COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Upper Cretaceous Ammonites from the Carnarvon Basin of Western Australia

I: The Heteromorph Lytoceratina

BY

R. O. BRUNNSCHWEILER

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MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.

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CONTENTS

UPPER CRETACEOUS AMMONITES FROM THE CARNARVON BASIN OF WESTERN AUSTRALIA: I. THE HETEROMORPH LYTOCERATINA

SUMMARY

This Bulletin is the first part of a monograph on the Upper Cretaceous Ammonoidea of the Carnarvon Basin, and deals with the Heteromorph Lytoceratina of Santon-Campanian and Maastrichtian age.

It is proposed to subdivide the Heteromorph Lytoceratina further by removing a number of genera from Turrilitaceae to form a new superfamily Diplomocerataceae. It is shown that Diplomocerataceae are derived from Cicatritidae, whereas Turrilitaceae stem from Macroscaphitidae.

Diplomocerataceae are represented in Western Australia by the genera *Hyphantoceras* Hyatt, *Diplomoceras* Spath, *Bostrychoceras* Hyatt, and *Eudiplomoceras* nov.; Turrilitaceae by *Baculites* Lamarck, *Eubaculites* Spath, *Giralites* nov., *Eubaculiceras* nov., *Cardabites* nov., *Nostoceras* Hyatt, *Glyptoxoceras* Spath, and *Neohamites* nov. Scaphitaceae are represented by a single specimen of a new species of *Indoscaphites* Spath.

Thirty species of the above 13 genera are described, 17 of which are new.

INTRODUCTION AND ACKNOWLEDGEMENTS

Spath (1926b) first described Upper Cretaceous ammonites from Western Australia. The specimens came from the Santonian Gingin Chalk in what is now known as the Perth Basin and, although not well preserved, they are undoubtedly pachydiscids, probably of the genus *Eupachydiscus* Spath.

A decade later Raggatt (1936) announced the discovery of another and much more widely spread Upper Cretaceous sequence in the Carnarvon Basin (then known as the North-West Basin)—the fossil faunas were found to be much richer and in the main younger than those in the Perth Basin. Whitehouse, who determined but did not describe them, was of the opinion that the principal ammonite-bearing bed is Campanian in age (Raggatt, 1936).

Spath (1940), who had received a small collection from Raggatt's ammonite-bearing bed through Dr C. Teichert, was again the first to describe and figure some of the material. He concluded that the assemblage sent to him is essentially of lower Maastrichtian age, but also contained Campanian forms. Most of the Western Australian specimens were identified with, or closely comparable to, forms occurring in the Valudayur beds of southern India; some, however, were identified with Aryalur species. In the final analysis Spath favoured the idea that the fauna indicates an age about the Campanian-Maastrichtian boundary and he reiterated that interpretation later (Spath, 1953).

In 1948 the Commonwealth Bureau of Mineral Resources, Geology and Geophysics began a programme of mapping the major sedimentary basins on the continent with a view to assessing their petroleum potential. Among the first basins to be investigated were those in north-western and northern Australia.

The large collection of ammonites which forms the subject matter of this monograph was, unless indicated otherwise in the text, gathered by the author as an officer of the Bureau in the years 1949 to 1954 from the Cretaceous sequence exposed in the Giralia Anticline (Condon et al., 1956) in the northern part of the Carnarvon Basin. Most of the material is from the ammonite-bearing bed mentioned by Raggatt (1936) and Spath (1940, 1953), but some specimens come from the limestone immediately underlying the ammonite beds. A single, indeterminable, specimen was collected from the thin greensand formation which overlies the ammonite horizon.

The only additional source of information on the ammonite assemblages since Spath (1940) is a preliminary summary report in the unpublished Records Series of the Bureau of Mineral Resources (Brunnschweiler, 1952). It pointed out that the main ammonite-bearing bed is much richer in species than suspected, that the Campanian elements in the assemblage are much more numerous both in species and in individuals than Spath's material suggested, and that the limestone underlying the main ammonite bed also contains a few ammonites in places, of Santonian to Campanian age.

The description of the rich material from Western Australia has been delayed for several reasons. In 1953, fire gutted part of the offices of the Bureau of Mineral Resources, the section worst affected being that of the palaeontologists. Notes and manuscripts were destroyed, fossil collections partly lost. Some type collections could be sorted out again, but in many cases new collections had to be restudied from the very beginning. Then, in 1954, the author resigned from the Bureau of Mineral Resources and until recently found little time to continue the studies begun 15 years ago.

The author gratefully acknowledges the technical facilities put at his disposal by the Bureau of Mineral Resources. Thanks are expressed to colleagues in the Bureau, the University of Western Australia, the Geological Survey of Western Australia, and West Australian Petroleum Pty Ltd for help in the field and at home.

For much expert advice I am indebted to authorities on Cretaceous ammonites, especially to C. W. Wright (London), M. Collignon (Moirans, France), R. A. Reyment (Ibadan, Nigeria), and T. Matsumoto (Fukuoka, Japan). These together with a number of other overseas colleagues also lent invaluable assistance by replenishing the palaeontological library in Canberra after the 1953 fire. May the completed monograph stand as a token of sincere gratitude to the international collegium of palaeontologists for their immediate and wholehearted response to the plight of its members in Canberra.

STRATIGRAPHICAL NOTES

Upper Cretaceous Formations Containing Ammonites

The stratigraphy of the Western Australian Cretaceous in general, and of that in the Carnarvon Basin in particular, is ably summarized in McWhae et al. (1958). A columnar section through the formations relevant to this monograph has previously been presented together with the description of the Aptian-Albian Aconeceratinae from the Windalia Radiolarite (Brunnschweiler, 1959).

Most of the material described is from the Miria Marl and was collected from a number of localities along the western limb of the Giralia Anticline (Condon et al., 1956) over a distance of about 60 miles. Most specimens are fairly hard and commonly slightly glauconic and (occasionally) phosphatic internal casts which retain smaller or larger portions of the calcitized, occasionally limonitized, shell. At the northern end of the Giralia Anticline, where the Marl is generally exposed only in creek beds, the specimens are softened and many are fractured by weathering. The best material comes from outcrops along the east-facing scarp of the southern Giralia Range near Remarkable Hill (see map in Brunnschweiler, 1959), and from some isolated hills east and immediately in front of the scarp. However, because the labels were destroyed by the fire in 1953, I am not in every case able to name the exact locality whence a specimen came.

A few of the ammonites come from the Korojon Calcarenite, which immediately underlies the Miria Marl in the Giralia Anticline. Much of the material from the Calcarenite is preserved in the form of limonite casts of external moulds; the finer elements of the shell sculpture and the suture lines are then obliterated, and the identification of the forms is possible only in the broadest of terms.

A single ammonite specimen comes from the Boongerooda Greensand, a soft glauconite sand formation which disconformably overlies the Miria Marl and which is currently regarded as the first post-Cretaceous bed.

Nature and Age of the Ammonite Assemblages

Although a comprehensive discussion about the composition and the age of the ammonite assemblages must await the completed description of the many forms it is necessary at this stage to familiarize the reader with the broader aspects of the material to be described as well as with some stratigraphic problems that have arisen from its study.

Current concepts, which are based primarily on pelagic foraminifera (Edgell, 1957; Belford, 1958, 1960), give the age of the Korojon Calcarenite as ranging from late lower Campanian into the early Maastrichtian, and that of the Miria Marl from late lower into upper Maastrichtian. A brief interruption of marine sedimentation is recognized between the formations.

As indicated in McWhae et al. (1958), the age indicated by the ammonites does not quite agree with that based on the foraminifera, the latter suggesting generally a younger age than the ammonites.

That there are Campanian elements (e.g. several genera of Kossmaticeratidae), among the ammonites from the Miria Marl had been noticed already by Spath (1940). Because Spath's material came from two localities a few miles apart, and the respective collections have only 2 out of 16 species in common, it was suggested the two assemblages might not be strictly contemporaneous, in spite of the fact that Raggatt (1936) showed them to have come from the same thin formation (mistakenly described as a greensand).

There is no longer any doubt that the main ammonite-bearing bed is a distinct formation, now known as Miria Marl, and that it is a glauconitic and condensed deposit (although not a greensand). The differences between the two assemblages discussed by Spath (1940) were simply due to the chances of collection. My own study showed that all outcrop localities of the 2 to 7 foot thick Miria Marl yield basically the same assemblage of ammonites. Naturally, some species are very rare and have been found only in one or two localities, but none of these species forces one to extend the age range indicated by the common forms—upper Campanian to lower Maastrichtian.

In order to find out whether there is a definite sequence of genera and species of ammonites through the thickness of the Marl, or whether it contains reworked material, a pit was dug through the Miria Marl below One Tree Hill at the northern end of the Giralia Anticline (see map in Brunnschweiler, 1959). It was found that the Marl lies on an uneven surface of the considerably harder Korojon Calcarenite. The lower 3 feet yielded an assemblage of Kossmaticeratidae together with various Phylloceratidae, Tetragonitidae, rather rare Eubaculitinae, Polyptychoceratidae, Desmoceratinae, Hauericeratinae, and Pachydiscidae. The upper 3 to 4 feet of the formation is characterized by the absence of Kossmaticeratidae (except *Brahmaites* Kossmat), by a great abundance of Eubaculitinae, and by a rapid decrease in the number of coiled species, so that near the top of the Miria Marl only species of Eubaculitinae occur; Nostoceratidae and Polyptychoceratidae also having disappeared with the coiled forms.

Despite the absence of further detail this record of the ammonite sequence is rather important. It clarifies my earlier statement about the clearly Campanian elements in the assemblage of the Miria Marl (Brunnschweiler, 1952); they are definitely restricted to the lower part of the formation. This had been suspected before from careful collecting in outcrops situated on steep slopes.

The recorded sequence also shows that the Campanian elements are not likely to have been reworked from an older formation. If they were, one would encounter them throughout the formation, not only in its lower part. Morever, not a single kossmaticeratid species has ever been found in any of the formations that are older than the Miria Marl, especially not in the directly underlying Korojon Calcarenite. The Korojon is characterized by a great abundance of more or less broken shells of medium to large *Inoceramus* species. Obviously, if innumerable ammonites had been reworked from this formation into the Miria Marl without appreciable damage to their fine shell sculpture, so would have innumerable fragments of *Inoceramus* shells. But such fragments are extremely rare in the Marl and they are more likely to stem from the *Inoceramus* species which is indigenous to the faunal assemblage of the Miria Marl.

As there is no evidence of pre-Maastrichtian faunal elements having been reworked into the Miria Marl, the discrepancy between the age determination from foraminifers and that from ammonites remains unresolved. The great number of kossmaticeratid forms belonging to genera such as *Gunnarites* Kilian & Reboul, *Grossouvrites* Kilian & Reboul, and *Maorites* Marshall in the lower Miria Marl definitely indicate Campanian (Spath, 1953, Collignon, 1955, Wright, 1957). The upper part of the Marl is just as clearly early Maastrichtian, with such species as *Pachydiscus gollevillensis* (d'Orbigny), *Brahmaites brahma* (Forbes), and *Eubaculites vagina* (Forbes).

Consequently, because the Miria Marl extends down into the Campanian, it is out of the question that an upper part of the Korojon Calcarenite is as young as Maastrichtian (Edgell, 1957, Belford, 1958; McWhae et al., 1958, p. 105). How much of the Campanian is represented by the Korojon cannot be determined by the ammonites found in it because they are either too poorly preserved or belong to long-ranging forms, some of which occur in the Santonian.

Another problem which I do not regard as resolved is the Cretaceous-Tertiary boundary in the Carnarvon Basin sequence. Between the topmost ammonite-bearing bed and the lowest nummulite-bearing bed is a sequence up to 120 feet thick: it contains calcareous and glauconitic and sandy beds. Its macrofaunal assemblage is Cretaceous, although without ammonites; but its microfauna is Tertiary—a *Globorotalia-Globigerina* assemblage. A similar transitional bed is reported from Madagascar (Collignon, 1954, 1960) and apparently from India (Kossmat, 1895).

In the Giralia Anticline the *Globorotalia-Globigerina* assemblage appears for the first time in the Boongerooda Greensand, a formation, 2 to 10 feet thick, which was laid down over what appears to be a slightly weathered and leached surface on the Miria Marl. The Greensand contains among others *Pycnodonta vesicularis* (Lamarck), *Gryphaeostrea vomer* (Morton), and brachiopods of the *Cyclothyris* group in great numbers; that is, a macrofaunal assemblage of typically late Cretaceous character. This character of the macrofauna, in fact, continues with echinoids such as *Echinocorys, Holaster,* and *Cardiaster,* and brachiopods of Cretaceous type, in the beds above the Greensand right up to the first beds with nummulitic foraminifera.

Because ammonites seemed to be absent from the formations above the Miria Marl, the Cretaceous-Tertiary boundary was placed for convenience at the base of the Boongerooda Greensand in spite of the continuing Cretaceous character of the macrofossils. However, in 1964 Mr R. Logan of the University of Western Australia found in the Greensand a single specimen of a platycone involute ammonite. The specimen is indeterminable and the possibility of reworking from the Miria Marl cannot be excluded. But the find may impose caution on those who attempt to determine the Cretaceous-Tertiary boundary within apparently transitional series on microfaunal criteria only. In fact, in Madagascar (Collignon, 1960) the so called typically Paleocene *Globorotalia-Globigerina* microfauna is known to occur in the same formation as sphenodiscid ammonites.

Until a full and detailed discussion and, perhaps, a solution of all these problems can be presented when all the Ammonoidea of the area have been discussed, this summarizing introduction may suffice to keep the reader aware of their nature and significance.

THE HETEROMORPH LYTOCERATINA

The classification and the phylogenetic relationships of the many lytoceratid heteromorphs of the upper Cretaceous are still in an unsatisfactory state. Some of the established families are scarcely more than dumping grounds for many of these insufficiently studied and often rare forms. Before describing and classifying the Western Australian heteromorphs it is appropriate to discuss some pertinent taxonomic problems and, where possible, to suggest new ways by which certain all too heterogeneous higher taxa can be improved.

Currently all except one of the forms described here are included in the superfamily Turrilitaceae Meek (Wright 1957, p. L214, nom. transl.) and they are grouped into eight families, namely Ptychoceratidae Meek, Hamitidae Hyatt, Baculitidae Meek, Anisoceratidae Hyatt, Phlycticrioceratidae Spath, Turrilitidae Meek, Nostoceratidae Hyatt, and Diplomoceratidae Spath. With the possible exception of Ptychoceratidae these families are presumed to be derived by way of Hamitidae from Macroscaphitidae Hyatt (Lytocerataceae). For a considerable number of heteromorphs this interpretation is probably right, but many forms seem to fit poorly into such a scheme if one chooses to give more weight, taxonomically, to major and consistent characteristics of the suture-line than to shell form and sculpture, which are extremely variable in heteromorphs.

The lytoceratid suture has few, but often very complex, elements. There are generally no auxiliaries and, with few exceptions, the lobes retain their ancestral bifidity (Wright, 1957). This applies on the whole also to the Turrilitaceae. Yet within this simple formula there is room for very considerable differentiation, and this is very evident indeed in that superfamily. To some extent the differences have found expression in the present classification because there is in many form groups a vague relationship between the shape of the septa and the shape of the shell. But there are conspicuous exceptions which should be, but are currently not, appropriately dealt with.

One can speak in a somewhat loose and general way of a hamitid, a baculitid, or a turrilitid suture and most workers in this field will have a fair idea of the meaning of such terms. On the other hand, there is no such thing as a nostoceratid or a diplomoceratid suture in terms of familial or superfamilial characteristics. A number of forms accommodated in Nostoceratidae and Diplomoceratidae have suture-lines which differ most markedly from the sutures of the genera which have given these families their names. In view of the great importance of the suture-line as a criterion of classification in Ammonoidea in general, its neglect in Cretaceous heteromorphs is odd.

At the superfamilial level attention must now be drawn to the genera *Cicatrites* Anthula (lower Aptian), *Ammonoceratites* Rafinesque (upper Aptian to Cenomanian), *Bostrychoceras* Hyatt (Cenomanian to Maastrichtian), *Hyphantoceras* Hyatt (Turonian and Santonian), *Diplomoceras* Hyatt (Campanian and Maastrichtian), and *Pravitoceras* Yabe (Maastrichtian). These six genera differ in mode of coiling and shell sculpture, but they have one important feature in common, namely a very florid, deeply incised suture-line with the first lateral saddle obliquely suspended half way up, so to speak, on the siphonal saddle. This sutural feature sets them clearly apart from the other genera with which they are currently grouped into families.

To me it seems incongruous to have sutures such as that of *Pravitoceras* grouped into the same family as the suture of *Polyptychoceras* Yabe or *Glyptoxoceras* Spath, or that of *Hyphantoceras* with those of *Neocrioceras* Spath and *Exiteloceras* Hyatt, as is the current practice (Wright, 1957, pp. L223-27; but note that fig. lb on p. L223 is misprinted upside down). A similar incongruity is *Ammonoceratites* in the company of *Pictetia* Uhlig and *Pterolytoceras* Spath (Wright, 1957, pp. 195-97). *Ammonoceratites,* together with *Ptycholytoceras* Spath and perhaps even *Villania* Till, should be removed from Lytoceratidae. For the latter two one ought to consider a close relationship with *Analytoceras* Hyatt, whereas *Ammonoceratites* is similar to and probably derived from *Cicatrites.*

Because of the profound differences in the suture, Spath (1927) removed *Cicatrites* from Macroscaphitidae and established Cicatritidae. This has found general acceptance. By the same token, however, consideration should have been given to a new classification for *Ammonoceratites, Bostrychoceras, Hyphantoceras, Diplomoceras,* and *Pravitoceras,* whose suture-lines are emphatically cicatritid.

The thesis is advanced that not only Macroscaphitidae but also Cicatritidae gave rise to various heteromorph offshoots by reduction and disappearance of the normally coiled part of the shell. If we remove the forms with cicatritid sutures, the Turrilitaceae immediately lose the most conspicuous elements of their heterogeneity.

The parallel development of heteromorphs from *Macroscaphites* and from *Cicatrites* should then be expressed in taxonomically equivalent categories. Thus if we accept Turrilitaceae from *Macroscaphites* by way of Hamitidae Hyatt, a new superfamily, Diplomocerataceae, is now proposed, derived from *Cicatrites* via Ammonoceratitidae nov. and Bostrychoceratidae Spath.

DIPLOMOCERATACEAE

(Nom. Transl. ex. Diplomoceratidae Spath, 1926a)

Diagnosis: Very evolute to loosely coiled and heteromorph Lytoceratina with a very florid and deeply lobed suture-line whose first lateral lobe is conspicuously asymmetrical, so that the first lateral saddle appears obliquely suspended half way or more up the slope to the siphonal saddle.

Remarks: Diplomocerataceae are presumably derived from *Cicatrites* Anthula by way of Ammonoceratitidae nov., the first representatives appearing in the upper Aptian, the last in the Maastrichtian. Among the genera which possess the diagnostic suture-line are *Ammonoceratites, Bostrychoceras, Hyphantoceras, Diplomoceras,* and *Pravitoceras.*

Whether there are additional genera with the cicatritid suture is a matter for future investigation, because the existing descriptions of suture-lines in the literature on Cretaceous heteromorphs are quite unsatisfactory. For example, the suture of *Diplomoceras notabile* Whiteaves in Wright (1957, p. L226), which is taken from Usher (1952), is not only incomplete with regard to the diagnostic first lateral lobe but also shows the antisiphonal lobe in the wrong position. In some cases, even in modern studies such as Young (1963), there is no information at all on the sutures of the described and figured heteromorphs because the material is either not well enough preserved or consists only of body-chamber fragments. Under these circumstances the published descriptions give no more than the general outline of the phylogeny of Diplomocerataceae.

It is proposed to group such genera into families, and it seems natural to do this as follows:

AMMONOCERATITIDAE nov.; very evolute coiled forms ranging from upper Aptian to the Cenomanian. Genus typicus: *Ammonoceratites* Rafinesque, 1815.

BOSTRYCHOCERATIDAE Spath, 1953 (nom. transl. ex Bostrychoceratinae); heteromorph forms ranging from Cenomanian to Maastrichtian. Genus typicus: *Bostrychoceras* Hyatt, 1900.

DIPLOMOCERATIDAE Spath, 1926a; wholly or partly heteromorph forms ranging from Campanian to Maastrichtian. Genus typicus: *Diplomoceras* Hyatt, 1900.

Ammonoceratitidae presumably includes, apart from *Ammonoceratites,* also *Argonauticeras* Anderson. Most probably some additional genera fit the diagnosis (perhaps *Metalytoceras* Spath), but the relevant literature is not at my disposal.

Bostrychoceratidae would include Bostrychoceratinae Spath, Hyphantoceratinae Spath, 1953, and perhaps some other forms which are currently included in Nostoceratidae Hyatt, 1894 (e.g. *Nostoceras hornbyense* (Whiteaves) in Usher, 1952, pl. 31, fig. 23 and pl. 27/28). More information is needed here.

Diplomoceratidae includes *Diplomoceras* and *Pravitoceras.*

Family BOSTRYCHOCERATIDAE Spath, 1953

Genus HYPHANTOCERAS Hyatt, 1900

?HYPHANTOCERAS sp. ind.

(Pl. 1, fig. 4; text-fig. 1)

Several localities in the Korojon Calcarenite (Campanian and ?Santonian) on the Marilla Anticline (Condon et al., 1956) yielded a few ammonite specimens, but they are almost all in the form of limonitic replacement casts and show little or no detail of shell sculpture, or of suture-lines. Among them are four fragments (Coll. D. Johnstone) of a small turrilitid genus which I suspect to be *Hyphantoceras*.

Description: The best of the four specimens, CPC 2732, is figured here. It consists of three somewhat crushed and damaged turreted volutions from a prominently ribbed species. The first and second volutions seem to be just in contact, but the second and third do not touch. From what remains of the second volution the species is estimated to possess 12 to 15 annular, oblique, ribs per volution. An occasional rib seems to be flared and weakly bituberculate. Except for one faintly discernible trace on the second volution suture-lines are obliterated. Turret angle is about 20 degrees.

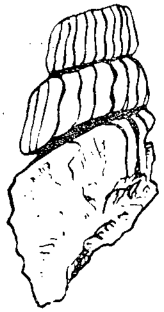


Fig. 1. *? Hyphantoceras* sp. ind., CPC 2732. Explanatory ink drawing. (x 1).

Of the non-figured specimens, CPC 2733 is a fragment from the last turreted whorl of a non-tuberculate and very densely ribbed individual, an occasional rib again showing a tendency to flare. CPC 2734, again a fragment from a turret, shows more distant and non-flared ribbing. CPC 2735 is a small fragment representing the apical point of a hyphantoceratid turret with a cone angle of 24 degrees. No ribbing is observable.

Remarks: If it were not for the faint suture trace on CPC 2732 the material could easily be identified as gastropod fragments. For the time being I refer them to *Hyphantoceras* because of the attenuated, although occasionally flared, ribbing; better material might one day reveal the presence of *Bostrychoceras, Nostoceras,* or even *Anaklinoceras* Stephenson or *Cirroceras* Conrad.

Genus BOSTRYCHOCERAS Hyatt, 1900

BOSTRYCHOCERAS INDICUM (Stoliczka, 1866)

(Pl. 1, figs 5, 6; Text-fig. 2, 3)

1866—*Helicoceras indicum Stoliczka,* p. 184, pl. 86, figs 1, 2.

1895—*Turrilites* (*Heteroceras*) *indicus* (Stoliczka); Kossmat, p. 143, pl. 20, figs 5, 6.

A single specimen, CPC 2701, proves the presence of the genus *Bostrychoceras* in the Australian upper Cretaceous. It was collected from the Korojon Calcarenite (Campanian and ?Santonian) of the southernmost outcrops in the Giralia Anticline by Mr D. Johnstone.

Description: The single specimen, which was badly damaged in the 1953 fire, is a clean internal cast of a large body-chamber fragment. The impression of the last turret whorl and its ribbing is well preserved (Pl. 1, fig. 6). A substantial part of the last suture-line at the beginning of the body chamber can be seen (Text-fig. 3).

The ribbing is low, fairly sharp, and dense, but with the interspaces a little wider than the ribs. On the hook-shaped body chamber all ribs are biplicate, the secondaries appearing in some places low, in others high on the flanks (Text-fig. 2). On approaching the turreted phragmocone, however, biplication disappears within a short distance so that on the turreted whorls the ribbing must have been simple. Constrictions are absent and there is no indication of tuberculation.

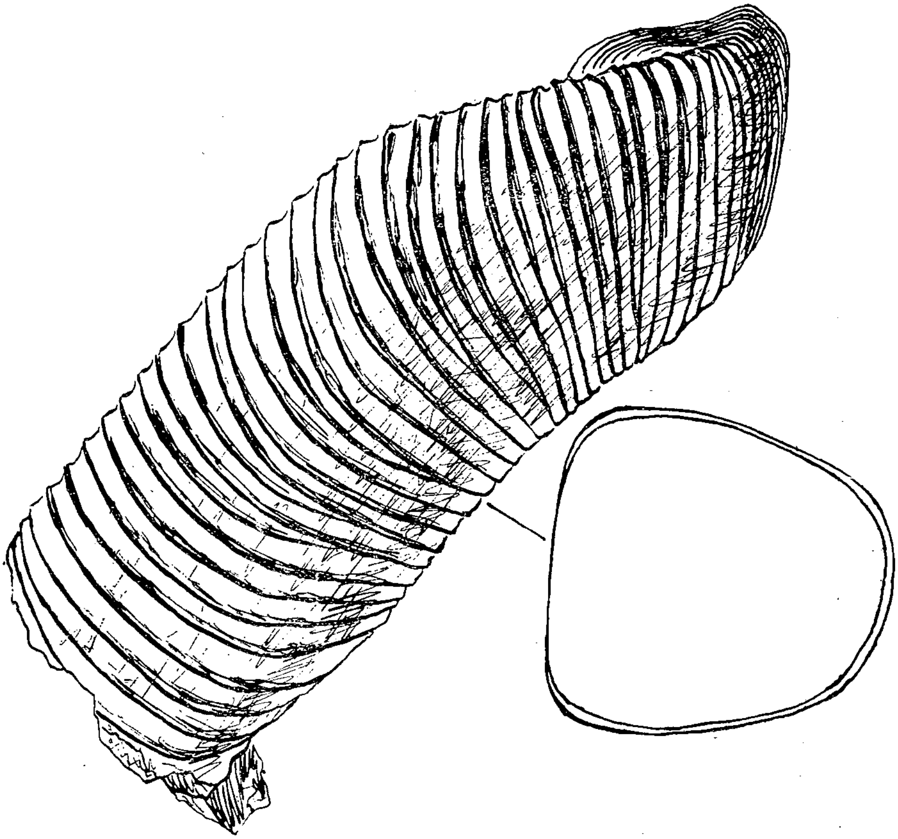


Fig. 2. ***Bostrychoceras indicum*** **(Stoliczka), CPC 2701. Explanatory ink drawing made before 1953 fire together with section of living chamber (x 1).**

The cross-section near the turret is obliquely compressed turrilitid, but along with the irregular unhooking of the body chamber it acquires a broadly rounded venter and a flattened dorsum with sharply rounded shoulders.

The suture is unfortunately incomplete. It seems to have its first lateral saddle very high (suspended) on the ventral slope of the first lateral lobe and is therefore most probably cicatritid.

Comparisons: Apart from the lack of constrictions and larger size, the Australian form is scarcely distinguishable from the Indian *Bostrychoceras indicum* (Stoliczka). As size is unlikely to be of taxonomical significance in heteromorphs and the presence or absence of constrictions may be a function of size there is no reason for establishing a separate species. Kossmat (1895), incidentally, gives an excellent picture of the diagnostic ventral elements in the cicatritid suture of *B. indicum*. In his text (p. 143) he also made it quite clear that *B. polyplocum* (Roemer) shows exactly the same features.

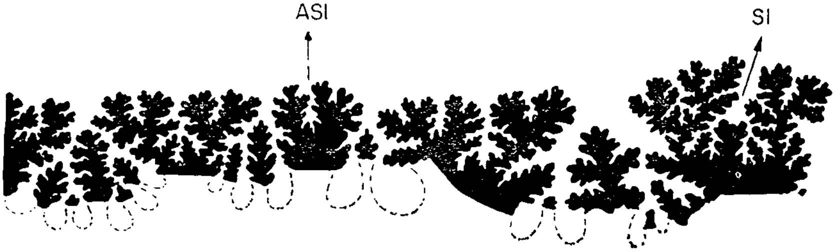


Fig. 3. ***Bostrychoceras indicum*** **(Stoliczka), CPC 2701. Suture at beginning of living chamber (x 1).**

Family DIPLOMOCERATIDAE Spath, 1926a, emend.

Genus EUDIPLOMOCERAS nov.

Diagnosis: Diplomoceratid forms, previously included in *Diplomoceras,* with perfectly, or near perfectly, circular cross-section. Internal casts of phragmocone smooth.

Type Species: Eudiplomoceras raggatti sp. nov.

Remarks: Within the group of species generally described under *Diplomoceras* it has become increasingly obvious that there are two main lineages. One has circular cross-section and is so far known only from Antarctica (Spath, 1953) and now from Australia, the other shows a distinctly compressed whorl section and appears to be worldwide, although it has not yet been found in Antarctica. The former are now generically separated under *Eudiplomoceras,* whereas *Diplomoceras* remains reserved for the compressed species such as the original type for the genus, *D. cylindraceum* Defrance. A similar grouping into compressed and circular forms is seen in Polyptychoceratidae Matsumoto. An important feature of the genus, which serves to distinguish it (and *Diplomoceras* s.s.) at once from similar forms belonging to Polyptychoceratidae (e.g. *Glyptoxoceras*), is the smooth internal cast of the septate part of the shell. Only on body chambers is the ribbing also noticeable inside (Spath 1953, pl. 3, fig. 1). No Polyptychoceratidae have smooth internal casts.

EUDIPLOMOCERAS RAGGATTI sp. nov.

(Pl. 8, fig. 7; Text-figs 4, 5, 6.)

1940—*Diplomoceras* similar to *D. cylindraceum* Defrance; Spath, p. 47.

Holotype: CPC 2632. Other material: CPC 2633 (paratype) and CPC 2634-2640.

Diagnosis: An *Eudiplomoceras* with 13 to 15 very sharp, low, and narrow ribs on a length equal to the dorso-lateral diameter.

Description: The holotype is a slightly curved, wholly septate fragment, about 130 mm long. The ribbing, though no more approximated than in some other species of the genus, is unusually sharp. The suture-line is well enough exposed to show the diagnostic cicatritid characteristics.

Remarks: The whorl section of all nine specimens before me is circular or very nearly so, the difference between longer and shorter diameter being at the most 5 percent. The largest fragment in the collection (200 mm) has a diameter of 55 mm, the smallest of 21 mm. None of the specimens include parts of the body chamber, and on all of them the ribbing is as sharp as on the holotype. The internal casts, however, are all smooth.

The paratype is selected for the purpose of showing a complete suture-line.

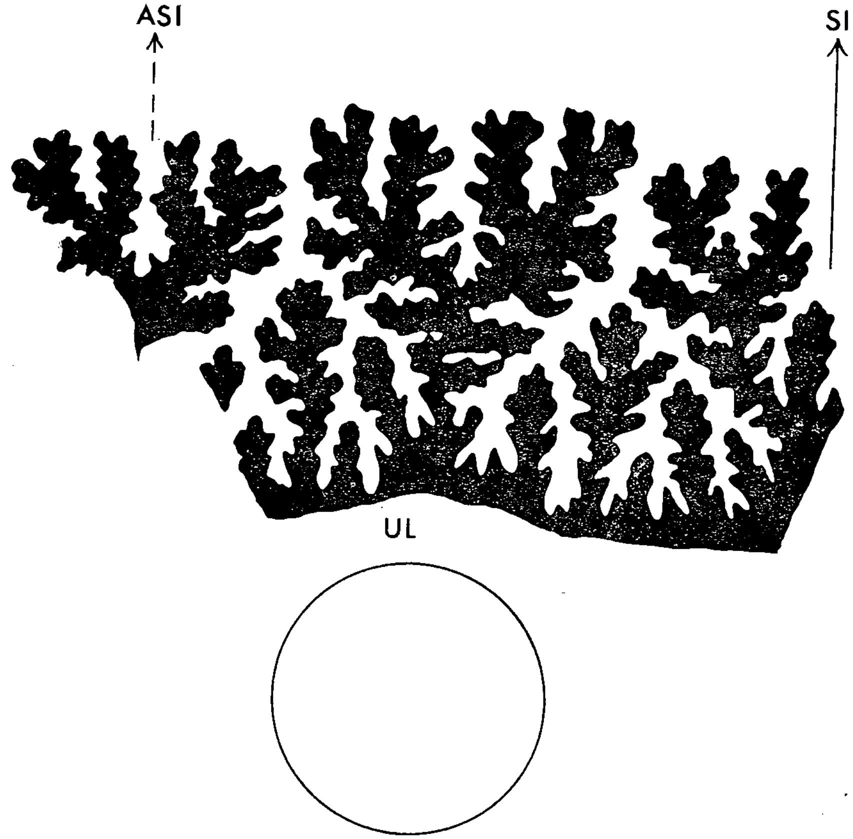


Fig. 4. ***Eudiplomoceras raggatti*** **gen. et sp. nov., Holotype CPC 2632. Suture (x 2) and cross section (x 1).**

Comparisons: The closest relative of *E. raggatti* is the Antarctican *Diplomoceras lambi* Spath, 1953, which, according to the generic diagnosis, is also an *Eudiplomoceras.* The Antarctic species differs by its blunt rounded ribbing, as is demonstrated by the shell fragment preserved near the beginning of the body chamber of Spath's specimen plate 3, figure 1.

E. raggatti is one of the commoner ammonites in the Miria Marl; there is very little variation between individuals: some are slightly curved, others straight.

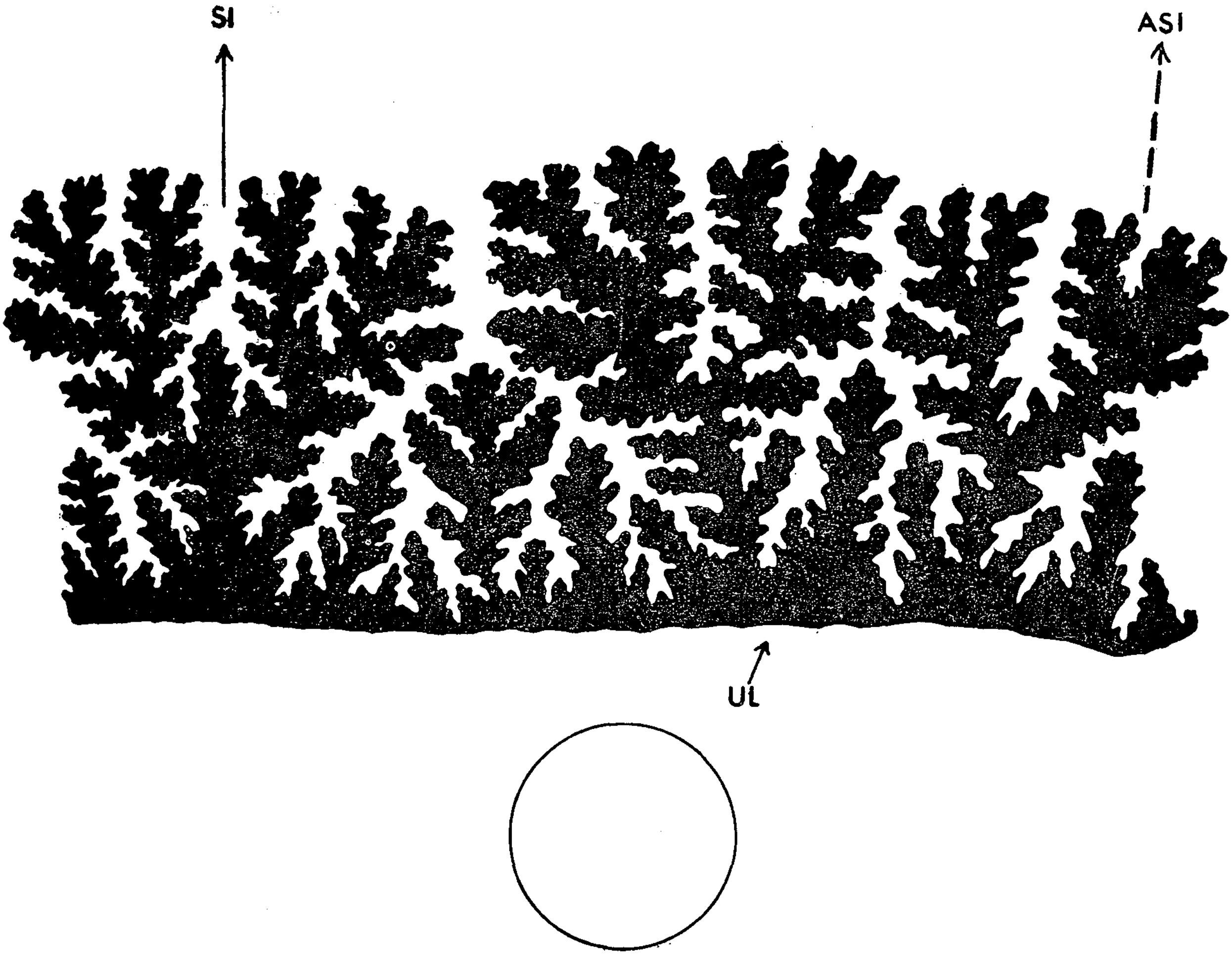


Fig. 5. *Eudiplomoceras raggatti* gen. et sp. nov., Paratype CPC 2633. Suture (x 2) and cross section (x 1)

Genus DIPLOMOCERAS Hyatt, 1900, emend.

Diagnosis: Diplomoceratidae with compressed oval cross-section. Internal cast of phragmocone smooth.

Type Species: Hamites cylindraceus Defrance, 1822.

DIPLOMOCERAS cf. D. NOTABILE (Whiteaves, 1903)
(Pl. 7, fig. 3; Text-fig. 7.)

A single specimen, CPC 2651, indicates the presence of the true *Diplomoceras.* It is a fully septate hooked fragment with strong and not very sharp ribs, of which there are 11 to 12 on a length equal to the longer diameter. The cross-section is distinctly compressed, the height/width ratio (between ribs) being 5 : 4.

The form superficially resembles larger body chambers of *Neohamites giraliensis* sp. nov. (e.g. Pl. 7, fig. 2) but removal of the limonitized test revealed at once the smooth internal cast and the cicatritid suture-line of Diplomoceratidae.

D. notabile from the Pacific Coast of Canada comes closest to the Australian form; type and density of ribbing are almost identical. However, because of the smallness and the poor preservation of our specimen I hesitate to make a definite identification with the Canadian material figured in Usher (1952).

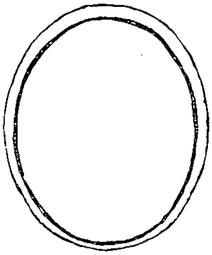


Fig. 6. ***Diplomoceras* cf. *D. notabile* (Whiteaves), CPC 2651. Cross section (x 1).**

European, western Canadian (Vancouver), and Brazilian forms all have a distinctly compressed cross-section and belong to *Diplomoceras.* In this connexion attention is drawn to a mistaken interpretation of the suture-line of *D. notabile* (Whiteaves) in Usher (1952, pl. 31, fig. 26). Firstly, I am quite certain that the antisiphonal lobe is wrongly placed (also in Wright 1957, fig. 3b, p. L226, which is ex Usher). As shown here in Text-fig 7, which I have copied from Usher, the antisiphonal lobe is, in fact, the narrow and short lobule dividing the slim-stemmed feature which may be called an antisiphonal saddle. Secondly, the second lateral (or umbilical) lobe is not likely to be as asymmetrical as shown in Usher (1952). Its external incision (UL in Text-fig 7) is probably as deep as that on *Eudiplomoceras raggatti* (viz. UL in Text-figs 4, 5) and on the species of *Diplomoceras* described from Europe.

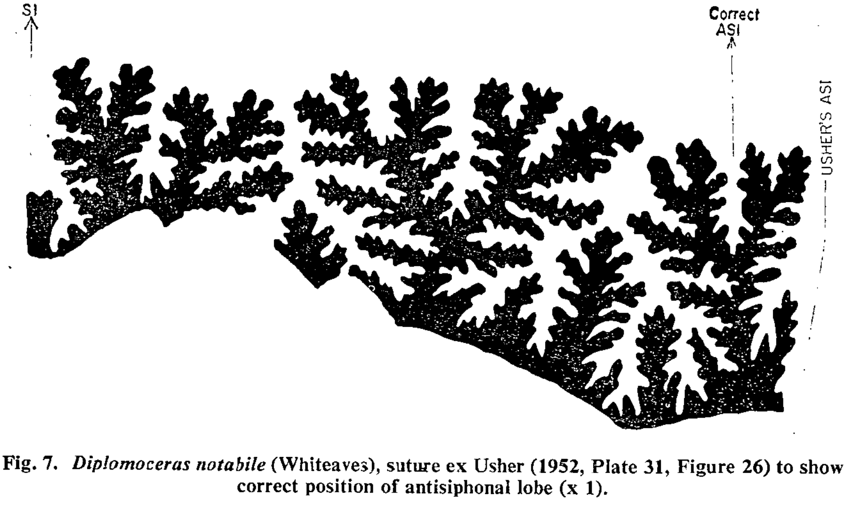


Fig. 7. ***Diplomoceras notabile* (Whiteaves), suture ex Usher (1952, Plate 31, Figure 26) to show correct position of antisiphonal lobe (x 1).**

Superfamily TURRILITACEAE Meek, 1876

The removal from Turrilitaceae of the lineage possessing the cicatritid suture necessitates changes in the names of one or two families.

Firstly there are the seven or eight currently recognized genera which were grouped with *Diplomoceras* and *Pravitoceras* into Diplomoceratidae. According to the Copenhagen Decisions the first-published name-giver of a family-group assemblage in a remnant taxon is to be recognized in forming a replacement name. This means that Polyptychoceratidae Matsumoto, 1938, takes the place of Diplomoceratidae Spath, 1926a, in Turrilitaceae.

Secondly there is some doubt whether Nostoceratidae Hyatt, 1894, can be retained. If the nominate genus *Nostoceras stantoni* Hyatt turns out to possess a cicatritid suture it would have to be removed to Bostrychoceratidae of Diplomocerataceae, in which case a replacement name for Nostoceratidae has to be found. In fact, I believe that the suture-lines of all forms at present included in Nostoceratidae should be carefully scrutinized in order to trace the development of the macroscaphitid as well as the cicatritid lineage through the taxonomic thicket of Upper Cretaceous heteromorphs.

Attention may be drawn to the drawings of sutures of heteromorphs in Usher (1952). Figure 23 on plate 31, although incomplete and in details doubtful, seems to be a cicatritid type. The form to which it belongs is identified as *Nostoceras hornbyense* (Whiteaves) but the turreted early whorls do not form a truly turrilitid spire as is typical for *Nostoceras*. Even the earliest whorls of specimen plate 28, figure 2, just barely touch each other and thereafter the volutions separate. This form should have remained in *Cirroceras* Conrad (=*Didymoceras* Hyatt), where Spath (1921a, 1921b) put it. On the other hand, Usher's *Bostrychoceras elongatum* (Whiteaves) on plate 28, figures 3, 4, has a suture-line (pl. 31, fig. 24) which, although incompletely presented, cannot be regarded as cicatritid because the first lateral saddle has a fairly solid stem and is only inclined, not precariously suspended on the side of the siphonal saddle (i.e. undercut by a near-horizontal major lobule of the first lateral lobe). In spite of the simple costation and the absence of tuberculation I do not think this is a *Bostrychoceras* but (if *Nostoceras* remains in Turrilitaceae) a non-tuberculate *Nostoceras*.

I realize that my belief that the grouping as presented in Wright (1957) underrates the significance of the suture-line will throw much of the accepted classification of heteromorphs into confusion. However, after sifting the evidence backing the thesis of two parallel major lineages in the upper Cretaceous heteromorphs I feel the new concept should be presented in full.

In the following text the families of Turrilitaceae will be discussed and their Australian representatives described in the same order as they are presented in Wright (1957).

Family BACULITIDAE Meek, 1876

The Campanian and Maastrichtian genus *Eubaculites*, as Spath (1953) pointed out, occurs only in the Southern Hemisphere, and it is at least as abundant and morphologically diverse there as *Baculites* in the Northern Hemisphere. In Western Australia *Eubaculites* Spath seems to replace *Baculites* Lamarck almost entirely. The conspicuous geographical grouping of these forms, their parallel and independently developed morphological diversity in their respective regions of predominance, and the fact that this diversity, as will be demonstrated, presents itself in the form of several genera and many species, lead me to propose the division of Baculitidae into two subfamilies, Baculitinae and Eubaculitinae.

Baculitinae nov., apart from the nominate genus *Baculites,* includes *Lechites* Nowak, *Sciponoceras* Hyatt, *Pseudobaculites* Cobban, and *Euhomaloceras* Spath, and the subfamily's time range is from upper Albian to Maastrichtian.

Eubaculitinae nov. includes the nominate genus *Eubaculites* Spath, and the new genera *Giralites* nov., *Eubaculiceras* nov., and *Cardabites* nov., and its time range is from Campanian to Maastrichtian.

Members of the Baculitinae seem to be extremely rare in the Australian upper Cretaceous; there is, in fact, only one specimen of *Baculites* in our collection of over 200 baculitids, all others being Eubaculitinae.

Subfamily BACULITINAE nov.

Diagnosis: Members of Baculitidae typically without a ventral keel or with keel developed only on the body chamber, where it is more or less sharply rounded, but never tabulate.

Nominate Genus: Baculites Lamarck, 1799.

Remarks: The subfamily includes all genera currently listed under Baculitidae Meek (Wright, 1957, pl. L218) with the exception of *Eubaculites* Spath, 1926a. It begins with *Lechites* in the upper Albian and ends with *Baculites* Lamarck in the Maastrichtian.

Genus BACULITES Lamarck, 1799

BACULITES LECHITIDES sp. nov.

(Pl. 1, figs 1, 2, 3, Text-fig. 8)

Holotype: CPC 2689, from Miria Marl, Locality GC 8 on Marilla Anticline.

Diagnosis: A costate *Baculites* with ovate cross-section. The ribs are low and moderately prorsiradiate; they continue across the venter without attenuation but are very weak across the dorsum. There are three ribs on a length equal to the longer diameter.

Description: The holotype is a partly ($\frac{1}{4}$) septate, clean internal cast, rather worn or weathered on one flank, straight, 60 mm long, over which length the height increases from 9 to 12 mm, the width from 7 to 9 mm. On the dorsum the ribs are very weak, but it can be clearly seen that they are projected forward. They become more conspicuous where they curve backward and then forward again over the dorsal shoulders, then continue in a slightly prorsiradiate attitude over the lower half of the flanks. On approaching the venter the ribs lean forward to an angle of 45 to 50 degrees and thence cross the evenly rounded venter without being attenuated.

If the ribbing reflects it, the shape of the aperture would show a short dorsal and an only slightly longer ventral lappet.

Suture-lines are only partly visible, mostly on the worn side of the specimen. The lateral saddles are broad-based, bifid, but shallowly incised, as is characteristic in baculitids. There is no indication of finer frilling around their margins, but this may be because the specimen is worn down too much to the deeper level of the main lobes. Growth-lines are not preserved.

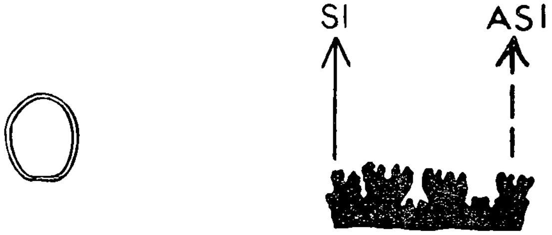


Fig. 8. ***Baculites lechitides*** **sp. nov., Holotype CPC 2689. Suture (x 2) and cross section (x 1).**

Remarks: With its only moderately prorsiradiate ribbing, its rounded venter and broadly rounded dorsum, over both of which the ribs continue uninterrupted, and its very simple suture, *B. lechitides* is a rare stranger in the Australian Upper Cretaceous. As the specific name implies it is particularly reminiscent of the mid-Cretaceous *Lechites* Nowak, e.g. the forms figured as *L. gaudini* (Pictet & Campiche) in Stoliczka (1866, pl. 90), although the relationship is more likely to be homoeomorphic than phylogenetic. There is a difference in the forward sweep of the ribbing.

Most other species of *Baculites* show not only a much more pronounced forward sweep but also an unmistakable attenuation of the ribbing toward the venter, which results in a smooth, or almost smooth, band along the upper part of the flanks. The venter itself, certainly on the body chamber, is commonly more sharply rounded than on the Australian form.

Subfamily EUBACULITINAE nov.

Diagnosis: Members of Baculitidae with a ventral keel which appears in very early growth stages. The keel is either acute or tabulate, never rounded.

Nominate Genus: Eubaculites Spath, 1926a.

Remarks: Eubaculitinid fragments are the most common cephalopod remains in the Miria Marl. All are internal casts on which the thin shell is seldom preserved. Finer details of shell sculpture are commonly destroyed by structural changes in the shell mineralogy during the replacement of aragonite with impure calcite. There are about 200 eubaculitid fragments in the collection, most of them from the Giralia Anticline, the rest from the Marilla Anticline.

The smallest cross-section is 5 mm high and 3 mm wide, the largest are 42 mm and 25 mm, and at that size the specimen is still septate. The overall length of such large individuals must have been almost 100 cm. The smallest were perhaps 10 to 15 cm long. It is assumed here that the small individuals are simply juveniles of larger forms, and that size need not be included in the diagnosis of taxa.

Neither initial coils nor apertural parts of body chambers are present in the collection.

The very considerable variability in size is matched by the variability of shell shape and sculpture. The following features of the shell are constant on one and the same individual, but vary from one specimen to another:

1. Cross-section: The cross-section varies from a slim, compressed, outline with a ratio of height to width of 2.3:1 to a pear shape with a ratio of 1.5:1 (measured between the ribs in costate species).
2. Degree of taper: Taper is more pronounced in small specimens, but does not exceed an angle of 8-10 degrees, and may be as little as 5 degrees. On larger forms it ranges between 2 and 5 degrees.
3. Curvature of shell: In most of the specimens the shell shaft shows its derivation from coiled forms by being slightly concave on the dorsal side. About 20 of the medium-sized and larger specimens are straight, and a few are slightly curved in the ventral direction.
4. Type of ribbing: (a) Prominence: The prominence of the ribs, even in medium-size specimens, varies from very weak to strong and even bullate (sexual dimorphism?). In the Australian material the costation is present even on the smallest specimens, not only from about 16 mm height as Spath (1953) claimed for the Indian *Eubaculites vagina* Forbes. (b) Density: The density of the costation is, as in Diplomoceratidae and Neohamitidae, expressed by the number of ribs that can be counted in a length equal to the height of the shell; the count being made where the height is measured. In these terms there is a variation from two to five ribs per height, i.e. from wide to very close ribbing. (c) If, because a specimen has badly worn flanks, costation is not immediately evident, one only has to inspect the ventral keel. In ribbed species it is mostly notched or undulate; smooth species have a smooth keel.
5. Shape of the ventral keel: (a) The keel, which is of the open type, varies from broadly through narrowly tabulate to acute. It is, however, never rounded as in Baculitinae. (b) The keel varies from a distinctly shouldered to a fastigiate shape. (c) In costate species the number of nodes which make up the slight serration of the keel may correspond to the number of ribs. Some specimens, however, have up to twice as many carinal notches as they have ribs on the same part of the shell shaft, although there is no indication of the ribs bifurcating on the ventral shoulder.
6. Shape of dorsal surface: The surface of the dorsum varies from round-shouldered with a narrow flattened central zone through tabulate with sharply rounded shoulders to concave and almost bicarinate with very sharply rounded shoulders.

The only other feature of possible use in classification is the suture-line. It is of very simple and commonly somewhat asymmetrical lytoceratid type. The significant characteristics of the baculitid suture are found in the shape and size of the saddles rather than the lobes. Thus, in Eubaculitinae, the second lateral is always markedly taller and broader than the first lateral saddle, the siphonal saddle is as broad-based as the first lateral although only half as tall, and the antisiphonal saddle with its narrow and short central lobule is tall and slender, in fact often almost as tall as the first lateral. In this regard the eubaculitinid suture resembles that of Neohamitidae, but in the latter the saddles are slimmer, more deeply incised, and very narrow-based.

In Baculitinae the considerable difference in height and width between first and second lateral, except in *Pseudobaculites* Cobban, seems much reduced.

The only part of a eubaculitinid suture-line which varies to some extent is the siphonal saddle. There are three types; the first two are common, the third very rare:

(a) with a single central lobule or prong (see Fig. 16)

(b) with a rounded central protrusion flanked by lobules (see Fig. 24)

(c) with several irregular and shallow incisions (see Fig. 23)

These variations in the shape of the siphonal saddle do not depend on the size or age of an individual, because on any specimen there is always only one type of saddle. There is also no relation between the saddle types and any particular shell form or sculpture. Among the specimens with a saddle of the type (a) or (b) there is a great variety of shell forms and sculpture, and even among the rare specimens with a (c)-type saddle there are ribbed and smooth forms (see also Steinmann, 1895).

The only feature of the suture which changes with the shape of the shell is the width of the low saddle on the dorsolateral shoulder. The more compressed the shell (e.g. *Eubaculiceras*) the narrower is the saddle. Which features, or combination of features, shall be made the basis of classification is problematical. Should for example the seemingly minute variation of the siphonal saddle be given taxonomic significance? Perhaps it is only an expression of sexual dimorphism. Moreover, inclusion of suture characteristics makes all body-chamber fragments indeterminable beyond a certain taxonomic category.

If the suture is taken to be the main criterion—there are many palaeontologists who would not reject such a procedure—Eubaculitinae would consist of three genera, according to the three saddle types, and each genus would comprise a number of species differing in shell form and sculpture.

On the other hand, as has been done by all previous authors, genera can be established on the basis of shell form and sculpture, and composed of species characterized by their siphonal saddle, if it is believed that this sutural feature is of specific significance.

There is, of course, no way of knowing the comparative significance of the various morphological features, and in the absence of data regarding the sequence in time, i.e. the order of appearance in terms of phylogeny, of such features the taxonomic treatment of all these forms cannot be other than purely morphological and subjective; a procedure which, incidentally, should not be called, as it frequently is, artificial.

Whether the taxa established in this Bulletin will in the future be meaningful in terms of phylogeny must remain an open question. The answer may one day be found where a thicker and better exposed section of Campanian and Maastrichtian age may allow sequential collecting of Eubaculitinae. Our attempt to collect sequentially by digging a pit into the Miria Marl did not bring conclusive results.

In spite of the seemingly 'gradational' nature of the phenotypical range of the Western Australian eubaculitinids, which to some might suggest an interbreeding population of one species or one genus, one cannot overlook the fact that this range is so great as to include several extremes. Most palaeontologists would recognize a number of separate genera; for example, ribbed versus smooth shells, or forms with a tabulate-shouldered keel versus those on which the keel is fastigiate and acute, etc. Moreover, the Miria Marl, thin as it is, covers such a long time span that it is extremely unlikely that the Eubaculitinae contained in it were an interbreeding population.

The following classification of the Eubaculitinae is based on shell form and sculpture; until evidence to the contrary is found the minute differences in the shape of the siphonal saddle seem too insignificant for taxonomical purposes.

Genus EUBACULITES Spath, 1926a, emend.

Diagnosis: A costate genus of the Eubaculitinae in which the ratio of shell height to width is 1.8:1 or less (measured between the ribs) at all growth stages, and which has a ventral keel that is distinctly tabulate and set off from the flanks by longitudinal grooves.

Type Species: Eubaculites ootacodensis (Stoliczka).

Remarks: The genus is here restricted to those costate forms which are truly similar in cross-section and shape of keel to the type species. Smooth forms and forms with a very compressed cross-section are excluded.

Stoliczka (1866) and Kossmat (1895) believed the smooth forms to be young individuals which in due course would have acquired ribbing too; this interpretation has not been seriously challenged through the years. However, because there is conspicuous ribbing on very small specimens and smooth forms grow to as large a size as costate ones the traditional concept of the genus can no longer be upheld. Smooth forms are not simply different species or subspecific varieties. As in other ammonoids they must be regarded as different genera, as must very compressed forms.

All three shapes of the siphonal saddle (p. 26) occur within *Eubaculites,* three species show all three types. Only in one species do all known specimens possess the same type of siphonal saddle, but this may be due to the very small number of specimens.

EUBACULITES OOTACODENSIS (Stoliczka, 1866)

1866—*Baculites vagina* Forbes var. *ootacodensis* Stoliczka, p. 198, pl. 90, fig. 14.

1895—*Baculites vagina* Forbes var. *otacodensis* Stoliczka, Kossmat, p. 157, pl. 19, figs 15, 16.

1940—*Eubaculites otacodensis* (Stoliczka); Spath, p. 49, pl. 1, figs 3ab, Text-fig. 1b.

1957—*Eubaculites otacodensis* (Stoliczka); Wright, p. L218, fig. 245/6ab.

Diagnosis: An *Eubaculites* with prominent, commonly bullate, ribs of which there are no more than two on a length equal to the height.

Remarks: The descriptions in Stoliczka (1866) and Kossmat (1895), and the notes in Spath (1953), are supplemented by the observation that the main diagnostic feature of the species, namely the distant ribbing, can without difficulty be recognized also on very small specimens of height 10-15 mm.

Details of the ribbing such as the shape and prominence of the nodes on the dorsal shoulders, of the bullae on the flanks, and of the more or less pronounced notching of the carina (Pl. 1, figs 9, 10) should no longer be included in the specific diagnosis because *ootacodensis* is little different from other species of the genus in this respect.

The original spelling of the species name (with double 'o' in the first syllable) was changed by Kossmat (1895, footnote, p. 102). Although this is a minor amendment it need not be accepted simply because by Kossmat's time the spelling of innumerable local Indian names had become officialized. There is certainly a good deal of inconsistency in the spelling of the word 'oota' in Kossmat's text. While Stoliczka (1863-66) used clearly phonetic spelling in 'ootacod', 'ootatoor', 'odium', 'moraviatoor', etc., and distinguished the o's from the oo's (=u in German), or from the u's (=ju or iu in German), because he obviously knew about the local pronunciation of these words, one notices in Kossmat (1895) that 'ootacod' is incorrectly turned into 'otacod', whereas 'ootatoor' is correctly germanized to 'utatur'.

I adhere to the original spelling throughout because I think Kossmat's is not valid under the Copenhagen Decisions on Zoological Nomenclature.

Australian Material: E. ootacodensis, as restricted in our diagnosis, is one of the rarer forms in Australia, and this, as may be gleaned from both Stoliczka's and Kossmat's text, is also the case in India. Only a few fragments of this species are known.

In the present collection the species is represented by only five specimens (CPC 2685-88). On one of them, CPC 2686, a substantial part of the delicate shell is preserved; the others are all clean internal casts.

Part of the body chamber of a large individual is shown in Plate 1, figures 9-11. Originally this specimen was considerably longer and included part of the phragmocone, but it was damaged in the 1953 fire and the septate section was

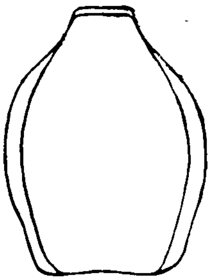


Fig. 9. ***Eubaculites ootacodensis*** **(Stoliczka), CPC 2685. Suture and cross section (x 1).**

lost. Fortunately the suture-line had been drawn before, and it is shown in Text-figure 9 to illustrate the relative size of the typically asymmetric bifid saddles, the tiny antisiphonal lobe, and the broad siphonal saddle. An interesting feature of this large specimen is the deformation of the venter, an abnormality that seems to occur exclusively in large individuals, probably because of injury to the body chamber, or as gerontic deformation. The grooved dorsum is also typical of large individuals.

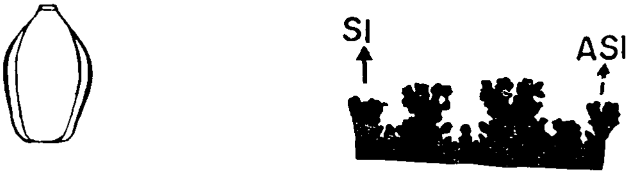


Fig. 10. ***Eubaculites ootacodensis*** **(Stoliczka), CPC 2686. Suture (x 2) and cross section (x 1).**

The specimen Plate 1, figures 13, 14 (and Text-figure 10), of medium size, illustrates the small rate of taper and the persistence of diagnostic shell sculpture from the phragmocone (one third of the specimen is septate) on to the body chamber. The shell adhering to this specimen is very thin and on its finely granulate surface the growth-lines are obliterated.

Plate 1, figure 12, illustrates the features on a small individual which is fully septate. It shows that the typical ribbing of the species is well developed in very early growth stages even if, as might be expected, the prominence and sharpness of the individual ribs are less apparent than on larger individuals. Such variations are evidently a matter of allometric growth.

Text-figure 11 shows the cross-section of the body chamber of a giant individual (the specimen was lost in the fire) with extremely strong ribbing.

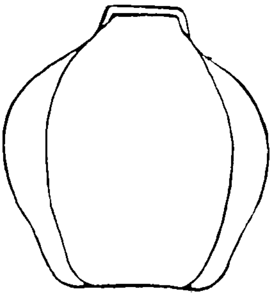


Fig. 11. ***Eubaculites ootacodensis*** **(Stoliczka), cross section of specimen 501/B30S which was destroyed in the 1953 fire (x 1).**

It is noteworthy that all three types of the siphonal saddle (see p. 26) are represented among the five specimens of this species; two types are shown in Text-figures 9, 10.

EUBACULITES VAGINA (Forbes, 1846)

(Pl. 1, fig. 7, Pl. 2, figs 1-14; Text-figs 12-14)

1846—*Baculites vagina* Forbes, p. 114, pl. 10, figs 4abc.

1866—*Baculites ?vagina* Forbes; Stoliczka, p. 198, pl. 91, figs 4, 4a.

1895—*Baculites ?vagina* Forbes; Kossmat, p. 156, pl. 19, fig. 17 (suture only).

1895—*Baculites vagina* Forbes; Steinmann, p. 90, pl. 6 (5 in text), fig. 4c only.

1940—*Eubaculites ?vagina* (Forbes); Spath, p. 49, not figured.

Diagnosis: A *Eubaculites* with more or less prominent, on larger specimens somewhat bullate, ribs of which there are three on a length equal to the height.

Remarks: The diagnosis of this species has been adjusted to incorporate Spath's (1940) observations and correction of Forbes' inadequate original figures.

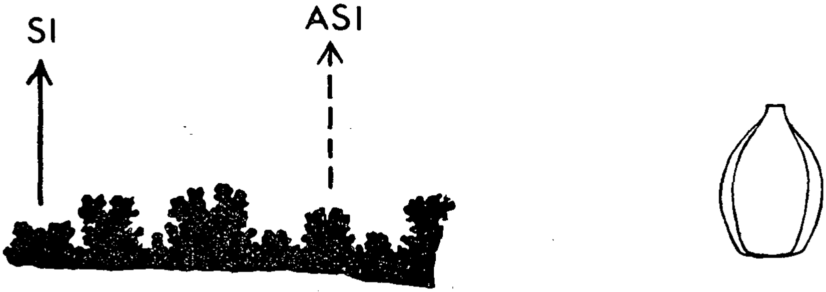


Fig. 12. ***Eubaculites vagina*** **(Forbes), CPC 2690. Suture (x 2) and cross section (x 1).**

Because the figures in Stoliczka (1866) and Kossmat (1895) are inadequate I am not in a position to verify whether the respective forms are rightly cited in the above synonymy. Forms illustrated in Darwin (1876, p. 43, pl. 5, fig. 3) and in d'Orbigny (1847, pl. 3, figs 3-6, and 1850, Vol. 2, p. 215, fig. 71) may also belong to this species, but the literature is not at my disposal. There is little doubt, though, that they are species of *Eubaculites* (Steinmann, 1895; Spath, 1940, 1953).

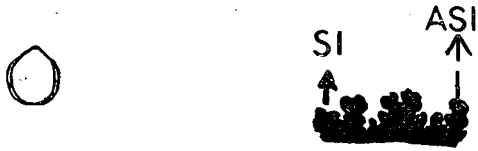


Fig. 13. ***Eubaculites vagina*** **(Forbes), CPC 2694. Suture (x 2) and cross section (x 1).**

Australian Material: With over 60 specimens, *E. vagina* is the most common form in the Miria Marl. As in *E. ootacodensis,* body-chamber fragments indicate a considerable range in size, or age, of the individuals. The height at the adapical end of the smallest body chamber is only 8 mm, whereas on the largest specimen it measures 35 mm.

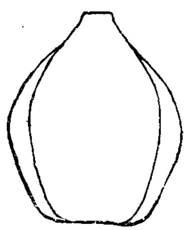


Fig. 14. ***Eubaculites vagina*** **(Forbes), CPC 2692. Cross section (x 1).**

The prominence and the sharpness of the ribbing are also variable, the keel may or may not be notched, and on a few specimens the smoothed zone on the upper part of the flanks show very faint longitudinal striation (lirae). Plate 2, figures 1-4, 7, 8, 10-14 show strongly ribbed individuals, whereas on the specimens

Plate 1, figure 7 and Plate 2, figures 5, 6, 9, the ribbing is weak. On about 10 percent of the fragments the carina, in spite of prominent ribbing, is perfectly smooth (e.g. Pl. 2, figs 2, 14) as it is on species of *Giralites nov.*

All three types of the siphonal saddle occur in the suture-lines of *E. vagina.* Types (a) and (b) are about equally common, but (c)-saddles are rare. Spath (1940), when commenting on Steinmann's (1895) observations with regard to the siphonal saddle, remarked that on his material from Western Australia type (b) was more common than (a). The present much more substantial collection shows that this is not the case.

EUBACULITES KOSSMATI sp. nov.

(Pl. 2, figs 15-17, Pl. 3, figs 1-7; Text-fig. 15)

1895—*Baculites vagina* Forbes var. *simplex* Kossmat, p. 156, pl. 19, figs 14abc only.

1895—*Baculites vagina* Forbes; Steinmann, pp. 89-94, pl. 6 (5 in text), fig. 4ab only.

Holotype: CPC 2704. Other material: (a) figured specimens—CPC 2705 to 2709; (b) unfigured specimens—total 23 under CPC 2702 and 2703.

Diagnosis: A *Eubaculites* with more or less prominent ribs, of which there are four on a length equal to the height.

Fig. 15. *Eubaculites kossmati* sp nov.; cross section of holotype CPC 2704 (x 1). Sutures on CPC 2702 (left) and CPC 2705 (right) (x 1).

Description: The holotype is a clean internal cast, wholly septate, 80 mm long. Over this length the height increased from 16 to 20 mm, the width from 10 to 13 mm. The fragment is very slightly curved in the sense of the ancestral coiling. The ribbing is quite strong, but not bullate, and the ribs are rounded, rursiradiate on the dorsal shoulder, thence straight for about two-thirds away up the flanks, whence they turn sharply forward and fade quickly away so as to leave a smooth longitudinal band between them and the low tabulate keel, which is set off from the smooth band by a shallow longitudinal groove. The keel is smooth and so is the flattened dorsum. The siphonal saddle of the poorly exposed suture is of type (a), i.e. with a deep central incision.

The other figured specimens have been selected to illustrate the range of variation in the species. The two specimens Figure 1 and Figure 6 on Plate 3, like the holotype, are fairly strongly ribbed; the larger of the two is a body-chamber fragment and shows a notched keel (Fig. 6), the smaller is part body chamber, part phragmocone, and has an almost smooth keel (Fig. 1). The specimens Plate 3, figures 2, 3, 4, 5, 7 are of the weakly ribbed variety; the smallest (Figs

2-4) is wholly septate with weakly notched keel, the largest (Fig. 5) is a fragment of the adapical part of a body chamber with a finely notched keel. Figure 7 is part phragmocone, part body chamber.

Again, as in *E. ootacodensis* and *E. vagina,* all three types of the siphonal saddle of the suture occur and there seems to be no connexion between the variations in shell shape and the form of the siphonal saddle.

Remarks: Because it is not certain that Kossmat's and Steinmann's specimens have survived the ravages of the Second World War it is not advisable to select one of their figures as type for *E. kossmati.* Moreover, the collection from Western Australia is much larger than any other that may be relevant to the taxonomy of the Eubaculitinae.

EUBACULITES MULTICOSTATUS sp. nov.

(Pl. 3, figs 8-12; Text-fig. 16)

Holotype: CPC 2710. Other material: (a) figured specimens—CPC 2711 and 2712; (b) specimens not figured: 4 under CPC 2713.

Diagnosis: A *Eubaculites* with more or less prominent ribs of which there are at least five on a length equal to the height.

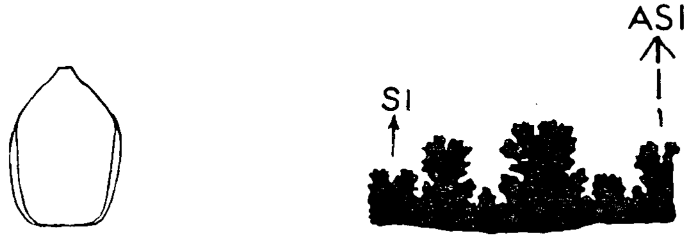


Fig. 16. ***Eubaculites multicostatus*** **sp. nov., Holotype CPC 2710. Cross section (x 1) and suture (x 2).**

Description: The holotype is a fragment of a clean internal cast, 59 mm long; about a quarter of its length is sepate. The height of the shell increases from 17 to 22 mm, the width from 11 to 14 mm; at the same time the width of the faintly notched carina increases from 2.5 to 3 mm. The longitudinal grooves along the base of the keel are shallow. There is a flattened, rather broad, dorsum and the dorsal shoulders are quite sharply rounded. The ribs are moderately prominent and rounded; there are no bullae on the dorsal shoulders. The smooth zone on the upper part of the flanks shows very faint lirae and is much wider than in more distantly ribbed forms. The siphonal saddle is of type (a); the two last sutures are visible.

Plate 3, figure 8, a fragment of a body chamber, illustrates the size of the largest individuals. The small fragment Plate 3, figure 9, displays a perfectly smooth keel and a faintly lirate smooth band between keel and the ventral ends of the ribs.

Remarks: This closely ribbed species, like the broadly ribbed *E. ootacodensis,* is not common. Apart from variation in size one notices, as in the other ribbed eubaculitids, variations in the prominence and sharpness of the ribs and in the minor characteristics of the carina. On the other hand, all specimens show the same type of siphonal saddle as the holotype, but because of the limited material one cannot be certain that this feature is really a specific characteristic.

Unlike the other species of the genus, *E. multicostatus* is recorded only from Australia.

Genus GIRALITES nov.

Diagnosis: A non-costate genus of the Eubaculitinae in which the ratio of height to width of the cross-section is less than 1.8:1.

Type Species: Giralites latecarinatus sp. nov.

Remarks: The idea that smooth Eubaculitinae are early growth stages of ribbed forms was proposed by Stoliczka (1866) and accepted by Kossmat (1895), in spite of the fact that d'Orbigny (1847) had not hesitated to separate smooth forms (*Baculites lyelli*) from ribbed ones (*Baculites ornatus*) in his description of the South American material. Modern authors such as Spath (1940, 1953) and Wright (1957) did not have sufficient or suitable material to check for themselves whether Stoliczka's concept is correct. The fact is that neither in the collections from Western Australia nor, as far as can be judged from the figured specimens, in those from India is there any material which would demonstrate Stoliczka's concept on one and the same single specimen.

On the other hand the Western Australian material shows that both smooth and ribbed *Eubaculitinae* occur in all sizes. Ribbed species, even if the ribs are very weak, can be recognized as such at very early growth stages. In any event, by the time they have reached the size of Stoliczka's specimens (1866, pl. 90, fig. 2; see also Kossmat, 1895, pl. 19, fig. 13) costation would most definitely be well established. In other words, if there is no costation at this stage the fragment must be classified with one of the smooth genera of Eubaculitinae.

GIRALITES LATECARINATUS sp. nov.

(Pl. 3, figs 13, 14, Pl. 4, figs 1-5; Text-figs 17,18)

1866—*Baculites vagina* Forbes; Stoliczka, p. 198, pl. 91, figs 1, 1b only.

Holotype: CPC 2718. Other material: (a) figured specimens—CPC 2719 (Paratype) and CPC 2720; (b) unfigured specimens—14 under CPC 2721.

Diagnosis: A *Giralites* with a broadly tabulate carina.

Description: The holotype is a clean internal cast, wholly septate, 45 mm long. In that length the height increases from 17 to 20 mm, the width from 10 to 12 mm. The width of the low smooth carina increases from 2 to 2.5 mm; it is distinctly, but shallowly, set off from the flanks by longitudinal grooves. On very small specimens these grooves are not developed and the venter is rounded rather than carinate (Pl. 4, fig. 5). The typical carina appears at a height of 10 to 15 mm.

On very large specimens (Pl. 3, figs 13, 14 and Pl. 4, fig. 1) the curvature of the shaft tends to turn to the ventral side and, as in *Eubaculites*, the dorsum becomes sulcate.

All three types of the siphonal saddle (see p. 26) have been observed among the 17 specimens known of this species, the holotype having type (c), the small specimen (CPC 2720) a type intermediate between (c) and (a). On the paratype the carina is too worn to trace the incisions of the siphonal saddle.

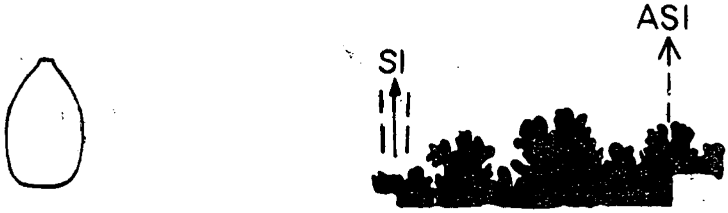


Fig. 17. *Giralites latecarinatus* gen. et sp. nov., Holotype CPC 2718. Cross section (x 1) and suture (x 1).

Remarks: The smooth forms from South America which d'Orbigny (1847, 1850) described under the name of *Baculites lyelli* seem to be closely related, but the carina is far less sharply defined than on the Australian species. The species *lyelli* is therefore more likely a smooth member of the Baculitinae than a *Giralites*.

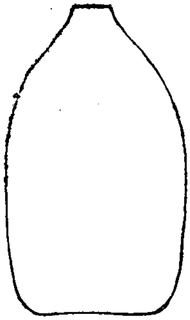


Fig. 18. *Giralites latecarinatus* gen. et sp. nov., Paratype CPC 2719. Cross section.

GIRALITES SIMPLEX (Kossmat, 1895)

(Pl. 4, figs 6-10; Text-fig. 19)

1866—*Baculites vagina* Forbes; Stoliczka, p. 198, pl. 91, figs 1, 1a only.

1895—*Baculites vagina* Forbes var. *simplex* Kossmat, p. 156, pl. 19, figs 13ab only.

1940—*Eubaculites simplex* (Kossmat); Spath, p. 49 (partim)

Diagnosis: A *Giralites* with a narrow, non-tabulate, sharply rounded, low carina which is only very faintly set off from the flanks by longitudinal grooves.

Remarks: In very small specimens the shallow grooves accompanying the carina are absent, the venter then being sharply rounded fastigiate. Such specimens are often, but not always, difficult to separate from *G. latecarinatus* of similarly small size.

Australian Material: Ten fragments are assigned to this species, and most of them are of small to medium size. Plate 4, figures 6-10, show some typical examples of the species. The adoral height of the largest wholly septate fragment (CPC 2716) measures 21 mm (Fig. 7); adapical ends of some fragments (e.g. CPC 2715) measure as little as 8 mm. CPC 2715 (Fig. 6) demonstrates the conspecificity with the smooth specimen of Kossmat's (1895) var. *simplex* listed in the synonymy, and so does CPC 2714 (Figs 8-10 and Text-fig. 19). Spath (1940) regarded this variety as a separate species, but whether he meant to include both the ribbed and the smooth specimens of Kossmat is not clear from his text (p. 49). Here they are placed in different genera.

Fig. 19. ***Giralites simplex*** **(Kossmat), CPC 2714. Cross section (x 1) and suture (x 2).**

The fully septate specimen CPC 2714 and the semiseptate CPC 2715 are figured to show the most common type of fragments. The seven unfigured specimens in the collection (all under CPC 2717) fall within that size range; the shafts are very conspicuously curved and commonly show more wear than larger fragments, which makes their identification often somewhat difficult.

All except one fragment have sutures with a siphonal saddle of the (b) type; the exception has an (a) saddle.

GIRALITES QUADRISULCATUS sp. nov.

(Pl. 4, figs 11-14; Text-fig. 20)

Holotype: CPC 2722. Other material: CPC 2723 (paratype).

Diagnosis: A *Giralites* with a narrow tabulate carina, set off from the flanks by longitudinal grooves, and with shallow, broad, longitudinal depressions in the lower half of the flanks.

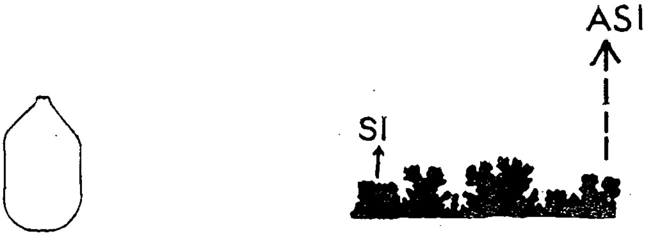


Fig. 20. ***Giralites quadrisulcatus*** **sp. nov., Holotype CPC 2722. Cross section (x 1) and suture (x 2).**

Description: The holotype, from the Miria Marl on the Marilla Anticline, is a partly septate internal cast with part of the calcitized shell adhering, 56 mm long. Over that length the height increases from 14 to 17 mm, the width from 8 to 10 mm, and the width of the carina from 1.5 to nearly 2 mm. The shallow sulcus on the flanks is from 3 to 4 mm wide, the dorsum rounded rather than flattened. The siphonal saddle of the suture is intermediate between (b) and (c) types.

The paratype is a fully septate clean internal cast. Its flanks are flattened rather than sulcate as on the holotype, but even so it is distinct enough from the invariably convex flanks of other species of *Giralites*. The siphonal saddle of the suture is of the (c) type.

From the fragments adhering to the body chamber of the holotype it can be concluded that the shell of this species was very fragile; it is about 0.2 mm thick on the flanks, but over the carina it seems to have thickened to about 1 mm. However, this may be a secondary incrustation associated with the transformation of aragonite into calcite over the irregular cast of the sharply edged keel.

Genus EUBACULICERAS nov.

Diagnosis: A ribbed genus of the Eubaculitinae with a very compressed cross-section, i.e. with a ratio of height to width of 2:1 or more (measured between the ribs).

Type Species: Eubaculiceras compressum sp. nov.

Remarks: Extremely slender Eubaculitinae such as *Eubaculiceras* are not common in our collection, and none seem to have been found elsewhere. It appears that the planifastigiate carina, that is, the absence of longitudinal grooves between keel and flanks, is a necessary result of the slimming of the shell in this genus as well as in *Cardabites* nov.

EUBACULICERAS COMPRESSUM sp. nov.

(Pl. 4, figs 15-17, Pl. 5, figs 1-3)

Holotype: CPC 2724. Other material: CPC 2725 (paratype).

Diagnosis: A *Eubaculiceras* with a narrow, but distinctly tabulate, keel and low fold-like ribs of which there are three on a length equal to the height.

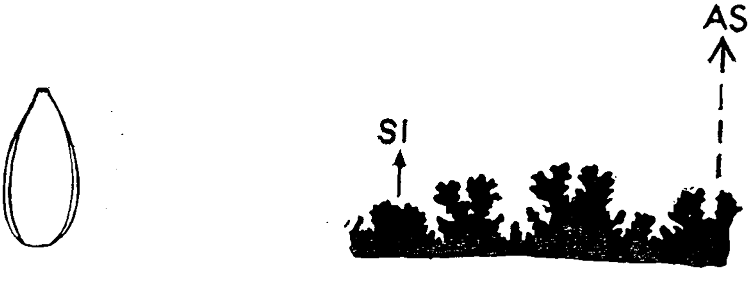


Fig. 21. ***Eubaculiceras compressum*** **gen. et sp. nov., Holotype CPC 2724. Cross section (x 1) and suture (x 2).**

Description: The holotype is a partly ($\frac{3}{4}$) septate internal cast, to which adhere small fragments of the shell, 95 mm long. In the undamaged portion (65 mm) the height increases from 16.5 to 21 mm, the width from 7.5 to almost 10 mm, and the width of the carina from 1.5 to 2 mm. The fold-like ribbing is strongest on the lower part of the flank, the ventral half of which is quite smooth and leads straight and flat up to the edge of the keel. The dorsum is smooth with a narrow flattened zone and rather sharply rounded shoulders. The keel is smooth, with the shell as a whole gently curved towards it. The siphonal saddle of the suture is of type (b).

The paratype displays a gently notched carina and a more distinctly flattened dorsum, and the flattened zone on the upper part of the flanks is narrower than on the holotype. The specimen is the adapical part of a body chamber.

From the remains of the shell on the holotype it seems that the fragile shell thickens a little over the dorsum as well as, but not quite so much as, over the venter. The holotype also shows what appear to be muscle scars on the body chamber.

EUBACULICERAS FASTIGIATUM sp. nov.

(Pl. 5, figs 7-9; Text-fig. 22)

Holotype: CPC 2726.

Diagnosis: A *Eubaculiceras* with a non-tabulate, very sharply rounded, keel and very weak fold-like ribs, of which there are four on a length equal to the height.

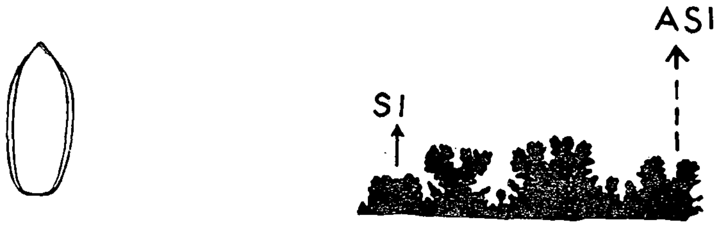


Fig. 22. ***Eubaculiceras fastigiatum*** **sp. nov., Holotype CPC 2726. Cross section (x 1) and suture (x 2).**

Description: The holotype and only known specimen is a clean internal cast with rather worn flanks, fully septate, 52 mm long, 40 mm of which is undamaged. In this length the height increases from 16 to 19 mm, the width from 8 to a little over 9 mm. The faint notching of the keel is the only indication that this is a ribbed species. The dorsal shoulders are gently rounded and the flattened zone on the dorsum is very narrow.

A feature of this specimen is a strongly prorsiradiate shallow constriction which can be clearly seen in the side view (Pl. 5, fig. 4) as a nick in the dorsum. This is the only fragment in the collection on which a constriction occurs. In the absence of additional specimens of this species it can, of course, not be decided whether periodic constrictions are a diagnostic feature of the form, however unique it may appear. The siphonal saddle of the suture is of type (b).

Genus CARDABITES nov.

Diagnosis: A non-costate genus of the Eubaculitinae with a very compressed cross-section which has a ratio of height to width of 2:1 or more.

Type Species: Cardabites tabulatus sp. nov.

Remarks: This genus, like *Eubaculiceras,* is a rare form and there is no record yet of its occurrence outside Australia.

Occasionally a specimen of one or the other of the species of *Cardabites* may appear to have a notched carina. On closer inspection it will be noticed, however, that this occurs only on internal casts, and only on the phragmocone. Body chambers invariably have a smooth carina. The notching is in such cases evidently due to selective weathering which attacks the narrowly tabulate, or acute, keel of the internal cast in the first place immediately in front of the fine sutural incisions made by the siphonal saddle. This results in the stem of the siphonal saddle on the keel being slightly raised over the area immediately in front of it. Since most, or all, cf these saddles may be affected by selective weathering the keel appears notched.

As can be seen on ribbed species of the Eubaculitinae, true notching carries through on to the keel of the body chamber. When observed on the phragmocone of a *Cardabites* it can only be called pseudo-notching.

CARDABITES TABULATUS sp. nov.

(Pl. 5, figs 12-15; Text-fig. 23)

Holotype: CPC 2727. Other material: CPC 2731 (paratype) and CPC 2728 (not figured).

Diagnosis: Cardabites with a narrowly tabulate keel and a flattened dorsum with very sharply rounded shoulders.

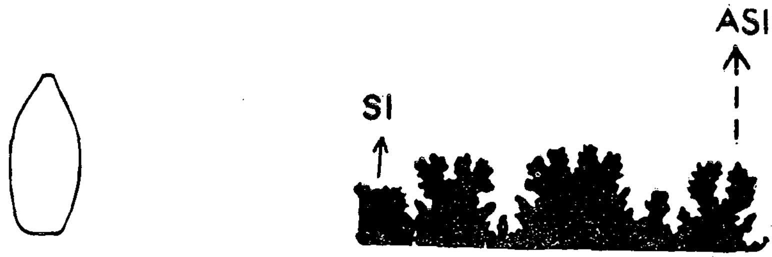


Fig. 23. *Cardabites tabulatus* gen. et sp. nov., Holotype CPC 2727. Cross section (x 1) and suture (x 2).

Description: The holotype is a clean internal cast, 54 mm long, 40 mm of which are undamaged. In that length the height increases from 19 to 21 mm, the width from 9 to 10 mm, and the width of the keel from a little more than 1 to 2 mm. About four-fifths of the fragment is septate; the rest belongs to the body chamber. The siphonal saddle of all the three known specimens of this species is of the (b) type.

The paratype illustrates the pseudo-notching of the phragmocone mentioned in the discussion of the genus as well as the extremely compressed cross-section this form may attain. The paratype has a height:width ratio of 2.3:1; it is, in fact, the most compressed specimen in the collection.

CARDABITES SCIMITAR sp. nov.

(Pl. 5, figs 16-211; Text-fig. 24)

Holotype: CPC 2729. Other material: CPC 2730 (paratype).

Diagnosis: A *Cardabites* with an acute and fastigiate keel.

Description: The holotype is an internal cast with a small fragment of the shell adhering to the adapical part of the venter. It is 60 mm long and in that length the height increases from 17 to 21 and the width from a little over 8 to 10.5 mm. About one third of the fragment is septate. The dorsum is flattened and the dorsal shoulders evenly rounded. The suture line has a (b)-type siphonal saddle.

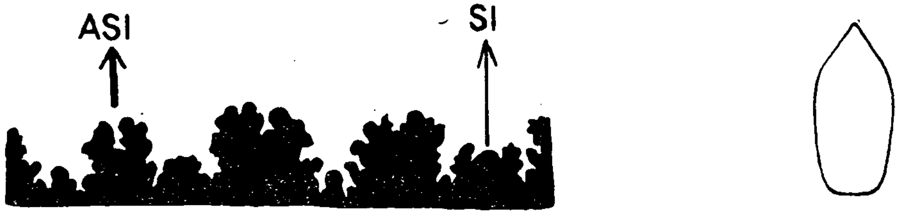


Fig. 24. ***Cardabites scimitar*** **sp. nov., Holotype CPC 2729. Suture (x 2). Cross section of Paratype CPC 2730 (x 1).**

The paratype, which is a fragment of a slightly larger individual than the holotype, is partly (¼) septate and serves to illustrate how sharp the keel can be on this species. The siphonal saddle of its suture is also of the (b) type.

Family Nostoceratidae Hyatt, 1894, emend.

Even after the removal of *Bostrychoceras* and *Hyphantoceras* to Diplomocerataceae (because of their cicatritid suture—p. 15) the family Nostoceratidae continues to appear as a heterogeneous group of genera. I find it difficult to accept Wright's proposal (1957, p. L223) to regard the family as almost certainly monophyletic, being derived (presumably in the Cenomanian) from a descendant of the Albian *Turrilitoides* Spath.

The sutural saddles of *Turrilitoides* are typically bifid, broad-stemmed, and, even when well incised, only moderately florid. The lobes remain adorally wide open as in some other genera of Turrilitidae, e.g. the Cenomanian *Turrilites* Lamarck itself. Undoubtedly some Nostoceratidae possess these sutural features, but some do not. They are lacking, for instance, on *Neocrioceras* Spath (Campanian) the suture of which resembles that of some Tetragonitidae Hyatt rather than *Turrilites*. The possibility of heteromorph offshoots from Tetragonitidae should not be lightly discarded.

It is unfortunate that published information about nostoceratid sutures is much too fragmentary to be of much help in a discussion of the derivation and relationships of the members of that family.

Meanwhile, in order to exclude *Bostrychoceras* and *Hyphantoceras*, the current (Wright 1957, p. L227) diagnosis of Nostoceratidae is amended to read as follows:

> Nostoceratidae are helicoid forms in which coiling is normally irregular in early or late stages or both or throughout life. Several stocks tend to revert to bilateral symmetry. Tuberculation is common but may be subordinate to dense ribbing. Constrictions are general. Suture similar to that of *Turrilites*, i.e. asymmetrical because of helical coiling, moderately florid, with lobes well opened adorally, and with erect to moderately inclined, more or less broad-stemmed, first lateral saddle.

In Australia the family seems to be represented only by *Nostoceras* itself. In the two earliest collections from the Miria Marl (Raggatt, 1936; Spath, 1940) the genus was not present, but a number of fragments were found in the field seasons 1949-51.

Genus NOSTOCERAS Hyatt, 1894

NOSTOCERAS ATTENUATUM sp. nov.

(Pl. 8, figs 8-10; Text-figs 25, 26)

Holotype: CPC 2628. Other material: MUGD 3388 (paratype).

Diagnosis: A *Nostoceras* with dense, low but fairly sharp, mostly bifurcate but occasionally trifurcate ribbing. A single row of ventral tubercles appearing on the body chamber together with bullae on the upper dorsal shoulder. Dorsum flat with sharply rounded shoulders, venter broadly rounded. Coiling sinistral or dextral.

Description: On the holotype there are 9 or 10 fairly sharp and somewhat sinuous primary ribs on a length equal to the greatest diameter (measured between ribs 30 mm in front of the last suture). On the dorsum the primaries are almost obliterated, but they quickly appear and become bullate on the dorsal shoulders. They remain so for about a quarter of the way up the flanks, whence they bifurcate. The secondaries begin very weakly but over the venter primaries and secondaries are of equal prominence. This results in very dense ventral ornament, i.e. about 20 ribs in a length equal to the greatest diameter. Occasionally a primary rib bifurcates on the dorsum, so that on the flanks it appears as if it were a single, annular rib. The tubercles in the single row on the venter are rather weak; whether bituberculation appears farther along the body chamber toward the aperture is not known.

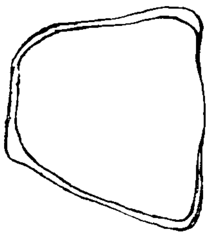


Fig. 25. ***Nostoceras attenuatum*** **sp. nov., Holotype CPC 2628. Cross section (x 1).**

The cross-section of the body chamber (Text-fig. 25) shows a broadly, but obliquely, rounded venter and sharply rounded dorsal shoulders which lead to a flattened and almost smooth dorsum. At the adapical end the cross-section changes within a short distance to an obliquely oval shape with a countersunk dorsal area (the imprint of the last turreted whorl) and almost angular dorsal shoulders. The coiling is sinistral.

The paratype is coiled dextrally and it is slightly smaller than the holotype. Damage to the venter has also removed the tuberculated zone. The ribbing is the same as on the holotype and is shown in Text-figure 26.

Although both specimens are fragments from the beginning of the body chamber, and adoral parts of the last sutures can in places be seen, the state of preservation is not good enough for an analysis of the lobes.

Remarks: Because important parts of the suture-line are not known the placing of this species in *Nostoceras* must be regarded with some reservations. The only feature supporting that classification is the tuberculation of the body chamber. Should additional material eventually show a cicatritid suture the species would have to be transferred to Bostrychoceratidae. As Kossmat (1895) pointed out, the type species for *Bostrychoceras, 'Turrilites' polyplocus* Roemer, includes individuals with very weak, single row, ventral tubercles (Schlueter, 1872) near the aperture. Because *Nostoceras attenuatum* develops tuberculation as far back as the end of the phragmocone it is for the time being classified as a nostoceratid, although most nostoceratids show tuberculation already on the turreted whorls. On the other hand, Young (1963) assigns both tuberculate and non-tuberculate forms to *Bostrychoceras* and in doing so refers also to Schlueter's (1871, p. 44) material.

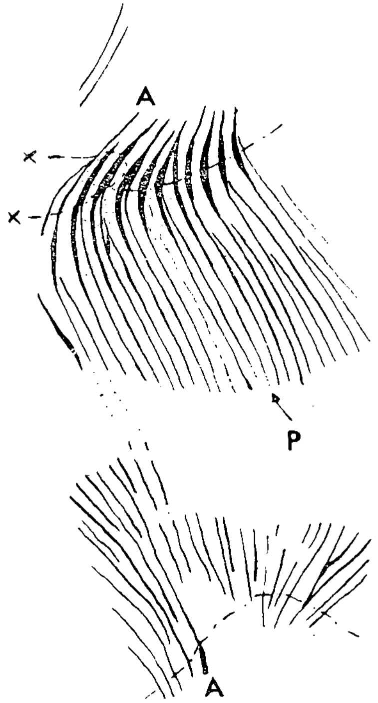


Fig. 26. ***Nostoceras attenuatum*** **sp. nov., Paratype MUGD 3388. Diagram of ribbing (x 1).**

Significantly, the sutures of both of Young's (1963, pp. 42-44) species (*secoense* and *braithwaitei*) are not known; therefore, why is the bituberculate species *B. secoense* Young placed in *Bostrychoceras* instead of *Nostoceras* which, by definition, is the bituberculate genus? Evidently, the classification of the upper Cretaceous heteromorphs will remain most confusing as long as one has, as in this case, to rely on highly variable characteristics such as the details of the tuberculation alone.

NOSTOCERAS FISHERI sp. nov.

(Pl. 6, figs 11 and 12; Text-fig. 27)

Holotype: CPC 2629. Other material: CPC 2630.

Diagnosis: A *Nostoceras* with dense, sharp, irregularly bifurcate and trifurcate ribs which, on the living chamber, are dorso-laterally bullate to slightly flared. The prominent ventral bituberculation is bullate on the earliest portion of the living chamber, but soon becomes spinose towards the aperture. Turreted whorls also tuberculate. Suture turrilitid.

Description: On the holotype there are 15 to 17 ribs on the venter in a length equal to the greater diameter. The dorsum is almost smooth. Tuberculation on the last of the turreted whorls is evident from the imprints left on the dorsum of the body chamber. On the downtwisted initial portion of the body chamber the tubercles

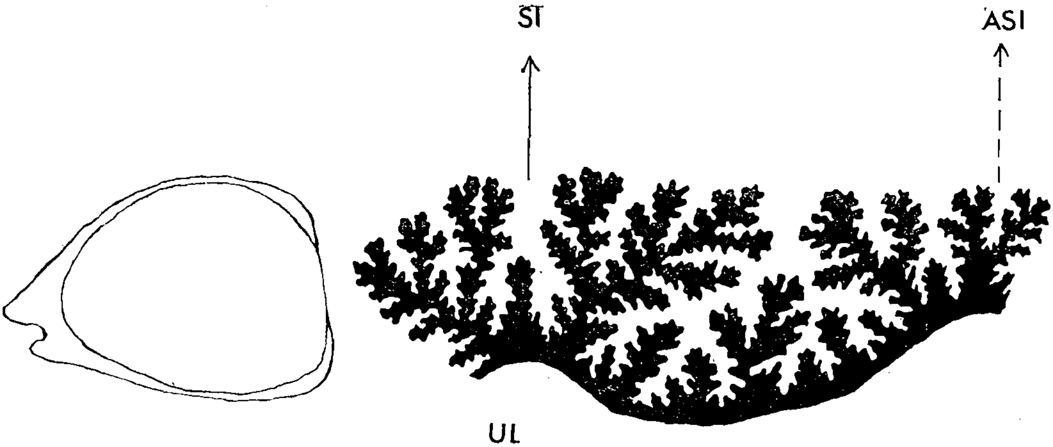


Fig. 27. ***Nostoceras fisheri*** **sp. nov., Holotype CPC 2629. Cross section (x 1) and suture (x 2).**

become bullate. Along with the opening of the coil to the hooked part of the body chamber (not preserved) the bullae contract again into sturdy spines. The ribs run very irregularly between the tubercles.

The cross-section of the body chamber is almost triangular, the venter fairly sharply rounded, and the dorsum gently concave with rounded shoulders. Towards the turreted whorls the section changes to an obliquely compressed oval shape with a concave dorsum (i.e. the imprint of the last turret whorl) and a sharply rounded venter. The dorsal shoulders become almost angular.

The typically asymmetric suture-line has a deep and large fan-like first lateral lobe, a very small and narrow second lateral, and a minute and very short antisiphonal lobe. The siphonal lobe is rather narrow but deep (about $\frac{3}{4}$ of the depth of the first lateral). The first and the second lateral saddles are rather narrow-stemmed and inclined towards the main lobe which shows a moderately wide adoral opening. All major elements are bifid; only the tiny antisiphonal lobe shows a single prong. Although this is a fairly florid suture it is not of the cicatritid type because the siphonal saddle is much too deep, i.e. the first lateral saddle is only inclined (turrilitid), not suspended on the ventral slope of the main lobe, and the adoral opening of the first lateral lobe is considerably wider than for instance on *Eudiplomoceras* (p. 19).

Remarks: The crudely spinose venter of the body chamber is peculiar to this species, and I know of no other described form which possesses that feature. All species from the American continent (Adkins, 1931; Stephenson, 1941; Usher, 1952; Young, 1963) seem to have smaller tubercles, certainly not spinose ones, and the cross-sections of the living chambers are usually more rounded. I do not know of any European species which is similar to *N. fisheri.*

?NOSTOCERAS sp. ind.
(Pl. 6, fig. 13)

Material: A single specimen, CPC 2631.

Description: A small fragment of an external mould from a body chamber. The tubercles are small and blunt, the ribs rounded (Pl. 6, fig. 13 is a plasticine cast).

Remarks: This small fragment is figured in order to show that there probably are a few more species of Nostoceratidae in the Miria Marl. It differs from both *N. attenuatum* and *N. fisheri* in its blunter ribbing and from the latter in its attenuated tuberculation. Whether it really belongs to *Nostoceras* itself or to *Cirroceras, Emperoceras,* etc., can, of course, not be decided.

Family POLYPTYCHOCERATIDAE Matsumoto, 1938, emend.

Nominate Genus: Polyptychoceras (Yabe, 1902) Matsumoto, 1938.

Diagnosis: Loosely coiled heteromorphs, tending to bilateral symmetry; typically with sharp, annular, non-tuberculate ribs, but ventrolateral tubercles or spines occur in a few genera. Constrictions or flares may be present. Unlike Diplomoceratidae internal casts are also ribbed, although commonly less sharply than the exterior of the shell. Suture hamitid, very simple to moderately florid with rather deep siphonal lobe and erect first lateral saddle, and typically short and narrow antisiphonal lobe.

Range: Turonian to Maastrichtian.

Remarks: After the cicatritid genera *Diplomoceras* and *Pravitoceras* have been placed in a family of their own (p. 15), the remainder of the forms previously grouped with them in Diplomoceratidae (Wright, 1957, pp. L224-28) make a true family unit. Even so, one may retain some doubts as to whether this family, Polyptychoceratidae, is monophyletic. Some genera may derive from Nostoceratidae, for example the tuberculate forms *Neancyloceras* Spath and *Pseudoxybeloceras* Wright & Matsumoto; but the majority seem to be offshoots from late hamitids such as *Stomohamites* Breistroffer without detours through Nostoceratidae. This thesis is exemplified by the new genus *Neohamites* which, together with some other members of the Polyptychoceratidae. I regard as offshoots from Turonian *Stomohamites*. Both form-groups are very similar in general shell morphology and characteristics of their suture-lines. In fact, if it were not that *Stomohamites* arose with many other hamitids as early as upper Albian times, one might be tempted to call it an early polyptychoceratid.

Spath (1953, p. 15) also believed that upper Cretaceous heteromorphs such as *Glyptoxoceras* Spath are fairly direct descendants of Hamitidae, although, by the inclusion of *Diplomoceras* and *Pravitoceras* in the group, he too underrated the profound sutural differences which demonstrate that only part of the so-called *Hamites* of the upper Cretaceous are really hamitids.

In any event, there is good reason to assume that the Hamitidae, like Baculitidae and Scaphitidae Meek, are a long-lived family. As the earliest polyptychoceratid genus *Scalarites* Wright & Matsumoto is likely to overlap the range of *Stomohamites* in the Turonian there is no need to interpose nostoceratids into the lineage from Hamitidae to Polyptychoceratidae; there are no difficulties from missing links.

Another point needs recapitulation at this juncture. In view of the fundamental differences in the suture-line, *Scalarites,* in spite of its flared ribs, is not an offshoot of *Hyphantoceras* (Wright & Matsumoto, 1954). In other words, Polyptychoceratidae are, like Hamitidae, members of the Turrilitaceae, not of the Diplomocerataceae (p. 15).

In dealing with such heteromorphs it seems to me that higher taxa are more safely established on the basis of morphological features which not only remain reasonably constant but also, to a significant degree, serve to indicate ancestral stocks and lineage. In this context it can be said that the suture-line tends to be neglected in classifications which are currently in use. This Bulletin, to some extent, intends to restore it to an important place among the taxonomic criteria. It is felt that Polyptychoceratidae, as understood here, are more likely to be a monophyletic family than Diplomoceratidae of the current classification (Wright, 1957).

Polyptychoceratidae includes six non-tuberculate genera (*Scalarites, Glyptoxoceras, Neohamites* nov., *Polyptychoceras, Phylloptychoceras, Ryugasella*) and two with tubercles or spines (*Neancyloceras, Pseudoxybeloceras*). Only two of these eight genera are known to occur in the Miria Marl. They are *Glyptoxoceras* and *Neohamites* nov.

Genus GLYPTOXOCERAS Spath, 1926a, emend.

Diagnosis: Cross-section circular or very nearly so. Coiling initially in the form of a shallow helix, then loose, regular or elliptic. Test ribbed both externally and internally at all growth stages. Ribs annular, typically straight or almost straight, close or distant, of varying sharpness. Constrictions few and more or less distinctly collared.

Type Species: Glyptoxoceras indicum (Forbes), Shimizu, 1935a.

Remarks: In species of *Glyptoxoceras* the lateral diameter is at least 90 percent of the dorso-ventral diameter both on the body chamber and on later growth stages of the phragmocone. Among the material from the Miria Marl there are no initial coils for study; the above diagnosis thus may or may not apply to early growth stages.

There are three previously established and one new species of *Glyptoxoceras* in the material from Western Australia. Two of them have sharp external, but weak internal, ribbing. The other two show sharp ribbing on the inside as well as on the outside of the test. Further specific distinction within these two form-groups is made on the base of the density of the ribbing.

The diagnostic features of these glyptoxoceratids are schematically summarized on Text-figure 38, which gives a key to the morphology of *Glyptoxoceras, Neohamites* nov., and the diplomoceratid genera *Eudiplomoceras* nov. and *Diplomoceras.*

GLYPTOXOCERAS INDICUM (Forbes, 1846)
(Pl. 6, figs 1, 2, 3; Text-fig. 28)

1895—*Hamites* (*Anisoceras*) *indicus* Forbes; Kossmat, p. 145, pl. 19, figs 4ab.

1895—*Hamites* (*Anisoceras*) *rugatus* Forbes; Kossmat, p. 146, pl. 19, figs 7ab, 9.

1935a—*Glyptoxoceras indicus* (Forbes); Shimizu, p. 272.

1940—*Glyptoxoceras* cf. *rugatum* (Forbes); Spath, p. 47, pl. 1, figs 1ab.

Diagnosis: A *Glyptoxoceras* with 6 to 7 sharp and low ribs on a length equal to the dorso-ventral diameter; interspaces wider than ribs, but only on exterior of shell. Internal casts show weak and blunt ribbing, interspaces equal in width to ribs.

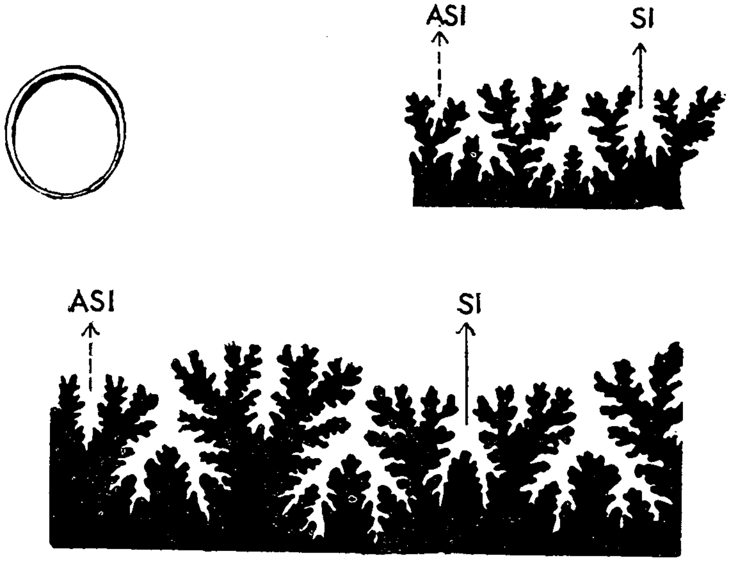


Fig. 28. ***Glyptoxoceras indicum*** **(Forbes); Cross section of CPC 2672 (x 1), sutures of CPC 2671 (x 2) and CPC 2674 (x 2).**

Remarks: As Plate 6, figure 3, shows, the ribbing can be distinctly prorsiradiate, at least on parts of the shell, for example the body chamber. Collars and constrictions, if present, are not very conspicuous on the Australian specimens. Shimizu (1935a) seems to believe that the antisiphonal lobe of the suture of this and all other species of the genus is asymmetrically bifid. He includes this feature in the generic diagnosis. I am certain that the antisiphonal lobe is quite useless diagnostically as it varies even within one and the same species. Most commonly it is what may be called 'reduced cruciform' i.e. there are three fine prongs at the base of the lobe, the central usually being the longest. Almost equally common, especially on small specimens, is simply a single central prong. A bifid termination of the lobe is, in fact, extremely rare in the Australian polyptychoceratids. There is but one example among the specimens of *Neohamites rugatus* (Forbes), the suture of which is illustrated in Text-figure 33. Among our material of *Glyptoxoceras* it does not occur, and the feature should no longer be included in the diagnosis of the genus.

It will be recalled that in the Eubaculitinae it is the siphonal saddle which varies appreciably, and that there too such a very minor feature of the suture is useless for the purpose of classification.

Australian Material: There are one hooked and four straight fragments, CPC 2671-75, the first three of which are figured on Plate 6. The difference between the internal and external shell sculpture is well illustrated by specimen CPC 2672 (Fig. 2); it is a feature which has to date been overlooked (perhaps because of unsuitable material), although it is undoubtedly of great diagnostic value on the species level.

GLYPTOXOCERAS CIRCULARE Shimizu, 1935a
(Pl. 6, figs 4, 5, 6; Text-fig. 29)

1866—*Anisoceras subcompressum* Forbes; Stoliczka, p. 179, pl. 85, figs 7, 7a.

1895—*Hamites (Anisoceras) indicus* Forbes; Kossmat, p. 145, pl. 19, fig. 4c.

1935a—*Glyptoxoceras circulare* Shimizu; p. 272, figs 10, 11.

1940—*Glyptoxoceras ?largesulcatum* (Forbes); Spath, p. 48.

Diagnosis: A *Glyptoxoceras* with 5 to 6 prominent and externally sharp ribs on a length equal to the dorso-ventral diameter, interspaces markedly wider than the ribs. Internal casts show blunt and weak ribbing, interspaces only on larger specimens wider than ribs.

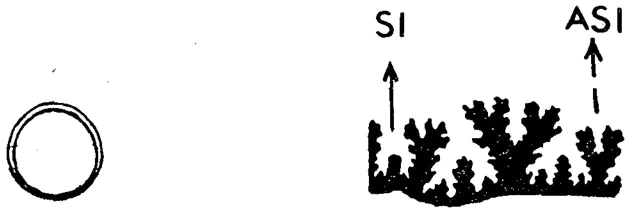


Fig. 29. *Glyptoxoceras circulare* Shimizu. Cross section of CPC 2677 (x 1); suture of CPC 2678 (x 2).

Remarks: Except for the less dense ribbing and a slightly less florid suture there is no difference between this species and *G. indicum*. The degree of floridity may be related to the density of the ribbing, i.e. the denser the ribbing the more florid the suture. A comparison of species of *Glyptoxoceras, Neohamites, Diplomoceras,* and *Eudiplomoceras* does certainly suggest that.

Australian Material: One hooked, two slightly curved, and one straight fragment, CPC 2676-79, the three first of which are figured on Plate 6.

GLYPTOXOCERAS NIPPONICUM Shimizu, 1935b
(Pl. 6, figs 7, 8, 9; Text-fig. 30)

1866—*Anisoceras largesulcatum* Forbes; Stoliczka, p. 180, pl. 85, figs 9, 9a.

1894—*Hamites* sp., Jimbo, p. 40, pl. 7, figs 7, 7a.

1935b—*Glyptoxoceras nipponicum* Shimizu, p. 199.

1954—*Scalarites scalaris* (Yabe); Wright & Matsumoto, p. 117 partim.

Diagnosis: A *Glyptoxoceras* with 4 to 5 prominent sharp and narrow ribs on a length equal to the dorso-ventral diameter; interspaces markedly wider than ribs. On internal casts the ribbing is only slightly less prominent and sharp, except on the early growth stages which, as a rule, have low and blunt ribs. Suture-line rather simple.

Remarks: This form was included in *Scalarites scalaris* (Yabe) by Wright & Matsumoto (1954) by an oversight, I believe, because they do not appear to have realized that Shimizu (1935b) had selected it as lectotype for *G. nipponicum*. Jimbo's (1894) form plate 9, figure 1, which was not included in Shimizu's lectotype, may perhaps be referable to *Scalarites*.

Scalarites Wright & Matsumoto is based on *Helicoceras scalare* Yabe (1904) from the Opirashibets, Teshio Province, Hokkaido. Because Jimbo's (1894) specimens are also from the Opirashibets their inclusion in *Scalarites* seems natural,

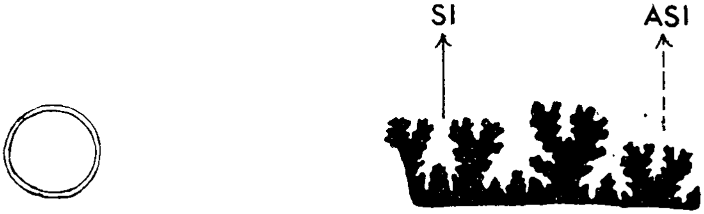


Fig. 30. ***Glyptoxoceras nipponicum*** **Shimizu. Cross section of CPC 2680 (x 1); suture of CPC 2681 (x 1).**

but apparently the case is not so simple. The evidence from Australia shows that a species indistinguishable from Shimizu's *Glyptoxoceras nipponicum* occurs in the Campano-Maastrichtian, and that this species is not a *Scalarites* as Wright & Matsumoto understand that genus.

Thus, either Shimizu's (1935b) lectotype is a Turon-Coniacian *Scalarites* and falls within the synonymy of *Scalarites scalaris* (Yabe), or it is a Campano-Maastrichtian *Glyptoxoceras* and in that case suggests that the Opirashibets of Hokkaido include strata which are post-Santonian. If the first alternative is correct the Australian form should be renamed, unless one agrees to extend the range of *Scalarites scalaris* into the early Maastrichtian, and agrees further that the Maastrichtian representative of that form looks like a *Glyptoxoceras*. The other alternative is to call for a revision of what is known as the Opirashibets of Hokkaido; there may be post-Santonian beds in them; and if so, *G. nipponicum* remains valid.

As no decision can be made on the evidence available at this stage I prefer to retain Shimizu's species simply because, morphologically, it is not distinguishable from the Australian forms.

Australian Material: There are two slightly curved and one straight fragment, CPC 2680-82, all of them figured on Plate 6. There are no flared ribs and no constrictions on any of the specimens. The suture is slightly to moderately florid and the internal lobe is not clearly trifid as it is supposed to be on *Scalarites scalaris* (but see remarks on internal saddle of *Glyptoxoceras indicum,* p. 45).

GLYPTOXOCERAS BULLARENSE sp. nov.

(Pl. 6, fig. 10; Text-fig. 31)

Holotype: CPC 2683. Other material: CPC 2684.

Diagnosis: A *Glyptoxoceras* with seven sharp, narrow prominent ribs on a length equal to the dorso-ventral diameter; the ribbing is sharp on internal casts as well as on the shell's exterior. Interspaces wider than ribs.

Description: The holotype is a clean internal cast, 75 mm long, with very slight taper (height increase only 1½ mm), and almost perfect circular cross-section. The sharp ribs are at first almost radial, then become increasingly prorsiradiate. Because both holotype and the unfigured specimen are body-chamber fragments, the suture-line is not known.

Remarks: The diagnostic significance of the degree of prominence of the external as compared with the internal ribbing of the shell is clearly demonstrated by this species and *G. indicum* (Forbes), which are both shown on Plate 6; the external ribbing on *G. indicum* compares with the internal ribbing on *G. bullarense*. The external ribbing of the latter species is not known, but most probably it is considerably sharper and more prominent than on the figured internal cast.

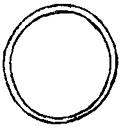


Fig. 31. ***Glyptoxoceras bullarense*** **sp. nov., Holotype CPC 2683. Cross section (x 1).**

Genus NEOHAMITES nov.

Diagnosis: Polyptychoceratid forms, previously included in *Glyptoxoceras,* with conspicuously oval cross-section, in some species even with flattened flanks.

Type Species: Neohamites giraliensis sp. nov.

Remarks: In species of *Neohamites* the lateral diameter is at the most 80 to 85 percent, often considerably less, of the dorso-ventral diameter both on phragmocone and on body chamber.

The increasing number of forms which under the current classification would all come under *Glyptoxoceras* presents such a variety of features in detail, even within the limits of their fairly simple morphology, that it has become possible to establish a much more comprehensive classification.

In the first instance, the Australian material shows that there are two major natural groups, namely those with circular and those with oval cross-section. As Spath (1926a) based his genus *Glyptoxoceras* on a species with circular cross-section, that form-group is established. For the other group the genus *Neohamites* is now created, and it will be seen that specific differentiation within this genus is even greater than in *Glyptoxoceras.* Considerable variation in type and density of ribbing and constrictions, of the internal and external appearance of the test, etc. permit very clear diagnoses of species.

In the material from Western Australia there are three previously established and three new species of *Neohamites.* Three of them have low to moderately high ribs and they differ from each other both in the density and the external versus internal sharpness of the ribbing. The other three species have sharp and high to very high ribs and differ more in the density of the ribbing than in the difference between its external and internal expression. These diagnostic characteristics of the neohamitids are illustrated in the chart, Text-figure 38, p. 53, together with those of *Glyptoxoceras, Diplomoceras,* and *Eudiplomoceras.*

NEOHAMITES GIRALIENSIS sp. nov.

(Pl. 7, figs 1, 2; Text-fig. 32)

Holotype: CPC 2649. Other material. CPC 2650 (paratype).

Diagnosis: A *Neohamites* with compressed oval to egg-shaped cross-section, frequent shallow constrictions. There are 10 to 12 straight or slightly rursiradiate ribs on a length equal to the dorso-ventral diameter; externally they are moderately prominent, but sharp and narrow so that the interspaces are a little wider than the ribs; internally they are lower and blunted, interspaces equal in width to ribs. Constrictions adapically with a slightly flared rib which on internal casts remain distinct and fairly sharp.

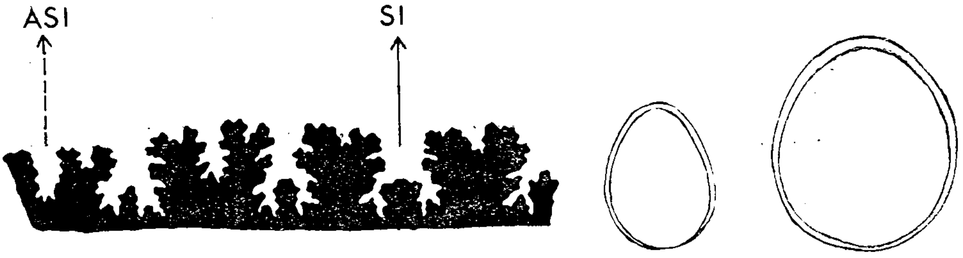


Fig. 32. ***Neohamites giraliensis*** **gen. et sp. nov.; suture (x 2) and cross section (x 1) of Holotype CPC 2649. Cross section of Paratype CPC 2650 on right (x 1).**

Description: The holotype is a clean internal cast, half septate, of a hook fragment with a distinct taper (15 to 18 mm) and two constrictions, one at the adapical end, the other on the body chamber (not visible on Fig. 1, which is the reverse side). On the body chamber ribs are so close together dorsally that one gets the impression of some ribs being bifurcate. Closer inspection shows that they really are annular. Suture with fairly deep, finely trifid, internal lobe.

The paratype, a gently curved fragment from the phragmocone of a larger individual than the holotype, has most of the test preserved and demonstrates the greater sharpness of the ribs on the outside of the shell as well as the less distinctly egg-shaped, more regularly oval, cross-section of specimens of that size.

Remarks: N. giraliensis is rather similar to *'Diplomoceras' wakanense* Marshall, 1926, which Spath (1953) recognized as a glyptoxoceratid. Because of its oval cross-section this New Zealand species is now referred to *Neohamites*. It differs from *N. giraliensis* chiefly by its suture-line, which has a wide and very deep antisiphonal lobe (trifid) and very slender and deeply incised saddles. The arrangement of the lobules at the base of the lateral saddles is also quite different, the Australian form showing a simple bifidity with a single stout central projection comparable to the external saddle. The suture of *Neohamites wakanense* (Marshall), if correctly drawn, is in fact rather an unusual one for a polyptychoceratid genus. Its characteristics are those seen on *Anisoceras* Pictet (e.g. Wright, 1957, p. L219, fig. 5c), or perhaps on *Plesiohamites* Breistroffer and *Stomohamites* Breistroffer, whatever that may mean in terms of phylogeny. In any event, this case illustrates again how very doubtfully monophyletic the family Polyptychoceratidae is, even after the removal of the diplomoceratids.

NEOHAMITES RUGATUS (Forbes, 1846)
(Pl. 7, figs 4, 5, 6; Text-fig. 33)

1846—*Anisoceras rugatum* Forbes, p. 117, pl. 11, fig. 4
1935a—*Glyptoxoceras rugatum* (Forbes); Shimizu, p. 272, figs 1-5
1940—aff. *Glyptoxoceras rugatum* (Forbes); Spath, p. 48

Diagnosis: A *Neohamites* with slightly flattened flanks; ribs on outside of shell only moderately sharp and fairly low, on internal casts rounded and low, although not as low as on *Glyptoxoceras indicum*. There are 7 to 8 ribs on a length equal to the dorso-ventral diameter.

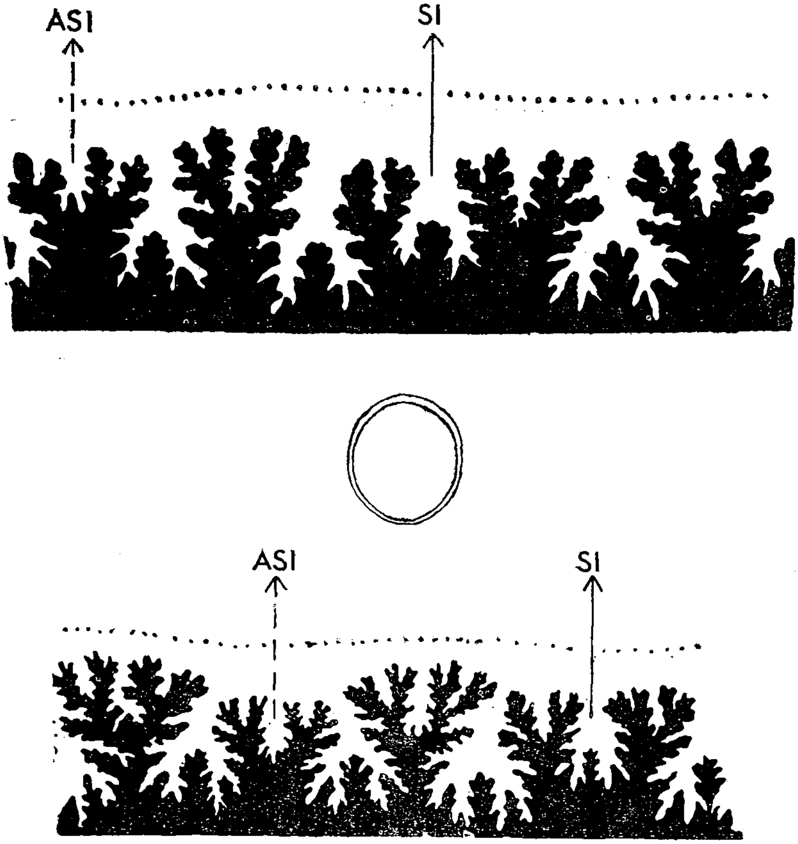


Fig. 33. ***Neohamites rugatus*** **(Forbes). Suture (x 2) and cross section (x 1) of CPC 2642 above; suture of CPC 2643 below (x 2).**

Australian Material: There are three hooked and five straight fragments in the collection under CPC 2641-48. Two hooked and one straight specimen are figured on Plate 7.

The two sutures shown in Text-figure 33 illustrate a feature which is very common in *Neohamites* as well as in *Glyptoxoceras,* namely the more or less conspicuous asymmetry especially of the first lateral saddles flanking the siphonal lobe. On CPC 2642 it is particularly evident. The tracing of a rib with the sutures shows that the ribbing is gently sinuous: straight over dorsum and venter but slightly prorsiradiate across the flanks.

NEOHAMITES SUBCOMPRESSUS (Forbes, 1845)

(Pl. 7, figs 10, 11, Pl. 8, fig. 1; Text-fig. 34)

1846—*Anisoceras subcompressum* Forbes, p. 116, pl. 11, fig. 6

1866—*Anisoceras indicum* Forbes; Stoliczka, p. 181, pl. 85, figs 1-5

1935a—*Glyptoxoceras subcompressum* (Forbes); Shimizu, p. 272, fig. 12

Diagnosis: A *Neohamites* with evenly oval cross-section and 8 to 9 sharp, narrow, moderately high ribs on a length equal to the dorso-ventral diameter. The ribbing is equally sharp on internal casts as on the shell exterior. Interspaces are markedly wider than the ribs.

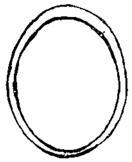


Fig. 34. ***Neohamites compressus*** **(Forbes). Cross section of CPC 2654 (x 1).**

Australian Material: One curved and two straight fragments, all from body chambers, CPC 2652-54, all figured here, tests partly preserved.

This species displays slight irregularities in the ribbing immediately in front of a constriction. The first rib in front (CPC 2652) is truncated by the constriction.

NEOHAMITES CARDABIENSIS sp. nov.

(Pl. 7, figs 7, 8, 9; Text-fig. 35)

Holotype: CPC 2655. Other material: CPC 2656 (paratype) and CPC 2657 and six more fragments from body chambers, all more or less curved (CPC 2658-63—not figured).

Diagnosis: A *Neohamites* with evenly oval cross-section and seven externally and internally sharp, almost flared, high, narrow ribs in a length equal to the dorso-ventral diameter. Interspaces slightly wider than ribs. Constrictions are deep and very narrow and accompanied adorally by a flared collar.

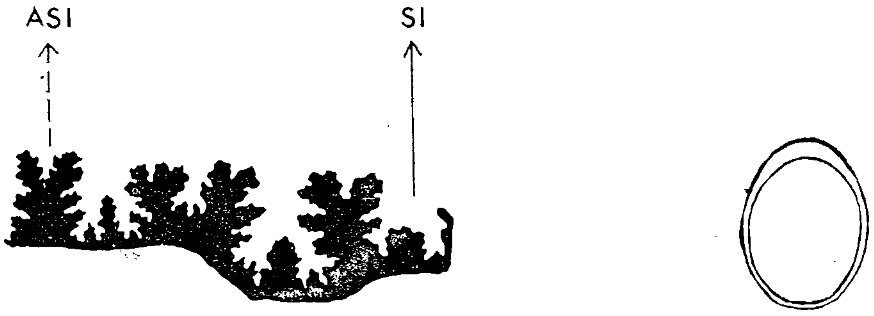


Fig. 35. ***Neohamites cardabiensis*** **sp. nov., Holotype CPC 2655. Suture (x 2) and cross section (x 1).**

Remarks: This is the most commonly found species of *Neohamites* in Western Australia and I suspect that 'the last example' of Spath (1940, p. 48) belongs to it. A commonly noticeable feature is the oblique twisting of the unusually prominent ribbing on curved or hooked fragments, that is, there is no symmetry about the dorso-ventral plane in these portions of the shell, but it is largely restored (except in the suture) as soon as the shaft straightens out again (CPC 2656).

Description: The holotype is a curved fragment, 52 mm long, with parts of the test preserved. The ribs are very prominent and the last suture is visible. On curved specimens the ribbing is always more or less rursiradiate, as can be seen on the curved paratype. Straight fragments such as CPC 2657 have prorsiradiate ribbing.

In this species the constrictions do not truncate the ribbing, but they are much deeper than on any other form of *Neohamites.*

Apart from *N. sofoulisi* sp. nov. I know of no other polyptychoceratid form that has such prominent, nearly flared, ribbing as *N. cardabiensis;* it is a very distinct and characteristic species of the genus.

NEOHAMITES LARGESULCATUS (Forbes, 1846)

(Pl. 1, fig. 8, Pl. 8, figs 3, 4, 5, 6; Text-fig. 36)

1846—*Hamites largesulcatus* Forbes, p. 117, pl. 11, figs 1abc

1866—*Anisoceras largesulcatum* Forbes; Stoliczka, p. 180, pl. 85, figs 8, 8a

Diagnosis: A *Neohamites* with oval to egg-shaped cross-section and 5 to 6 sharp narrow moderately high ribs in a length equal to the dorso-lateral diameter; interspaces wider than ribs. On internal casts the ribs are narrow but blunted and the interspaces scarcely wider than the ribs.

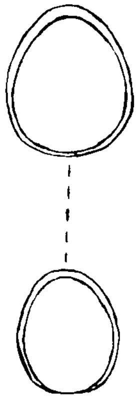


Fig. 36. ***Neohamites largesulcatus*** **(Forbes). Suture (x 2) of CPC 2664; cross sections at anterior and posterior end of CPC 2665.**

Australian Material: There are four hooked, one curved, and one straight fragment, CPC 2664-69 and 2736, all except 2664 from body chambers.

The ribbing varies from radial to prorsiradiate to rursiradiate. Constrictions are rare and shallow (CPC 2666, adoral end).

Shimizu (1935b, p. 199), when establishing *Glyptoxoceras nipponicum* with Jimbo's *'Hamites* sp.' (1894, pl. 7, fig. 7) thought it might belong to *N. largesulcatus,* but Spath (1940) made it quite clear that Jimbo's form has a circular cross-section. It remains a valid species of *Glyptoxoceras.*

NEOHAMITES SOFOULISI sp. nov.

(Pl. 8, fig. 2; Text-fig. 37)

Holotype: CPC 2670

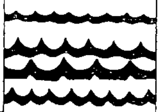
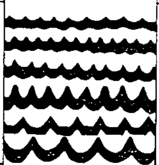
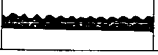
Diagnosis: A *Neohamites* with compressed egg-shaped cross-section and very prominent coarse sharp ribbing on both internal cast and exterior of the shell. There are only four ribs in a length equal to the dorso-ventral diameter and the interspaces are scarcely wider than the ribs.

Fig. 37. ***Neohamites sofoulisi*** **sp. nov., Holotype CPC 2670. Cross section (x 1).**

Description: The holotype, 32 mm long, is a septate fragment with small patches of the shell preserved. It is by far the most coarsely ribbed form in the collection, and the test is so thin that there is scarcely any difference in the prominence and sharpness of the ribbing between internal cast and shell exterior. As on all other species of *Neohamites* the ribbing is somewhat attenuated dorsally and, as a rule, the more prominent the ribbing, the more noticeable the attenuation. This applies particularly to *N. sofoulisi,* but is evident also on *N. cardabiensis*. Although the specimen is septate the sutures are not well enough preserved to be reproduced in any detail; what can be seen of them, however, agrees with the general pattern of the *Neohamites* species.

Remarks: If it were not for the circular cross-section of the American forms, as well as for their extremely simplified suture, one might be tempted to indicate an affinity between *N. sofoulisi* and *'Helicoceras'* (*?Glyptoxoceras*) *rubeyi* Reeside (1927, pl. 3, figs 8-10, and pl. 5, figs 3-11) or the *Hamites* sp. of the same author (1927, pl. 4, figs 7, 8). There appears to be no other form of upper Cretaceous heteromorphs apart from the species of *Neohamites* described here that are in any significant way similar to *N. sofoulisi.*

Fig. 38. Tabulation of main morphological features of species of *Glyptoxoceras*, *Neohamites* (Polyptychoceratidae), and *Eudiplomoceras*, *Diplomoceras* (Diplomoceratidae). Top of longitudinal sections is outside, bottom inside; 'unit of length' is dorso-ventral diameter at place where ribs are counted.

FAMILY	GENUS	CROSS-SECTION	LONGITUDINAL SECTION	RIBS PER UNIT OF LENGTH	HEIGHT OF RIBS	SPECIES
POLYPTYCHOCERATIDAE MATSUMOTO 1938	GLYPTOXOCERAS SPATH 1926	*Circular*		6–7	*low*	*indicum (Forbes)*
				5–6	*high*	*circulare Shimizu*
				4–5	*high*	*nipponicum Shimizu*
				7	*moderate*	*bullarensis sp. nov.*
	NEOHAMITES NOV.	*Oval*		7–8	*moderate*	*rugatus (Forbes)*
				10–12	*moderate*	*giraliensis sp. nov.*
				8–9	*moderate*	*subcompressus (Forbes)*
				7	*very high*	*cardabiensis sp. nov.*
				5–6	*high*	*largesulcatus (Forbes)*
				4	*very high*	*sofoulisi sp. nov.*
DIPLOMOCERATIDAE SPATH 1926	EUDIPLOMOCERAS NOV.	*Circular*		13–15	*low*	*raggatti sp. nov.*
	DIPLOMOCERAS HYATT 1900	*Oval*		11–12	*moderate*	*cf. notabile (Whiteaves)*

Superfamily SCAPHITACEAE (Meek, 1876)

Subfamily SCAPHITINAE (Meek) Wright, 1953

Genus INDOSCAPHITES Spath, 1953

INDOSCAPHITES KOROJONENSIS sp. nov.

(Pl. 5, figs 4-6)

Holotype: CPC 2777 (monotypic) from Korojon Calcarenite on Marilla Anticline, collected by M. A. Condon, 1951.

Diagnosis: A very compressed, flat-sided *Indoscaphites;* ornament on at least part of the regularly coiled inner whorls consisting of strong, sinuous, broad ribs which bifurcate above weak radial bullae and terminate in prorsiradiate stronger bullae on the edge of the tabulate venter, which therefore is serrate-bicarinate. This ornament disappears on latest growth-stages.

Description: The only known specimen of this form is fragmental and strongly limonitized, but it shows enough features to permit its identification as a new species of *Indoscaphites.*

The diagnostic ornament of the inner whorls (Pl. 5, fig. 5) disappears quite suddenly on approaching the body chamber. Unfortunately, only an apparently crushed and certainly very worn fragment remains of the latter, and it shows only indistinct indications of the kind of ornament, if any, that it carried. It may well have been but faintly ribbed or even smooth.

The umbilicus, as is characteristic of the genus, is rather wide (18 to 19 per-cent of the diameter), the umbilical wall low and gently rounded (Pl. 5, fig. 4).

The suture-line (Pl. 5, fig. 5) is preserved only in parts, but there is no doubt that it possesses a wide and fairly deep first lateral lobe and that there are no more than three saddles on the flank, the third being placed over the umbilical shoulder. The siphonal lobe seems to be very narrow.

Remarks: If it were not for the simple and very little dissected suture-line this form might easily be mistaken for one of the less prominently tuberculate species of the *plasticus*-group of *Hoplito-Placenticeras* (Paulcke).

I. korojonensis is evidently a close relative of *I. andoorensis* (Stoliczka) and *I. idoneus* (Stoliczka), which are both from the Santon-Campanian upper part of the Trichinopoly Group, and of *I. pavana* (Forbes) from the Campan-Maastrichtian Valudayur Group.

I. andoorensis and *I. idoneus* differ by their more prominent ventrolateral tubercles, and by their ribs continuing straight across the venter; they also show no indication of an adorally weakening ornament. In fact, if anything, it becomes coarser. *I. pavana* lacks the umbilical bullae and also shows no weakening of the ornament.

Spath (1953) proposed to group the above three Indian species, together with *I. cunliffei* (Forbes), into one genus which he named *Indoscaphites.* Wright (1957) seems to restrict that genus to the straight-ribbed and prominently bituberculate forms of the *cunliffei*-type (i.e. Spath's genotype). This restriction is in my opinion not justified because there are very obvious morphological affinities between the members of Spath's grouping which set them well apart from other Scaphitinae. *I.*

korojonensis is another member of this group, the main characteristics of which are the tabulate-bicarinate venter, parallel flattened flanks, wide umbilicus, and very early appearance of strong ornament.

Indoscaphites as Spath (1953) understood it ranges through both Campanian (perhaps even late Santonian) and Maastrichtian, *I. idoneus* and *I. andoorensis* appearing before *I. cunliffei* and *I. pavana*. As *I. korojonensis* seems more closely related to the former two species it is not surprising that it was found in the formation which underlies the late Campanian to early Maastrichtian Miria Marl, i.e. below the latter's basal horizon with kossmaticeratid genera such as *Gunnarites, Grossouvrites, Maorites*.

GLOSSARY OF NEW NAMES

attenuatum (*Nostoceras*): Lat.; 'reduced in strength', alludes to low ribs and weak tuberculation.

bullarense (*Glyptoxoceras*): After Bullara Homestead, which lies west of the Cretaceous outcrops in the Giralia Range.

cardabiensis (*Neohamites*): After Cardabia Creek, which drains the area of the Giralia Range.

Cardabites: After Cardabia Creek, Giralia Range.

compressum (*Eubaculiceras*): Lat.; 'compressed', alludes to the laterally compressed whorl section.

Eubaculiceras: Neuter, Lat.; 'a good horned stick'.

Eudiplomoceras: Neuter, Greek; 'a good *Diplomoceras*'.

fastigiatum (*Eubaculiceras*): Lat.; 'gable-ended', alludes to the shape of the keel.

fisheri (*Nostoceras*): After Dr N. H. Fisher, Chief Geologist, Bureau of Mineral Resources, Canberra.

giraliensis (*Neohamites*): After Giralia Homestead, which lies east of the Cretaceous outcrops in the Giralia Range.

Giralites: After Giralia Homestead.

korojonensis (*Indoscaphites*): After the formation in which it occurs, the Korojon Calcarenite.

kossmati (*Eubaculites*): After Dr F. Kossmat, famous Austrian palaeontologist.

latecarinatus (*Giralites*): Lat.; 'with a broad keel (carina)'.

lechitides (*Baculites*): Lat.; Greek; 'similar to or recalling *Lechites*'.

multicostatus (*Eubaculites*): Lat.; 'with many ribs'.

Neohamites: Masc., Lat.; 'a newer *Hamites*'.

quadrisulcatus (*Giralites*): Lat.; 'with four grooves', alludes to the four longitudinal sulci on the flanks.

raggatti (*Eudiplomoceras*): After Sir Harold Raggatt, former Secretary of the Department of National Development, Canberra; one of the pioneers of modern stratigraphical studies in the Australian sedimentary basins.

scimitar (*Cardabites*): Pers., Turk.; 'a single-edged curved sword', alludes to the sharp keel.

sofoulisi (*Neohamites*): After Mr J. Sofoulis, Geologist with the Geological Survey of Western Australia, Perth, who in 1949 introduced me to land and people of the Carnarvon Basin region.

tabulatus (*Cardabites*): Lat.; 'flattened', alludes to the flattened keel.

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PLATE 1

Figs 1-3 — *Baculites lechitides* sp. nov., p. 23, holotype, CPC 2689.

Fig. 1. Lateral view with venter turned to right; note very moderate forward sweep of ribbing.

Fig. 2. Ventral view; note ribs crossing worn venter.

Fig. 3. Dorsal view: note weakened ribs crossing dorsum.

Fig. 4. — *? Hyphantoceras* sp. ind., p. 15, CPC 2732.

Figs 5-6. — *Bostrychoceras indicum* (Stoliczka), p. 16, CPC 2701.

Fig. 5. Lateral view of adapical portion of hooked living chamber; note sharp ribbing.

Fig. 6. View upon adapical end of hooked living chamber to show strong impression of last turret whorl and portion of suture line.

Fig. 7. — *Eubaculites vagina* (Forbes), p. 29, CPC 2736.

Lateral view of one of the smallest fragments on which ribbing is already established although it is too weak to show up in the photograph. The venter of the specimen is turned to the right.

Fig. 8. — *Neohamites largesulcatus* (Forbes), p. 52, CPC 2736.

Lateral view of the largest fragment in the collection; it is part of the living chamber with venter turned to the right.

Figs 9-14. — *Eubaculites ootacodensis* (Stoliczka), p. 27.

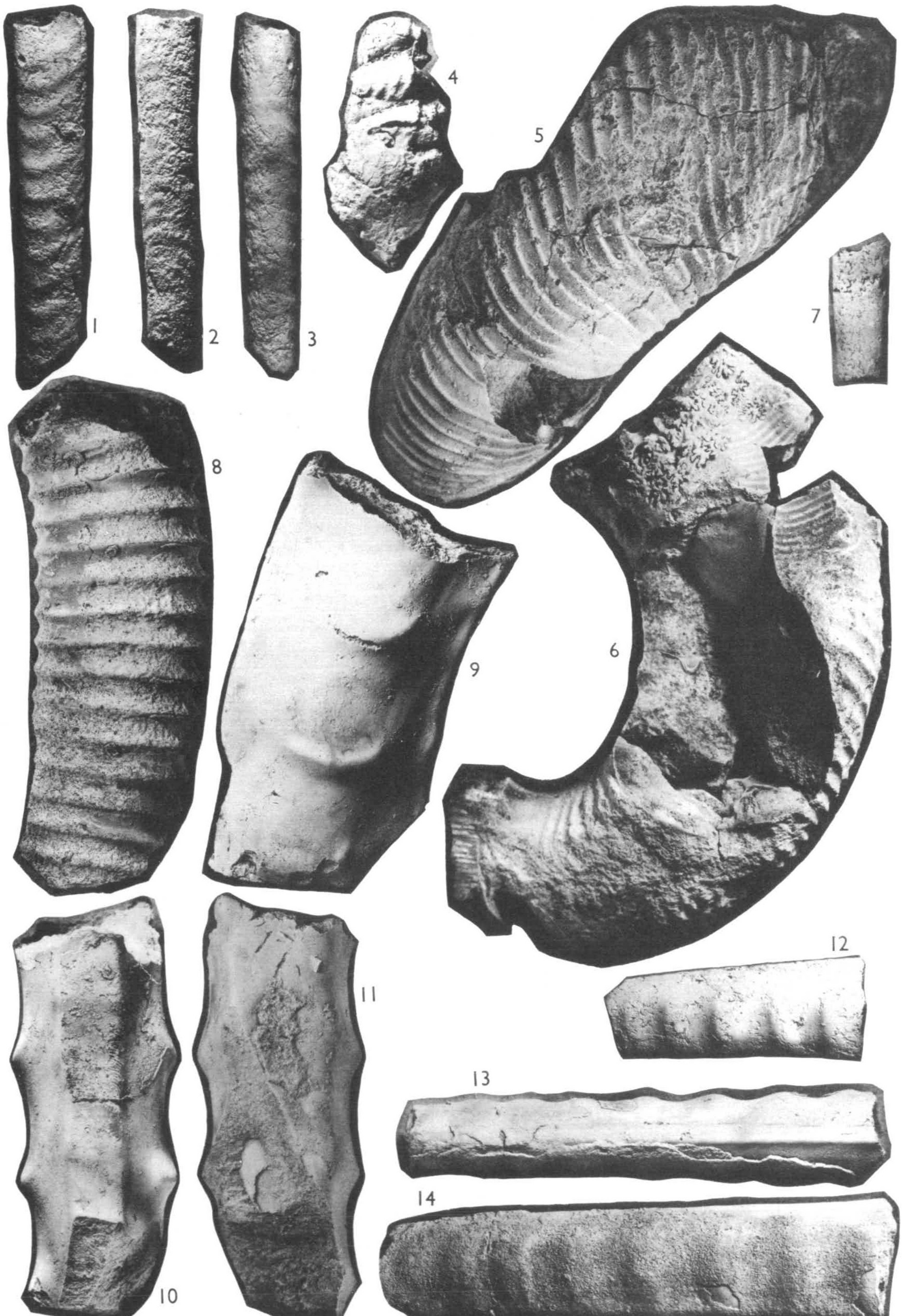
Fig. 9-11. Lateral (venter facing right), ventral, and dorsal view of large body chamber fragment CPC 2685.

Fig. 12. Lateral view of small septate fragment CPC 2687 with well established ribbing.

Figs. 13-14. Ventral and lateral (venter facing upward) view of partly (a third) septate fragment CPC 2686; note partly preserved test.

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).



HYPHANTOCERAS, BOSTRYCHOCERAS, BACULITES, EUBACULITES, NEOHAMITES

PLATE 2

Figs 1-14. ***Eubaculites vagina*** **(Forbes), p. 29.**

Figs 1-3. Lateral, ventral, and dorsal view of partly septate fragment CPC 2690; note portion of test attached.

Fig. 4. Lateral view (venter facing left) of a fragment of a large individual CPC 2691, with dorsolateral bullae.

Figs 5-6. Lateral (venter right) and ventral view of a weakly ribbed, fully septate, small fragment, CPC 2695.

Fig. 9. Lateral view of weakly ribbed, septate specimen CPC 2696; note broadly notched keel.

Figs 10-12. Lateral, ventral, and dorsal view of prominently ribbed, septate, small specimen CPC 2693.

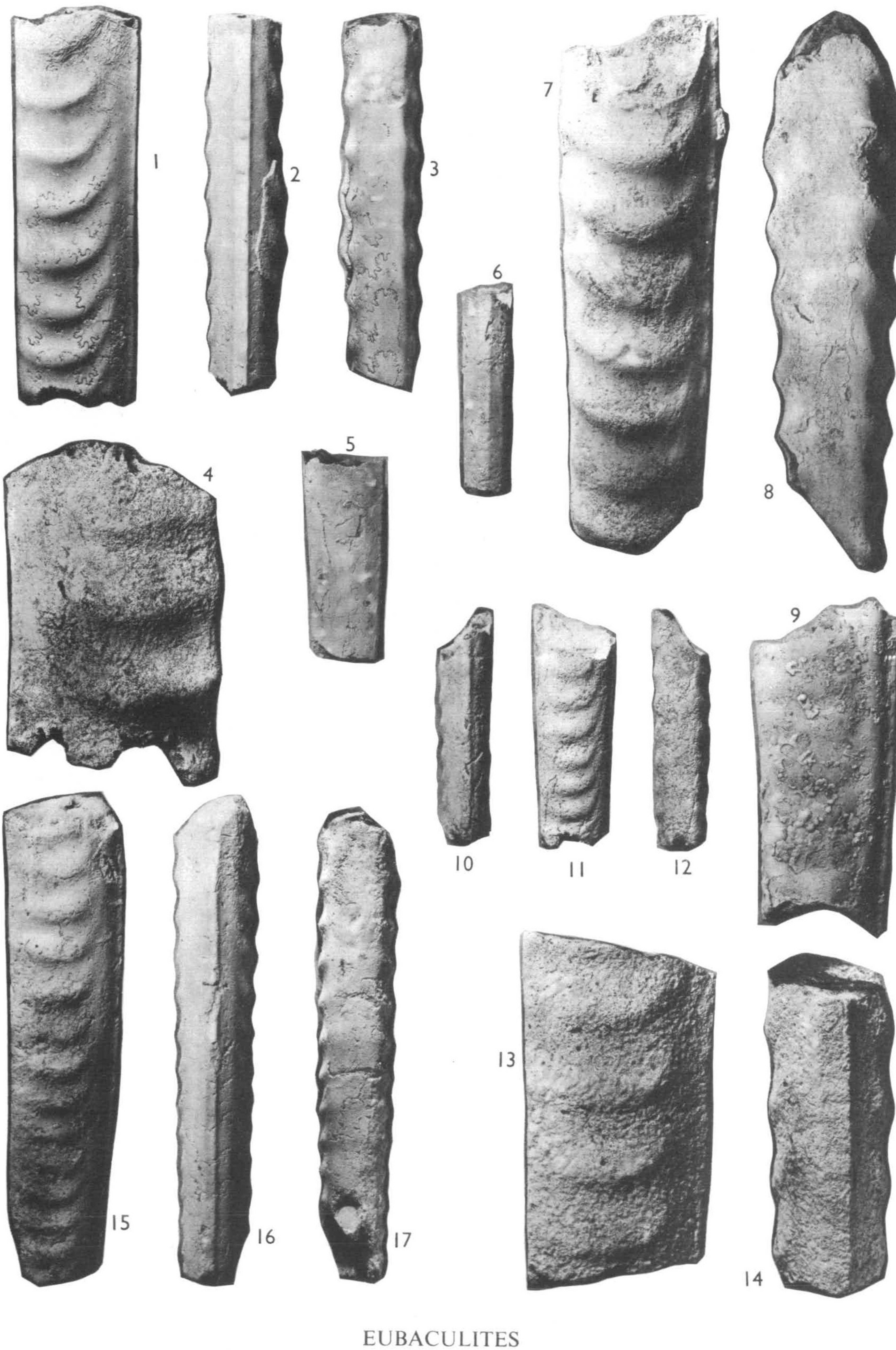
Figs 13-14. Lateral and ventral view of living chamber fragment CPC 2697; note particularly sturdy and perfectly tabulate carina.

Figs 15-17. ***Eubaculites kossmati*****, sp. nov., p. 31, holotype CPC 2704.**

Lateral (venter turned right), ventral, and dorsal view; note comparatively narrow carina of this species.

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).



EUBACULITES

PLATE 3

Figs 1-7. ***Eubaculites kossmati* sp. nov., p. 31.**

Fig. 1. **Lateral view of partly septate fragment CPC 2706; note weak notching of carina.**

Figs 2-4. **Dorsal, ventral, and lateral view of weakly ribbed, septate specimen CPC 2705; note notched carina.**

Fig. 5. **Lateral view of moderately strongly ribbed, large, body chamber fragment CPC 2707.**

Fig. 6. **Lateral view (venter to left) of prominently ribbed body chamber fragment CPC 2709 with notched carina.**

Fig. 7. **Lateral view (venter to left) of weakly ribbed, partly septate fragment CPC 2708 with smooth keel.**

Figs 8-12. ***Eubaculites multicostatus* sp. nov., p. 32.**

Fig. 8. **Lateral view of specimen CPC 2711, a body chamber fragment of a fairly large individual, carina weakly and broadly notched.**

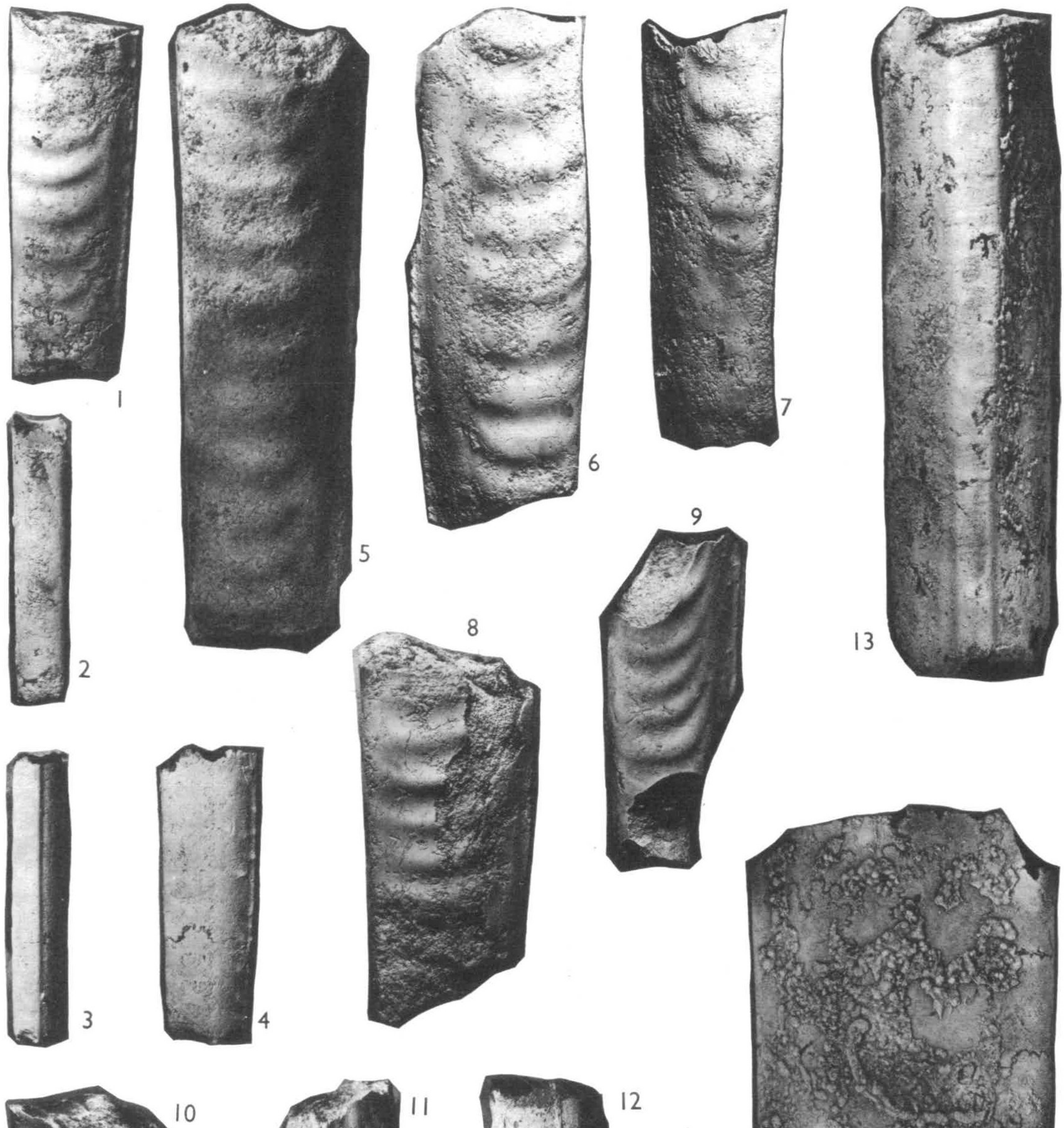
Fig. 9. **Lateral view of small body chamber fragment CPC 2712 showing the typically long drawn-out ventral termini of the ribs which give the ventrolateral sulcus its lirate ornament.**

Figs 10-12. **Lateral, ventral, and dorsal view of holotype CPC 2710; note lirate ventrolateral sulcus.**

Figs 13-14. ***Giralites latecarinatus* gen. nov. sp. nov., p.33, paratype CPC 2719, ventral and lateral (venter to left) view.**

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).



EUBACULITES, GIRALITES

PLATE 4

Figs 1-5. ***Giralites latecarinatus*** **gen. nov. sp. nov., p. 33.**

Fig. 1. Dorsal view of septate paratype CPC 2719.

Figs 2-4. Lateral, ventral, and dorsal view of septate holotype CPC 2718.

Fig. 5. Lateral view of a small, not yet properly carinate, septate fragment, CPC 2720.

Figs 6-10. ***Giralites simplex*** **(Kossmat), p. 34.**

Fig. 6. Lateral view of slender body chamber fragment CPC 2715 which is broken off at the last suture.

Fig. 7. Lateral view of septate specimen CPC 2716, the largest individual of this species in the collection.

Figs 8-10. Lateral, ventral, and dorsal view of typical septate specimen CPC 2714.

Figs 11-14. ***Giralites quadrisulcatus*** **sp. nov., p. 35.**

Fig. 11. Lateral view of paratype CPC 2723, fully septate.

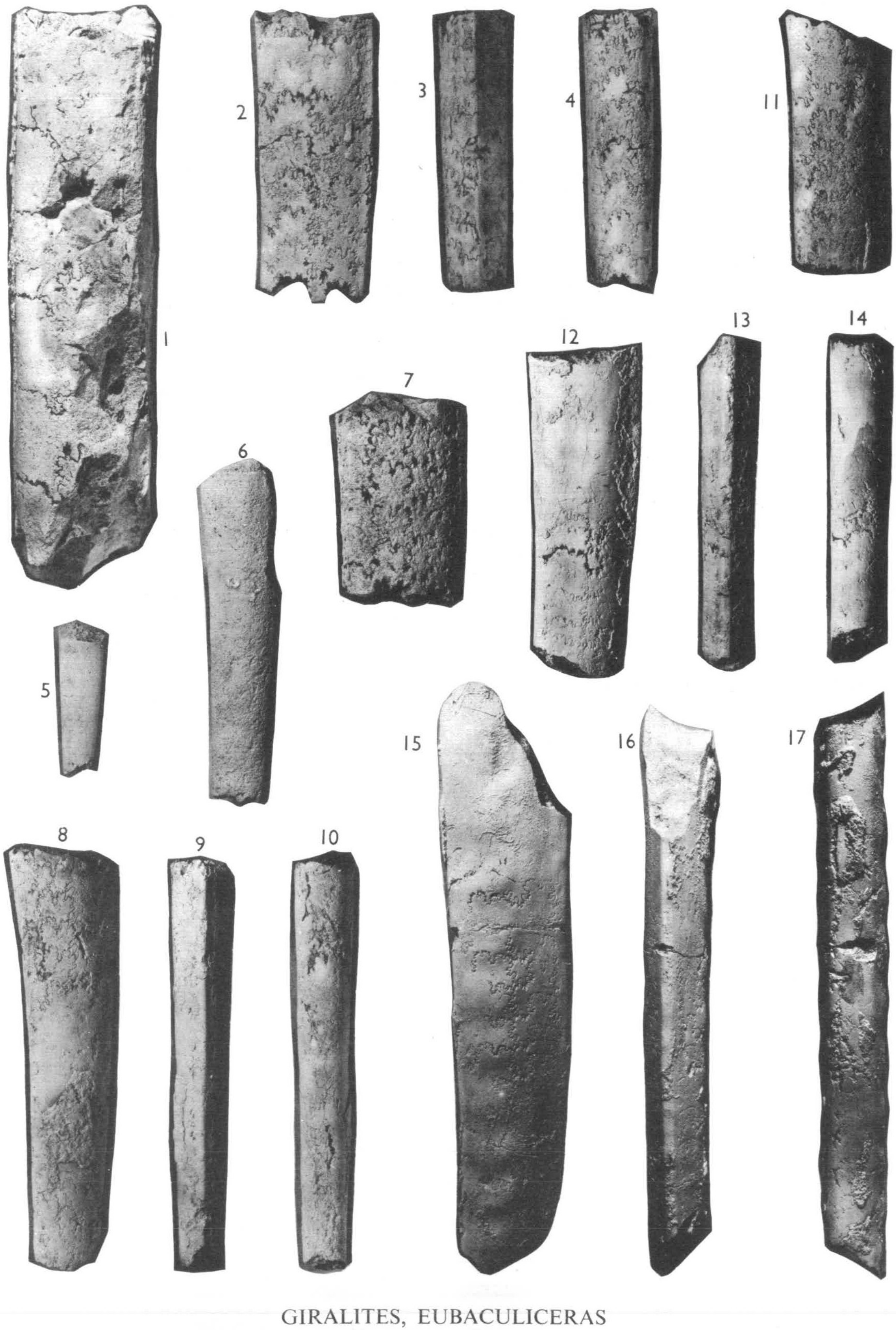
Figs 12-14. Lateral, ventral, and dorsal view of partly septate holotype CPC 2722.

Figs 15-17. ***Eubaculiceras compressum*** **gen. nov. sp. nov., p. 36.**

Lateral, ventral, and dorsal view of holotype CPC 2724; note imprint of muscle attachment 20 mm above last suture on fig. 15.

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).



GIRALITES, EUBACULICERAS

PLATE 5

Figs 1-3. *Eubaculiceras compressum* gen. nov. sp. nov., p. 36.

Lateral, ventral, and dorsal view of paratype CPC 2725; a body chamber fragment with distinctly notched carina.

Figs 4-6. *Indoscaphites korojonensis* sp. nov., p. 54, holotype CPC 2777.

Figs 4-5. Both lateral views of specimen; note trace of umbilicus on fig. 4 and portions of suture lines on fig. 5.

Fig. 6. View of the bicarinate flat venter.

Figs 7-9. *Eubaculiceras fastigiatum* sp. nov., p. 37.

Lateral, ventral, and dorsal view of septate holotype CPC 2726; note forward swerving constriction on fig. 7 and its trace in lower half of figs 8 and 9.

Figs 10-15. *Cardabites tabulatus* gen. nov. sp. nov., p. 38.

Figs 10-12. Lateral, ventral, and dorsal view of partly septate holotype CPC 2727.

Figs 13-15. Lateral, ventral, and dorsal view of partly septate paratype CPC 2731.

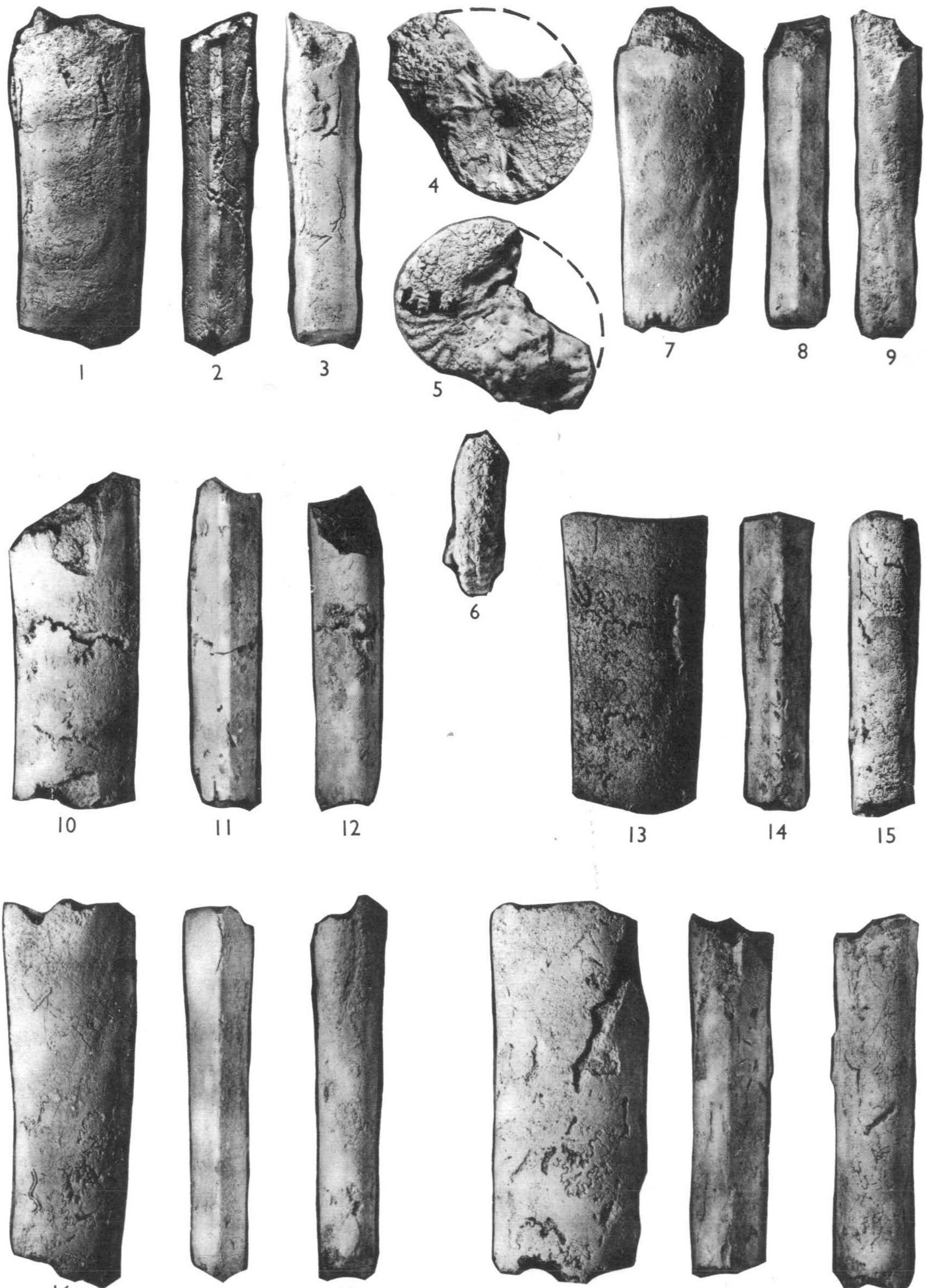
Figs 16-21. *Cardabites scimitar* sp. nov., p. 38.

Figs 16-18. Lateral, ventral, and dorsal view of partly septate holotype CPC 2729; note oblique liration on ventral portion of flank (fig. 16) and smooth keel.

Figs 19-21. Lateral, ventral, and dorsal view of partly septate paratype CPC 2730 which lacks the fine ventrolateral liration.

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).



EUBACULICERAS, CARDABITES, INDOSCAPHITES

PLATE 6

Figs 1-3. *Glyptoxoceras circulare* Shimizu, p. 46.

Lateral views of specimens CPC 2671, 2672, and 2673 in that order; note fragments of test preserved on figs 2 and 3 showing difference of acuteness of ribbing between interior and exterior of test. Fig. 2 (2672) with constriction in upper half.

Figs 4-6. *Glyptoxoceras circulare* Shimizu, p. 46.

Lateral views of specimens CPC 2676, 2677, 2678 in that order; note constriction on fig. 4, also small fragments of test. Fig. 6 (2678) has most of test preserved and shows the typical ribbing.

Figs 7-9. *Glyptoxoceras nipponicum* Shimizu, p. 46.

Lateral views of specimens CPC 2680, 2681, 2682 in that order. Fig. 7 is partly septate, the other two are living chamber fragments.

Fig. 10. *Glyptoxoceras bullarense* sp. nov., p. 47.

Lateral view of holotype CPC 2683; an almost straight living chamber fragment.

Figs 11-12. *Nostoceras fisheri* sp. nov., p. 41, holotype, CPC 2629.

Fig. 11. View upon adapical end of the hooked living chamber to show strong impression of the last tuberculate turret whorl.

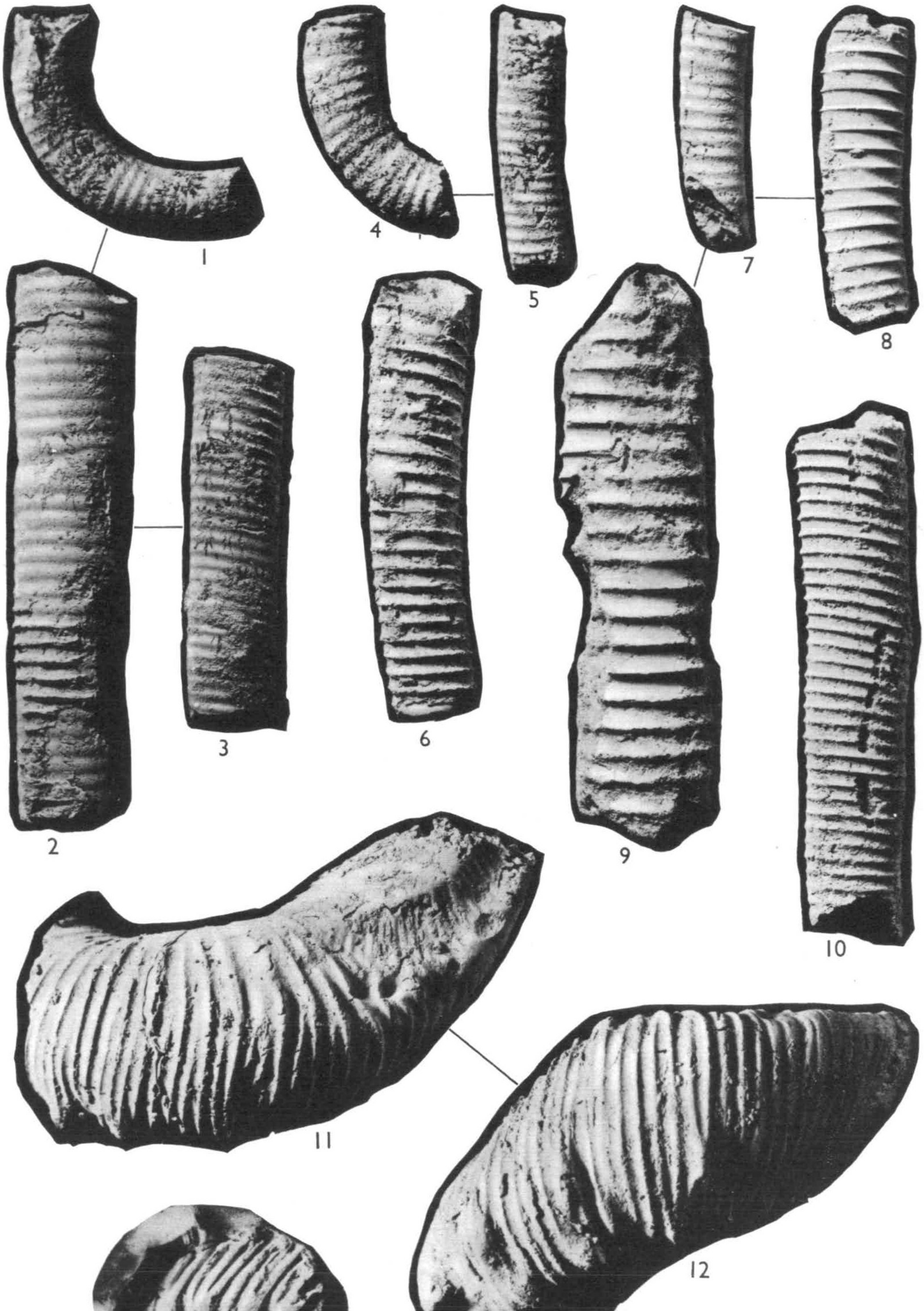
Fig. 12. Lateral view showing bituberculation and sharp twist away of the hook from the turret near the beginning of the living chamber.

Fig. 13. *Nostoceras* sp. ind., p. 43, CPC 2631.
Plasticine cast.

All figures of *Glyptoxoceras* have the venter turned to the left, only in fig. 9 it is slightly turned toward the viewer.

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).



GLYPTOXOCERAS, NOSTOCERAS

PLATE 7

Figs 1-2. ***Neohamites giraliensis* gen. nov. sp. nov., p. 48.**

Fig. 1. Lateral view of partly septate holotype CPC 2649; note shallow constrictions near both ends.

Fig. 2. Lateral view of paratype CPC 2650, a slightly curved living chamber fragment (venter on right).

Fig. 3. ***Diplomoceras* cf. *D. notabile* (Whiteaves), p. 20.**

Lateral view of septate hook fragment with test preserved in the form of a limonitic crust; CPC 2651. Venter on right.

Figs 4-6. ***Neohamites rugatus* (Forbes), p. 49.**

Lateral views of specimens CPC 2641, 2642, 2643 in that order; note partly preserved test on lower part of living chamber fragments fig 4 (2641).

Figs 5 and 6 have venter on right.

Figs 7-9. ***Neohamites cardabiensis* gen. nov. sp. nov., p. 51.**

Fig. 7. Lateral view of holotype CPC 2655; the adapical part of a living chamber showing a collared (in front), flared constriction and the last suture. Test partly preserved.

Fig. 8. Lateral view of paratype CPC 2656, a straight living chamber with fragments of test preserved.

Fig. 9. Lateral view of living chamber fragment CPC 2657 with fragments of test preserved.

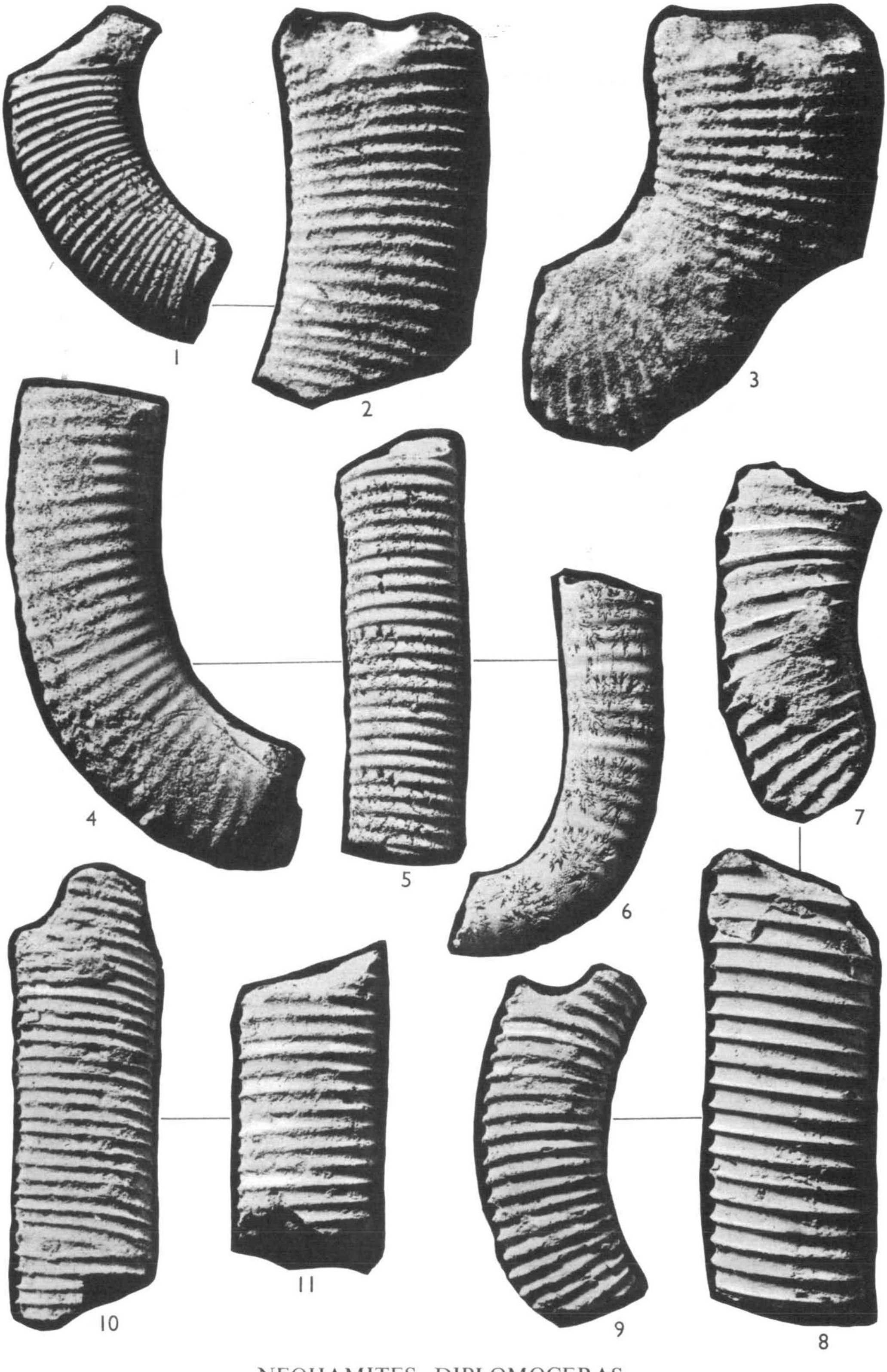
Figs 10-11. ***Neohamites subcompressus* (Forbes), p. 51.**

Lateral views of specimens CPC 2652 and 2653 in that order; both are living chamber fragments, but note constriction truncating ribs at lower end of fig. 10.

Unless stated otherwise all specimens have venter turned to the left.

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).



NEOHAMITES, DIPLOMOCERAS

PLATE 8

Fig. 1. *Neohamites subcompressus* (Forbes), p. 51.

Lateral view of a gently curved living chamber fragment, CPC 2654.

Fig. 2. *Neohamites sofoulisi* sp. nov., p. 53, holotype CPC 2670 a curved living chamber fragment, lateral view.

Figs 3-6. *Neohamites largesulcatus* (Forbes), p. 52.

Lateral view of specimens CPC 2664, 2665, 2666, and 2667 in that order (venter of fig. 6 turned to right), all except fig. 3 (2662) being living chamber fragments. On fig. 5 (2666) the test is partly preserved.

Fig. 7. *Eudiplomoceras raggatti* gen. nov. sp. nov., p. 18, holotype CPC 2632.

Lateral view, most of the test preserved; a fully septate specimen.

Figs 8-10. *Nostoceras attenuatum* sp. nov., p. 40.

Fig. 8. View from turret side of holotype CPC 2628 showing the weak impression of the last turret whorl and the bi- and trifurcation of the ribbing.

Fig. 9. Lateral view of holotype CPC 2628 showing the dense ribbing on the venter and the gentle twist away from the last turreted whorl; note single row of tubercles below and weak bullae above.

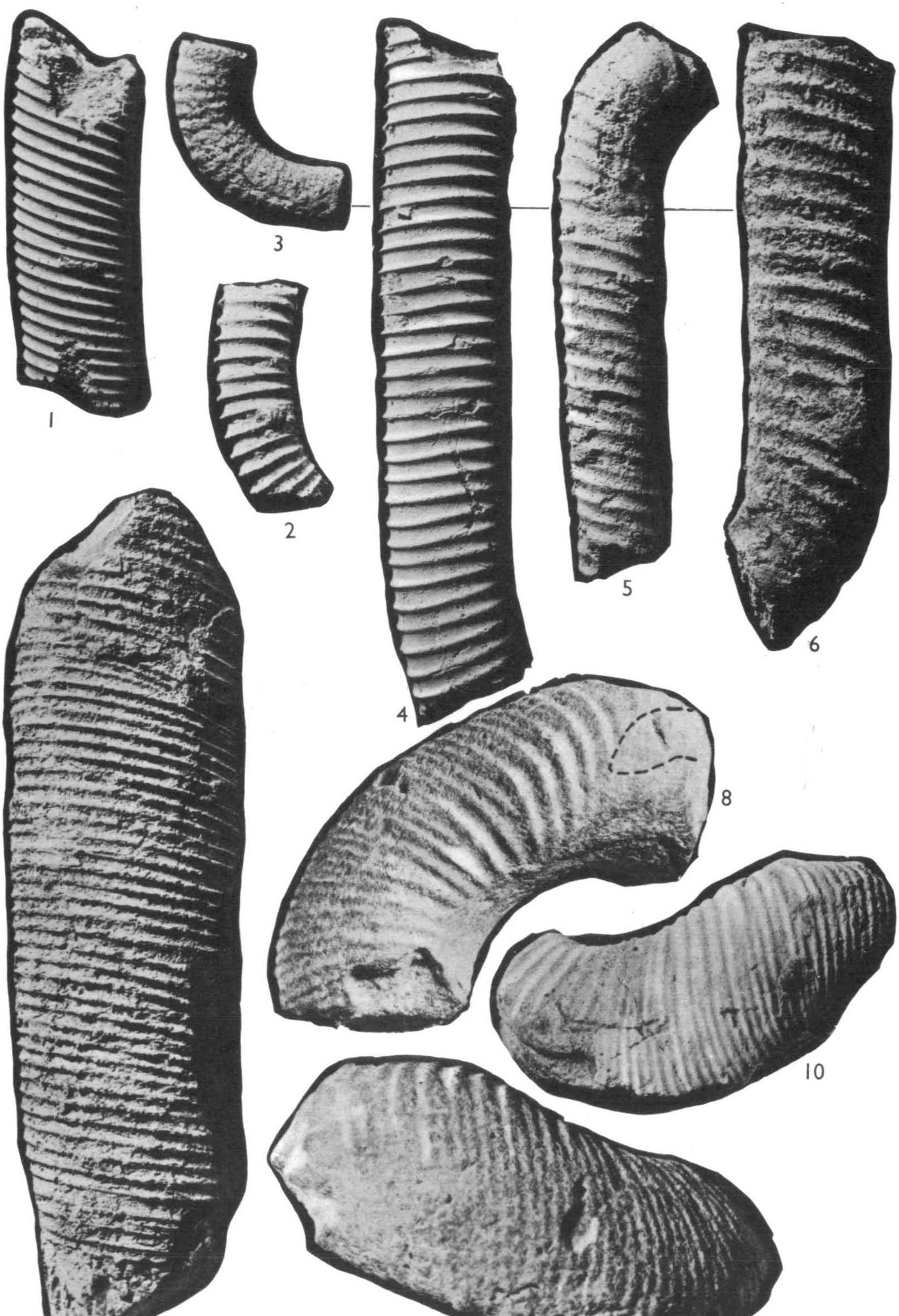
Fig. 10. Lateral view of paratype MUGD 3388; note dextral coiling as against sinistral coiling of holotype (in both figures the top leads to the turret).

Unless stated otherwise all *Neohamites* have venter turned to the left.

All figures approximately natural size.

CPC: Commonwealth Palaeontological Collection (Canberra).

MUDG: Melbourne University Geological Department.



NEOHAMITES, EUDIPLOMOCERAS, NOSTOCERAS