1, (a) left side view, (b) ventral view (both × 5/2). Fig. 8: A.M.N.H. No. 25114:2, (a) left side view, showing almost continuous ribs, (b) ventral view, (c) section at anterior end (all × 3/2). Fig. 9: A.M.N.H. No. 25114:3, (a) right side view, showing ribs fading in the middle of the sides, (b) section at anterior end (both × 3/2). Fig. 10: An evolute form, A.M.N.H. No. 25114:5, left side view (× 3/2). Fig. 11: Specimen with comparatively coarse and stiff costation, A.M.N.H. No. 25114:6, (a) right side view, (b) ventral view, (c) section at anterior end (all × 3/2). Fig. 12: Slightly crushed specimen, A.M.N.H. No. 25114:7, (a) left side view, (b) section at fracture (both × 3/2). Fig. 13: A.M.N.H. No. 25114:8, ventral view (× 3/2). Fig. 14: A.M.N.H. No. 25114:10, section at anterior end (× 3/2). Fig. 15: A stouter and more involute form, A.M.N.H. No. 25114:19, (a) left side view, (b) ventral view, (c) section at posterior end (all × 3/2). Fig. 16: Fragment of an inner whorl, A.M.N.H. No. 25114:20, (a) right side view, (b) ventral view, (c) sectional view at posterior end (all × 5/2). Fig. 17: A.M.N.H. No. 25114:27, left side view (× 3/2), showing pre-fossil break in peripheral outline.

Fig. 18. *Hysteroceras carinatum* Spath, var. *robustecostata*, new variety; smallest specimen but one, A.M.N.H. No. 25115:4, (a) right side view, (b) ventral view (both × 3/2).

Fig. 19. *Hysteroceras semilēve*, new species; holotype, A.M.N.H. No. 25117:1, (a) right side view, (b) ventral view (both × 3/2), (c) section at posterior end.

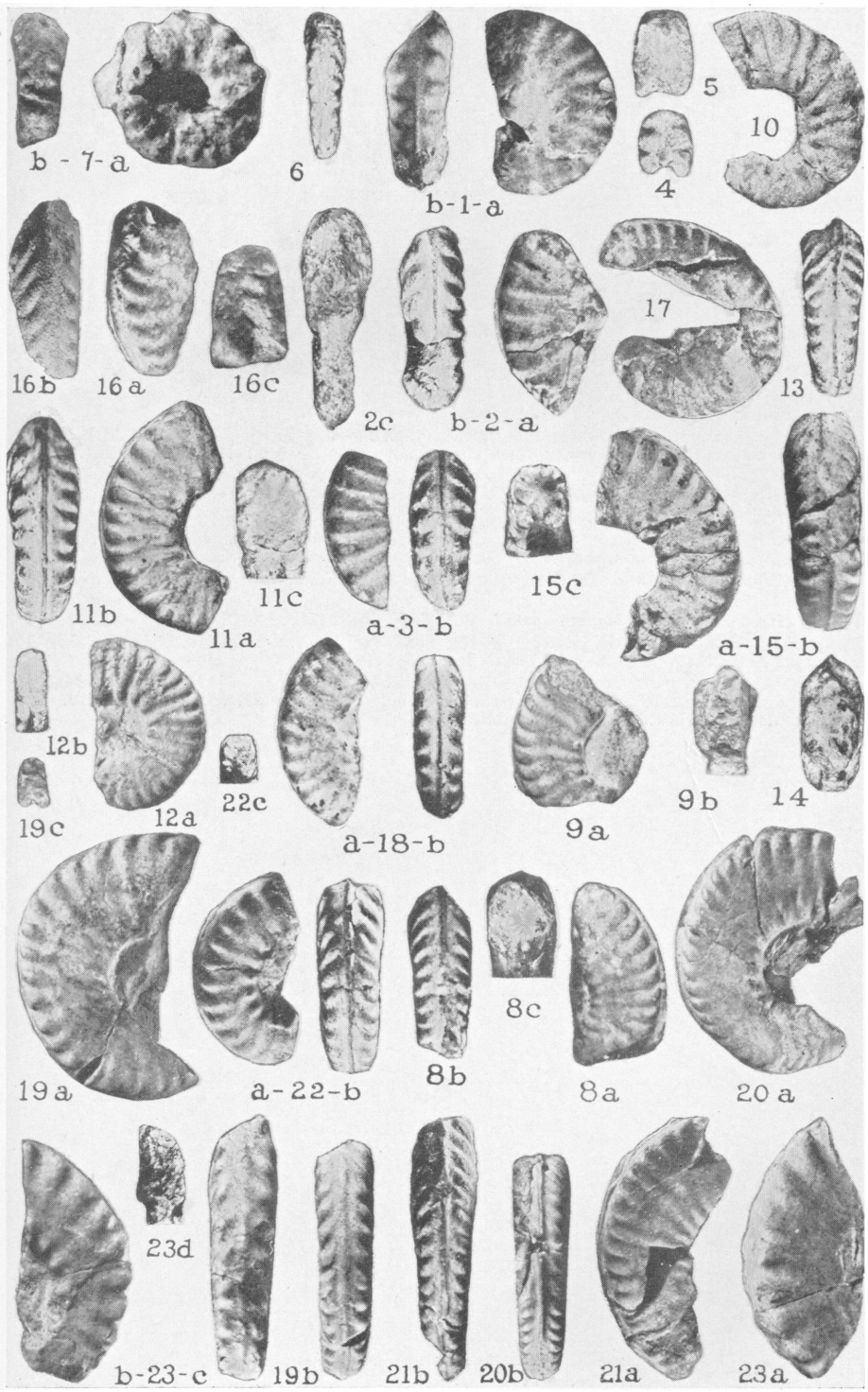
Fig. 20. *Hysteroceras semilēve*, new species, var. *elegans*, new variety; holotype, A.M.N.H. No. 25118:1, (a) right side view, (b) ventral view (both × 3/2).

Fig. 21. *Hysteroceras semilēve*, new species, var. *densicostata*, new variety; holotype, A.M.N.H. No. 25119:1, (a) right side view, (b) ventral view (both × 3/2).

Fig. 22. *Hysteroceras semilēve*, new species, var. *sparsicostata*, new variety; holotype, A.M.N.H. No. 25120:1, (a) right side view, (b) ventral view (both × 3/2), (c) section at posterior end.

Fig. 23. *Hysteroceras propinquum*, new species; holotype, A.M.N.H. No. 25121:1, (a, b) right and left side views, (c) ventral view (all × 3/2), (d) section at anterior end.

Note the following rows of ventral views: vertical, figs. 1b (with 6 for comparison), 2b, 3b, 18b, 8b (with 22b for comparison), 21b; horizontal, figs. 23c, 19b, 21b, 20b.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2c
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11c
a-3-b
15c
a-15-b
12b
19c
12a
22c
a-18-b
9a
9b
14
19 a
a- 22-b
8b
8c
8a
20 a
23d
b-23-c
19b
21b
20b
21a
23a

Plate VI

Suture lines of:

Figs. 1, 2. *Hysteroceras varicosum* (Sowerby), var. *angolana* Haas. Fig. 1: A.M.N.H. No. 25101:16, a very early stage, showing open siphuncular tube. Fig. 2: Holotype, A.M.N.H. No. 25101:1.

Fig. 3. *Hysteroceras choffati* Spath?; A.M.N.H. No. 25105:2.

Fig. 4. *Hysteroceras* cf. *choffati* Spath; A.M.N.H. No. 25106.

Figs. 5, 6. *Hysteroceras binum* (Sowerby), var. *lobitoensis*, new variety. Fig. 5: A.M.N.H. No. 25107:4, (a) inner whorl, (b) outer whorl. Fig. 6: Paratype, A.M.N.H. No. 25107:5.

Fig. 7. *Hysteroceras binum* (Sowerby), var. *angusteumbilicata*, new variety; A.M.N.H. No. 25109:3.

Fig. 8. *Hysteroceras* cf. *subbinum* Spath?; A.M.N.H. No. 25110.

Figs. 9–11. *Hysteroceras falcicostatum*, new species. Fig. 9: A.M.N.H. No. 25111:2. Fig. 10: A.M.N.H. No. 25111:5. Fig. 11: A.M.N.H. No. 25111:15.

Figs. 12–14. *Hysteroceras carinatum* Spath. Fig. 12: A.M.N.H. No. 25114:4, part of a left suture line, beginning with interior half of first lateral lobe. Fig. 13: A.M.N.H. No. 25114:10. Fig. 14: A.M.N.H. No. 25114:19, right first lateral lobe.

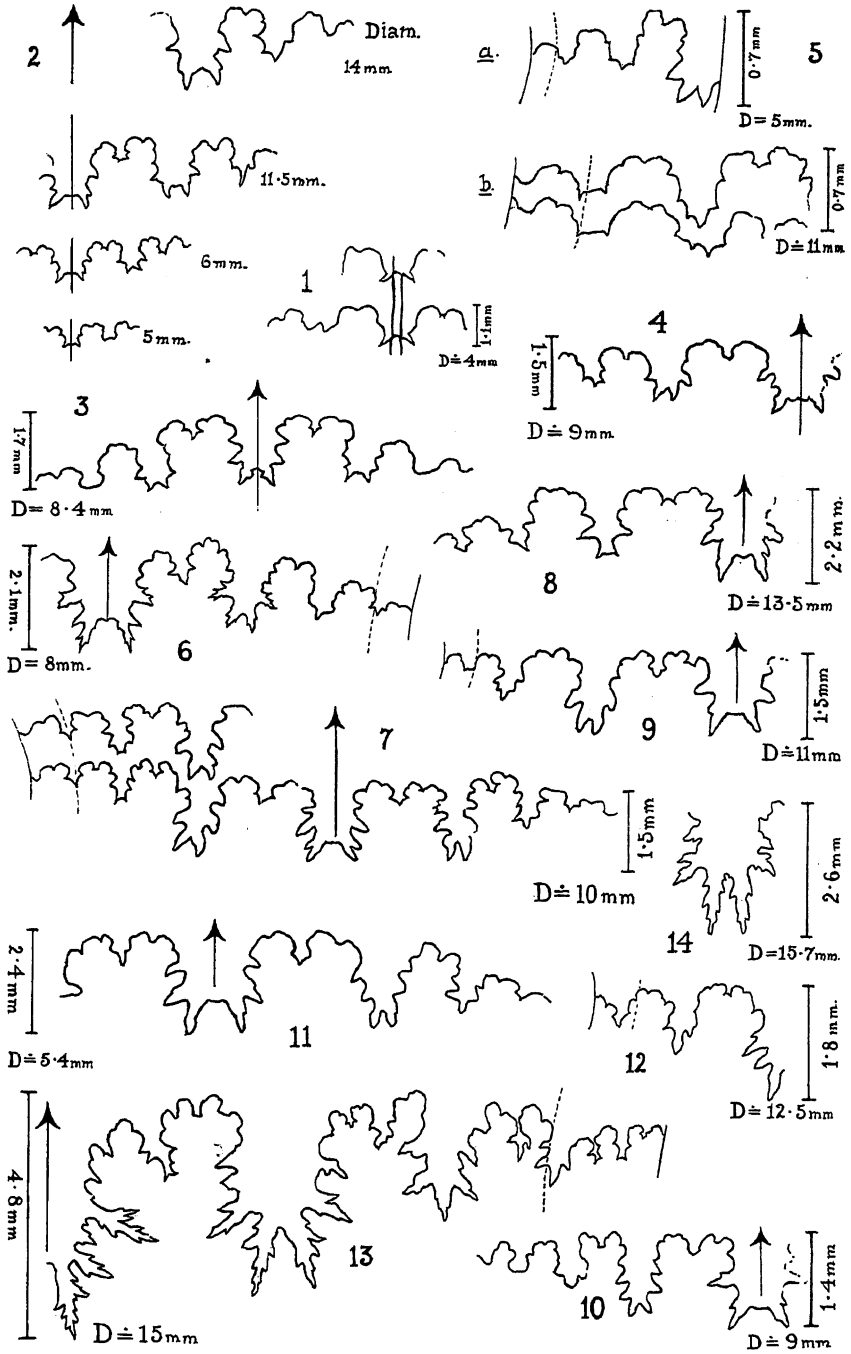

2
Diam.
14mm.
11·5mm.
6mm.
5mm.
1
1·1mm
D=4mm
3
1·7mm
D=8·4mm
2·1mm.
D=8mm.
6
7
1·5mm
D=10mm
2·4mm
D=5·4mm
11
4·8mm
D=15mm
13
a.
0·7mm
5
D=5mm.
b.
0·7mm
D=11mm
4
1·5mm
D=9mm.
8
2·2mm.
D=13·5mm
9
1·5mm
D=11mm
14
2·6mm
D=15·7mm.
12
1·8mm.
D=12·5mm
10
1·4mm
D=9mm

PLATE VII

Figs. 1, 2, 4. *Hysteroceras carinatum* Spath, var. *robustecostata*, new variety. Fig. 1: Holotype, A.M.N.H. No. 25115:1, (a) left side view, (b) section at front end, keel destroyed (both × 3/2). Fig. 2: The smallest specimen, A.M.N.H. No. 25115:3, (a) right side view, (b) ventral view (both × 3/2). Fig. 4: A.M.N.H. No. 25115:5, ventral view (× 3/2).

Figs. 5–7. *Hysteroceras carinatum* Spath, var. *exigua*, new variety. Fig. 5: Holotype, A.M.N.H. No. 25116:1, left side view (× 3/2). Fig. 6: A.M.N.H. No. 25116:4, right side view, slightly oblique (× 3/2). Fig. 7: A.M.N.H. No. 25116:5, ventral view (× 3/2).

Figs. 8–11. *Hysteroceras semilēve*, new species. Fig. 8: Fragment of an inner whorl, A.M.N.H. No. 25117:10, (a) right side view, (b) ventral view (both × 5/2). Fig. 9: A.M.N.H. No. 25117:2, right side view, showing weak ornamentation. Fig. 10: A.M.N.H. No. 25117:8, (a) right side view, showing strong ornamentation, (b) ventral view. Fig. 11: Fragment of a large individual, A.M.N.H. No. 25117:6, ventral view.

Fig. 12. *Hysteroceras semilēve*, new species, var. *elegans*, new variety; fragment of a small specimen, A.M.N.H. No. 25118:4, (a) right side view, (b) ventral view, (c) section at anterior end (all × ca. 5/2).

Fig. 13. *Hysteroceras semilēve*, new species, var. *sparsicostata*, new variety; fragment of a small specimen, A.M.N.H. No. 25120:2, (a) right side view, (b) ventral view (both × ca. 5/2).

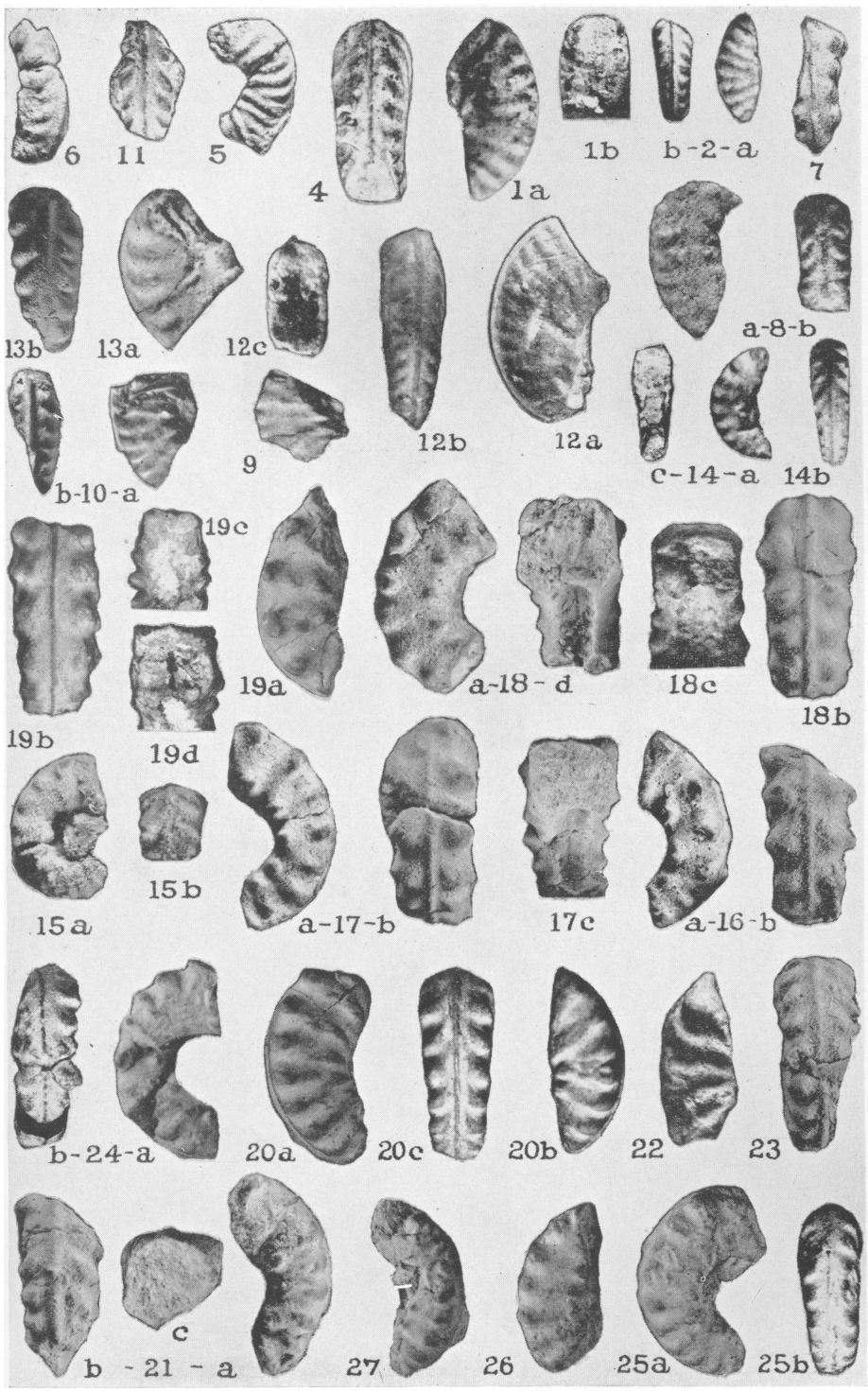
Fig. 14. *Hysteroceras propinquum*, new species; A.M.N.H. No. 25121:2, (a) right side view, (b) ventral view, (c) sectional view.

Figs. 15–18. *Neokentroceras choffati* Spath. Fig. 15: A.M.N.H. No. 25123:1, (a) right side view, (b) ventral view of anterior part (both × 5/2). Fig. 16: A.M.N.H. No. 25123:3, (a) left side view, (b) ventral view (both × 5/2). Fig. 17: A.M.N.H. No. 25123:4, (a) left side view, (b) ventral view, showing at its top deviation of keel, (c) nodal and internodal section at fracture (all × 5/2). Fig. 18: A.M.N.H. No. 25123:5, (a) right side view, (b) ventral view, showing the last tubercle but one on the left side to be notched and stronger than the others, (c, d) sectional views at posterior and anterior ends (all × 5/2).

Fig. 19. *Neokentroceras choffati* Spath, var. *crassinodosa*, new variety; holotype, A.M.N.H. No. 25124, (a) right side view, (b) ventral view, (c, d) nodal and internodal sections at posterior and anterior ends (all × 3/2).

Figs. 20–25. *Neokentroceras costatum*, new species. Fig. 20: Holotype, A.M.N.H. No. 25125:1, (a, b) right and left side views, (c) ventral view (all × 3/2). Fig. 21: A.M.N.H. No. 25125:2, (a) left side view, (b) ventral view, (c) nodal and internodal section at anterior end (all × 5/2). Fig. 22: A.M.N.H. No. 25125:3, right side view (× 5/2). Fig. 23: A.M.N.H. No. 25125:4, ventral view (× 5/2). Fig. 24: Specimen transitional to *Neokentroceras magnum*, new species, A.M.N.H. No. 25125:11, (a) right side view, (b) ventral view (both × 3/2). Fig. 25: Specimen transitional to *Neokentroceras pseudovaricosum* Spath, var. *gracilis*, new variety, A.M.N.H. No. 25125:12, (a) right side view (× ca. 3/2), (b) ventral view (× 3/2).

Figs. 26, 27. *Neokentroceras costatum*, new species, var. *tenuis*, new variety. Fig. 26: Holotype, A.M.N.H. No. 25126:1, right side view (× 3/2). Fig. 27: A.M.N.H. No. 25126:2, left side view (× 3/2).


6
11
5
4
1a
1b
b-2-a
7
13b
13a
12c
12b
12a
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9
c-14-a
14b
19c
19a
a-18-d
18c
18b
19b
19d
15b
15a
a-17-b
17c
a-16-b
b-24-a
20a
20c
20b
22
23
c
b-21-a
27
26
25a
25b

Plate VIII

Fig. 1. *Neokentroceras costatum*, new species, var. *tenuis*, new variety; paratype, A.M.N.H. No. 25126:4, (a) right side view, (b) ventral view (both × 3/2), (c) sectional view at anterior end (× 5/2).

Figs. 2–6. *Neokentroceras magnum*, new species. Fig. 2: Holotype, A.M.N.H. No. 25127:1, (a, b) left and right side views, (c) ventral view, (d) sectional view at anterior end. Fig. 3: A.M.N.H. No. 25127:2, (a) right side view of posterior part, (b) ventral view, (c) section at fracture (all × 3/2). Fig. 4: A.M.N.H. No. 25127:3, (a) right side view, (b) ventral view of posterior part, (c) sectional view at posterior end (all × 3/2). Fig. 5: A.M.N.H. No. 25127:4, (a) right side view, slightly oblique, showing blunt lateral node, (b) ventral view (both × 3/2). Fig. 6: A.M.N.H. No. 25127:12, right side view (× 3/2).

Fig. 7. *Neokentroceras* cf. *subtuberculatum* Spath; A.M.N.H. No. 25128:1, (a) left side view, (b) ventral view, both of outer whorl.

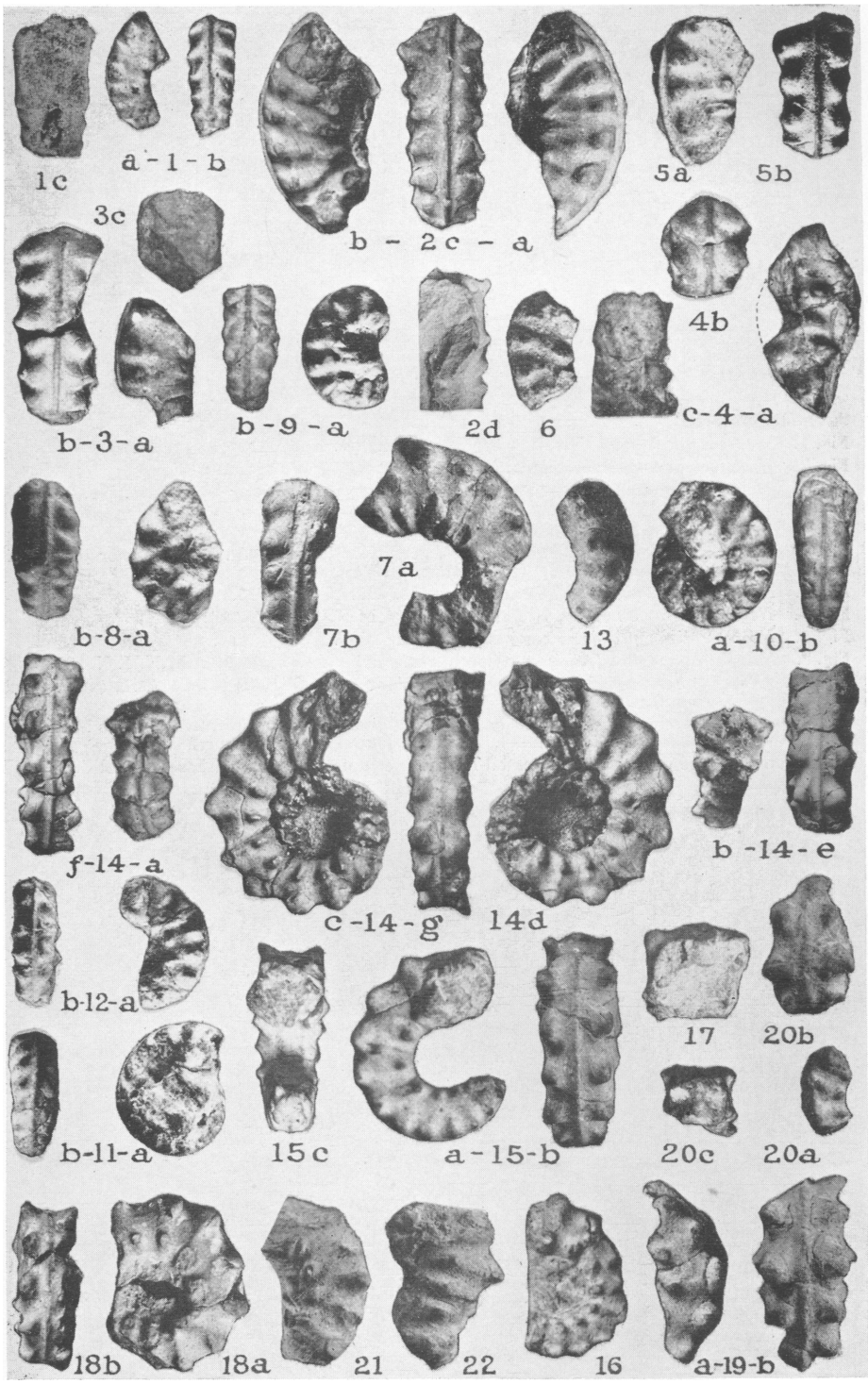
Figs. 8, 9. *Neokentroceras pseudovaricosum* Spath. Fig. 8: A.M.N.H. No. 25129:1, (a) right side view, (b) ventral view (both × 3/2). Fig. 9: A.M.N.H. No. 25129:3, (a) right side view, (b) ventral view (both × 3/2).

Figs. 10–13. *Neokentroceras pseudovaricosum* Spath, var. *gracilis*, new variety. Fig. 10: Holotype, A.M.N.H. No. 25130:1, (a) left side view, (b) ventral view (both × 3/2). Fig. 11: A.M.N.H. No. 25130:2, (a) right side view, (b) ventral view (both × 5/2). Fig. 12: A.M.N.H. No. 25130:3, (a) left side view, (b) ventral view (both × 3/2). Fig. 13: A.M.N.H. No. 25130:4, oblique left side view, showing notched outer tubercles (× 5/2).

Figs. 14–17. *Neokentroceras speciosum*, new species. Fig. 14: Holotype, A.M.N.H. No. 25132:1, (a) ventral view of penultimate whorl, showing open siphuncular tube, (b) sectional view of same at fracture (both × 3/2), (c, d) right and left side views, (e, f) ventral views of posterior part and of a more anterior portion of outer whorl, (g) ventral view, showing fading of keel. Fig. 15: Paratype, A.M.N.H. No. 25132:2, (a) right side view, (b) ventral view, (c) sectional view, showing the impressed zone to be deeper than in the holotype (all × 3/2). Fig. 16: A.M.N.H. No. 25132:3, left side view. Fig. 17: A.M.N.H. No. 25132:5, nodal and internodal section at posterior end (× 3/2).

Figs. 18, 19. *Neokentroceras speciosum*, new species, var. *rudis*, new variety. Fig. 18: Holotype. A.M.N.H. No. 25133:1, (a) left side view, (b) ventral view. Fig. 19: A.M.N.H. No. 25133:2, (a) right side view, (b) ventral view (both × 3/2).

Figs. 20–22. *Neokentroceras curvicornu* Spath? Fig. 20: A.M.N.H. No. 25134:1, (a) right side view, showing one lateral tubercle, (b) ventral view, (c) section at posterior end (both × 3/2). Fig. 21: A.M.N.H. No. 25134:2, left side view (× 3/2). Fig. 22: A.M.N.H. No. 25134:3, left side view (× 3/2), showing one almost spinous outer tubercle pointing slightly backward.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7b
7a
13
a-10-b
f-14-a
c-14-g
14d
b-14-e
b-12-a
17
20b
b-11-a
15c
a-15-b
20c
20a
18b
18a
21
22
16
a-19-b

Plate IX

Suture lines of:

Fig. 1. *Hysteroceras intermedium*, new species; A.M.N.H. No. 25112:5.

Fig. 2. *Hysteroceras carinatum* Spath; A.M.N.H. No. 25114:27, last suture line.

Fig. 3. *Hysteroceras semilēve*, new species, var. *elegans*, new variety; A.M.N.H. No. 25118:2, last suture lines.

Fig. 4. *Neokentroceras choffati* Spath; A.M.N.H. No. 25123:6.

Fig. 5. *Neokentroceras costatum*, new species ?; A.M.N.H. No. 25125:18, (a) lower part of siphonal lobe, (b) top of external saddle, (c) bottom of first lateral lobe.

Fig. 6. *Neokentroceras magnum*, new species; A.M.N.H. No. 25127:3.

Fig. 7. *Neokentroceras* cf. *subtuberculatum* Spath; A.M.N.H. No. 25128:1.

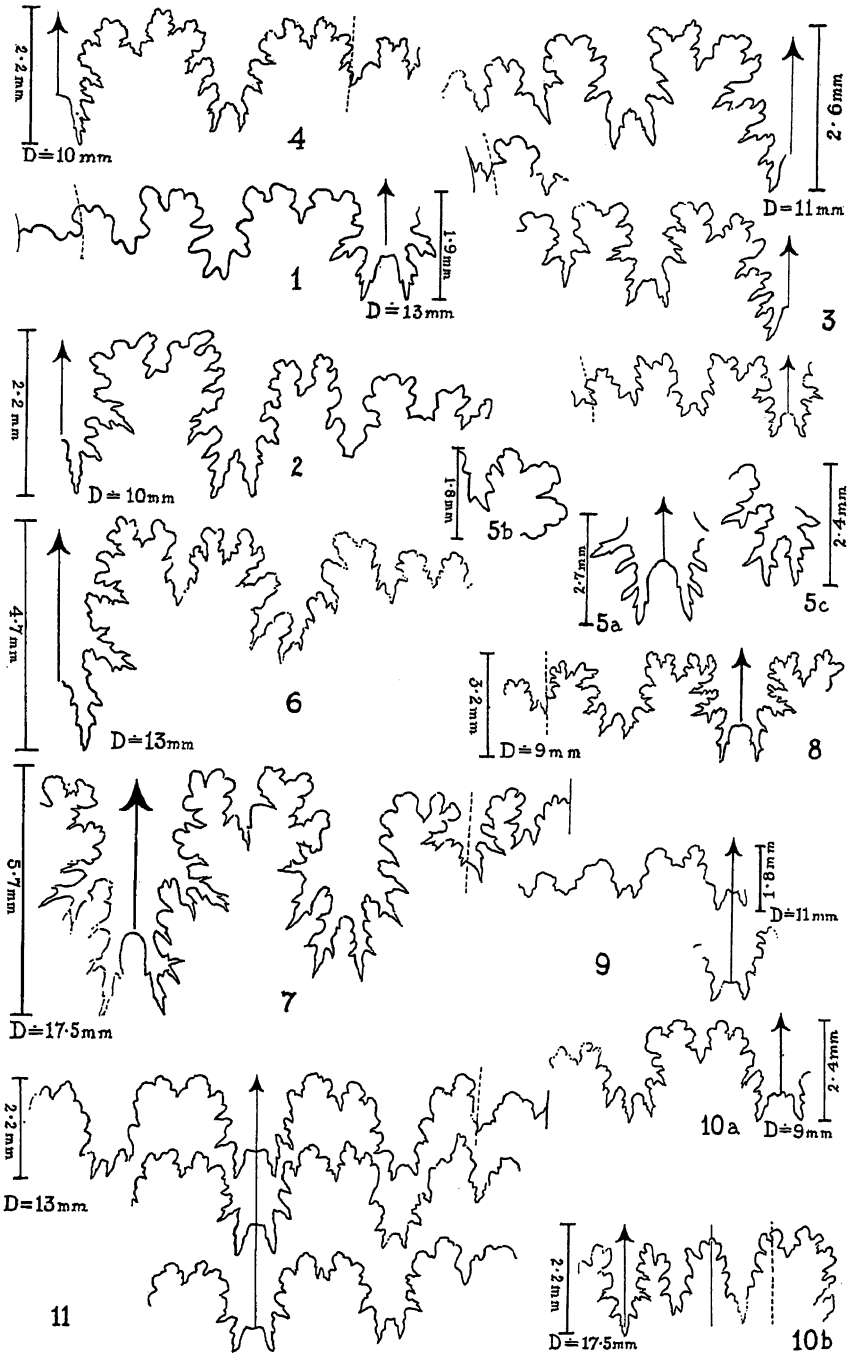
Fig. 8. *Neokentroceras pseudovaricosum* Spath; A.M.N.H. No. 25129:8.

Fig. 9. *Neokentroceras pseudovaricosum* Spath, var. *gracilis*, new variety; A.M.N.H. No. 25130:3,

Fig. 10. *Neokentroceras speciosum*, new species; holotype, A.M.N.H. No. 25132:1, (a) external. (b) internal part of a suture line.

Fig. 11. *Neokentroceras singulare*, new species; holotype, A.M.N.H. No. 25135, three last suture lines, showing gradual lengthening of first lateral lobe, as compared to siphonal one.

No diameter of the disc can be indicated for the incomplete fragment whose sutural details are depicted in fig. 5.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D=10 mm
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1
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2·2 mm
D=10 mm
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1·8 mm
5b
2·7 mm
5a
2·4 mm
5c
4·7 mm
D=13 mm
6
3·2 mm
D=9 mm
8
5·7 mm
D=17·5 mm
7
1·8 mm
D=11 mm
9
2·2 mm
D=13 mm
11
10a
D=9 mm
2·4 mm
2·2 mm
D=17·5 mm
10b

Plate X

Fig. 1. *Neokentroceras singulare*, new species; holotype, A.M.N.H. No. 25135, (a) left side view, (b, c) ventral views of posterior and anterior parts of outer whorl.

Figs. 2, 3. *Neokentroceras* (?), indeterminate new species. Fig. 2: A.M.N.H. No. 25136:1, right side view (× 5/2). Fig. 3: A.M.N.H. No. 25136:2, ventral view (× 5/2).

Fig. 4. *Pervinquieria inflata* (Sowerby), var. *aequatorealis* Kossmat; A.M.N.H. No. 25138, (a) left side view, (b) right side view, without foremost part, (c) ventral view (all × 3/4).

Figs. 5, 6. *Pervinquieria margaritata*, new species. Fig. 5: Holotype, A.M.N.H. No. 25139:1, right side view. Fig. 6: Paratype, A.M.N.H. No. 25139:2, (a) left side view, (b) ventral view of posterior part of outer whorl, showing open siphuncular tube.

Fig. 7. *Pervinquieria* cf. *stoliczkai* Spath; A.M.N.H. No. 25140, (a) left side view, (b) frontal view, (both × 2/5), (c) ventral view (× ca. 1/2); keel destroyed except at one spot.

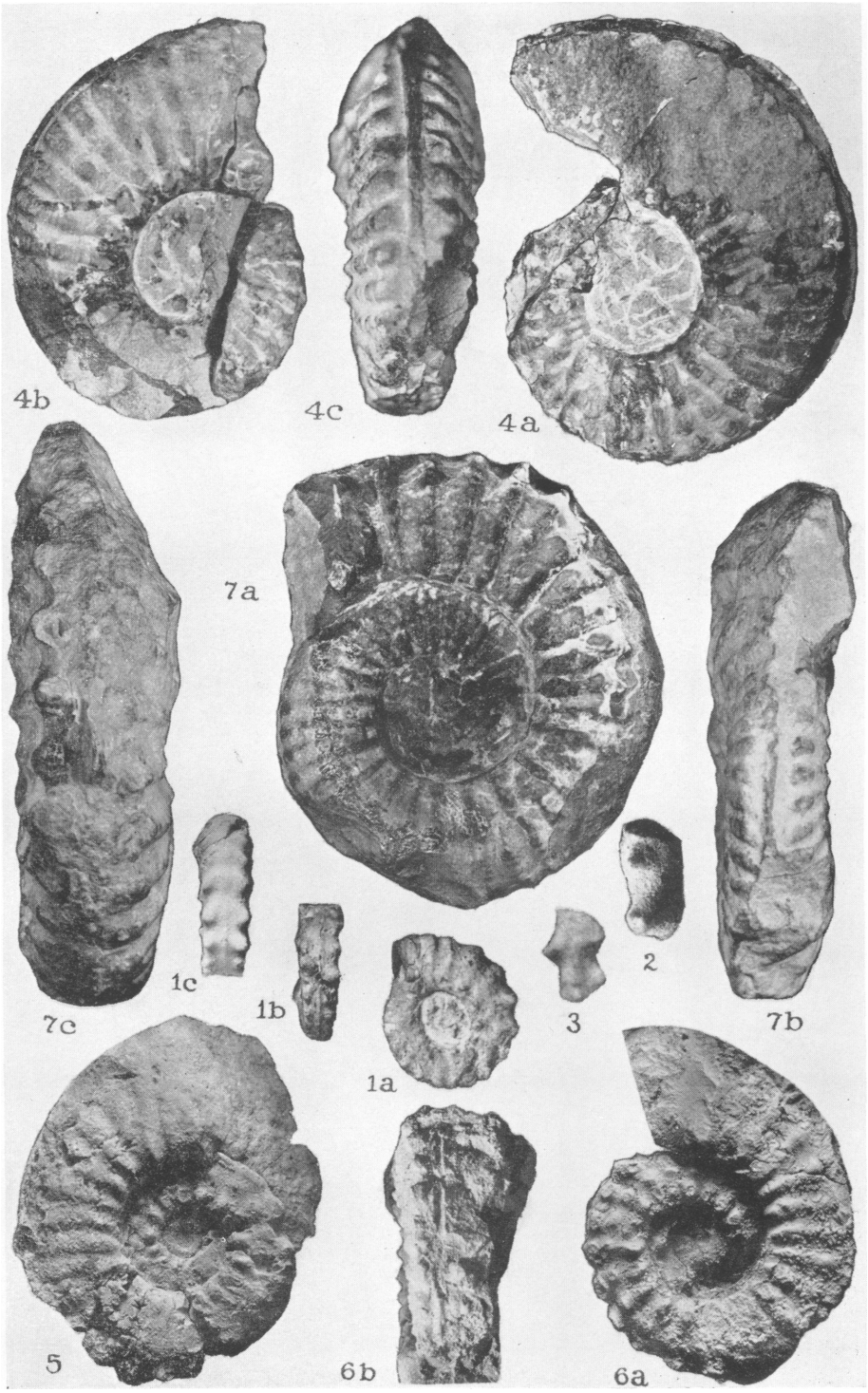

4b
4c
4a
7a
7c
1c
1b
1a
2
3
7b
5
6b
6a

PLATE XI

Figs. 1, 2. *Pervinquieria romeri*, new species. Fig. 1: Holotype, A.M.N.H. No. 25141:2, (a) right side view, (b) ventral view, (c) section at anterior end (all × 1/2). Fig. 2: Paratype, A.M.N.H. No. 25141:1, (a) left side view, (b) ventral view (both × 7/12), (c) section at anterior end (× 1/2).

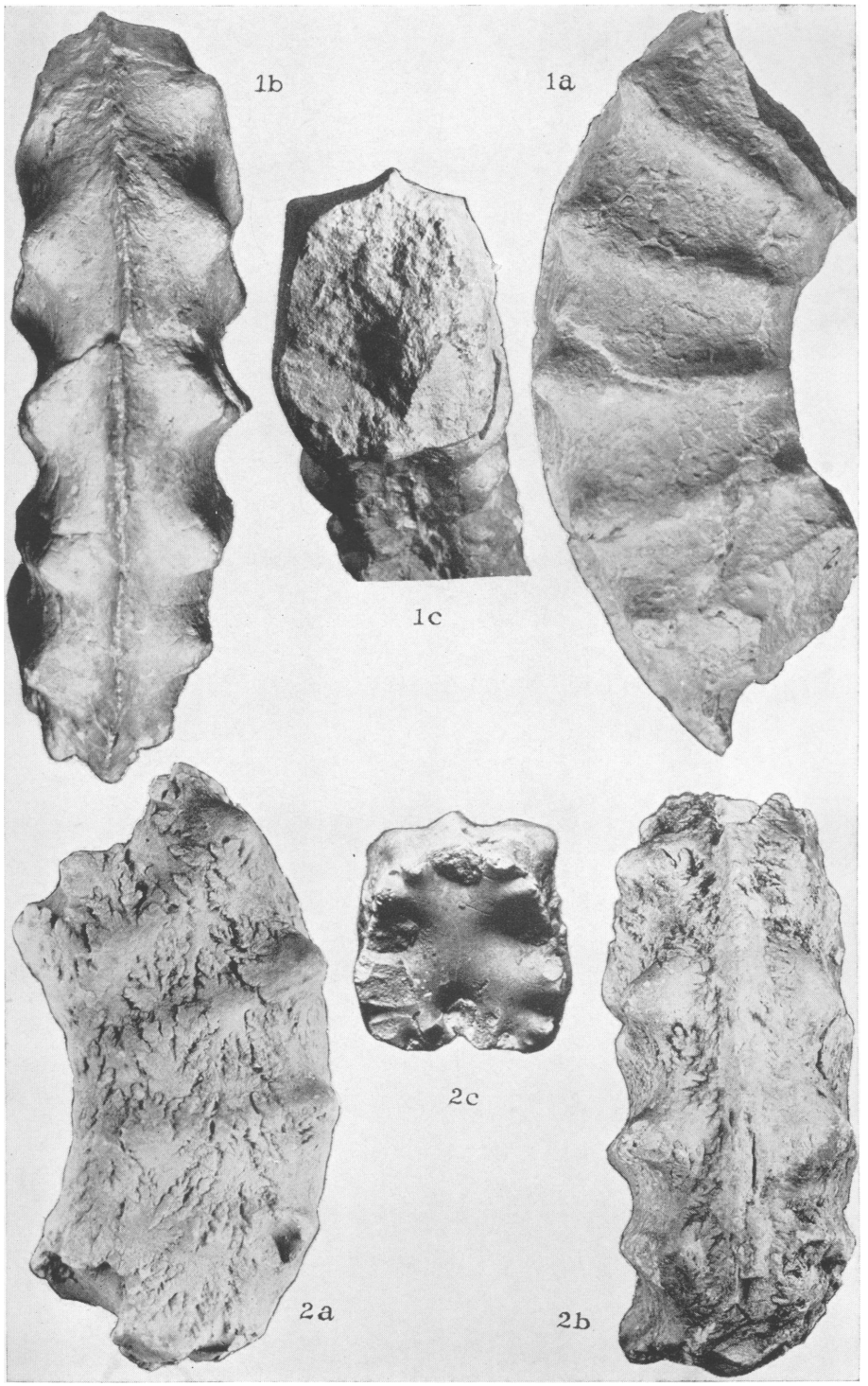

1b
1a
1c
2c
2a
2b

PLATE XII

Fig. 1. *Pervinquieria perarmata*, new species; holotype, A.M.N.H. No. 25143, (a) left side view. (b) ventral view, (c) sectional view at posterior end (all × 1/2).

Fig. 2. *Pervinquieria barbouri*, new species; holotype, A.M.N.H. No. 25144, (a) right side view, (b) ventral view (both × 2/5), (c) sectional view at anterior end (× ca. 1/2).

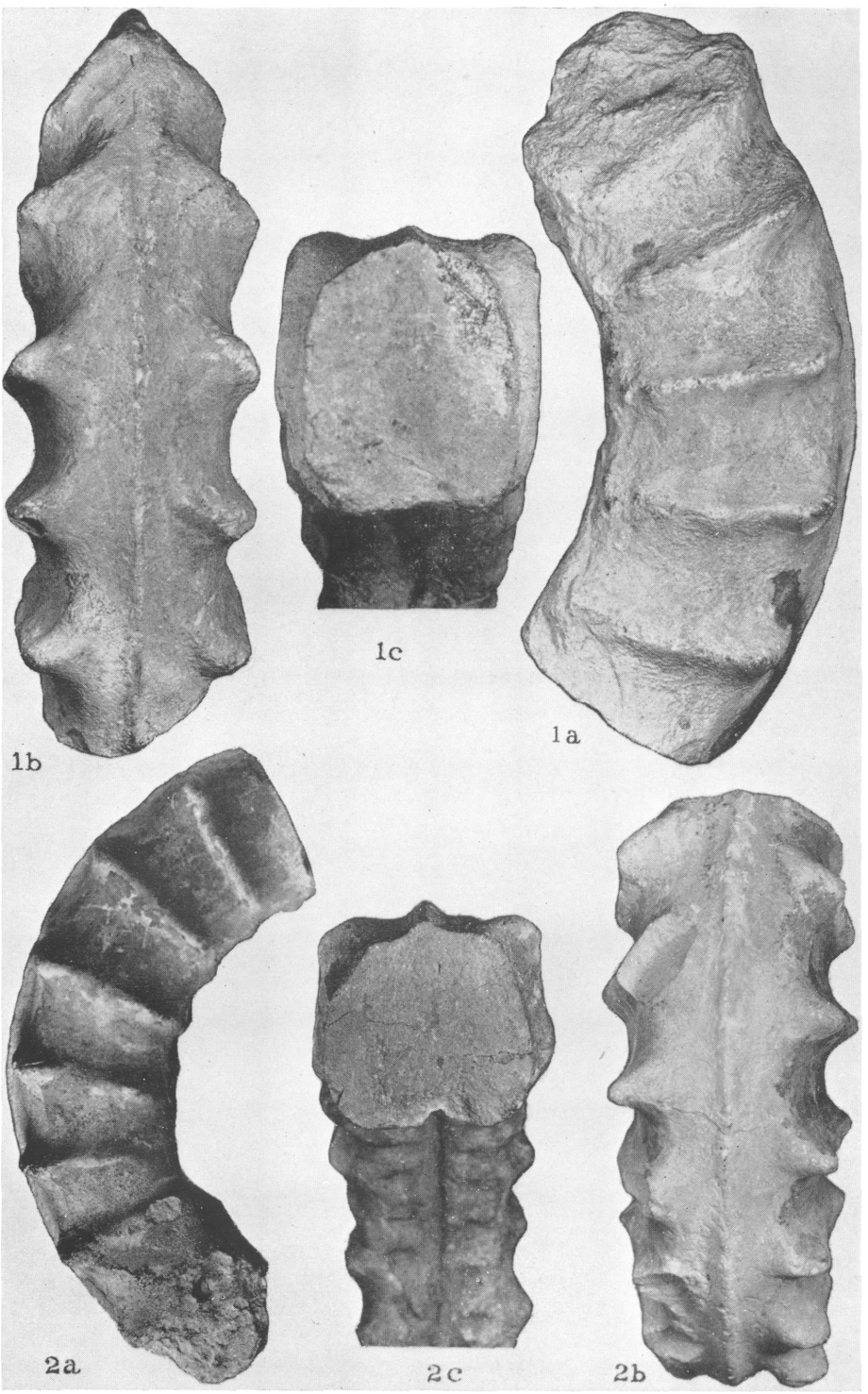

1b
1c
1a
2a
2c
2b

Plate XIII

Fig. 1. *Pervinquieria romeri*, new species, var. *fastigata*, new variety; holotype, A.M.N.H. No. 25142, (a) ventral view, (b) sectional view at front end (both × 1/2).

Figs. 2, 3. *Pervinquieria howelli*, new species. Fig. 2: Holotype, A.M.N.H. No. 25145:1, (a) left side view, (b) ventral view, showing open siphuncular tube, (c) sectional view at posterior end (all × 1/2). Fig. 3: Paratype, A.M.N.H. No. 25145:2, ventral view (× 2).

Fig. 4. *Pervinquieria montraynaudensis*, new name, var. *gracilis*, new variety; holotype, A.M.N.H. No. 25149, (a) right side view, (b) ventral view (both × 3/4), (c) section at fracture.

Fig. 5. *Pervinquieria bassleri* Haas; a small specimen, A.M.N.H. No. 25153:2, (a) right side view, (b, c) ventral views of smaller and larger fragments, the latter showing dissymmetry of conch (all × 3/2), (d) section at anterior end of smaller fragment, (e) section at posterior end of larger fragment (both × 2).

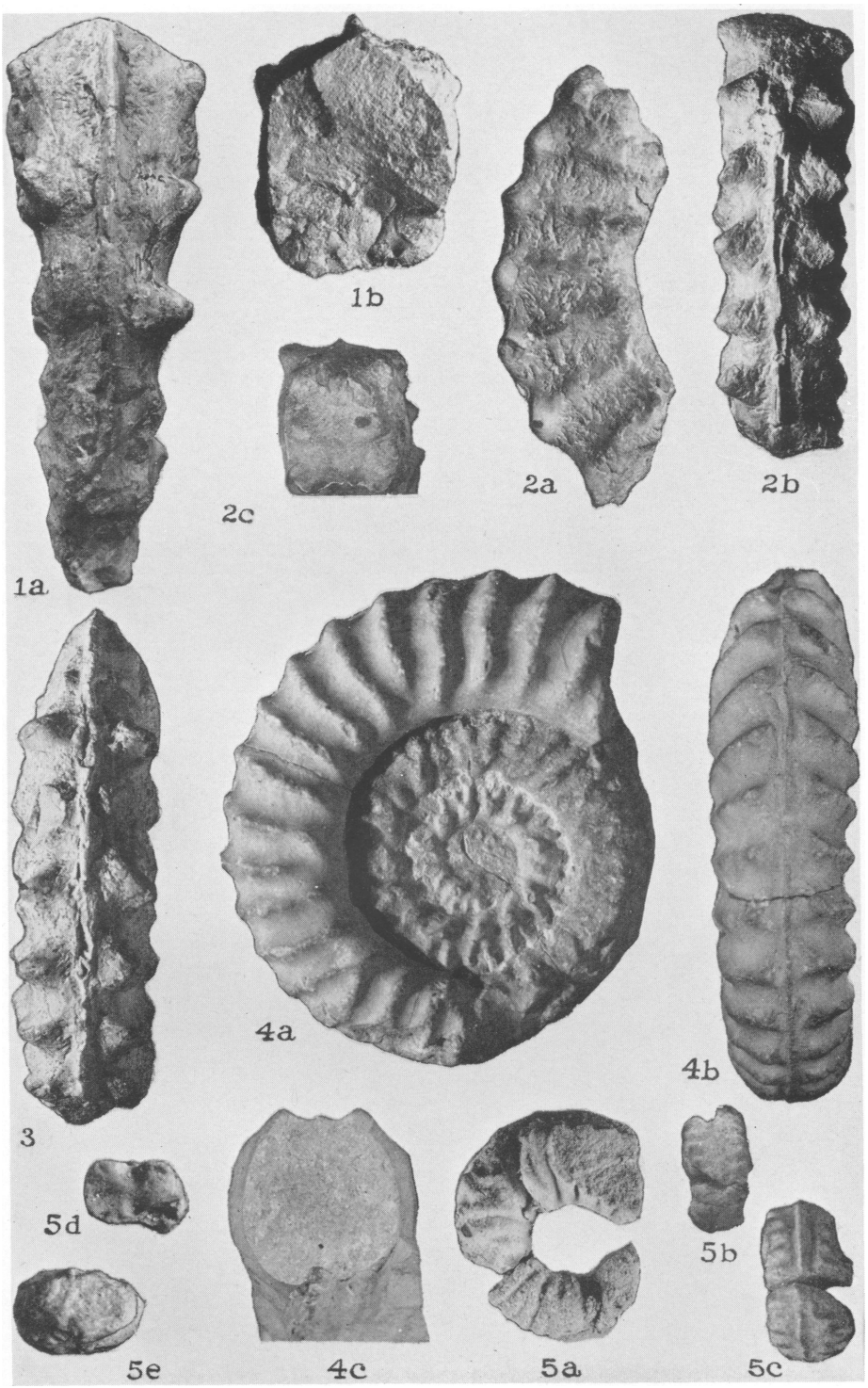

1a
1b
2c
2a
2b
3
4a
4b
5d
5e
4c
5a
5b
5c

PLATE XIV

Fig. 1. *Pervinquieria proteus*, new species; holotype, A.M.N.H. 25147, (a) left side view (× 2/5), (b) ventral view of penultimate whorl, (c) ventral view (× 2/5), (d) section at fracture.

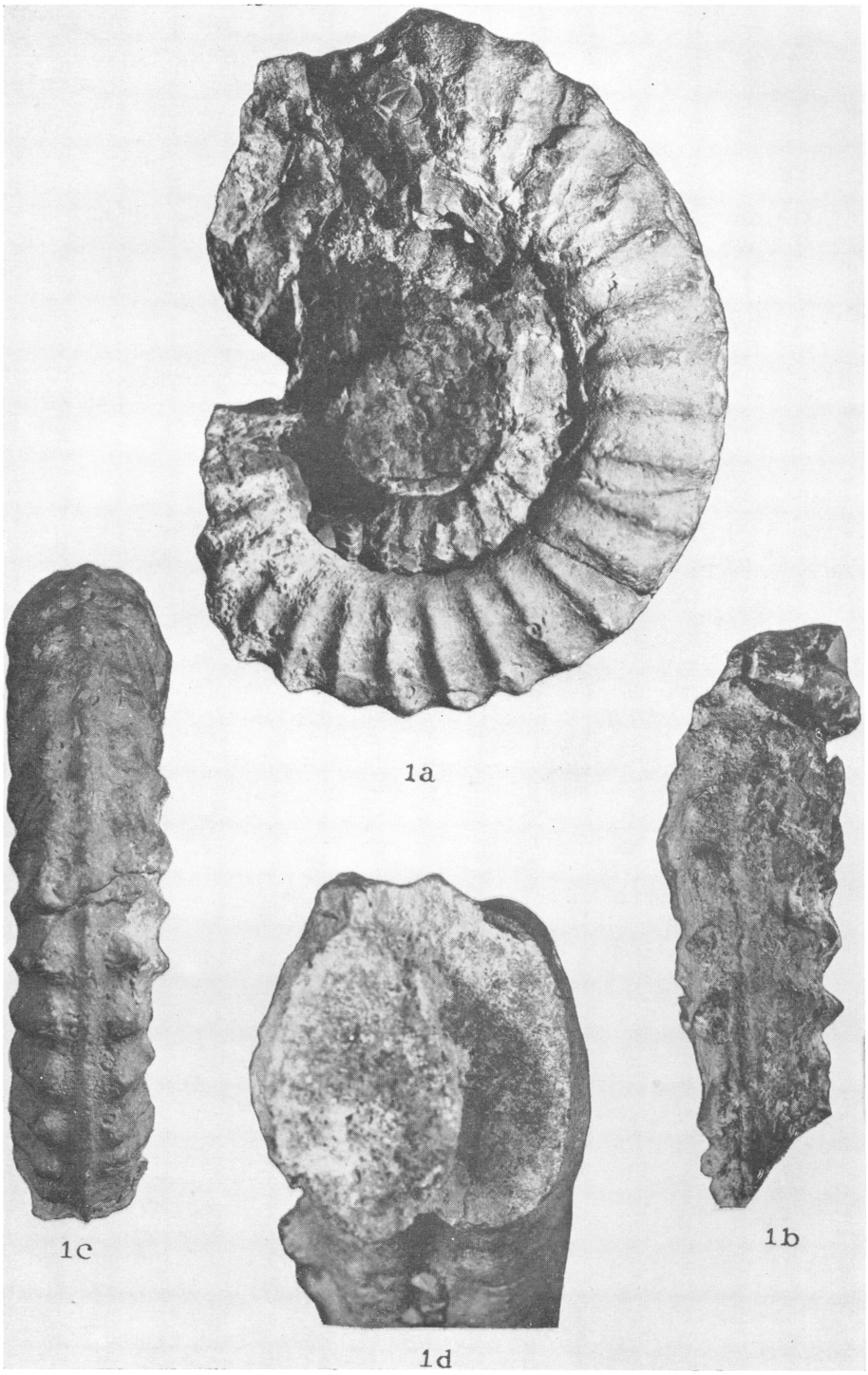

1a
1b
1c
1d

PLATE XV

Fig. 1. *Pervinquieria evoluta* (Spath); A.M.N.H. No. 25148, (a) right side view, (b) ventral view (both × 2/3).

Fig. 2. *Pervinquieria bassleri* Haas; holotype, A.M.N.H. No. 25153:1, (a) left side view, (b) frontal view, showing section at anterior end with several lateral nodes on penultimate rib on the right side of the conch, (c) frontal view at fracture (without anterior half of outer whorl), (d) ventral view (all × 3/2).

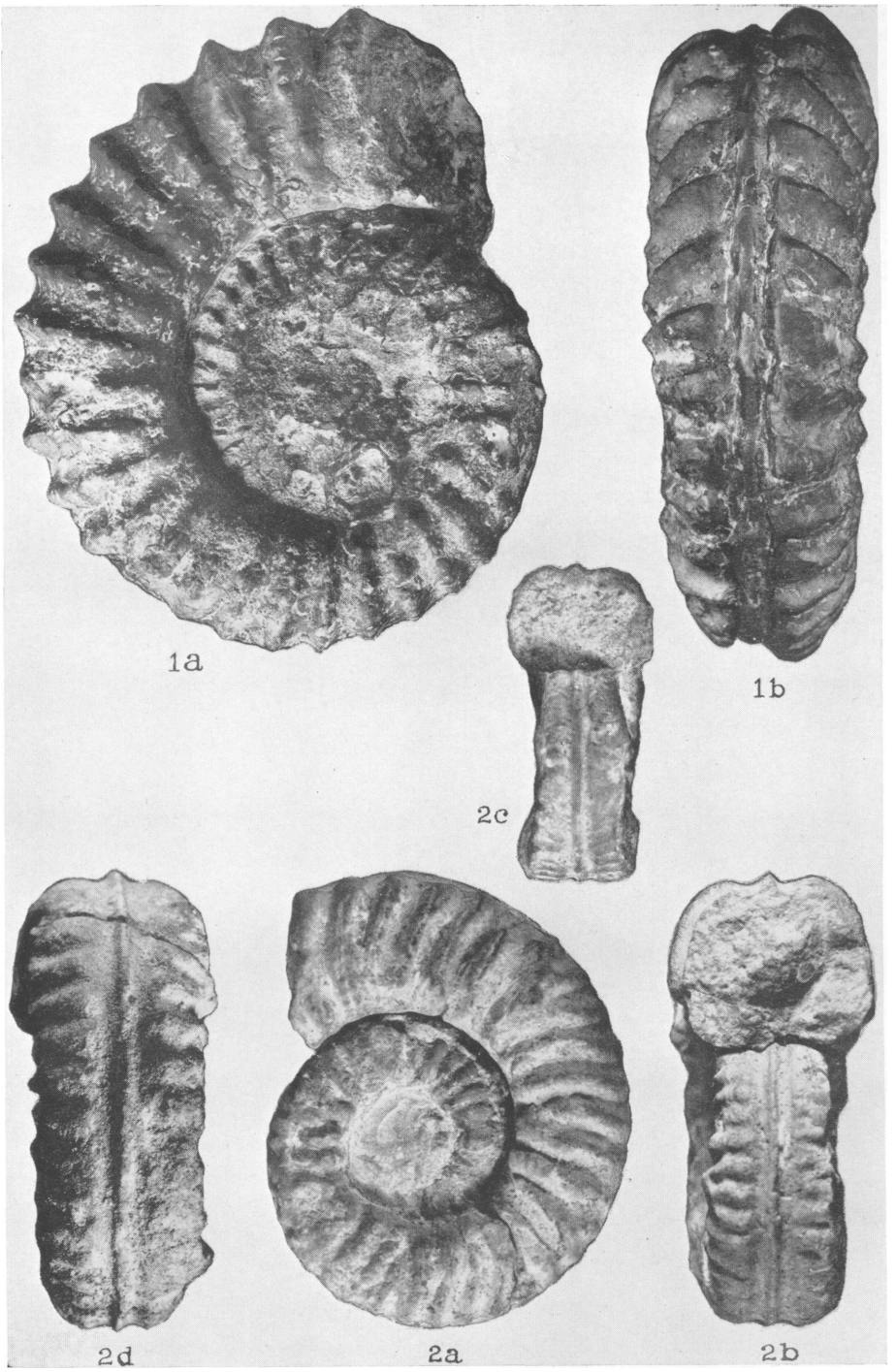

1a
1b
2c
2d
2a
2b

PLATE XVI

Fig. 1. *Pervinquieria simplex* (Choffat), var. *tenuis*, new variety; holotype, A.M.N.H. No. 25150, (a) right side view, (b) left side view of preserved part of outer whorl, showing details of ribbing and radial striation, (c) ventral view (all × 1/2).

Fig. 2. *Pervinquieria vicina*, new name; A.M.N.H. No. 25151:1, (a) right side view (× 2/3), (b) ventral view (× 5/6).

Fig. 3. *Pervinquieria vicina*, new name, var. *evoluta*, new variety; holotype, A.M.N.H. No. 25152, (a) left side view, (b) right side view of last third of outer whorl, showing details of ornamentation, (c) ventral view (all × 2/3).

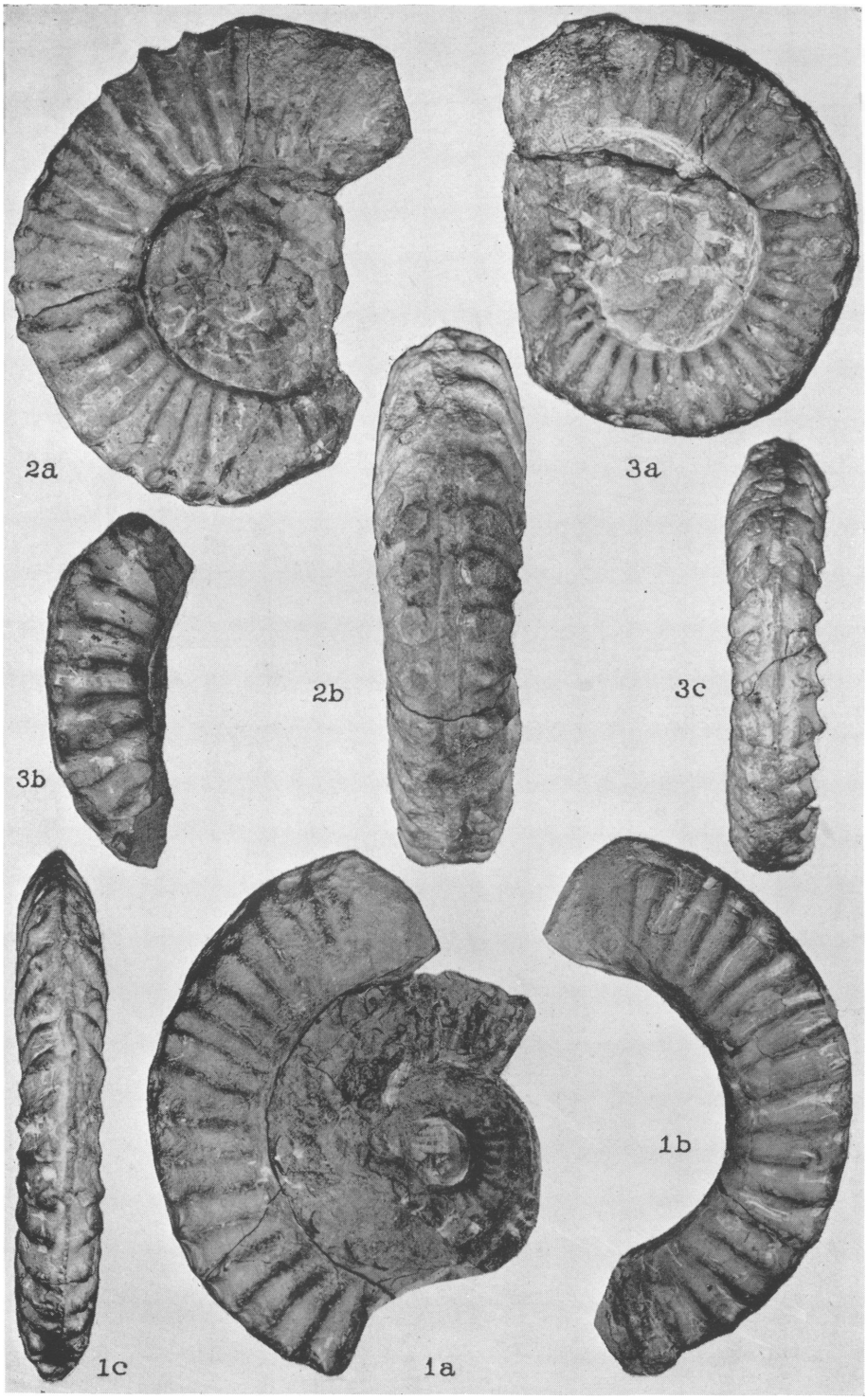

2a
3a
3b
2b
3c
1c
1a
1b

Plate XVII

Figs. 1, 2. *Pervinquieria ferecostata*, new species. Fig. 1: Holotype, A.M.N.H. No. 25154:1. (a, b) left and right side views (both figured to show irregularity of ornamentation), (c) ventral view, showing, near anterior end, strong umbilical tubercle on right side (all × 3/2). Fig. 2: A small specimen, A.M.N.H. No. 25154:2, (a) left side view, (b) ventral view (both × 3/2).

Fig. 3. Specimen transitional between *Pervinquieria bassleri* Haas, and *Pervinquieria ferecostata*, new species; A.M.N.H. No. 25155, (a) left side view (× 2), (b) ventral view (× 3/2).

Figs. 4, 5. *Pervinquieria*, indeterminate species No. 1. Fig. 4: A.M.N.H. No. 25156:1, (a, b) right and left side views, (c) ventral view, (d) section at fracture (all × 3/2). Fig. 5: A small fragment, A.M.N.H. No. 25156:2, ventral view (× 3/2).

Fig. 6. *Pervinquieria*, indeterminate new species No. 2; A.M.N.H. No. 25162, left side view (× 3/2).

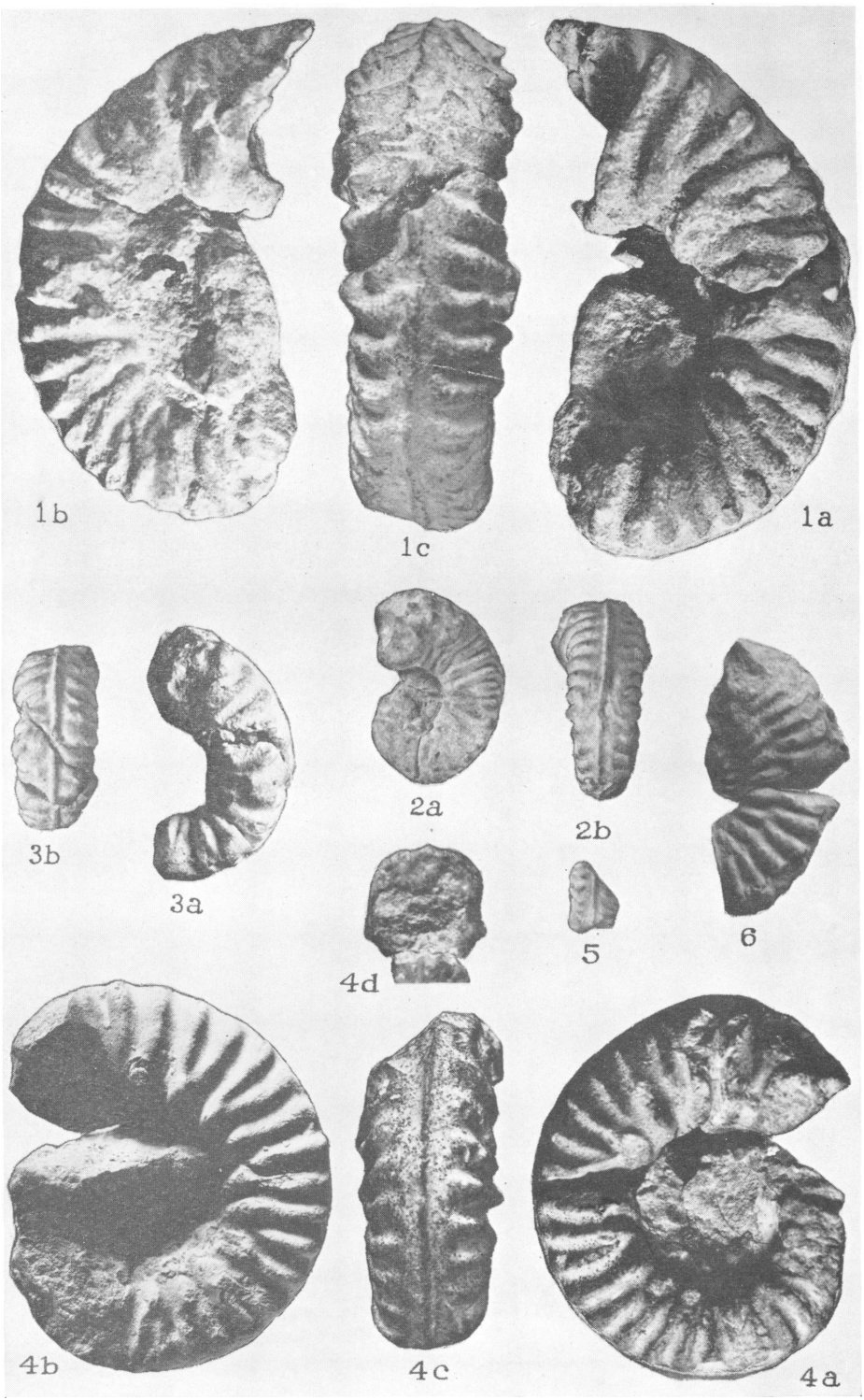

1b
1c
1a
3b
3a
2a
2b
6
4d
5
4b
4c
4a

PLATE XVIII

Figs. 1–4. *Pervinquieria arietiformis* (Spath). Fig. 1: A.M.N.H. No. 25157:1, (a) left side view, (b) ventral view. Fig. 2: A.M.N.H. No. 25157:2, (a) right side view, (b, c) sectional views on both sides of fracture, (d) frontal view, (e) ventral view, both of innermost whorls. Fig. 3: A.M.N.H. No. 25157:4, (a) frontal view (× 1/2), (b, c) sections at posterior end of smaller fragment and at anterior end of larger fragment. Fig. 4: A.M.N.H. No. 25157:8, (a) right side view (× 2/3), (b) ventral view, (c) frontal view at fracture (both × 1/2).

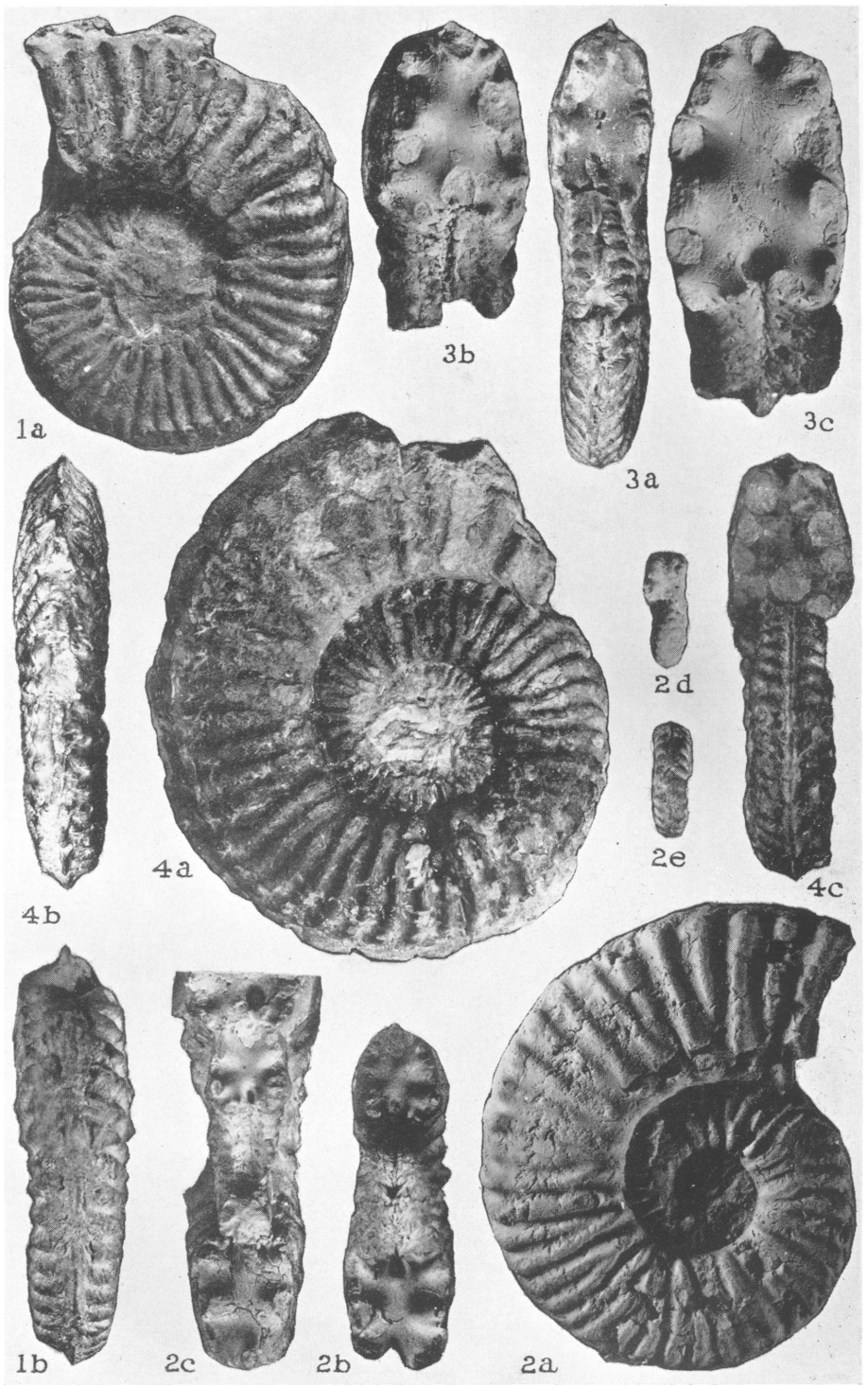

1a
3b
3a
3c
4b
4a
2d
2e
4c
1b
2c
2b
2a

PLATE XIX

Figs. 1, 2. *Pervinquieria arietiformis* (Spath). Fig. 1: A.M.N.H. No. 25157:5, (a) ventral view (× 2/5), (b, c) sectional views at last but one and last fractures (both × 1/2). Fig. 2: The largest disc, A.M.N.H. No. 25157:6, (a) left side view, (b) ventral view (both × 2/5).

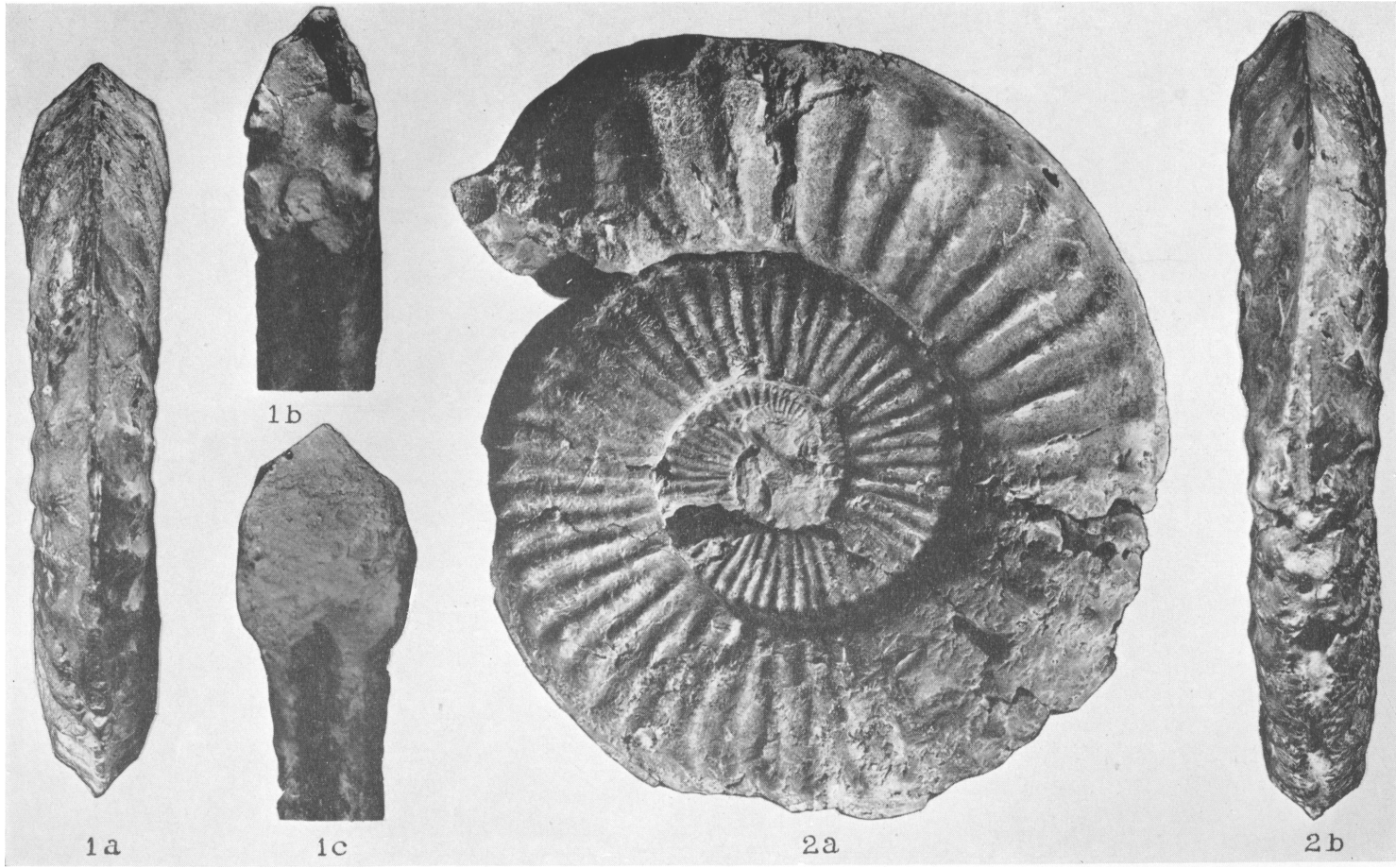

1a
1b
1c
2a
2b

Plate XX

Figs. 1, 2. *Pervinquieria arietiformis* (Spath). Fig. 1: A more evolute specimen, A.M.N.H. No. 25157:9, section at beginning of body chamber (× 2/3). Fig. 2: A.M.N.H. No. 25157:10, section at posterior end of anterior fragment (× 1/2).

Fig. 3. *Pervinquieria arietiformis* (Spath), var. *compressa*, new variety; holotype, A.M.N.H. No. 25158:1, (a) left side view, showing apertural margin, (b) section at posterior end (both × 1/2).

Fig. 4. *Pervinquieria arietiformis* (Spath), var. *lēvicostata* Haas; holotype, A.M.N.H. No. 25159, (a, b) left and right side views, (c) ventral view (all × 1/2).

Fig. 5. *Pervinquieria arietiformis* (Spath), var. *elegans*, new variety; holotype, A.M.N.H. No. 25160, (a) left side view, (b) ventral view, right side crushed (both × 1/2).

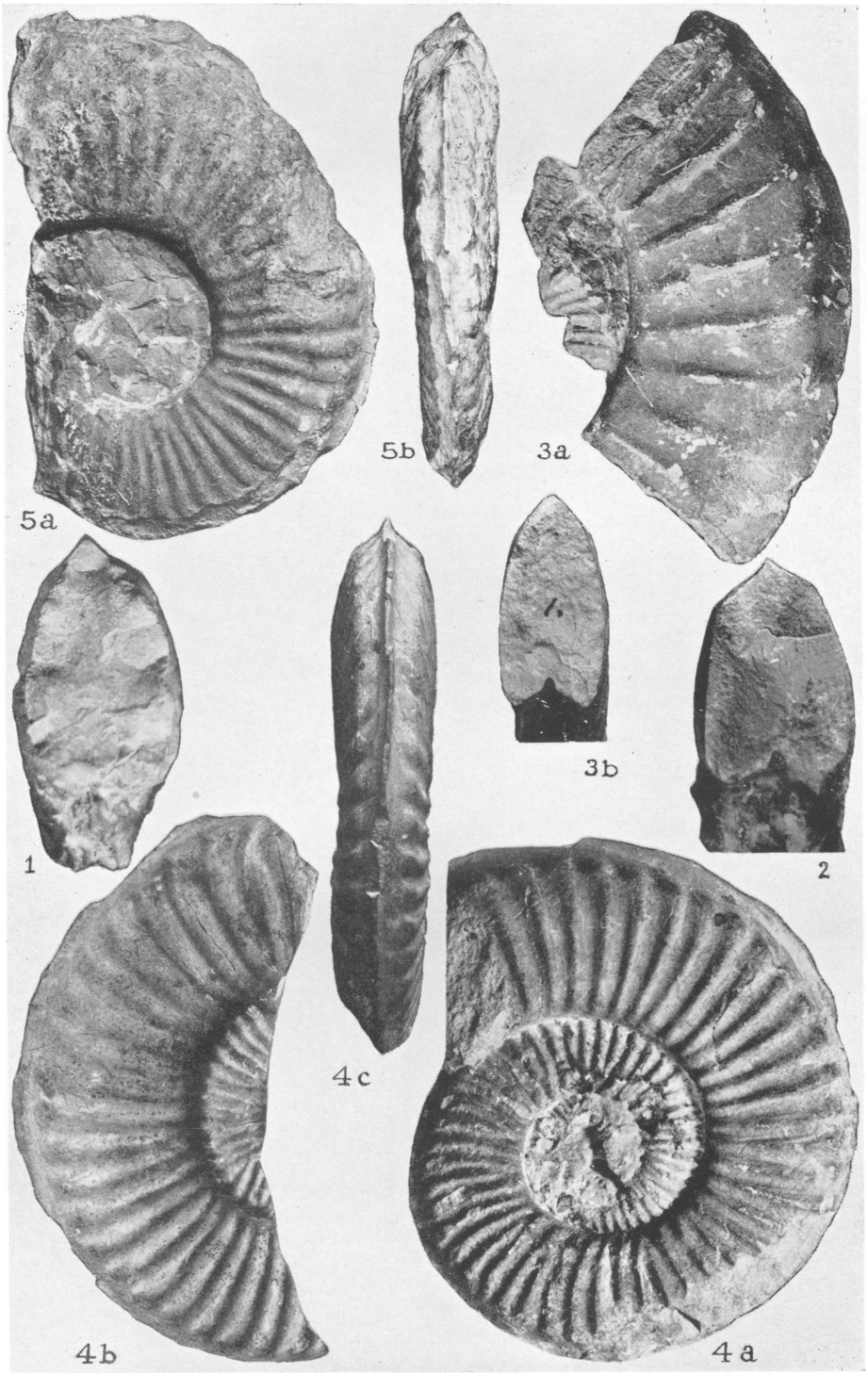

5a
5b
3a
1
3b
2
4c
4b
4a

PLATE XXI

Fig. 1. *Pervinquieria vokesi*, new species; holotype, A.M.N.H. No. 25161, (a) left side view, (b) ventral view (both × 2/5), (c) section at fracture, with ventral view of a part of the penultimate whorl, (d) section at anterior end (both × ca. 2/5), (e) ventral view of inner whorl.

Fig. 2. *Pervinquieria* cf. *lampasensis* (Choffat); larger fragment, A.M.N.H. No. 25192:2, from the "Upper Albian–Basal Cenomanian," south of Cabo Ledo, forty kilometers south of mouth of Cuanza River, Angola, (a) left side view, (b) ventral view (× 2/3).

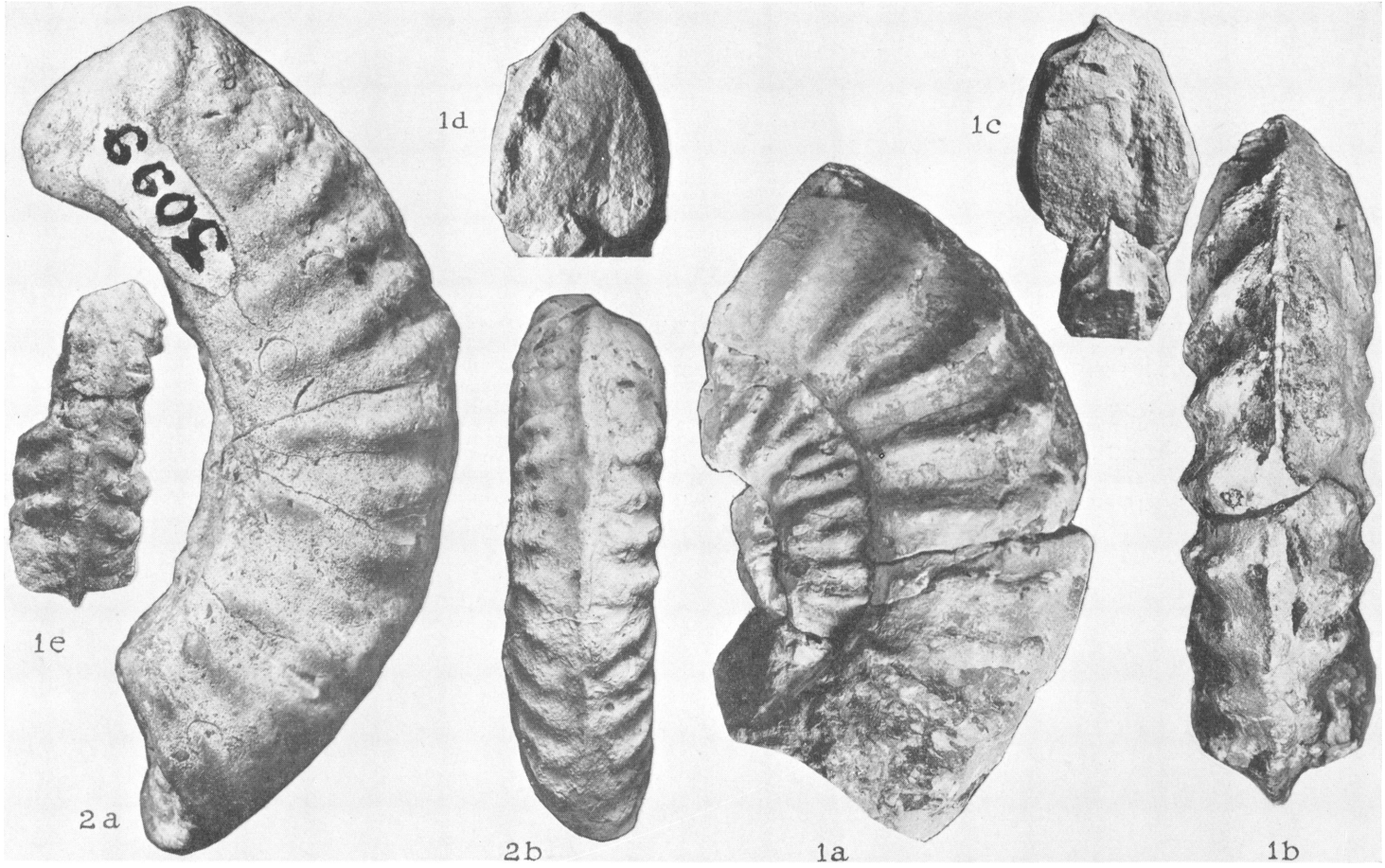

3099
1d
1c
1e
2a
2b
1a
1b

Plate XXII

Suture lines of:

Fig. 1. *Pervinquieria margaritata*, new species; holotype, A.M.N.H. No. 25139:1, parts of two different suture lines.

Figs. 2–7. *Pervinquieria arietiformis* (Spath). Fig. 2: A.M.N.H. No. 25157:2, (a) siphonal lobe and parts of adjacent saddles at an early stage, (b) a complete suture line. Fig. 3: A.M.N.H. No. 25157:4. Fig. 4: A.M.N.H. No. 25157:8, (a) part of a suture line from first lateral saddle to antisiphonal lobe, (b) first lateral lobe. Fig. 5: The largest disc, A.M.N.H. No. 25157:6, (a) part of a suture line from interior margin of external saddle to umbilical seam, (b) siphonal lobe and external saddle of another suture line. Fig. 6: A.M.N.H. No. 25157:9, drawing combined of two neighboring suture lines. Fig. 7: A.M.N.H. No. 25157:12, part of a suture line from interior margin of external saddle to first auxiliary saddle.

Fig. 8. *Pervinquieria arietiformis* (Spath), var. *elegans*, new variety; holotype, A.M.N.H. No. 25160, bottom of first lateral lobe and part of the same suture line from interior part of first lateral saddle to umbilical seam.

Fig. 9. *Pervinquieria vokesi*, new species; holotype, A.M.N.H. No. 25161, lower part of right half of siphonal lobe.

13·3mm
D=35mm
2b
4·2mm
D=13·6mm
2a
19·7mm
D=100mm
9
29·5mm
D=115mm
7
1
10·5mm
D=36mm
5a
29·2mm
D=160mm
5b
41·5mm
D=220mm
21mm
D=97mm
3
8
17·2mm
D=120mm
4a
10·7mm
D=87mm
18·1mm
D=90mm
4b
29·2mm
D=180mm
6

Plate XXIII

Fig. 1. *Pervinquieria* cf. *lampasensis* (Choffat); smaller fragment, A.M.N.H. No. 25192:1, from the "Upper Albian–Basal Cenomanian," south of Cabo Ledo, forty kilometers south of mouth of Cuanza River, Angola, (a) left side view, (b) sectional view at anterior end.

Fig. 2. *Elobiceras primordiale*, new species; holotype, A.M.N.H. No. 25163:1, (a) left side view, (b) section at posterior end, (c) ventral view.

Fig. 3. *Elobiceras*, indeterminate new species No. 1, A.M.N.H. No. 25164:1, (a) right side view, (b) ventral view.

Fig. 4. *Elobiceras irregulare* (Spath); A.M.N.H. No. 25165:1, right side view, showing high keel and occasional coalescence of ribs (× 2/3).

Fig. 5. *Elobiceras oxytropidoceratoides*, new species, var. *minor*, new variety; holotype, A.M.N.H. No. 25170, (a) left side view, (b) ventral view (both × 2/3), (c) sectional view at anterior end.

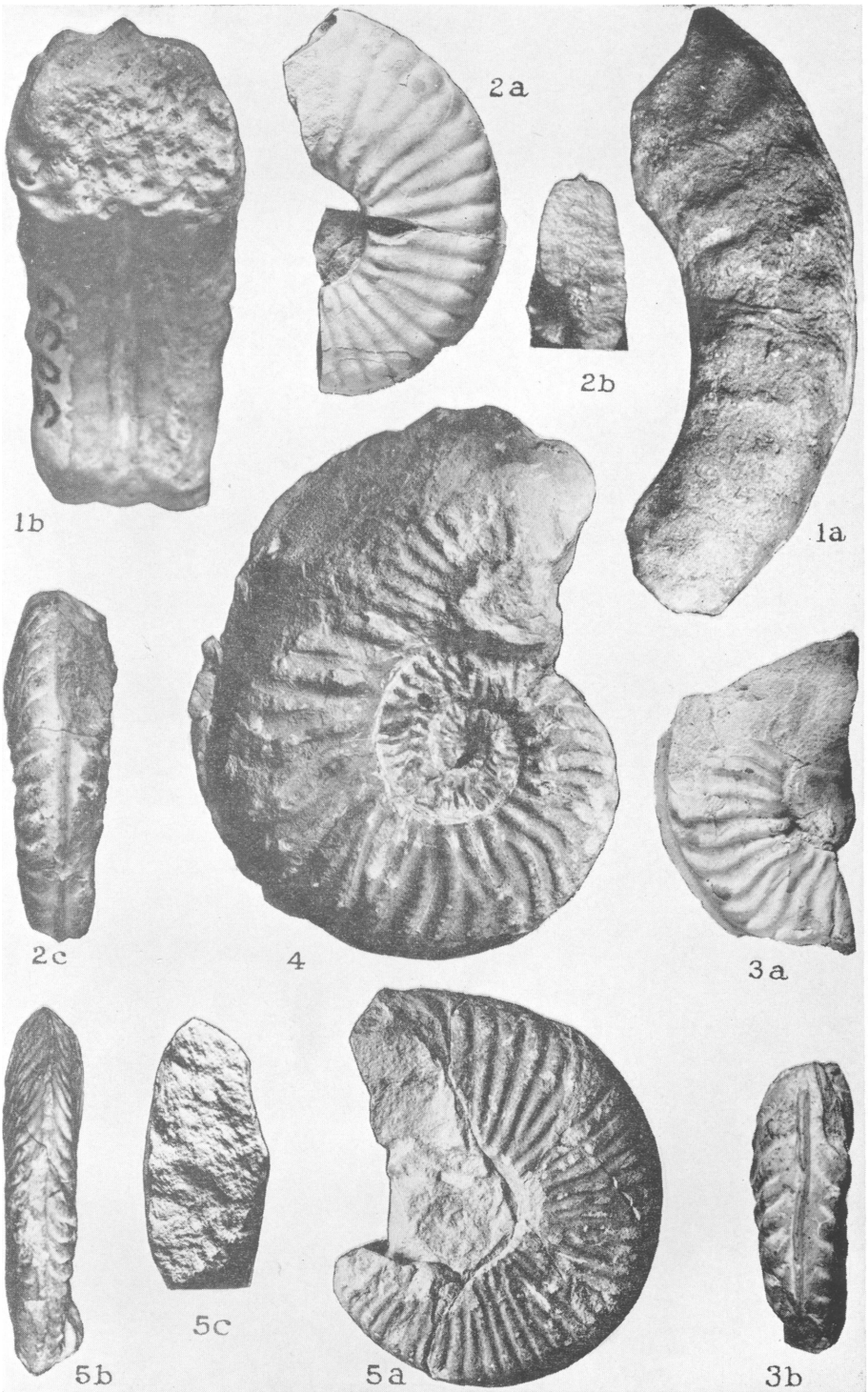

2a
2b
1b
1a
4
2c
3a
5c
5b
5a
3b

PLATE XXIV

Figs. 1, 2. *Elobiceras irregulare* (Spath). Fig. 1: A.M.N.H. No. 25165:2, (a) right side view, (b) ventral view of second and third quarters of outer whorl, (c) another ventral view, taken farther orad, to show the sharply projected outer ends of the ribs, almost joining the keel, (d) sectional view at fracture (all × 2/3). Fig. 2: Fragment, A.M.N.H. No. 25165:4, oblique side view, to show details of costation.

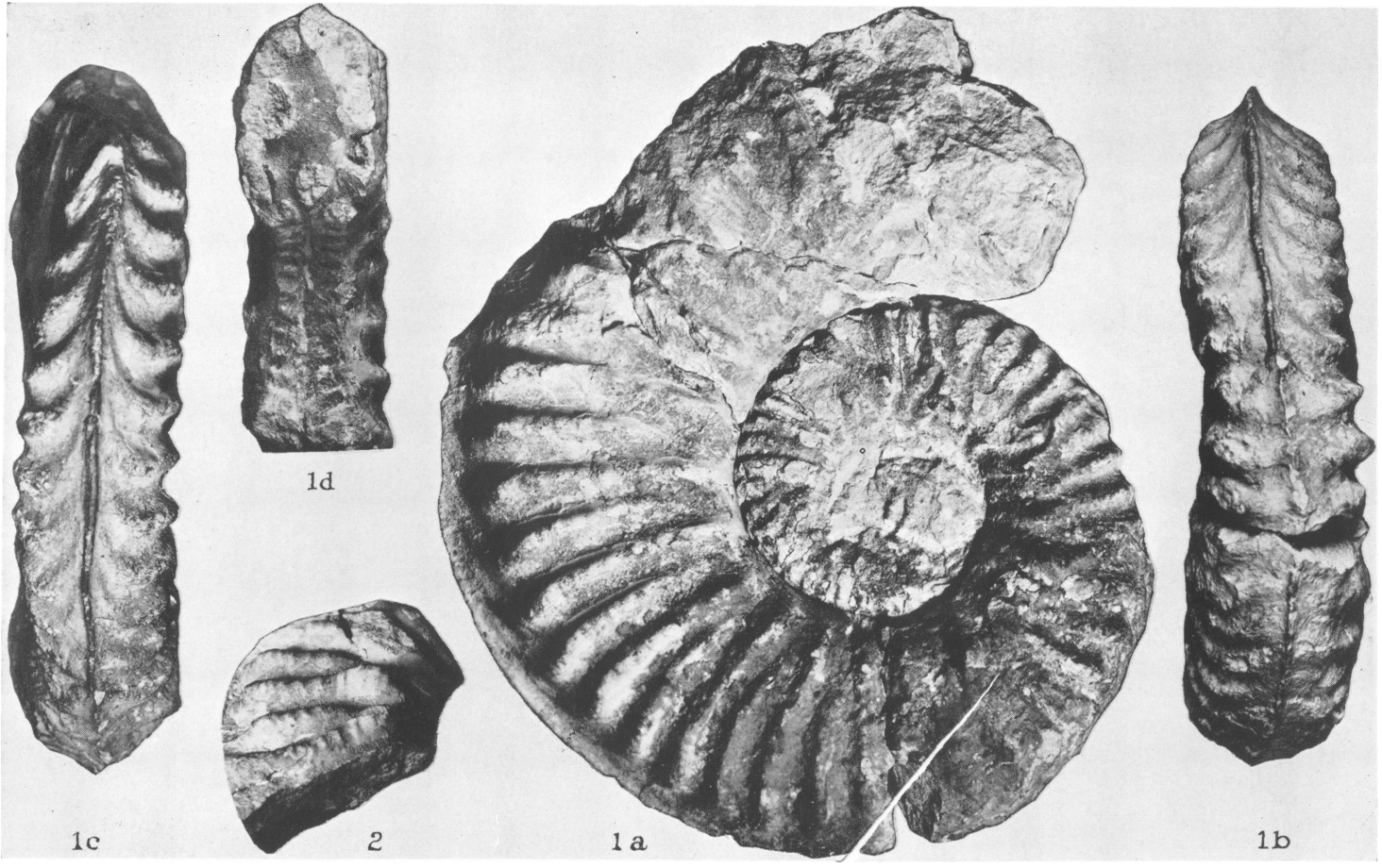

1d
1c
2
1a
1b

PLATE XXV

Fig. 1. *Elobiceras irregulare* (Spath), var. *rigidecostata*, new variety; holotype, A.M.N.H. No. 25166, (a) left side view, (b) ventral view, (c) section at last fracture (all × 2/3).

Fig. 2. *Elobiceras spathianum*, new species; holotype, A.M.N.H. No. 25167, (a) right side view, (b) ventral view (both × 2/3).

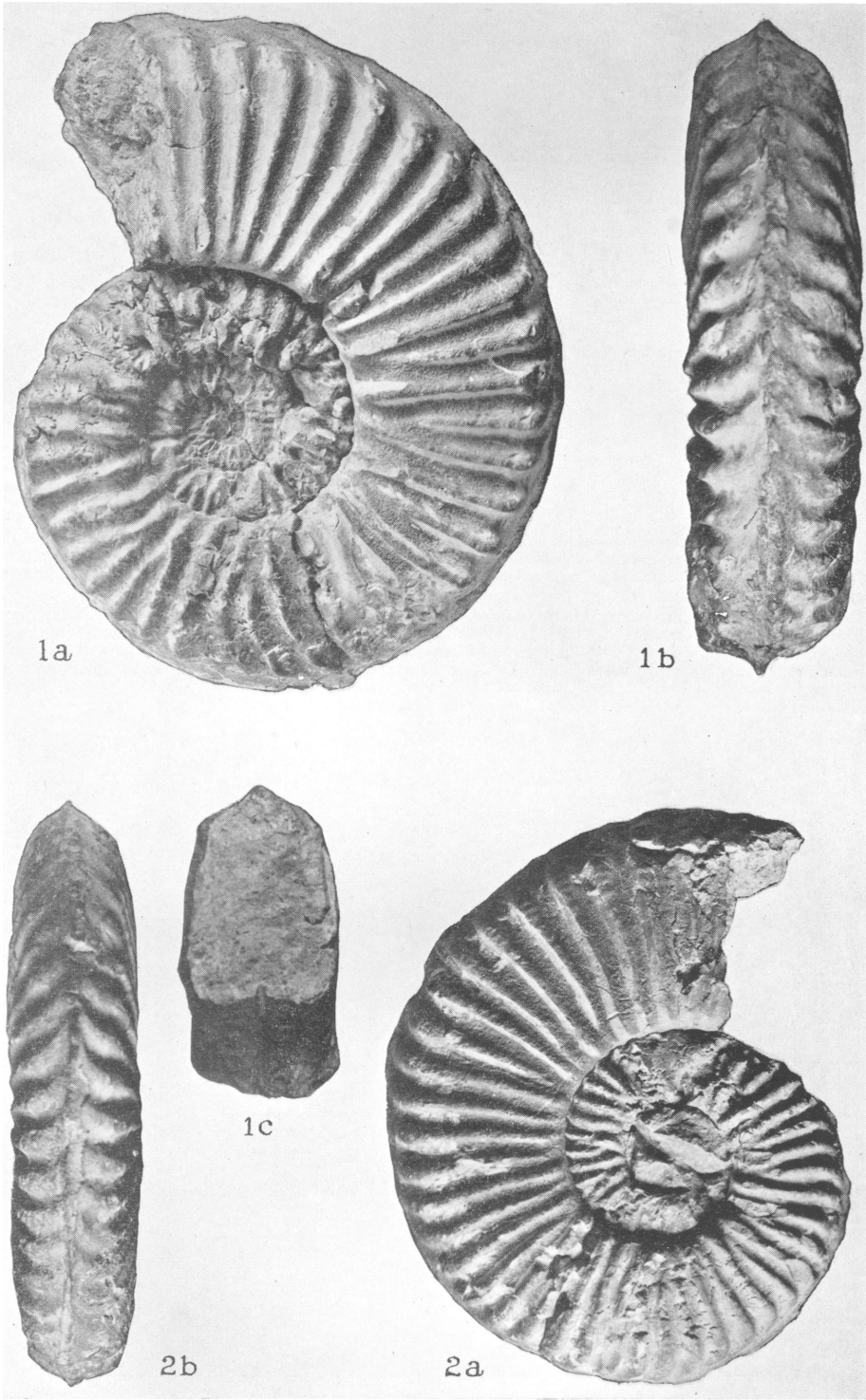

1a
1b
1c
2b
2a

Plate XXVI

Fig. 1. *Elobiceras* cf. *flexicostatum* Spath; A.M.N.H. No. 25168, left side view, with a fragment of *Elobiceras elobiense* (Szajnocha) ?, A.M.N.H. No. 25180:4, seen in left side view on top of the figure to the left. The more inflated fragment seen in the upper right corner of the figure is believed to belong to another individual.

Figs. 2–5. *Elobiceras oxytropidoceratoides*, new species. Fig. 2: Holotype, A.M.N.H. No. 25169:1, (a) right side view, (b) ventral view, showing, in anterior part, split periphery (both × 2/3), (c) sectional view (without front part of outer whorl). Fig. 3: Largest specimen, A.M.N.H. No. 25169:2, (a) right side view (× 2/3), (b) section at fracture (crushed). Fig. 4: Fragment of the inner whorl of A.M.N.H. No. 25169:3, (a) left side view, (b) section at posterior end. Fig. 5: Little whorl fragment, A.M.N.H. No. 25169:4, section at posterior end.

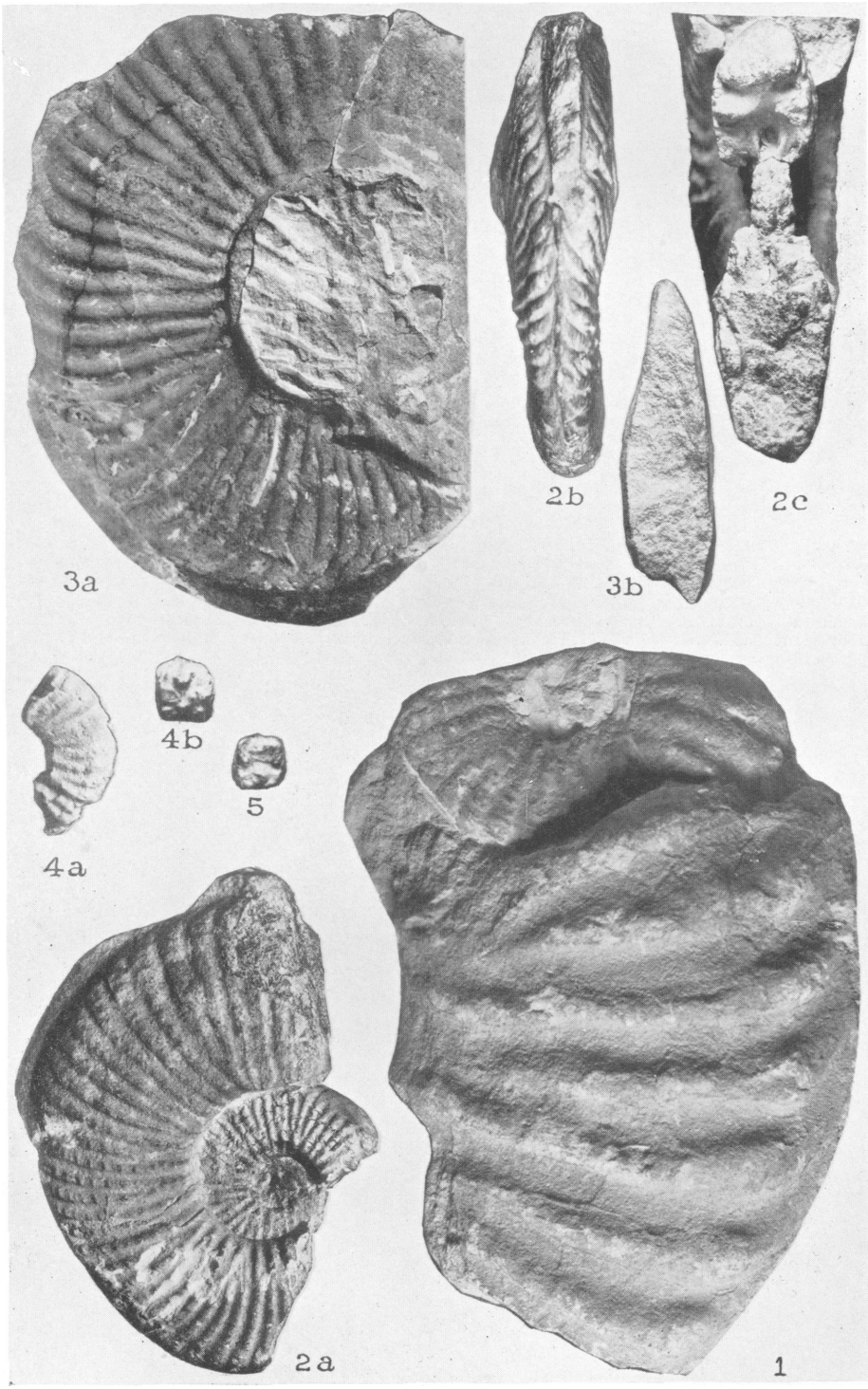

3a
2b
3b
2c
4b
5
4a
2a
1

PLATE XXVII

Fig. 1. *Elobiceras oxytropidoceratoides*, new species; a larger fragment, A.M.N.H. No. 25169:8, right side view, showing details of costation and spiral striation.

Figs. 2–5. *Elobiceras intermedium* Spath. Fig. 2: A.M.N.H. No. 25171:1, (a) left side view, (b) ventral view (both × 2/3), (c) sectional view at last fracture. Fig. 3: A.M.N.H. No. 25171:2, left side view (× 2/3). Fig. 4: A nucleus, A.M.N.H. No. 25171:4, left side view. Fig. 5: Half an inner whorl, A.M.N.H. No. 25171:11, (a) left side view, (b) sectional view of posterior end (× 2).

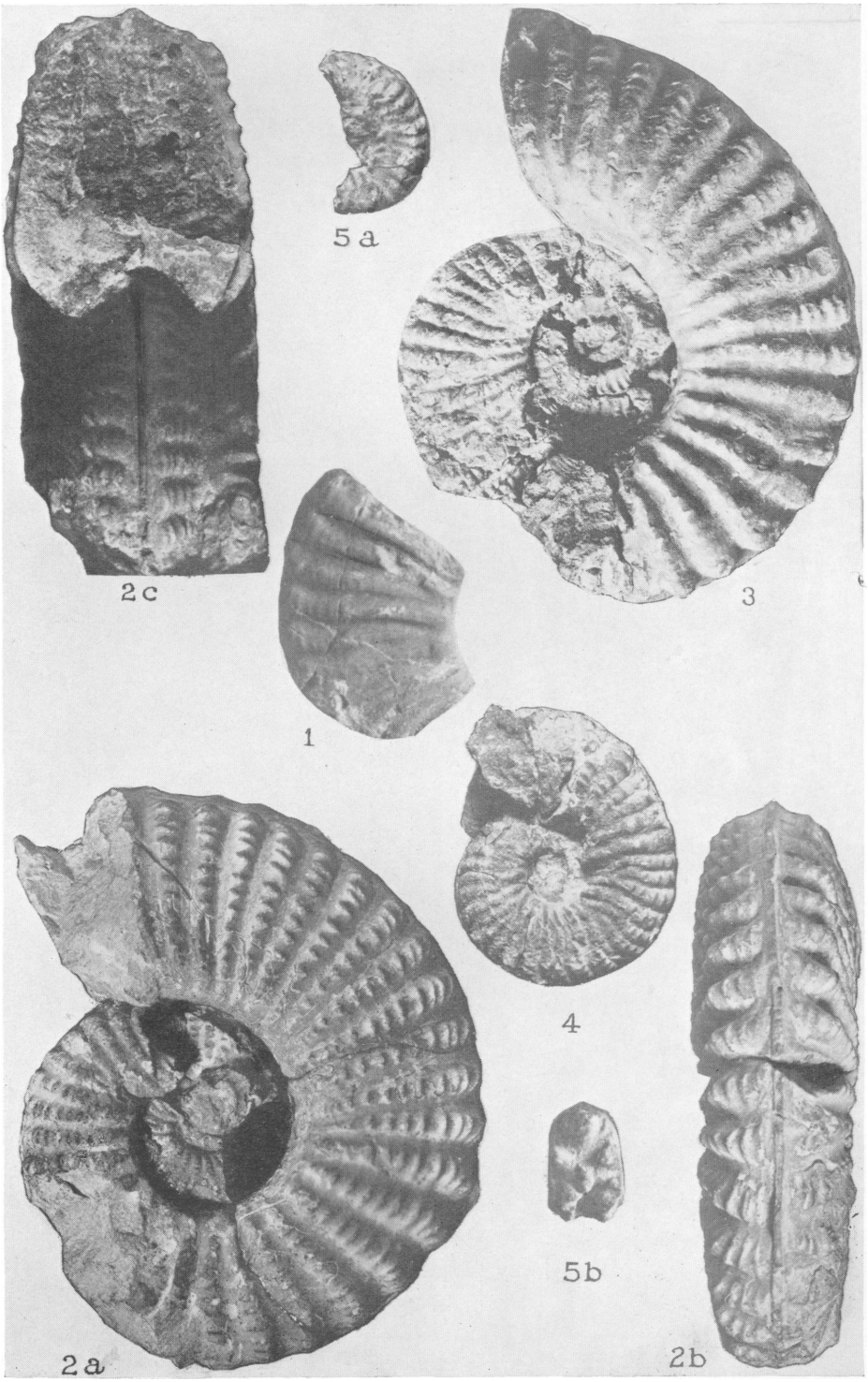

5a
2c
3
1
4
2a
5b
2b

PLATE XXVIII

Figs. 1, 2. *Elobiceras lobitoense* (Crick MS) Spath. Fig. 1: A.M.N.H. No. 25172:1, left side view of rubber cast. Fig. 2: Fragment, A.M.N.H. No. 25172:2, oblique side view, showing details of ornamentation.

Fig. 3. *Elobiceras subelobiense* Spath; A.M.N.H. No. 25173:1, (a) right side view, (b) ventral view, (c) sectional view.

Figs. 4–6. *Elobiceras raymondi*, new species. Fig. 4: A.M.N.H. No. 25173:1, section at posterior end (× 2). Fig. 5: A.M.N.H. No. 25173:6, (a) right side view, (b) ventral view, (c) section at posterior end. Fig. 6: A.M.N.H. No. 25173:8, section at fracture.

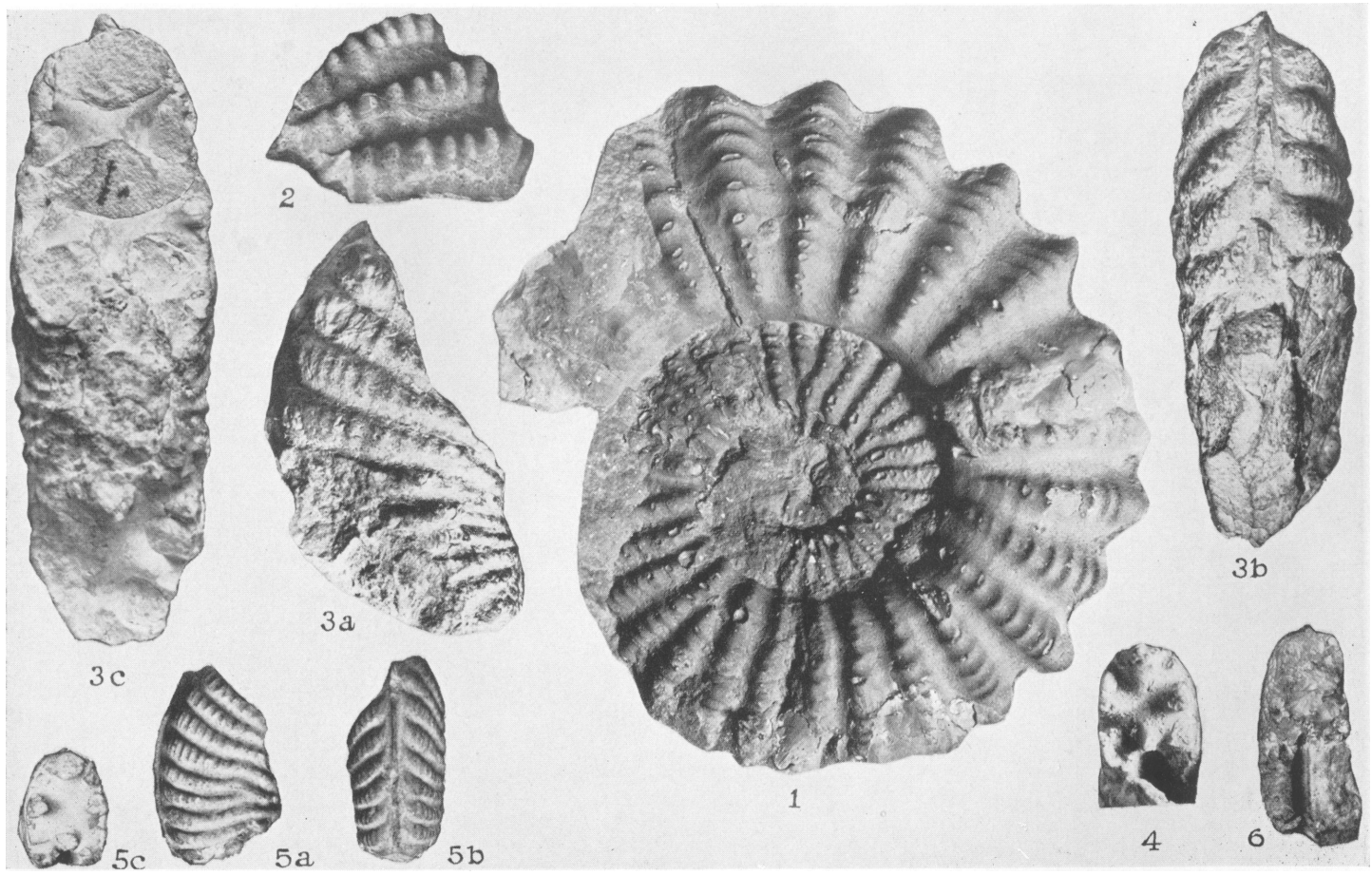

2
3a
3b
3c
1
4
6
5c
5a
5b

Plate XXIX

Figs. 1–3. *Elobiceras raymondi*, new species. Fig. 1: Holotype, A.M.N.H. No. 25175:4, (a) right side view, (b, c) sectional views at second and third fractures, (d) sectional view at anterior end, (e) ventral view of body chamber. Fig. 2: A nucleus, A.M.N.H. No. 25175:18, (a) right side view, (b) ventral view. Fig. 3: Whorl fragment, A.M.N.H. No. 25175:27, (a) left side view, (b) ventral view, both showing details of ornamentation.

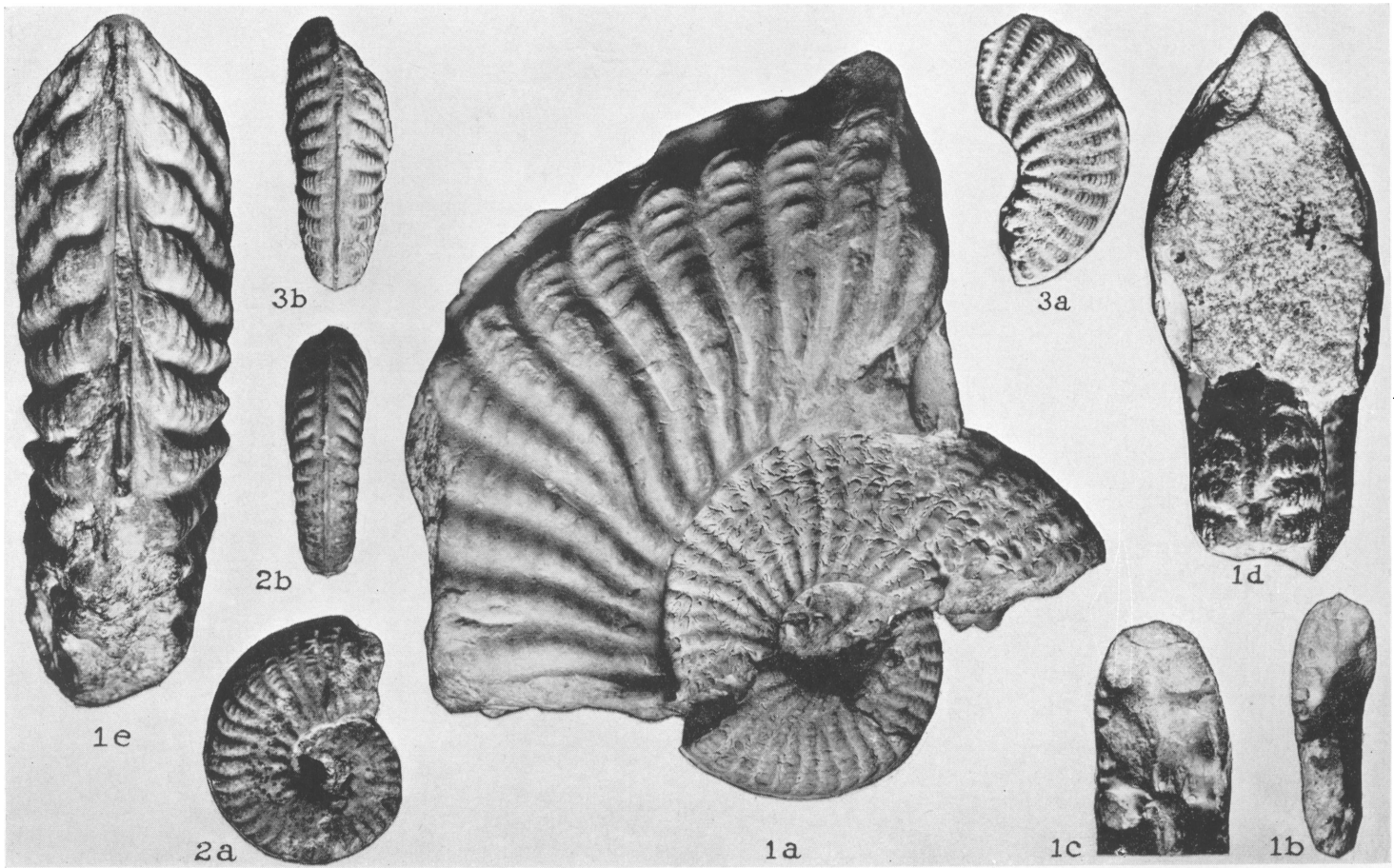

3b
3a
2b
1d
1e
2a
1a
1c
1b

Plate XXX

Fig. 1. *Elobiceras raymondi*, new species; largest specimen, A.M.N.H. No. 25175:5, (a) left side view (× 2/3), (b) section at fracture.

Figs. 2–4. *Elobiceras raymondi*, new species, var. *tenuis*, new variety. Fig. 2: Holotype, A.M.N.H. No. 25176:1, (a) right side view, (b) ventral view. Fig. 3: Fragment, A.M.N.H. No. 25176:2, section at posterior end. Fig. 4: A small fragment, A.M.N.H. No. 25176:4, (a) right side view, (b) ventral view.

Figs. 5–8. *Elobiceras hexagonum*, new species. Fig. 5: A small nucleus, A.M.N.H. No. 25177:4, (a) left side view, (b) ventral view (both × 5/2). Fig. 6: A.M.N.H. No. 25177:5, (a) left side view, (b) ventral view, (c) sectional view. Fig. 7: A.M.N.H. No. 25177:1, (a) right side view, (b) ventral view, (c) section at anterior end. Fig. 8: A.M.N.H. No. 25177:2, (a) ventral view, (b) ventral part of section.

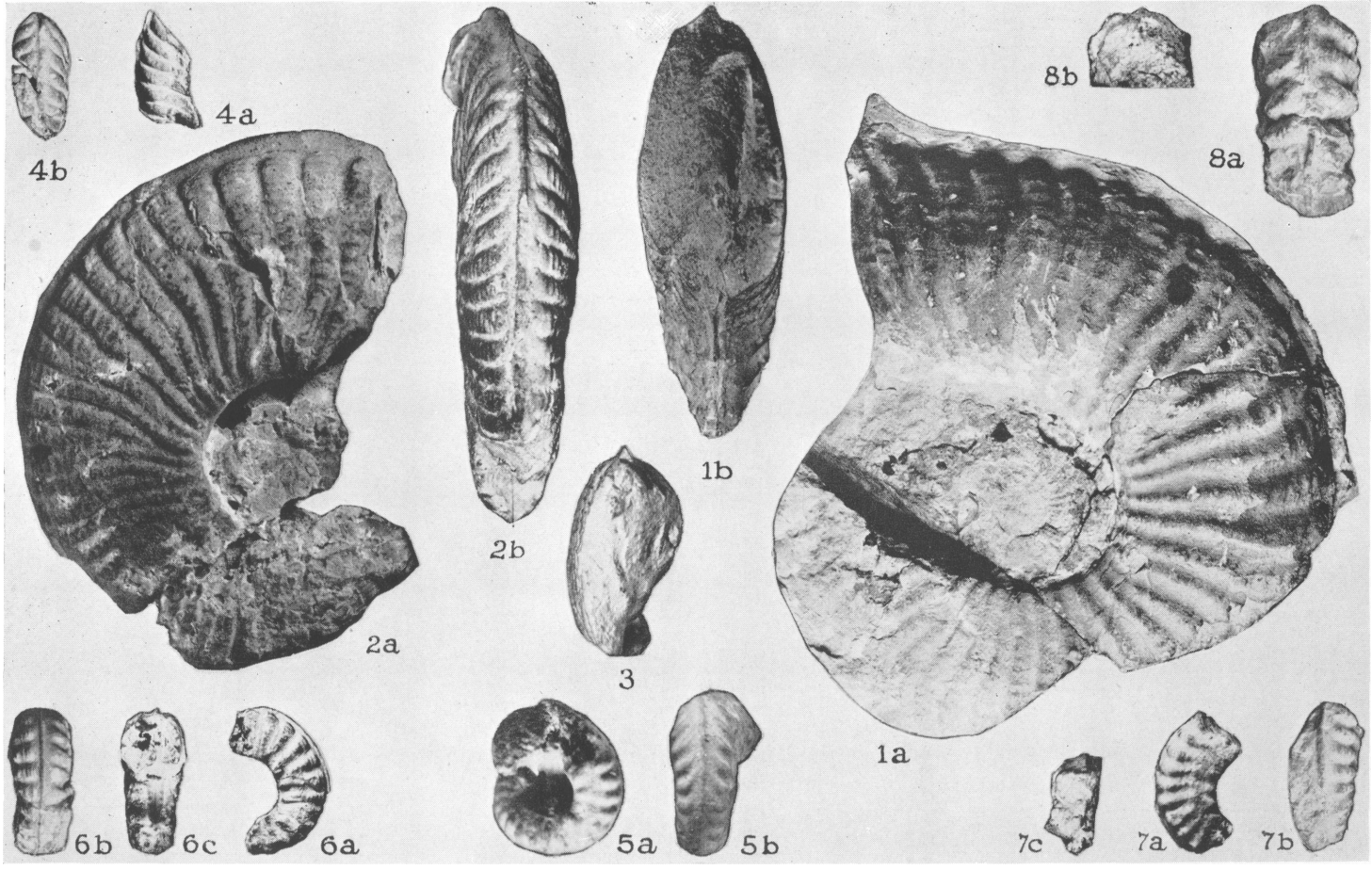

4b
4a
2a
2b
1b
3
8b
8a
1a
6b
6c
6a
5a
5b
7c
7a
7b

PLATE XXXI

Fig. 1. *Elobiceras hexagonum*, new species; holotype, A.M.N.H. No. 25177:3, left side view.

Figs. 2, 3. *Elobiceras browni*, new species. Fig. 2: Holotype, A.M.N.H. No. 25178:1, (a) right side view, (b) ventral view (both × 2/3). Fig. 3: A small whorl fragment, A.M.N.H. No. 25178:3, (a) right side view, (b) ventral part of section at posterior end.

Fig. 4. *Elobiceras*, indeterminate new species No. 2; A.M.N.H. No. 25179, left side view (× 2/3).

Fig. 5. *Prohysteroceras wordiei* Spath; whorl fragment of a small individual, A.M.N.H. No. 25184:3, right side view.

Figs. 6, 7. *Prohysteroceras gracile*, new name. Fig. 6: A.M.N.H. No. 25185:1, (a) right side view, (b) sectional view of posterior end. Fig. 7: A.M.N.H. No. 25185:2, ventral view.

Fig. 8. *Prohysteroceras decipiens* Spath, A.M.N.H. No. 25186:3, (a) left side view, (b) ventral view, (c) sectional view.

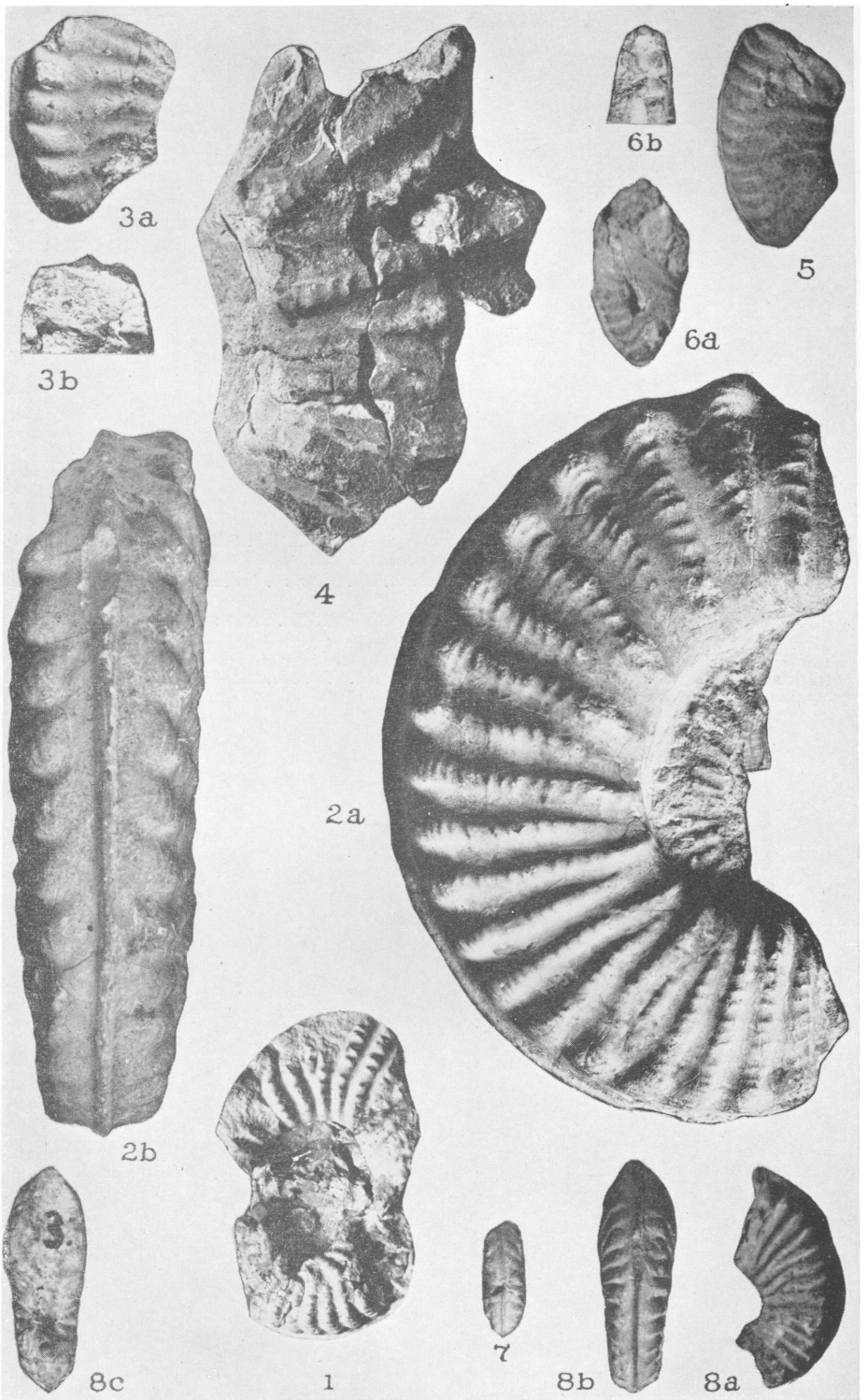

3a
3b
4
6b
6a
5
2a
2b
1
7
8c
8b
8a

Plate XXXII

Fig. 1. *Elobiceras browni*, new species; paratype, A.M.N.H. No. 25178:2, (a) right side view (× 2/3), (b) section at fracture (inner figure), (c) sectional view of anterior end.

Fig. 2. *Prohysteroceras decipiens* Spath; A.M.N.H. No. 25186:2, (a) left side view, (b) right side view of posterior part.

Fig. 3. *Prohysteroceras hanhaense*, new species; A.M.N.H. No. 25188:4, left side view.

Figs. 4, 5. *Prohysteroceras hanhaense*, new species ?; two specimens showing *Neokentroceras* characters at earlier stages. Fig. 4: A.M.N.H. No. 25188:6, (a) right side view, (b) ventral view of posterior part, (c) section at posterior end. Fig. 5: A.M.N.H. No. 25188:8, (a) left side view, (b) ventral view, (c) section at posterior end.

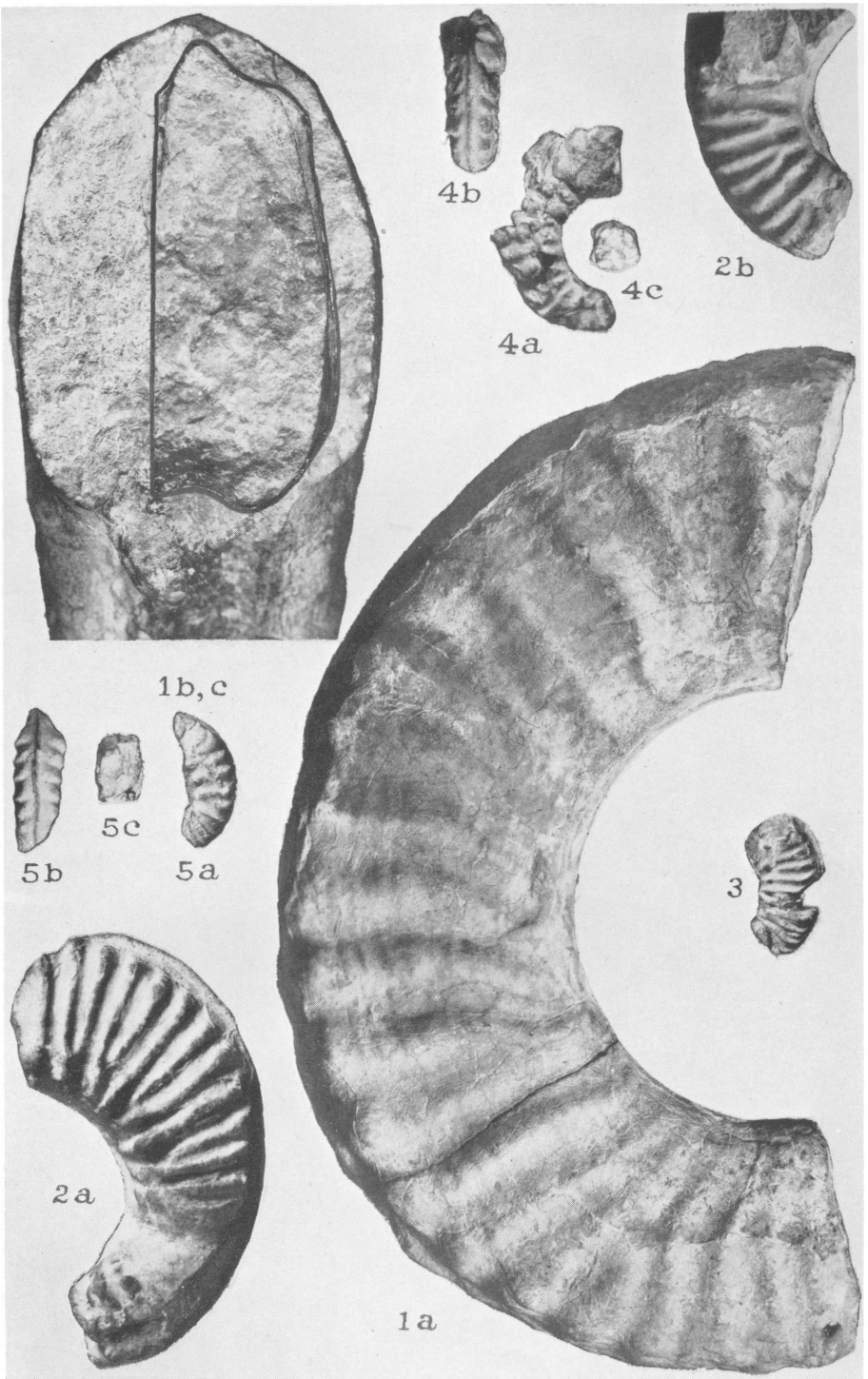

4b
2b
4c
4a
1b, c
5c
5b
5a
3
2a
1a

Plate XXXIII

Fig. 1. *Elobiceras elobiense* (Szajnocha); conditional neotype, A.M.N.H. No. 25180:1, (a) right side view, (b) left side view of anterior part of rubber cast of outer whorl, (c) ventral view, (d) section at posterior end of anterior fragment.

Figs. 2, 3. *Prohysteroceras wordiei* Spath. Fig. 2: A.M.N.H. No. 25184:1, (a) left side view, (b) ventral view (both × 2/3), (c) section at first fracture, (d) sectional view at last fracture, showing crystallized inner whorls. Fig. 3: A.M.N.H. No. 25184:2, ventral view (× 2/3).

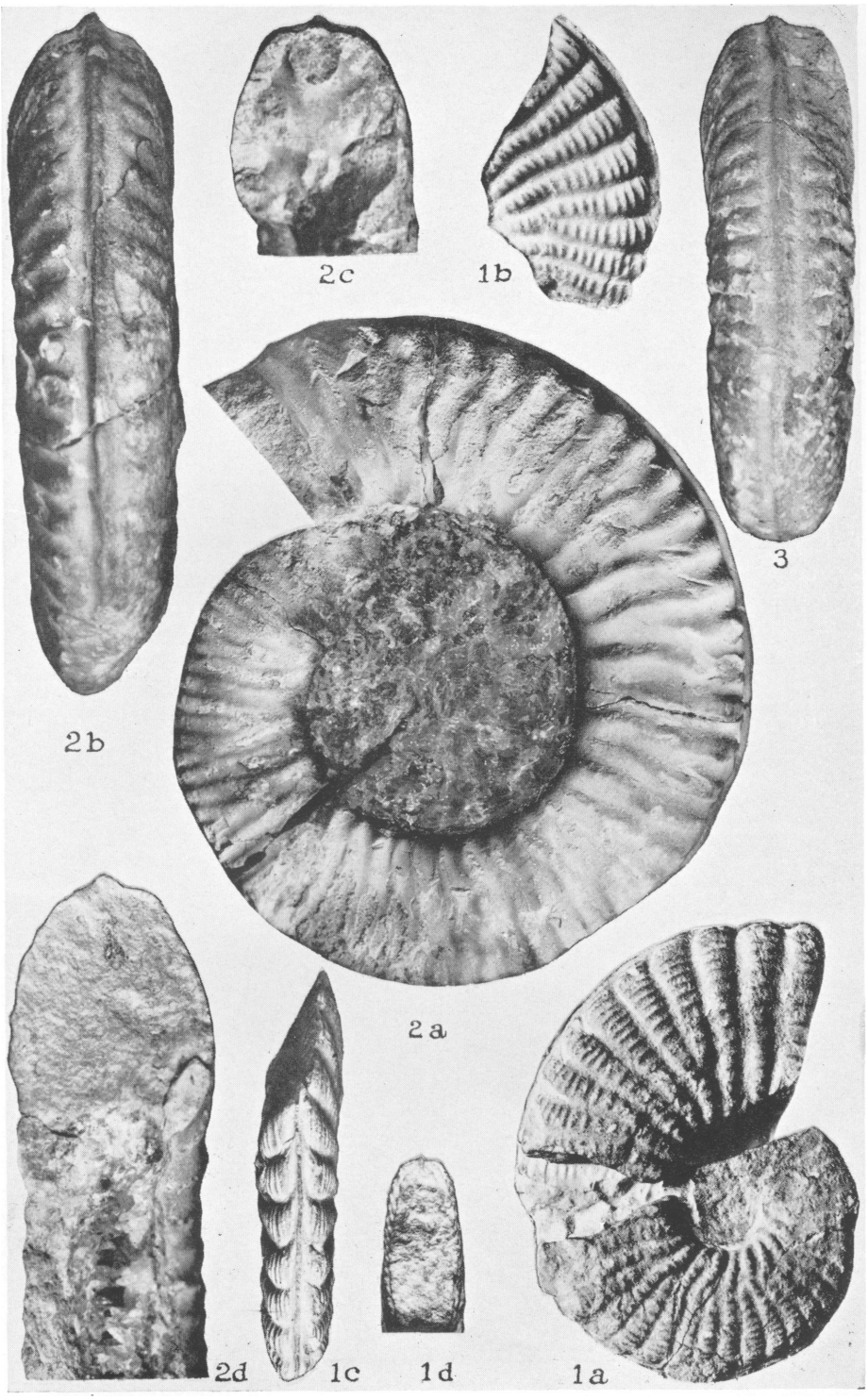

2c
1b
3
2b
2a
2d
1c
1d
1a

Plate XXXIV

Fig. 1. *Prohysteroceras decipiens* Spath; A.M.N.H. No. 25186:1, (a) left side view, showing indication of a rostrum, (b) ventral view of penultimate whorl, (c) ventral view, (d) section at anterior end of preserved part of penultimate whorl.

Fig. 2. Fragment at the right: *Prohysteroceras* cf. *dubium* Spath; A.M.N.H. No. 25187, left side view. Fragment at the left: *Neoharpoceras angolanum*, new species; A.M.N.H. No. 25190:3, right side view.

Figs. 3–5. *Prohysteroceras hanhaense*, new species. Fig. 3: Holotype, A.M.N.H. No. 25188:1, (a) right side view, (b) oblique left side view, to show details of ornamentation, particularly on the umbilical edge, (c) ventral view of penultimate whorl, (d) ventral view, (e) sectional view (without inner whorls). Fig. 4: A.M.N.H. No. 25188:2, ventral view. Fig. 5: A.M.N.H. No. 25188:3, (a) right side view of preserved part of outer whorl, (b) ventral view of its posterior part, (c) half ventral view of its anterior end.

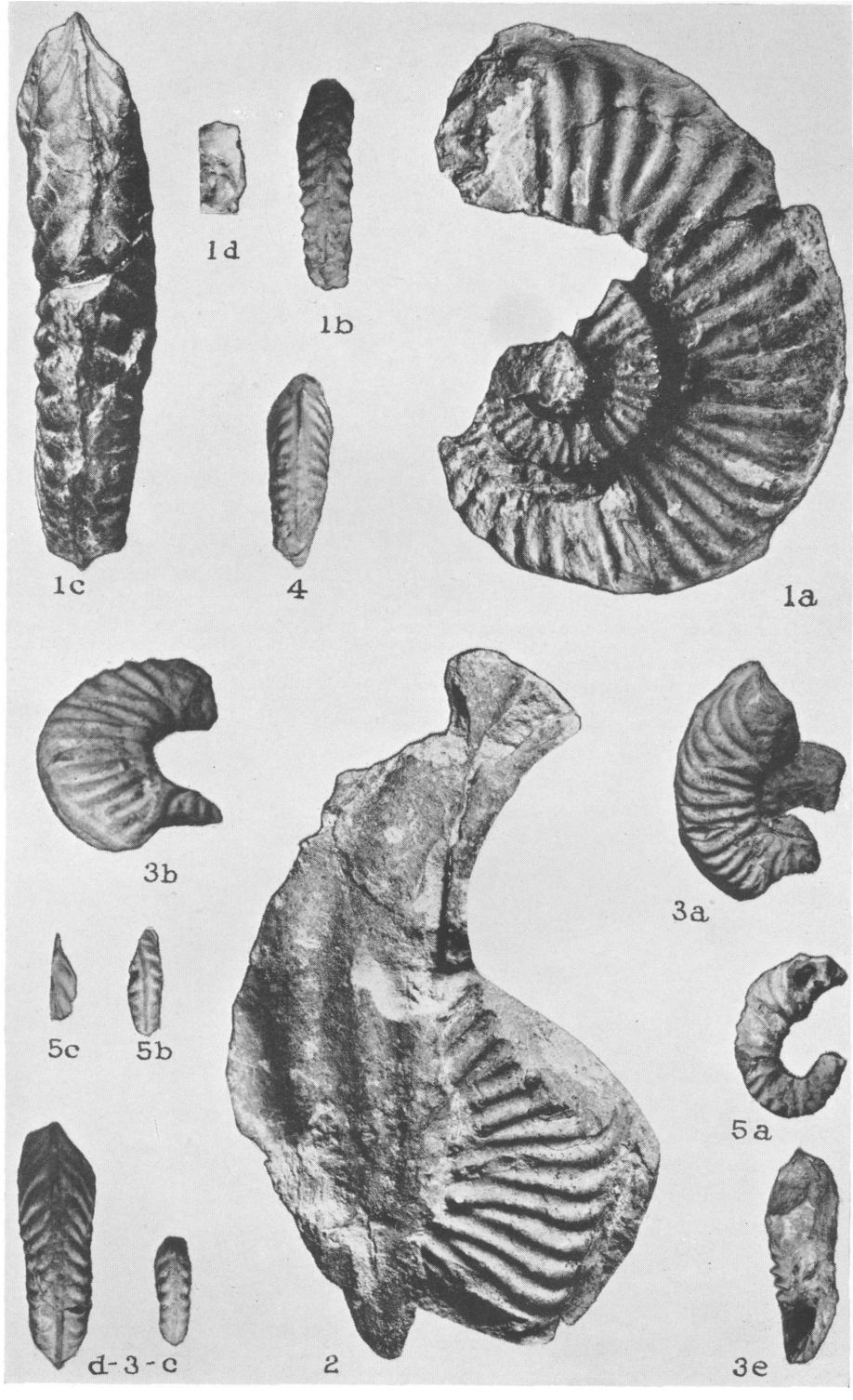

1c
1d
1b
4
1a
3b
3a
5c
5b
5a
d-3-c
2
3e

PLATE XXXV

Suture lines of:

Fig. 1. *Elobiceras irregulare* (Spath); A.M.N.H. No. 25165:5.

Fig. 2. *Elobiceras irregulare* (Spath), var. *rigidecostata*, new variety; holotype, A.M.N.H. No. 25166, from siphonal lobe to second lateral one.

Fig. 3. *Elobiceras spathianum*, new species; holotype, A.M.N.H. 25167.

Figs. 4–10. *Elobiceras raymondi*, new species. Fig. 4: A.M.N.H. No. 25175:28, showing gradual lengthening of first lateral lobe in three subsequent suture lines. Fig. 5: A.M.N.H. No. 25175:23, siphonal lobe and parts of adjacent saddles. Fig. 6: A.M.N.H. No. 25175:24. Fig. 7: A.M.N.H. No. 25175:18. Fig. 8: A.M.N.H. No. 25175:22. Fig. 9: A.M.N.H. No. 25175:8, (a) external suture line, showing abnormally narrow external saddle and abnormally broad first lateral lobe, (b) median part of internal suture line, showing dissymmetry of both sides. Fig. 10: Holotype, A.M.N.H. No. 25175:4, (a) siphonal lobe and adjacent part of right external saddle, (b) the other elements of the external suture line at a greater diameter.

Fig. 11. *Prohysteroceras decipiens* Spath; A.M.N.H. No. 25186:2.

Figs. 12, 13. *Prohysteroceras hanhaense*, new species. Fig. 12: Holotype, A.M.N.H. No. 25188:1, (a) inner whorl, (b) penultimate whorl, (c) median part of internal suture line of outer whorl. Fig. 13: A.M.N.H. No. 25188:2.

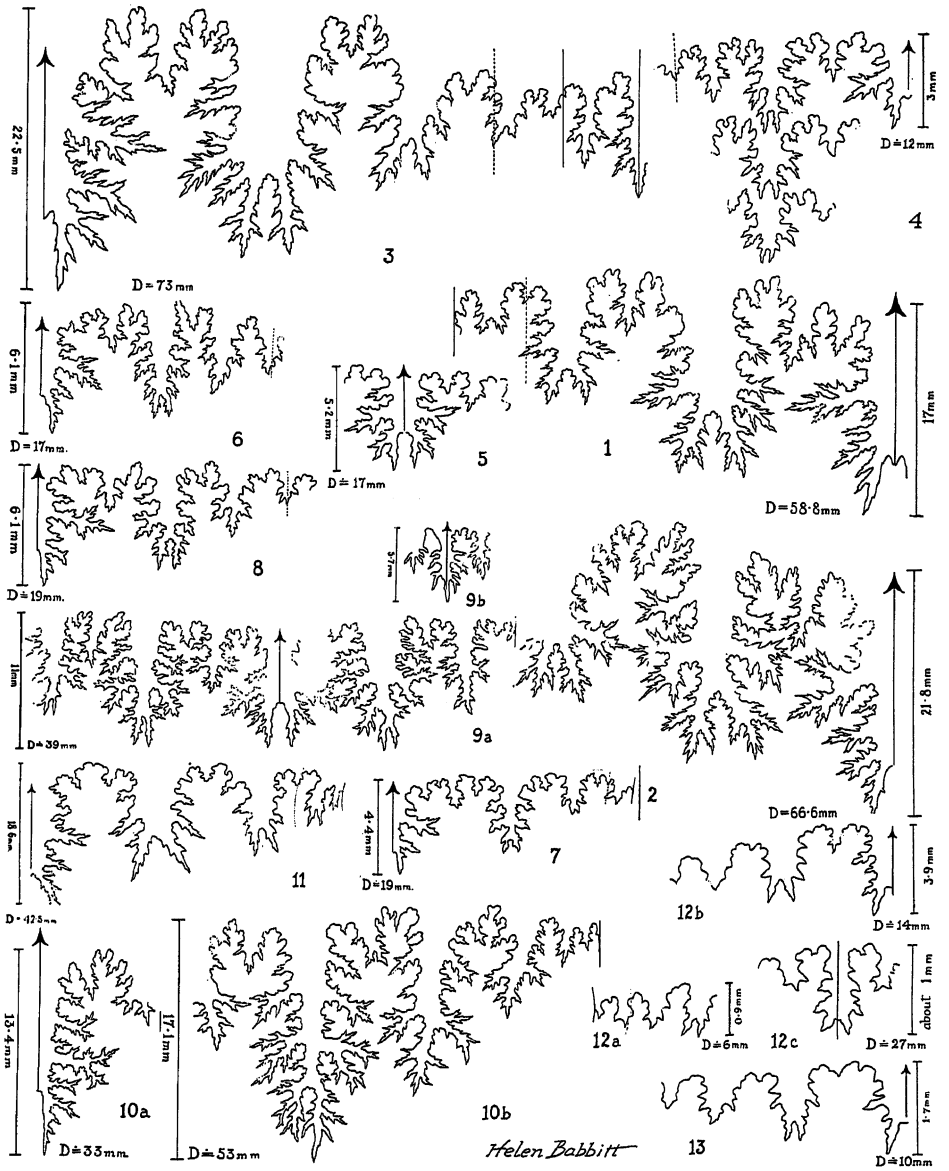

22·5mm
D=73mm
3
3mm
D=12mm
4
6·1mm
D=17mm.
6
5·2mm
D=17mm
5
1
17mm
D=58·8mm
6·1mm
D=19mm.
8
4·9mm
9b
11mm
D=39mm
9a
21·8mm
D=66·6mm
18·6mm
D=42·5mm
11
4·4mm
D=19mm.
7
2
3·9mm
D=14mm
12b
13·4mm
10a
D=33mm
17·1mm
D=53mm
10b
Helen Babbitt
12a
0·9mm
D=6mm
12c
about 1mm
D=27mm
13
1·7mm
D=10mm

PLATE XXXVI

Fig. 1. *Neoharpoceras angolanum*, new species; holotype, A.M.N.H. No. 25190:1, (a) left side view, (b) sectional view of posterior end (right side of fragment damaged).

Fig. 2. *Neoharpoceras conditum* Haas; holotype, A.M.N.H. No. 25191, (a) left side view, (b) ventral view, (c) sectional view.

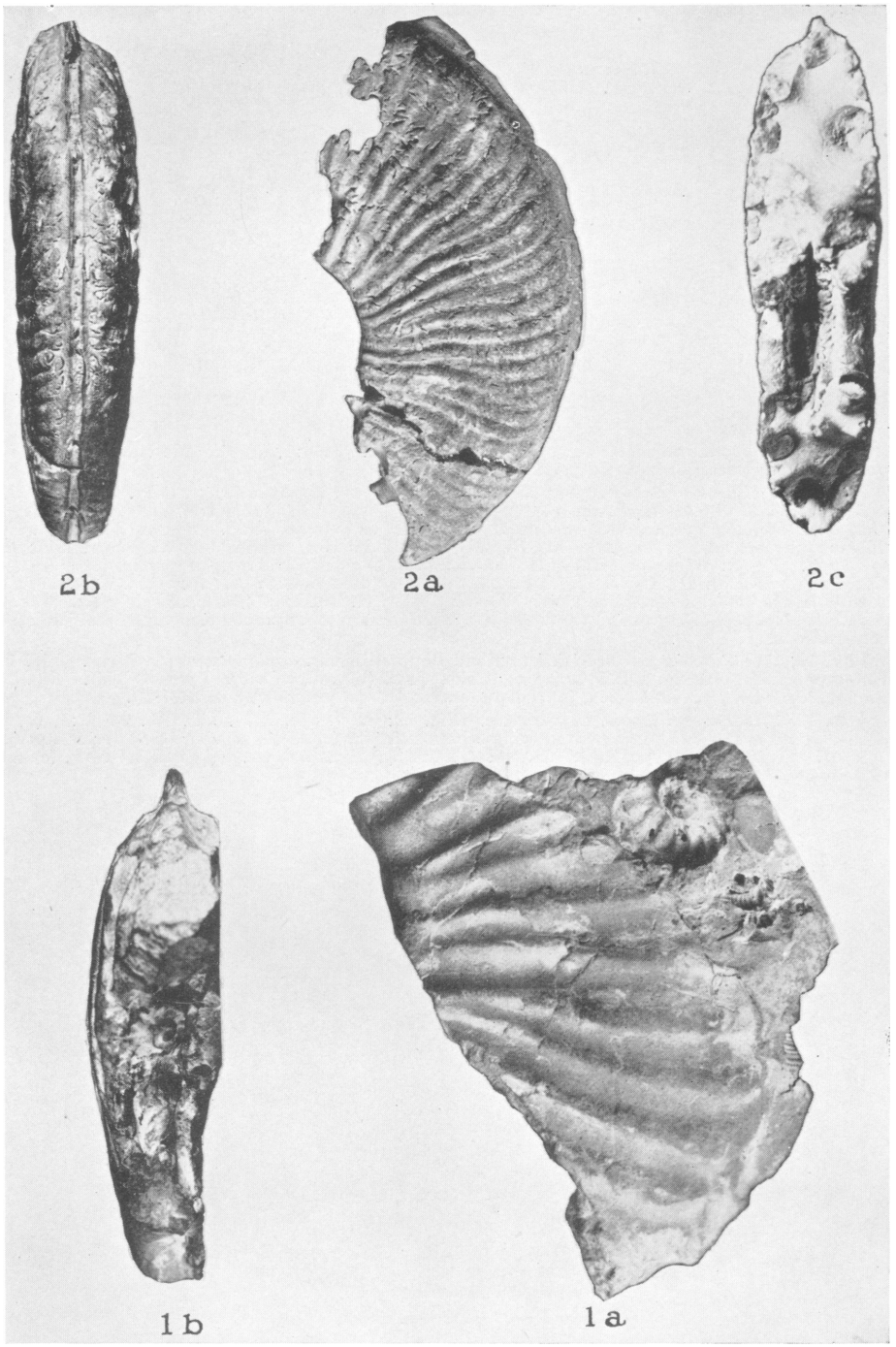

2b
2a
2c
1b
1a

Plate XXXVII

Fig. 1. *Phylloceras velledae* (Michelin); A.M.N.H. No. 25386:1, (a) left side view (× 2/3), (b) ventral view of posterior half of outer whorl.

Figs. 2–9. *Puzosia quenstedti* (Parona and Bonarelli), var. *angolana*, new variety. Fig. 2: A.M.N.H. No. 25387:11, (a) right side view, (b) ventral view, (c) sectional view (all × 3). Fig. 3: A.M.N.H. No. 25387:1, (a) left side view, (b) ventral view (both × 2). Fig. 4: A.M.N.H. No. 25387:2, (a) right side view, (b) ventral view, (c) sectional view, showing section at posterior end (all × 2). Fig. 5: Paratype, A.M.N.H. No. 25387:3, (a) right side view, (b) ventral view, (c) sectional view. Fig. 6: Holotype, A.M.N.H. No. 25387:4, (a) left side view, (b) ventral view. Fig. 7: A.M.N.H. No. 25387:5, sectional view. Fig. 8: A.M.N.H. No. 25387:21, right side view. Fig. 9: A.M.N.H. No. 25387:39, ventral view. Figs. 8 and 9 to show more pronounced ventral projection of constrictions.

Figs. 10, 11. *Puzosia quenstedti* (Parona and Bonarelli), var. *applanata*, new variety. Fig. 10: Holotype, A.M.N.H. No. 25388:1, (a) right side view, (b) ventral view (both × 3/2). Fig. 11: Paratype, A.M.N.H. No. 25388:2, (a) right side view, (b) ventral view (both × 3/2).

Figs. 12, 13. *Puzosia tenuis*, new species. Fig. 12: Holotype, A.M.N.H. No. 25389:1, (a, b) right and left side views, the latter showing ornamentation, (c) sectional view of posterior end (all × 3/2). Fig. 13: Paratype, A.M.N.H. No. 25389:4, (a) right side view, (b) ventral view, (c) sectional view, showing section at anterior end.

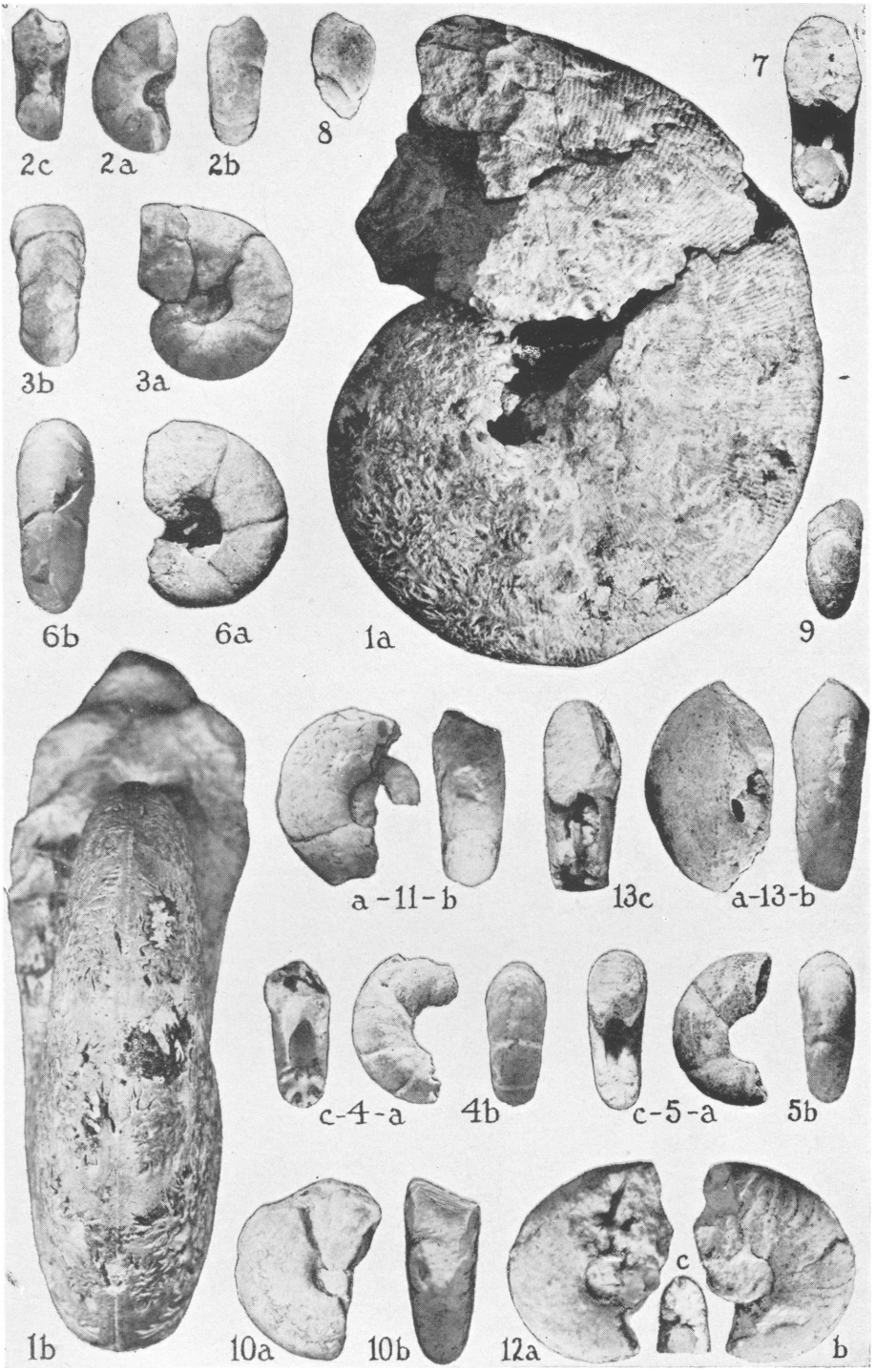

2c
2a
2b
8
7
3b
3a
6b
6a
1a
9
1b
a-11-b
13c
a-13-b
c-4-a
4b
c-5-a
5b
10a
10b
12a
c
b

PLATE XXXVIII

Figs 1, 2. *Puzosia tenuis*, new species. Fig. 1: A.M.N.H. No. 25389:2, (a) right side view, (b) ventral view, (c) sectional view at fracture (all × 3/2). Fig. 2: A.M.N.H. No. 25389:9, sectional view of posterior end.

Figs. 3, 4. *Puzosia*, indeterminate new species. Fig. 3: Smallest fragment, A.M.N.H. No. 25390:1, (a) right side view, (b) ventral view, both showing course of constriction. Fig. 4: Largest fragment, A.M.N.H. No. 25390:2, (a) left side view, (b) ventral view.

Figs. 5, 6. *Puzosia cuvervillei* (Meunier). Fig. 5: A.M.N.H. No. 25391:2, (a) left side view, (b) ventral view, (c) sectional view at fracture. Fig. 6: A.M.N.H. No. 25391:5, ventral view, to show fine striation.

Figs. 7–10. *Puzosia cuvervillei* (Meunier), var. *flexisulcata*, new variety. Fig. 7: Paratype, A.M.N.H. No. 25392:2, (a) left side view, (b) sectional view. Fig. 8: A.M.N.H. No. 25392:1, (a) right side view, (b) ventral view. Fig. 9: A.M.N.H. No. 25392:4, right side view, showing humps. Fig. 10: Holotype, A.M.N.H. No. 25392:6, (a, b) right and left side views, the latter showing the high, perpendicular, umbilical wall, (c) ventral view, showing ornamentation.

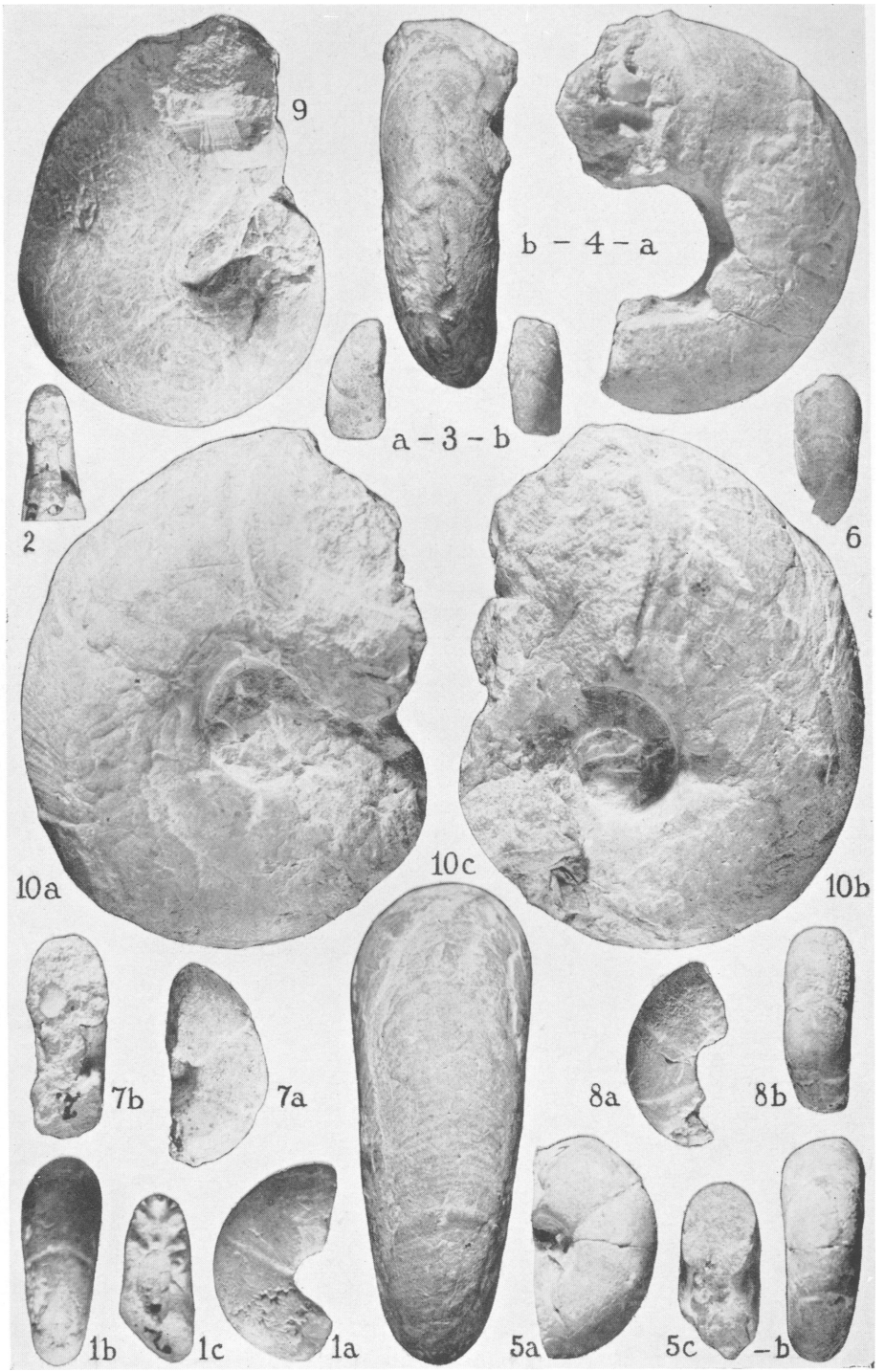

9
b – 4 – a
a – 3 – b
2
6
10a
10c
10b
7b
7a
8a
8b
1b
1c
1a
5a
5c
–b

PLATE XXXIX

Fig. 1. *Puzosia cuvervillei* (Meunier); conditional neotype, A.M.N.H. No. 25391:1, (a) left side view, (b) ventral view.

Fig. 2. *Puzosia cuvervillei* (Meunier), var. *flexisulcata*, new variety; A.M.N.H. No. 25392:8, latero-ventral view, to show course of constriction.

Figs. 3–5. *Puzosia spathi* Venzo. Fig. 3: A.M.N.H. No. 25393:1 (free part of disc), (a) right side view, (b) ventral view, (c) sectional view. Fig. 4: A.M.N.H. No. 25393:2, (a) right side view, (b) ventral view of anterior part of outer whorl, to show the "bourrelet" behind the foremost constriction (both × 1/2). Fig. 5: A.M.N.H. No. 25393:11, details of bottom of a first (or second?) lateral lobe.

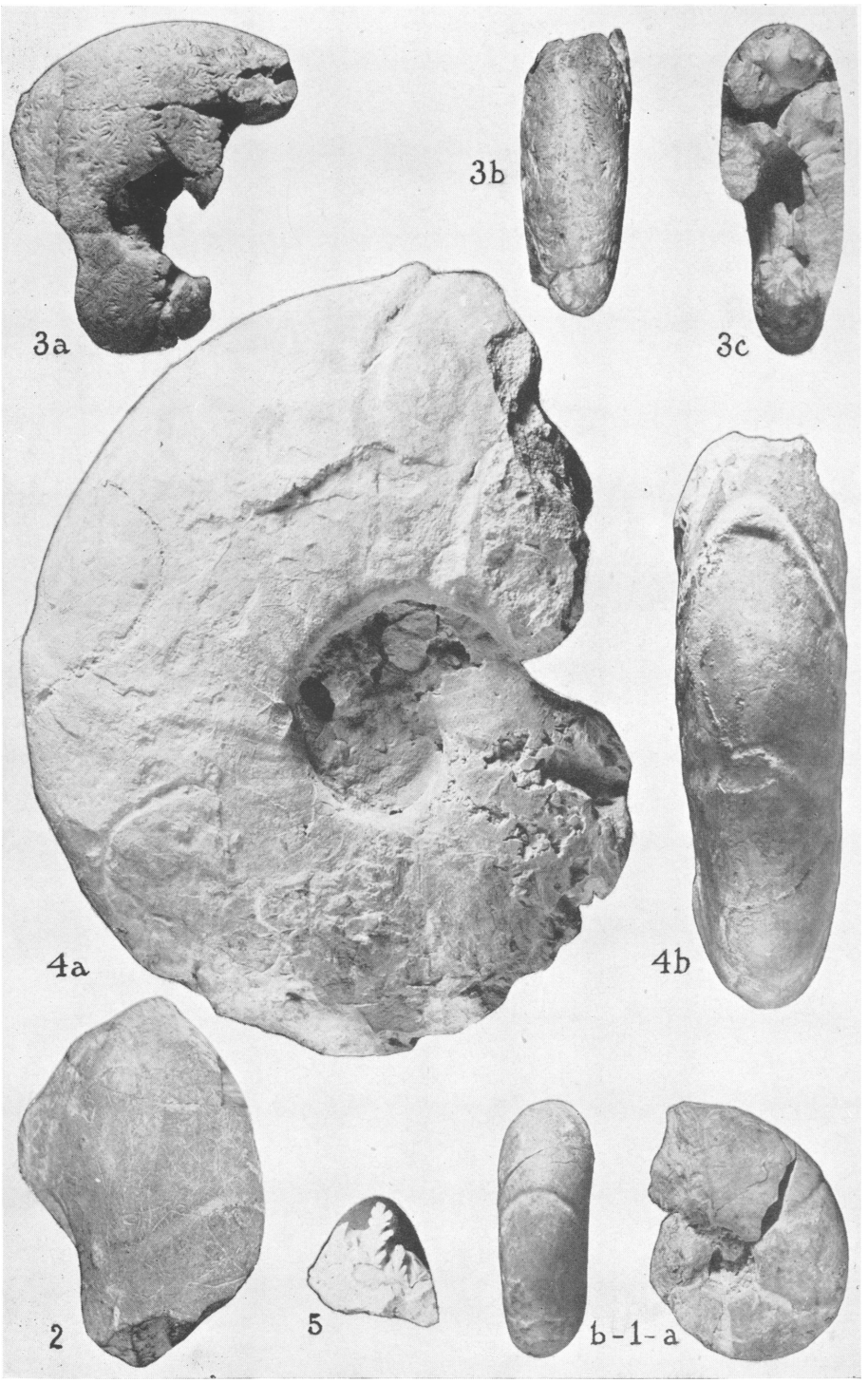

3a
3b
3c
4a
4b
2
5
b-1-a

PLATE XL

Fig. 1. *Puzosia spathi* Venzo; A.M.N.H. No. 25393:3, (a) right side view, to show crowding of "bourrelets" toward anterior end (× ca. 2/5), (b) left side view (× 1/2).

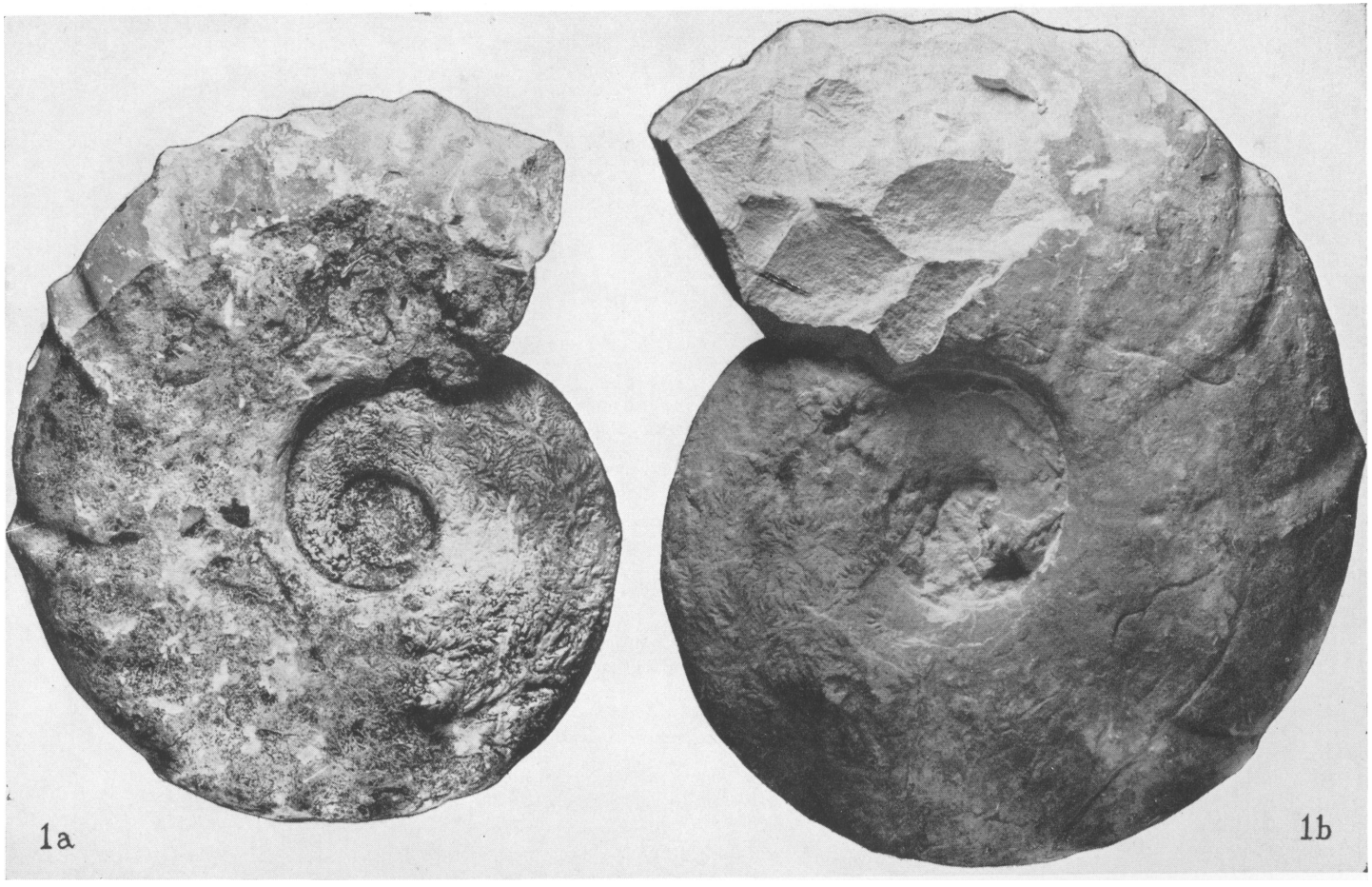

1a
1b

Plate XLI

Suture lines of *Puzosia:*

Figs. 1–6. *P. quenstedti* (Parona and Bonarelli), var. *angolana*, new variety. Fig. 1: A.M.N.H. No. 25387:6, innermost whorls, at diameters of (a) 3 mm., (b) ca. 5 mm. Fig. 2: A.M.N.H. No. 25387:7. Fig. 3: A.M.N.H. No. 25387:8. Fig. 4: A.M.N.H. No. 25387:9. Fig. 5: A.M.N.H. No. 25387:10, internal suture line. Fig. 6: A.M.N.H. No. 25387:23.

Figs. 7, 8. *P. quenstedti* (Parona and Bonarelli), var. *applanata*, new variety. Fig. 7: Paratype, A.M.N.H. No. 25388:2. Fig. 8: Holotype, A.M.N.H. No. 25388:1.

Figs. 9, 10. *P. tenuis*, new species. Fig. 9: A.M.N.H. No. 25389:13. Fig. 10: A.M.N.H. No. 25389:2.

Figs. 11–13. *P. cuvervillei* (Meunier). Fig. 11: A.M.N.H. No. 25391:6. Fig. 12: A.M.N.H. No. 25391:8. Fig. 13: A.M.N.H. No. 25391:7.

Figs. 14, 15. *P. spathi* Venzo. Fig. 14: A.M.N.H. No. 25393:1. Fig. 15: A.M.N.H. No. 25393:3, siphonal lobe and right lateral lobes and adjacent saddles.

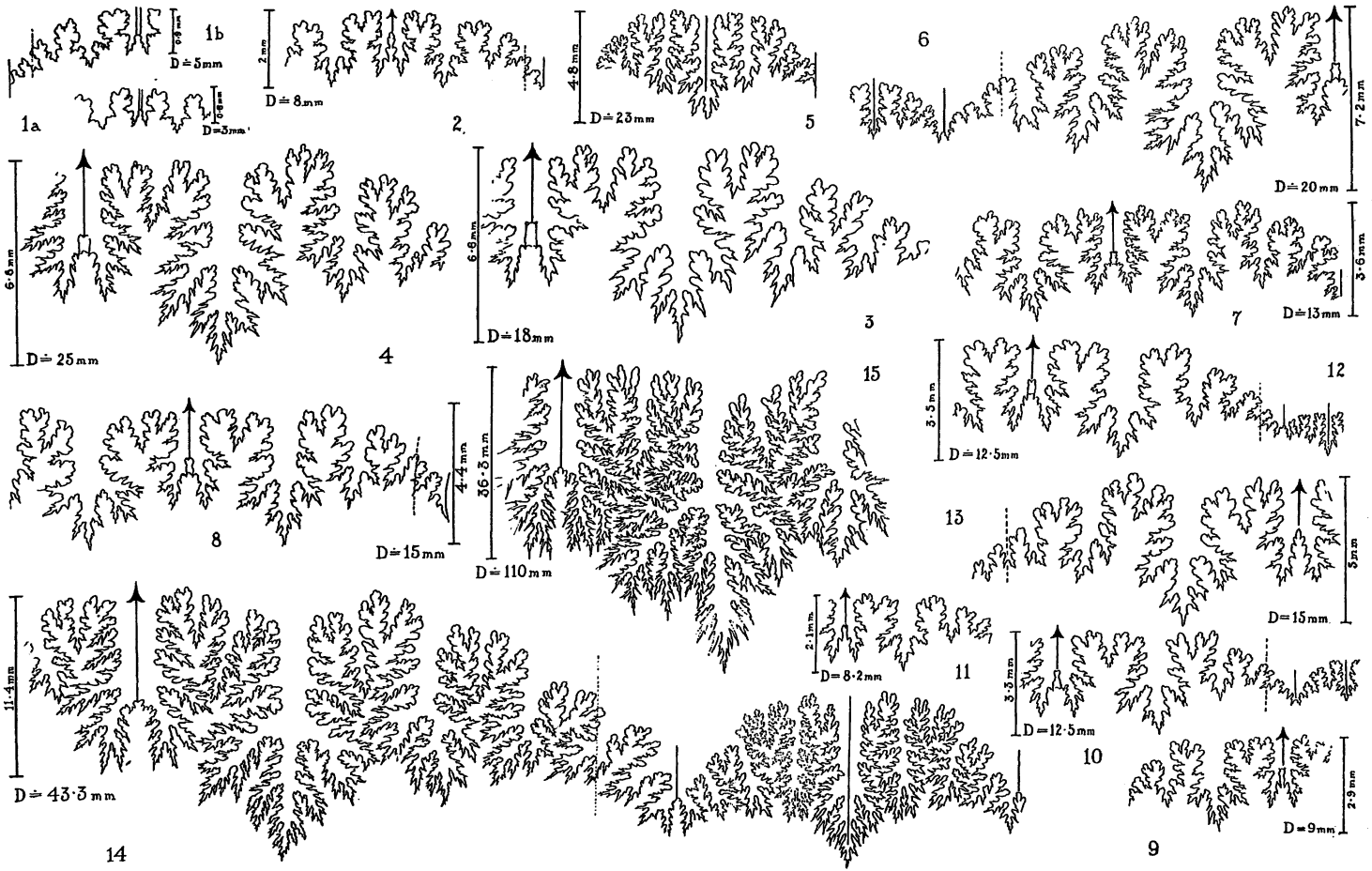

1b
D = 5mm
1a
D = 5mm
2
D = 8mm
5
D = 23mm
6
D = 20mm
7
D = 13mm
4
D = 25mm
3
D = 18mm
15
D = 110mm
12
D = 12·5mm
8
D = 15mm
13
D = 15mm
11
D = 8·2mm
10
D = 12·5mm
14
D = 43·3mm
9
D = 9mm

PLATE XLII

Fig. 1. *Puzosia spathi* Venzo; A.M.N.H. No. 25393:4, left side view (× 1/2).

Fig. 2. *Beudanticeras beudanti* (Brongniart); A.M.N.H. No. 25395, (a) left side view, (b) right side view, to show constrictions and ridges more distinctly, (c) ventral view.

Fig. 3. *Gaudryceras aenigma*, new species; holotype, A.M.N.H. No. 25397, (a) right side view, (b, c) ventral views of posterior and anterior parts of outer whorl, (d) oblique ventral view of a fragment, showing translucent lobes and saddles. The visibility of the suture lines in figs. a, b and d is not due to any preparation.

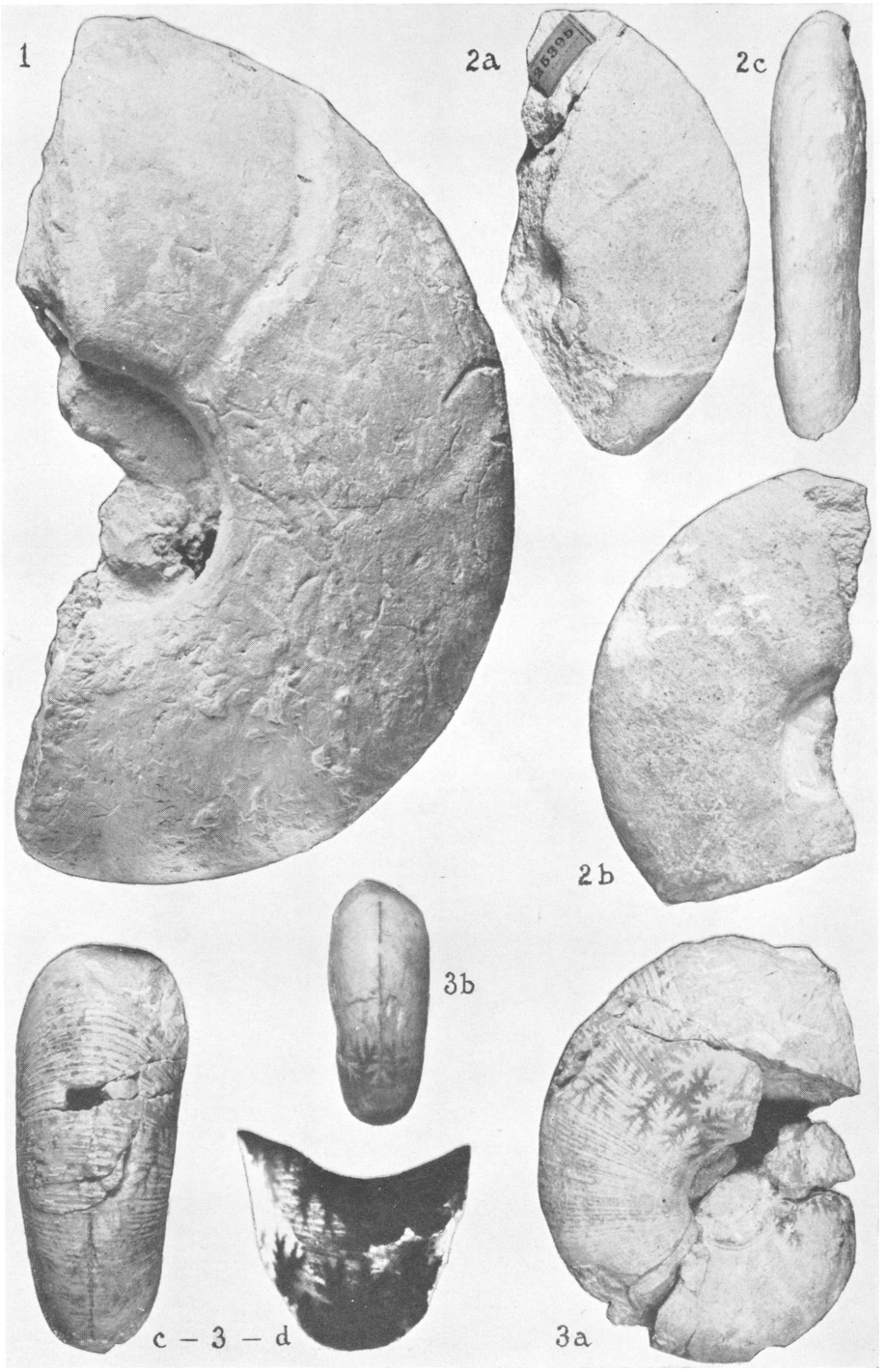

1
2a
2c
2b
3b
c – 3 – d
3a

Plate XLIII

Fig. 1. *Hamites compressus* Sowerby; A.M.N.H. No. 25399:1, (a, b) right and left side views, (c) ventral view, (d) dorsal view (slightly oblique), (e) sectional view of anterior end.

Figs. 2–4. *Hamites compressus* Sowerby, var. *gracilis* Spath. Fig. 2: A.M.N.H. No. 25400:1, (a) left side view, (b) ventral view, (c) dorsal view. Fig. 3: A.M.N.H. No. 25400:2, (a, b) right and left side views, (c) ventral view. Fig. 4: A.M.N.H. No. 25400:3, left side view.

Figs. 5–7. *Hamites tenuis* Sowerby. Fig. 5: A.M.N.H. No. 25401:1, right side view. Fig. 6: A.M.N.H. No. 25401:2, (a) left side view, (b) ventral view. Fig. 7: A.M.N.H. No. 25401:3, (a) right side view, (b) ventral view.

Fig. 8. *Hamites tenuis* Sowerby, var. *subacuaria* Spath; A.M.N.H. No. 25402:1, (a) right side view, (b) ventral view.

Figs. 9, 10. *Hamites virgulatus* (Brongniart ?) Pictet and Campiche. Fig. 9: A.M.N.H. No. 25403:1, (a) right side view, (b) ventral view, (c) dorsal view. Fig. 10: A.M.N.H. No. 25403:2, (a) right side view, (b) ventral view, (c) dorsal view.

Fig. 11. *Hamites subvirgulatus* Spath?; A.M.N.H. No. 25404, (a, b) right and left side views, (c) ventral view, (d) dorsal view.

Figs. 12–15. *Hamites venetzianus* Pictet. Fig. 12: A.M.N.H. No. 25405:2, (a) right side view, (b) ventral view, (c) dorsal view. Fig. 13: A.M.N.H. No. 25405:6, (a) right side view, (b) ventral view. Fig. 14: A.M.N.H. No. 25405:7, (a) left side view, (b) ventral view. Fig. 15: A.M.N.H. No. 25405:8, right side view, to show horizontal ribbing.

Figs. 16–19. *Hamites duplicatus* Pictet and Campiche. Fig. 16: A.M.N.H. No. 25406:1, (a) right side view, (b) ventral view. Fig. 17: A.M.N.H. No. 25406:2, right side view. Fig. 18: A.M.N.H. No. 25406:3, latero-dorsal view, to show duplication of ribs. Fig. 19: A.M.N.H. No. 25406:4, latero-ventral view, to show supposed apertural collars.

Fig. 20. *Hamites* (?) cf. *nokonis* Adkins and Winton; A.M.N.H. No. 25407, (a, b) right and left side views.

Except Nos. 20a, b, the figures of this plate are enlarged × 3/2.

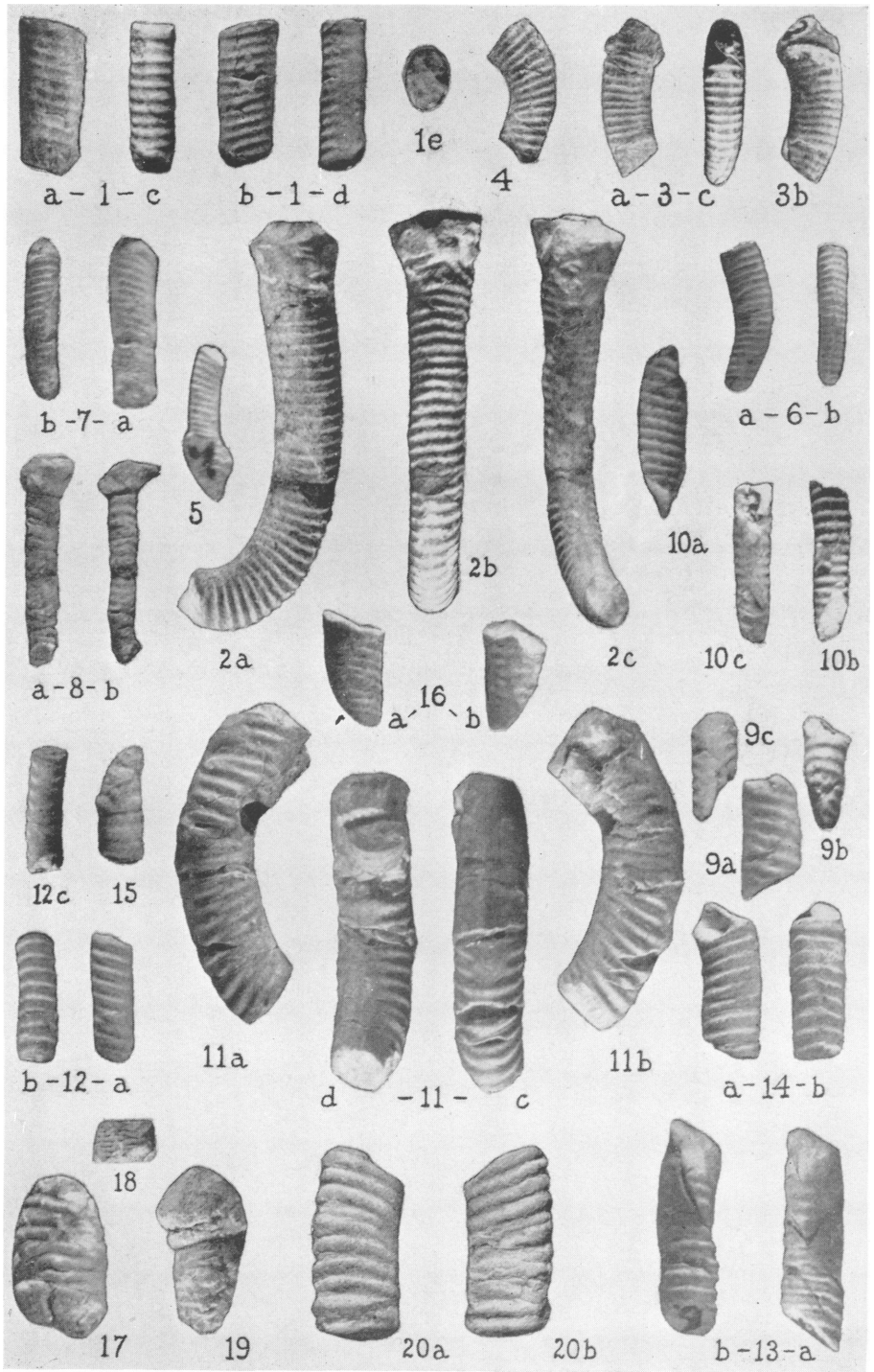

a - 1 - c
b - 1 - d
1e
4
a - 3 - c
3b
b - 7 - a
5
2a
2b
2c
a - 6 - b
10a
10c
10b
a - 8 - b
a - 16 - b
12c
15
11a
d - 11 - c
11b
9c
9a
9b
b - 12 - a
a - 14 - b
18
17
19
20a
20b
b - 13 - a

Plate XLIV

Suture lines of:

Fig. 1. *Phylloceras velledae* (Michelin); A.M.N.H. No. 25386:1.

Fig. 2. *Gaudryceras aenigma*, new species; holotype, A.M.N.H. No. 25397, (a) siphonal lobe and external saddles at first quarter of outer whorl, (b) right half of external suture line at third quarter of outer whorl.

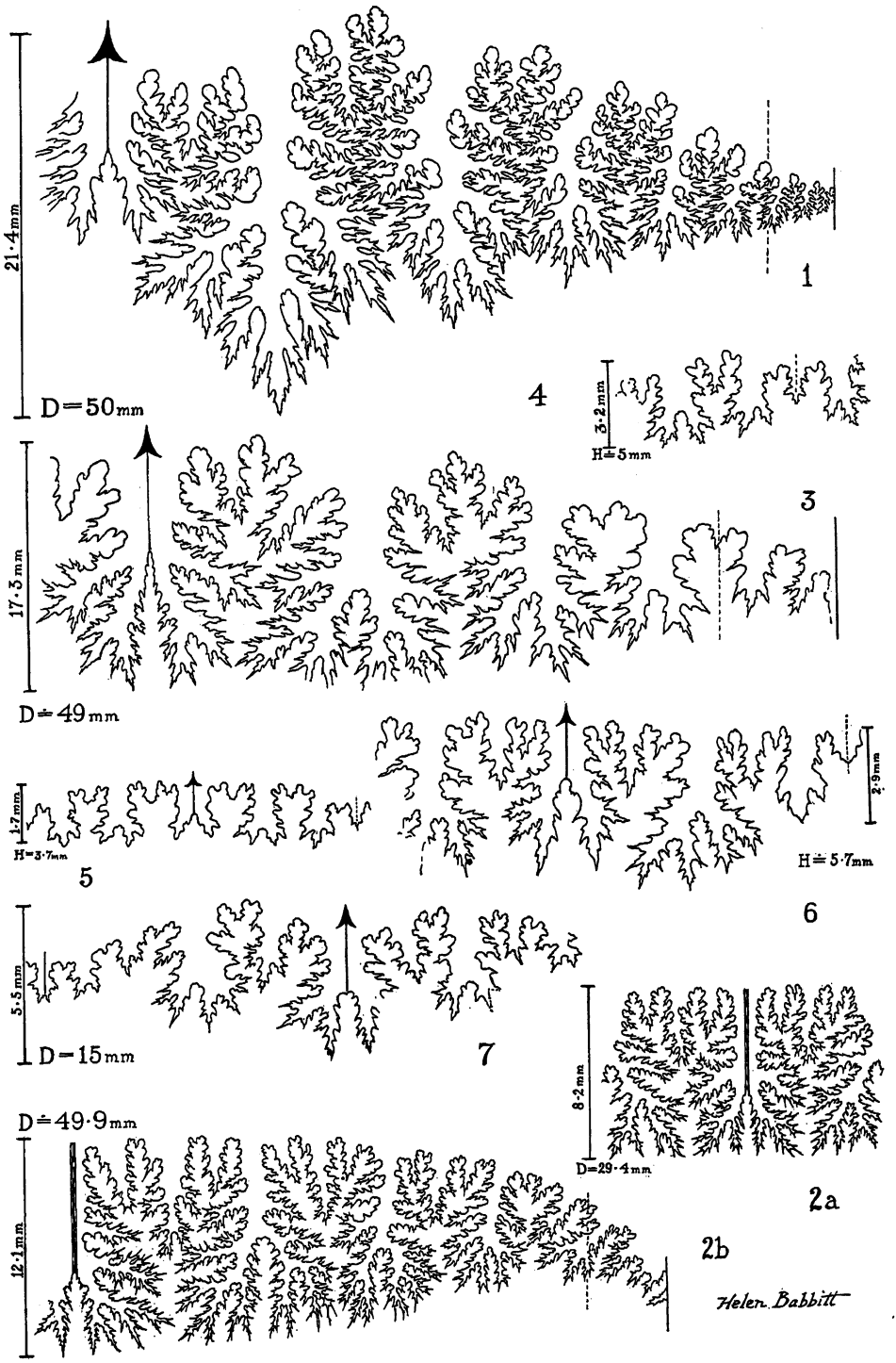
Fig. 3. *Tetragonites jurinianus* (Pictet), var. *angolana*, new variety; holotype, A.M.N.H. No. 25398.

Fig. 4. *Hamites virgulatus* (Brongniart ?) Pictet and Campiche; A.M.N.H. No. 25403:1.

Fig. 5. *Hamites venetzianus* Pictet; A.M.N.H. No. 25405:2.

Fig. 6. *Hamites duplicatus* Pictet and Campiche; A.M.N.H. No. 25406:1.

Fig. 7. *Pseudhelicoceras* cf. *quadrituberculatum* Spath; A.M.N.H. No. 25421:2.


21·4mm
D=50mm
1
4
3·2mm
H=5mm
3
17·3mm
D=49mm
1·7mm
H=3·7mm
5
2·9mm
H=5·7mm
6
5·5mm
D=15mm
7
D=49·9mm
8·2mm
D=29·4mm
2a
12·1mm
2b
Helen Babbitt

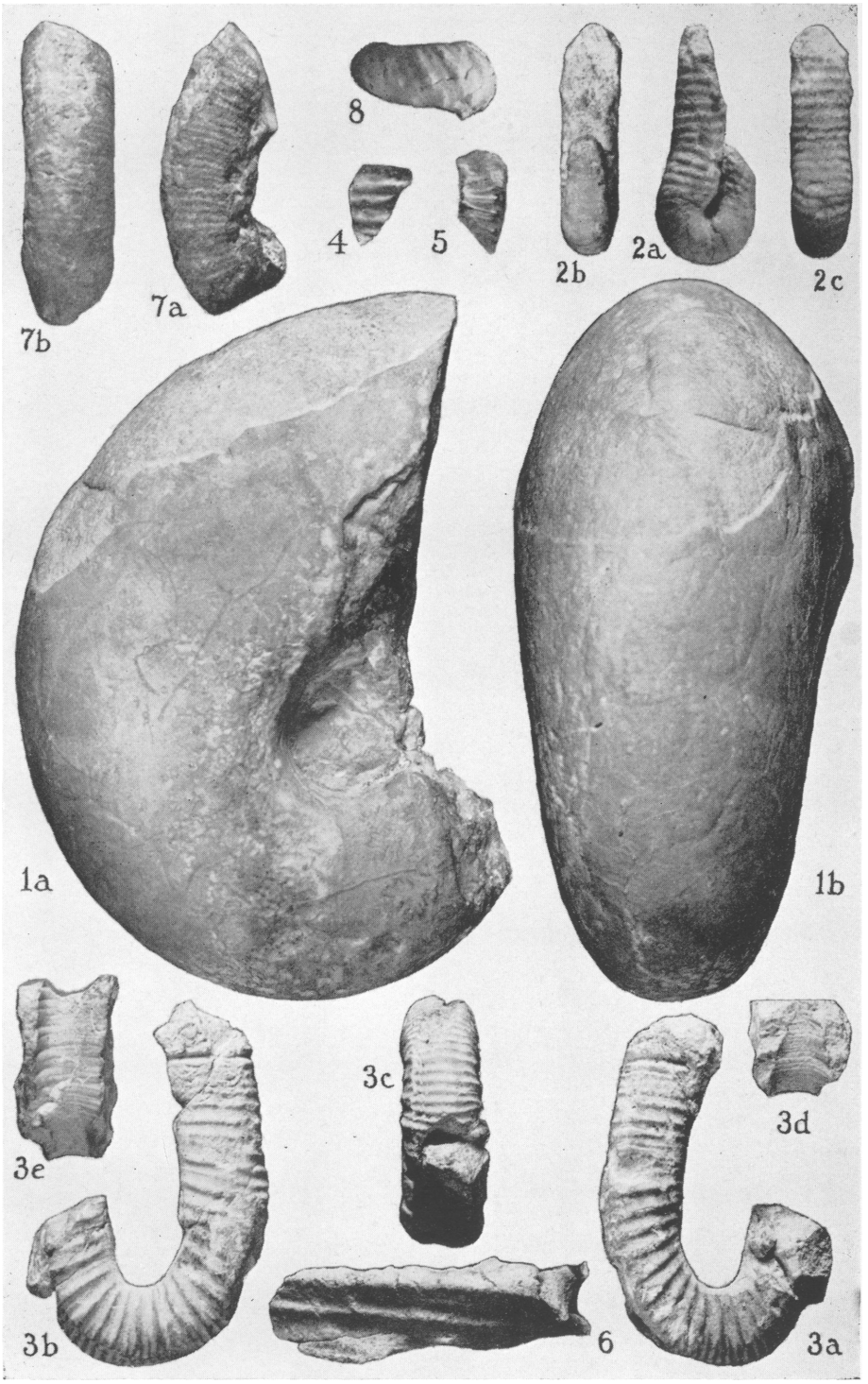

8
4
5
2b
2a
2c
7b
7a
1a
1b
3c
3d
3e
3b
6
3a

PLATE XLVI

Figs. 1–3. *Anisoceras saussureanum* (Pictet), var. *spinosa*, new variety, from locality "R28" (= "3041"), south of Benguela Velha, Angola. Fig. 1: A.M.N.H. No. 25414:4, left side view. Fig. 2: Holotype, A.M.N.H. No. 25414:1, (a) left side view, (b) ventral view (taken a little obliquely from the left). Fig. 3: A.M.N.H. No. 25414:3, (a, b) left and right side views, showing dissymmetry of ornamentation.

Fig. 4. *Idiohamites spiniger* (Sowerby); A.M.N.H. No. 25416, most probably from locality "R 30," south of Benguela Velha, Angola, (a) right side view, (b) ventral view, (c) dorsal view.

Fig. 5. *Idiohamites* aff. *subspinigero* Spath; A.M.N.H. No. 25418, from locality "R 28" (= "3041"), south of Benguela Velha, Angola, left side view.

Fig. 6. *Turrilitoides*, indeterminate new species; A.M.N.H. No. 25419, ventral view.

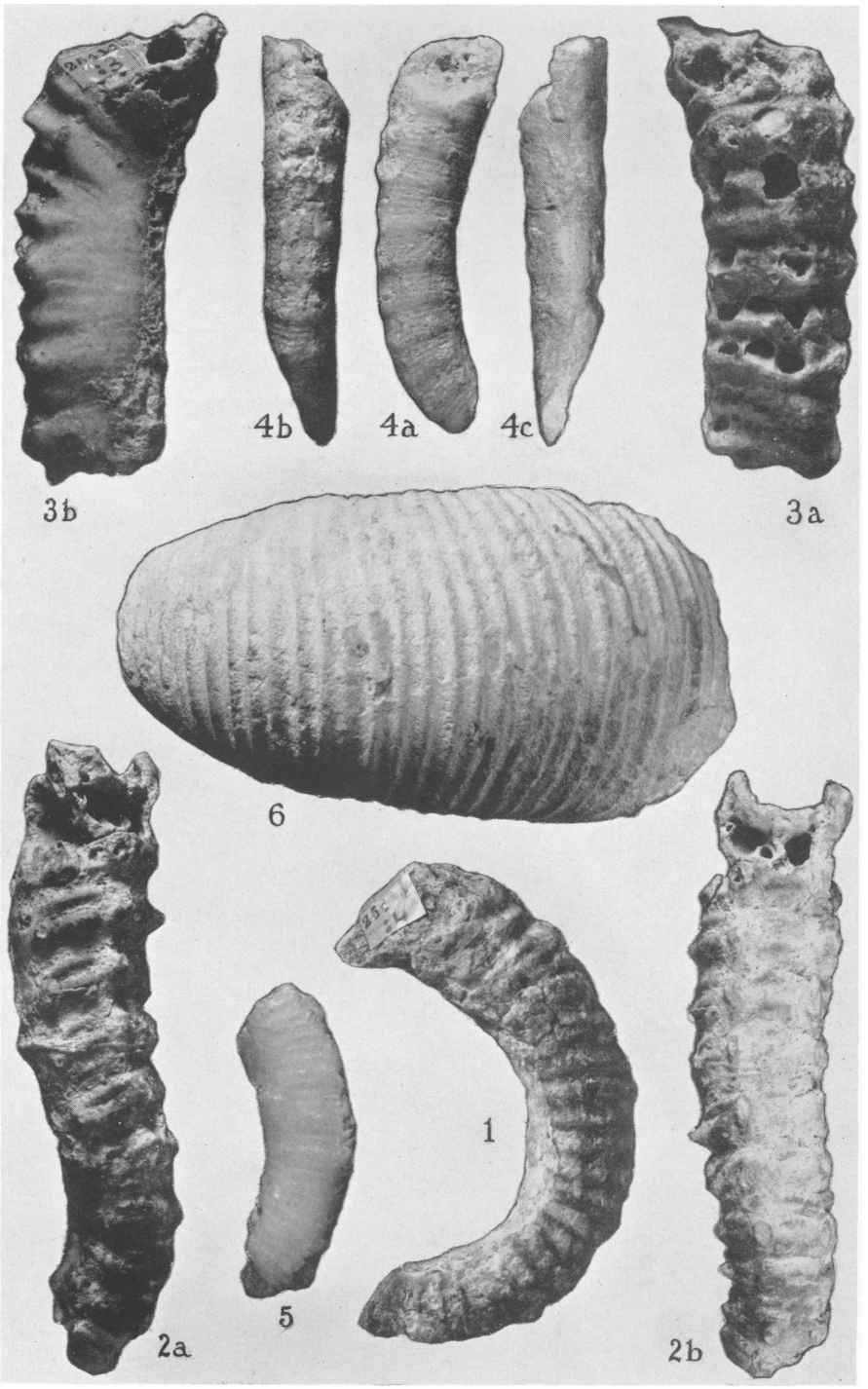

4b
4a
4c
3b
3a
6
2a
5
1
2b

PLATE XLVII

Limestone Cliffs bordering the Hanha River, Hanha Estate, near Lobito, Angola. Photograph by Herbert Lang.

Plate XLV

Fig. 1. *Tetragonites jurinianus* (Pictet), var. *angolana*, new variety; holotype, A.M.N.H. No. 25398, (a) right side view, (b) ventral view.

Fig. 2. *Ptychoceras fauncei*, new species; holotype, A.M.N.H. No. 25409, (a) right side view, (b, c) ventral views of thinner and thicker shafts (all × 3/2).

Fig. 3. *Hamitoides angolanus*, new species; holotype, A.M.N.H. No. 25410, (a, b) right and left side views, (c) ventral view, (d, e) molds of conch apicad and orad of hook, to show ornamentation of dorsum.

Fig. 4. *Anisoceras perarmatum* Pictet and Campiche ?; A.M.N.H. No. 25412, left side view (× 3/2), to show ornamentation.

Fig. 5. *Anisoceras* (?), indeterminate species; A.M.N.H. No. 25413, side view (× 3/2), to show ornamentation.

Fig. 6. *Idiohamites* (?), indeterminate species; A.M.N.H. No. 25415, oblique side view of a short fragment, to show spine pointing backward.

Fig. 7. *Idiohamites*, indeterminate species; A.M.N.H. No. 25417, from locality "R 30," south of Benguela Velha, Angola, (a) right side view, (b) ventral view.

Fig. 8. *Pseudhelicoceras* cf. *quadrituberculatum* Spath; A.M.N.H. No. 25421:1, ventral view (× 3/2).