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Campanian (Late Cretaceous) Ammonites from the upper part of the Anacacho Limestone in South-Central Texas

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ABSTRACT:

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The ammonite assemblage from the upper part of the Anacacho Limestone in Medina County in south-central Texas consists of *Pachydiscus* (*Pachydiscus*) *travisi* (ADKINS, 1929), *Pachydiscus* (*P.*) sp., *Pachydiscus* (*P.*) *streckeri* (ADKINS, 1928), *Hoplitoplacenticeras* (*H.*) *marroti* (COQUAND, 1859), *Eubostrychoceras reevesi* (YOUNG, 1963), *Bostrychoceras polyplocum* (ROEMER, 1841), *Lewyites clinensis* (ADKINS, 1929), *Baculites taylorensis* ADKINS, 1929, and *Trachyscaphites spiniger porchi* (ADKINS, 1929). Several of these species are also found in the Pecan Gap Chalk in central and northeastern Texas and in the basal part of the Demopolis Formation in Mississippi and Alabama. The fauna is probably contemporaneous with the *Baculites asperiformis* zone in the U.S. Western Interior, which lies in the lower part of the middle Campanian in the sense of the Western Interior threefold division of the Campanian. In terms of the European twofold division of the Campanian, the fauna lies in the lower part of the upper Campanian.

Key words: Cretaceous, Campanian, U.S. Western Interior, Ammonites, Biostratigraphy.

INTRODUCTION

The Anacacho Limestone was named by HILL & VAUGHAN (1898 p. 240) for the Anacacho Mountains in Kinney County, Texas (Text-Fig. 1). Reviews of previous work on the Anacacho and discussions on the stratigraphy and depositional environments were given by HAZZARD (1956), BROWN (1965), LUTTRELL (1977), WILSON (1986), and RODGERS (1988). Megafossils were listed by ELDER (1994, 1996). The formation, of early and middle Campanian age, is as much as 152 m thick according to ADKINS (1932), although RODGERS (1988, Fig. 2) indicated thicknesses of 122 m or less. It rests unconformably on the Austin Chalk and is overlain unconformably by the Escondido Formation.

The Anacacho is largely a carbonate-bank unit of shallow-water origin associated with extensive intrusive and extrusive igneous activity (LUTTRELL, 1977). The unit is stratigraphically complex, and HAZZARD (1956) proposed a threefold subdivision consisting of a lower limestone, a middle Milam Chalk Member, and an upper limestone. HAZZARD correlated the lower limestone with the Gober Chalk of northeastern Texas mainly on the basis of the presence of the ammonite *Menabites*. ELDER (1996) postulated the presence of at least two depositional intervals in the Anacacho Limestone in its type area and probably elsewhere, a lower Campanian and a middle Campanian interval, the lower interval corresponding to the lower Anacacho of HAZZARD (1956), with a major unconformity between the two intervals (ELDER 1996, Figs 1-2).

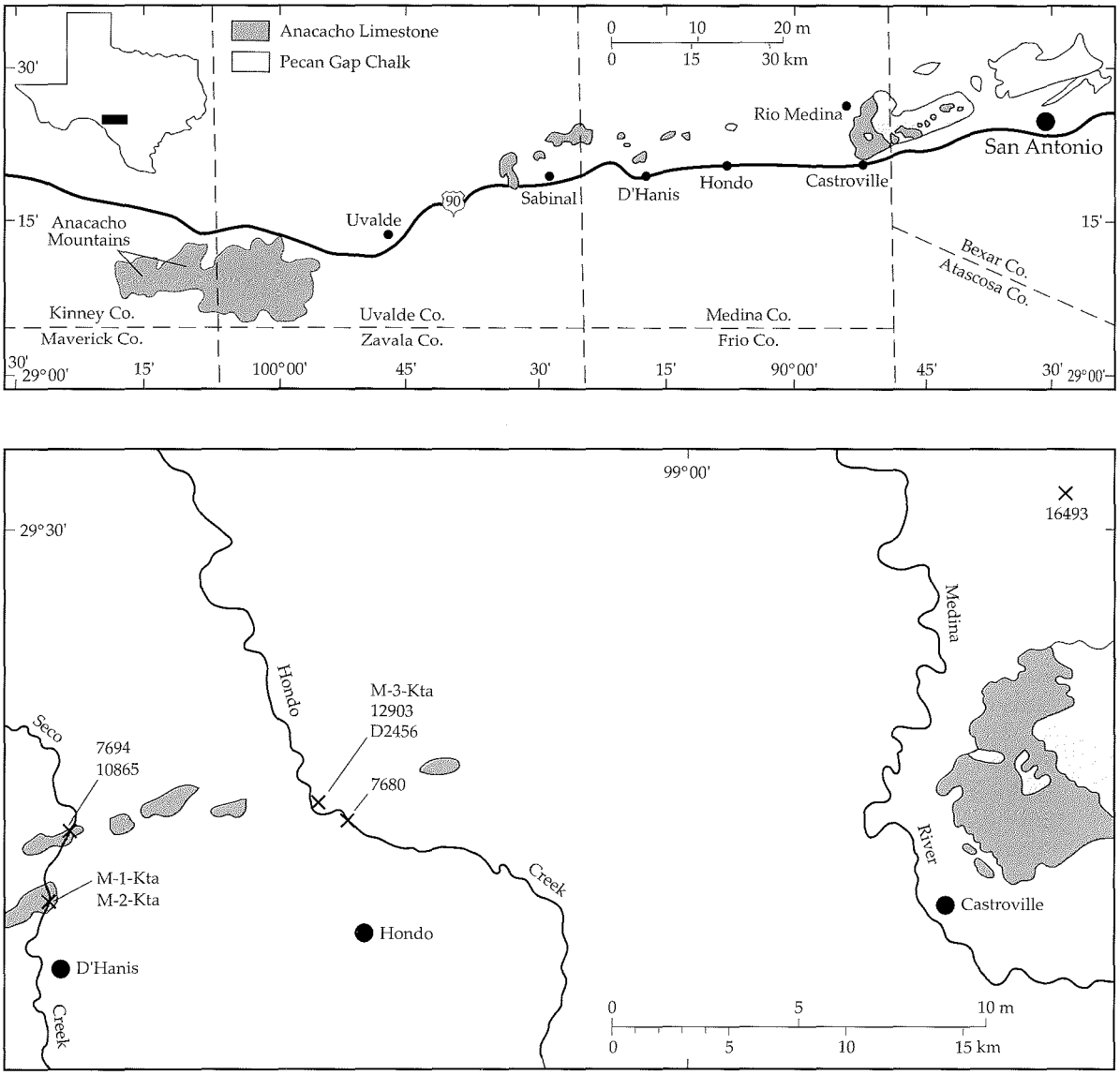

Fig. 1 - Above: outcrop belt of Anacacho Limestone and Pecan Gap Chalk in Kinney, Uvalde, Medina, and Bexar Counties, Texas (from BARNES & *al.* 1974). Below: localities where ammonites were collected in Medina County (localities are described in Table 1)

Ammonites from the younger part of the Anacacho are the subject of the present account; the following species are described herein: *Pachydiscus* (*Pachydiscus*) *travisi* (ADKINS, 1929), *Pachydiscus* (*P.*) sp., *Pachydiscus* (*P.*) *streckeri* (ADKINS, 1928), *Hoplitoplacenticeras* (*H.*) *marroti* (COQUAND, 1859), *Eubostrychoceras reevesi* (YOUNG, 1963), *Bostrychoceras polyplocum* (ROEMER, 1841), *Lewyites clinensis* (ADKINS, 1929), *Baculites taylorensis* ADKINS, 1929, and *Trachyscaphites spiniger porchi* (ADKINS, 1929). This assemblage indicates a correlation with the Pecan Gap Chalk in central and northeastern Texas, which also yields most of these ammonites (COBBAN & KENNEDY, 1994), and the base of the Demopolis Formation in Alabama and Mississippi (KENNEDY, COBBAN & LANDMAN, 1997), where it defines the *Baculites taylorensis* zone of KENNEDY & *al.* (1997). A correlation with part of the lower part of the Pierre Shale of the U.S. Western Interior is indicated by the presence of *T. spiniger porchi* in the zones of *Baculites mclearni* and *B. asperiformis* (COBBAN & SCOTT 1964). Inasmuch as *B. mclearni* occurs in the Wolfe City Sand in northeastern Texas (COBBAN & KENNEDY, 1993a) below the Pecan Gap Chalk, the Anacacho assemblage is more likely to be contemporaneous with the *B. asperiformis* zone.

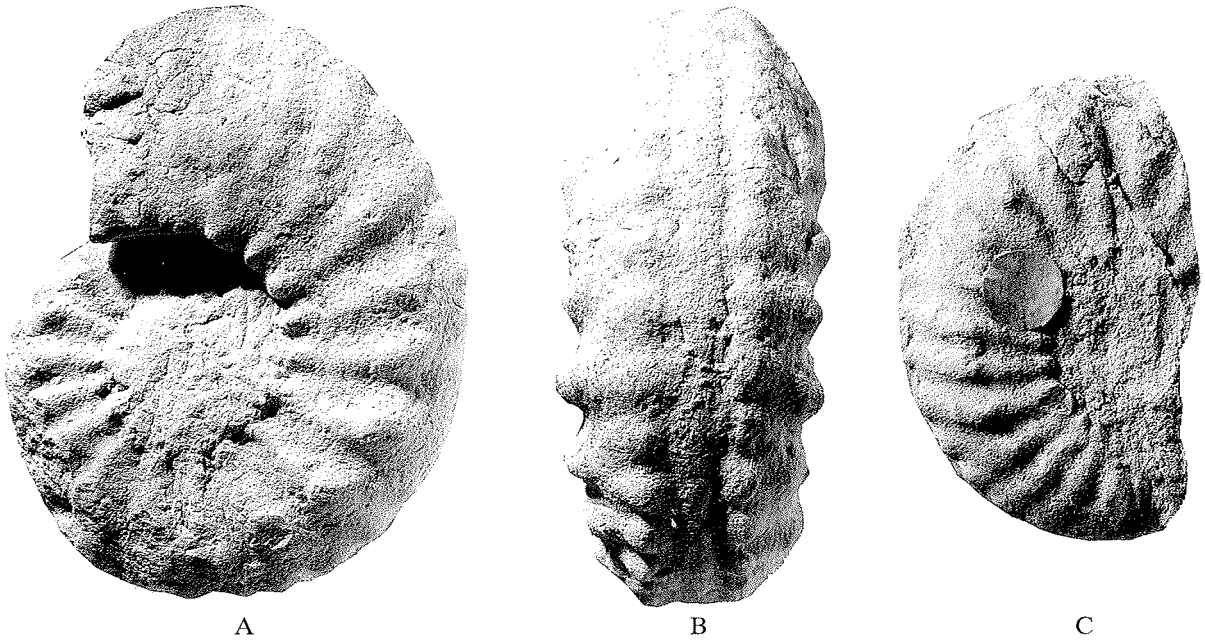

Fig. 2. *Menabites* (*Delawarella*) *delawarensis* (MORTON, 1834). A, B, USNM 501153, ex J.P. CONLIN Collection, Anacacho Limestone, Uvalde County, Texas. C, USNM 501154, collected by L.W. STEPHENSON in 1911, bed of Sabinal Creek, 5.8 km (3.5 mi.) north of Sabinal, Uvalde County, Texas

The ammonite evidence for the age of the lower Anacacho given by ELDER (1996) was the occurrence of *Hoplitoplacenticeras*, *Menabites* (*Delawarella*) and *Placenticeras*, identified to generic level only, and taken to indicate a correlation with the Gober Chalk, at the top of the Austin Group in northeast Texas. The only ammonites we have studied from the lower Anacacho are *Menabites* (*Delawarella*) *delawarensis* (MORTON, 1830) (Text-Fig. 2). These indeed occur in the Gober Chalk at the top of the Austin, but extend to a much higher horizon, into the Ozan Formation in Fannin County, Texas, and into the Arcola Limestone in Oklahoma, Mississippi and Alabama. In the latter two states, the highest occurrence of *M.* (*D.*) *delawarensis* in the Arcola is succeeded by beds with elements of the *Baculites taylorensis* Zone. *Hoplitoplacenticeras* and *Placenticeras* are very long-ranging genera, and the current ammonite evidence for a major break between upper and lower Anacacho is slight in our view.

The presence of *Bostrychoceras polyplocum* (ROEMER, 1841) in the upper Anacacho Limestone is useful for correlation as this is an important marker fossil in Europe, where it characterizes a zone in the European upper Campanian some distance below the base of the Maastrichtian (note that in Europe, the Campanian is divided into lower and upper parts, in contrast to the threefold division of the Western Interior, and that the European upper Campanian equals the Western Interior middle and upper Campanian). Records by ERNST & SCHMID (1975), SCHMID & ERNST (1975), ERNST & *al.* (1979), SCHULZ & *al.* (1984), SCHÖNFELD & *al.* (1996) and NIEBUHR (1996) show that *B. polyplocum* occurs in a 90 m interval in the lower part of their lower upper Campanian in northeastern Germany. BŁASZKIEWICZ (1980) used the species as an index for the oldest of the three upper Campanian ammonite zones in the Vistula River valley, Poland. The species was recorded previously from Texas (ADKINS 1928, p. 214, Pl. 37, Figs 1, 3) as *Bostrychoceras* n.sp.aff. *polyplocum* (ROEMER) and by YOUNG (1963) as *Bostrychoceras secoense*. *Bostrychoceras polyplocum* also occurs farther south in Mexico, and a specimen from there is described in the present report as the first record from Mexico.

LOCALITIES WHERE AMMONITES WERE COLLECTED

Most of the ammonites illustrated in this report were collected from the Anacacho Limestone in Medina County, Texas. The collection data for the

Table 1. Localities where ammonites were collected from the Anacacho Limestone in Medina County, Texas. [The first five locality numbers are U.S. Geological Survey Mesozoic locality numbers; those without a prefix are in the Washington, D.C. register, and the one with the prefix D is in the Denver, Colorado register. The last three numbers are for J.P. CONLIN localities; the prefix M indicates Medina County]

Locality no.	Collector(s), year of collection, and description of locality (Text-fig. 1)	
7680	L.W. STEPHENSON, 1911.	Left bank of Hondo Creek at the "King water hole" 4.8 km northwest of
Hondo.		
7694	L.W. STEPHENSON, 1911.	Right bank of Seco Creek about 6 km northwest of D'Hanis.
10865	L.W. STEPHENSON, 1921.	Seco Creek about 6 km northwest of D'Hanis.
12903	L.W. STEPHENSON, 1924.	Hondo Creek about 6 km, northwest of Hondo.
16493	A.N. SAYRE, 1933.	Unnamed stream east of Medina road and 0.16 km north of Culebra road.
D2456	V.L. FREEMAN & W.A. COBBAN, 1959.	Hondo Creek at crossing of Vandenburg School road 6 km northwest of U.S. Highway 90 in Hondo.
M-1-Kta	A.F. CRANE, 1959.	North-facing bluff on Seco Creek about 3 km north of D'Hanis.
M-2-Kta	A.F. CRANE, 1959.	Tributary to Seco Creek about 3 km north of D'Hanis.
M-3-Kta	A.F. CRANE, 1959.	Hondo Creek 6 km northwest of Hondo.

Medina localities is given in Table 1, and the localities are plotted in Text-Fig. 1. Localities for a few additional fossils are described in the text or plate captions.

REPOSITORIES OF SPECIMENS

Specimens described in this report are in the U.S. National Museum of Natural History, Washington, D.C., where they have USNM catalogue numbers. Plaster casts of a few of the specimens are at the U.S. Geological Survey, Federal Center, Denver, Colorado. Other specimens referred to in this report are at the Texas Memorial Museum, Austin, where they have TMM catalogue numbers.

SYSTEMATIC PALEONTOLOGY

Order Ammonoidea ZITTEL, 1884
Suborder Ammonitina HYATT, 1889
Superfamily Desmoceratacea ZITTEL, 1895
Family Pachydiscidae SPATH, 1922
Genus and subgenus *Pachydiscus* ZITTEL, 1884

TYPE SPECIES: *Ammonites neubergicus* HAUER, 1858, p. 12, Pl. 2, Figs 1-3; Pl. 3, Figs 1-2, by the subsequent designation of DE GROSSOUVRE (1894, p. 177).

Pachydiscus (*Pachydiscus*) *travisi* (ADKINS, 1929) (Pl. 1; Pl. 2, Figs 6-7, 11-13)

1929. *Parapachydiscus travisi* ADKINS, p. 207, Pl. 6, Figs 7-9.
1963. *Pachydiscus* sp. no. 2 cfr. *P. gollevillensis* (D'ORBIGNY, 1850); YOUNG, p. 56, Pl.13, Figs 1-2, 5; Pl. 14, Fig. 4; Pl. 17, Figs 1, 8; Text-Fig. 10d, g.
1994. *Pachydiscus* (*Pachydiscus*) *travisi* (ADKINS, 1929); COBBAN & KENNEDY, p. D3, Pl. 1, Figs 1-15; Pl. 2, Figs 9-11; Text-fig. 4.
1994. *Pachydiscus* (*Pachydiscus*) *travisi* (ADKINS, 1929); EMERSON & *al.*, p. 78, p. 358.

TYPES: The holotype is TMM 34010, paratype TMM 34009; both are from the phosphate beds in the basal part of the Pecan Gap Chalk, Travis County, Texas.

MATERIAL: Nine specimens, including USNM 475975-475978, from the Anacacho Limestone, Medina County, Texas.

DESCRIPTION: Specimens at hand have diameters from an estimated 38 mm to 112 mm. Coiling is moderately involute. The umbilicus has a steep, nearly vertical wall in the early growth stages, but becomes more inclined outwards in later growth stages. Umbilical shoulder very narrowly rounded, flanks flattened to very broadly rounded, venter rather narrowly rounded.

Table 2. Dimensions in millimetres and ratios to diameter and estimated number of umbilical tubercles and ventral ribs per whorl of *Pachydiscus* (*P.*) *travisi* (ADKINS, 1929) [USNM, U.S. National Museum of Natural History; D, diameter; Wb, whorl breadth; Wh, whorl height; U, umbilicus]

	D	Wb	Wh	Wb:Wh	U	Umbilical tubercles	Ventral ribs
USNM 475975	92.0(100)	22.3(24)	44.2(48)	0.50	19.9(22)	11	36
USNM 475976	110.0(100)	28.3(26)	51.6(47)	0.55	26.4(24)	12	37
USNM 475977	112.2(100)	27.7(25)	47.6(42)	0.58	28.7(26)	12	39

Three of the least distorted specimens have dimensions as listed in Table 2.

Ornament consists of umbilical tubercles and ventral ribs on the larger specimens and, in addition, ribs extend onto the flanks on the smaller specimens. On the smallest specimen seen (Pl. 2, Figs 6-7: whorl height about 15.5 mm), narrow primary ribs arise at the umbilical seam, strengthen across the umbilical wall, and develop into delicate bullae on the umbilical shoulder. The bullae give rise to widely spaced, narrow, straight, prorsiradiate ribs that cross the inner and middle flank, where two or three shorter ribs may intercalate. All ribs bend forward slightly at the ventrolateral shoulder and cross the venter in a broad convexity. In the middle growth stage, the umbilical bullae become stronger and pass into small, but conspicuous nodate tubercles from which pairs of very weak prorsiradiate ribs extend onto the lower part of the flank. A secondary rib may separate the paired ribs. All ribs greatly weaken on the middle of the flank, and some are barely discernible, but, at the ventrolateral shoulder, all ribs become strong and cross the venter with forward arching. During later growth stages, the umbilical tubercles persist, but ribs disappear from the flank, and, on adult body chambers, the ventral ribbing weakens and disappears as the venter becomes more rounded. The two specimens 110 and 112 mm in diameter (Pl. 1, Figs 1-6) are adults. One of these (Pl. 1, Fig. 5) has a complete aperture that has a small ventral projection. Sutures are not preserved on any of the specimens.

REMARKS: These more-or-less flattened specimens can be matched with undeformed phosphatic material from the Pecan Gap Chalk (COBBAN & KENNEDY 1994, Pl. 1, Figs 1-12). The *Pachydiscus* sp. no. 2 cfr. *P. gollevillensis* (D'ORBIGNY) of YOUNG (1963, p. 56, Pl. 13, Figs 1-2, 5; Pl. 14, Fig. 4; Pl. 17, Figs 1, 8; Text-fig. 10d, g) is a crushed example of *P. travisi*. Although compared to *P. gollevillensis* by YOUNG, this *P.* (*P.*) *travisi* has the strong umbilical tubercles and very distant ventral ribs that immediately distinguish it from *P.* (*P.*) *gollevillensis* (D'ORBIGNY, 1850, p. 212, pars; see revision *in* KENNEDY, 1986a, p. 28, Pls 1-3; Pl. 4, Figs 4-6; Pl. 5, Figs 12-14, 20-24; Pl. 11, Figs 1-5; Text-figs 3P, R, 4C).

OCCURRENCE: *Pachydiscus* (*P.*) *travisi* is present in collections from the Anacacho Limestone of Medina County, Texas, at USGS Mesozoic locality 7680 and at J.P. CONLIN's locality M-2-Kta. The species also occurs in the Pecan Gap Chalk a little to the east in the San Antonio area, as well as farther northeastward to the northeast corner of Texas. Phosphatic fragments of pachydiscids in the Annona Chalk in southwestern Arkansas may be *P.* (*P.*) *travisi*.

Pachydiscus (*Pachydiscus*) sp.
(Pl. 2, Figs 9, 10)

MATERIAL: A single septate internal mould, USNM 475979 (ex J.P. CONLIN Collection no. 8453).

DESCRIPTION: USNM 475979 is a distorted fragment of about one-third of a phragmocone whorl that had an estimated diameter of 67 mm. The umbilicus is of moderate depth with a flattened, outward inclined wall and narrowly rounded shoulder. Flanks of the whorl are flattened and convergent to a well-rounded venter. Prominent umbilical bullae perch on the umbilical shoulder and give rise to strong, straight prorsiradiate ribs either singly or in pairs. One or two ribs intercalate between the primaries on the outer flank and strengthen to match the primaries on the outer flank and venter. The specimen probably had 4 umbilical bullae and 16 or 17 ventral ribs per half whorl.

REMARKS: This specimen may be an unusually robust, strongly ornate variant of *P. travisi*. *Pachydiscus* sp. no. 3 cf. *P. gollevillensis* (D'ORBIGNY) of YOUNG (1963, p. 57, Pl. 14, Figs 2-3; Text-figs 7n, 8h), from the Anacacho Limestone, has similar ribs crossing the flank, but they are more closely spaced.

OCCURRENCE: USNM 475979 is from J.P. CONLIN's locality M-2-Kta.

Pachydiscus (P.) streckeri (ADKINS, 1928)
(Pl. 3)

1928. *Parapachydiscus streckeri* ADKINS, p. 221, Pl.35; Pl.36, Figs 2-4.

TYPES: The holotype is the original of ADKINS (1928, Pl. 36, Fig. 1), in the collections of the Texas Memorial Museum. It is from the Anacacho Limestone at the Texas Asphalt Company's pit at Cline, Uvalde County, Texas; a paratype is at Baylor University, Waco, Texas.

MATERIAL: USNM 475980, an uncrushed internal mould.

DESCRIPTION: An internal mould of a large, robust phragmocone 176 mm in diameter has a whorl breadth (Wb) of 77.3 mm (ratio to diameter of 0.44), a whorl height (Wh) of 75.3 (0.43), Wb:Wh of 1.03, and an umbilical diameter of 46.0 mm (0.26). The umbilical wall is broadly rounded and sloping, the umbilical shoulder is narrowly rounded, the flanks are very broadly rounded, and the venter is well rounded. Sutures are poorly preserved. The specimen, although undeformed, is not well preserved. The only ornament visible consists of fairly closely spaced, prorsiradiate ribs on the outer part of the flank, which weaken on crossing the venter convexly. They number 20 on the older half whorl; they are still present, but much weakened on the younger half. Flanks on the older half whorl are not well enough preserved to determine whether they were crossed by the ribs or whether umbilical bullae were present. Flanks are preserved better on the last quarter whorl of the specimen, but ornament is lacking on the flank and umbilical shoulder.

REMARKS: In its general form and stoutness, the specimen resembles some of the robust European pachydiscids such as *P. (P.) launayi* DE GROSSOUVRE, 1894 (p. 184, Pl. 19). YOUNG (1963, p. 55, Pl. 13, Figs 3-4; Text-fig. 7t) described a robust specimen from the Anacacho Limestone that he assigned to *Pachydiscus*(?) n. sp. that may be allied to *P. (P.) streckeri*. It has 12 umbilical bullae per whorl and possibly twice as many low ribs crossing the venter.

OCCURRENCE: The specimen, from the J.P. CONLIN collection, is simply labelled "Anacacho. Seco Creek, D'Hanis, Tex."

Superfamily Hoplitaceae H. DOUVILLÉ, 1890
Family Placenticeratidae HYATT, 1900
Genus and subgenus *Hoplitoplacenticeras*
PAULCKE, 1907

TYPE SPECIES: *Hoplites-Placenticeras plasticus* PAULCKE, 1907, p. 186; HEMMING, 1959, ICZN Opinion 554, name no. 1629.

Hoplitoplacenticeras (Hoplitoplacenticeras) marroti
(COQUAND, 1859)

1859. *Ammonites marroti* COQUAND, p. 995.
1894. *Hoplites vari* SCHLÜTER sp. var. *marroti* COQUAND; DE GROSSOUVRE, p. 118, Pl. 8, Fig. 3a, b; Pl. 9, Figs 2a, b, 3a, b.
1933. *Hoplitoplacenticeras* aff. *vari*. ADKINS, p. 473.
1963. *Hoplitoplacenticeras marroti* (COQUAND, 1859); YOUNG, p. 63, Pl. 2, Figs 5, 15, 17; Pl. 17, Figs 3-4; Pl. 20, Figs 2-3; Pl. 21, Figs 1, 4; Pl. 81, Fig. 4; Text-figs 9b, c, f, 11a.
1986b. *Hoplitoplacenticeras marroti* (COQUAND). KENNEDY, p. 70, Pl. 2, Figs 3-4; Pl. 9, Figs 1-8, 11, 12; Pl. 10, Figs 1-12; Pl. 12, Figs 1-2 (with full synonymy).
1992. *Hoplitoplacenticeras (Hoplitoplacenticeras) marroti* (COQUAND, 1859); KENNEDY & *al.*, p. 272, Pl. 1, Figs 2, 5; Pl. 2, Figs 6-7.
1994. *Hoplitoplacenticeras (Hoplitoplacenticeras) marroti* (COQUAND, 1859); EMERSON & *al.*, p. 102-103.

TYPES: The holotype, by monotypy, is the specimen from Ribérac (Dordogne, France) mentioned by COQUAND (1859, p. 995) and figured by KENNEDY (1986, Pl. 9, Figs 5-6).

MATERIAL: A fragment of an internal mould, USNM 456695.

DESCRIPTION: USNM 456695 (not illustrated) consists of a quarter of a whorl of a phragmocone? that has a whorl height of 30 mm and a breadth of 21.0 mm; the greatest breadth is at the poorly preserved umbilical shoulder. Flanks are very broadly rounded and converge toward the flattened venter. One or two strong, prorsiradiate primary ribs arise from an umbilical bulla. An occasional secondary rib is long and strong. All ribs support low bullate ventrolateral tubercles and then flex forward and terminate in prominent ventral clavi that border the venter. Umbilical bullae are estimated at 7 per whorl, and ribs are estimated at 18 per half whorl. The suture is not preserved.

REMARKS: USNM 456695 closely resembles in its

size and ornament the last part of a specimen from the Anacacho Limestone figured by YOUNG (1963, Pl. 2, Figs 15, 17) as *H. marroti*; it was associated with *Pachydiscus* (*P.*) *travisi* (ADKINS, 1929).

OCCURRENCE: YOUNG (1963) recorded the species from the Anacacho Limestone of Bexar and Medina Counties. His record from the Wolf City Sand represent a different species. KENNEDY (1986b, p. 73) noted the presence of *H. marroti* in France, Germany, Belgian-Netherlands border area, Portugal, Israel, central Asian republics that were formerly part of the Soviet Union, and Madagascar. USNM 456695 is from USGS Mesozoic locality 16493, Medina County, Texas.

Suborder Ancyloceratina WIEDMANN, 1966
Superfamily Turrilitaceae GILL, 1871
Family Nostoceratidae HYATT, 1894
Genus *Eubostrychoceras* MATSUMOTO, 1967

TYPE SPECIES: *Eubostrychoceras indopacificum* MATSUMOTO, 1967, p. 333, Pl. 18, Fig. 1, by original designation.

Eubostrychoceras reevesi (YOUNG, 1963)
(Pl. 2, Figs 1-5, 8; Pl. 4, Figs 1-5; Pl. 5, Fig. 4)

1963. *Cirroceras reevesi* YOUNG, p. 44, Pl. 5, Figs 2, 3, 6, Text-fig. 7k, m.
1994. *Eubostrychoceras reevesi* YOUNG; COBBAN & KENNEDY, p. D5, Pl. 2, Figs 15-18.

TYPES: Holotype is TMM 30491, paratype TMM 30490; both are from the Anacacho Limestone 8.7 km. north of Sabinal, Medina County, Texas. Figured specimens are USNM 475981-475988 from the Anacacho Limestone, Medina County.

MATERIAL: Twelve fragments including USNM 475981-475988, all internal moulds, from the Anacacho Limestone.

DESCRIPTION: The holotype comprises two dextral helical whorls not in contact. Whorls have circular cross sections and ornament of about 40 rursiradiate ribs per volution. The paratype is apparently an adult body chamber of two helical whorls not in contact. YOUNG (1963, p. 44) mentioned the presence of one or two tubercles on some ribs.

Most of the specimens in the USGS collections have sinistral coiling. All but one have open helical whorls that do not touch one another. The exception, USNM 475981 (Pl. 2, Figs 1, 2), has two whorls barely in contact. The smallest specimen in the collections (USNM 475982) is an open helical fragment of half a whorl 56.5 mm in diameter (Pl. 2, Fig. 3). The largest specimen, USNM 475983, is a complete body chamber of about 11/4 whorls (Pl. 2, Fig. 8) that forms a low, open spire for most of its length and then straightens slightly and recurves back a little so that the aperture is directed obliquely upward alongside the helix.

All specimens have dense ribbing that is strongest on the outer side of the whorls and weakest on the inner side. Ribs are mostly single and pass completely around the whorl; an occasional rib branches into two ribs on either the lower or upper whorl face. Ribs are narrow and rursiradiate on the outer whorl face and prorsiradiate on the inner face. Six to ten ribs are present on the middle of the outer whorl face in a distance equal to the whorl height. Three to five constrictions per whorl are bordered on their adapertural sides by high, thickened ribs that parallel the rest of the ribbing. Constrictions are absent on the two body chambers in the collections; ribbing on these body chambers is coarser and sparser than that on the helical spire, and every second to fourth rib supports a low, nodate tubercle with one row in the middle of the outer whorl face and the other lower down on that face. Sutures are poorly preserved on the septate specimens in the collections.

REMARKS: *Eubostrychoceras reevesi* differs from the associated *Bostrychoceras polyplocum* (ROEMER, 1841) in its loose coiling, the whorls well-separated, and lack of tubercles on all volutions except the body chamber. The extremely loose helical coiling of some specimens of *E. reevesi* (Pl. 4, Fig. 5) is comparable to that of *Bostrychoceras otsukai* (YABE 1904, p. 14, Pl. 3, Fig. 9; Pl. 4, Figs 1-2) and to that of specimens from Madagascar referred to that Japanese species by COLLIGNON (1969, p. 31, Pl. 524, Figs 2066-2068). *Bostrychoceras otsukai*, of Santonian age, is densely ribbed like *E. reevesi* but has no constrictions or tubercles. *Bostrychoceras protractum* COLLIGNON, 1969 (p. 32, Pl. 524, Figs 2069, 2070), from the lower Campanian of Madagascar, is also much like *B. otsukai*.

OCCURRENCE: Anacacho Limestone in Medina County, Texas, at USGS Mesozoic localities 7680, 7694, 12903, and D2456; J.P. CONLIN localities M-1-Kta and M2-Kta. The species has also been found in the Anacacho Limestone to the southwest in Uvalde County, Texas, and in the Pecan Gap Chalk in central Texas.

Genus *Bostrychoceras* HYATT, 1900

TYPE SPECIES: *Turrilites polyplocus* ROEMER, 1841, p. 92, Pl. 14, Figs 1-2, by original designation.

Bostrychoceras polyplocum (ROEMER, 1841)
(Pl. 4, Fig. 6; Pl. 5, Figs 1-3, 5-7; Text-fig. 3)

1841. *Turrilites polyplocus* ROEMER, p. 92, Pl. 14, Fig. 1 only, not 2 = *Eubostrychoceras saxonicum* (SCHLÜTER, 1876).
1963. *Bostrychoceras secoense* YOUNG, p. 42, Pl. 3, Figs 1-5; Pl. 4, Figs 4-8; Text-fig. 7s.
1986b. *Nostoceras (Bostrychoceras) polyplocum* (ROEMER, 1841); KENNEDY, p. 92, Pl. 6, Fig. 1; Pl. 15, Figs 1-3, 4-8; Text-figs 32-35 (with full synonymy).
1994. *Nostoceras (Bostrychoceras) polyplocum* (ROEMER, 1841); EMERSON & *al.*, p. 306, upper unnumbered Figs on p. 307.
1997. *Bostrychoceras polyplocum* (ROEMER, 1841); KENNEDY & CHRISTENSEN, p. 104, Fig. 20.
1997. *Bostrychoceras polyplocum* (ROEMER, 1841); KENNEDY & KAPLAN, p. 52, Pls 39-51 (with full synonymy).

TYPES: ROEMER mentioned specimens from Dülmen, Lemförde, and Weinböhlen, figured one from an unspecified locality (Pl. 14, Fig. 1) and a second from the "Pläner bei Weinböhlen" (Pl. 14, Fig. 2). In the synonymy he cited "GEINITZ Pl. 13, Fig. 2", the original of which is thus also a syntype. WIEDMANN (1962, p. 198) stated that SCHLÜTER (1872a) designated the original of ROEMER's Pl. 14, Fig. 1 lectotype, but this is not the case; BŁASZKIEWICZ (1980, P. 20) attributed lectotype designation to WIEDMANN (1962, p. 198), but this is also not the case. ROEMER's types are lost; the only specimen assignable to *polyplocum* in the collections at Wroclaw (letter from Dr. J. GORCZYCA-SKALA, 27.11.1984) is from Haldem and is thus not part of the type series. A specimen in the ROEMER Museum, Hildersheim, said to be from Lemförde, does not correspond to ROEMER's figure. The paratype figured by GEINITZ is, according to WIEDMANN (1962, p. 198) referable to *Turrilites saxonicus* SCHLÜTER, 1876 (p. 135), who designated the lost original of ROEMER (1841, Pl. 14, Fig. 2), the lectotype of *saxonicus*. KENNEDY designated the original of ROEMER, 1841, Pl. 14, Fig. 1, lectotype of *polyplocum* and stated that neotype designation was highly desirable to stabilize the nomenclature. KENNEDY & KAPLAN (1997, p. 54) accordingly designated the lower part of BMNH 37092 neotype. It is from Haldem, Westphalia, and is illustrated here as Text-fig. 3.

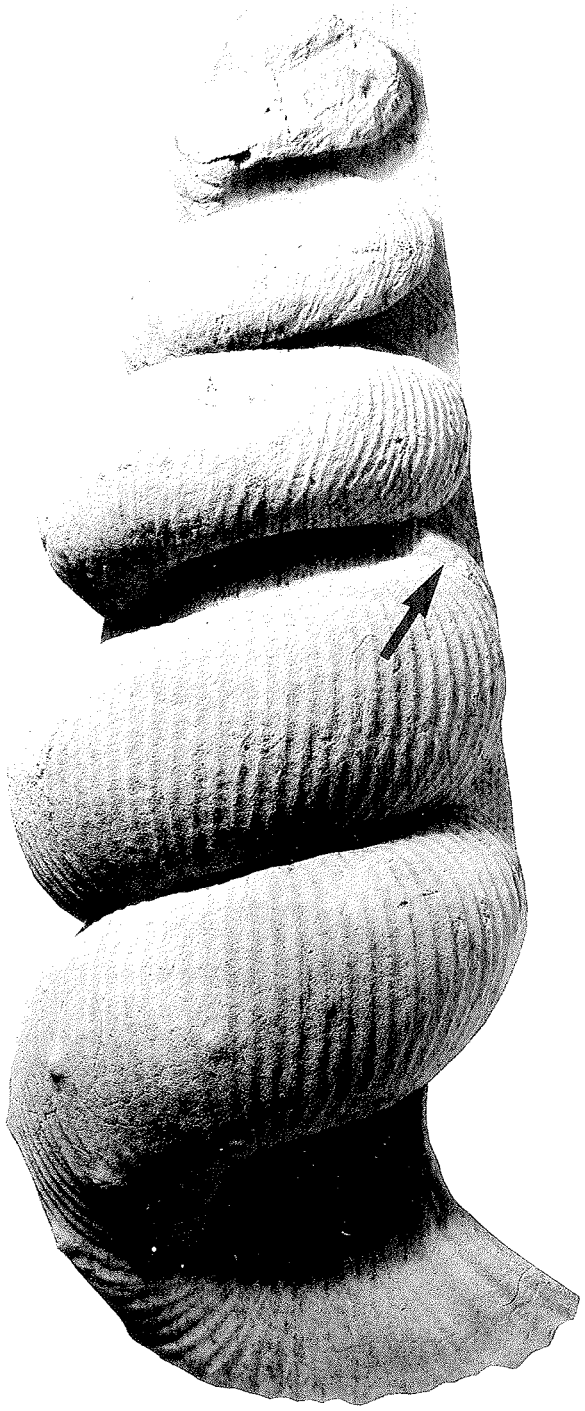

Fig. 3. *Bostrychoceras polyplocum* (ROEMER, 1841). BMNH 37092, ex KRANTZ Collection, from 'Haldem', Westphalia, Germany; the last 3 whorls of this specimen (to the point indicated by the arrow) was designated neotype by KENNEDY & KAPLAN (1997); there is a marked break at the point marked, and the upper 3 whorls may not belong to the same specimen; reduced × 0.75

MATERIAL: Six variously crushed internal moulds, including USNM 475989-475992.

DESCRIPTION: The smallest whorls known (whorl height of 10 mm) form a loose helix in which whorls are not in contact (KENNEDY 1986b, Text-fig. 34B, C). Later whorls are loosely in contact and form high to low spires. Whorl cross sections are circular. Constrictions are present, but few, and are usually not conspicuous except for a pronounced one at the aperture. A high rib may bound a constriction on one side or the other. The younger part of the body chamber straightens a little as it leaves the spire and then recurves back and up slightly so that the aperture is directed obliquely upward (Pl. 5, Fig. 6).

Ornament consists mainly of narrow, closely spaced ribs that are weak on the inner whorl face but strengthen and become convex on the base of the whorl and cross the outer whorl face in a markedly prorsiradiate manner. Specimens from the Anacacho Limestone have 9 to 12 ribs on the middle of the outer whorl face in a distance equal to the whorl height. Most ribs are single, although some ribs may link in pairs at rounded to slightly bullate midlateral tubercles, or they may intercalate between and loop in pairs to a second row of tubercles displaced adaperturally to the upper row and located near the base of the whorl. One to three nontuberculate ribs are intercalated between the tuberculate ones, but the spacing is both variable and irregular. Some individuals have only one row of tubercles during part of their growth. Sutures are not preserved in the Anacacho specimens.

REMARKS: The species is dimorphic (KENNEDY 1986b, p. 95, Fig. 32; KENNEDY & KAPLAN 1997). Macroconchs are about twice as large as microconchs. The few specimens at hand from the Anacacho may be all microconchs. Two whorls of an undistorted macroconch from a calcareous concretion collected near Esperanzaa, Coahuila, Mexico, are shown in Pl. 5, Fig. 7. This is the first record of the species from Mexico.

The synonymy of *B. polyplocum* and the relationship of this species to other species were reviewed in detail by KENNEDY (1986b) and KENNEDY & KAPLAN (1997). The latter studied more than 100 specimens from Haldem, Westphalia, the source of the neotype. Their material came from a more than 50 m interval in the Upper Haldem-Schichten, and they interpreted the species as widely variable.

This study of the Haldem material suggests that, following the early bituberculate stage there is a middle growth stage in which all tubercles are lost, the upper row persists, the lower row persists, both upper and lower rows persist, or tubercle development may be irregular, with parts of the same individual showing different conditions (e.g. uni- and non-tuberculate). Adult individuals all show a return to a bituberculate final section of recurved body chamber. KENNEDY & KAPLAN concluded that the material could be interpreted as a highly variable dimorphic species, with some evidence that there may be a vertical change in the incidence of variants.

The missing lectotype of *polyplocum* is an individual that lacks tubercles on the 1.5 whorls preserved. The apparent development of what seem to be occasional tubercles at three different levels on the ribs is in our view no more than the irregular presence of conellae, a diagenetic development of small cones of calcite. ROEMER recorded the species from Dülmen, Lemförde and Weinböhlen, and indicated the original of his Pl. 14, Fig. 2 to be from Weinböhlen. This specimen, now missing is a specimen of *Eubostrychoceras saxonicum* (SCHLÜTER, 1876), as in the paralectotype figured by GEINITZ (1843, Pl. 3, Fig. 1) and referred to *polyplocum* by ROEMER.

We have no way of determining the original locality of the lectotype. Dülmen is best known for Lower Campanian fauna of the Dülmener Schichten (KENNEDY & KAPLAN 1995). *Bostrychoceras* do, however, occur in the Münster Basin, and the Baumberger Schichten yields an assemblage that consists almost entirely of individuals with a nontuberculate middle growth stage.

WIEDMANN (1962) provided an extensive discussion of *Bostrychoceras polyplocum*, and introduced a number of new names, based on SCHLÜTER figures. WIEDMANN regarded the missing originals of SCHLÜTER, 1872, Pl. 33, Figs 3-4, as belonging to the Indian species *Eubostrychoceras* [*Heteroceras*] *indicum* STOLICZKA, 1866 (p. 184, Pl. 86, Figs 1-2), subspecies *saxonicum* SCHLÜTER, 1876 (p. 135). The syntypes of *indicum* were refigured by MATSUMOTO (1967, Pl. 18, Figs 2-3). The species *saxonicum* of SCHLÜTER was revised by KAPLAN & SCHMID (1988). It is a much older, Turonian-Coniacian species, and resemblance to SCHLÜTER's Haldem specimens is superficial only. WIEDMANN referred the original of SCHLÜTER's Pl. 34, Fig. 1 to *polyplocum*. It was reillustrated by KENNEDY & KAPLAN (1997, Pl. 40, Fig. 11), and is bituberculate throughout. The original of SCHLÜTER's Pl. 34, Figs 2, 3 was made the holotype of *Cirroceras depressum* WIEDMANN, 1962 (p. 199, footnote), and SCHLÜTER's Pl. 34, Figs 4-5, was referred to the new species with a query. These two specimens cannot be traced in the SCHLÜTER collection. Both are, in our view, *Bostrychoceras polyplocum* that were buried with the axis of coiling normal to bedding,

and their wide apical angle and low spire are a post-mortem artefact of compaction. A comparable specimen was illustrated by KENNEDY & KAPLAN (1997, Pl. 47, Figs 4-6). The holotype of *depressum* has the lower row of tubercles only indicated on the illustration (SCHLÜTER 1872, Pl. 34, Fig. 3); similar individuals occur in *polyplocum* crushed normal to the axis of coiling (KENNEDY & KAPLAN 1997, Pl. 46, Figs 1, 2). SCHLÜTER's Pl. 34, Figs 4-5, referred to *depressum* with a query by WIEDMANN, lacks all indication of tubercles and is a crushed individual corresponding to the neotype (Text-fig. 3). WIEDMANN described *depressum* as having 120 ribs per whorl; the figure of the holotype has only just over 100.

SCHLÜTER's Pl. 35, Figs 1-4, referred to by him as *Heteroceras polyplocum*? was made the holotype of *Cirroceras* (*Cirroceras*) *schloenbachi densecostatum* WIEDMANN, 1962 (p. 204). This specimen has not been traced, but the original of SCHLÜTER's Pl. 35, Figs 5-7 survives, and was refigured by KENNEDY & KAPLAN (1997, Pl. 39, Figs 2-3). The holotype and paratype of *C.* (*C.*) *schloenbachi densecostatum* are no more than early growth stages of *B. polyplocum* crushed normal to the axis of coiling. True *Helicoceras schloenbachi* FAVRE, 1869 (p. 30, Pl. 7, Fig. 5) is a small, distinctive Maastrichtian species, revised by KENNEDY & SUMMESBERGER (1987, p. 30, Pl. 2, Figs 1-5).

YOUNG (1963, p. 42) did not believe that *B. secoense* n. sp. can be differentiated from the nodate forms described as *B. polyplocum* (RÖMER) by SCHLÜTER (1872) on his Pl. 34, Figs 1 and 3. We agree with this, but rather than separating these forms as *Bostrychoceras secoense*, regard it as a synonym of *polyplocum*. The holotype of *secoense* (YOUNG, 1963, Pl. 3, Figs 3-4) is from the Anacacho Limestone on Seco Creek in Medina County, Texas.

BŁASZKIEWICZ (1980) described a series of large nostoceratids from the Upper Campanian of the Vistula Valley, Poland, as species of *Bostrychoceras* and *Didymoceras*. Two subspecies of *Bostrychoceras polyplocum* were recognized. *B. polyplocum schlueteri* BŁASZKIEWICZ, 1980 (p. 20, Pl. 2, Figs 1, 4, 9-11) was recognized in the Haldem faunas, with the originals of SCHLÜTER (1872a, Pl. 33, Figs 3-4), being referred to the subspecies, and the original of Pl. 33, Fig. 5 referred with a query. The subspecies was regarded by BŁASZKIEWICZ as occurring at a lower level in his *polyplocum* Zone than the nominate subspecies, having a lower rib density (about 50 ribs per whorl), lack of tuberculation on, and a tight coiling of the helicoid part.

Bostrychoceras unituberculatum BŁASZKIEWICZ, 1980 (Pl. 3, Figs 1-8; Pl. 4, Figs 3-6) co-occurs with what BŁASZKIEWICZ regarded as typical *B. polyplocum polyplocum* in the Vistula Valley sections and is characterized by a single row of tubercles (the upper one). Similar individuals occur in the Haldem faunas and may be both uni- and non-tuberculate in the same individual. KENNEDY & KAPLAN regard all of these Polish specimens as variants of a variable *B. polyplocum*.

The relationship of the other large Polish nostoceratids described by BŁASZKIEWICZ (1980) to *B. polyplocum* is fully discussed by KENNEDY & KAPLAN (1997).

Madagascan specimens referred to *polyplocum* (e.g. BOULE & *al.* 1907, p. 41 (61), Pl. 7 (14), Figs 1-2) are *Eubostrychoceras*, referred to *saxonicum* of SCHLÜTER by WIEDMANN (1962, p. 201) and to *indopacificum* by MATSUMOTO (1967, p. 333).

Cirroceras (*Cirroceras*) *polyplocum zumayaense* WIEDMANN, 1962 (p. 200, Pl. 9, Fig. 5) is an Upper Campanian *Nostoceras hyatti* STEPHENSON, 1941, as discussed by WARD & KENNEDY (1993, p. 14, Text-fig. 15).

OCCURRENCE: Anacacho Limestone in Medina County, Texas, at USGS Mesozoic localities 7694 and 10865 and at J.P. CONLIN's localities M-1-Kta and M-2-Kta. Anacacho Limestone in Travis County, Texas at USGS Mesozoic locality 16424. Flattened specimens also occur in the Pecan Gap Chalk to the east in the San Antonio area. *Bostrychoceras polyplocum* is widely distributed outside the United States; it occurs in Coahuila, Mexico, and in the upper Campanian of northern Ireland, England (Norfolk), France (Aquitaine and Tercis in Landes), Spain, Germany, Poland, European Russia, Bulgaria, central Asian republics that were formerly part of the Soviet Union, Iran, and North Africa.

Family Diplomoceratidae SPATH, 1926
Genus *Lewyites* MATSUMOTO & MIYAUCHI, 1984

TYPE SPECIES: *Idiohamites*(?) *oronensis* LEWY, 1969, p. 127, Pl. 3, Figs 10, 11, by original designation by MATSUMOTO & MIYAUCHI (1984, p. 64). The type species came from the upper Campanian Mishash Formation of Israel.

Lewyites clinensis (ADKINS, 1929)
(Pl. 4, Figs 7-9; Text-fig. 4)

1929. *Hamites*(?) *clinensis* ADKINS, p. 208, Pl. 6, Figs 10, 11.
1956. *Neancyloceras clinense* (ADKINS); ADKINS, p. 107.
1994. *Neancyloceras clinense* (ADKINS, 1929); EMERSON & *al.*, p. 315, unnumbered Fig. on p. 315.

TYPE: The holotype is TMM 21006, from the Anacacho Limestone near Cline, Uvalde County, Texas.

DESCRIPTION: The holotype, and only known specimen (Pl. 4, Figs 7-9) is a partly septate internal mould of a straight shaft and part of a curved sector of a specimen 120 mm long that has a costal breadth (Wb) of 17.6 mm and a height (Wh) of 191.0 mm Wb:Wh=0.93) at its larger end. The intercostal cross section is nearly circular, but the costal section has a flattened venter. Ribs are prorsiradiate, straight, single, narrower than the interspaces, and strongest on the flank. The rib index is 7. Pairs of ribs are united at the ventrolateral shoulder by a low clavus and then weaken on crossing the venter transversely, where the adapical rib supports a very low siphonal node. A single nontuberculate rib separates the tuberculate ribs. Septa are unusually widely spaced and separated by a distance almost twice the whorl height. The suture has deeply bifid triangular lobes and saddles (Text-fig. 4).

REMARKS: *Lewyites clinensis* is the only known species of *Lewyites* that has siphonal tubercles. *Lewyites taylorensis* (ADKINS, 1929) (p. 209, Pl.6, Figs 12, 13) has a more compressed cross section and finer ribbing with broad, blunt swellings connecting the tubercles across the venter. *Lewyites circularis* (LEWY, 1969) (p. 128, Pl.3, Fig. 9) has a circular cross section like that of *L. clinensis*, but it lacks siphonal tubercles.

OCCURRENCE: Known with certainty only from the holotype from the Anacacho Limestone at the Texas Asphalt Company's pit near Cline, Uvalde County, Texas.

Family Baculitidae GILL, 1871
Genus *Baculites* LAMARCK, 1799

TYPE SPECIES: *Baculites vertebralis* LAMARCK, 1801, p. 103, by subsequent designation by MEEK (1876, p. 391).

Baculites taylorensis ADKINS, 1929
(Pl. 6, Figs 8-9)

1929. *Baculites taylorensis* ADKINS, p. 204, Pl. 5, Figs 9-11.
1993. *Baculites taylorensis* ADKINS; KENNEDY & COBBAN, p. 93, Figs 10.1-10.9, 10.11, 10.12, 10.16, 10.18, 10.19, 11.1, 11.2.
non 1970. *Baculites* cf. *taylorensis* ADKINS; COLLIGNON, p. 13, Pl. 612, Fig. 2285.
1993a. *Baculites taylorensis* ADKINS, 1929; KENNEDY & COBBAN, p. 143, Pl. 6, Figs 1-9; Pl. 7, Figs 1-6, 10-13; Text-figs 8b, d.
1994. *Baculites taylorensis* ADKINS, 1929; EMERSON & *al.*, p. 323, 394.

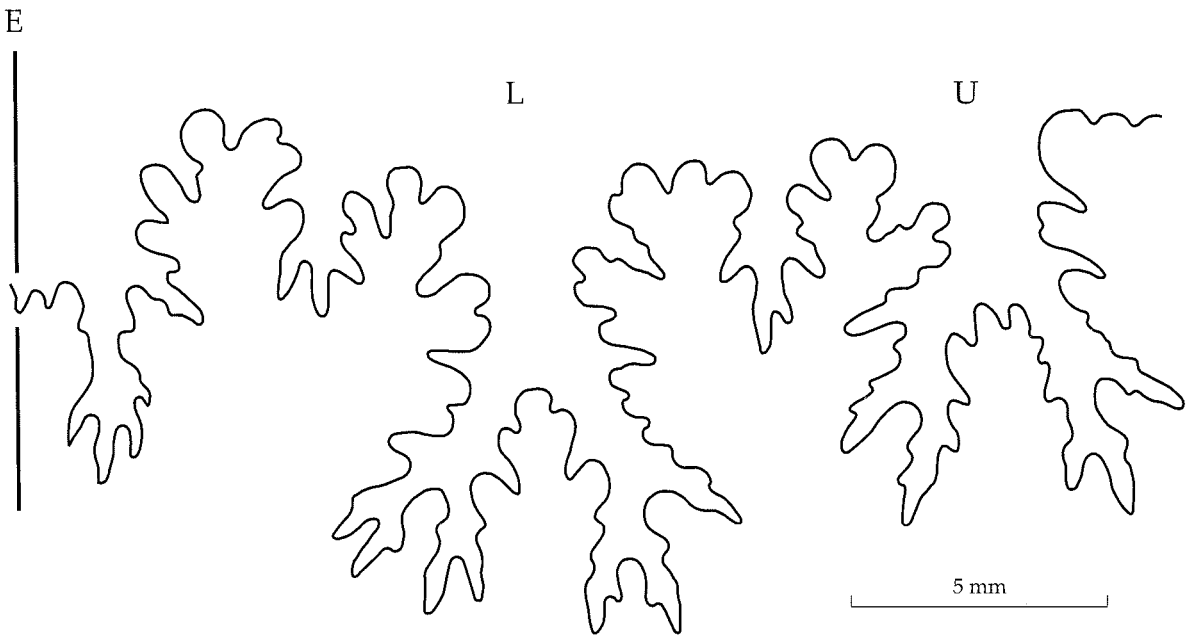

Fig. 4. Most of the suture of the holotype of *Lewyites clinensis* (ADKINS, 1929) (TMM 21006). E is the external lobe, L is the lateral lobe, and U is the umbilical lobe; the heavy, straight line marks the middle of the venter

TYPES: Holotype is TMM 21014, and paratypes are TMM 21015 and 21016. All are from the basal part of the Pecan Gap Chalk in Travis County, Texas.

MATERIAL: Two crushed specimens, USNM 475994 and 475995, from the Anacacho Limestone at USGS Mesozoic locality 7680.

DESCRIPTION: USNM 475994 is an internal mould 115 mm long that has a whorl height of 30 mm at its larger end (Pl.6, Fig. 9) . Large, strong, crescentic flank nodes are spaced at 1.7-2.0 times the distance equal to the whorl height at the midpoint of the interval counted. Ribs are barely discernible on the venter. USNM 475995 is a smaller internal mould 76 mm long with a whorl height of 20 mm at the larger end (Pl. 6, Fig. 8). Prominent flank nodes are very widely spaced at 0.5 times the whorl height. Sutures are not preserved on either specimen.

REMARKS: Although crushed, the two specimens from the Anacacho Limestone have the same ornament as typical uncrushed *B. taylorensis* from the Pecan Gap Chalk.

OCCURRENCE: Both specimens are from USGS Mesozoic locality 7680 on Hondo Creek, Medina County, Texas. The species is abundant in the basal part of the Pecan Gap Chalk in central and northeastern Texas and is less common in the base of the Annona Chalk in Hempstead and Howard Counties in southwestern Arkansas.

Superfamily Scaphitaceae GILL, 1871
Family Scaphitidae GILL, 1871
Genus *Trachyscaphites* COBBAN & SCOTT, 1964

TYPE SPECIES: *Trachyscaphites redbirdensis* COBBAN & SCOTT (1964, p. E7, Pl.1, Figs 1-7; Text-fig. 3), by original designation, from the Pierre Shale of eastern Wyoming.

Trachyscaphites spiniger (SCHLÜTER, 1872) *porchi*
(ADKINS, 1929)
(Pl. 6, Figs 1-7)

1929. *Scaphites porchi* ADKINS, p. 203, Pl. 5, Figs 1-3.
1929. *Scaphites aricki* ADKINS, p. 206, Pl. 5, Figs 7-8.
1964. *Trachyscaphites spiniger* (SCHLÜTER) subspecies *porchi* ADKINS; COBBAN & SCOTT, p. E10, Pl. 2, Figs 1-23; Pl. 3, Figs 1-11; Text-fig. 4.
1969. *Trachyscaphites spiniger levantinensis* LEWY, p. 132, Pl. 4, Fig. 1.
1993a. *Trachyscaphites spiniger* (SCHLÜTER, 1872); *porchi* (ADKINS, 1929); KENNEDY & COBBAN, p. 77, Figs 7.1-7.17.
1994. *Trachyscaphites spiniger* (SCHLÜTER, 1872) *porchi* (ADKINS, 1929); COBBAN & KENNEDY, p. D7, Pl. 4, Figs 1-4; Pl. 5; Text-fig. 8.
1994. *Trachyscaphites spiniger porchi* (ADKINS, 1929); EMERSON & *al.*, p. 337, 396.
1997. *Trachyscaphites spiniger* (SCHLÜTER, 1872) *porchi* (ADKINS, 1929); KENNEDY & *al.*, p. 40, Figs 24A, B, E-1.
1997. *Trachyscaphites spiniger porchi* (ADKINS, 1929); KENNEDY & KAPLAN, p. 65, Pl. 74, Figs 1-3, 7.

TYPES: The holotype is no. 21011, paratypes nos. 21012, and 21013, in the collections of the Bureau of Economic Geology, now housed in the Texas Memorial Museum, Austin, and from the Pecan Gap Chalk on the Austin-Manor Road, 12.4 km (7.5 mi.) northeast of Austin, Travis County, Texas.

DESCRIPTION: The holotype is a phosphatic internal mould of most of a body chamber that has a length of 47.5 mm. and, at its larger end, an intercostal breadth of 26 mm and a restored height of about 21 mm (Wb:Wh-1.24). When viewed from the side, the specimen has a concave umbilical wall, which suggests a microconch. Ornament consists only of four rows of nearly equal-sized, somewhat clavate tubercles. The holotype of *Scaphites aricki* ADKINS (1929, p. 206, Pl. 5, Figs 7-8), which represents the phragmocone of *T. spiniger porchi*, is most of the last half whorl of a septate coil that had an estimated diameter of about 51 mm. Ornament on this internal mould consists of four rows of small, nearly equal-sized, pointed, nodate tubercles and fairly weak, dense ribbing.

Like all scaphites, *T. spiniger porchi* is dimorphic. Macroconchs from the Anacacho Limestone are as much as 75 mm long, and microconchs attain lengths of 60 mm. Macroconchs have swollen body chambers that have broad, slightly convex, sloping umbilical walls, whereas microconchs have more slender body chambers and steep, concave umbilical walls. When viewed from the side, the older half of the body chamber has a nearly straight (slightly convex or slightly concave) umbilical wall, whereas the venter has an even, broadly rounded form; the younger half of the body chamber has a narrowly curved umbilical wall and a well-rounded venter. The aperture is marked by a conspicuous, slightly flexuous constriction that has a dorsal lappet and faint lateral and ventral projections (Pl. 6, Fig. 1).

Ornament on the Anacacho body chambers consists of 5 or 6 nodate tubercles on the ventrolateral shoulder, 9 or 10 smaller, nodate tubercles at midflank, 10 or 11

slightly larger inner ventrolateral tubercles, and 10 to 13 outer ventrolateral clavi. Most macroconch body chambers lack ribs. but occasional specimens have barely discernible dense ribbing. Ribbing is well developed on phragmocones. Rectiradiate umbilical ribs connect to conical tubercles located on the umbilical shoulder. From these tubercles, pairs of ribs and intercalated ribs cross the flank; the paired ribs link to stronger nodate lateral tubercles that are more numerous than those in the umbilical row. The lateral tubercles give rise to single ribs or pairs of ribs that, with additional intercalated ribs, link to conical inner ventrolateral tubercles and to similar-sized outer ventrolateral tubercles. Sutures are not preserved.

REMARKS: Because the specimens from the Anacacho Limestone are not well preserved, an excellent specimen (USNM 476000) from the Mancos Shale of western Colorado is shown in Pl. 6, Figs 6-7, for comparison. *Trachyscaphites spiniger porchi* evolved from *T. s. spiniger* (SCHLÜTER, 1872, p. 82, Pl. 25, Figs 1-7; see revision in KAPLAN & KENNEDY, 1997) by loss of all or most ribbing on the body chamber. *Trachyscaphites redbirdensis* COBBAN & SCOTT (1964, p. E7, Pl.1, Figs 1-7; Text-fig. 3) evolved from *T. s. porchi* by the addition of another row of tubercles.

OCCURRENCE: Anacacho Limestone in Medina County, Texas, at USGS localities 7680 and D2456 and at J.P. CONLIN localities M-2-Kta and M-3-Kta. The subspecies is also found in the Pecan Gap Chalk to the east in Texas and in the Wolfe City Sand and Pecan Gap Chalk in northeastern Texas. In the Western Interior, *T. s. porchi* ranges through the middle Campanian zones of *Baculites mclearni* and *B. asperiformis*. The scaphite occurs in the Claggett Shale in central Montana, in the Mancos Shale in western Colorado, and in the Pierre Shale in eastern Colorado and western Kansas. It is also present in the Mishash Formation in Israel.

Acknowledgments

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PLATES 1-6

PLATE 1

1-6 – *Pachydiscus* (*Pachydiscus*) *travisi* (ADKINS, 1929).
1-3 - USNM 475976, from J.P. CONLIN's locality M-2-Kta.
4-6 - USNM 475977, from USGS Mesozoic locality 7680.


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PLATE 2

1-5, 8 – *Eubostrychoceras reevesi* (YOUNG, 1963)
1-2 – USNM 475981, from J.P. CONLIN's locality M-2-Kta.
3 – USNM 475982, from USGS Mesozoic locality 12903.
4-5 – USNM 475984, from J.P. CONLIN's locality M-2-Kta.
8 – USNM 475983, from USGS Mesozoic locality 7694.

6-7, 11-13 – *Pachydiscus* (*P.*) *travisi* (ADKINS, 1929) 6, 7 - USNM 475978, from USGS Mesozoic locality 7680.
11-13 – USNM 475975, from USGS Mesozoic locality 7680.

9-10 – *Pachydiscus* (*Pachydiscus*) sp. USNM 475979, from J.P. CONLIN's locality M-2-Kta.

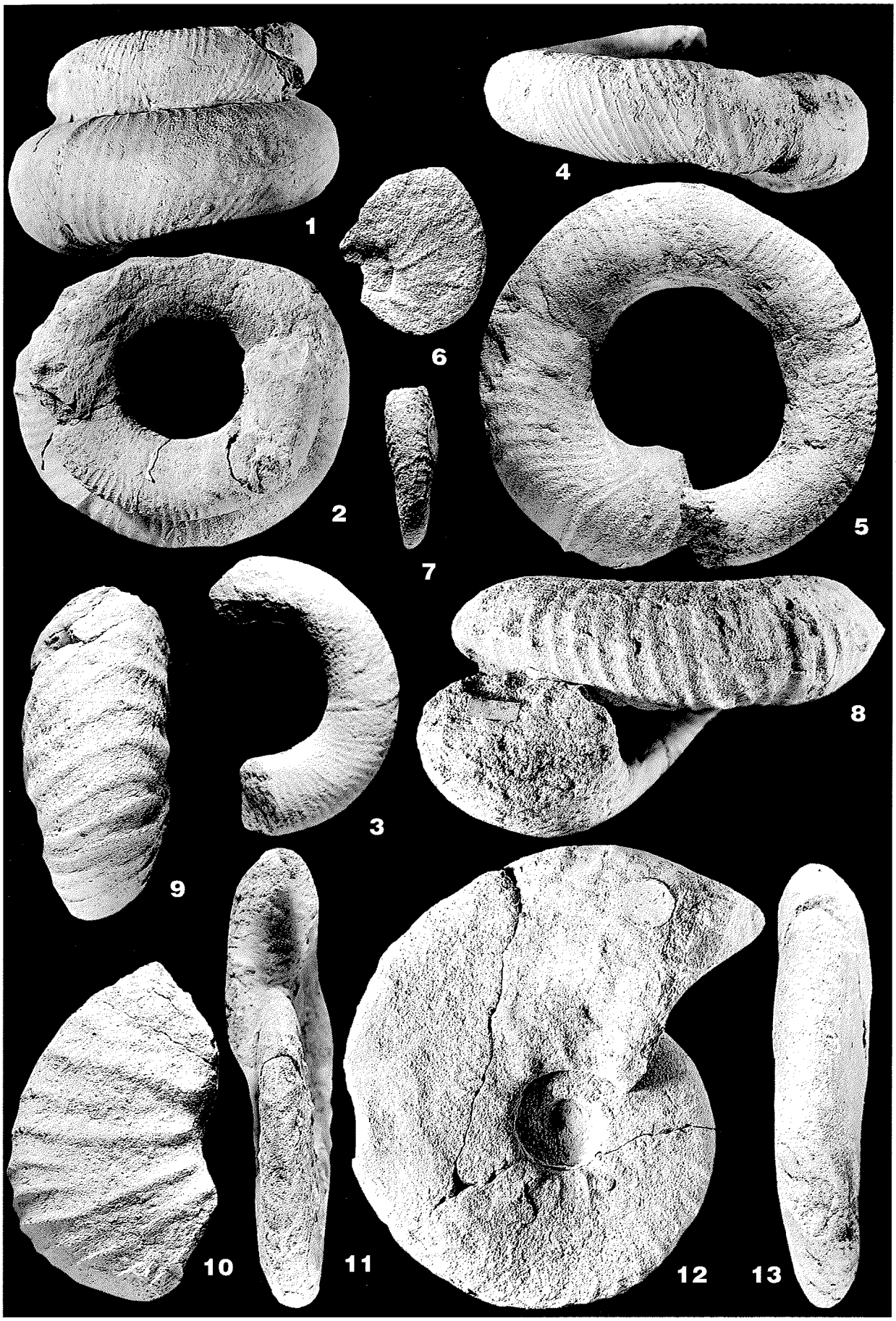
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PLATE 3

Pachydiscus (*P.*) *streckeri* (ADKINS, 1928). USNM 475980, from Seco Creek near D'Hanis, Texas.

PLATE 4

1-5 – *Eubostrychoceras reevesi* (YOUNG, 1963)
1-2 – USNM 475985, from USGS Mesozoic locality D2456.
3-4 – USNM 475986, from J.P. CONLIN's locality M-2-Kta.
5 – USNM 475987, from USGS Mesozoic locality 12903.

6 – *Bostrychoceras polyplocum* (ROEMER, 1841). USNM 475989, from USGS Mesozoic locality 16424, Anacacho Limestone, right bank of Colorado River 0.6 km northeast of Delvalle, Travis County, Texas, collected by L.W.STEPHENSON, 1933.

7-9 – *Lewyites clinensis* (ADKINS, 1929). Holotype, TMM 21006, from the Anacacho Limestone near Cline, Uvalde County, Texas.

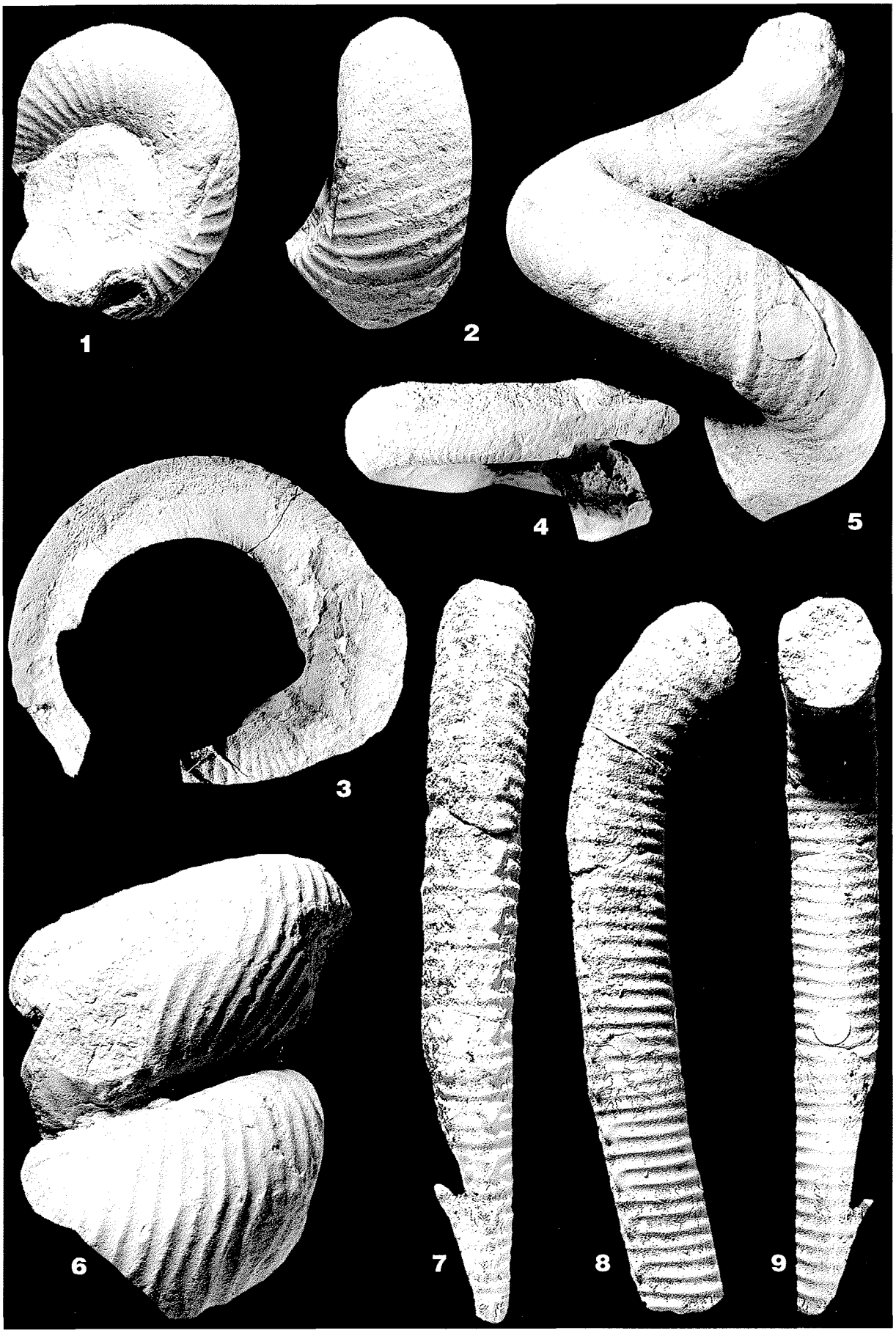
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PLATE 5

1-3, 5-7 – *Bostrychoceras polyplocum* (ROEMER, 1841).
1-2 – USNM 475990, from USGS Mesozoic locality 10865.
3 – USNM 475991, from J.P. CONLIN's locality M-1-Kta.
5-6 – USNM 475992, from USGS Mesozoic locality 7694.
7 – TMM 3552, from Esperanzas, Coahuila, Mexico.

4 – *Eubostrychoceras reevesi* (YOUNG, 1963). USNM 475988, from USGS Mesozoic locality 7680.

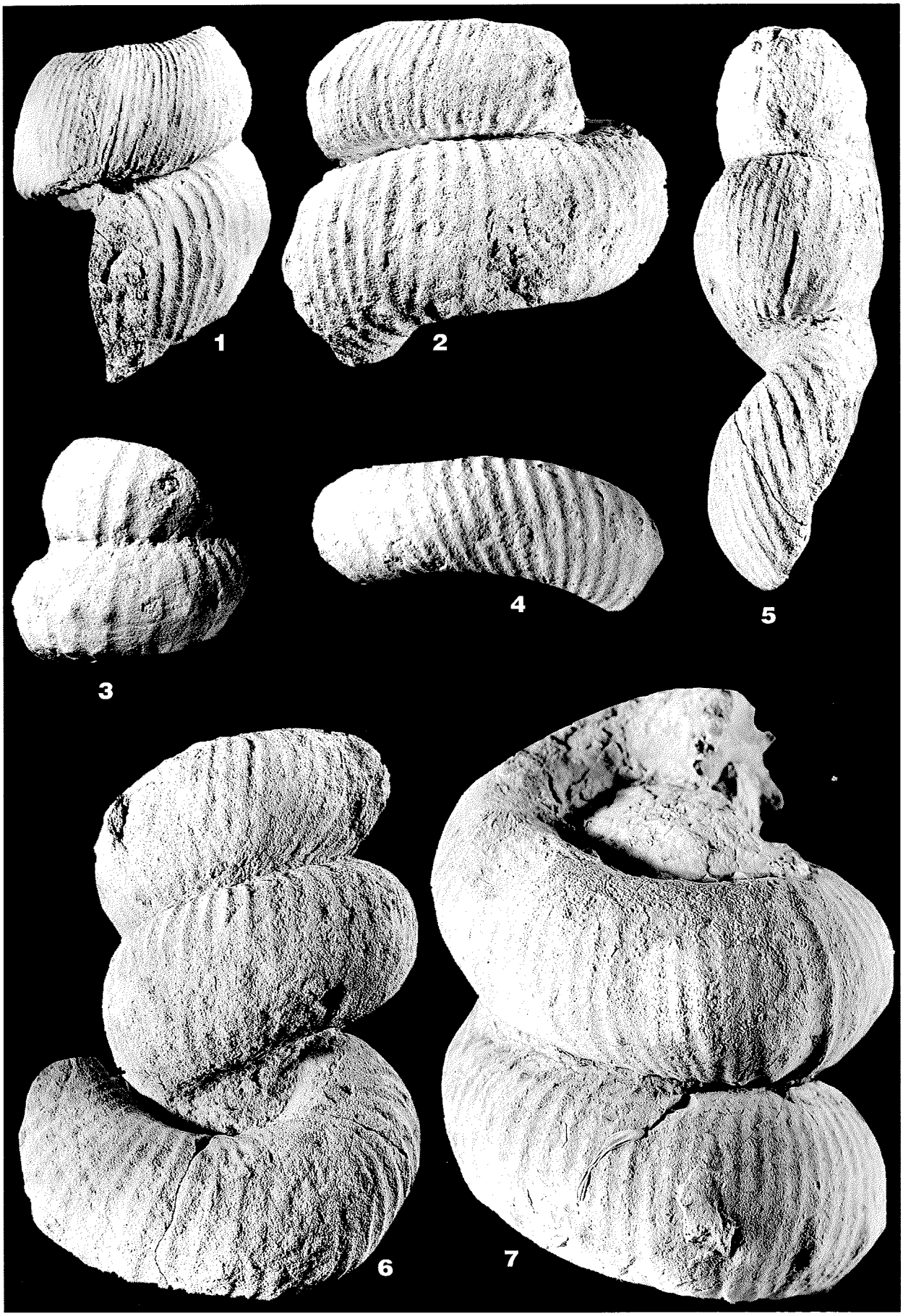
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PLATE 6

1-9 – *Trachyscaphites spiniger* (SCHLÜTER, 1872) *porchi* (ADKINS, 1929)
1 – USNM 475996, from USGS Mesozoic locality 7680.
2-3 – USNM 475997, from J.P. CONLIN's locality M-3-Kta.
4 – USNM 475998, from J.P. CONLIN's locality M-2-Kta.
5 – USNM 475999, from USGS Mesozoic locality 7680.
6-7 – USNM 476000, from a limestone concretion in the Mancos Shale 80 m below the base of the Castlegate Sandstone at USGS Mesozoic locality D9086 in the NE1/4 sec. 23, T. 5 N., R. 96 W., Moffat County, Colorado. Collected by Michael BROWNFIELD, 1973.

8-9 – *Baculites taylorensis* ADKINS, 1929.
8 – USNM 475995. from USGS Mesozoic locality 7680.
9 – USNM 475994, from USGS Mesozoic locality 7680.


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