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SOME ABNORMALLY COILED AMMONITES FROM THE UPPER CRETACEOUS OF ANGOLA

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INTRODUCTORY REMARKS

The ammonites here dealt with were studied in the course of the preparation of Part III of the writer's paper on Albian ammonites from Angola, to whose Introduction (Haas, 1942b, pp. 2-10) the reader is referred with regard to taxonomic problems, terminology and previous literature. Furthermore, particular reference is made to the survey of previous records of the Angolan Upper Cretaceous deposits and their ammonites in an earlier paper on this subject (Haas, 1942a, p. 21).

As in the case of the ammonites there discussed, the present forms are also believed to have been collected by Dr. Chester W. Washburne about 1915. The field labels and inscriptions on the specimens indicate five different localities: "S-3" (= "2054") and "S-22," both southwest of Maria Theresa¹; "2073" near Bembe; "2004" (= "30"), east of Bembe (near railroad station of Maria Theresa²); and "E 50" (= "2003") near Capolo (about 200 kilometers southeast of Loanda, and about fifty-five kilometers northeast of Benguela Velha). Except for the last, all these localities are near

Maria Theresa, a railroad station about 105 kilometers east southeast of Loanda.³ To judge by one of Haughton's (1924, pp. 80, 95) locality data, "Carimba ou Maria Theresa," Carimba, whence come most of the Senonian ammonites described by that author, must be quite near Maria Theresa, but it could not be found on any of the maps available.

On all the labels the locality is preceded by the formation name "Teba" (or "Teba, Senonian"), first used, according to the information kindly given by Mr. W. B. Heroy, by Dr. Chester W. Washburne in a written report on the geology of Angola which he made to a Belgian oil company, and since repeatedly applied, though not properly defined, also by Haughton (1924, pp. 81-83, 88, 95-99); here the beds "A," "C" and "F" are distinguished within this formation.

The acknowledgments previously (1942a, p. 1) made to Mr. W. B. Heroy and Dr. H. E. Vokes are, for the same reasons, here renewed. For the drawings of the present paper also Miss Helen Babbitt is to be credited.

DESCRIPTION OF FORMS

NOSTOCERAS HYATT

Hyatt (1894, p. 569), when creating this genus, included it with *Didymoceras*, *Emperoceras* and *Exiteloceras* in his family Nostoceratidae (*ibid.*, p. 568), though

¹ This reference is found only on the label indicating the first locality, but it apparently covers the second as well.

² This reference is found on the label indicating locality "2005" from which only gastropods were collected, but it apparently covers "2004," as well, as *Baculites*, found only in the collections from the latter locality, are mentioned on this label.

admitting the latter to be "probably a more or less artificial group" in which he united "all such distorted forms" of the American Cretaceous "with unsymmetrical spirals in the ephebic stages, more or less prominent costae and two rows of tubercles

³ Maria Theresa cannot be found on Mouta and O'Donnell's (1933) geological map of Angola, but it is indicated on Folio 1 of the official topographic map (1935). Bembe (certainly not the Bembe at 7° south latitude and about 14°30' east longitude) cannot be found even on the latter map.

on the abdomen. . . . The gerontic stages often have a retroversal living chamber and are tuberculated."

On the other hand, Hyatt stated the species of *Nostoceras* to be "true turrilites." For this very reason the writer, as pointed out elsewhere (1942b, p. 199), prefers to include the present genus in the Turrilitidae, thus following Stephenson's (1941, p. 407) example.¹

rating the taxonomic significance of the mode of coiling.

Nostoceras helicinum (Shumard)

Figures 1a, 6, 7

A.M.N.H. No. 25461: two specimens

Turrilites helicinus SHUMARD, 1861, p. 191.

Nostoceras helicinum. *Heteroceras helicinum*, Shumard; HYATT, 1894, p. 573.

Nostoceras helicinum (Shumard); STEPHENSON, 1941, p. 410, Pl. LXXX, figs. 11, 12.

DIMENSIONS²

Spec. No.		D	H	W	U	T
2	(a)	15.1 mm.	7.0 mm.	7.0 mm.	4.9 mm.	10.3 mm.
	(b)	ca. 24.0 mm.	ca. 10.0 mm.	? ³	?	ca. 16.0 mm.
1		31.8 mm.	14.1 mm.	13.6 mm.	9.0 mm.	ca. 23.0 mm.

Nostoceras has been previously recorded from Angola by Haughton (1924) who described and figured an interesting form from "Maria Theresa ou Carimba" under the name *N. angolense*. Two forms closely allied to Haughton's species are here discussed, and a third is referred to *N. helicinum*, hitherto known only from the Navarro group of Texas. All these forms come from about the same locality as Haughton's.

In referring them to *Nostoceras*, the writer relies chiefly on the turrilitid manner of coiling of the earlier septate whorls, as do also Stephenson (1941), Haughton (1924) and, though doubtfully, Spath (1921a). No complete body chamber is present in any of the specimens examined, but in two of them the beginning of the detachment of the last whorl seems to be visible. However, sometimes the assignment of a form to one of the genera of Hyatt's family Nostoceratidae may depend on the characters of the body chamber, as pointed out by Hyatt (1894, p. 576) for the separation of *Exiteloceras* from *Nostoceras*. On the other hand, it may be doubted whether the whimsical ways of coiling chosen by the living chambers of these late Cretaceous aberrant ammonites (see Stephenson's [1941, pp. 414-415, Pl. LXXXIII, figs. 1-5] new genus *Anaklinoceras*) are at all qualified for generic characters. Such a doubt would be quite in line with Spath's repeated warnings (e.g., 1939, p. 606) against over-

DESCRIPTION.—The larger specimen (No. 1, Figs. 1a, 6) is sinistrally coiled and consists of one whorl and a half; it is septate throughout. Except for a small fragment of a gas chamber, the first two or three whorls are missing, as is the body chamber. At the anterior end of this specimen the last preserved volution is still in closely coiled contact with the precedent one; the test of the former's continuation is seen on the matrix filling the umbilicus, thus wrongly suggesting a "columella," and the beginning of the detachment of the last volution seems to be recognizable. Three almost complete whorls are preserved in the smaller specimen (No. 2, Fig. 7), which is dextrally coiled; here only the first half of the initial whorl seems to be missing near the apex; the last preserved volution has been oddly crushed and damaged, apparently before fossilization. This specimen too seems to be septate throughout, but no septa can be traced.

In both specimens the apical angle seems to be close to 90°, and the whorl section is subcircular, the dorso-ventral diameter but slightly exceeding (specimen No. 1) or equaling (specimen No. 2) the transverse one. In the former specimen the outermost point of the section is at first slightly

² In the tables of dimensions for the *Nostoceras* "D" means the greatest diameter that could be measured, "H" the height (dorso-ventral diameter) of the last whorl, "W" its width (transverse diameter), "U" the width of the umbilicus and "T" the total height of the preserved part of the spire. All these figures are expressed in millimeters and tenths thereof.

³ Whorl crushed.

¹ Roman (1938, p. 445) also attaches *Nostoceras* to *Turrilites*.

above the siphuncle, which marks about the middle of the outer surface of the whorl; then it coincides with the siphuncular site, and still later it is shifted farther down toward the lower row of tubercles. In the same specimen two deep constrictions diametrically opposing each other are clearly visible in apical view (Fig. 6c); they appear to be deepest on the lower surface of the whorl and are flanked by ribs which are much higher and sharper than the others. There is one more constriction, less distinct than the precedent ones and almost aligned with the first of them, in the anterior part of the last preserved volution. In one of the earlier whorls of specimen No. 2 even three such constrictions are indicated; here they are much narrower. There seems to be another indistinct constriction on the last preserved whorl, but none can be recognized on its crushed part. It seems worth noting that these constrictions, although clearly visible in Stephenson's neotype of this species (1941, Pl. LXXX, figs. 11, 12) and in the holotype of his variety *humilis* (*ibid.*, Pl. LXXXI, figs. 4-6), as well as in *N. stantoni* (*ibid.*, Pl. LXXX, fig. 2) and in its variety *prematura* (*ibid.*, Fig. 8), are not mentioned in any of Shumard's, Hyatt's or Stephenson's descriptions of the forms concerned. They are, however, duly stressed in Stephenson's (1941, p. 413) description of his *N. colubriforme* and mentioned also in Haughton's (1924, p. 95) description of his *N. angolense*; they are best seen in the side view (Stephenson, 1941, Pl. LXXXI, fig. 2) of the holotype of *N. colubriforme*.

Only the posterior quarter of the first preserved volution of the smaller specimen (No. 2) seems to be smooth. Then at a diameter of about 5 mm. fine, uniform ribs appear, which gradually become sharper and a little oblique, running from the upper right to the lower left in this dextral example. On the next whorl the costae become stronger, sharper and a little more oblique; sporadically they bifurcate at the boundary between the outer and the umbilical surfaces. From forty-five to fifty ribs per whorl can be counted throughout development. The

first indication of tubercles appears at a diameter of about 12 mm. All the ribs are just a little raised on the outermost part of the whorl section, thus forming at first only one row of fine tubercles. About a whorl's length farther orad, however, there are two rows of tubercles on either side of the siphuncle; these tubercles are not found on every rib, from one to two plain ones being intercalated between two tuberculate ones. Here and there, particularly in the foremost part of the last preserved volution, these tubercles develop into veritable spines (Fig. 7c).¹ Those of the upper row point outward and slightly upward, those of the lower one outward and slightly downward. Bifurcation of ribs seems now to occur more frequently in the same zone as before.

The earliest preserved part of the larger specimen (No. 1) corresponds in ornamentation to the last preserved one of No. 2, except for the fact that in the former, which is sinistrally coiled, the costae are oblique from the upper left to the lower right. In this example the tubercles can be observed to be formed first on the prominent ribs bordering the constrictions; on each side of the first of them there is but one transversely elongated tubercle, approximately occupying the siphuncular site; soon, however, two rows of tubercles can be recognized. The lower ones are always further developed than the upper ones. The former are situated immediately above the line of contact with the succeeding volution. Only in the anterior part of the last whorl do they become distinctly spinous, although not to the same degree as in the smaller example. In this part of the whorl the ornamentation of the outer surface is obviously disturbed and somewhat distorted by a lesion of the shell which, however, healed afterward. On the intact lower surface of this part of the conch the ribs are seen (Fig. 6d) to bifurcate almost regularly on, or slightly above, the umbilical edge and to be slightly rursiradial; all of them are rather

¹ Another spine, even longer and sharper than that seen in this figure, could also be freed from matrix and reconstructed, but its tip broke off afterward and could not be recovered.

sharp and prominent, but some stand out by being particularly so. In the more advanced ontogenetic stages represented by this specimen the total number of ribs per whorl increases from fifty-eight on the posterior part of the preserved part of the spire to sixty-three on the anterior one. Also in this specimen there are from one to two, occasionally three, simple ribs intercalated between two tuberculate ones.

The siphonal lobe and a part of the left half of the external suture line could be studied well in specimen No. 1 (Fig. 1a); (preparation of the right side of this suture line would have meant destruction of the beautifully preserved test of the

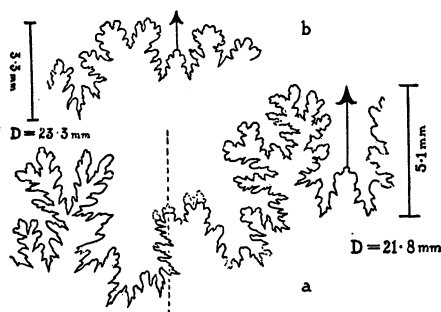


Fig. 1. Suture lines of (a) *Nostoceras helicinum* (Shumard), A.M.N.H. No. 25461:1; (b) *Nostoceras maria-theresianum*, new species, holotype, A.M.N.H. No. 25463.

lower surface, as seen in Fig. 6d). The rather short siphonal lobe is divided by a comparatively slender, trapezoidal, median knob, with moderately indented margins, into two branches with two points each; the lower ones of the latter are almost perpendicular; the upper ones approach a horizontal position; there is one more lateral branch on either side of this lobe. The external saddle is the most outstanding element of this suture line; it is intersected by a strong, trifid lobule which points decidedly ventrad; its outer stem is upright and much higher than the dorsad-inclined inner one; both are subdivided by three-pronged lobules. The first lateral lobe is extraordinarily wide, about twice as broad as the external saddle, and attains

a depth of one and two-thirds of that of the siphonal lobe; it is divided by a clumsy, broad-trapezoidal, dorsad-inclined, bifid leaf which might better be called a secondary saddle; the inner of the two main branches of this lobe is much deeper and is also wider than the outer; the former is trifid; the latter is bifid, and its two branchlets are separated from each other by an elaborate, dorsad oblique leaf. The lateral saddle is much lower than the external one, its top growing only a little higher than the median knob; it is intersected, in its upper half, by a long, three-pronged, perpendicular lobule, and its two bifid stems are arranged almost symmetrically on both sides of this lobule. Dorsad of this saddle follow a deep, almost perpendicular, trifid branch of a lobe, apparently the outer branch of the second lateral lobe, ending in a three-pronged point, and a richly indented leaflet which is inclined dorsad.

OCCURRENCE.—Locality "S-22," southwest of Maria Theresa.

REMARKS.—It is true that specimen No. 1 is sinistrally, No. 2 dextrally, coiled. This does not, however, prevent their reference to the same form, since, as seen from Hyatt's (1894) and Stephenson's (1941) papers, the forms of this genus often include individuals of both modes of coiling.

As to the delimitation of the typical form of this species from its two varieties separated by Stephenson, variety *crassa* and variety *humilis*, the reader may be referred to that author (1941, p. 412, Pl. LXXXI, figs. 4–8). Among the other *Nostoceras* of the Navarro group, *N. hyatti* Stephenson (1941, p. 410, Pl. LXXXI, figs. 9–12) appears most closely to resemble the present species, but it can readily be distinguished by its coarser and, particularly on the earlier whorls, less dense ribbing, by the earlier appearance of its tubercles, by its more angular, less rounded whorl section and by the more pointed apical angle, especially of its earlier volutions.

The two other forms of *Nostoceras* described in this paper will be compared below.

In its general plan the suture line of the present species, here described and figured for the first time, resembles fairly well that of *N. subangulatum* Spath (1921a, p. 251, Pl. XXII, fig. 3c), which, on its part, has been compared by that author with those of three North American *Didymoceras*, *D. tortum* (Meek, 1876, Pl. XXII, fig. 4c), *D. stvensoni* (Whitfield, 1880, Pl. XIV, fig. 8) and *D. pauperum* (Whitfield, 1892, Pl. XLV, fig. 5). *N. subangulatum* and *N. helicinum* have in common the short siphonal lobe and the extremely broad first lateral lobe, the latter being divided by an unusually broad and clumsy trapezoidal leaf and having an inner branch remarkably stronger and longer than the outer one. Attention may, however, be drawn to the fact that the one or the other of these sutural characters can be observed in some Albian turrilitids, e.g., *Mariella bergeri* (see Spath, 1937, text fig. 178f), *M. nobilis* (*ibid.*, text fig. 181c), *Ostlingoceras puzosianum* (*ibid.*, text fig. 183c). This observation may well support the writer's belief in the relationship of *Nostoceras* to the older Turrilitidae.

There is, in both the shape of the conch and the ornamentation, some resemblance between the present form and "*Turrilites*" *binodosus* Hauer (1866, p. 8, Pl. I, fig. 6) from the Upper Cretaceous Gosau Beds of the Austrian Alps, but the latter species, thought by Spath (1921a, p. 251) to belong either to *Didymoceras* or to *Bostrychoceras*, has a finer ornamentation, particularly with fewer and less prominent tubercles.

The smaller specimens from Hornby Island described by Whiteaves (1903, p. 332, *cum synon.*, Pl. XLII, figs. 1-3) under the name "*Heteroceras*" *hornbyense* resemble the present species even more closely; the similarity between his fig. 2 and Stephenson's neotype of the latter might even suggest conspecificity; at least both forms must be considered congeneric. However, Spath (1921a, p. 251) and, following his example, Haughton (1924, p. 95, Pl. IV, fig. 2) refer Whiteaves' species to Hyatt's (1894, p. 573) genus *Didymoceras*. It may be added that Spath (1921b, p. 56) recorded "*Didymoceras*

of the type of *D. nebraskense-cooperi* (Meek) and *D. hornbyense* (Whiteaves)" from the Barro do Dande (north northeast of Loanda), Angola.

Nostoceras cf. *angolense* Haughton

Figures 2, 8

A.M.N.H. No. 25462: two specimens

Cf. *Nostoceras angolense* HAUGHTON, 1924, p. 95, Pl. IV, fig. 1.

DIMENSIONS

Spec. No.	D	H	W	U	T
1	?	ca. 11.0 mm. ¹	ca. 12.0 mm. ¹	?	31.0 mm.

DESCRIPTION.—The larger fragment (specimen No. 1) consists of about one whorl, with the base of the precedent one, of a dextral turrilitid shell with a rather acute apical angle. It corresponds in size to the fifth whorl of Haughton's type and seems to show just the beginning of the detachment of the spire. At its anterior end the fragment is unseptate; it cannot be decided whether or not its beginning, which is in part hollow and in part filled with crystallized calcite, is still septate.

The whorl section (Fig. 2) is decidedly



Fig. 2. *Nostoceras* cf. *angolense* Haughton, A.M.N.H. No. 25462: 1, section at anterior end.

angular, even between the sharp tubercles; the upper tubercles are at about the upper third of the whorl, marking its outermost point; the lower ones are at the line of contact with the following volution. The siphuncle is assumed to be situated between the tubercles, slightly below the middle of the outer surface.

As far as the ornamentation can be examined, it consists of transversely elongated, prominent tubercles which are developed as sharp spines and are alternately arranged in two rows, the site of which

¹ At anterior end.

has been indicated above. Ten tubercles per half whorl can be counted along the base of the precedent volution, which is just visible; they are slightly less abundant (eight or nine per half whorl) in each row of the preserved volution. Indistinct folds, forming a sharp, orad concave arc culminating in the upper tubercles, are present, but there are no proper ribs, nor is there any distinct connection between upper and lower tubercles.

A small slice of a whorl of another specimen, corresponding in size to the last preserved one of No. 1, shows the same characters in section and ornamentation and is, therefore, also referred to this form (specimen No. 2).

No suture lines could be studied.

OCCURRENCE.—Locality "S-3" (= "2054"), southwest of Maria Theresa.

REMARKS.—In the shape of the conch, the mode of coiling, the section of the whorls and the site and sharpness of the tubercles this form agrees fairly well with *N. angolense* Haughton from the same region. However, it does not show any distinct ribs, and its tuberculation seems to be slightly denser at the same diameter. It is, therefore, not thought to be fully conspecific with Haughton's type, referred to the Senonian by that author. The present fragments, found in the same piece of matrix as the undoubtedly Maestrichtian *Axonoceras* described below, might represent a younger mutation of Haughton's species.

The form under discussion is readily distinguished from *N. helicinum* by its much more pointed apical angle and by its quite different ornamentation; on the other hand, it is closely related to *N. maria-theresianum* which will be compared below.

***Nostoceras maria-theresianum*,**
new species

Figures 1b, 9

A.M.N.H. No. 25463: one specimen

DIMENSIONS OF HOLOTYPE

D	H	W	U	T
23.3 mm.	ca. 10 mm.	12.5 mm.	4.3 mm.	24 mm.

DESCRIPTION.—The single specimen (holotype) is a sinistrally coiled, turritid shell, consisting of two closely coiled volutions which are apparently septate throughout. The apical angle amounts to about 45°.

In internodal section the outer surface appears to be rounded, with its outermost point between the half and the upper third of the whorl. Both the upper and lower surfaces are also rounded, the impressed zone of the upper one hardly exhibiting any concavity. The umbilical wall is gently vaulted, with its convexity dorsad.

The dominant features of the ornamentation are two rows of obliquely elongated, sharp tubercles. Some of those near the anterior end become decidedly spinous. Those of the upper row mark the farthest projecting point of the outer surface, slightly below the upper third of the whorl, whereas those of the lower row accentuate the edge separating the outer surface from the base of the whorl; they are just visible at the line of contact with the succeeding volution. In either row from twenty-two to twenty-four of these tubercles can be counted per whorl; they seem to be slightly more closely spaced on the penultimate whorl than on the final one. As a rule there are only indistinct folds or fine riblets connecting the upper tubercles with the lower ones obliquely from the upper left to the lower right, in the same direction as the elongation of the tubercles. Here and there other folds or riblets can be seen to be intercalated between, and parallel to, those mentioned above. Stronger ribs are found only where they flank the two constrictions of the last whorl which are separated from each other by an interval of about half a volution. Three more such constrictions, distant only about a third of a whorl from each other, are, though less distinctly, seen on the penultimate volution. All these constrictions run in a slightly sigmoidal course across the outer surface, as do the accompanying ribs (Fig. 9b). In addition to the folds and riblets, there are also fine striae of growth, best visible above the upper tubercles, where all these elements of ornamentation first assume a radial direction and then turn sharply forward on the upper surface, describing, in the impressed zone, an arc which is strongly convex orad (cf. Spath's, 1921a, pp. 250-251, description of the ornamentation of his *N. subangulatum*).

Only a part of the suture line, from the right external saddle to the middle of the left first lateral lobe, is visible (Fig. 1b). There is a short, rather broad siphonal lobe, divided by a lancetiform median knob with comparatively richly indented margins; its two terminal points diverge but little, and there is one lateral point on either side. Only the external saddles can be studied on both sides of this suture line; they disclose the dissymmetry usual in turritids. Both of them are low and sturdy, but the right one is even a little lower than the left and much more deeply intersected by the trifid lobule, and a line connecting the tops of its stems would slope more decidedly dorsad. The two main

stems of the left external saddle are almost equal in both height and width; in addition, there is, at its left margin, a lateral leaf which is almost as strong as the main stems. Only the outer branch of the first lateral lobe is still visible; it is more than one and a half times as deep as the siphonal lobe, strong, ventrad oblique and bifid with two rather long terminal points and two shorter lateral ones immediately above them. Dorsad there follows a strong upright leaf whose height is about three-fifths of that of the external saddle. This leaf may represent only a part of the secondary saddle dividing the first lateral lobe which, in this species too, seems to be extremely broad. By this feature, by the strong development of the leaf in the middle of this lobe and by the shallowness of the siphonal lobe this suture line much resembles in its general plan those of other *Nostoceras*, particularly that of *N. subangulatum* Spath (1921a, Pl. xxii, fig. 3c).

OCCURRENCE.—Locality "S-3" (= "2054"), southwest of Maria Theresa, in same piece of matrix as *N. cf. angolense*.

REMARKS.—This form is, no doubt, very close to the precedent one, but it cannot be considered conspecific; it differs from the latter and from Haughton's type of *N. angolense* by its less pointed apical angle, by its more rounded inter-nodal section and by the somewhat lower site of the outermost point of the external surface, as marked by the upper tubercle; from the typical *N. angolense* it differs, moreover, by its indistinct costation.

From *N. helicinum* the new species can easily be distinguished by its less depressed conch and by its stronger tubercles which constitute the dominant feature of the ornamentation, whereas the costation, so distinct in Shumard's species, is here almost missing. Furthermore the suture line of the latter is, at about the same size of the conch, much more elaborate, and its external saddles are not so low nor so sturdy as those of the present form.

It resembles in its shape, in whorl section and in its sutural characters *N. subangulatum* Spath (1921a, p. 250 Pl. xxii, figs. 3a-c) from the Senonian Umkwelane Hill fauna of Zululand, which is, however, a much larger and more robust form with a much more distinct, coarser costation and comparatively less pronounced and less closely spaced tubercles; it also differs in whorl section inasmuch as the upper

surface appears to be less rounded and the external one to be steeper in its upper part and more concave between the tubercles; also the outermost point of the section, marked by the upper tubercle, is situated a little lower, viz., at half the height of the whorl, in Spath's species.

"*Turrilites*" *pauper* Whitfield (1892, p. 268, Pl. xlv, figs. 1-5) from the lower Greensand marls of New Jersey, repeatedly compared by Spath with his Zululand form mentioned above, also somewhat resembles the present specimen in its sutural characters, but it has a more pointed apical angle and a quite different ornamentation, with much more pronounced ribs and far less well developed tubercles.

AXONOCERAS STEPHENSON

This genus, created quite recently by Stephenson (1941, p. 422) to include some peculiar forms from the Neylandville marl, the basic member of the Navarro group of Texas, is stated by that author to be restricted to that region and horizon. Indeed it has hitherto not been recorded from any other region, unless the fragment described and figured by Maury (1930, p. 187, Pl. xi, fig. 7), under the name *Glyptoxoceras* sp. indet., from the Campanian? of the State of Parahyba do Norte, Brazil, whose ribs are ventrally developed as collars very much like those of some *Axonoceras*, should turn out to belong to this genus. However, a species undoubtedly referable to it is here described from Angola.

In the writer's opinion the most distinctive generic character of *Axonoceras* is its peculiar mode of coiling which is, so to say, irresolute and irregular in the early stages but becomes quite regular at maturity, thus leaving open interspaces varying in width between the outer whorls and the inner ones. As this manner of coiling is beyond any doubt recognizable in the Angola examples, the writer does not hesitate to refer them to Stephenson's new genus, although this may involve two slight modifications of his generic diagnosis. As seen from the following description, the forms of this genus are

not necessarily coiled in one plane but may also exhibit a slightly helicoid coiling; and the two rows of ventral tubercles do not necessarily persist throughout development but may be confined to certain ontogenetic stages. A suture line of this genus is described and figured for the first time in the present paper.

Stephenson, without indicating his reasons, includes his genus in the family Cosmoceratidae. As this family, according to Hyatt's (*in* Zittel-Eastman, 1900, p. 586) diagnosis, comprises only "discoïdal and involute forms," it must be assumed that Stephenson does not take it in Hyatt's circumscription but in the wider one of Zittel (see 1910, p. 495),

Spec. No.		DIMENSIONS ⁴			
		D	H	W'	U
Paratype: 2	(a)	18.8 mm.	29 ¹ / ₂	31	46 ¹ / ₂
	(b)	ca. 33.0 mm.	ca. 28	ca. 28	?
Holotype: 1	(a)	24.0 mm.	28 ¹ / ₂	29	52
	(b)	33.6 mm.	26	24 ¹ / ₂	52 ¹ / ₂

and that he was induced to refer *Axonoceras* to it by his belief in some relationship between this genus and *Crioceras*, which is included by Zittel in his family Cosmoceratidae, as is the family Crioceratidae by Hyatt (*ibid.*, p. 588) in his superfamily Cosmoceratida. However, not only the affinity between *Cosmoceras* and *Crioceras* may be questioned,¹ but also that between the latter genus and *Axonoceras* is not certain. Its slightly helicoid coiling might suggest that *Axonoceras* is even more closely related to d'Orbigny's typical *Helicoceras*,² which it resembles also, to a remarkable degree, in the character of costation. This would, however, involve the reference of *Axonoceras* to the Hamitidae, in which *Helicoceras* is included by Spath (1939, p. 604)³; but the new genus would not quite fit into this family which was intended by Hyatt (*in* Zittel-Eastman, 1900, p. 586) to include solely forms "with no tubercles at

any stage." *Axonoceras* seems, furthermore, to be related also to some late Turrilitidae, e.g., *Nostoceras*, and to the "ptychoceratid" genus *Solenoceras* (see p. 10); with both those genera it has in common the two rows of ventral tubercles, as have all the genera included by Hyatt (1894, p. 568) in his family Nostoceratidae. Be that as it may, it seems at present hardly possible definitely to determine the family relationship of this interesting genus, which might meanwhile better be considered to be "incertae sedis."

Axonoceras angolanum, new species

Figures 3, 10-13

A.M.N.H. No. 25464: six specimens

DESCRIPTION.—The holotype (specimen No. 1), although not complete, is a full spiral. The paratype (specimen No. 2) is preserved up to about the same diameter as the holotype, but about a third of its outer whorl is missing. In both these examples only the foremost part seems to belong to the body chamber. In addition, there are four whorl fragments (Nos. 3-6), corresponding to from a quarter to a third of a volution and varying in length from 13.5 mm. to 32 mm. The largest of them (specimen No. 6) corresponds, in both size and ontogenetic stage, to the last third of the outer whorl of the holotype and seems to be unseptate, at least in its anterior part; the others, which are smaller, seem to be septate throughout.

In both the holotype and the paratype the peculiar mode of coiling characteristic of this genus can well be studied. In the former almost the apex is visible; at any rate, the conch begins with a whip-shaped, irregularly curved portion, which is about a third of a volution long and less than half a millimeter thick at its visible origin. Then this innermost volution forms a steep hump and turns abruptly under an angle of a little less than 90°, to continue in an almost straight portion which corresponds to about another third of a volution. Then there is another, less steep hump, whence the conch continues, quite surprisingly, in a graceful

¹ Roman (1938, p. 352), on his part, attaches *Crioceras* to his family Palaeohoplitidae.

² Hardly any of the various forms described later under this generic name seem really to be related to the genotype *H. annulatum* d'Orbigny (1841, p. 611, Pl. CXLVIII, figs. 7-9).

³ Spath even believes it "to represent merely ordinary *Hamites* in which the coiling may be helicoid" and, in consequence, proposes to suppress the generic name *Helicoceras*.

⁴ Here "D" means the diameter expressed in mm., "H" the height of the last whorl, "W'" its width measured over the ribs and "U" the width of the umbilicus. "H," "W'" and "U" are expressed in per cent of "D," decimals having been reduced or increased, respectively, to full or half per cent. Both specimens have been measured: (a) about half a whorl apical of, and (b) at, the anterior end.

spiral which is slightly elongated elliptically. Thus the inner whorl has a more or less triangular shape, the triangle having an almost straight base but convex sides and rounded corners, whereas the outer volution forms an almost regular spiral. Up to the first hump the inner whorl has a rather loose contact with the outer one; from there on they never again touch each other, the distance between the venter of the former and the dorsum of the latter varying from 1 mm. to 2.5 mm. This variation is due chiefly to the lesser degree of curvature of the inner whorl, as compared to the outer one (see e.g., Stephenson's, 1941, fig. 4 of a paratype of his *A. compressum*). The open space within the inner coil is about 7 mm. wide and of about the same height. It is noteworthy that this shell deviates from Stephenson's (1941, p. 422) generic diagnosis in the fact that it is not coiled in one plane but in an extremely flat, helicoid, dextral spiral (see Fig. 10d). The paratype exhibits about the same peculiarities of coiling, but here the deviation from the plane seems to be sinistral (Fig. 11c).

The whorl section is subcircular in the earlier stages (specimen No. 4, Fig. 12), the width, as a rule, slightly exceeding the height. Later the dorsum becomes decidedly flat and the maximum width is, now, near the umbilical edge; this development is best seen in the paratype (Fig. 11c) and at the posterior end of the largest whorl fragment (No. 6, Fig. 13).

There seems to be a slight indication of ribbing even on the first, whip-shaped portion of the inner coil of the holotype; certainly the costation is quite distinct on its next portion, between the first hump and the second, and on the corresponding one of the paratype. In the holotype about twenty fine, closely spaced, almost radial riblets can be counted on that portion of the inner whorl which is about 10 mm. long. They become more pronounced and, gradually, rursiradiate on the last third of this whorl, where about twenty-five ribs can be counted. At the end of this whorl they are seen to describe an extremely flat, orad concave sinus across the venter. There are altogether fifty-two ribs on the outer volution of the holotype. They are weakest on the dorsum on which they run straight across or in a very shallow, orad convex sinus. On the umbilical edge they become more distinct and then run in a decidedly rursiradiate, slightly sinuous course across the sides, gradually gaining strength and sharpness. In the outer zone of the sides they are markedly narrower than the intercostals; on the venter they are only half as wide. Here the costae are sharpest and most prominent. In about the third quarter of this volution small, though rather sharp, tubercles, which mark the latero-ventral edges, are clearly perceptible. Elsewhere in the holotype as well as in the paratype and in two of the whorl fragments (Nos. 4, 6) these tubercles can be found but rarely and, it may be added, only by one who expects to find them, since they

are as a rule only slightly indicated. It seems worth noting that here and there in the outer whorl of the holotype the costae seem to cross the venter slightly obliquely "from the upper right to the lower left"; this seems to have some connection with the slightly helicoid, dextral coiling of this example.

The ornamentation of the paratype agrees fairly well with that of the holotype, except that in the foremost portion, believed to belong to the body chamber, some ribs are farther apart from each other than the others and, particularly on the venter, reinforced to form "collars," such as are also seen in Stephenson's (1941, Pl. LXXXIX) figs. 1 (holotype of *A. compressum*) and 6 (holotype of *A. pingue*). Such a development is also found in the ventral portion of one of the earlier ribs of this specimen, which is not reinforced on the sides. These collars seem to be a gerontic feature; they occur on the paratype but not on the holotype, which, although of the same diameter, seems to attain the gerontic stage only later.

On the largest whorl fragment (No. 6) the ribs can be seen to cross the dorsum a little obliquely; some of them are almost effaced here, whereas others continue across it almost unweakened. It is true that there are slight differences in density of costation and strength of the ribs between the four whorl fragments under examination, but on the whole their ornamentation seems to agree with that of the correspondent stages of the holotype. As best seen in the latter (Fig. 10a, b), the costae slope in maturity much more steeply on their apical side than on the orad one.

Continuous suture lines can be traced only in the two smallest whorl fragments (Nos. 3



H = 5 · 6 mm

Fig. 3. Suture line of *Axonoceras angolanum*, new species, A.M.N.H. No. 25464:4.

and 4); the latter permits study of the right suture line in full, though in different places (Fig. 3). There is a comparatively narrow siphonal lobe with two long and but slightly diverging terminal points and two lateral ones on each side; the median knob is triangular in shape and has a distinct notch on each side. The external saddle is broad and but little intersected, except for the short, three-pronged lobule which points slightly dorsad; both its stems are about equal in height and width. The first lateral lobe is markedly shorter than the siphonal one, wide and distinctly bifid, its

two terminal prongs pointing decidedly apicad. The lateral saddle is lower and narrower than the external one and divided by a three-pronged, dorsad-inclined lobule into a lower, narrower, outer stem and a higher, broader, bifid, inner one. The second lateral lobe is shorter than the first and remarkably broad; this lobe is also distinctly bifid; both its branches are three-pronged, the outer one being the stronger. Dorsad there follows the internal saddle, which is lower and narrower than the lateral one, bifid and comparatively richly indented. The antisiphonal lobe is a little more than half as deep as the second lateral one, with a three-pronged terminal point and two lateral ones on each side. It is noteworthy that the tops of the three saddles and the bottoms of the three first lobes each lie in one straight line.

The presence in this suture line of only six lobes and six saddles appears to support the belief in some hamitid relationship of this genus, as voiced above (p. 8). The bifidity of its lateral lobes may suggest derivation from a lycoceratid stock.

OCCURRENCE.—Locality "S-3" (= "2054"), southwest of Maria Theresa, in same piece of matrix as *N. cf. angolense* and *N. maria-theresianum*.

REMARKS.—The sharp, decidedly rursiradate ribs of the outer whorl, as seen best in the holotype of this new species, are strongly reminiscent of those of *Helicoceras annulatum* d'Orbigny (1841, p. 611, Pl. CXLVIII, figs. 7-9), the genotype of *Helicoceras*. However, the peculiar manner of coiling of the present form and its two rows of ventral tubercles, although observable only occasionally, leave no doubt concerning its reference to *Axonoceras*. *A. angolanum* can justly be called not only the most elegant but also (taking into account the fact that its holotype must have attained, when complete, a diameter of about 45 mm.) the largest known species of this genus.

It is specifically different from all of Stephenson's species. The genotype, *A. compressum* (1941, p. 422, Pl. LXXXIX, figs. 1-5), is, except for its initial whorl, more closely coiled and has a stiffer, less sharp and less rursiradate costation. *A. pingue* (*ibid.*, p. 423, Pl. LXXXIX, figs. 6-8) is stouter than the present species and has much coarser ribs and tubercles. *A. multicostatum* (*ibid.*, p. 423, Pl. LXXXIX, figs. 9-11), as well as its variety *rotunda* (*ibid.*, p. 424, Pl. LXXXIX, figs. 12-14),

is readily distinguishable by its closer coiling and its finer and denser costation, consisting of radial and straight, or almost straight, ribs. Furthermore, all these forms are said to be coiled in one plane.

SOLENOCERAS CONRAD

This genus, established by Conrad (1860, p. 284) on *Hamites annulifer* Morton (1842, p. 213, Pl. XI, fig. 4; Whitfield, 1892, p. 273, Pl. XLV, figs. 6-8) and afterward explicitly discussed by Meek (1876, pp. 410-412) and Whitfield (1892, pp. 271-273), being rejected by the former author and amended by the latter, is represented in this collection by a single, incomplete, but well preserved specimen.

Stephenson (1941, pp. 398, 399) includes this genus in the family Ptychoceratidae, apparently created by Meek (1876, p. 410) and "provisionally" also used by Hyatt (1894, p. 577), who, however, no longer acknowledged this family in 1900 (*in* Zittel-Eastman, p. 571). It is indeed doubtful whether this family can be maintained, especially since *Ptychoceras* is now considered by Spath (1939, p. 605; 1941, p. 656) merely a subgenus of *Hamites*. This would, of course, involve the inclusion of *Solenoceras* in the Hamitidae, which, on the other hand, are stated by Hyatt (1900, *in* Zittel-Eastman, p. 587) to have "no tubercles at any stage"; *Solenoceras*, however, is distinguished from the older *Ptychoceras* chiefly by its two rows of ventral tubercles. Moreover, its resemblance to *Ptychoceras* does not necessarily prove its descent from the latter but may be due merely to the recurrence of the same characteristic manner of coiling.

On the other hand, there seems to be some relationship between this genus and *Axonoceras*, as both have in common certain characters of the ornamentation and, to a lesser degree, also of the suture line. Here again quite different ways of coiling may have been followed by two genera of the same stock. In the writer's opinion *Solenoceras* like *Axonoceras* cannot at present definitely be included in any known family. However, its markedly

bifid lateral lobes seem, as in *Axonoceras*, to indicate the origin from a lytoceratid lineage.

All species described under the generic name *Solenoceras* are North American, but there are also some late Cretaceous ammonites recorded from other parts of the world under other generic names which undoubtedly belong to this genus. As an example might be cited "*Hamites* (*Ptychoceras*)" *minimus* Basse (1931, p. 17, Pl. I, figs. 20-22) from the Upper Maestrichtian of Andrafiavelo, Madagascar, whose ribs are "pourvues, sur la région ventrale, de deux tubercules fins et aigus." "*Ptychoceras*" *crassum* Whitfield (1880, p. 459, Pl. xvi, figs. 3-6), made by Hyatt (in Zittel-Eastman, 1900, p. 588) the genotype of his genus *Oxybeloceras*, is thought by Stephenson (1941, pp. 399, 400) to be probably a *Solenoceras*, despite its greater size; the writer is inclined to

DESCRIPTION.—The single specimen (holotype) consists of a comparatively long portion of the thinner limb with the beginning of the hook which is, however, preserved only on the left side. The fragment is septate throughout.

The whorl section, as seen in a fracture near the mid-length of this fragment (Fig. 4a), is inverse-oval and slightly higher than wide; it attains its maximum width at about the first third of the height, whence the sides converge decidedly toward the venter, less so toward the latero-dorsal edges. The dorsum is comparatively wide and almost flat, the venter is narrowly rounded, though distinctly separated from the sides by latero-ventral edges, which are marked by the tubercles. At the beginning of the hook the section (Fig. 4b) has become a trifle wider than high; here the venter is flat and still more neatly separated from the sides, while the dorsum is slightly concave.

There is a distinct, though shallow and rather narrow constriction at about the first third of the length of the fragment; it runs all around the limb, but it is more clearly visible on the left side (Fig. 14b) than on the right (Fig. 14a). It is projected on the venter, where it forms a shallow, orad convex sinus; then it crosses the

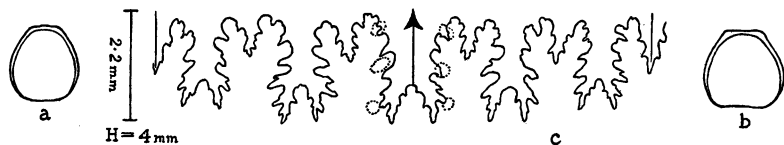


Fig. 4. *Solenoceras bembense*, new species, holotype, A.M.N.H. No. 25465. Sections, (a) at fracture, (b) at anterior end, both $\times 2$; (c) suture line.

share this opinion, which involves the inclusion of "*Oxybeloceras*" in *Solenoceras*. As an "*Oxybeloceras binodosa*" has been described, though unfortunately not figured by Haughton (1924, p. 97)¹ from the Teba formation of Carimba, the species described below would then not be the first record of the present genus from Angola.

Solenoceras bembense, new species

Figures 4, 14

A.M.N.H. No. 25465: one specimen

DIMENSIONS² OF HOLOTYPE

L	Hp	Wp	Ha	Wa
27.0 mm.	3.8 mm.	3.6 mm.	4.8 mm.	4.9 mm.

¹ His description, from which not even the dimensions of his specimens can be seen, is, however, hardly sufficient to establish a valid species.

² Here "L" means the full length of the fragment; "Hp" and "Wp" mean its dorsal-ventral and transverse diameters, respectively, at, or near, the posterior end, "Ha" and "Wa" those at, or near, the anterior end.

sides in an oblique, orad convex arc, and the dorsum in another sinus which is, however, orad concave. The transitions of the lateral parts into the dorsal and ventral ones cause this constriction to appear slightly sinuous. It is bordered apicad by a rib which is sharper and markedly stronger than the others. The ventral part only of another constriction is visible at the very beginning of the fragment, 8.5 mm. farther apicad of the above described one (Fig. 14b).

Twenty-four ribs can be counted on the preserved part of the straight limb which is 24 mm. long; there are, thus, ten of them to the centimeter, or five to the length of the dorso-ventral diameter. There are three more costae on the initial part of the hook. Except for the prominent ribs, mentioned above, which mark the apicad sides of the constrictions, all costae are almost uniform and rather regular. Their course is, throughout the straight limb, exactly the same as that of the constrictions, described above. On the hook, however, the ribs seem to assume an almost radial direction, instead of the prorsiradial one prevailing on the limb.

The two rows of fine tubercles, which accen-

tuate the latero-ventral edges, are more pronounced on the posterior part of the limb than on the anterior one and are just indicated on the initial part of the hook, where they seem to be a little elongated transversely; on the limb, however, they are circular, not longitudinally elongated, as in some other species of this genus.

The costae do not continue across the dorsum which appears to be smooth to the naked eye; under the lens, however, a fine, very dense striation appears, which runs parallel to the dorsal part of the constriction. It is particularly distinct on the anterior part of the limb where it is occasionally interrupted by fine, sharply engraved furrows which follow each other at irregular intervals.

Suture lines can be studied throughout the fragment, best at about the first third of its length (Fig. 4c). It is remarkably simplified. As in Stephenson's (1941, p. 400) neotype of *S. texanum*, the siphonal lobe appears to be shifted slightly to the left, as seen by the position of the nodes, indicated in the suture line drawing. This lobe has two but slightly diverging, two-pronged branches; its median knob is rather low. The external saddle¹ is halved by a lobule with three blunt prongs; the outer of its two stems is broader and a little higher than the inner; both exhibit some indentation but cannot be called bifid, as are those of *S. texanum* by Stephenson. The first lateral lobe is as deep as the siphonal one, broad and plainly bifid, with two-pronged terminal points. The lateral saddle² equals the external one in both height and width; it is also intersected by a three-pronged lobule, and here too the outer stem is the higher and broader one. The second lateral lobe is markedly shorter than the first and is also distinctly bifid. It is followed dorsad by the internal saddle which is slightly higher than the others and inclined a little ventrad. The antisiphonal lobe is only a little deeper than the lobules of the main saddles; it is rather narrow and three-pronged at its end and has one more lateral point on each side. The most striking feature of this suture line is the bifidity and symmetry of all its lobes, except the antisiphonal one; they are so much like each other that any of them, if isolated, might be taken for the siphonal lobe.

OCCURRENCE.—Locality "2073," near Bembe.

REMARKS.—The ptychoceratid coiling, the small size, the ornamental characters and the simplified suture line leave no doubt concerning the reference of this specimen to the genus *Solenoceras*. It agrees in certain features with some of the typical North American species of this genus, but

the latter have been separated from each other on the basis of such fine differences in section and ornamentation that the Angola form, which cannot be fully identified with any of them, had also to be given a new specific name.

The genotype, *S. annuliferum* (Morton, 1842, p. 213, Pl. XI, fig. 4; Whitfield, 1892, p. 273, Pl. XLV, figs. 6-8), is difficult to compare with the present form, as the type and only described specimen consists of an unseptate limb; to judge by the impression left on its dorsal side by the septate one (see Whitfield's fig. 7), it is by no means so slender as in *S. bembense*. Of the American species, *S. mortoni* (Meek and Hayden; Meek, 1876, p. 412, Pl. XX, figs. 4a-e) seems most closely to resemble the present form, particularly in the general plan of its suture line, which may appear so very simplified in Meek's drawing merely owing to the corrosion of the figured specimen. The section of its septate limb is, however, slightly depressed, not compressed, and it does not taper ventrad to such an extent as in the Angola specimen. Furthermore, its ribs are slightly broader, stiffer, less oblique and lack the ventral tubercles. *S. texanum* (Shumard, 1861, p. 190; Stephenson, 1941, p. 399, *cum synonym.*, Pl. LXXVII, figs. 4, 5, Pl. LXXIX, figs. 1-4) is even more slender than the present form and has a coarser and less dense costation (three to four instead of five ribs to the length of "H"); furthermore, it differs by its section which is, according to the original description, "broad ovate" in the thinner limb. The suture lines, however, to judge by Stephenson's description, seem to agree fairly well. *S. reesidei* Stephenson (1941, p. 401, Pl. LXXVII, figs. 1-3) can readily be distinguished by its broader section and its much finer and denser costation (twenty-three or more ribs to the centimeter as compared to ten in *S. bembense*). In the shape of the unseptate limb *S. multicoelatum* Stephenson (1941, p. 402, Pl. LXXVI, figs. 12-14) most resembles the present species, but its costation is still finer and denser (twenty-six or more ribs to the centimeter). Also the ribs in both these Texan species are not at all

¹ Called "first lateral" by Stephenson (1941, p. 400).

² Called "second lateral" by Stephenson (*loc. cit.*).

so oblique as in the Angolan one. *S. crassum* Whitfield (1880, p. 459, Pl. vi, figs. 3-6) and *S. meekianum* Whitfield (*ibid.*, p. 457, Pl. xvi, figs. 1, 2) are much larger forms than the present one, with sharper and more widely spaced ribs, higher tubercles and more indented suture lines.

Of other African forms *S. minimum* (Basse, 1931, p. 17, Pl. I, figs. 20-22) seems to have a wider whorl section and thinner, less crowded ribs. *S. (?) binodosum* (Haughton, 1924, p. 97) cannot properly be compared for lack of figures and of a sufficiently precise description; from its assignment to "*Oxybeloceras*" it may, however, be inferred that it is larger than the present form.

BACULITES LAMARCK

This genus, which has previously been recorded from the Upper Cretaceous of

Baculites anceps (Lamarck) d'Orbigny

Figures 15-19

A.M.N.H. No. 25466: five (three?) specimens

Baculite dissemblable (*Baculites dissimilis*) DESMAREST, 1817, p. 49, Pl. II, figs. 4-6.

Baculite gladiée (*Baculites anceps*) LAMARCK, 1822, p. 648.

Baculites carinatus MORTON, 1834, p. 44, Pl. XIII, fig. 1.

Baculites anceps Lamarck; d'ORBIGNY, 1841, p. 565, *cum synon.*, Pl. CXXXIX, figs. 1-7.

Baculites anceps; ROEMER, 1852, p. 36, *pro parte*; Pl. II, figs. 3a, d; ?b, ?c; *non e-g.*

Baculites anceps, Lam. d'Orb.; SCHLÜTER, 1876, p. 145, Pl. XL, fig. 2.

Baculites anceps; MEEK, 1876, p. 406, *cum synon.* (*non* figured specimens).

Baculites anceps Lamarck; JOHNSON, 1903, p. 132, Pl. XI, fig. 30.

Baculites anceps Lamarck; LASSWITZ, 1904, p. 235.

Baculites anceps Lamarck; BOULE, LEMOINE AND THEVENIN, 1907, p. 64.

Baculites anceps Lamk., d'Orbigny; ROMAN, 1938, p. 53.

DESCRIPTION.—Under the above specific

DIMENSIONS¹

Spec. No.	L	Hp	Wp	Ha	Wa
1	26 mm.	12.4 mm.	ca. 9.0 mm.	13.8 mm.	10.3 mm.
2 ²	33 mm.	16.0 mm.	10.7 mm.	18.0 mm.	13.0 mm.
3	25 mm.	9.0 mm.	7.0 mm.	10.2 mm.	8.3 mm.
4 ³	44 mm.	ca. 12.0 mm.	9.0 mm.	?	11.8 mm.
5	37 mm.	20.0 mm.	ca. 12.5 mm.	?	ca. 16.0 mm.

Angola (see below), is represented in this collection by six fragments, all but one of which are referred to *B. anceps*.

That species has been proposed for the genotype by Roman (1938, p. 53), but Meek's (1876, p. 391) earlier selection of *B. vertebralis* is valid (cf. Boule, Lemoine and Thevenin, 1907, p. 63). Roman is mistaken in his footnote 1, as the latter specific name was created by Lamarck as early as 1801 and wrongly used by Defrance, in 1816, for a form which d'Orbigny includes in the synonymy of *B. anceps*.

As Schlüter (1876, p. 139) has convincingly pointed out, von Hübsch's generic name of 1768, "*Homaloceratites*," quoted "*Homaloceras*" by Schlüter, has priority over *Baculites*; however, the latter name is used in this paper as elsewhere in literature, sanctioned as it is by almost immemorial usage.

name five more or less short fragments are described, of which two pairs may belong together. Only the thickest fragment (No. 5) seems to be unseptate; the longest one (No. 4) shows the last septum 18 mm. apicad of the anterior end; the others are septate throughout.

The section (Figs. 15, 16a, b, 17b) is lancetiform, with the maximum width at about the first third of the sides, whence they converge gently toward the dorsum, which is almost flat, but ogival toward the fastigate venter, which is, in specimens Nos. 1 and 2, seen to carry a broad, blunt keel, neatly separated by indistinct furrows from the outermost zone of the sides.

The ornamentation consists of more

¹ For explanation of abbreviations see p. 11, footnote 2.

² Believed to belong to the same individual as No. 1.

³ May belong to the same individual as No. 3.

or less distinct, broad, blunt ribs which form a shallow, orad concave crescent on the inner two-thirds of the sides and are then decidedly projected; they gradually vanish toward the venter. From three to four of these ribs are counted to the length of the dorso-ventral diameter; they are most closely spaced in specimen No. 3, which represents the earliest preserved stage, less so in the thicker fragments, where they are less distinct and more fold-like. In addition, there is a fine striation which runs parallel to the costae on the sides and forms a shallow, orad concave sinus on the dorsum.

No suture line could be prepared so well as to deserve delineation, but it can be seen from a septum at the anterior end of fragment No. 2 that the lateral saddle occupies the middle zone of the sides, that the second lateral lobe is wider, but a little shorter than the first, and that both are bifid, as are also both their terminal branches.

OCCURRENCE.—Locality “E-50” (= “2003”), near Capolo.

REMARKS.—After careful comparisons the writer believes the present fragments to be referable to *B. anceps* (Lamarck) d’Orbigny,¹ since they exhibit all the essential characters of this species. It is true that the keel is in d’Orbigny’s figures, except near the aperture, not so neatly separated from the outer zone of the sides as it is in two of the Angola fragments. In the literature available to the writer only Roemer’s (*loc. cit. in. synon.*) ventral view (fig. 3b) indicates a similar feature, but, according to Schlüter (1876, p. 146), it is much more pronounced in Binkhorst’s² fig. 2. The writer cannot, however, share Schlüter’s opinion that the Maestricht form has, therefore, to be excluded from the synonymy of *B. anceps*, as d’Orbigny, although calling the venter “comprimé et presque caréné” in his description (*ibid.*, p. 566), later (p. 567)

speaks of this species as being “carénée sur le dos,” and as Morton (1834, p. 44) also calls the siphuncular margin of his *B. carinatus*, included also by Schlüter in the synonymy of *B. anceps*, “distinctly carinated.”

It has been pointed out by Meek (1876, p. 408) that Desmarest’s specific name *dissimilis* antedates and should, therefore, replace Lamarck’s name *anceps*; this is particularly true since d’Orbigny’s reason for rejecting Desmarest’s name, which was based on an erroneous conception, is certainly not valid under the laws of priority. However, the specific name “*anceps*” has been so generally accepted for a century that the writer also cannot make up his mind to replace it by “*dissimilis*.”

Many subsequently described forms are very similar to *B. anceps*, particularly *B. aquilaensis* Reeside (1927, p. 12, Pl. vi, figs. 11–13, Pl. viii, figs. 1–14) from the Eagle Sandstone and related formations of the Campanian of North America, in whose synonymy also Roemer’s Texas form is included by Reeside; the separation of this species from *B. anceps* might, however, be questioned. *B. undatus* from the Navarro group of Texas can be distinguished only by its venter which is much less narrow and sharp. Some other North American species of this group, e.g., *B. grandis* Hall and Meek (see Meek, 1876, p. 398, text figs. 53, 54, Pl. xxxiii, fig. 1), *B. compressus* Say (*ibid.*, p. 400, text figs. 55, 56, Pl. xx, fig. 3), *B. claviformis* Stephenson (1941, p. 403, Pl. i, Pl. lxxvii, figs. 6–8, Pl. lxxviii, figs. 1–6) differ chiefly by their much greater size.

None of the *Baculites* hitherto recorded from Angola by Haughton (1924) can be considered conspecific with the present form; his *B. subanceps* (p. 98, Pl. iii, figs. 6–8) is described as having an ornamentation “analogue à celle du groupe *anceps*,” but it cannot be seen in Haughton’s fig. 6; moreover, his species has a blunt, even truncate venter. His “*Baculites* sp.” from near Capolo (p. 99, Pl. iii, fig. 9), on the other hand, exhibits the same section as the present form, but it is

¹ As Lamarck’s (1822) specific diagnosis, calling the test smooth, is insufficient and not accompanied by any illustration, all later research had to depend on d’Orbigny’s (1841) description and figures.

² “Monographie des Gasteropodes et Cephalopodes de la Craie supérieure du Duché de Limbourg,” Bruxelles-Maestricht, 1861; this paper could not be secured in New York.

explicitly stated to have no ribs whatsoever.

None of the other African *Baculites* recorded by Bailly (1855, p. 457, Pl. XI, fig. 5), Woods (1906, pp. 341-343, Pl. XLIV, figs. 4-7), and Spath (1921a, pp. 257-261, Pl. XXIV, figs. 4-7) from Pondoland and Zululand, by Boule, Lemoine and Thevenin (1907, pp. 63-66, text fig. 29, Pl. xv, figs. 1-3) and Collignon (1931a, pp. 22-23, 34-38, Pl. III, figs. 6, 7, Pl. v, Pl. VIII, fig. 12, Pl. ix, figs. 13-18) from Madagascar, and by Pervinquière (1907, pp. 91-95, text figs. 22-25, Pl. iv, figs. 7-12) from Tunisia is sufficiently similar to the present form to require comparison.

Baculites, indeterminate species

Figures 5, 20

A.M.N.H. No. 25467: one specimen

DIMENSIONS¹ OF SINGLE FRAGMENT

L	Hp	Wp	Ha	Wa
28.2 mm.	10.1 mm.	5.7 mm.	12.1 mm.	7.0 mm.

DESCRIPTION.—The single fragment, which is septate throughout, differs from those discussed above under the name of *B. anceps* not only by being much more compressed (compare the tables of dimensions) but also by lacking any costation.

Except for being much more slender, its section (Fig. 5) agrees well with that of the preceding form; a keel like that

observed in specimens Nos. 1 and 2 of the former is also present, but it is narrower.

Also, the sutural characters of this fragment agree with those observed in fragment No. 2 of *B. anceps*. Here the lateral saddle and the internal one and the antisiphonal lobe are also recognizable; both the former are seen to be bifid, the



Fig. 5. *Baculites*, indeterminate species, A.M.N.H. No. 25467, section at posterior end, $\times 2$.

latter to be short and three-pronged. On the whole, this suture line seems to be rather richly indented.

OCCURRENCE.—Locality "E-50" (= "2003"), near Capolo, together with *B. anceps*.

REMARKS.—The differences from *B. anceps* have been pointed out above. As this specimen also lacks costation, it may require comparison with Houghton's (1924, p. 99, Pl. III, fig. 9) "*Baculites* sp." from the same region; the latter can, however, readily be distinguished by being much less compressed.

APPENDIX

A block of matrix from locality "2004" (= "30"), east of Bembe, A.M.N.H. No. 25468, contains many fossils, among them fish teeth, particles of crinoids, little gastropods and particularly a considerable number of rod-shaped cephalopods.

The latter look, at first glance, like rostra of belemnites, but most turned out to be septate, and in some of them suture lines very much like those of the *Baculites* described above can be recognized. These specimens are, therefore, referable to that genus and seem to be closely related to the

group of *B. anceps*, as many of them exhibit its peculiar section with a fastigate venter and a flat dorsum, as described above.

This does not, however, apply to all ammonites present in this block; at least one of them shows the beginning of a hook and might, therefore, be referable to one of the larger species of *Solenoceras*, one of which is recorded, under the new specific name "*Oxybeloceras binodosa*," by Houghton (1924, p. 97) from the Teba formation of Carimba.

However, all these ammonites, which are filled with crystallized calcite and in part badly crushed, are in a poor state of preservation and cannot in a satisfactory

¹ For explanation of abbreviations see p. 11, footnote 2.

way be removed from the matrix, which is a rather coarsely textured, very brittle limestone. In consequence, it seems wisest

to refrain from any description and specific, or even more than tentative generic, determination.

RÉSUMÉ

The fossils from the locality "S-3" (= "2054"), which has yielded a new species of *Axonoceras*, a genus hitherto known only from the Maestrichtian Navarro group of Texas, and from "S-22," where a species characteristic of the same group (*Nostoceras helicinum*) has been found, are undoubtedly of Maestrichtian age. The same can be assumed for locality "E-50" (= "2003"), as *Baculites anceps* is generally considered a Maestrichtian species (see Roman, 1938, p. 53).

The typical, small North American species of the genus *Solenoceras* which most resemble *S. bembense*, new species, from locality "2073" near Bembe occur in the Maestrichtian Navarro group of Texas as well as in the Pierre Shale of Missouri and in the Crosswicks Clay of Delaware, both of which are of Campanian age (see Carter, 1937, pp. 251-256; Stephenson, *et al.*, 1942, Correlation Chart). Another small *Solenoceras*, *S. minimum* from Madagascar, is of late Maestrichtian age. Locality "2073" has thus to be considered Maestrichtian or Upper Campanian, and the same may be true of the undetermined ammonites,

dealt with in the Appendix, from the nearby locality "2004" (= "30").

The age of the present assemblage, on the whole, is, therefore, recognized to be Maestrichtian and perhaps in part also Campanian. In consequence, the so-called Teba formation of Angola, thought by Houghton (1924, p. 82) to correspond to the Campanian, but probably also to the Lower Senonian, seems also to include strata of Maestrichtian age.

Palaeogeographically, the evidence of the presence of a neritic sea in Angola, previously (Spath, 1921b, p. 56; Haas, 1942a, p. 21) established for the time extending from the Albian to the Campanian, can now be farther expanded to include also the Maestrichtian. This result was anticipated by Spath as early as 1922 (p. 155), when he mentioned "the introduction . . . of Maestrichtian Ammonoids as far as Angola."¹

Particularly interesting is the close affinity of the present assemblage with the Navarro fauna of Texas; it strongly suggests for the Maestrichtian epoch an open sea connection between the neritic seas of Texas and Angola.²

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¹ It is, however, not quite clear how Spath arrived at this result, as he had considered a year earlier (1921b, p. 56) the youngest ammonites from Angola known to him at that time, viz., "a small collection of Nostoceratidae [*Didymoceras* of the type of *D. nebraskense-cooperi* (Meek) and *D. hornbyense* (Whitcaves)] from the Barra do Dande," as of Campanian age.

² Spath (1922, p. 156) assumed for the Albian "a Brasilo-African continent across the Southern Atlantic, with direct marine connection between the Indo-Malagascan and the 'Austral' or 'South-Andine' provinces, along the southern edge of this continent." If such a continent is believed to have persisted up to Maestrichtian times, this connection must be thought to have gone around it.

³ To supplement the Literature Cited in Haas, 1942a.

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- ¹ Only after the above paper was in press did the writer become aware of the two following papers:
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He, therefore, wishes to add here that Spath (1937), contrary to his conception of 1926 (adopted in Haas, 1942a, p. 6), restores Hyatt's genus *Calyco-ceras*, with *C. naviculare* (Mantell) as its genotype and now considers his generic name *Metacalyco-ceras* a synonym of *Calyco-ceras*. Basse (1938) selects, of the two cotypes of d'Orbigny's species mentioned in Haas, 1942a, p. 4, the one figured in her (1937) Pl. VIII, fig. 2, as the lectotype.
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Figs. 6, 7. *Nostoceras helicinum* (Shumard). Fig. 6: A.M.N.H. No. 25461:1, (a) side view, (b) another side view, showing "columella," (c) apical view, showing constrictions, (d) basal view. Fig. 7: A.M.N.H. No. 25461:2, (a) side view, (b) another side view, showing crushed last whorl, (c) apical view, showing constrictions of first whorl and spines of last whorl, (d) basal view of earlier whorls, with parts of crushed last whorl.

Fig. 8. *Nostoceras* cf. *angolense* Haughton, A.M.N.H. No. 25462:1, side view.

Fig. 9. *Nostoceras maria-theresianum*, new species, holotype, A.M.N.H. No. 25463, (a) side view, showing strong spine near anterior end, (b) another side view, showing sigmoidal course of constriction and of accompanying ribs, (c) apical view.

Figs. 10-13. *Axonoceras angolenum*, new species. Fig. 10: holotype, A.M.N.H. No. 25464:1, (a) right, (b) left side view, (c) ventral view, showing some tubercles on the latero-ventral edges, (d) frontal view, showing slightly helicoid coiling. Fig. 11: paratype, A.M.N.H. No. 25464:2, (a) left side view, (b) ventral view, both showing collars, (c) sectional view, showing slightly helicoid coiling. Fig. 12: A.M.N.H. No. 25464:4, section at anterior end. Fig. 13: A.M.N.H. No. 25464:6, sectional view from posterior end.

Fig. 14. *Solenoceras bembense*, new species, holotype, A.M.N.H. No. 25465, (a, b) right and left side views, both $\times \frac{3}{2}$.

Figs. 15-19. *Baculites anceps* (Lamarck) d'Orbigny. Fig. 15: A.M.N.H. No. 25466:1, section at anterior end, showing keel. Fig. 16: A.M.N.H. No. 25466:2, sections at (a) posterior, (b) anterior ends. Fig. 17: A.M.N.H. No. 25466:3, (a) left side view, (b) section at anterior end. Fig. 18: A.M.N.H. No. 25466:4, right side view, showing faint folds and fine striation. Fig. 19: A.M.N.H. No. 25466:5, right side view.

Fig. 20. *Baculites*, indeterminate species, A.M.N.H. No. 25467, (a) right side view, showing septal edge at anterior end, (b) ventral view, showing keel.

Unless otherwise indicated, the figures are natural size.

