Shorter Contributions to Paleontology and Stratigraphy 1993

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William J. Sando, Editor

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The Crummies Member (New Name) of the Pennsylvanian Breathitt Formation, Eastern Kentucky—Its Distribution and Biostratigraphy

By Charles L. Rice, Thomas W. Henry, and Donald R. Chesnut, Jr.

SHORTER CONTRIBUTIONS TO PALEONTOLOGY AND STRATIGRAPHY

U.S. GEOLOGICAL SURVEY BULLETIN 2073–A

Naming and description of an important and previously miscorrelated marine unit in the Middle Pennsylvanian of the central Appalachian basin

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1994

CONTENTS

FIGURES

TABLES

METRIC CONVERSION FACTORS

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile

The Crummies Member (New Name) of the Pennsylvanian Breathitt Formation, Eastern Kentucky—Its Distribution and Biostratigraphy

By Charles L. Rice ,[1] Thomas W. Henry,[2] and Donald R. Chesnut Jr.[3]

ABSTRACT

The name Crummies Member of the Breathitt Formation is here given to a marine unit that I.C. White in 1885 called the Cannelton Limestone in the Kanawha River valley of West Virginia. Rocks now assigned to the Crummies Member have been miscorrelated by other workers with the Campbell Creek Limestone of White (1885) in other areas of West Virginia as well as in eastern Kentucky and southwestern Virginia. Fieldwork and literature review suggest that the Crummies Member is an extensive deposit. In southeasternmost Kentucky, where it contains a varied molluscan fauna, it attains its greatest thickness; in northeastern Kentucky, it is present as a thin, discontinuous sandstone and sandy siltstone unit that contains more open-marine fauna.

INTRODUCTION

Geologists mapping poorly exposed and ill-defined marine units of Pennsylvanian age in eastern Kentucky before 1987 commonly accepted names that Hennen and Reger (1914) used for similar marine units underlying Logan and Mingo Counties in West Virginia. Three of these units (from oldest to youngest) are the Eagle Shale and Limestone of White (1891), the Cannelton (Stockton) Limestone of White (1885), and the Campbell Creek Limestone of White (1885). These three units, which are similar in appearance, were projected into eastern Kentucky from their type areas in the Kanawha River valley southeast of Charleston, W. Va. (fig. 1). However, the Eagle was incorrectly correlated with an older stratum, the Cannelton was miscorrelated with strata of the Eagle, and the Campbell Creek was miscorrelated with strata of the Cannelton (fig. 2). Regional correlation charts for Kentucky (such as Rice and Smith, 1980) unfortunately recorded these miscorrelations as part of the Pennsylvanian stratigraphic framework. Subsequently, the Eagle Shale and Limestone was renamed the Betsie Shale Member of the Breathitt Formation by Rice and others (1987). B.M. Blake, A.F. Keiser, and C.L. Rice (unpub. data, 1993) extended the Betsie Shale into West Virginia as a formal member of the Kanawha Formation for strata called there, as noted, the Eagle Shale and Limestone of White (1891). To correct the confusion surrounding the name and position of the Cannelton Limestone in eastern Kentucky, this extensive marine unit (incorrectly called the Campbell Creek Limestone of White (1885) before 1987) is here renamed the Crummies Member of the Breathitt Formation after the village of Crummies in Harlan County, Ky. The type section is a 109-ft section of shale, siltstone, and sandstone on U.S. Highway 421 about 1,500 ft east of Crummies (see appendix).

DESCRIPTION AND DISTRIBUTION

The Crummies Member is a unit of upward-coarsening shale, siltstone, limestone, and sandstone that is as much as 140 ft thick at the type locality (Tazelaar and Newell, 1974). It directly overlies the Path Fork coal bed and is disconformably overlain by a coal bed or, more commonly, by a channel-fill sandstone. The member is unusually fossiliferous in the vicinity of Crummies and is well exposed at mine adits along Cranks Ridge and Lone Spur. The lower few feet of the member are dark-gray silty claystone that contains a varied molluscan fauna. At the type locality, the Crummies Member directly overlies the 3-ft-thick Path Fork coal bed, which is extensively mined. Although the basal shale of the Crummies is reported to form a good roof for mining of the Path Fork coal bed, the roof rock dries out and tends to crack and spall down along

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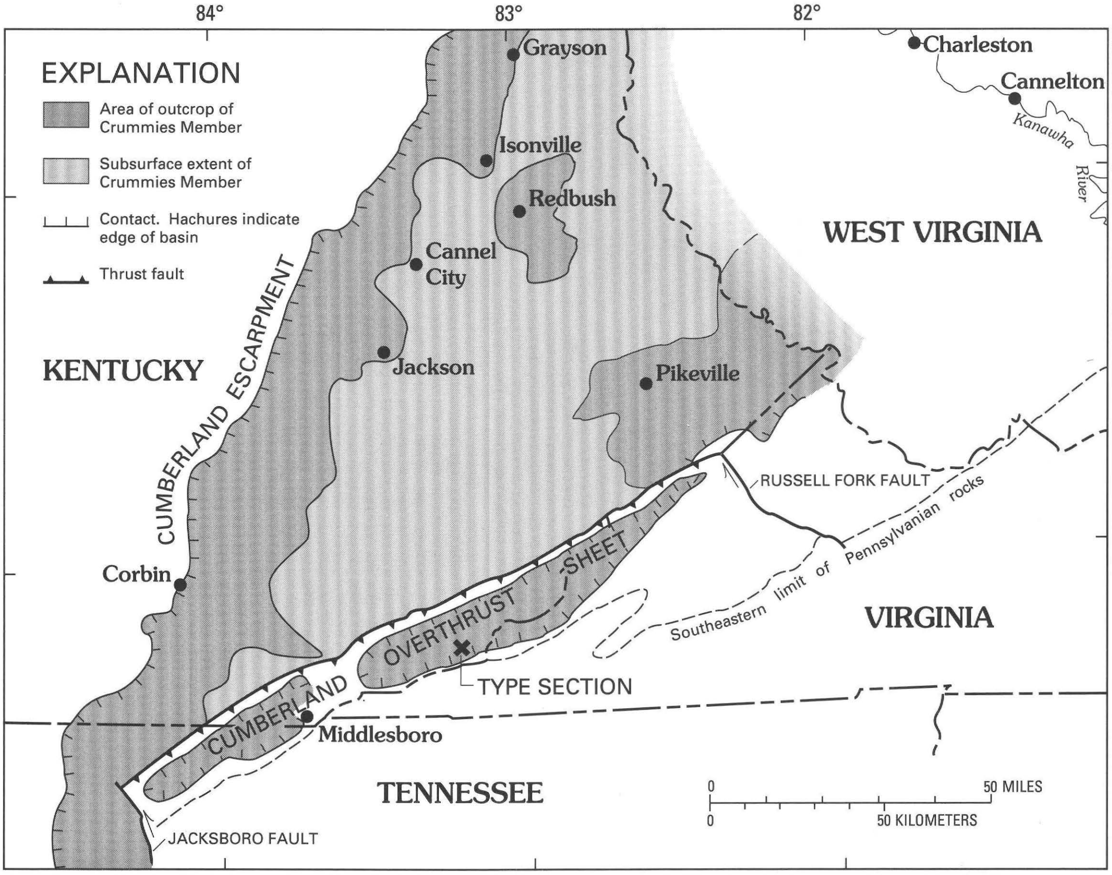

Figure 1. Location of the type section and distribution of the Crummies Member of the Breathitt Formation and equivalent strata in eastern Kentucky and adjacent areas of Tennessee and Virginia. The distribution of equivalent strata in West Virginia is not shown because of the uncertainty of correlation of the Cannelton Limestone of White (1885) with other marine units of the Kanawha Formation. The Cannelton Limestone takes its name from the village of Cannelton on the Kanawha River in West Virginia.

the main mining corridors and those used for ventilation. Some of this roof-fall material, which is periodically removed from the active mines, was found in a dump near the entrance of an adit on the southern side of Crummies Creek, approximately 3,600 ft ENE. of Little Creek Church (see Tazelaar and Newell, 1974). This dump provided a wealth of fossil material, which is listed listed in table 1.

Throughout eastern Kentucky, much of the Crummies Member is below drainage, but it does form three major outcrop belts (fig. 1): (1) the belt along the Cumberland overthrust sheet, (2) the easternmost Kentucky belt, which extends generally northeastward from Kentucky and Virginia into West Virginia, where it is equivalent to the Cannelton Limestone of White (1885), and (3) the belt that borders the Cumberland Escarpment along the northwestern edge of the eastern Kentucky coal field. A Crummies Member inlier is present near Redbush, Ky. (fig. 1). The Crummies Member is commonly fossiliferous at the type locality on the Cumberland overthrust sheet (Chesnut, 1991); however, no fossils have been reported in the unit southwest of Middlesboro, Ky. (fig. 1). In easternmost Kentucky, the Crummies Member overlies the Pond Creek rider (Lower Elkhorn rider) coal bed, and its middle part is characterized by large discoidal limestone concretions as much as 5 ft in diameter; some linguloid brachipods occur in the basal part of the unit east and northeast of Pikeville, Ky. (fig. 1), and some invertebrate fossils are reported south of Pikeville (Barr and Arndt, 1968). The Crummies Member probably directly overlies the Kelly coal bed in the lower part of the Wise Formation in Virginia.

Along the Cumberland Escarpment, a few marine and brackish-water fossils have been reported in the Crummies Member in the shale above the Blue Gem coal bed in the vicinity of Corbin, Ky. (for example, see Puffett, 1963) (fig. 1). No fossils are reported elsewhere in the southwestern part of this outcrop belt in Kentucky or in Tennessee, where the member occurs above the Blue Gem coal bed in the upper part of the Slatestone Formation. However, discoidal limestone concretions, found locally in the Crummies in the Corbin area, are also found in shale above the Vires coal bed in the vicinity of Jackson, Ky. (for example, see Hansen and Johnston, 1963) (fig. 1). In the area

Table 1. Lists of fossils from the type locality of the Crummies Shale Member of the Breathitt Formation and two nearby localities.

[All in the Evarts 7.5-min quadrangle, Harlan County, Ky. Collections contain mollusks in which aragonitic shell material has been preserved; some pelecypods appear to have original coloration preserved. Faunas are biostratigraphically poorly diagnostic]

USGS collection 30702–PC

Site at abandoned mine on Path Fork coal bed on northern side of Days Branch; located on Cranks Ridge at point 1.8 mi SSE. of BM 1,253 at Cawood, Ky., and 1.6 mi southwest of BM 1,419 at Crummies, Ky. Small collection from blocks of shale and weathered siderite nodules from dark-gray shale from zone about 15 ft above top of Path Fork coal bed. Type locality of Crummies Shale Member.

Neochonetes? cf. *N.*? *platynotus* (C.A. White)
Aviculopecten eaglensis? (Price)
Astartella sp. indet. (immature specimen)
Wilkingia sp.
Trepospira (*Trepospira*) sp.
Retispira sp.
Straparollus (*Euomphalus*) sp.
Phragmacone of orthoconic cephalopod (gen. indet.)
Fragment of a goniatite, possibly *Gastrioceras*
Trace fossil: *Echinostoma*?

USGS collection 30703–PC

From fresh cutface at active Terry Glenn Coal Co. Barn Branch Mine on Path Fork coal bed; located on eastern side of Barn Branch directly beneath powerline at point 0.9 mi NNW. of BM 1,450 (located on U.S. Highway 421 bridge over Barn Branch) and 0.9 mi east of BM 1,419 at Crummies, Ky. Small collection from 3 to 3.5 ft of dark-gray shale.

Neochonetes? cf. *N.*? *platynotus* (C.A. White)
Solenomorpha? *solenoides* (Genitz)
Nuculopsis (*Nuculanella*) sp.
Edmondia cf. *E. ovata* (Meek and Worthen)
Naticopsis? sp. indet.

USGS collection 30704–PC

Large collection (mainly mollusks) from fallen roof shale of airline (shaft) in active Terry Glenn Coal Co. Mine in Path Fork coal bed; roof fall removed from about 3,000 ft of shaft and dumped beside mine buildings outside main portal; mine located on southern side of Crummies Creek at point 0.5 mi ENE. of Little Creek Church and 1.5 mi northeast of BM 1,419 at Crummies, Ky. Crummies Member of Breathitt Formation.

Neochonetes? cf. *N.*? *platynotus* (C.A. White)
Sandia? sp. indet.
Desmoinesia nambeensis Sutherland and Harlow
Large productid, gen. and sp. indet.
Composita sp. indet.
Phestia sp.
Aviculopecten eaglensis (Price)
Pinna sp.
Astartella newberryi Meek
Myalinid, gen. and sp. indet.
Edmondia cf. *E. ovata* (Meek and Worthen)
Nuculopsis (*Nuculanella*) sp.
Wilkingia sp.
Lima cf. *L. retifera* (Shumard)

Table 1. Lists of fossils from the type locality of the Crummies Shale Member of the Breathitt Formation and two nearby localities —Continued.

USGS collection 30704–PC—Continued

Bellerophon (*Bellerophon*) sp.
Trepospira (*Trepospira*) *depressa* (Cox)
Retispira sp.
Straparollus (*Euomphalus*) sp.
Ianthinopsis sp. indet.
Orthoconic cephalopod, probably *Pseudorthoceras*
Phragmacone of orthoconic cephalopod, gen. indet.
Stearoceras sp. (small, coiled nautiloid)
Tylonautilus? sp. indet. (large, coiled nautiloid with large lateral nodes)
Ostracode: probably *Bairdia*
Trace fossil (gen. indet.)
Plants: *Calamites* fragments

between Corbin and Jackson, shale beds of the Crummies Member are poorly exposed and difficult to distinguish from other shale units of that part of the stratigraphic section; however, apparently equivalent shales in this area locally are reported to be bioturbated (Rice and Lee, 1978).

In the outcrop belt along the Cumberland Escarpment near Cannel City and northward (fig. 1), limestone concretions commonly occur above the Grassy coal bed (Sable, 1978). Englund (1955) tentatively and incorrectly correlated these limestone concretions with the Campbell Creek Limestone of White (1885). Although Huddle and others (1963) correlated the Grassy coal bed of this area with the Upper Elkhorn Nos. 1 and 2 coal beds, a northwestward thinning of the section and the discontinuity of the several thin coal beds in this part of the section could easily result in the miscorrelation of the Grassy coal bed with a younger coal bed. Limestone concretions such as those reported above the Grassy coal bed commonly are reported about 15 mi to the east in the inlier near Redbush, Ky. (fig. 1), at a stratigraphic position above coal beds equivalent to the Lower Elkhorn coal bed (for example, see Rice, 1969), and a thick sequence of fossiliferous calcareous shale and sandstone, which appears to be at the same stratigraphic position, has been quarried for road metal about 4 mi east of Redbush (Rice, 1968). Extensive collections of fossils have been made from the Redbush localities and are listed in table 2. Northwest of the inlier, Englund and DeLaney (1966) reported a persistent marine zone above the Grassy coal bed near Isonville, Ky. (fig. 1), which contains large, silty, calcareous sandstone or silty limestone concretions and, locally, a fossiliferous ferruginous sandstone bed. This latter lithology also is reported above the Grassy coal bed as far north as Grayson, Ky. (fig. 1) (Whittington and Ferm, 1967). A sandstone bed as much as 2.5 ft thick, which contains sparse marine fossil fragments, crops out in a small cove at road level just north of U.S. Highway 60 about 2 mi west of Grayson, Ky., and may be the Crummies Member.

At scatttered locations in southwestern West Virginia, a restricted brachiopod/bivalve fauna has been reported in the equivalent Cannelton Limestone of White (1885) by B.M. Blake, Jr., A.F. Keiser, and C.L. Rice (unpub. data, 1993). Thus, if the correlation of the Crummies Member with the marine unit overlying the Grassy coal bed in northeastern Kentucky is correct, then the facies distribution suggests a broad embayment extending from a more open-marine environment in northwestern Kentucky to a more restricted environment in the southeast, probably extending across all of eastern Kentucky and into a large part of southern West Virginia and southwestern Virginia. The Crummies reaches its greatest thickness in the southeastern part of the foreland basin along the Cumberland overthrust sheet in Kentucky and Virginia, where the basin had the greatest subsidence. The more open-marine fauna in northeastern Kentucky appears to have been deposited mostly in a relatively high energy environment as a thin sandstone or sandy siltstone that was preserved only locally.

The Crummies Member is Middle Pennsylvanian in age and probably correlates with late Morrowan strata in the midcontinent. The oldest coal balls known in Pennsylvanian strata of the central Appalachian basin are associated with the Crummies Member. These coal balls, which contain mineralized plant debris and marine fossils such as shark denticles, occur in the upper part of the Path Fork coal bed (Phillips and Chesnut, 1980; Phillips and others, 1985). The coal balls were collected from a locality on an unnamed branch of Cranks Creek about 1.5 mi SSW. of Crummies, Ky.

Table 2. Composite list of invertebrate fossils from the lower part of the Breathitt Formation.

[From material (USGS collections 27491–, 27492–, 27493–, and 39696–PC) from underground quarry and from spoil piles on northern side of Billy Cox Branch at point 0.7 mi east of elementary school at village of Flat Gap, on border between Redbush and Sitka 7.5-min quadrangles, Johnson County, Ky. Brachiopod fauna is a late Morrowan fauna assignable to *Linoproductus nodosus* Brachiopod Assemblage Zone of Sutherland and Henry (1975, 1980) and Henry and Sutherland (1977)]

Rhabdomeson? sp.
Rhomboporoid, gen. and sp. indet.
Trepostomotous bryozoan
Prismopora sp. indet.
Cystodictya sp. indet.
Lingula? sp. indet.
Trigonoglossa sp. indet.
Orbiculoidea sp. indet.
Derbyia cf. *D. crassa* (Meek and Worthen)
Neochonetes? cf. *N.*? *platynotus* (C.A. White)
Plicochonetes? *arkansanus* (Mather)
Large spinose productid, probably *Buxtonia*
"*Juresania*" sp. indet.
Echinoconchus sp. indet.
Desmoinesia nambeensis Sutherland and Harlow
Sandia sp. indet., possibly *S. welleri* (Mather)
Linoproductus nodosus (Newberry)
Marginovatia pumila (Sutherland and Harlow)
Hustedia miseri Mather
Composita ovata Mather
Composita gibbosa Mather
Anthracospirifer tanoensis Sutherland and Harlow
Spiriferellina sp. indet.
Palaeoneilo? sp. indet.
Septimyalina sp.
Aviculopecten n. sp.
Schizodus sp.
Permophorus? sp. indet
Cypricardella? sp.
Platyceras sp. indet.
Strophostylus sp.
Ianthinopsis sp.
Gastropod, gen. and sp. indet.
Pelmatozoan columnals
Paladin morrowensis (Mather)
Ditomopyge conwayense Wheeler
Fish denticle
Adetognathus lautus (Gunnell)
Streptognathodus cf. *S. cancellosus* (Gunnell)
Miscellaneous platform element fragments, indet.

CONCLUSIONS

Detailed geologic mapping, published stratigraphic reports, and our own analysis of the stratigraphic section have shown that three regionally important marine units—the Eagle Shale and Limestone of White (1891), the Cannelton Limestone of White (1885), and the Campbell Creek Limestone of White (1885)—have been completely and repeatedly miscorrelated from their type areas along the Kanawha River valley to other areas of the central Appalachian basin. The Cannelton Limestone of White (1885) has been confused in past geologic reports in Kentucky, Virginia, and large areas of West Virginia with both overlying and underlying marine units. Renaming this unit as the Crummies Member of the Breathitt Formation is essential to the development of a coherent nomenclature for the Middle Pennsylvanian of the central Appalachian basin. Furthermore, the Crummies Member is an extensive unit that this report shows can be identified in large areas of eastern Kentucky and adjacent areas. A further analysis of facies of the Crummies Member may lead to a better understanding of the tectonic framework in this part of the Appalachian basin in Middle Pennsylvanian time and the paleogeography of a major marine transgression that may have extended into Ohio and perhaps be identifiable in the Eastern Interior basin.

The regional miscorrelations of many coal beds and the wide misuse of coal-bed names implied by figure 2 should be of great significance to coal geologists and to the coal industry in general. Such coal names as Campbell Creek and Cedar Grove have been extended to large areas of the Appalachian basin mainly because of their perceived relations to the miscorrelated marine units. This misuse of nomenclature reinforces the notion that, in the absence of

KANAWHA FORMATION, KANAWHA RIVER VALLEY SECTION, WEST VIRGINIA[1]	KANAWHA FORMATION, LOGAN AND MINGO COUNTIES,[2] WEST VIRGINIA; BREATHITT FORMATION, KENTUCKY[3]	BREATHITT FORMATION, EASTERN KENTUCKY[4]
Campbell Creek Limestone of White (1885)	Elkins Fork Shale of Morse (1931)	Elkins Fork Shale of Morse (1931)
Campbell Creek coal zone	*Cedar Grove coal zone* and Alma coal zone	Upper Elkhorn coal zone
Cannelton Limestone of White (1885)	*Campbell Creek Limestone of White (1885)*	CRUMMIES MEMBER OF BREATHITT FORMATION
Eagle coal zone	*Campbell Creek coal zone*	Lower Elkhorn (Grassy, Path Fork, Pond Creek) coal zone
Eagle Shale and Limestone of White (1891)	*Cannelton Limestone of White (1885)*	Betsie Shale Member of Breathitt Formation
Unnamed coal bed	Matewan coal zone	Matewan (Clintwood) coal zone
(?)	*Eagle Shale and Limestone of White (1891)*	Unnamed marine zone
(?)	Little Cedar coal bed	Hagy coal zone

[1]White (1914). [2]Hennen and Reger (1914). [3]Rice and Smith (1980). [4]This report.

Figure 2. Correlation of the Crummies Member of the Breathitt Formation and major stratigraphic marker beds from the type section of the Kanawha Formation in the Kanawha River valley to eastern Kentucky. Italicized units in the middle column have commonly been miscorrelated in southwestern West Virginia, Virginia, and eastern Kentucky from their type areas in central West Virginia.

detailed mapping, geologists would be more prudent and better serve regional stratigraphic purposes by using local names for coal beds.

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APPENDIX

APPENDIX

Type section of the Crummies Member of the Breathitt Formation beginning about 1,500 ft east of Crummies, Harlan County, Ky., on U.S. Highway 421. Measurement by altimeter.

	Thickness (ft)
Sandstone, fine-grained, weathered; crossbedded, channel-fill, irregular base	30+
Top of Crummies Member about 8 ft below BM 1668. Sandstone and siltstone, interbedded, in laminated sets 1 to 6 in. thick	13
Sandstone, silty; massive or disturbed bedding; slumped channel deposit	2.5
Sandy siltstone and siltstone, interbedded in thin laminated sets	12
Siltstone and shale, interbedded with 3-in. lens of silty limestone at top and base	3
Siltstone and shale, interbedded; in lower 10 ft, several silty sandstone or sandy siltstone beds characterized by massive or disturbed bedding, 1.5 to 5 ft thick	27
Siltstone and shale, interbedded; 20-in.-thick silty limestone bed or zone of concretions at base	5
Siltstone and shale, interbedded in irregular sets, ranging from 1 in. to 1 ft thick; contains thin beds and discontinuous lenses of siderite	28
Covered (commonly exposed above mine entrances, upward-coarsening shale and siltstone; basal 10 ft fossiliferous, bioturbated dark-gray clay shale containing discoidal nodules of siderite 0.5 in. thick and as much as 2 in. in diameter throughout; sparse lenses of limestone several inches thick)	18
Total thickness Crummies Member	108.5
Coal bed (Path Fork), top part slumped	2.5
Covered	8
Silty shale having 4-in. clayey sandstone 6 in. from base	6
Coal bed (unnamed)	3

Upper Cretaceous Ammonites from the Coon Creek Tongue of the Ripley Formation at its Type Locality in McNairy County, Tennessee

By William A. Cobban and W. James Kennedy

SHORTER CONTRIBUTIONS TO PALEONTOLOGY AND STRATIGRAPHY

U.S. GEOLOGICAL SURVEY BULLETIN 2073–B

Descriptions and illustrations of upper Campanian ammonites from a classic North American locality

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1994

CONTENTS

PLATES

[Plates follow References Cited]

FIGURES

METRIC CONVERSION FACTORS

Multiply	By	To obtain
	Length	
millimeter (mm)	0.0394	inch
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile

Upper Cretaceous Ammonites from the Coon Creek Tongue of the Ripley Formation at its Type Locality in McNairy County, Tennessee

By William A. Cobban[1] and W. James Kennedy[2]

ABSTRACT

The Coon Creek Tongue of the Ripley Formation at its type locality in McNairy County, Tenn., contains an ammonite fauna that consists of *Nostoceras* (*Nostoceras*) *approximans* (Conrad), *N.* (*N.*) *hyatti* Stephenson, *N.* (*N.*) *helicinum* (Shumard), *Didymoceras navarroense* (Shumard), *D. hornbyense* (Whiteaves), *Lewyites* sp., *Solenoceras texanum* (Shumard), *S. reesidei* Stephenson, *Parasolenoceras pulcher* Cobban and Kennedy, *Baculites undatus* Stephenson, *B. claviformis* Stephenson, and *Jeletzkytes nodosus* (Owen). This fauna has generally been placed in the lower Maastrichtian, but it is here attributed to the upper Campanian, inasmuch as two of the characteristic species present, *N.* (*N.*) *hyatti* and *J. nodosus*, are confined to the upper Campanian in western Europe. A younger ammonite fauna of early Maastrichtian age is present, however, in the Coon Creek Tongue of Mississippi, Alabama, and Georgia.

INTRODUCTION

The Coon Creek Tongue of the Ripley Formation, named by Wade (1917, 1926), has its type locality on Coon Creek in McNairy County, Tenn. (Sohl, 1960, p. 27, loc. 1). Details of the sequence were given by Wade (1917, 1926), and a historical review of the stratigraphic nomenclature was given by Sohl (1960). Some 8.2 m of exposed glauconitic, micaceous, silty clays contain calcareous concretions. The fauna was described by Wade (1926), and the gastropods were revised by Sohl (1960, 1964). The Coon Creek Tongue at its type locality contains *Exogyra cancellata* Stephenson, 1914, a widely recognized zonal marker bivalve throughout the Gulf and Atlantic coasts (Stephenson, 1933); the base of the Coon Creek Tongue has been believed to mark the base of the Maastrichtian (for example, Sohl, 1960; Brouwers and Hazel, 1978; Russell and others, 1982). A few ammonites were described by Wade (1926), but subsequent collecting by members of the U.S. Geological Survey (USGS) and others (notably, P.L. Larson and his colleagues at the Black Hills Geological Institute in Hill City, S. Dak.) has greatly extended our knowledge of the ammonite fauna and forms the basis for the present account. The following species are described below: *Nostoceras* (*Nostoceras*) *approximans* (Conrad, 1855), *N.* (*N.*) *hyatti* Stephenson, 1941, *N.* (*N.*) *helicinum* (Shumard, 1861), *Didymoceras navarroense* (Shumard, 1861), *D. hornbyense* (Whiteaves, 1895a), *Solenoceras reesidei* Stephenson, 1941, *Parasolenoceras pulcher* Cobban and Kennedy, 1991, *Baculites undatus* Stephenson, 1941, *B. claviformis* Stephenson, 1941, and *Jeletzkytes nodosus* (Owen, 1852).

The placement of this fauna in the Campanian as opposed to the Maastrichtian depends very much on where the boundary between the two is drawn; that delineation, in turn, depends on what fossils are used (Birkelund and others, 1984). A widely accepted definition for the Campanian-Maastrichtian boundary among macrofossil workers in western Europe is the first appearance of the belemnite *Belemnella lanceolata* and, stratigraphically a little higher, *Hoploscaphites constrictus* (J. Sowerby). This definition is adopted herein. Neither of these species has been found in North America, but two of the ammonites in the Coon Creek fauna occur in western Europe, where they can be shown to occur only in the upper Campanian, below the first appearance of *B. lanceolata* in the Vistula River Valley in Poland. There, Błaszkiewicz (1980) recognized the following zonal sequence (zonal nomenclature has been revised to agree with taxonomic revisions given below):

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lower Maastrichtian	*Belemnella occidentalis* zone *Belemnella lanceolata* zone
upper Campanian (part)	*Nostoceras* (*N.*) *hyatti* [*N.* (*N.*) *pozaryskii*] zone *Didymoceras donezianum* zone *Bostrychoceras polyplocum* zone

Nostoceras (*N.*) *pozaryskii* Błaszkiewicz is a synonym of *N.* (*N.*) *hyatti*, as discussed below, and is restricted to the *N.* (*N.*) *hyatti* zone. *Jeletzkytes nodosus* (Owen, 1852) is the senior synonym of *Acanthoscaphites praequadrispinosu* Blaszkiewicz (1980), which is also restricted to the *N.* (*N.*) *hyatti* zone. Both species occur at Coon Creek, and, on this basis, we correlate the present fauna with a part of the European uppermost Campanian. It is important to note, however, that the Coon Creek Tongue extends up into the Maastrichtian. In Mississippi, Alabama, and Georgia, the Ripley yields a younger fauna of the *N.* (*N.*) *alternatum* zone that is undoubtedly Maastrichtian (Cobban, 1974a; Cobban and Kennedy, 1991).

Many collectors contributed to the ammonites described or figured in the present report. The largest collections were made by the late N.F. Sohl (USGS), G.R. Scott (recently retired from the USGS), and Neal L. Larson, Neal C. Larson, and Peter L. Larson of the Black Hills Institute of Geological Research.

Most of the fossils described in this report are kept in the National Museum of Natural History (USNM) in Washington, D.C., and carry USNM catalog numbers. Some specimens are at the Black Hills Geological Institute in Hill City, S. Dak., where they have BHI catalog numbers. Plaster casts of a few of the specimens are kept at the Federal Center in Denver, Colo.

Some of the specimens were photographed by R.E. Burkholder, recently retired from the USGS in Denver.

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SYSTEMATIC PALEONTOLOGY

Suborder ANCYLOCERATINA Wiedmann, 1966

Superfamily TURRILITACEAE Gill, 1871

Family NOSTOCERATIDAE Hyatt, 1894

Genus and Subgenus *NOSTOCERAS* Hyatt, 1894

Type species.—By original designation *Nostoceras stantoni* Hyatt, 1894, p. 569 (=*Nostoceras*? *approximans* Conrad, 1855, p. 266).

Nostoceras (*Nostoceras*) *approximans* (Conrad, 1855)

Plate 1, figures 4–9, 18, 19, 22–24; plate 2, figures 1–6, 11; plate 3, figures 1–3

1855. *Ancyloceras*? *approximans* Conrad, p. 266.
1860. *Ancyloceras*? *approximans* Conrad. Conrad, pl. 47, fig. 4.
1894. *Nostoceras stantoni* Hyatt, p. 570.
1894. *Nostoceras stantoni* var. *aberrans* Hyatt, p. 572.
1894. *Nostoceras stantoni* var. *retrorsus* Hyatt, p. 579.
1938. *Nostoceras stantoni* (Hyatt). Roman, p. 445.
1941. *Nostoceras stantoni* (Hyatt emend.) Stephenson. p. 407, pl. 80, figs. 1–5.
1941. *Nostoceras stantoni prematurum* Hyatt. Stephenson, p. 409, pl. 80, figs. 6–8.
1941. *Nostoceras stantoni aberrans* Hyatt. Stephenson, p. 409, pl. 80, figs. 9, 10.
non 1955. *Nostoceras* spec. aff. *stantoni aberrans* Hyatt. Bürgl, p. 43, pl. 6, fig. 12.
non 1957. *Nostoceras* aff. *stantoni aberrans* Hyatt. Bürgl, pl. 17, fig. 3.
1971. *Nostoceras stantoni serratum* Collignon, p. 12, pl. 644, fig. 2383.
1974b. *Nostoceras* cf. *N. stantoni* Hyatt. Cobban, p. 12, pl. 9, figs. 23–31.
?1977. *Nostoceras* cf. *N. stantoni* Hyatt. Matsumoto, p. 323, pl. 61, fig. 3.
1993. *Nostoceras* (*N.*) *approximans* (Conrad). Kennedy and Cobban, p. 414, figs. 6.1–6.33, 7.21–7.23, 7.25–7.29, 8.1–8.5

Type.—Holotype, by monotypy, is the original of Conrad (1855, p. 266) illustrated by Conrad (1860, pl. 47, fig. 4) in the collections of the Academy of Natural Sciences in Philadelphia, Pa., and said to be from White River, Ark.

Description.—*Nostoceras* (*N.*) *approximans* is a common species in the fauna. The spire is fairly high and has an apical angle of about 53° to 92°. Whorls are in tight contact and have a concave impressed zone that accommodates the base of the preceding whorl. The outer whorl face, which is high and broadly rounded, merges into the more rounded lower whorl face. About 45 to 55 ribs per whorl are present. The ribs are straight and prorsiradiate on the upper and outer whorl faces and link singly or in pairs to bullate midlateral tubercles or intercalate between them. A second aperturally displaced row of tubercles lies at the lower whorl contact. One or two ribs loop between the tubercles of the two rows, and others are intercalated. The lower row of tubercles usually gives rise to single ribs, which, along with nontuberculate ribs, slant forward and are convex on the lower whorl face. As many as four strong, distant constrictions per whorl are present. The body chamber uncoils and recurves into a U. Ribbing on the initial sector is dense, crowded, even, and bituberculate, followed by a section that has coarsened tubercles and ribs; the latter loop and zigzag between the tubercles in the two rows. Ribbing becomes regular, annular, and bituberculate on the final section of the hook. Sutures were not seen.

Discussion.—The holotype of *N.* (*N.*) *approximans* and numerous other specimens from the Saratoga Chalk encompass a range of variation that includes *N.* (*N.*) *stantoni* Hyatt (1894) and the varieties *aberrans, prematurum,* and *retrorsus*. *Nostoceras* (*N.*) *hyatti* Stephenson (1941, p. 410, pl. 81, figs. 9–12) is a larger species that has much coarser ribs and tuberculation. Body chambers bear very coarse,distant ribs that have widely separated spinose tubercules on simple ribs or ribs that zigzag between tubercles, especially at the beginning of the final hook (Cobban, 1974b, p. 10, pl. 5, figs. 1–2; pl. 6, figs. 1–12; pl. 7, figs. 1–10). *Nostoceras* (*N.*) *helicinum* (Shumard, 1861, p. 191; see Cobban 1974b, p. 8, pl. 4, figs. 1–2; text fig. 6) is also much larger and has a lower densely ribbed spire and a body chamber ornamented by coarse spines in two rows.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Saratoga Chalk in Arkansas; Nacatoch Sand in northeastern Texas; the basal part of the Navesink Formation in New Jersey. Records from Colombia (Bürgl, 1955, 1957) belong to other species, and those from Japan are doubtful and based on poor material.

Nostoceras (Nostoceras) hyatti Stephenson, 1941

Plate 1, figures 10–12, 16, 17, 20, 21, 25–27; plate 2, figures 7–10, 12–15; plate 3, figures 4, 5, 9–11

1941. *Nostoceras hyatti* Stephenson, p. 410, pl. 81, figs. 9–12.

1974b. *Nostoceras hyatti* Stephenson. Cobban, p. 10, pl. 5, figs. 1–21; pl. 6, figs. 1–12; pl. 7, figs. 1–10; pl. 8, figs. 1–30, text fig. (with full synonymy).

1980. *Nostoceras pozaryskii* Błaszkiewicz, p. 26, pl. 10, figs. 1–5, 8, 9, 11–15.

1986. *Nostoceras* (*Nostoceras*) *hyatti* Stephenson, 1941. Kennedy, p. 90, pl. 20, figs. 7–9.

1986. *Nostoceras* (*Nostoceras*) *pozaryskii* Błaszkiewicz. Kennedy, p. 92, text fig. 31A.

1993. *Nostoceras* (*Nostoceras*) *hyatti* Stephenson , 1941. Kennedy and Cobban, p. 417, figs. 9.2, 11.1–11.27.

Types.—Holotype is USNM 77258, the original of Stephenson (1941, pl. 81, fig. 9) from the Nacatoch Sand on Postoak Creek on the northern edge of Corsicana in Navarro County, Tex. There are four paratypes.

Description.—This species is common in the fauna. The moderately elevated spire has an apical angle of 65° to 80°. Whorls are in contact, so that the upper whorl face is concave to accommodate the lower surface of the previous whorl. The exposed part of the upper whorl face and the outer and lower parts in intercostal section are broadly rounded. Some 43 to 60 ribs per whorl on the upper whorl face are straight, rectiradiate to slightly prorsiradiate, narrow, and sharp. Ribs link in pairs at coarse spines at the contact of the upper and the outer whorl faces. About 20 to 25 ribs per whorl are tuberculate. Coarse prorsiradiate ribs link the tubercles in the upper row to similar-sized tubercles in a lower row; both rows may alternate in position. Ribs occasionally zigzag between tubercles. Single ribs extend from the tubercles onto the lower whorl face where, along with nontuberculate ribs, they are prorsiradiate and slightly concave and link into single ribs in the umbilicus. A few ribs are flared, and some interspaces may be deepened into constrictions. The body chamber uncoils into a twisted U, so that the aperture faces the base of the spire. On the first part of the U, ribs coarsen and become annular or zigzag between strong ventral tubercles. Ribs are coarser, simple, annular, and bituberculate near the adult aperture. Body chambers occur in two size ranges, an indication of dimorphism.

Discussion.—*Nostoceras* (*N.*) *hyatti* has coarser ribbing than *N.* (*N.*) *approximans* and *N.* (*N.*) *helicinum*. The lack of numerous delicate ribs on the hook and the lack of lateral bullae separate fragments from *N.* (*N.*) *helicinum*. *Nostoceras* (*N.*) *pozaryskii* Blaszkiewicz (1980, p. 26, pl. 10, figs. 1–5, 8, 9, 11–15), from the upper Campanian of the Vistula River Valley in Poland, were not compared with *N.* (*N.*) *hyatti* by its author, even though Cobban (1974b, p. 3) noted the close similarities between Polish and American material. *Nostoceras* (*N.*) *pozaryskii* differs in no significant respects from *N.* (*N.*) *hyatti* and is regarded as a synonym by us. The *Nostoceras* cf. *N. hyatti* from Israel described by Lewy (1969, p. 118, pl. 1, fig. 4) is transitional to *N.* (*N.*) *helicinum*. The same author's *N.* (*N.*) *hyatti* (Lewy, 1969, pl. 1, fig. 5) has very widely separated tubercles. *Nostoceras hyatti* var. *mitraikyensis* Collignon (1970, p. 17, pl. 614, fig. 2293), from the middle Campanian of Madagascar, is more slender and more loosely coiled than *N.* (*N.*) *hyatti*.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Saratoga Chalk in Arkansas; Nacatoch Sand in northeastern Texas; lower part of the Navesink Formation in New Jersey. *Baculites jenseni* zone of the Pierre Shale in southern Colorado. Upper Campanian of Angola, Israel (?), France, and the Vistula River Valley in Poland.

Nostoceras (*Nostoceras*) *helicinum* (Shumard, 1861)

Plate 1, figures 1–3, 13–15

1861. *Turrilites helicinus* Shumard, p. 191.

1893. *Turrilites helicinus* Shumard. Boyle, p. 293.

1894. *Nostoceras helicinum* (Shumard). Hyatt, p. 573.

1941. *Nostoceras helicinum* (Shumard). Stephenson, p. 410, pl. 80, figs. 11, 12.
1941. *Nostoceras helicinum crassum* Stephenson, p. 412, pl. 81, figs. 7, 8.
1941. *Nostoceras helicinum humile* Stephenson, p. 412, pl. 81, figs. 4–6.
1943. *Nostoceras helicinum* (Shumard). Haas, p. 2, figs. l*a*, 6, 7.
1960. *Nostoceras helicinum* var. *crassum* Stephenson. Easton, fig. 11.26–1.
?1965. *Nostoceras helicinum* (Shumard). Howarth, p. 383, pl. 8, figs. 3*a*, *b*, 5*a–c*.
?1969. *Nostoceras* aff. *N. helicinum* (Shumard). Sornay, *in* Antunes and Sornay, p. 86, pls. 2–5.
1969. *Nostoceras helicinum* (Shumard). Lewy, p. 120, pl. 2, figs. l*a*, *b*.
1974b. *Nostoceras helicinum* (Shumard). Cobban, p. 8, pl. 4, figs. 1–21; text fig. 6.
1993. *Nostoceras* (*Nostoceras*) *helicinum* (Shumard, 1861). Kennedy and Cobban, p. 414, figs. 8.6–8.12, 9.1, 10.1–10.23.

Types.—Shumard's types, from the Nacatoch Sand of Navarro County, Tex., are lost. The lectotype, selected by Stephenson (1941, p. 410, pl. 80, figs. 11, 12), is USNM 21103a, from the Nacatoch Sand near Chatfield in Navarro County. The holotype of *N. helicinum humile* Stephenson is USNM 77263 from the Nacatoch near Kaufman in Kaufman County, Tex., and the holotype of *N. helicinum crassum* Stephenson is USNM 77261 from the Nacatoch Sand near Chatfield.

Description.—This rather rare species is characterized by its low spire and dense ribbing. Stephenson's figured specimens have apical angles of 92° to 115°. The spire of the lectotype has 68 narrow, sharp ribs on the last whorl. About every third rib has a small, sharp, bullate node that represents either the lower or upper row of tubercles. Four constrictions per whorl are usually present. The U-shaped body chamber of this species has umbilical bullae and rounded ventral tubercles located on the same ribs and separated by two or three nontuberculate ribs. Tubercles are strongest on the elbow, and ribs coarsen near the aperture.

Discussion.—*Nostoceras* (*N.*) *helicinum* differs from *N.* (*N.*) *approximans* and *N.* (*N.*) *hyatti* in its lower spire, in the presence of umbilical bullae on the body chamber, and in the more numerous nontuberculate ribs on the body chamber. Only a few helicoid whorls are present in the collections from the Coon Creek Tongue.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; basal part of the Saratoga Chalk in southwestern Arkansas; Nacatoch Sand in northeastern Texas; lower part of the Navesink Formation in New Jersey. Also found in Israel and Angola.

Genus *DIDYMOCERAS* Hyatt, 1894

Type species.—By original designation, *Ancyloceras nebrascense* Meek and Hayden (1856, p . 71).

Didymoceras navarroense (Shumard, 1861)

Plate 3, figure 6; plate 4; plate 5; plate 6 , figures 4–6; text figure 1

1861. *Helicoceras navarroensis* Shumard, p. 190.
1926. *Helicoceras navarroense* (Shumard). Wade, p. 184, pl. 61, figs. 8–11; pl. 62, figs. 1, 2.
1928. *Helicoceras*? *navarroense* Shumard. Adkins, p. 210.
1941. *Helicoceras navarroense* Shumard. Stephenson, p. 417, pl. 83, figs. 9–13.
1959. *Didymoceras* sp. indet. Sornay, p. 222, pl. 7, figs. 3*a*, *b*.
1965. *Didymoceras navarroense* (Shumard). Howarth, p. 373.
1969. *Didymoceras* cf. *navarroense* (Shumard). Lewy, p. 115, pl. 1, fig. 1.
1974b. *Didymoceras navarroense* (Shumard). Cobban, p. 16, pl. 11, figs. 1–4; text fig. 13.
1993. *Didymoceras navarroense* (Shumard, 1861). Kennedy and Cobban, p. 421, figs. 12.1, 13.1–13.18, 14.1–14.4, 14.13, 14.14.

Type.—Neotype, designated by Stephenson (1941, p. 418, pl. 83, figs. 9, 10), is USNM 77282, from the Nacatoch Sand near Chatfield in Navarro County, Tex.

Description.—The earliest growth stages seen have whorl heights of 2.5 to 10 mm. These limbs are slightly curved, suggestive of an initial open criocone or possibly a hamitid coil in some individuals. The whorl section is compressed oval. Ornament on the flank consists of straight, prorsiradiate ribs that have a rib index of 5. Ribs are weak on the dorsum but strengthen across the flanks and may differentiate into weaker and stronger ones. The latter link in pairs at strong, bullate, flat-topped tubercles that occasionally preserve a septate spine. A low, broad rib or a pair of ribs links these tubercles across the venter. One to three weaker ribs separate looped pairs of strong ribs. Some of the weaker ribs bear weak ventral tubercles that are linked over the venter by weak transverse ribs. The later growth stages consist of a loose helix. The size at which this change occurs is variable; the presence of both large and small helices indicates dimorphism within the species. Ribbing is weak, uniform, and prorsiradiate on the inside of the whorl. The junction of inner and upper whorl faces is broadly rounded; the upper face is rounded intercostally and flattened costally. Ribs bend forward and are markedly convex and prorsiradiate; they link in groups of two or three large, blunt, rounded tubercles, 20 to 23 per whorl, at the juncture of upper and outer whorl faces. Occasional well-preserved specimens show these flat-topped tubercles to represent the bases of septate spines. The outer whorl face

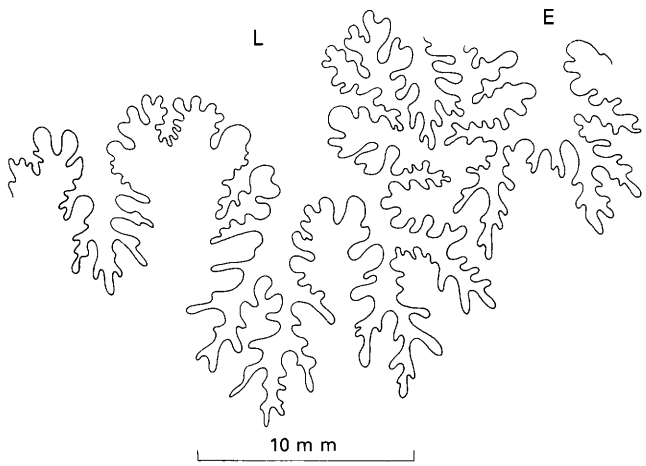

Figure 1. Part of the external suture of *Didymoceras navarroense* (Shumard). Hypotype USNM 449439, from the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. E is external lobe, and L is lateral lobe.

is flattened and crossed by prorsiradiate, sinuous ribs that loop in pairs or zigzag between the rows of tubercles. Tubercles in the lower row give rise to groups of two or three ribs that are prorsiradiate and convex on the lower whorl face. Ribbing and tuberculation coarsen markedly on the later parts of the adult body chamber, where single coarse ribs link tubercles or zigzag between them. Occasional weak, nontuberculate ribs extend over the upper, outer, and lower whorl faces. The deeply and intricately incised suture has narrow-stemmed, bifid saddles (text fig. 1).

Discussion.— *Didymoceras navarroense* is a conspicuous species in the present fauna. The species differs from *D. hornbyense* (Whiteaves, 1895a), described below, in its apparently looser coiling, flattened outer whorl face, and much coarser tuberculation. Coarser tuberculation, weak irregular ribs, and differences in coiling of the early and late growth stages distinguish the species from the older *D. cheyennense* (Meek and Hayden, 1856; see Scott and Cobban, 1965; Gill and Cobban, 1973, fig. 5*c*), *D. nebrascense* (Meek and Hayden, 1856; see Scott and Cobban, 1965; Gill and Cobban, 1973, fig. 5*a*), and *D. stevensoni* (Whitfield, 1880; Scott and Cobban, 1965; Gill and Cobban, 1973, fig. 5*b*).

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Saratoga Chalk in southwestern Arkansas; Neylandville Marl and Nacatoch Sand in northeastern Texas. *Baculites cuneatus* zone of Pierre Shale near Kremmling in Grand County, Colo., and *B. reesidei* zone near Fort Collins in Larimer County, Colo. Upper Campanian of Israel and Angola; also recorded from Colombia (Petters, 1955, p. 216, 224).

Didymoceras hornbyense (Whiteaves, 1895a)

Plate 6, figures 1–3

1876. *Heteroceras cooperi* Gabb. Meek, p. 367, pl. 3, fig. 7.
1895a. *Anisoceras vancouverensis* (Gabb). Whiteaves, p. 313, pl. 2.
1895a. *Heteroceras hornbyense* Whiteaves, p. 316.
1895a. *Heteroceras perversum* Whiteaves, p. 317.
1895b. *Anisoceras vancouverensis* (Gabb). Whiteaves, p. 130.
1903. *Anisoceras cooperi* (Gabb). Whiteaves, p. 336, pl. 43, fig. 1.
1903. *Heteroceras hornbyense* Whiteaves. Whiteaves, p. 332, pl. 42, figs. 1–4.
1915. *Turrilites* (*Hyphantoceras*) *hornybyence* (sic) (Whiteaves). Yabe, p. 18.
1921. *Didymoceras hornbyense* (Whiteaves). Spath, p. 251.
1925. *Heteroceras* (*Bostrychoceras*?) *hornbyense* Whiteaves. Diener, p. 91.
?1925. *Didymoceras hornbyense* (Whiteaves). Haughton, p. 276, pl. 15, fig. 2.
1943. *Nostoceras hornbyense* (Whiteaves). Haas, p. 5.
1952. *Nostoceras hornbyense* (Whiteaves). Usher, p. 103, pl. 27, figs. 1, 2; pl. 28, fig. 2; pl. 31, fig. 23.
1952. *Anisoceras cooperi* Gabb. Usher, p. 107, pl. 29, fig. 1.
1958. *Didymoceras whiteavesi* Anderson, p. 196.
1959. *Didymoceras hornbyense* (Whiteaves). Matsumoto, p. 157.
?1963. *Didymoceras* aff. *D. hornbyense* (Whiteaves). Jones, p. 30, pl. 23, fig. 1.
?1965. *Didymoceras* cf. *hornbyense* (Whiteaves). Howarth, p. 377, pl. 8, fig. 4.
1982. *Nostoceras hornbyense* (Whiteaves). Case, fig. 12 (72).

Type.—Lectotype, designated by Usher (1952, p. 104), is no. 5805 in the collections of the Geological Survey of Canada; it came from the upper part of the Lambert Formation of British Columbia.

Description.—BHI 2014 is a fragment of half a whorl that has a whorl height of 26.5 mm. The whorl section is nearly circular in intercostal section. Ornament on the inner whorl face consists of delicate, rursiradiate, convex growth lines and striae that flex forward and are concave over the juncture of the upper and outer whorls. This ornament strengthens and passes prorsiradiate and slightly flexuous across the outer whorl face. Ribs join singly or in pairs at strong conical midlateral tubercles linked by delicate ribs. Some nontuberculate ribs are intercalated. Ribs loop to a row of slightly smaller tubercles at the junction of the outer and lower faces. These tubercles give rise to pairs of coarse ribs that are rursiradiate on the lower whorl face.

Discussion.—Large, binodose *Didymoceras* are known from horizons as young as the *D. cheyennense* zone in the Western Interior and are thus much older than the present material. The specimen from the Coon Creek Tongue is referred to *D. hornbyense* (Whiteaves, 1895a, p. 316; see Usher, 1952, p. 103, pl. 27, figs. 1, 2; pl. 28, fig. 2; pl. 31, fig. 23), a species that Ward (1978) used as an index fossil for the highest Campanian and lowest Maastrichtian in British Columbia. Howarth (1965) recorded the species as possibly occurring with *N. (N.) hyatti* in Angola.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee. Upper Campanian of British Columbia and possibly Angola.

Family DIPLOMOCERATIDAE Spath, 1926
Subfamily DIPLOMOCERATINAE Spath, 1926
Genus *LEWYITES* Matsumoto and Miyauchi, 1984

Type species.—*Idiohamites*(?) *oronensis* Lewy, 1969, p. 127, pl. 3, figs. 10, 11, by original designation by Matsumoto and Miyauchi (1984, p. 64).

Lewyites sp.

Plate 3, figures 7, 8

Description.—BHI 2016 is an apertural fragment that has a whorl height of 56 mm and a compressed whorl section. Flanks are very broadly rounded, and the venter is flattened, but, at the apertural end, the venter rounds. Ribs are coarse, flexuous, and prosiradiate, and each bears a pointed, transversely elongated ventrolateral tubercle. Growth lines strengthen toward the aperture into coarse lirae.

Discussion.—This fragment is referred to *Lewyites* on the basis of comparison with the large phragmocone fragment described by Cobban (1974b) as *Exiteloceras oronense* (Lewy) from the Navesink Formation of New Jersey.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee.

Genus *SOLENOCERAS* Conrad, 1860

Type species.—*Hamites annulifer* Morton, 1842, p. 213, by original designation by Conrad (1860, p. 284).

Solenoceras texanum (Shumard, 1861)

Plate 7, figures 10, 16, 17, 19–24, 26–28, 30, 31

1861. *Ptychoceras texanus* Shumard, p. 189.
1894. *Ptychoceras texanum* Shumard. Hyatt, p. 580.
1928. *Oxybeloceras texanum* (Shumard). Adkins, p. 213.
1941. *Solenoceras texanum* (Shumard). Stephenson, p. 399, pl. 77, figs. 4, 5; pl. 79, figs. 1–4.
1969. *Solenoceras* cf. *S. texanum* (Shumard). Lewy, p. 127, pl. 3, fig. 8.
1976. *Solenoceras* sp. cf. *S. texanum* (Shumard). Klinger, p. 77, pl. 34, fig. 7.

Type.—Neotype is USNM 21092a, the original of Stephenson (1941, pl. 79, fig. 1), from the Nacatoch Sand near Chatfield in Navarro County, Tex.

Description.—*Solenoceras texanum* is common in the Coon Creek fauna. Specimens in which the two limbs are joined occur in two different sizes, suggestive of dimorphism. The species is large and has fragments as long as 70 mm. The shell consists of two parallel shafts in close contact; the dorsum of the larger shaft is sulcate to accommodate the dorsum of the smaller shaft. Shafts expand gradually. The whorl section of the smaller shaft is depressed and reniform, whereas the section is compressed and ovate on the larger shaft. Ornament on the smaller shaft consists initially of coarse, distant, low, prorsiradiate ribs that may or may not bear coarse, blunt, slightly clavate ventral tubercles. Periodic irregular constrictions, usually preceded by a thickened rib, are present. On the curved section between shafts, ribs become sharper and narrower and have well-developed sharp clavi linked across the venter by a low rib. Ribs are initially prorsiradiate but flex back and are markedly rursiradiate on the large shaft, where the ribs are rounded, straight, and prorsiradiate on the flanks and have a rib index of 4 or 5. All ribs bear sharp clavi connected across the venter by strong transverse ribs. Sutures were not seen.

Discussion.—The distinguishing features of *S. texanum* are its large size, moderately spaced ribs, and the compressed whorl section of the larger shaft. These features distinguish the species from *S. reesidei* Stephenson (1941, p. 401, pl. 77, figs. 1–3), *S. multicostatum* Stephenson (1941, p. 402, pl. 76, figs. 12–14), and *S. annulifer* (Morton, 1841, p. 109; also see Reeside, 1962, p. 121, pl. 70, figs. 8–10). *Solenoceras nitidum* Cobban (1974a, p. 83, figs. l*a–k*, 2) is distinguished by its lack of tubercles.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Nacatoch Sand of Navarro County in Texas; *Baculites cuneatus* and *B. reesidei* zones in the Pierre Shale in northern Colorado; upper Campanian of Israel; Maastrichtian(?) of Zululand in Africa. A poorly preserved fragment, best referred to as *Solenoceras* cf. (*S.*) *texanum,* was found in the Saratoga Chalk in Arkansas.

Solenoceras reesidei Stephenson, 1941

Plate 7, figures 1–9, 11, 12, 14, 15, 18, 25

1941. *Solenoceras reesidei* Stephenson, p. 401, pl. 77, figs. 1–3.
1992. *Solenoceras reesidei* Stephenson. Cobban, Kennedy, and Scott, p. A6.

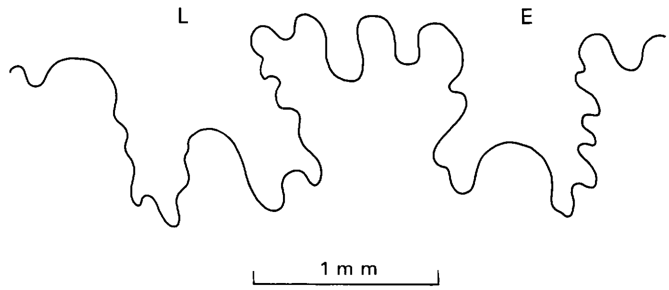

Figure 2. Part of the suture of *Solenoceras reesidei* Stephenson. Hypotype USNM 449419, from the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. E is external lobe, and L is lateral lobe.

Types.—Holotype is USNM 77238, the original of Stephenson (1941, p. 401, pl. 77, figs. 1–3); it and four paratypes (USNM 77239) are from the Neylandville Marl, 4.1 km north of Corbett, Navarro County, Tex.

Description. —*Solenoceras reesidei* is fairly abundant in the Coon Creek fauna. Specimens fall into two size classes and presumably reflect dimorphism. The shell consists of two subparallel shafts, the dorsum of the larger one being sulcate to accommodate the dorsum of the smaller. The whorl section of the smaller shaft is depressed to circular, and that of the larger shaft is slightly compressed. Ornament of the smaller shaft consists of fine, dense, crowded, prorsiradiate ribs that have a rib index of 6. Most ribs bear delicate ventral tubercles. A few widely spaced constrictions are present, and each is preceded by a thickened rib. Ribbing strengthens markedly around the curved sector that connects the two shafts, where the ventral tubercles are prominent and separated by a deep midventral depression. Ribs are prorsiradiate at the end of the small shaft but become rursiradiate on the larger shaft, where the rib index is 6. Ribs on the large shaft are straight, narrow, and equal sized. Ventral tubercles are prominent at the beginning of the shaft and are present but very weak for most of its length. A conspicuous constriction and associated flared collar ribs are present close to the adult aperture. The little incised suture has bifid lobes and saddles (text fig. 2).

Discussion.—Dense ribbing and small size distinguish this species from *S. texanum. Solenoceras multicostatum* Stephenson (1941, p. 402, pl. 76, figs. 12–14) and *S. annulifer* (Morton, 1841, p. 109) are finer ribbed and have depressed, reniform sections up to the adult shaft. *Solenoceras nitidum* Cobban (1974a, p. 83, figs. 1*a–c*, 2) lacks tubercles.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Neylandville Marl and Nacatoch Sand in northeastern Texas; *Baculites compressus* and *B. reesidei* zones of the Pierre Shale in northern Colorado.

Genus *PARASOLENOCERAS* Collignon, 1969

Type species—*Parasolenoceras splendens* Collignon, 1969, p. 44, pl. 530, figs. 2087, 2088, by original designation.

Parasolenoceras pulcher Cobban and Kennedy, 1991

Plate 7, figures 13, 29

1991. *Parasolenoceras pulcher* Cobban and Kennedy, p. C4, pl. 1, figs. 7–9.

Types.—Holotype is USNM 442107; it and four paratypes (USNM 442108) are from the *Nostoceras rugatum* zone of the Nacatoch Sand at USGS Mesozoic locality D7861 on the old Confederate military road, 4.8 km northeast of Washington in Hempstead County, Ark.

Description.—A few fragments consist of two widely separated parallel shafts connected by a narrowly curved section. The smaller shaft has a nearly circular whorl section and ornament of low, broad, distant, prorsiradiate ribs. These ribs are much weakened on the dorsum; they are stronger on the venter, where most bear blunt ventral tubercles linked across the venter by broad, slightly convex ribs. Occasional weak, nontuberculate ribs and widely spaced constrictions are present. Ribs become sharpened and crowded at the end of the initial shaft, where they become markedly convex and prorsiradiate; all bear flat-topped tubercles that were the bases of septate spines. Rib direction changes from prorsiradiate to rursiradiate around the elbow, and the ribs become straight and prosiradiate on the larger, slightly compressed shaft, where the rib index is 8. All ribs on the larger shaft have tubercles linked over the venter by narrow ribs. One specimen has a pronounced constriction on the curved sector and a weaker one at a larger diameter. The larger shaft is partially septate. The poorly exposed suture has broad, bifid saddles.

Discussion.—Distinguishing features of *Parasolenoceras pulcher* are its small size, compressed whorls, and irregular development of tubercles on the smaller shaft along with some nontuberculate ribs. These features separate it from *P. interruptum* (Schlüter, 1872, p. 102, pl. 32, figs. 8, 9), *P. splendens* (Collignon, 1969, p. 44, pl. 530, figs. 2087, 2088), and species described by Matsumoto (1984) and Matsumoto and Miyauchi (1984, 1986).

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Nacatoch Sand in Arkansas; *Baculites reesidei* zone of the Pierre Shale in northern Colorado.

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 undatus Stephenson, 1941

Plate 8, figures 9–11; plate 9, figures 1–6

1941. *Baculites undatus* Stephenson, p. 405, pl. 79, figs. 5–10.
1973. *Baculites undatus* Stephenson. Cobban, p. 459, figs. 2–5.
1974b. *Baculites undatus* Stephenson. Cobban, p. 5, text fig. 3.
1992. *Baculites undatus* Stephenson. Cobban, Kennedy, and Scott, p. A7.

Types.—Holotype is USNM 77245, the original of Stephenson (1941, pl. 79, figs. 5–7) from the Nacatoch Sand near Chatfield in Navarro County, Tex. Paratypes USNM 77246 and 77247 are also from the Nacatoch Sand, the former from the same locality as the holotype and the latter from another locality northwest of Chatfield.

Description.—The species attains a fairly large size; a septate specimen 44 mm in whorl height was illustrated by Cobban (1973, fig. 3*n*). The shell has a moderate taper and a stout, subelliptical whorl section. Broad, blunt, crescentic ribs extend across the dorsal two-thirds of the flank; they are strongest on the dorsal half but weaken markedly on the dorsum or disappear. The ribs project strongly forward on the ventral third of the flank and then decline rapidly. These ribs and the interspaces between are covered by dense riblets that intersect the line of the venter at an angle of 20° to 30°. Internal molds retain the crescentic ribs, but the riblets may not be preserved. The intricately subdivided suture has broad bifid saddles and slightly narrower lobes (Cobban, 1973, fig. 4).

Discussion.—*Baculites undatus* differs from co-occurring *B. claviformis* Stephenson (1941, p. 403, pl. 1; pl. 77, figs. 6–8; pl. 78, figs. 1–6) in having a stouter whorl section and ornamented juveniles.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Nacatoch Sand near Chatfield in Navarro County, Tex.; Saratoga Chalk in Arkansas; Navesink Formation in New Jersey; Mount Laurel Sand in Delaware; *Didymoceras cheyennense* to *Baculites reesidei* zones of the Pierre Shale in Colorado and New Mexico.

Baculites claviformis Stephenson, 1941

Plate 8, figures 1–8; plate 10; plate 11; text figure 3

1892. *Baculites asper* Morton. Whitfield, p. 278, pl. 46, figs. 10, 11.
1907. *Baculites asper* Morton? Weller, p. 823, pl. 109, figs. 6, 7.
1926. *Baculites grandis* Hall and Meek. Wade, p. 182, pl. 60, figs. 8, 12.
1941. *Baculites claviformis* Stephenson, p. 403, pl. 1; pl. 77, figs. 6–8; pl. 78, figs. 1–6.
1962. *Baculites* sp. Reeside, p. 117, pl. 68, fig. 9.
1974b. *Baculites claviformis* Stephenson. Cobban, p. 5, pl. 3, figs. 7, 8, 12–14.

Types.—Holotype is USNM 77241; there are seven paratypes from the Nacatoch Sand near Kaufman in Kaufman County, Tex.

Description.—The shell expands fairly rapidly in juveniles (pl. 8, figs. 1–8). Juveniles have compressed ovate whorl sections and smooth flanks and dorsums; ventral ribbing is inconspicuous. Adults taper less than juveniles and have stouter whorl sections characterized by a flattened dorsum and narrowly rounded venter. Ornament on adults consists of broad, crescentic flank ribs or low, crescentic flank swellings, both of which weaken on the venter. The venter is crossed by low, convex ribs of irregular height and spacing (pl. 10, fig. 8; pl. 11, fig. 1). Suture has broad, bifid E/L, narrow, bifid L/U, and narrow, bifid U (text fig. 3).

Discussion.—The largest septate specimens in the collections from Coon Creek have whorl heights of 80 mm (pl. 11), 68 mm (unfigured specimen USNM 449436), and 60 mm (pl. 10, figs. 6–8). A fragment of a body chamber has a whorl height of 110 mm (BHI 2024).

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee, Alabama and, possibly, Mississippi; Nacatoch Sand in southwestern Arkansas and northeastern Texas; Navesink Formation in New Jersey; Mount Laurel Sand in Delaware; Owl Creek Formation in Mississippi; Pierre Shale in Colorado and New Mexico.

Superfamily SCAPHITACEAE Gill, 1871
Family SCAPHITIDAE Gill, 1871
Subfamily SCAPHITINAE Gill, 1871
Genus *JELETZKYTES* Riccardi, 1983

Type species.—*Scaphites nodosus* Owen, 1852, p. 481, pl. 8, fig. 4, by original designation by Riccardi (1983, p. 14).

Jeletzkytes nodosus (Owen, 1852)

Plate 9, figures 7–11

1852. *Scaphites* (*Ammonites*?) *nodosus* (n.s.) Owen, p. 581, pl. 8, fig. 4.
1880. *Scaphites nodosus* Owen. Whitfield, p. 441, pl. 13, fig. 12.
?1892. *Scaphites nodosus* Owen. Whitfield, p. 261, pl. 44, figs. 13, 14.
1896. *Scaphites nodosus* Owen. Gilbert, pl. 45, fig. 2.
1905. *Scaphites nodosus* Owen. Smith, p. 638, pl. 3, fig. 14.
?1907. *Scaphites nodosus* Owen?. Weller, p. 824, pl. 107, figs. 1, 2.
1916. *Scaphites nodosus* Owen. Diener, p. 565, text fig. 16.

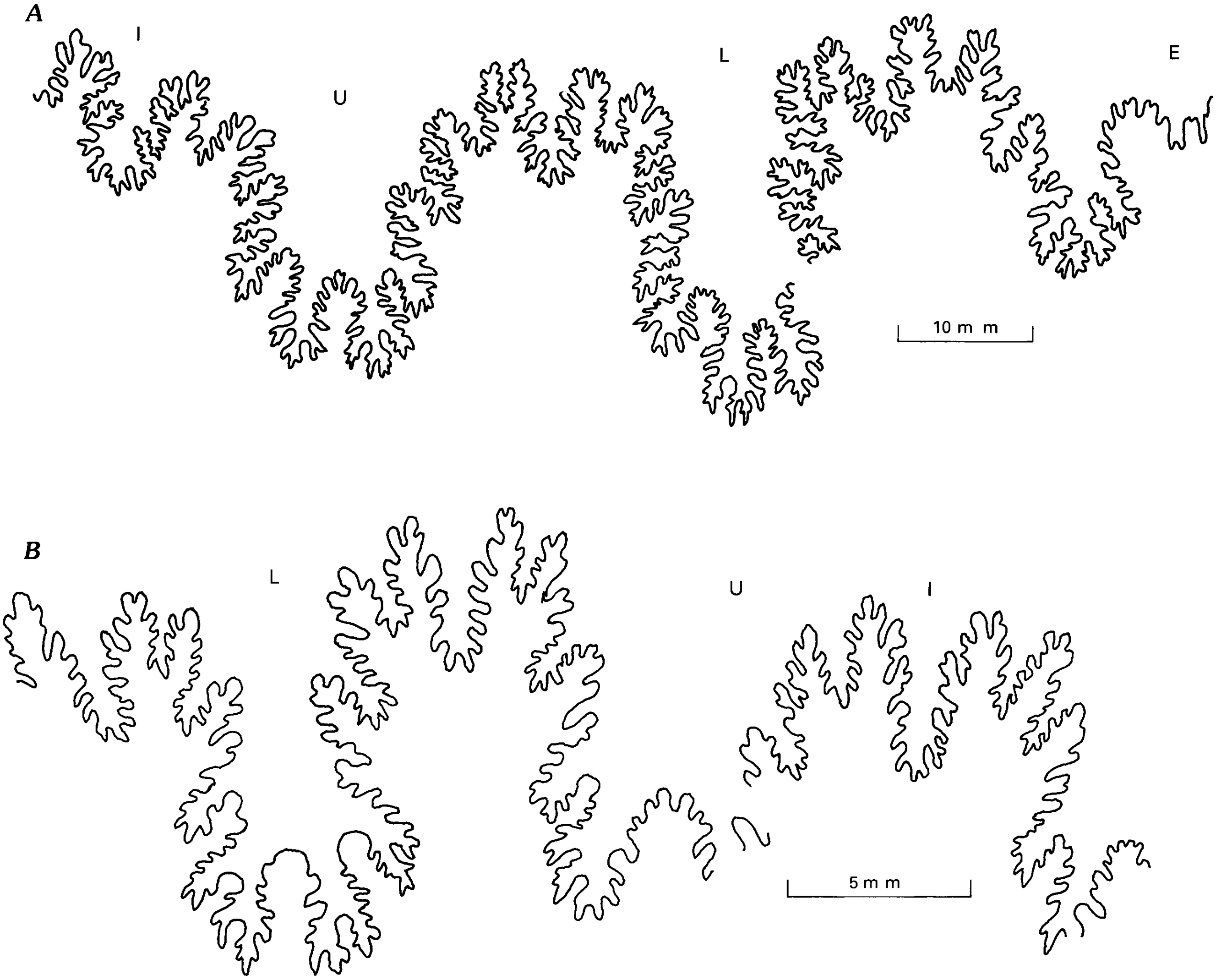

Figure 3. Sutures of *Baculites claviformis* Stephenson. From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. E is external lobe, L is lateral lobe, U is umbilical lobe, and I is internal lobe. *A*, Hypotype USNM 449434; *B*, hypotype USNM 449440.

1917. *Scaphites nodosus* Owen. Dowling, p. 32, pl. 32, fig. 3.
1925. *Acanthoscaphites nodosus* (Owen). Diener, p. 205.
1926. *Scaphites reesidei* Wade, p. 198, pl. 41, figs. 3–7.
?1933. *Acanthoscaphites nodosus* (Owen). Elias, p. 320; pl. 38, figs. 1–3.
1940. *Acanthoscaphites nodosus* Owen. Landes, p. 177–178.
1941. *Scaphites rugosus* Stephenson, p. 425, pl. 89, figs. 15–16.
1970. *Scaphites nodosus* Owen. Jeletzky, pl. 27, fig. 7.
1975. *Hoploscaphites nodosus* (Owen). Hirsch, text fig. 9*b*.
1980. *Acanthoscaphites praequadrispinosus* Błaszkiewicz, p. 38, pl. 19, figs. 2, 3, 6–8; pl. 20, figs. 1–3, 6–8; pl. 21, figs. 1–6.
1983. *Jeletzkytes nodosus* (Owen, 1852). Riccardi, p. 15, pl. 2, figs. 1–8; text figs. 5–6, 7*a*.
1992. *Jeletzkytes nodosus* (Owen, 1852). Cobban, Kennedy, and Scott, p. A8, pl. 3, figs. 2–5, 7–11.

Type.—Holotype, by monotypy, is no. 6381 in the collections of the Field Museum of Natural History in Chicago, Ill., from the Pierre Shale of "Sage Creek, tributary of the Cheyenne," near the Badlands of South Dakota. The specimen probably came from the *Baculites compressus* zone or possibly the *B. cuneatus* zone.

Description.—Juvenile stages of this species are well represented by the holotype of *Scaphites reesidei* Wade (1926, pl. 41, figs. 3–7), an involute phragmocone 59 mm in diameter. The whorl section is compressed (though modified by crushing); it has a whorl breadth-to-height ratio of 0.8. Flanks are broadly rounded, and the venter is more narrowly rounded. Weak primary ribs arise at the umbilical seam and strengthen across the umbilical wall and shoulder. These ribs are narrow, straight, and prorsiradiate on the inner flank, where they increase by branching or by intercalating. Ribs are convex around midflank and then flex back a little before they pass over the venter in broad convexity. Ventrolateral tubercles develop on some ribs that are separated by one to three nontuberculate ribs. A midlateral tubercle appears a little later in ontogeny. Ribs branch in pairs from both tubercles and may loop between lateral and ventral tubercles or between ventral tubercles. Additional ribs may intercalate on the outer flank to give a total of approximately 80 ribs per whorl.

BHI 1981 is a nearly complete macroconch that has a length of 75 mm. The specimen shows coarse tubercles and ribs that persist onto the shaft of the body chamber and the initial part of the final hook.

Discussion.—Workers on Gulf coast scaphites have, curiously, failed to recognize the presence of *S. nodosus* in the region. Both *S. reesidei* Wade (1926, p. 198, pl. 41, figs. 3–7 *non* Collignon, 1969), originally described from Coon Creek, and *S. rugosus* Stephenson (1941, p. 425, pl. 89, figs. 15–18) from the Nacatoch Sand in Navarro County, Tex., are synonyms of *Jeletzkytes nodosus*. So too is *Acanthoscaphites praequadrispinosus* Błaskiewicz, 1980 (p. 38, pl. 19, figs. 2, 3, 6–8; pl. 20, figs. 1–3, 6–8; pl. 21, figs. 1–6) from the upper Campanian of the Vistula River Valley in Poland.

Occurrence.—Coon Creek Tongue of the Ripley Formation in Tennessee; Nacatoch Sand in northeastern Texas; Saratoga Chalk in southwestern Arkansas; Navesink Formation in New Jersey; *Baculites compressus, B. cuneatus, B. reesidei,* and *B. jenseni* zones in the Pierre Shale in the Western Interior; *Nostoceras* (*N.*) *hyatti* [*pozaryskii*] zone of the Vistula River Valley in Poland.

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PLATES 1–11

Contact photographs of the plates in this report are available, at cost, from the U.S. Geological Survey Photographic Library, Federal Center, Denver, CO 80225.

PLATE 1

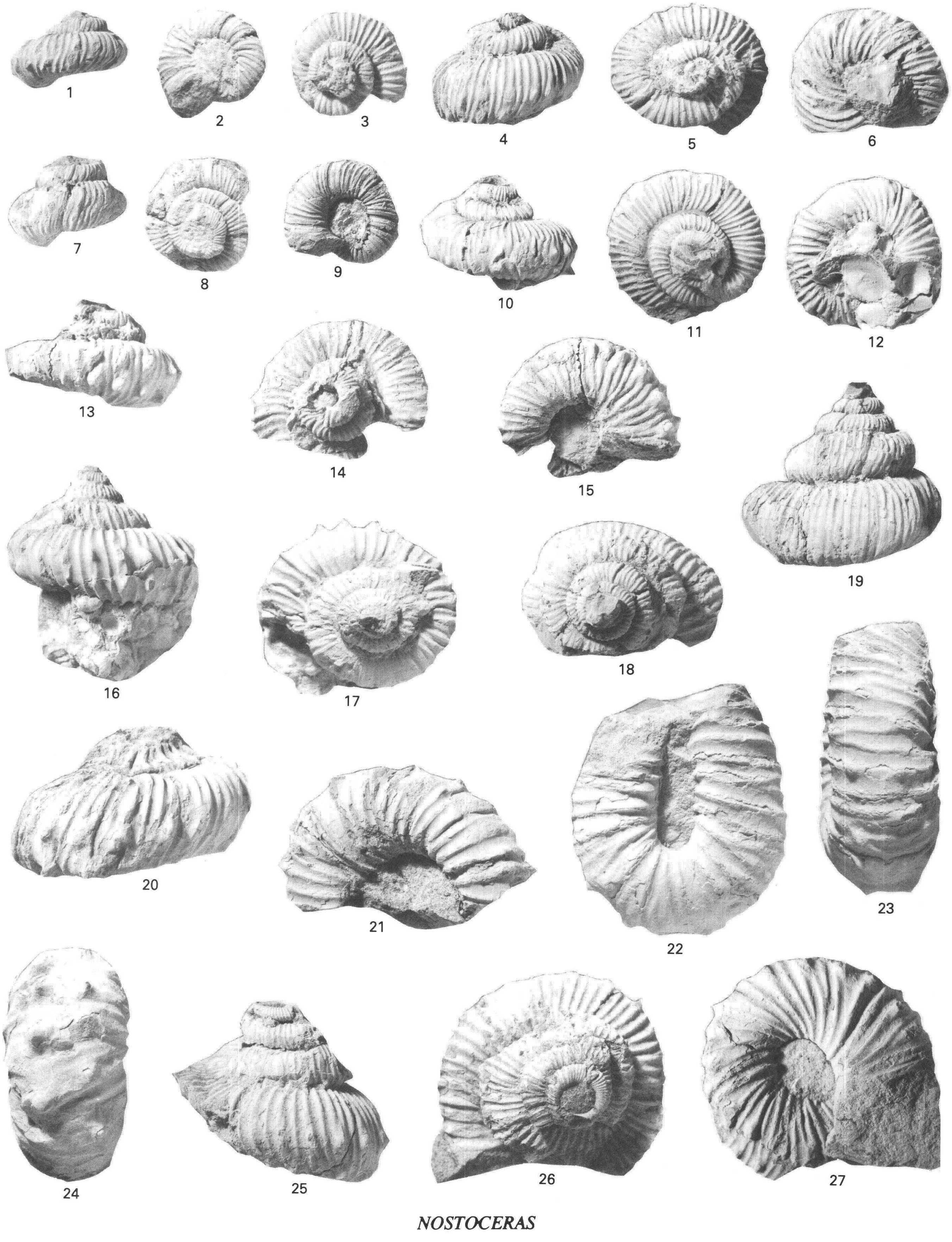
Nostoceras

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size]

Figures 1–3, 13–15. *Nostoceras* (*Nostoceras*) *helicinum* (Shumard) (p. B3).
- 1–3. Hypotype BHI 2002.
- 13–15. Hypotype BHI 1999.

4–9, 18, 19, 22–24. *Nostoceras* (*Nostoceras*) *approximans* (Conrad) (p. B2).
- 4–6. Hypotype USNM 449390.
- 7–9. Hypotype BHI 2003.
- 18, 19. Hypotype USNM 449392.
- 22–24. Hypotype BHI 2008.

10–12, 16, 17, 20, 21, 25–27. *Nostoceras* (*Nostoceras*) *hyatti* Stephenson (p. B3).
- 10–12. Hypotype USNM 449391.
- 16, 17. Hypotype BHI 2004.
- 20, 21. Hypotype USNM 449393.
- 25–27. Hypotype USNM 449394.



NOSTOCERAS

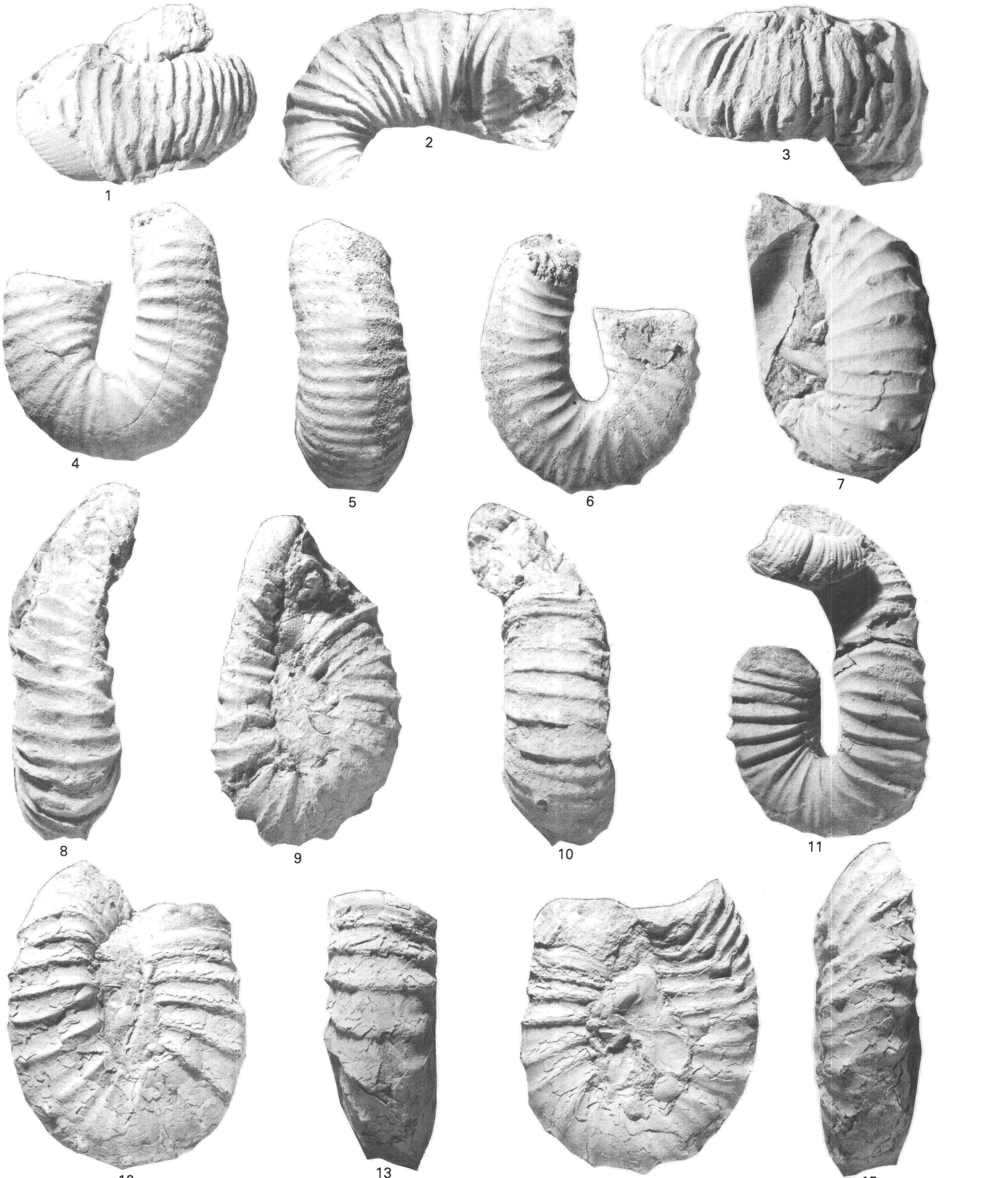
PLATE 2

Nostoceras

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size]

Figures 1–6, 11. *Nostoceras (Nostoceras) approximans* (Conrad) (p. B2).
- 1. Hypotype USNM 449395.
- 2, 3. Hypotype USNM 449396 .
- 4–6. Hypotype USNM 449397.
- 11. Hypotype USNM 449399.

7–10, 12–15. *Nostoceras (Nostoceras) hyatti* Stephenson (p. B3).
- 7. Hypotype BHI 2005.
- 8–10. Hypotype USNM 449398.
- 12–15. Hypotype BHI 2007.



NOSTOCERAS

PLATE 3

Nostoceras, *Didymoceras*, and *Lewyites*

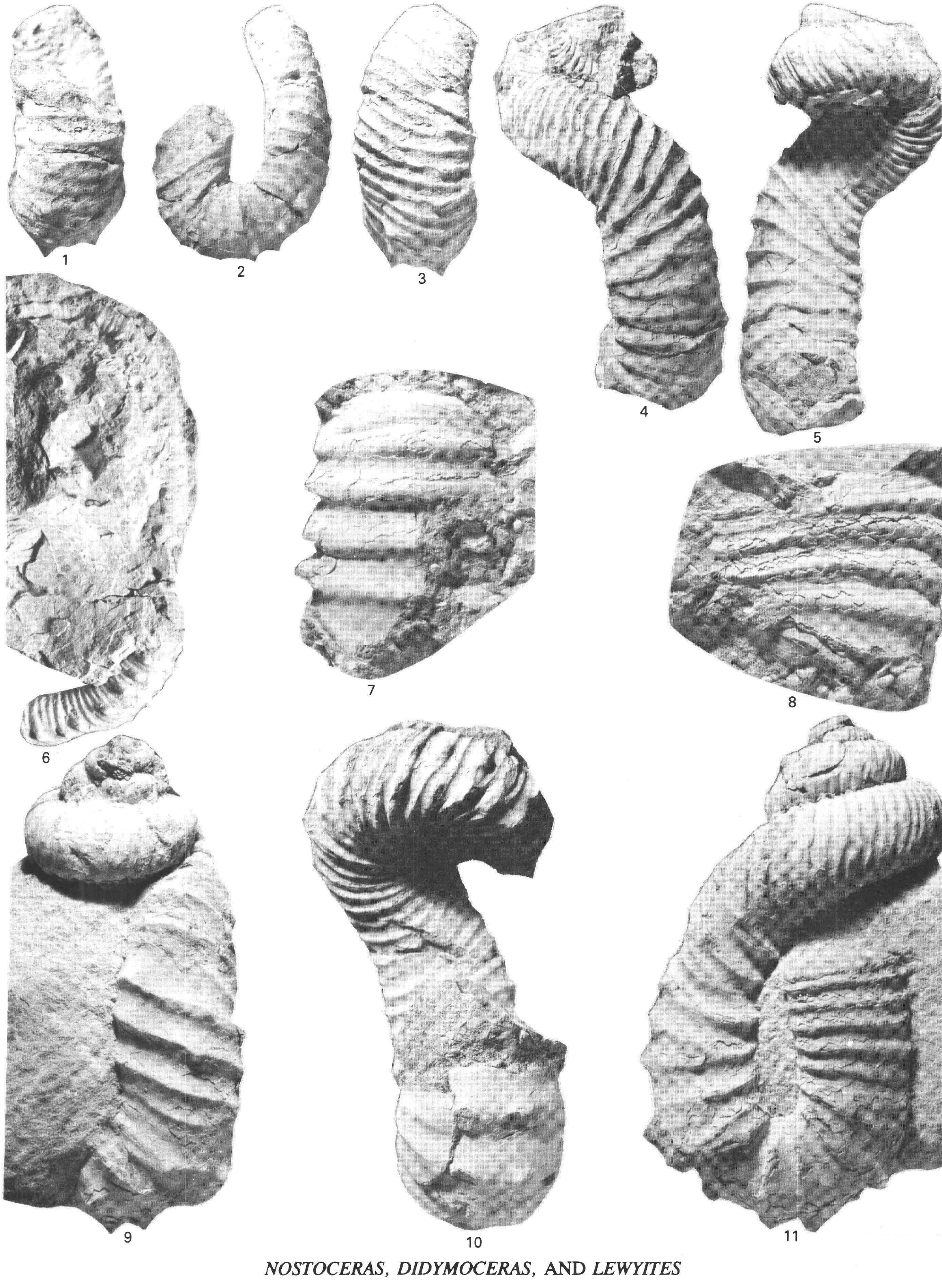
[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size]

Figures 1–3. *Nostoceras* (*Nostoceras*) *approximans* (Conrad) (p. B2).
Hypotype USNM 449400.

4, 5, 9–11. *Nostoceras* (*Nostoceras*) *hyatti* Stephenson (p. B3).
4, 5. Hypotype USNM 449401.
9, 11. Hypotype BHI 2000.
10. Hypotype USNM 449402.

6. *Didymoceras navarroense* (Shumard) (p. B4).
Hypotype BHI 2012.

7, 8. *Lewyites* sp. (p. B6).
Figured specimen BHI 2016.



NOSTOCERAS, DIDYMOCERAS, AND *LEWYITES*

PLATE 4

Didymoceras

[All figures natural size]

Figures 1–8. *Didymoceras navarroense* (Shumard) (p. B4).

1, 2, 5, 6. Hypotype BHI 2013. From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn.

3. Hypotype BHI 2011. From the same locality as BHI 2013.

4. Hypotype USNM 449403. Latex cast of a specimen from the Neylandville Marl at U.S. Geological Survey Mesozoic locality 15543, 4 km south of Ben Hur, Limestone County, Tex.

7, 8. Hypotype USNM 449404. From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn.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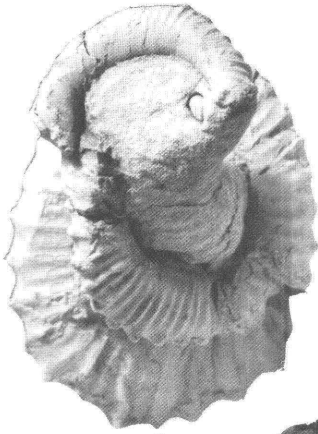
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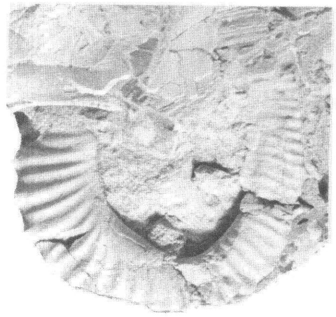
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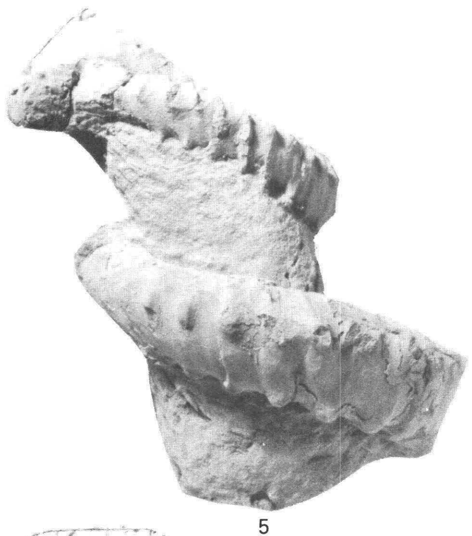
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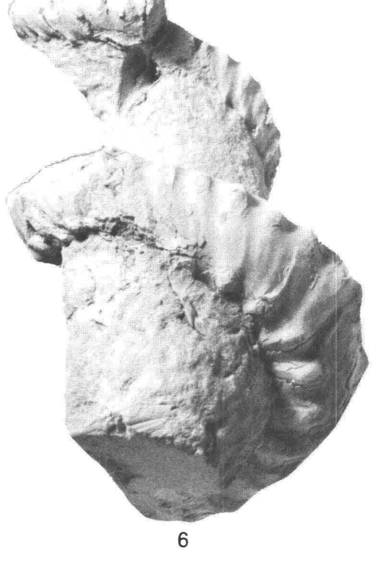
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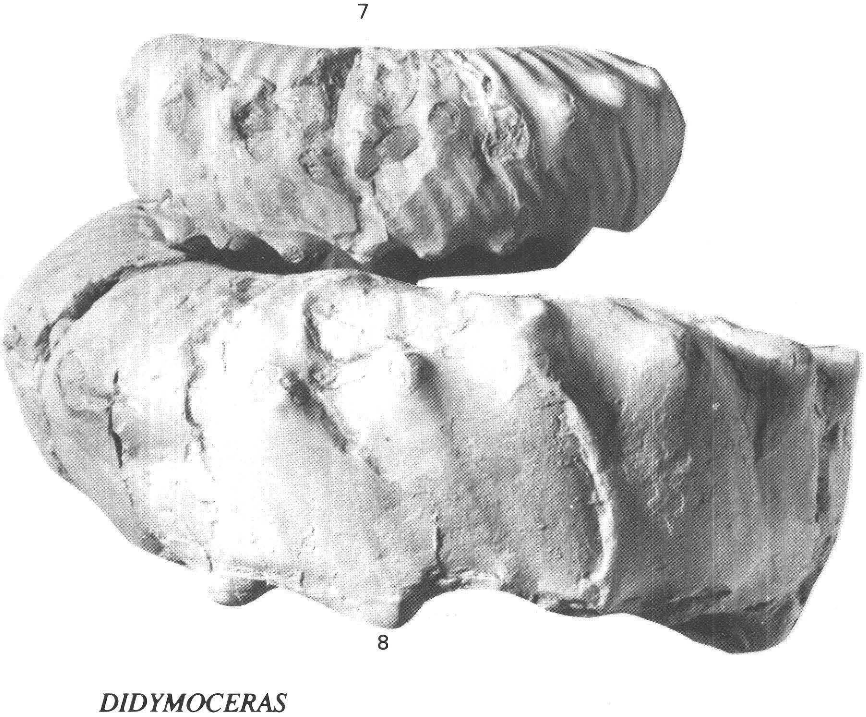
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DIDYMOCERAS

PLATE 5

Didymoceras

[All figures natural size]

Figures 1–23. *Didymoceras navarroense* (Shumard) (p. B4).

1, 2. Hypotype USNM 449405. From the Neylandville Marl at U.S. Geological Survey Mesozoic locality 15543, 4 km south of Ben Hur, Limestone County, Tex.

3–5. Hypotype USNM 449406. From the same locality as USNM 449405.

6, 7. Hypotype USNM 449407. From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn.

8–10. Hypotype USNM 449408. From the same locality as USNM 449407.

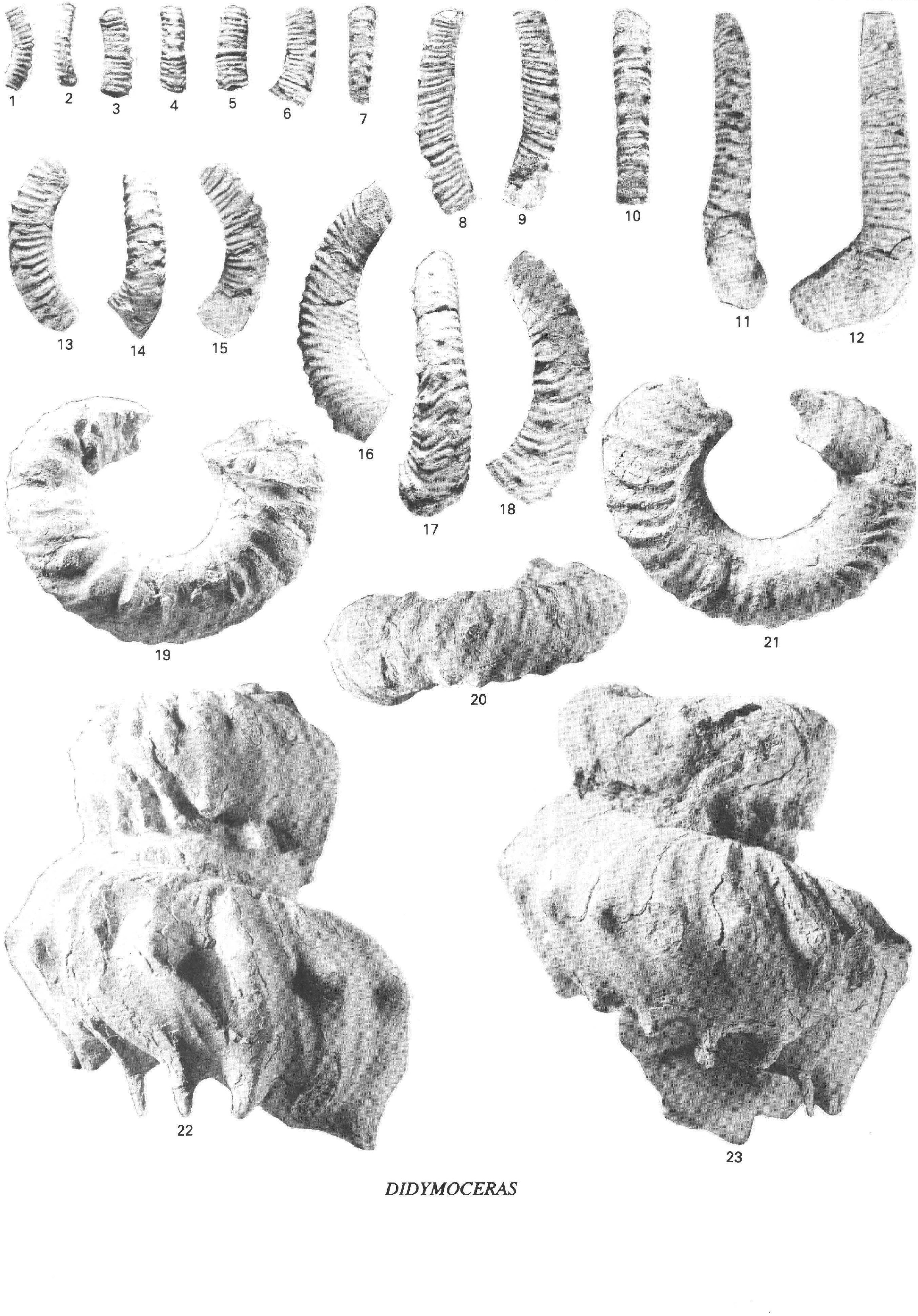
11, 12. Hypotype BHI 2009. From the same locality as USNM 449407.

13–15. Hypotype USNM 449409. From the same locality as USNM 449407.

16–18. Hypotype USNM 449410. From the same locality as USNM 449407.

19–21. Hypotype USNM 449411. From the same locality as USNM 449407.

22, 23. Hypotype USNM 449412. From the same locality as USNM 449407.



DIDYMOCERAS

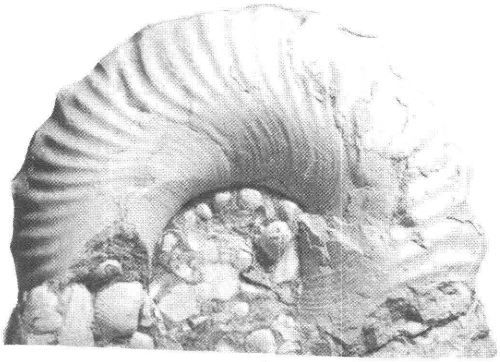
PLATE 6

Didymoceras

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size]

Figures 1–3. *Didymoceras hornbyense* (Whiteaves) (p. B5).
Hypotype BHI 2014.

4–6. *Didymoceras navarroense* (Shumard) (p. B4).
4. Hypotype USNM 449413.
5. Hypotype USNM 449404. For other views, see plate 4, figures 7 and 8.
6. Hypotype USNM 449414.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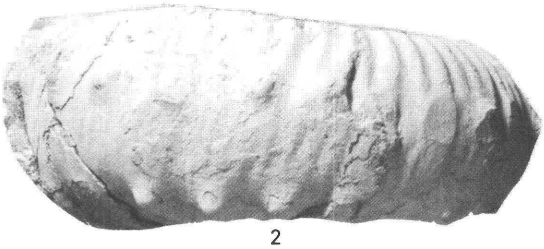
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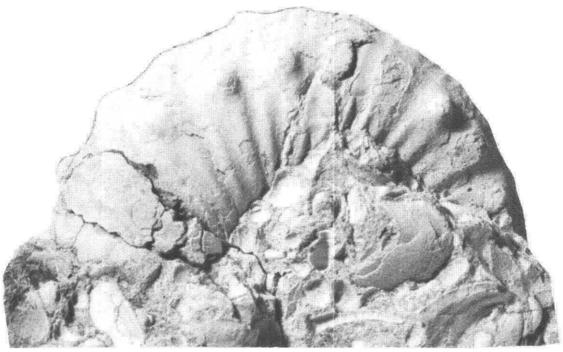
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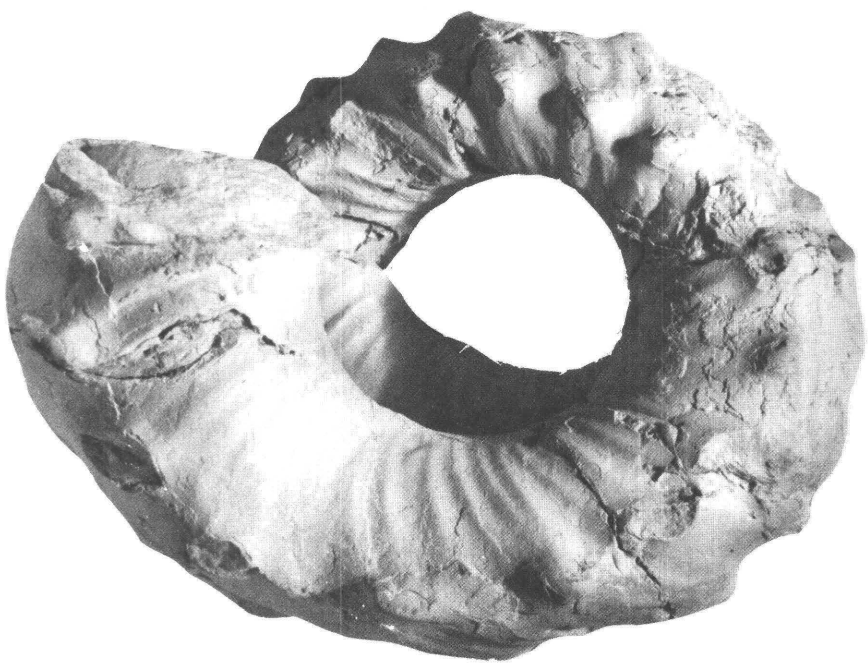
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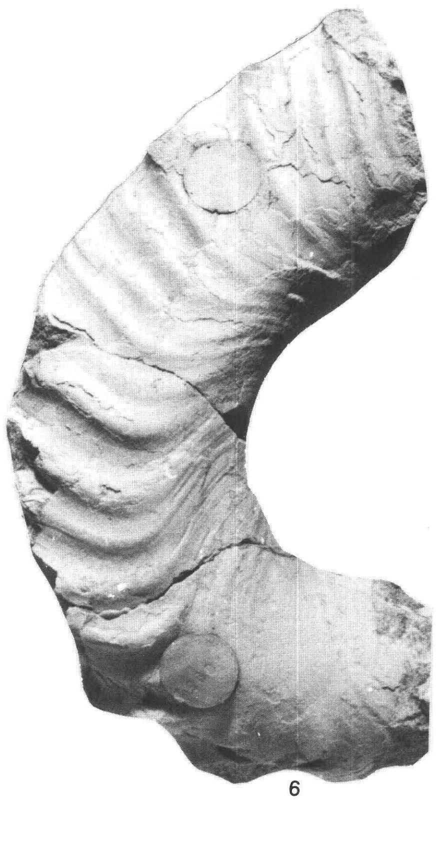
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DIDYMOCERAS

PLATE 7

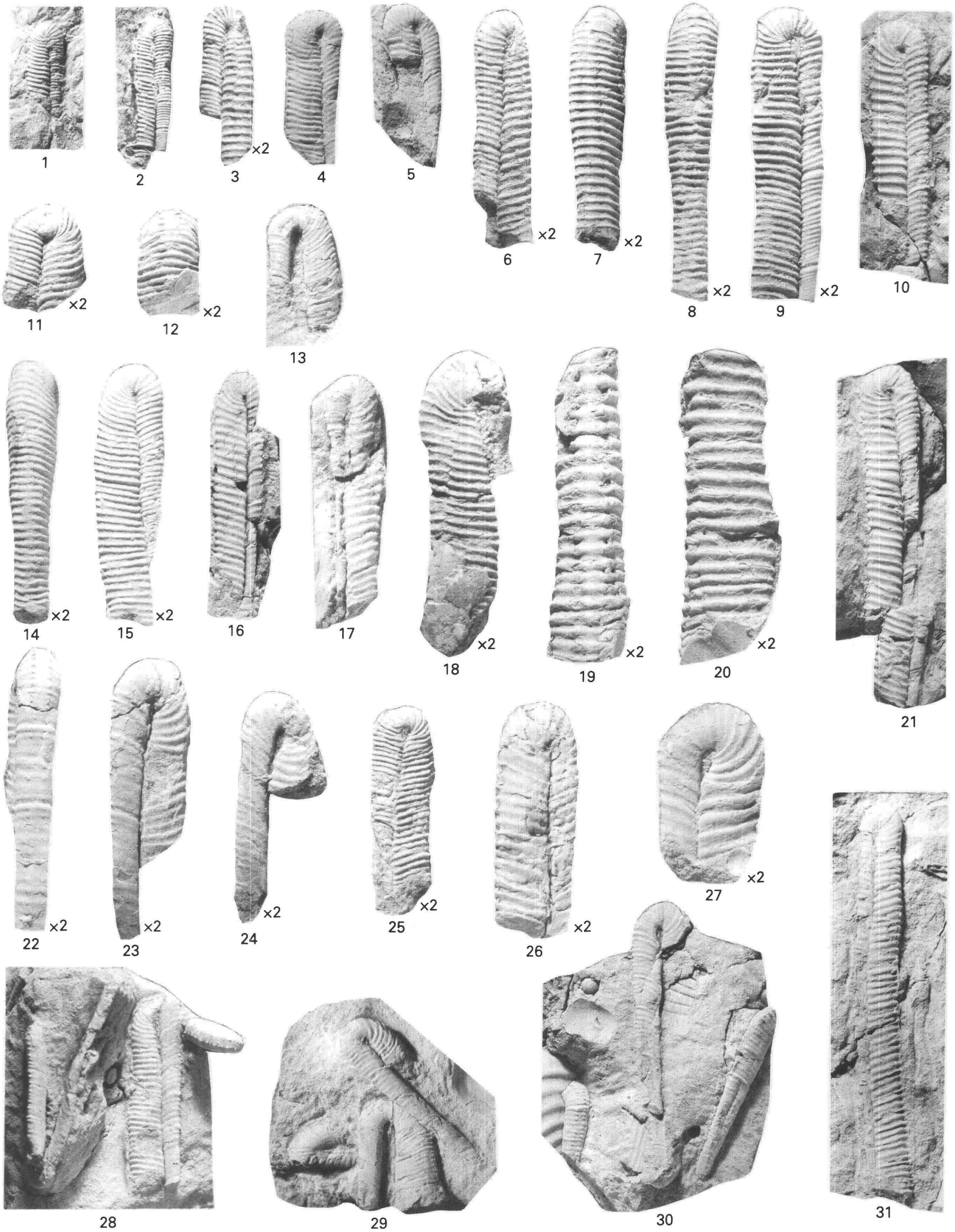
Solenoceras and *Parasolenoceras*

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size except as indicated]

Figures 1–9, 11, 12, 14, 15, 18, 25. *Solenoceras reesidei* Stephenson (p. B6).
- 1. Hypotype BHI 1989.
- 2. Hypotype BHI 1988.
- 3. Hypotype USNM 449415. ×2.
- 4. Hypotype BHI 1991.
- 5. Hypotype BHI 1993.
- 6, 7. Hypotype USNM 449416. ×2.
- 8, 9. Hypotype USNM 449417. ×2.
- 11, 12. Hypotype USNM 449418. ×2.
- 14, 15. Hypotype USNM 449419. ×2.
- 18. Hypotype USNM 449420. ×2.
- 25. Hypotype USNM 449421. ×2.

10, 16, 17, 19–24, 26–28, 30, 31. *Solenoceras texanum* (Shumard) (p. B6).
- 10. Hypotype BHI 1995.
- 16. Hypotype USNM 449422.
- 17. Hypotype USNM 449423.
- 19, 20. Hypotype USNM 449424. ×2.
- 21. Hypotype BHI 1994.
- 22, 23. Hypotype USNM 449425. ×2.
- 24. Hypotype USNM 449426. ×2.
- 26. Hypotype USNM 449427. ×2.
- 27. Hypotype USNM 449428. ×2.
- 28. Hypotype BHI 1990.
- 30. Hypotype BHI 1987.
- 31. Hypotype BHI 1996.

13, 29. *Parasolenoceras pulcher* Cobban and Kennedy (p. B7).
- 13. Hypotype BHI 2032.
- 29. Hypotype BHI 1986.



SOLENOCERAS AND *PARASOLENOCERAS*

PLATE 8
Baculites

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size]

Figures 1–8. *Baculites claviformis* Stephenson (p. B8).
- 1–3. Hypotype USNM 449429.
- 4–6. Hypotype USNM 449430.
- 7, 8. Hypotype USNM 449431.

9–11. *Baculites undatus* Stephenson (p. B8).
Hypotype USNM 449437.

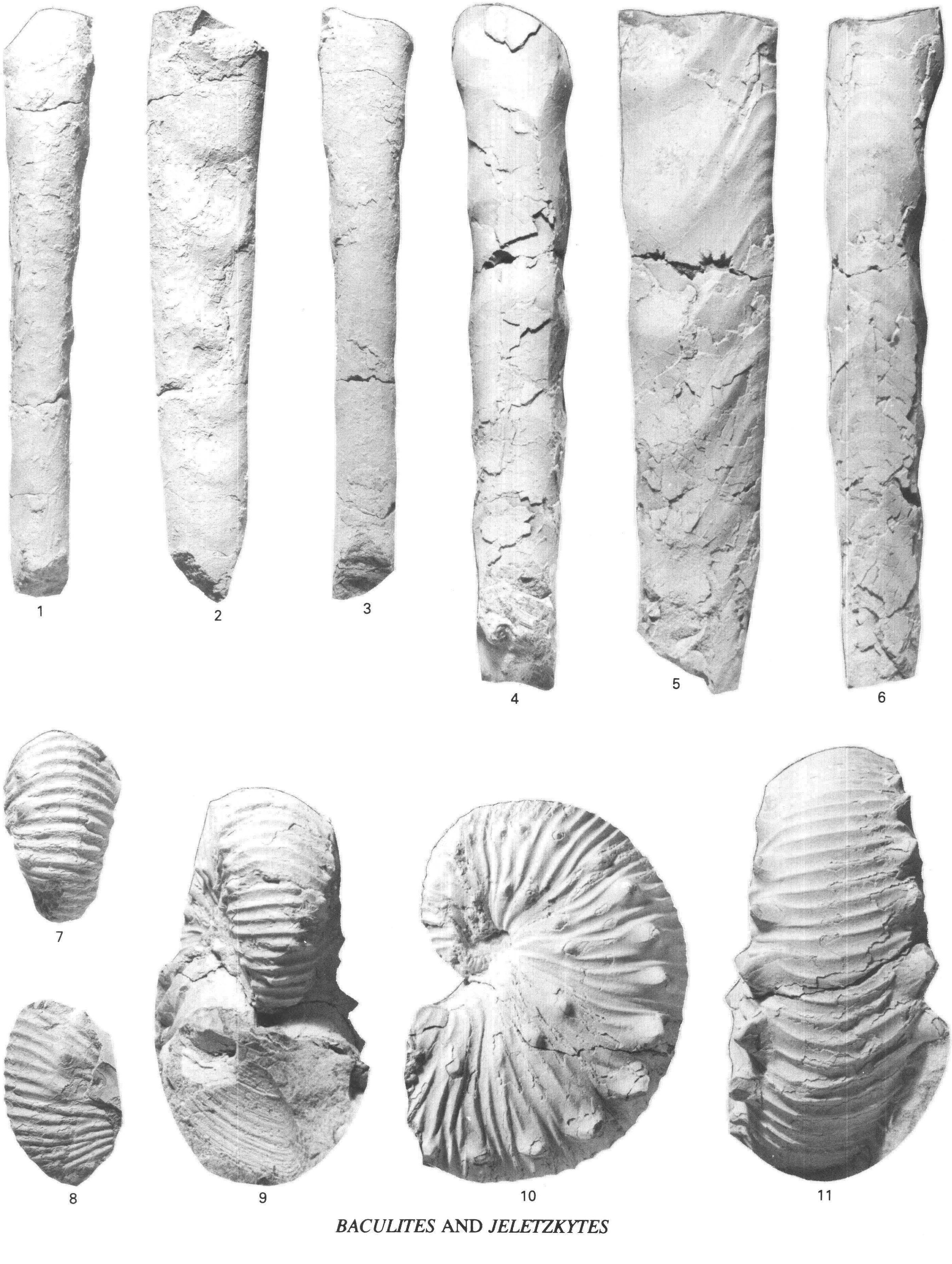
BACULITES

PLATE 9

Baculites and *Jeletzkytes*

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size]

Figures 1–6. *Baculites undatus* Stephenson (p. B8).
1–3. Hypotype USNM 449438.
4–6. Hypotype BHI 2018.
7–11. *Jeletzkytes nodosus* (Owen) (p. B8).
7, 8. Hypotype BHI 1983.
9–11. Hypotype BHI 1981.



BACULITES AND *JELETZKYTES*

PLATE 10

Baculites

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. All figures natural size]

Figures 1–8. *Baculites claviformis* Stephenson (p. B8).
1, 2. Hypotype USNM 449432.
3–5. Hypotype USNM 449433.
6–8. Hypotype USNM 449434.

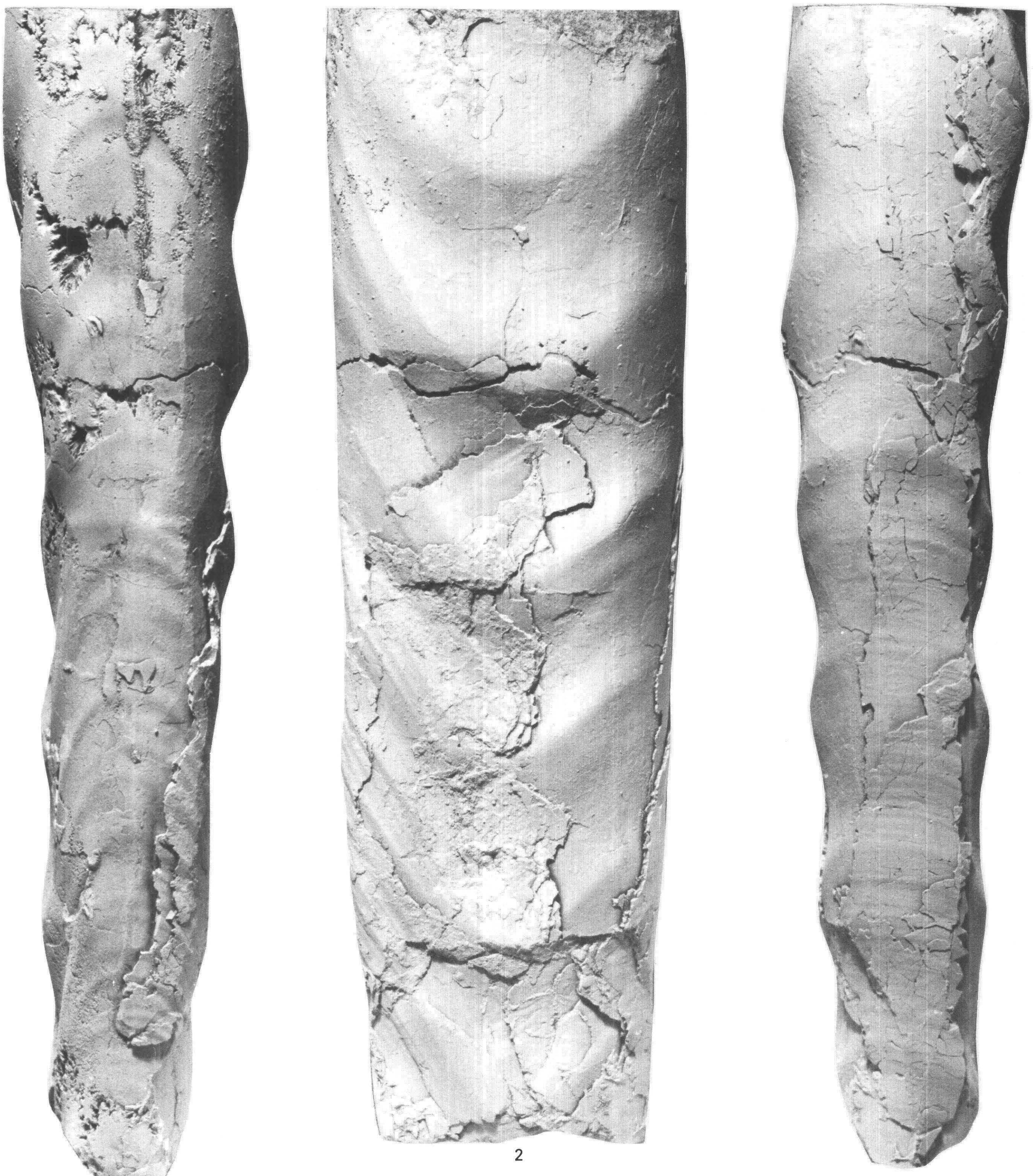
BACULITES

PLATE 11

Baculites

[From the Coon Creek Tongue of the Ripley Formation at Coon Creek, McNairy County, Tenn. Figures three-fourths natural size]

Figures 1–3. *Baculites claviformis* Stephenson (p. B8).
Hypotype USNM 449435.



1 2 3

BACULITES

A Giant Baculite from the Upper Campanian and Lower Maastrichtian of the Western Interior

By William A. Cobban and W. James Kennedy

SHORTER CONTRIBUTIONS TO PALEONTOLOGY AND STRATIGRAPHY

U.S. GEOLOGICAL SURVEY BULLETIN 2073–C

Description of Pseudobaculites natosini *(Robinson, 1945) from the Bearpaw Shale of Montana, the Lewis Shale of Wyoming, and the Pierre Shale of Colorado*

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1994

CONTENTS

PLATES

[Plates follow References Cited]

FIGURES

TABLE

METRIC CONVERSION FACTORS

Multiply	By	To obtain
	Length	
millimeter (mm)	0.0394	inch
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile

A Giant Baculite From the Upper Campanian and Lower Maastrichtian of the Western Interior

By William A. Cobban[1] and W. James Kennedy[2]

ABSTRACT

Pseudobaculites natosini (Robinson, 1945) is the largest baculite (straight or nearly straight ammonite) known from the Western Interior of Canada and the United States. The species is characterized by its high expansion rate, compressed whorl section, and deeply incised suture that has the terminal branches of the lateral lobe constricted at their bases. Occurrences of the species are in the upper Campanian zone of *Baculites jenseni* and in the lower Maastrichtian zone of *B. eliasi* in Montana, Wyoming, and Colorado. The known occurrence in Saskatchewan has not been placed in the baculitid sequence.

INTRODUCTION

Robinson (1945, p. 52, pl. 1, figs. 5, 6) described, as *Baculites natosini* n. sp., a fragment of a body chamber of a very large, compressed, smooth baculite that has a whorl height of 240 mm. The specimen is from the Bearpaw Shale of southwestern Saskatchewan. Collections made by members of the U.S. Geological Survey (USGS) from the upper Campanian zone of *Baculites jenseni* and from the lower Maastrichtian zone of *B. eliasi* in Montana, Wyoming, and Colorado show that Robinson's species is the largest baculite known in the Western Interior of North America. In addition to its great size, the species is set apart from contemporary baculites by the unusually high expansion rate, very compressed whorl section, and deeply divided suture. These features necessitate an assignment of Robinson's species to *Pseudobaculites* Cobban (1952), a genus previously known mainly from the upper Coniacian of Wyoming, Utah, Colorado, and New Mexico.

The present paper adds more information regarding the morphologic character of *P. natosini* as well as data concerning its geographic and stratigraphic distribution. The species has not previously been reported from the United States, but the published records of *Pseudobaculites* sp. near Kremmling, Colo. (Izett and others, 1971, p. A7), and in east-central Montana (Gill and others, 1972, p. 94) probably represent this species.

Most of the specimens described herein are kept in the National Museum of Natural History (USNM) in Washington, D.C., and have USNM catalogue numbers 458236 through 458244. Some of the specimens figured here were photographed by R.E. Burkholder, recently retired from the USGS. Kennedy acknowledges the financial support of the Natural Environment Research Council (U.K.) and the technical assistance of the staff of the Geological Collections, University Museum, Oxford, and the Department of Earth Sciences (Oxford).

LOCALITIES OF *PSEUDOBACULITES NATOSINI* (ROBINSON, 1945)

Pseudobaculites natosini is present in 16 USGS collections from Montana, Wyoming, and Colorado. Localities of these collections are shown in figure 1, and data concerning the locality number, name(s) of collectors, year of collection, locality, and stratigraphic assignment are given in table 1. The prefix D indicates Denver Mesozoic locality numbers; the rest are Washington, D.C., Mesozoic locality numbers.

SYSTEMATIC PALEONTOLOGY

Family BACULITIDAE Gill, 1871

Genus *PSEUDOBACULITES* Cobban, 1952

Type species.—*Pseudobaculites nodosus* Cobban, 1952, p. 759, pl. 110, figs. 1–10, 17, 18, by original designation.

Diagnosis—Medium-sized to very large baculitids having a high angle of taper and a deeply incised, complex suture. Whorl section is oval to elliptical and may be very

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compressed. Flanks are usually smooth but may have a row of dorsolateral tubercles. Venter is smooth or has low, broad ribs.

Discussion.—Large size and a high expansion rate combined with great sutural complexity separate *Pseudobaculites* from all other Western Interior baculites. The genus has a curious disjunct stratigraphic distribution.

Occurrence.—Middle(?) and upper Coniacian of Wyoming; upper Coniacian of Utah, Colorado, and New Mexico; uppermost Campanian and lowermost Maastrichtian of Montana, Wyoming, and Colorado. Also found in Campanian or Maastrichtian in Saskatchewan.

Pseudobaculites natosini (Robinson)

Plates 1, 2

1945. *Baculites natosini* Robinson, p. 52, pl. 1, figs. 5, 6.

Types.—Holotype, by monotypy, is no. 9119 in the collections of the Geological Survey of Canada, the original of Robinson (1945, pl. 1, figs. 5, 6) from 96 m below the top of the Bearpaw Shale on McShane Creek in sec. 13, T. 9, R. 27, west third meridian, in southwestern Saskatchewan. Hypotypes are USNM 458236 through 458244 from the Lewis and Pierre Shales in central and eastern Wyoming.

Material.—About 25 specimens were available for study. Most are uncrushed internal molds from sandstone and limestone concretions. Nearly half of the specimens are from a small area in central Wyoming.

Description.—The holotype is part of an internal mold of a huge body chamber that has a whorl height (*Wh*) of 240 mm, a whorl breadth (*Wb*) of 140 mm, a *Wb*:*Wh* ratio of 0.58, and an angle of taper of about 6°. The whorl section is a compressed oval. Growth lines are the only ornament; they are broadly convex on the dorsum, flexed back into a broad arc on the dorsal half of the flanks, and then projected strongly forward on the ventral part of the flanks and on the venter. The form of the growth lines is the same as that of *Baculites* (for example, Stephenson, 1941, pl. 77, fig. 6; pl. 78, figs. 1, 2).

None of the specimens in the USGS's collections from the Western Interior of the United States attains the size of the holotype. The largest specimen (USNM 458236), from the lower Maastrichtian *Baculites eliasi* zone in the Pierre Shale at locality D3192 (text fig. 1, table 1), is a small part of a body chamber that has a whorl height of 218 mm and a whorl breadth of 113 mm (*Wb*:*Wh*=0.52). Its compressed ovate section has a very broadly rounded dorsum, somewhat flattened flanks, and a rather narrowly rounded venter. Ornament is lacking, other than a few faint growth lines that follow a sinuous course like that of the holotype.

Twelve specimens examined from the uppermost Campanian zone of *Baculites jenseni* in the Lewis Shale in central Wyoming have diameters ranging from 63 to 152 mm at the base of their body chambers. Growth angles range from 10° to 15°. Whorl sections are ovate to subelliptical (pl. 1, fig. 2), and all are narrow. Most specimens are smooth except for weak growth lines (pl. 1, figs. 1, 3, 4). Two specimens (USNM 458237, 458238) have faint ventral ribs that number about seven in a distance equal to the whorl height. The largest specimen from the Lewis Shale (USNM 458239), a fragment of the last three chambers and a small part of the body chamber, has an angle of

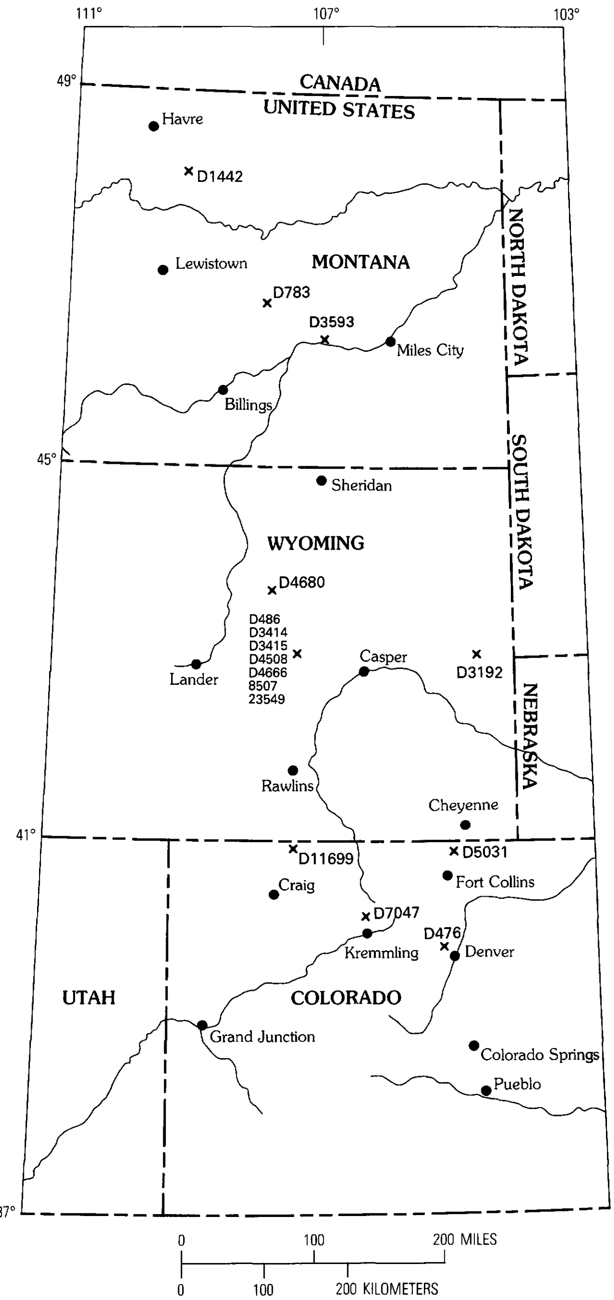

Figure 1. Localities in part of the Western Interior of the United States where *Pseudobaculites natosini* has been collected. Numbers are U.S. Geological Survey Mesozoic localities (table 1).

Table 1. Localities at which *Pseudobaculites* was collected

U.S. Geological Survey Mesozoic locality	Collector(s), year of collection, and description of locality
D144	W.P. Pecora and others, 1957. NW¼SW¼ sec. 9, T. 27 N., R. 20 E., Blaine County, Mont. Bearpaw Shale, about 90 to 120 m below top.
D783	H.R. Smith, P.W. Richards, and W.A. Cobban, 1955. About 23 km NNE. of Melstone, in the NW¼ sec. 24, T. 12 N., R. 31 E., Rosebud County, Mont. Bearpaw Shale, about 270 to 275 m above base.
D3583	J.R. Gill, L.G. Schultz, and W.A. Cobban, 1961. S½ sec. 25, T. 7 N., R. 40 E., Rosebud County, Mont. Bearpaw Shale, 213 m above base.
D4680	R.C. Givens, 1964. NE¼ sec. 36, T. 44 N., R. 90 W., Washakie County, Wyo. Lewis Shale, 51.8 m above base.
D486	W.A. Cobban, 1955. SE¼ sec. 30, T. 35 N., R. 84 W., Natrona County, Wyo. Lewis Shale.
D3414	A.D. Zapp, 1961. SW¼ sec. 13, T. 35 N., R. 85 W., Natrona County, Wyo. Lewis Shale, 82 m above base.
D3415	A.D. Zapp, 1961. SE¼SW¼ sec. 24, T. 35 N., R. 85 W., Natrona County, Wyo. Lewis Shale, 87 m above base.
D4508	W.H. Laraway, 1964. SE¼SW¼ sec. 24, T. 35 N., R. 85 W., Natrona County, Wyo. Lewis Shale.
D4666	J.R. Gill, 1964. SE¼SW¼ sec. 31, T. 36 N., R. 85 W., Natrona County, Wyo. Lewis Shale, 48.8 m above base.
8507	C.J. Hares, 1913. Sec. 14, T. 35 N., R. 85 W., Natrona County, Wyo. Lewis Shale.
23549	H.A. Tourtelot, 1951. Sec. 10, T. 36 N., R. 86 W., Natrona County, Wyo. Lewis Shale.
D3192	J.R. Gill, 1961. NE¼SW¼ sec. 26, T. 36 N., R. 65 W., Niobrara County, Wyo. Pierre Shale, from upper part.
D11699	C.S.V. Barclay, 1981. NW¼ sec. 13, T. 12 N., R. 89 W., Moffat County, Colo. Almond Formation, from upper part.
D5031	R.E. Burkholder and W.A. Cobban, 1965. SE¼NW¼ sec. 19, T. 11 N., R. 68 W., Larimer County, Colo. Pierre Shale, from 10.6 m above base of Richard Sandstone Member.
D7047	G.A. Izett, 1969. NE¼SW¼ sec. 8, T. 3 N., R. 80 W., Grand County, Colo. Pierre Shale, 6 m above lower sandstone unit of Gunsight Pass Member.
D476	R. Van Horn, 1955. SE¼SE¼ sec. 20, T. 2 S., R. 70 W., Jefferson County, Colo. Pierre Shale, about 900 m above base.

taper of 11°, a whorl height of 152 mm at the base of the body chamber, and a whorl breadth of 72 mm (*Wb*:*Wh*=0.48). The smallest specimen (USNM 458240) is somewhat crushed and has a diameter of 33 mm at its smaller end and an angle of taper of 13°. Sutures are well displayed on the second largest specimen from the Lewis Shale (pl. 2), which has a whorl height of 141 mm, a whorl breadth of 60 mm (*Wb*:*Wh*=0.43), and an angle of taper of 15°. Terminal branches of the lateral lobe are constricted at their base, like those of the type species for the genus (Cobban, 1952, pl. 110, fig. 3) as well as those of the *B. compressus* group (Scott and Cobban, 1965; Gill and Cobban, 1973).

The largest specimen of *B. natosini* that the authors know about is part of a body chamber 260 mm in whorl height housed in the collections of the Department of Geology of Rocky Mountain College in Billings, Mont. The locality of the specimen is unknown, but it is probably from the upper part of the Bearpaw Shale of central Montana.

Discussion.—Large size, very compressed whorls, and pronounced taper distinguish *Pseudobaculites natosini* from contemporaneous late Campanian and early Maastrichtian species of *Baculites*. *Pseudobaculites wyomingensis* Cobban (1952, p. 760, pl. 110, figs. 11–16, 19–21), from the middle(?) and upper Coniacian, closely resembles *P. natosini* in its rapid taper, very compressed whorl, and complex suture; it may differ only in its smaller size (none is known that has a septate diameter of more than 40.5 mm). *Pseudobaculites nodosus* Cobban (1952, p. 759, pl. 110, figs. 1–10, 17, 18), of late Coniacian age, differs from *P. natosini* in having a much smaller size, flank tubercles, and a well-ribbed venter.

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PLATES 1, 2

Contact photographs of the plates in this report are available, at cost, from the U.S. Geological Survey Photographic Library, Federal Center, Denver, CO 80225.

PLATE 1

Pseudobaculites natosini (Robinson, 1945) (p. C2)

[All figures natural size]

Figures 1, 3, 4. USNM 458242, from the Lewis Shale at U.S. Geological Survey Mesozoic locality D4508 in the SE1/4SW1/4 sec. 24, T. 35 N., R. 85 W., Natrona County, Wyo. (text fig. 1). Figure 1 is part of one side showing growth lines. Figure 3 is all of the other side. Figure 4 is the ventral view.

2. USNM 458243, from the same locality. End view of a specimen showing the compressed, elliptical whorl section.

5. USNM 458244, from the Bearpaw Shale at U.S. Geological Survey Mesozoic locality D1442 in the NW1/4SW1/4 sec. 9, T. 27 N., R. 20 E., Blaine County, Mont. (text fig. 1).

PSEUDOBACULITES NATOSINI

PLATE 2

***Pseudobaculites natosini* (Robinson, 1945) (p. C2)**

[Figure slightly reduced. Specimen is 245 mm long]

USNM 458241, from the Lewis Shale at U.S. Geological Survey Mesozoic locality D4508 in the SE1/4SW1/4 sec. 24, T. 35 N., R. 85 W., Natrona County, Wyo. (text fig. 1).

PSEUDOBACULITES NATOSINI

Middle Campanian (Upper Cretaceous) Ammonites from the Pecan Gap Chalk of Central and Northeastern Texas

By William A. Cobban and W. James Kennedy

SHORTER CONTRIBUTIONS TO PALEONTOLOGY AND STRATIGRAPHY

U.S. GEOLOGICAL SURVEY BULLETIN 2073–D

Descriptions and illustrations of some widely distributed ammonites

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1994

CONTENTS

PLATES

[Plates follow References Cited]

FIGURES

METRIC CONVERSION FACTORS

Multiply	By	To obtain
	Length	
millimeter (mm)	0.0394	inch
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile

Middle Campanian (Upper Cretaceous) Ammonites from the Pecan Gap Chalk of Central and Northeastern Texas

By William A. Cobban[1] and W. James Kennedy[2]

ABSTRACT

The Pecan Gap Chalk of central and northeastern Texas contains an ammonite fauna of *Pachydiscus* (*Pachydiscus*) *travisi* (Adkins, 1929), *P.* (*P.*) aff. *P. haldemsis* (Schlüter, 1867), *Anapachydiscus* sp. juv., *Eubostrychoceras reevesi* (Young, 1963), *Lewyites taylorensis* (Adkins, 1929), *Baculites taylorensis* Adkins, 1929, and *Trachyscaphites spiniger* (Schlüter, 1872) *porchi* (Adkins, 1929). The fauna is about the age of the middle Campanian *B. asperiformis* zone of the Western Interior ammonite sequence. In northwestern Europe, where the Campanian stage is usually divided into lower and upper parts, the Pecan Gap fauna would be placed in the upper Campanian.

INTRODUCTION

The Pecan Gap Chalk, named by Stephenson (1918, p. 156, 157), takes its name from the town of Pecan Gap in Delta County in northeastern Texas (fig. 1). The formation is as much as 36.6 m thick in northeastern Texas (Barnes, 1966). In its type area, the Pecan Gap rests disconformably on the underlying Wolfe City Sand (fig. 2) and has a bed of phosphatic fossils at the base (Rouse, 1944). A detailed account of the northern outcrops of the Pecan Gap is given by McNulty and others (1981) and Thompson and others (1991), who reviewed previous literature.

The name Pecan Gap is also used as far south as Austin and beyond (for example, Young, 1965, fig. 5; Barnes and others, 1972; Barnes, 1974), until it merges into the Anacacho Limestone. The best known outcrops of the Pecan Gap in the central Texas area are those along the Austin-Manor road about 12 km northeast of Austin in the Walnut Hill area in Travis County, which yielded most of the ammonites described by Adkins (1929) as well as most of those in the present account (fig. 3). Here, the Pecan Gap Chalk rests on marls of the Sprinkle Formation of Young (1965). Phosphatized fossils occur at the base of the Pecan Gap as well as 4.8 m higher in the section. Detailed logs of this locality were given by Wilson and Philpott (1949, p. 61, 62) and Young (1965, fig. 2), and locality maps were given by Plummer (1931, fig. 12, locality 226–T–7), Frizzel and Anderson (1950), and Chimene and Maddocks (1984).

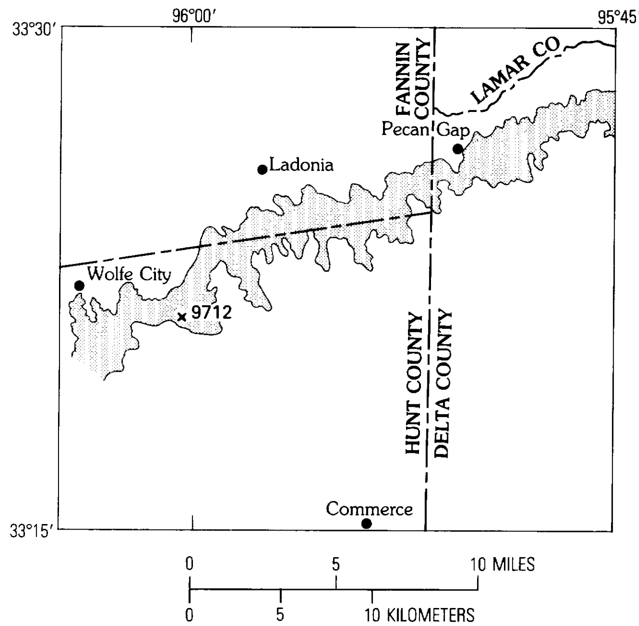

Figure 1. Outcrop belt (patterned) of the Pecan Gap Chalk in the type area in northeastern Texas. U.S. Geological Survey Mesozoic locality 9712 (Cox farm) is also shown. Outcrop belt is from Barnes (1966, 1967).

Ammonites occur as phosphatic molds associated with hiatuses in sedimentation at the base of the Pecan Gap or in higher beds of nodules, as they do in central Texas (Stephenson, 1918, 1929; Frizzel and Anderson, 1950). Most are fragmentary. The assemblage is dominated by *Baculites taylorensis* Adkins, 1929, along with rarer *Pachy-*

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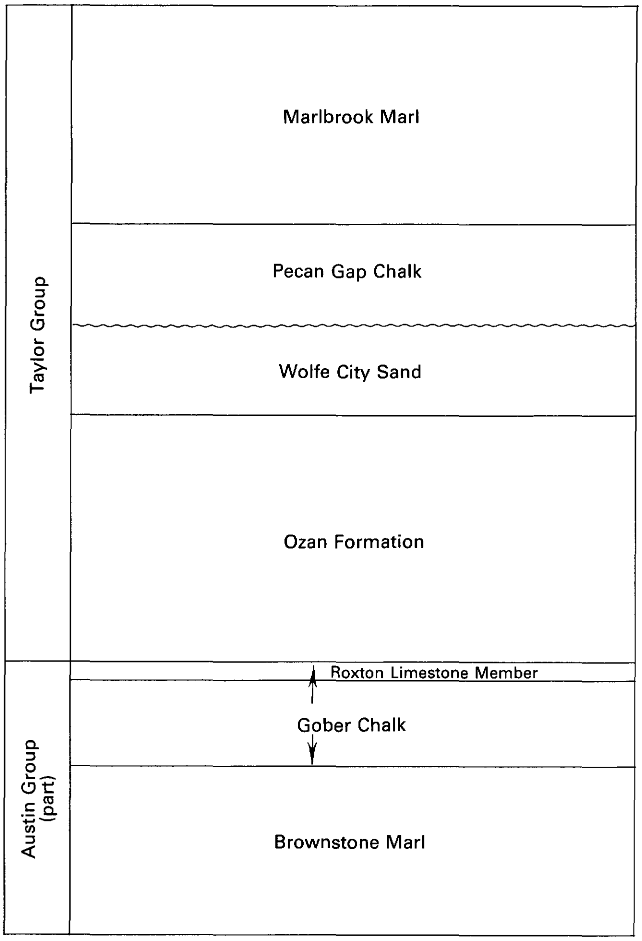

Figure 2. The Taylor Group and part of the Austin Group in the Wolfe City-Pecan Gap area of northeastern Texas (modified from Thompson and others, 1991, fig. 10).

discus (*Pachydiscus*) *travisi* (Adkins, 1929), *P.* (*P.*) aff. *P.* (*P.*) *haldemsis* (Schlüter, 1867), *Anapachydiscus* sp. juv., *Eubostrychoceras reevesi* (Young, 1963), *Lewyites taylorensis* (Adkins, 1929), and *Trachyscaphites spiniger* (Schlüter, 1872) *porchi* (Adkins, 1929).

The age of the Pecan Gap Chalk ammonites can be determined directly by comparison with the Western Interior ammonite sequence (Cobban, in press). There, *Trachyscaphites spiniger porchi* occurs in the zones of *Baculites mclearni* and *B. asperiformis* within the middle Campanian as defined in the Western Interior. The occurrence of *B. mclearni* in the Wolfe City Sand below the Pecan Gap Chalk in northeastern Texas suggests that the Pecan Gap Chalk fauna is probably equivalent to the *B. asperiformis* zone. Correlation with the northwestern European sequence is less certain. The Ozan Formation (fig. 2), 46 m above its base in Fannin County in northeastern Texas, contains *T. spiniger spiniger* (Schlüter, 1872), a lower upper Campanian species in the northwestern European sense (Schmid and Ernst 1975; Błaszkiewicz, 1980), and the Wolfe City Sand contains undescribed species of *Hoplitoplacenticeras* of European upper Campanian aspect. The Pecan Gap Chalk fauna, above the Wolfe City Sand, is thus upper Campanian in a northwestern European sense and middle Campanian in the American threefold sense.

Most of the fossils described in this report are kept in the National Museum of Natural History (USNM) in Washington, D.C., where the specimens have USNM catalogue numbers. Other fossils are at the Texas Memorial Museum (TMM) in Austin and have TMM catalogue numbers. Plaster casts of a few of the specimens are kept at the Federal Center in Denver, Colo.

C.J. Durden of the Texas Memorial Museum kindly loaned the type specimens described by Adkins from the Pecan Gap Chalk at the Austin-Manor road locality. Some specimens from that locality were provided by the late James P. Conlin of Fort Worth, Tex., who thoughtfully donated his very large, well-curated Cretaceous ammonite collection to the U.S. Geological Survey (USGS). Kennedy acknowledges the assistance of the staff of the Geological Collections, Oxford University Museum, and the Department of Earth Sciences, Oxford, U.K., and the financial support of the Natural Environment Research Council (U.K.), the Royal Society, and the Astor Fund (Oxford).

LOCALITIES WHERE FOSSILS WERE COLLECTED

The fossils described in this report are mostly from outcrops of the Pecan Gap Chalk at USGS Mesozoic locality D104 along the old Austin-Manor highway on the eastern side of Big Walnut Creek valley about 9 km northeast of Austin in Travis County, Tex. (fig. 3). Here "sandy, glauconitic clay in a restricted zone of about 2 feet thickness contains innumerable phosphatized individuals, both shells and casts..." (Adkins, 1929, p. 205). This locality, well known since the 1920's, yielded many ammonites to collectors in the 1930's (for example, L.W. Stephenson) and in the 1950's (for example, A.R. Loeblick, J.P. Conlin, and W.A. Cobban), which, along with Adkins' types, form the basis of the present account. A stratigraphic section that included the fossil bed was given by Feray and Plummer (1949). Other fossils, also phosphatized, were collected by Conlin and Stephenson, both deceased, from outcrops of the Pecan Gap Chalk at USGS Mesozoic locality 9712 in the bed and banks of a small creek on the Cox farm 4.8 km southeast of Wolfe City in Hunt County, Tex. (fig. 1). This locality was mentioned by Adkins (1932, p. 461).

SYSTEMATIC PALEONTOLOGY

Order AMMONOIDEA Zittel, 1884

Superfamily DESMOCERATACEAE 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 (1893, p. 177).

Pachydiscus (*Pachydiscus*) *travisi* (Adkins, 1929)

Plate 1, figures 1–15; plate 2, figures 9–11; text figure 4

1929. *Parapachydiscus travisi* Adkins, p. 207, pl. 6, figs. 7–9.

Types.—Holotype is TMM 34010 from the phosphate bed in the Pecan Gap Chalk 8.25 km west of Emhouse in Navarro County, Tex. Figured paratype TMM 34009 is from 9.4 km northeast of Austin on the Austin-Manor road. Hypotypes USNM 441555 through 441559, 441587, and 445208 are from the same locality.

Dimensions.—Dimensions (in millimeters) for diameter (*D*), whorl breadth (*Wb*), whorl height (*Wh*), *Wb*:*Wh*, umbilicus (*U*), and their ratios to the diameters of two specimens (in parentheses) are, for TMM 34010 (holotype), *D*=56.5 (100), *Wb*=21.5 (38.0), *Wh*=24.0 (42.0), *Wb*:*Wh*= 0.90, and *U* =14.3 (25.0) and, for USNM 441558, *D*=72.0 (100), *Wb*=23.8 (33.0), *Wh*=32.0 (44.0), *Wb*:*Wh*=0.74, and *U* =1.43 (20.0).

Description.—Coiling is moderately involute. The umbilicus is of moderate depth and has a flattened, outward-inclined umbilical wall. The whorl section is compressed and ovate. The umbilical shoulder is narrowly rounded, inner flanks are broadly rounded, outer flanks are flattened and convergent, and the venter is broadly rounded. The only ornament visible to a diameter of 25 mm is delicate concave ribs on the outer flank. Typical ornament of the middle growth stages appears by a diameter of 25 to 30 mm. An estimated 14 distant umbilical bullae are perched on the umbilical shoulder and separated by deep interspaces (pl. 1, figs. 4, 6, 10, 13). Bullae give rise singly or in pairs to delicate prorsiradiate primary ribs. These ribs are straight to the middle of the flank, where they may weaken markedly but strengthen over the ventrolateral shoulders and venter, as do additional intercalated ribs, to give a total of approximately 17 widely spaced ventral ribs per half whorl (pl. 1, figs. 6, 7). Ribs may weaken over the siphonal line and resemble long ventrolateral bullae (pl. 1, fig. 11). When they are well preserved, specimens may show delicate intercalated ribs between the main strong ribs on both outer flank and venter. The deeply incised suture has narrow-stemmed bifid lobes and deeply incised trifid lateral lobe (L) and second umbilical lobe (U_2) (fig. 4).

Discussion.—*Pachydiscus* sp. no. 1 cfr. *P. gollevillensis* (d'Orbigny) of Young (1963, p. 56, pl. 8, fig. 5; pl. 17, fig. 5; text figs. 10*e*, *o*) and *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 figs. 10*d*, *g*) may be crushed examples of the present species. Although compared to *P. gollevillensis* by Young, the strong bullae and very distant ventral ribs immediately distinguish *P. travisi* from Maastrichtian *P.* (*P.*) *gollevillensis* (d'Orbigny, 1850, p. 212 *pars*) (see revision by Kennedy, 1986, p. 28, pls. 1–3; pl. 4, figs. 4–6; pl. 5, figs. 12–14, 20–24; pl. 11, figs. 1–5; text figs 2, 3*P*, *R*, 4*C*) and *P.* (*P.*) *neubergicus* (Hauer, 1858, p. 12 *pars*, pl. 2, figs. 1–3 only) (see revision by Kennedy and Summesberger, 1986). Campanian species such as *P.* (*P.*) *oldhami* (Sharpe, 1855) (see Kennedy, 1986) and *P.* (*P.*) *haldemsis* (Schlüter, 1867) (see Kennedy and Summesberger, 1984) have many more and crowded ventral ribs and numerous long primary ribs that are not effaced at midflank.

Occurrence.—Pecan Gap Chalk in northeastern and central Texas.

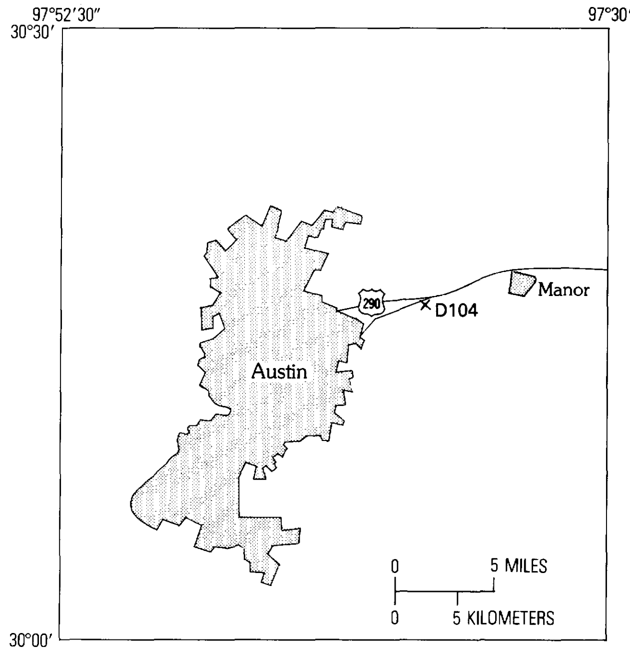

Figure 3. Location of U.S. Geological Survey Mesozoic locality D104 along the old Austin-Manor road, Travis County, Tex.

Pachydiscus (*Pachydiscus*) aff. *P.* (*P.*) *haldemsis* (Schlüter, 1867)

Plate 2, figures 19–26

Types.—Figured specimens USNM 441560 through 441563.

Description.—A second species of *Pachydiscus* (*Pachydiscus*) is represented by fragments that have whorl heights ranging from 26 to 41 mm. Coiling is moderately evolute. Whorl section is compressed; whorl breadth-to-

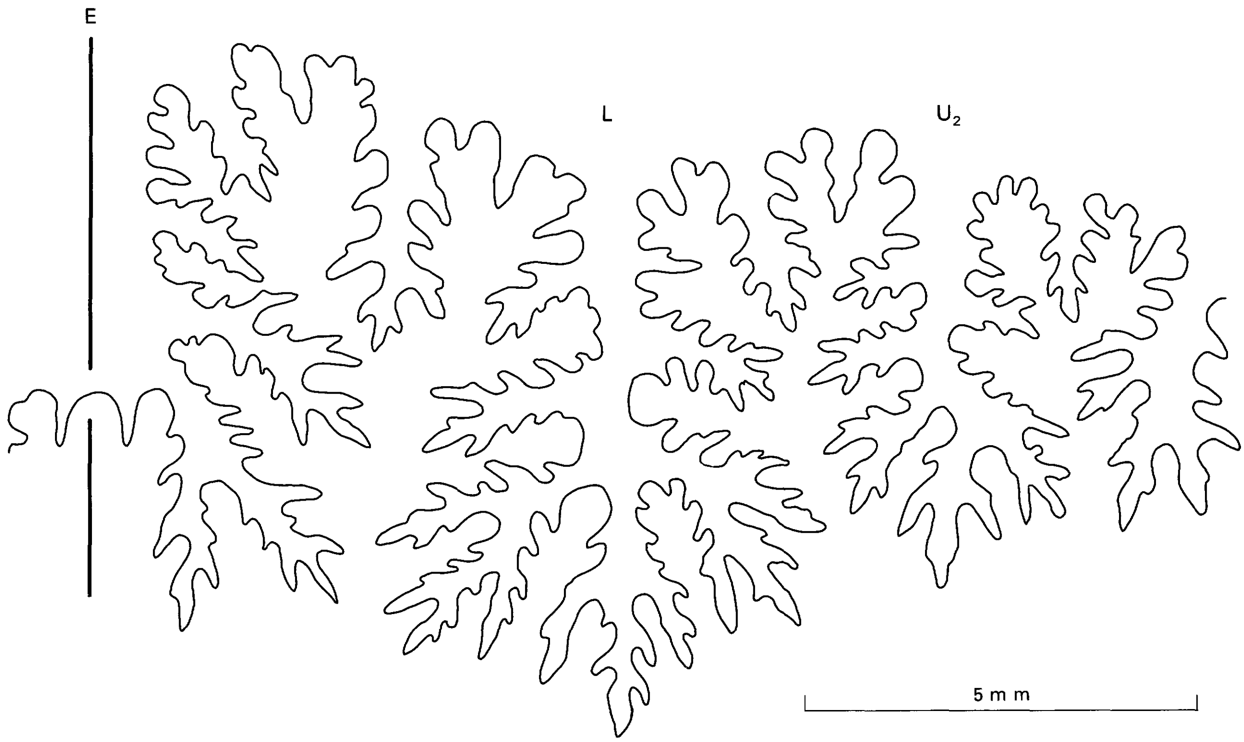

Figure 4. Partial suture line of *Pachydiscus* (*Pachydiscus*) *travisi* (Adkins, 1929). Hypotype USNM 441587 is from U.S. Geological Survey Mesozoic locality D104. E is external lobe, L is lateral lobe, and U_2 is second umbilical lobe. Heavy, straight line marks the middle of the venter as well as the middle of the external lobe.

height ratio is 0.8. The greatest breadth is at the umbilical bullae; inner flanks are broadly rounded, outer flanks are flattened and convergent, ventrolateral shoulders are broadly rounded, and the venter is flattened. Strong umbilical bullae give rise to strong prorsiradiate primary ribs, both singly or in pairs. Ribs are low, blunt, and prorsiradiate; they are straight on the inner and middle flanks and then curve forward and become concave on the outermost flank and ventrolateral shoulder, where they strengthen and cross the venter in a broad convexity. Shorter intercalated ribs arise both low and high on the flank so that there are more than twice as many ventral ribs as umbilical bullae. The suture is deeply and intricately subdivided, typical for the genus.

Discussion.—The stout whorl section and crowded ribs that are strong across the flank immediately distinguish these specimens from *P.* (*P.*) *travisi* and point to the presence of an albeit indeterminate member of the strongly ribbed *P.* (*P.*) *haldemsis* (Schlüter, 1867) group (see Kennedy and Summesberger, 1984, p. 158, pl. 4, figs. 1–5; pl. 5, fig. 1; pl. 6, fig. 2; pl. 7, figs. 1–11; pl. 13, fig. 1). The present species is similar in form to the *Pachydiscus* sp. no. 3 cfr. *P. gollevillensis* (d'Orbigny) of Young (1963, p. 5, pl. 14, figs. 2, 3; text figs. 7*n*, 8*h*) from the Anacacho Limestone in Texas, but that species is much more finely ribbed.

Occurrence.—Pecan Gap Chalk in northeastern and central Texas.

Genus *ANAPACHYDISCUS* Yabe and Shimizu, 1926

Type species.—*Pachydiscus fascicostatus* Yabe *in* Yabe and Shimizu 1921, p. 57, pl. 8, fig. 5; pl. 9, figs. 2–5; by original designation.

Anapachydiscus sp. juv.

Plate 2, figures 12–14; text figure 5

Type.—Figured specimen USNM 441564.

Description.—USNM 441564 is a wholly septate fragment that has a maximum preserved whorl height of 26 mm. The depressed, reniform whorl section has a whorl breadth-to-height ratio of 1.36. The umbilical shoulder is narrowly rounded, and inner flanks are strongly inflated. Outer flanks and venter merge imperceptibly and are broadly and evenly rounded. Weak umbilical bullae give rise to pairs of low, blunt, prorsiradiate ribs. Long intercalated ribs are present that strengthen over the flanks and cross the venter in a broad convexity; they weaken somewhat on the middle of the venter. The suture (text fig. 5) is complex and typical for the genus.

Occurrence.—Pecan Gap Chalk, central Texas.

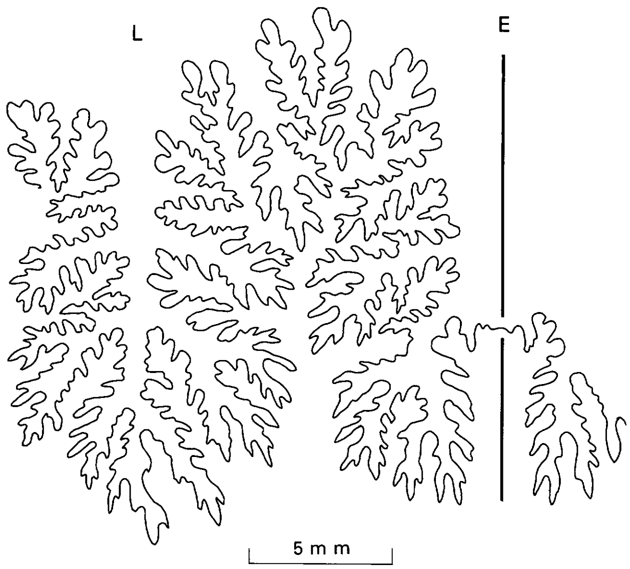

Figure 5. Partial suture line of *Anapachydiscus* sp. juv. Figured specimen USNM 441564 (pl. 2, figs. 12–14), from U.S. Geological Survey Mesozoic locality D104. E is external lobe, and L is lateral lobe. Heavy, straight line marks the middle of the venter as well as the middle of the external lobe.

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.

Eubostrychoceras reevesi (Young, 1963)

Plate 2, figures 15–18

1963. *Cirroceras reevesi* Young, p. 44, pl. 5, figs. 2, 3, 6; text fig. 7*k*, *m*.

Types.—Holotype is no. 30491 in the collections of the Texas Memorial Museum; it is from the Anacacho Limestone on the Sabine River, 8.7 km north of Sabinal in Medina County, Tex. Hypotypes are USNM 441565 and 441566.

Description.—Two small specimens that are at hand have whorl heights of 11 mm (USNM 441565) and 17 mm (USNM 441566). They have compressed oval whorl sections and no trace of a dorsal impressed zone, this absence suggesting that the whorls were barely touching. The smaller specimen is smooth, and the larger has faint prorsiradiate ribs.

Occurrence.—Pecan Gap Chalk in central Texas.

Family DIPLOMOCERATIDAE Spath, 1926
Subfamily DIPLOMOCERATINAE Spath, 1926
Genus *LEWYITES* Matsumoto and Miyauchi, 1984

Type species.—*Idiohamites*(?) *oronensis* Lewy, 1969, p. 127, pl. 3, figs. 10, 11, by original designation by Matsumoto and Miyauchi (1984, p. 64).

Lewyites taylorensis (Adkins, 1929)

Plate 2, figures 1–8; text figure 6

1929. *Hamites*(?) *taylorensis* Adkins, p. 209, pl. 6, figs. 12, 13.

1984. *Hamites*(?) *taylorensis* Adkins. Matsumoto and Miyauchi, p. 64.

Types.—Holotype is TMM 21007, from the phosphate bed in the Pecan Gap Chalk in Navarro County, Tex. Figured paratype TMM 21008 is from the phosphate bed in the Pecan Gap Chalk about 12 km northeast of Austin on the Austin-Manor road, Travis County, Tex. Hypotypes are USNM 441567 and 441568.

Description.—All specimens are fragments of phragmocones; the largest has a whorl height of 21 mm. The whorl section is compressed, the whorl breadth-to-height ratio is 0.8, the intercostal section is ovate, and the venter is flattened costally. Ornament consists of blunt rursiradiate ribs that have a rib index of 9. Ribs are effaced and convex on the dorsum; they strengthen, flex back, and become slightly convex on the flank. One or two ribs are annular and without tubercles and separate pairs of stronger ribs that link at coarse ventral tubercles, which are connected over the venter by a broad swelling bearing a pair of looped ribs. The intricately subdivided suture has narrow-stemmed, bifid saddles (text fig. 6).

Discussion.—We have seen four specimens in addition to the types. The largest shows striking differentiation of ribs into weak, nontuberculate ribs and broad, blunt tuberculate ribs. *Lewyites oronensis* (Lewy, 1969, p. 127, pl. 3, figs. 10, 11) is more compressed and has equal-sized ribs. *Lewyites circularis* (Lewy, 1969, p. 128, pl. 3, fig. 9; text fig. 3) has a circular whorl section and coiling and ornament of even ribs.

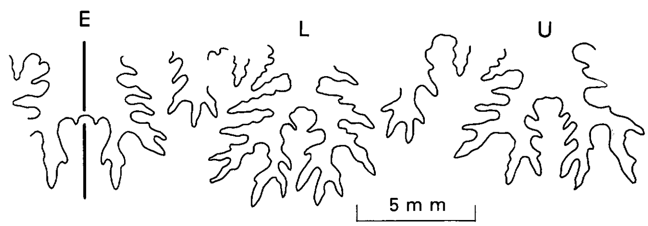

Figure 6. Most of the suture line of *Lewyites taylorensis* (Adkins, 1929). Holotype TMM 21007 (pl. 2, figs. 3, 4). E is external lobe, L is lateral lobe, and U is umbilical lobe. Heavy, straight line marks the middle of the venter as well as the middle of the external lobe.

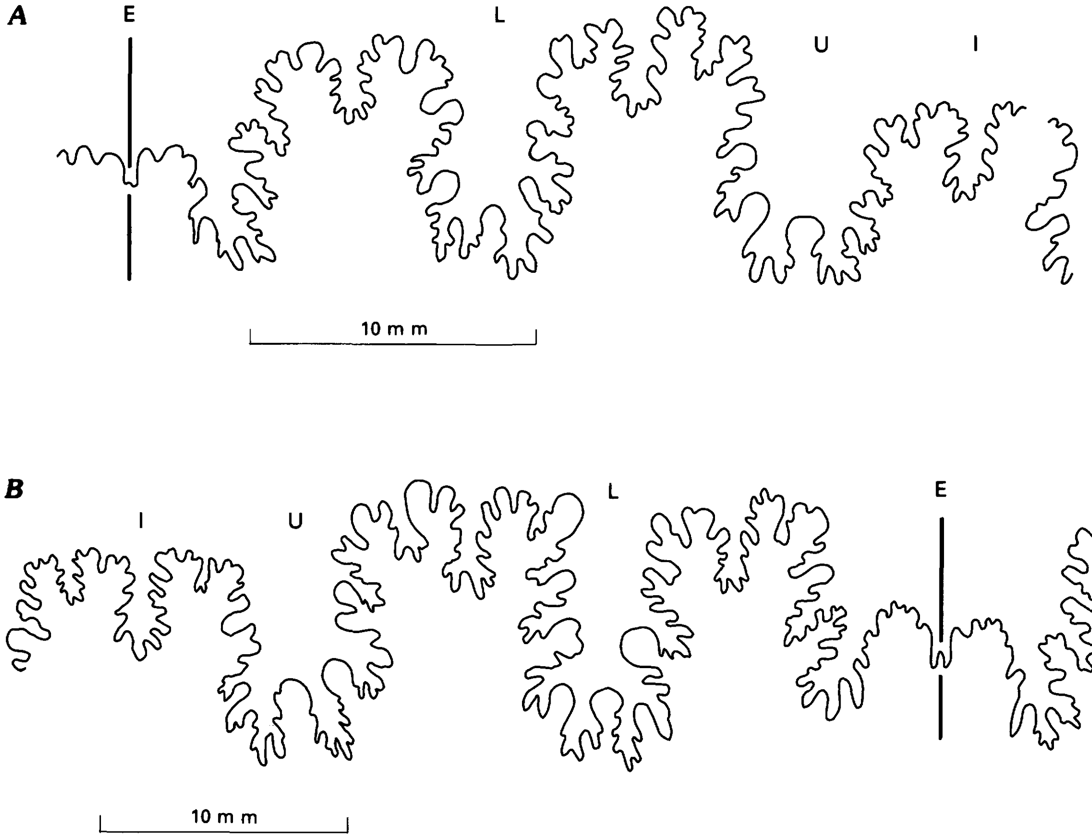

Figure 7. Suture lines of *Baculites taylorensis* Adkins, 1929. *A*, Hypotype USNM 441572 (pl. 3, figs. 10–12); *B*, hypotype USNM 441575 (pl. 3, figs. 19–21). E is external lobe, L is lateral lobe, U is umbilical lobe, and I is internal lobe. Heavy, straight line marks the middle of the venter as well as the middle of the external lobe.

Occurrence.—Pecan Gap Chalk in central 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

Plate 3; plate 4, figures 5–19; text figure 7

1929. *Baculites taylorensis* Adkins, p. 204, pl. 5, figs. 9–11.

non 1970. *Baculites* cf. *taylorensis* Adkins. Collignon, p. 13, pl. 612, fig. 2285.

Types.—Holotype is TMM 21014, and paratypes are TMM 21015 and 21016, all from the Pecan Gap Chalk, 12.4 km northeast of Austin on the Austin-Manor road in Travis County, Tex. Hypotypes USNM 441569 through 441581 are from the same locality.

Description.—Shell expands slowly and may attain a moderately large size; the largest septate fragment (USNM 441581) seen from the type locality has a whorl height of 29.5 mm. The stout, ovate whorl section has a broadly rounded dorsum and narrower venter. Specimens having whorl heights of less than 10 mm may be smooth or nodate; all larger specimens have nodes that are widely spaced and separated by 1 to 1.5 times the whorl height. Nodes originate at the dorsolateral shoulder; they are weak to strong (the latter predominate), crescentic, and confined to the dorsal half or third of the flanks. Nodes decline markedly on the dorsum and ventral part of the flanks. Flanks between nodes are ornamented by variable growth lines, striae, and riblets. These lines follow a broad convexity on the dorsum, where they may be relatively prominent; they are concave on the dorsal two-thirds of the flank and then project strongly forward to intersect the line of the venter at an angle of 18°. The nodes cross the dorsum in a narrow curve. Ornament thus defines an aperture that has a short dorsal rostrum and a long ventral rostrum.

The moderately incised suture has broad, bifid saddles and narrow lobes (text fig. 7).

Discussion.—*Baculites taylorensis* is the most abundant ammonite in the Pecan Gap Chalk, and several hundred specimens are at hand. When compared to other middle Campanian *Baculites* from Texas and adjacent areas, the development of distant nodes, rather than crescentic ribs, distinguishes the present species from *B. mclearni* Landes (1940) (see Cobban, 1962, p. 712, pl.

105, fig. 15; pl. 107, figs. 17–19; text fig. 1*g*, *h*) from the underlying Wolfe City Sand, and *B. scotti* Cobban (1958, p. 660, pl. 90, fig. 1*a–e*, *h*), which occurs in the Kimbro nodule horizon above the Pecan Gap Chalk in the succeeding Bergstrom Formation of Young (1965). There are close similarities to *B. reduncus* Cobban (1977, p. 459, figs. 2–6), which co-occurs with *B. taylorensis* in the Annona Chalk in Arkansas, but the nodes of *B. taylorensis* are restricted to the dorsolateral area, rather than extending, in crescentic form, across most of the flanks, and the shell is straight, rather than markedly curved, as it is in *B. reduncus*.

Occurrence.—Pecan Gap Chalk in central and northeastern Texas; basal phosphate bed of Annona Chalk in Hempstead and Howard Counties, Ark.

Superfamily SCAPHITACEAE Gill, 1871
Family SCAPHITIDAE Gill, 1871
Subfamily SCAPHITINAE Gill, 1871
Genus *TRACHYSCAPHITES* Cobban and Scott, 1964

Type species.—*Trachyscaphites redbirdensis* Cobban and Scott, 1964, p. E7, pl. 1, figs. 1–7; text fig. 3, by original designation.

Trachyscaphites spiniger (Schlüter, 1872) *porchi* (Adkins, 1929)

Plate 4, figures 1–4; plate 5; text figure 8

1929. *Scaphites porchi* Adkins, p. 205, pl. 5, figs. 1–3.
1929. *Scaphites aricki* Adkins, p. 206, pl. 5, figs. 7, 8.
1963. *Acanthoscaphites* sp. cfr. *A. spiniger* (Schlüter). Young, p. 49, pl. 4, figs. 1, 6, 7; pl. 5, figs. 1, 4, 5.
1964. *Trachyscaphites spiniger* (Schlüter) subspecies *porchi* Adkins. Cobban and Scott, p. E10, pl. 2, figs. 1–23; pl. 3, figs. 1–11; text fig. 4.
?1969. *Scaphites porchi levantinensis* Lewy, p. 132, pl. 4, fig. 1.

Types.—The holotype of *Scaphites porchi* Adkins, 1929, is TMM 21011, and paratypes are TMM 21012 and 21013; the holotype of *S. aricki* Adkins, 1929, is TMM 21009, and the paratype is TMM 21010, all from the Pecan Gap Chalk on the Austin-Manor road northeast of Austin in Travis County, Tex. Hypotypes are USNM 132317, 132320, 132321, 441582, and 441583.

Description.—The spire is very involute and has a deep, conical umbilicus and an intercostal whorl section that varies from compressed to depressed reniform. Strong, distant primary ribs, eight per half whorl, arise on the umbilical wall and strengthen across the shoulder into weak bullae. These give rise to strong, straight, prorsiradiate ribs that develop subspinose inner lateral tubercles; intercalated ribs arise at this point, strengthen to match the primary ribs, and, like the primaries, develop stronger, conical outer lateral tubercles. From each tubercle, one or two narrow ribs arise that terminate in inner ventrolateral tubercles, and delicate ribs loop or intercalate between these tubercles. Subspinose outer ventrolateral tubercles alternate in position with the inner tubercles to which they are linked by delicate ribs; the ribs loop and zigzag between them and between the outer ventrolateral tubercles on either side of the siphonal line. The species is markedly dimorphic. Microconch body chambers are slender and have concave umbilical walls such that the umbilicus of the spire is not concealed. The one complete microconch is 48.5 mm long. Strong umbilical bullae perch on the umbilical shoulder and number five or six. More numerous are outer lateral tubercles and inner and outer ventrolateral clavi; the latter number as many as 10. Ribs are lacking on the molds. Aperture is marked by a constriction. Macroconchs have spires as much as 50 mm in diameter. The umbilical wall of the body chamber is straight in profile, and the umbilicus is partially occluded. None of the body chambers is complete. They are ornamented by distant umbilicolateral bullae, clavate outer lateral tubercles, inner and outer ventrolateral tubercles, and traces of delicate ribs that loop and intercalate between tubercles. The fairly simple suture has a symmetrically bifid lateral lobe (L) and a broader asymmetrically bifid saddle between the lateral and external (E) lobes.

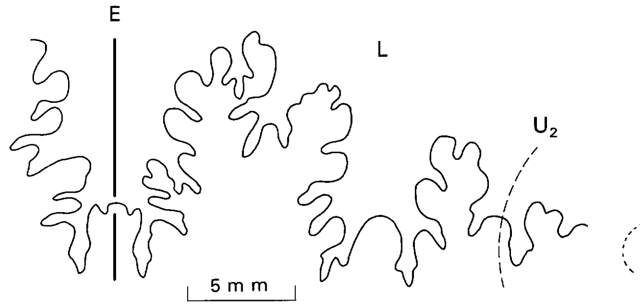

Figure 8. Suture line of *Trachyscaphites spiniger* (Schlüter, 1872) *porchi* (Adkins, 1929). Hypotype USNM 441582 (pl. 4, figs. 1–4), from U.S. Geological Survey Mesozoic locality 9712. E is external lobe, L is lateral lobe, and U_2 is second umbilical lobe. Heavy, straight line marks the middle of the venter as well as the middle of the external lobe. Short-dash line marks the umbilical seam; long-dash line marks the umbilical shoulder.

Discussion.—As first revising authors, Cobban and Scott (1964, p. E10) selected *porchi* as the name of this subspecies, *porchi* being based on fragments of stout individuals and *aricki* on fragments of slender ones. *Trachyscaphites spiniger porchi* is a chronological subspecies and successor to *T. spiniger spiniger* that occurs in the Wolfe City Sand and Ozan Formation in northeastern Texas. The two differ in that *porchi* has fewer tubercles in all rows on the body chamber and generally lacks the dense secondary and intercalate ribs of *T. spiniger spiniger*. *Trachyscaphites spiniger levantinensis* Lewy (1969, p. 132, pl. 4, fig. 1), originally separated from *T. spiniger spiniger* on a similar absence of ribs on the body chamber, may be a synonym. *Trachyscaphites praespiniger* Cobban and Scott (1964, p. E11, pl. 4, figs. 1–3; text fig. 5) differs from *T. spiniger porchi* in having three or, rarely, four rows of tubercles, of which only the lateral row persists onto the body chamber; ribs are strong on the phragmocone but weak on the body chamber.

Occurrence.—Wolfe City Sand in northeastern Texas; Pecan Gap Chalk in central and northeastern Texas; *Baculites mclearni* and *B. asperiformis* zones in the Claggett Shale of central Montana and in the Mancos Shale of western Colorado; Sharon Springs Member of the Pierre Shale in north-central and southern Colorado. Possibly present in upper flint complex in Mishash Formation, Israel.

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PLATES 1–5

Contact photographs of the plates in this report are available, at cost, from the U.S. Geological Survey Photographic Library, Federal Center, Denver, CO 80225.

PLATE 1

Pachydiscus (pachydiscus) travisi (Adkins, 1929)

[All figures natural size. Figs. 1–11 from Austin-Manor roadcuts, Travis County, Tex. Figs. 12–15 from Cox farm locality, Hunt County, Tex.]

Figures 1–15. *Pachydiscus (Pachydiscus) travisi* (Adkins, 1929) (p. D3)

1–3. Paratype TMM 34009.

4, 5. Holotype TMM 34010.

6, 7. Hypotype USNM 441555 (J.P. Conlin collection 7529).

8, 9. Hypotype USNM 441556 (J.P. Conlin collection 7532).

10, 11. Hypotype USNM 441557 (J.P. Conlin collection 7528).

12–15. Hypotype USNM 441558 (J.P. Conlin collection 7605).

PACHYDISCUS (PACHYDISCUS) TRAVISI

PLATE 2

Lewyites, *Pachydiscus*, *Anapachydiscus*, and *Eubostrychoceras*

[All figures natural size. All specimens from Austin-Manor roadcuts, Travis County, Tex.]

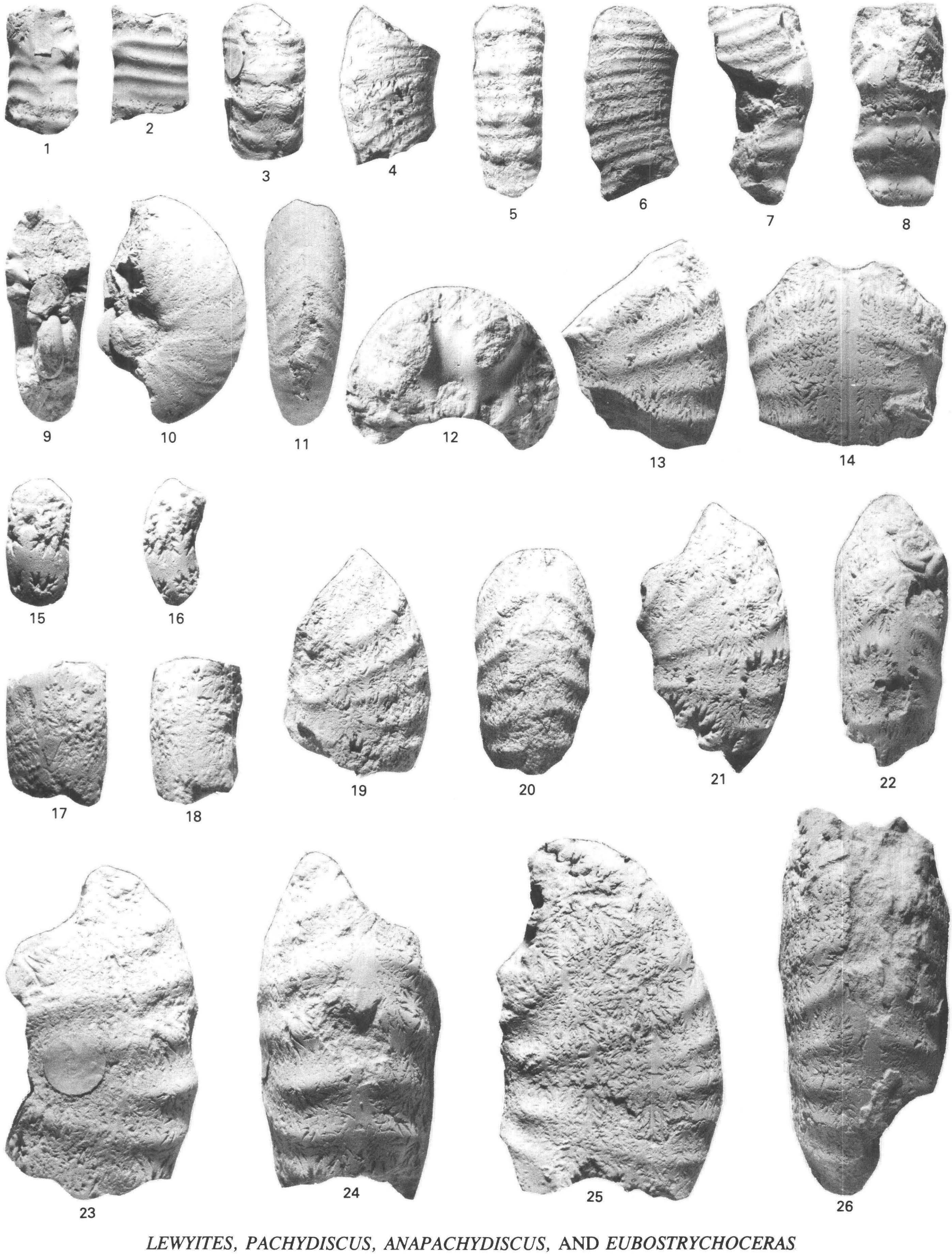
Figures 1–8. *Lewyites taylorensis* (Adkins, 1929) (p. D5)
- 1, 2. *Hypotype USNM 441567.*
- 3, 4. Holotype TMM 21007.
- 5, 6. Paratype TMM 21008.
- 7, 8. Hypotype USNM 441568.

9–11. *Pachydiscus* (*Pachydiscus*) *travisi* (Adkins, 1929) (p. D3) Hypotype USNM 441559.

12–14. *Anapachydiscus* sp. juv. (p. D4) Figured specimen USNM 441564 (J.P. Conlin collection 7534).

15–18. *Eubostrychoceras reevesi* (Young, 1963) (p. D5)
- 15, 16. *Hypotype USNM 441565.*
- 17, 18. Hypotype USNM 441566.

19–26. *Pachydiscus* (*Pachydiscus*) aff. (*P.*) (*P.*) *haldemsis* (Schlüter, 1867) (p. D3)
- 19, 20. Figured specimen USNM 441560.
- 21, 22. Figured specimen USNM 441561.
- 23, 24. Figured specimen USNM 441562.
- 25, 26. Figured specimen USNM 441563.



LEWYITES, PACHYDISCUS, ANAPACHYDISCUS, AND *EUBOSTRYCHOCERAS*

PLATE 3

Baculites taylorensis Adkins, 1929

[All figures natural size]

Figures 1–31. *Baculites taylorensis* Adkins, 1929 (p. D6)

1–3. *Hypotype USNM 441569.*

4–6. Hypotype USNM 441570 (J.P. Conlin collection 7518).

7–9. Hypotype USNM 441571.

10–12. Hypotype USNM 441572.

13–15. Hypotype USNM 441573.

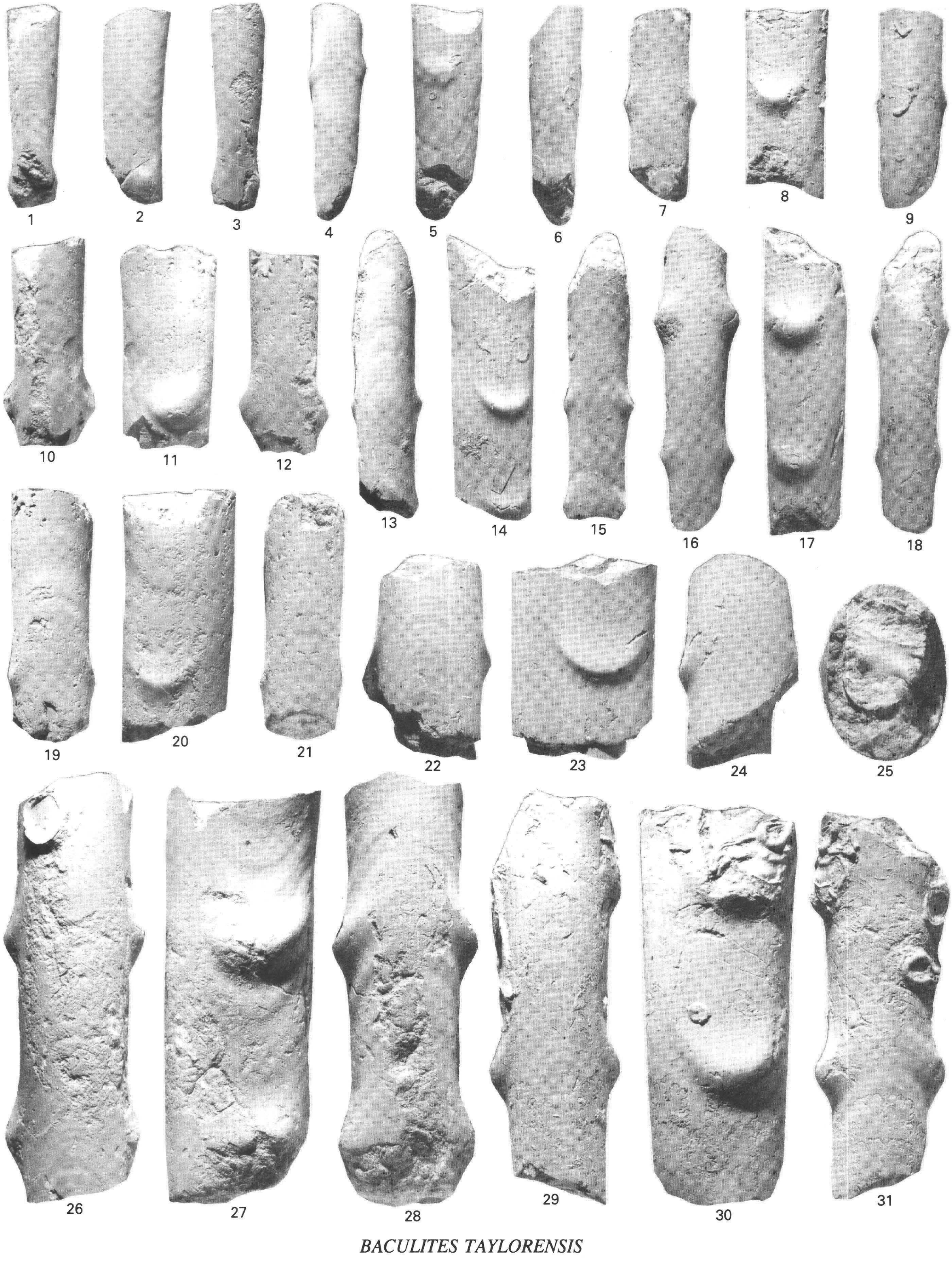
16–18. Hypotype USNM 441574.

19–21. Hypotype USNM 441575.

22–25. Hypotype USNM 441576.

26–28. Hypotype USNM 441577.

29–31. Hypotype USNM 441578 (J.P. Conlin collection 7517).



BACULITES TAYLORENSIS

PLATE 4

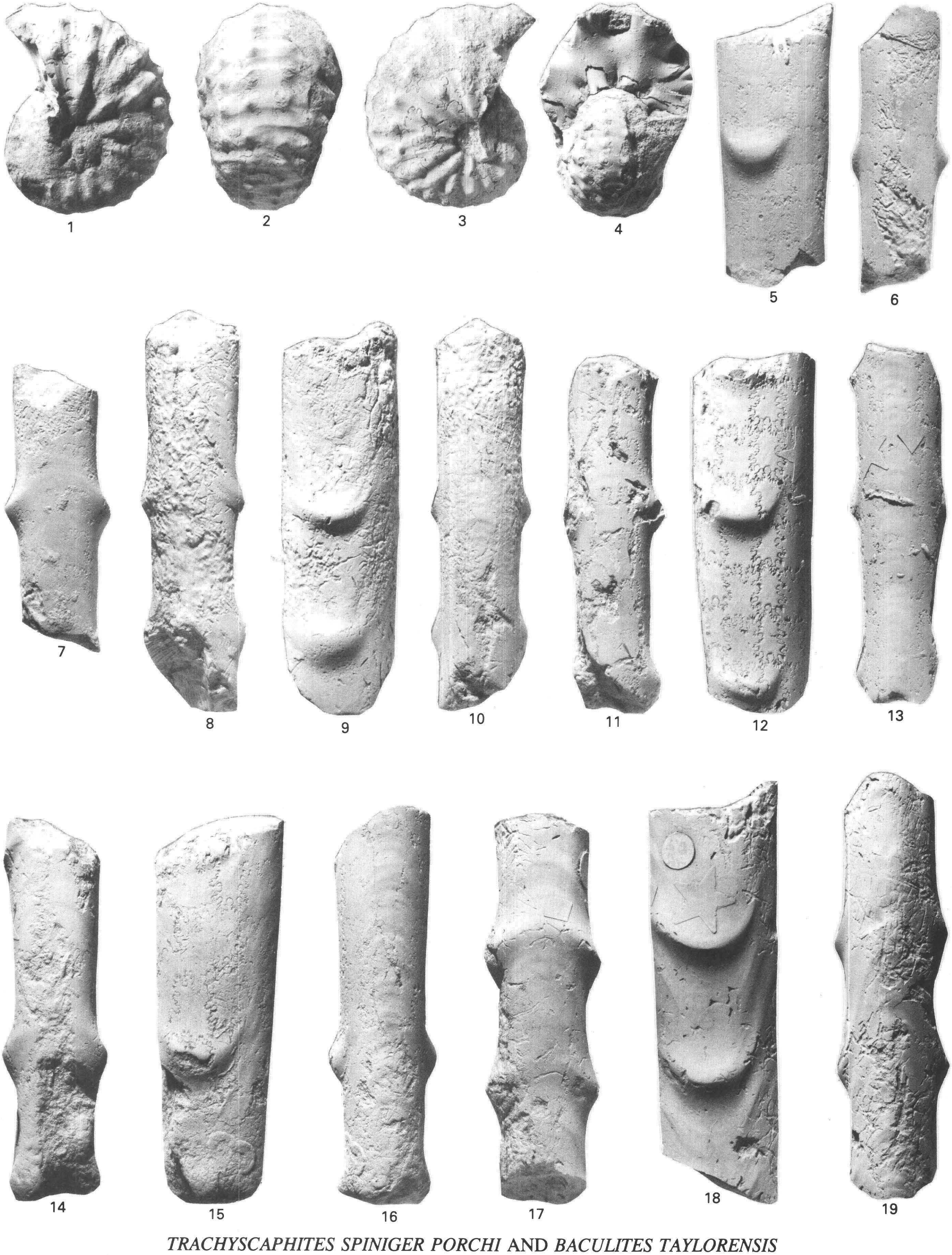
Trachyscaphites spiniger porchi and *Baculites taylorensis*

[All figures natural size]

Figures 1–4. *Trachyscaphites spiniger* (Schlüter, 1872) *porchi* (Adkins, 1929) (p. D7)
Hypotype USNM 441582.

5–19. *Baculites taylorensis* Adkins, 1929 (p. D6).

- 5–7. Hypotype USNM 441579.
- 8–10. Hypotype USNM 441580 (J.P. Conlin collection 7523).
- 11–13. Paratype TMM 21015.
- 14–16. Paratype TMM 21016.
- 17–19. Holotype TMM 21014.



TRACHYSCAPHITES SPINIGER PORCHI AND *BACULITES TAYLORENSIS*

PLATE 5

Trachyscaphites spiniger (Schlüter, 1872) *porchi* (Adkins, 1929)

[All figures natural size. All specimens from Austin-Manor roadcuts, Travis County, Tex.]

Figures 1–16. *Trachyscaphites spiniger* (Schlüter, 1872) *porchi* (Adkins, 1929) (p. D7).

1–3. *TMM 21010, paratype of Scaphites aricki Adkins, 1929, pl. 5, fig. 8.*

4. TMM 21009, holotype of *Scaphites aricki* Adkins, 1929, pl. 5, fig. 7.

5. TMM 21011, holotype of *Scaphites porchi* Adkins, 1929, pl. 5, figs. 1, 2.

6, 7. Hypotype USNM 132317.

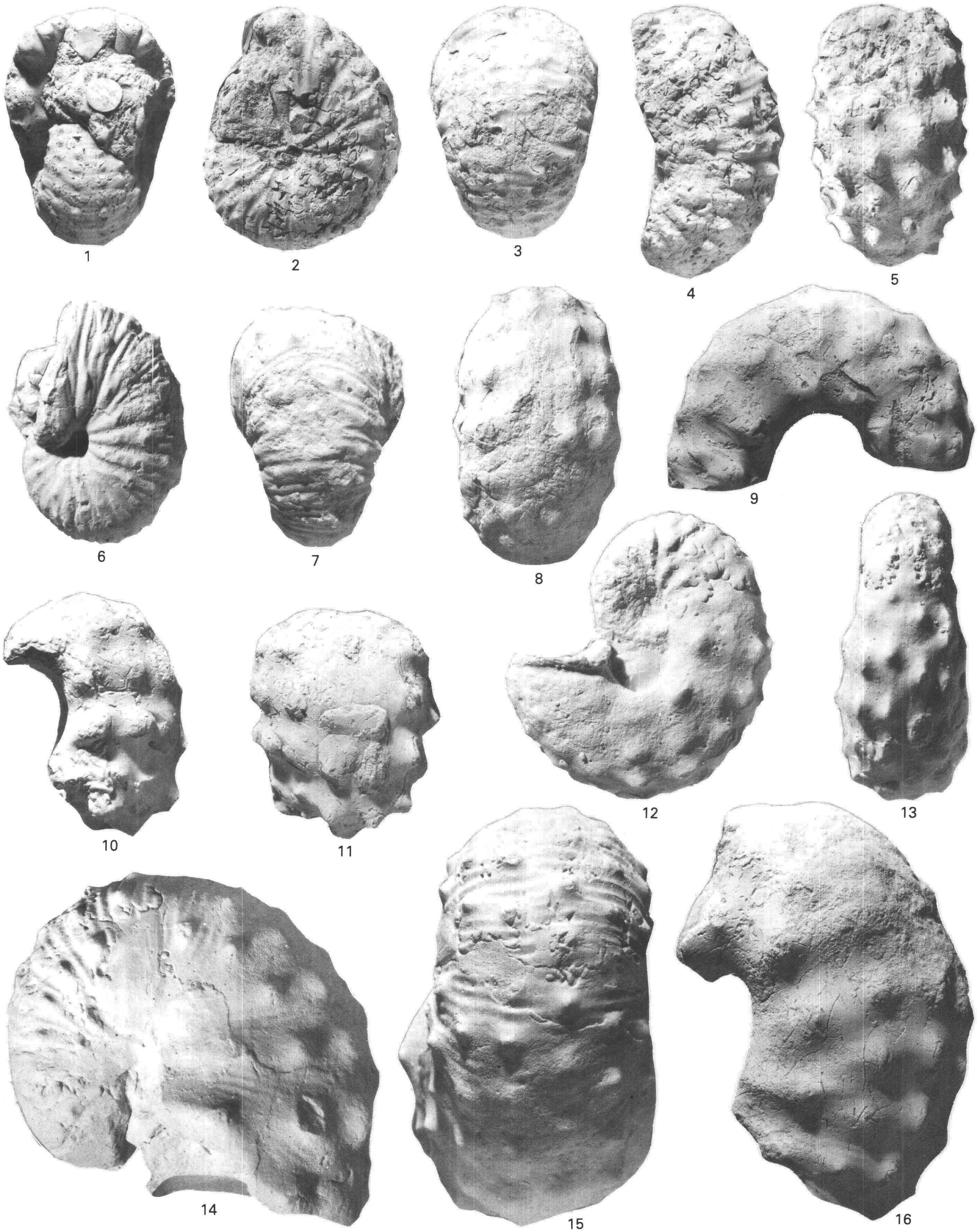
8, 9. TMM 21012, paratype of *Scaphites porchi* Adkins, 1929, pl. 5, fig. 2.

10, 11. TMM 21013, paratype of *Scaphites porchi* Adkins, 1929, pl. 5, fig. 3.

12, 13. Hypotype USNM 132320.

14, 15. Hypotype USNM 132321.

16. Hypotype USNM 441583.



TRACHYSCAPHITES SPINIGER PORCHI

Cenomanian (Upper Cretaceous) Nautiloids from New Mexico

By William A. Cobban and W. James Kennedy

SHORTER CONTRIBUTIONS TO PALEONTOLOGY AND STRATIGRAPHY

U.S. GEOLOGICAL SURVEY BULLETIN 2073–E

Description of rare occurrences of nautiloid cephalopods in rocks of Cenomanian age in the southern part of the Western Interior

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1994

CONTENTS

PLATES

[Plates follow References Cited]

METRIC CONVERSION FACTORS

Multiply	By	To obtain
	Length	
millimeter (mm)	0.0394	inch
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile

Cenomanian (Upper Cretaceous) Nautiloids From New Mexico

By William A. Cobban[1] and W. James Kennedy[2]

ABSTRACT

Nautiloids are rare fossils found in Cenomanian rocks in the Western Interior of the United States. The only occurrences known are *Pseudocenoceras largilliertianum* (d'Orbigny, 1840) in the *Acanthoceras amphibolum* zone of Cerro de Cristo Rey in Doña Ana County, N. Mex., and *Angulithes fleuriausianus* (d'Orbigny, 1840) in the *A. amphibolum* zone in Valencia and McKinley Counties, N. Mex.

INTRODUCTION

Nautiloids are rare fossils found in rocks of Cenomanian age in the Western Interior of the United States. Like so many other groups of wholly marine organisms (corals, brachiopods, bryozoans, echinoderms, coleoid cephalopods), nautiloids are thought to be excluded by hostile environmental conditions. We here record the only occurrences known to us from the middle Cenomanian *Acanthoceras amphibolum* zone of Doña Ana, Valencia, and McKinley Counties in New Mexico; we know of no records in Cenomanian rocks to the north. Farther south, *Cymatoceras* and *Pseudocenoceras* occur in the lower Cenomanian Grayson Marl and Del Rio Clay in Texas (Miller and Harris, 1945; Kummel, 1953; Mancini, 1982).

Fossils described in this report are kept in the National Museum of Natural History (USNM) in Washington, D.C., and have been assigned USNM catalogue numbers. Plaster casts of some of the specimens are kept at the Federal Center in Denver, Colo.

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SYSTEMATIC PALEONTOLOGY

Superfamily NAUTILACEAE de Blainville, 1825

Family NAUTILIDAE de Blainville, 1825

Genus *PSEUDOCENOCERAS* Spath, 1927

Type species.—*Nautilus largilliertianus* d'Orbigny, 1840, p. 86, pl. 18, by original designation.

***Pseudocenoceras largilliertianum* (d'Orbigny, 1840)**

Plate 1, figures 1–5

1840. *Nautilus largilliertianum* d'Orbigny, p. 86, pl. 18.

1853. *Nautilus largilliertianus* d'Orbigny. Sharpe, p. 16, pl. 6, fig. 1 only.

non 1897. *Nautilus largilliertianus* d'Orbigny? Parona and Bonarelli, p. 76, pl. 10, fig. 6.

1927. *Pseudocenoceras largilliertianum* (d'Orbigny). Spath, p. 21.

1956. *Pseudocenoceras largilliertianum* (d'Orbigny). Kummel, p. 385, pl. 10, figs. 3, 4.

1960. *Angulithes (Pseudocenoceras) largilliertianus* (d'Orbigny,1840). Wiedmann, p. 174, pl. 22, fig. *F*.

1964. *Pseudocenoceras largilliertianum* (d'Orbigny). Kummel, p. 450, fig. 330.6.

1979. *Pseudocenoceras largilliertianum* (d'Orbigny). Wiedmann and Schneider, p. 654, pl. 3, fig. 1; text fig. 4*C*.

Type.—Hypotype USNM 441584 is from the base of the Boquillas Formation (Cenomanian and Turonian) at U.S. Geological Survey (USGS) Mesozoic locality D10142, about 1.2 km north of Cerro de Cristo Rey in the center of the N½SW¼ sec. 9, T. 29 S., R. 4 E., Doña Ana County, N. Mex. Other molluscan species from this locality were described by Kennedy and others (1988).

Description.—USNM 441584 consists of a phragmocone 38.5 mm in diameter and a fragment of the outer whorl that is part body chamber. The estimated original diameter of the shell is 93 mm. The nucleus is very involute and has a very small, deep umbilicus. The umbilical shoulder is broadly rounded, the inner flanks are subparallel, the outer flanks are convergent, and the ventrolateral shoulders and narrow venter are broadly rounded. At the smallest diameter visible, ornament consists of faint, strongly rursiradiate, low, convex flank ribs. These ribs increase by branching and intercalation on the outermost flank and on the ventrolateral shoulder, where they strengthen, bend back, and cross the venter in a broad, deep sinus. The whorl breadth-to-height ratio cannot be determined owing to crushing, but the whorls were compressed. The outer whorl was also compressed; it has a small umbilicus, a low, rounded umbilical wall, and a broadly rounded umbilical shoulder. Inner flanks are broadly rounded, outer flanks are flattened and convergent, ventrolateral shoulders are broadly rounded, and the venter is narrowly rounded. Most of the surface is worn, but there are traces of low, broad, concave folds on the venter at the largest diameter preserved.

The suture bends back on the inner flank, where it is markedly concave. It is nearly straight and rursiradiate across most of the flank and ventrolateral shoulder and slightly convex across the venter.

Discussion.—The specimen differs in no significant respects from specimens of *Psuedocenoceras largilliertianum* from the Cenomanian of England and France. *Pseudocenoceras fittoni* (Sharpe, 1853, p. 17, pl. 6, fig. 4), from the Cenomanian of southern England, has a much more compressed, subtrigonal whorl section and markedly convergent flanks. *Pseudocenoceras undulatus* (Sowerby, 1813, pl. 40; Sharpe, 1853, p. 15, pl. 5, fig. 4), also from the Cenomanian of southern England, has a stouter whorl and very coarse lateral dorsal folds in later growth. *Pseudocenoceras dorsoplicatus* (Wiedmann, 1960, p. 176), on the basis of the figures of Sharpe (1853, pl. 6, fig. 2) and Parona and Bonarelli (1897, pl. 10, fig. 6), is known from the Albian of France and the Cenomanian of southern England. The lectotype has a relatively broad venter and narrow, concave, distant ventral folds.

Occurrence.—Lower, middle, and upper Cenomanian of southern England. Lower and middle Cenomanian of France and Germany. Cenomanian of Spain. Middle Cenomanian *Acanthoceras amphibolum* zone of New Mexico.

Genus *ANGULITHES* Montfort, 1808

Type species.—*Nautilus triangularis* Montfort, 1802, by original designation by Montfort, 1808, p. 7.

Angulithes fleuriausianus (d'Orbigny, 1840)

Plate 1, figures 6–9; plate 2

1840. *Nautilus fleuriausianus* d'Orbigny, p. 82, pl. 15.

non 1853. *Nautilus fleuriausianus* d'Orbigny. Sharpe, p. 16, pl. 6, fig. 3.

1866. *Nautilus fleuriausianus* d'Orbigny. Stoliczka, p. 206, pl. 94, fig. 1.

non 1876. *Nautilus fleuriausianus* d'Orbigny. Schlüter, p. 174, pl. 48, figs. 3–5.

1956. *Angulithes fleuriausianus* (d'Orbigny). Kummel, p. 456.

1960. *Angulithes* (*Angulithes*) *fleuriausianus* (d'Orbigny). Wiedmann, p. 183, ?pl. 19, fig. *A*; pl. 20, figs. *N*, *O*; pl. 21, figs. *I*, *L*, *M*; ?pl. 23, fig. *O*; pl. 26, figs. 1–3; text figs. 14, 15.

Types.—Hypotypes USNM 441585 and 441586 are from the *Acanthoceras amphibolum* zone at USGS Mesozoic locality D7084 in brown-weathering, calcareous sandstone concretions in the Paguate Tongue of the Dakota Sandstone in the SE1/4NE1/4 sec. 20, T. 10 N., R. 5 W. in Cibola County, N. Mex. Hypotype USNM 441588 (not illustrated) is from the Paguate Tongue at USGS Mesozoic locality D7333, near the center of sec. 5, T. 14 N., R. 12 W. in McKinley County, N. Mex.

Description.—The best preserved specimen is USNM 441586 (pl. 2), a slightly crushed individual 150 mm in diameter and septate to 130 mm. Coiling is very involute. The whorl section is compressed (but accentuated by crushing) and has broadly rounded inner flanks, convergent outer flanks, and a narrowly rounded venter, all of which produce a subtrigonal whorl section that has an estimated whorl breadth-to-height ratio of 0.72. The shell surface, where preserved, is smooth except for growth lines on the phragmocone; these lines are prorsiradiate on the inner flanks, curved back and convex over the outer flanks, and deeply convex on the venter. On the adult body chamber, the growth lines are paralleled by faint grooves and folds. USNM 441585 (pl. 1, figs. 6–9) is a crushed internal mold of a juvenile 96 mm in diameter that has a sharp venter due to postmortem crushing over most of the outer whorl. The suture is slightly convex across the umbilical wall and shoulder, and it bends back and follows a low concave course on the flanks, forming a broad, shallow lobe that has a narrow, shallow ventral saddle. USNM 441588 is a septate fragment.

Discussion.—Compressed whorls having rounded venters and slightly flexuous septa characterize this species. *Angulithes triangularis* (Montfort, 1802) (see revision by Wiedmann, 1960, p. 187, pl. 21, fig. *P*; pl. 22, fig. *I*) has a triangular whorl section and an acute venter. *Angulithes mermeti* (Coquand, 1862, p. 166, pl. 2, figs. 1, 2; see revision by Wiedmann, 1960, p. 188, pl. 22, fig. *H*; pl. 25, figs. 8, 9; pl. 26, fig. 4; pl. 27, figs. 1, 2; text figs. 16–20) is very compressed and has an acute venter and a lanceolate whorl section. *Angulithes vascogoticus* Wiedmann (1960, p. 191, pl. 27, fig. 3; text figs. 22, 23) has a narrow venter, a sublanceolate whorl section, and a much more markedly flexed suture that has a narrow saddle on the inner flank.

Occurrence.—This typically Cenomanian species ranges from lower to upper Cenomanian in England and France; it also occurs in Germany, Tunisia, and southern

India. Wiedmann (1960) also recorded the species from the Turonian(?) of Saxony (Germany) and from the Coniacian of Spain and Austria. The two specimens figured herein (pl. 1, figs. 6–9; pl. 2) are from the middle Cenomanian *Acanthoceras amphibolum* zone of Cibola and McKinley Counties, N. Mex. The specimens were listed as *Eutrephoceras*? sp. (Cobban, 1977, table 1).

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PLATES 1, 2

Contact photographs of the plates in this report are available, at cost, from the U.S. Geological Survey Photographic Library, Federal Center, Denver, CO 80225.

PLATE 1

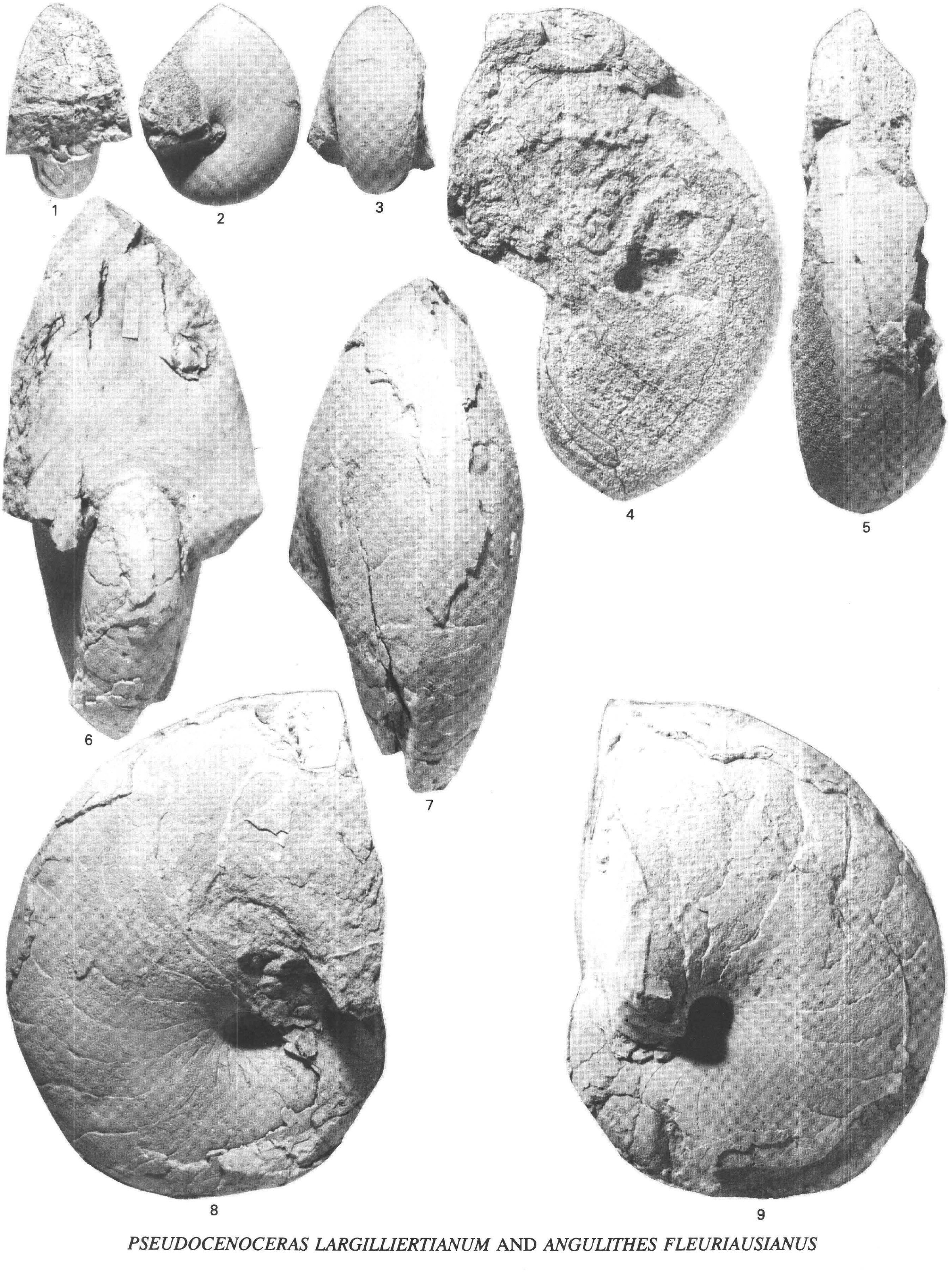
Pseudocenoceras largilliertianum (d'Orbigny, 1840) and *Angulithes fleuriausianus* (d'Orbigny, 1840)

[All figures natural size]

Figures 1–5. *Pseudocenoceras largilliertianum* (d'Orbigny, 1840). Hypotype, USNM 441584, from the base of the Boquillas Formation at U.S. Geological Survey Mesozoic locality D10142 in the N1/2SW1/4 sec. 9, T. 29 S., R. 4 E., Doña Ana County, N. Mex.

- 1–3. Inner whorls.
- 4, 5. Outer whorl.

6–9. *Angulithes fleuriausianus* (d'Orbigny, 1840). Hypotype USNM 441585, from the Paguate Tongue of the Dakota Sandstone at U.S. Geological Survey Mesozoic locality D7084 in the SE1/4NE1/4 sec. 20, T. 10 N., R. 5 W., Cibola County, N. Mex.



PSEUDOCENOCERAS LARGILLIERTIANUM AND ANGULITHES FLEURIAUSIANUS

PLATE 2

Angulithes fleuriausianus (d'Orbigny, 1840)

[Figures 0.9 natural size]

Hypotype USNM 441586, from the Paguate Tongue of the Dakota Sandstone at U.S. Geological Survey Mesozoic locality D7084 in the SE¼NE¼ sec. 20, T. 10 N., R. 5. W., Cibola County, N. Mex.

1 2 3

ANGULITHES FLEURIAUSIANUS

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