

# Campanian (Late Cretaceous) ammonites from the Bergstrom Formation in Central Texas

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## ABSTRACT:

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Calcareous concretions 12-18 m below the top of the Upper Cretaceous Bergstrom Formation in Travis County, Texas, contain abundant ammonites. *Menuites stephensoni* YOUNG, 1963, *Manambolites ricensis* YOUNG, 1963, and *Trachyscaphites pulcherrimus* (ROEMER 1841) have been described previously but are minor elements of the fauna, which is characterized, in addition, by abundant *Didymoceras binodosum* (KENNEDY & COBBAN 1993a) and *Spiroxybeloceras kimbroense* gen. & sp. n., with rarer *Menuites* sp., *Placenticerias* sp., and *Baculites texanus* sp. n. The fauna correlates with the *Baculites scotti* zone (Campanian) in the U.S. Western Interior and part of the *Bostrychoceras polyplacum* zone in northwestern Europe.

## INTRODUCTION

The name Bergstrom Formation was introduced by YOUNG (1965) for the upper Taylor Marl (Upper Cretaceous) of previous authors (*see* discussions in YOUNG 1965, and in ADKINS 1932). The formation occurs in Central Texas, is about 122 m thick, and is a greenish-grey to brownish-grey claystone that is especially calcareous in the lower part. According to YOUNG, the formation grades down into the underlying Pecan Gap Chalk, and it is disconformably overlain by the Corsicana Formation. Hard, barite-bearing, calcareous concretions 12-18 m below the top of the Bergstrom in the Manda-Kimbro area of Travis County (Text-fig. 1) are the source of abundant ammonites in the collections of the Texas Memorial Museum in Austin as well as in the collections of the U.S. Geological Survey in Denver, Colorado. This unit of concretions was referred to

as the Kimbro nodule zone by ADKINS (1932) and YOUNG (1963, 1965).

Many concretions consist largely of crowded masses of fragmentary heteromorph ammonites. Most ammonites occur as uncrushed internal moulds of body chambers with or without associated uncrushed phragmocones. YOUNG (1963) described the new species *Menuites stephensoni* and *Manambolites ricensis* from these concretions, and COBBAN (1973) added *Trachyscaphites pulcherrimus* (ROEMER, 1841), but the other ammonites that dominate the fauna remained undescribed. We describe below the rest of the ammonite assemblage, which consists of the following forms: *Menuites* sp., *Placenticerias* sp., *Didymoceras binodosum* (KENNEDY & COBBAN 1993a), *Spiroxybeloceras kimbroense* gen. & sp. n., and *Baculites texanus* sp. n. Additional data concerning *T. pulcherrimus* are also given. Other fossils in the Kimbro concretions include the soli-

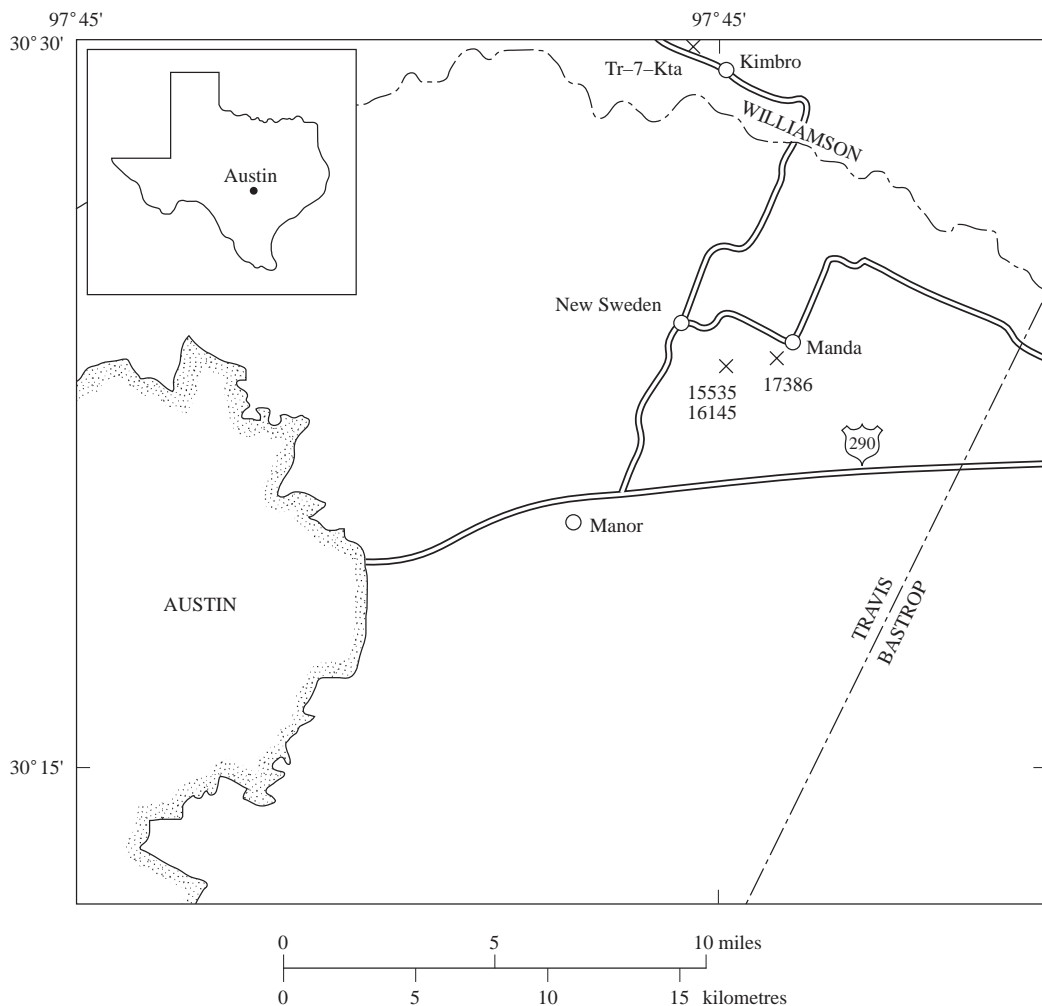


Fig. 1. Localities where ammonites were collected in Travis County, Texas; localities are described in Table 1

tary coral *Micrabacia*, fragments of echinoids, a variety of gastropods and bivalves including a fragment of a rudist, the nautiloid *Eutrephoceras*, and fish teeth and vertebrae.

#### AGE AND CORRELATION OF THE FAUNA

The Kimbro nodule zone is confined to the marls of the Bergstrom Formation. The underlying Pecan Gap Chalk contains a small assemblage of *Pachydiscus* (*Pachydiscus*) *travisi* (ADKINS, 1929), *P.* (*P.*) aff. *P.* (*P.*) *haldemsi* (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) (COBBAN & KENNEDY 1994). This

assemblage correlates with the *Baculites asperiformis* Zone of early middle Campanian age in the U.S. Western Interior (Text-fig. 2). The Corsicana Formation, which overlies the Bergstrom, has yielded *Discoscaphites conradi* (MORTON, 1834) and *Nostoceras major* KENNEDY & COBBAN, 1993b, in the New Sweden-Manda area, Travis County (KENNEDY & COBBAN 1993b). These two ammonites are from the Gulf Coast *Discoscaphites conradi* Zone that correlates with the upper Maastrichtian *Hoploscaphites nicolletii* Zone of the Western Interior (Text-fig. 2).

Three ammonites, *Didymoceras binodosum* (KENNEDY & COBBAN, 1993a), *Spiroxybeloceras kimbroense* gen. & sp. n., and *Baculites texanus* sp. n., that occur in the Kimbro concretions are also found in the Western Interior in the zone of *Baculites scotti* of latest middle Campanian age (Text-fig. 2). These occurrences firmly place the Kimbro concre-

tions in that part of the Campanian in terms of the Western Interior divisions of the Campanian Stage.

Two of the Kimbro species are also found in the Wenonah Formation of New Jersey. These species are *Baculites texanus* sp. n., and *Trachyscaphites pulcherrimus* (ROEMER, 1841). Other ammonites from the Wenonah include fragments of a *Didymoceras* that may be *D. binodosum*, and of a *Spiroxybeloceras* gen. n. that may be *S. kimbroense* gen. & sp. n.

Correlation of the Kimbro nodule zone fauna with the Campanian of north-western Europe is

facilitated by the common occurrence of *D. binodosum* and *T. pulcherrimus* in the Bergstrom Formation and in the Campanian zones of *Bostrychoceras polyplacum* and *Didymoceras donezianum* of Europe.

BLASZKIEWICZ (1980) recognized the following upper Campanian zones in the Vistula River valley in Poland:

- Nostoceras pozaryskii* (youngest)
- Didymoceras donezianum*
- Bostrychoceras polyplacum*
- Neancyloceras phaleratum* (oldest)

Cretaceous Stages and Western Interior informal substages		Western Interior ammonite zones
Maastrichtian (part)	Upper (part)	<i>Jeletzkytes nebrascensis</i> <i>Hoploscaphites nicolletii</i> <i>Hoploscaphites birkelundi</i> <i>Baculites clinolobatus</i> <i>Baculites grandis</i> <i>Baculites baculus</i> <i>Baculites eliasi</i> <i>Baculites jenseni</i> <i>Baculites reasidei</i> <i>Baculites cuneatus</i> <i>Baculites compressus</i> <i>Didymoceras cheyennense</i> <i>Exiteloceras jenneyi</i> <i>Didymoceras stevensoni</i> <i>Didymoceras nebrascense</i>
	Lower	
Campanian	Upper	<i>Baculites scotti</i> <i>Baculites reduncus</i> <i>Baculites gregoryensis</i> <i>Baculites perplexus</i> <i>Baculites</i> sp. (smooth) <i>Baculites asperiformis</i> <i>Baculites maclearni</i> <i>Baculites obtusus</i> <i>Baculites</i> sp. (weak flank ribs) <i>Baculites</i> sp. (smooth) <i>Scaphites hippocrepis</i> III <i>Scaphites hippocrepis</i> II <i>Scaphites hippocrepis</i> I
	Middle	
	Lower	

Fig. 2. Campanian and Maastrichtian ammonite zones of the U.S. Western Interior

Note that the *N. pozaryskii* zone should be called the *N. hyatti* zone inasmuch as a part of the type material of *N. pozaryskii* belongs to *N. hyatti* (KENNEDY & *al.* 1992). *Trachyscaphites pulcherrimus* was recorded from both the *B. polyplacum* and *D. donezianum* zones (*see also* NIEBUHR 1996, KAPLAN & KENNEDY 1997), and *D. binodosum* has a similar range (as *Didymoceras cf. secoense* (YOUNG 1963) in BŁASZKIEWICZ (1980, p. 24, Pl. 5, Figs 4, 6; Pl. 7, Figs 16, 19). KENNEDY has seen *D. binodosum* from the Ultrahelvetic zone of Gschlifgraben, upper Austria (KENNEDY & SUMMESBERGER 1984), where it also occurs with species of these two zones. The Austrian occurrences can be correlated with the upper part of the *Globotruncanita calcarata* planktic foraminifer zone via the Gschlifgraben occurrences (PREY 1983).

#### LOCALITIES WHERE AMMONITES WERE COLLECTED

Ammonites described in this report came from a small area in northeastern Travis County, Texas. Most specimens are from brown-weathering calcareous concretions that contain abundant colorless to light-grey, coarsely crystalline barite. The figured ammonites are from four localities described in Table 1 and plotted in Text-fig. 1.

[The first three locality numbers are U.S. Geological Survey Mesozoic locality numbers in the Washington, D.C., register. The last number is for J.P. CONLIN's locality]	
Locality no. (Text-fig. 1)	Collector(s) year of collection (if known), and description of locality
15535	L.W. STEPHENSON & W.S. ADKINS, 1930. Cottonwood Creek 1.6 km southwest of Manda.
16145	L.W. STEPHENSON & F.L. WHITNEY, 1932. Cottonwood Creek 1.6 km southwest of Manda.
17386	L.W. STEPHENSON & F.B. PLUMMER, 1936. Cottonwood Creek 1.1 km southwest of Manda.
Tr-7-Kta	A.F. CRANE. Cottonwood Creek 1.6 km southwest of Kimbro.

Table 1. Localities where ammonites were collected from the Kimbro nodule zone in the Bergstrom Formation, Travis County, Texas

#### REPOSITORIES OF SPECIMENS

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

#### SYSTEMATIC PALEONTOLOGY

In the descriptions, umbilical diameter, whorl breadth, and whorl height are given as ratios to the shell diameter. For some specimens of less than a full whorl, rib and tubercle counts are given for a half whorl. In the descriptions of sutures, E = external lobe, L = lateral lobe, and U1 and U2 = umbilical lobes; suture terminology is that of WEDEKIND (1916) (*see* KULLMANN & WIEDMANN 1970).

Order **Ammonoidea** ZITTEL, 1884  
Suborder **Ammonitina** HYATT, 1889  
Superfamily **Desmocerataceae** ZITTEL, 1895  
Family **Pachydiscidae** SPATH, 1922

Genus *Menuites* SPATH, 1922  
(= *Besairieites* COLLIGNON, 1931;  
*Anapachydiscus* YABE & SHIMIZU, 1926;  
*Cobbanoscaphites* COLLIGNON, 1969).  
Type species: *Ammonites menu* FORBES, 1846  
(p. 111, Pl. 10, Fig. 1), by original designation.

*Menuites* sp.

**MATERIAL:** Three small specimens, USNM 475014, 475015, and 475067.

**DESCRIPTION:** The smallest specimen (USNM 475014), a phragmocone, has a shell diameter of only 12.3 mm and an umbilical diameter of 3.0 mm (ratio to diameter of 0.24). Its breadth cannot be determined owing to one incomplete side. The deep umbilicus has sloping walls and narrowly rounded shoulders. Flanks are well rounded, and the venter is broadly rounded. Ornament is lacking.

The largest specimen (USNM 475015), a mostly worn internal mold 43 mm in diameter, has one side fairly well preserved, whereas most of the

other side is somewhat damaged and incomplete. The whorl section can be measured only at one place about one-third of a whorl from the larger end, where the whorl breadth (Wb) is 21.8 mm and the whorl height (Wh) is 17.0 mm (Wb:Wh=1.28). Broadly rounded flanks and venter and narrowly rounded umbilical shoulder characterize the whorl section. The umbilicus, which is deep, has a rounded wall and occupies 24 percent of the shell diameter. Ornament consists of weak, narrow primary ribs that arise on the umbilical shoulder and weaker secondary ribs that arise on the inner part of the flank. The primaries are faintly bullate on the umbilical shoulder. All ribs are slightly prorsiradiate on crossing the flank and somewhat arched forward on crossing the venter. Primary and secondary ribs are about equal in numbers. Approximately seven or eight ribs cross the venter on the last quarter of a whorl. Only parts of the suture are visible, but the pattern is highly denticulate and complex, as is typical of most pachydiscid ammonites. The third specimen (USNM 475067) is almost as large as USNM 475015 but is not as well preserved.

**OCCURRENCE:** Kimbro nodule zone in the Bergstrom Formation, Travis County, Texas, at USGS Mesozoic localities 17386 and 15535.

Superfamily **Hoplitaceae** H. DOUVILLÉ, 1890  
Family **Placenticeratidae** HYATT, 1900

Genus *Placenticerias* MEEK, 1876

**TYPE SPECIES:** *Ammonites placenta* DEKAY, 1828, p. 278, by original designation by MEEK (1876 p. 426).

*Placenticerias* sp.  
(Pl. 1, Figs 19-22)

**MATERIAL:** Fragments of five internal molds. Figured or described specimens are USNM 475016-475019.

**DESCRIPTION:** Two specimens, USNM 475016 and 475017, consist of nearly one-half whorl each. USNM 475016 (Pl. 1, Figs 21-22) is a microconch made up of the adapical two-thirds of a body chamber attached to the last five chambers of the phragmocone. The larger end of the body chamber has a height (Wh) of 54.3 mm and a breadth (Wb) of 30.0 (Wb:Wh=0.55). The fairly broad

umbilicus has rounded sides that merge evenly into the rounded umbilical shoulder. Flanks are nearly flat and converge to the narrow, flat venter. Umbilical tubercles, located on the umbilical shoulder, are small and nodate and number about six in half a whorl. Outer lateral tubercles are low and nodate; there are about 12 per half whorl. Clavi that border the narrow venter are twice as numerous as the lateral tubercles. USNM 475017 (Pl. 1, Figs 19, 20) is most of a microconch body chamber; whorl dimensions near its larger end are height 39.4 mm and breadth 24.7 mm (Wb:Wh=0.63). The specimen is much more strongly ornamented than USNM 475016 and has about 5 nodate umbilical tubercles, 11 nodate outer lateral tubercles, and 22 nodate to slightly clavate ventral tubercles per whorl.

Another specimen, USNM 475018 (not illustrated), consists of two-thirds of a septate whorl that has a whorl height of 66.5 mm at its larger end. The largest specimen, USNM 475019 (not illustrated), is the adapical part of a macroconch body chamber with two septa of the phragmocone attached. The body chamber has a whorl height of 93.0 mm at its adapical end; the venter is rather narrowly rounded. This specimen is poorly preserved but appears to be smooth.

**REMARKS:** The specimens resemble *Placenticerias intercalare* MEEK & HAYDEN, 1860 (p. 177; MEEK 1876, p. 468, Pl. 23, Fig. 1a-c) in their general shape and strong ornament, although the ventral clavi are a little more numerous in *P. intercalare*, and the latter's venter rounds at a much larger shell diameter. *Placenticerias minor* KENNEDY & COBBAN, 1994 (p. 99, Figs 4.6-4.16, 4.19, 4.20, 5.1, 5.3, 6.1-6.7) also has three rows of tubercles and a rounded venter to the adult body chamber, but the ornament tends to be weaker than that of the Kimbro specimens; the ventral tubercles are less conspicuous, with some even being nodate instead of clavate, and the venter of the body chamber rounds at a smaller size. *Placenticerias syrtale* (MORTON, 1834) (p. 40, Pl. 16, Fig. 4) resembles the Kimbro specimens in having similar ornament of three rows of tubercles, but *P. syrtale* seems to be a stouter species according to the illustrations of WOLLEBEN (1967).

**OCCURRENCE:** Kimbro nodule zone in the Bergstrom Formation, Travis County, Texas, at USGS Mesozoic localities 15535, 16145, and 17386.



Suborder **Ancyloceratina** WIEDMANN, 1966  
 Superfamily **Turrilitaceae** GILL, 1871  
 Family **Nostoceratidae** HYATT, 1894

Genus *Didymoceras* HYATT, 1894  
 (= *Emperoceras* HYATT, 1894, p. 575;  
*Didymoceratoides* KENNEDY & COBBAN,  
 1993a, p. 90)

TYPE SPECIES: *Ancyloceras nebrascense* MEEK & HAYDEN, 1856 p. 71, by original designation by HYATT (1894 p. 573). The holotype, USNM 469, is from a limestone concretion from rocks now assigned to the Pierre Shale in South Dakota.

*Didymoceras binodosum*  
 (KENNEDY & COBBAN, 1993a)  
 (Pls 2-4; Pl. 5, Figs 11-20; Text-figs 3-4)

1963. *Bostrychoceras secoense* YOUNG, p. 42 (pars), Pl. 4, Fig. 8 only.  
 1980. *Didymoceras* cf. *secoenes* [sic!] (YOUNG); BŁASZKIEWICZ, p. 24, Pl. 5, Figs 4, 6; Pl. 7, Figs 16, 19.  
 1993a. *Didymoceratoides binodosum* KENNEDY & COBBAN, p. 92, Figs 8.1, 8.2, 8.5, 8.6, 8.13-8.15, 8.22-8.24, 8.28, 8.29, 8.32, 8.33, 8.35-8.39, 9.1-9.5, 12.1.  
 1994. *Didymoceratoides binodosum* KENNEDY & COBBAN; EMERSON & al., p. 314, unnumbered figures.  
 1997. *Didymoceras binodosum* (KENNEDY & COBBAN); LARSON & al., frontispiece on p. vi; p. 53, upper two unnumbered figures.

TYPES: Holotype is USNM 441521, from the *Baculites scotti* zone in the Pierre Shale at USGS Mesozoic locality D1412 about 1.6 km. north-northeast of Oral in the NW1/4NW1/4 sec. 26, T. 7S., R. 7E, Fall River County, South Dakota. Hypotype USNM 475020 is also from USGS Mesozoic locality D1412. Other hypotypes are USNM 475021-475037 from the Bergstrom Formation of Travis County, Texas, and USNM 475038 from USGS Mesozoic locality D904 in the Pierre Shale of Fall River County, South Dakota.

MATERIAL: About 80 fragments, mostly parts of single whorls, were available for study.

DIAGNOSIS: Early whorls consist of a loose open planispire followed by a loose elliptical whorl or a loose circular whorl; later whorls form a helix with the whorls barely in contact except for the last part of the body chamber, which is slightly uncoiled

(Text-fig. 3). Ornament consists of prominent, narrow ribs, most of which bear two tubercles. Widely spaced constrictions are present.

DESCRIPTION: The holotype (KENNEDY & COBBAN 1993a, Figs 9.1-9.3), interpreted as a paedomorphic derivative of *Didymoceras* by the authors, is now reinterpreted as a juvenile, rather than a complete adult of *Didymoceras binodosum*; this species has a loose planispiral juvenile growth stage and a helical adult stage terminating in a short retroversal whorl. The phragmocone of the holotype consists of an open criocone of two whorls followed by an open elliptical whorl. The body chamber occupies half of a fairly evenly curved planispiral whorl that has a diameter of 64 mm.

The species has an unusually long adult body chamber. A specimen from the type locality (Pierre Shale near Oral, South Dakota) is illustrated in Pl. 5, Figs 19 and 20. It consists of 1.5 helical whorls in contact and a loose later whorl that recurves back and upward a little. The specimen has a length of 115 mm; diameter of the second whorl is 76 mm. Whorl cross sections are elliptical and higher than wide. A low

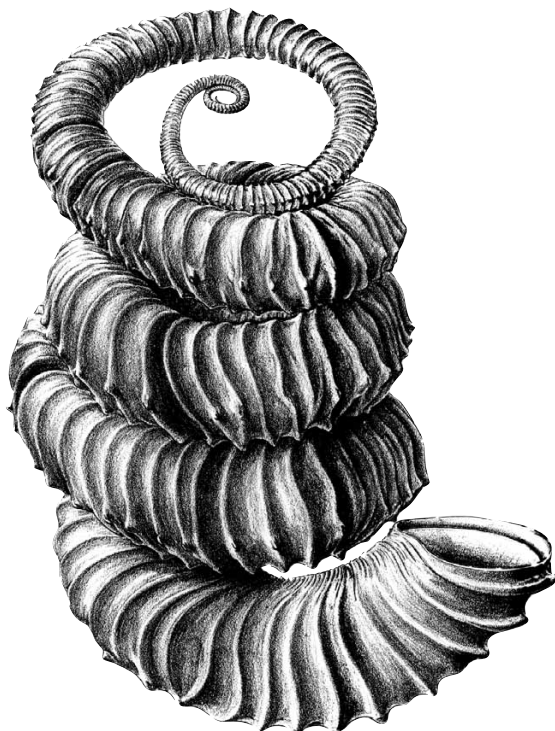


Fig. 3. Restoration of *Didymoceras binodosum* (KENNEDY & COBBAN, 1993a). Drawing by John R. STACY is based on specimens from the Pierre Shale of South Dakota and is approximately two-thirds natural size

impressed area is present on the upper whorl face of the upper whorl. Only part of the body chamber is preserved at its oral end, but enough of the specimen is present to show that this part curved up at an angle so that the aperture was directed upward and outward (Text-fig. 3). Constrictions are spaced about four or five per whorl; some are bordered on one side or the other by a high, flared rib. Ornament consists of strong, narrow ribs that are considerably narrower than the interspaces. The ribs are rursiradiate on the flanks and lower whorl face but curve and become prorsiradiate on the upper whorl face; they weaken on the upper whorl face but remain strong on the lower one. There are 45 ribs per whorl on the upper part of the whorl. Most ribs bear a small, nodate tubercle at midflank and a similar tubercle near the base of the whorl. Occasionally, two ribs branch from a tubercle of either row. Nontuberculate ribs are rare. The specimen lacks the early open planispiral growth stage, but a few examples of that stage are present in the collections from the type locality (USGS Mesozoic locality D1412) near Oral, South Dakota.

Fragments of *D. binodosum* are abundant in the Kimbro nodules, but not one at hand consists of more than two whorls in contact. Considerable variation is present in the form of the helical whorls, from low, broad spires (Pl. 2, Figs 8, 10) to higher, narrower spires (Pl. 2, Fig. 11). Some specimens have the partly uncoiled body chamber (Pl. 2, Figs 9, 11; Pl. 3, Figs 1-2, 5-6; Pl. 4, Fig. 7). Other specimens represent parts of the earlier loose, open, helical to planispiral whorls (Pl. 2, Fig. 7; Pl. 3, Figs 4, 8; Pl. 4, Figs 4-5; Pl. 5, Figs 11-18). Ribs on the early open helical whorls slant across the whorls (Pl. 5, Fig. 12), whereas the ribs pass directly across the whorls in the planispiral stage (Pl. 3, Fig. 3; Pl. 4, Fig. 5; Pl. 5, Fig. 15).

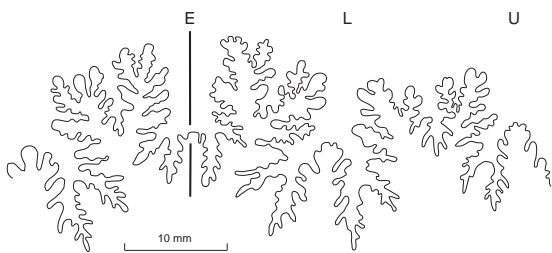


Fig. 4. Most of suture of *Didymoceras binodosum* (KENNEDY & COBBAN, 1993a), USNM 475038, from the Pierre Shale at USGS Mesozoic locality D904, in the SE1/4NW1/4 sec. 22, T. 7 S., R. 7 E., Fall River County, South Dakota. E is external lobe, L is lateral lobe, U is umbilical lobe. Heavy, straight line marks middle of venter

Low, looped ribs connect the tubercles across the venter on some of the early whorls (Pl. 5, Fig. 16), and, occasionally, on later whorls (Pl. 2, Fig. 6).

The species is dimorphic. Macroconchs (Pl. 5, Figs 19-20) are nearly twice as large as microconchs (Pl. 3, Figs 7-8).

Sutures are highly digitate (Text-fig. 4). The lateral and umbilical lobes are deeply bifid and much larger than the external lobe.

REMARKS: The species is distinguished from all other species of *Didymoceras* in the U.S. Western Interior in possessing strong constrictions. Constrictions are present in the many species of *Nostoceras* from the Gulf coastal region, but those species are much smaller than *D. binodosum*, and most of their whorls are in tight contact.

One of the specimens of *Bostrychoceras secoense* YOUNG, 1963, illustrated by YOUNG (1963, Pl. 4, Fig. 8) is a *D. binodosum*; the remainder of YOUNG's figured specimens are *Bostrychoceras polyplacum* (ROEMER, 1841) (see KENNEDY 1986, KENNEDY & KAPLAN 1997 for discussion). The fragments referred to as *Didymoceras* cf. *secoense* by BŁASZKIEWICZ (1980, p. 24, Pl. 5, Figs 4-6; Pl. 7, Figs 16, 19) also belong to *D. binodosum*.

OCCURRENCE: Kimbro nodule zone in the Bergstrom Formation in Travis County, Texas, at USGS Mesozoic localities 15535, 16145, and 17386 and at J.P. CONLIN's locality Tr-7-Kta. The species occurs in the lower part of the *Baculites scotti* Zone in the Pierre Shale in South Dakota and Colorado. That zone was subdivided into several subzones in southern Colorado by SCOTT (1964, SCOTT & COBBAN 1986), who also mapped the subzones. One subzone designated as characterized by "*Didymoceras* n. sp. (loosely coiled)" by SCOTT represents the level of *D. binodosum*. The species also occurs in USGS collections from Utah in the Segoe Sandstone and in the Anchor Mine Tongue of the Mancos Shale. Fragments of a *Didymoceras* in the Wenonah Formation in New Jersey may be *D. binodosum*. The species is also found in Poland, and Austria.

Family **Diplomoceratidae** SPATH, 1926  
Subfamily **Polyptychoceratinae** MATSUMOTO, 1938

Genus *Spiroxybeloceras* gen. n.

TYPE SPECIES: *Ptychoceras meekianum* WHITFIELD, 1877 (p. 44), illustrated by WHITFIELD

(1880, Pl. 16, Figs 1, 2) by original designation. WHITFIELD's type came from the Pierre Shale in the valley of Beaver Creek southwest of Newcastle, Weston County, Wyoming.

ETYMOLOGY: Greek, *spira*, coil; *oxys*, sharp; *belon*, needle; *keras*, horn.

DIAGNOSIS: Heteromorph ammonites that have a loosely coiled planispiral juvenile growth stage followed by the adult growth stage of two parallel limbs that may be tightly appressed or barely in contact (Text-fig. 5).

REMARKS: The genus is closely related to *Solenoceras* CONRAD (1860), from which it differs in its planispiral juvenile whorls and in its lack of constrictions. *Oxybeloceras* HYATT (1900), based on *Ptychoceras crassus* WHITFIELD (1877), is considered a junior synonym of *Solenoceras* (WRIGHT 1957, p. L224; 1996, p. 255).

*Spiroxybeloceras kimbriense* gen. & sp. n.

(Pl. 1, Figs 1-18; Pl. 5, Figs 1-10;  
Text-figs 5-6)

1993a. *Oxybeloceras crassum* (WHITFIELD, 1877);  
KENNEDY & COBBAN, p. 93, Fig. 8.7-8.12, 8.16-8.21.

1993c. *Oxybeloceras crassum* (WHITFIELD, 1877);  
KENNEDY & COBBAN, p. 142, Pl. 8, Figs 18-37; Text-  
figs 7B, 10B.

1994. *Oxybeloceras crassum* (WHITFIELD, 1877);  
EMERSON & *al.*, p. 318, unnumbered figures.

ETYMOLOGY: From the Kimbro nodule zone of the Bergstrom Formation of Texas.

TYPES: Holotype USNM 475039, from the Kimbro nodule zone in the Bergstrom Formation at USGS Mesozoic locality 17386, 1.1 km southwest of Manda, Travis County, Texas. Paratypes USNM 475040-475058 are from USGS Mesozoic localities 15536, 16145, 17386, and J.P. CONLIN's locality Tr-7-Kta (Table 1).

MATERIAL: Fragments of about 200 individuals are at hand.

DIAGNOSIS: Early whorls form a loose criocone followed by a broadly curved limb and finally by two straight parallel limbs connected by an elbow. The two straight limbs are barely in contact for most of their length.

DESCRIPTION: The holotype (Pl. 1, Figs 1-2) consists of parts of two straight, nearly parallel limbs connected by an elbow. Part of the smaller limb, the elbow, and the larger limb represent the older part of an adult body chamber. The limbs are not in contact, and the dorsum of the larger limb lacks an impressed dorsal furrow. A fairly large opening shaped like the eye of a needle (hence, the origin of part of the generic name from the Greek terms *oxys*, sharp, and *belon*, needle) separates the limbs at the elbow. Cross sections of both limbs are more-or-less circular, with a slight ventral flattening. The specimen is 35 mm long; the larger end of the larger limb is 10.3 mm high and 10.5 mm wide.

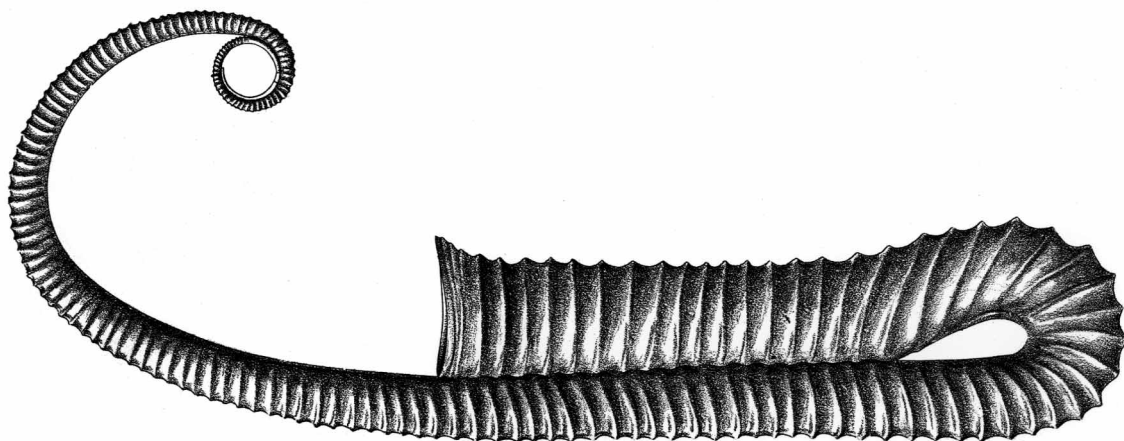


Fig. 5. Restoration of *Spiroxybeloceras kimbriense* gen. & sp. n. Drawing by John R. STACY is based on specimens from the Pierre Shale of South Dakota and is approximately natural size



[Rib index is the number of ribs in a distance along the venter equal to the whorl height of the limb]

USNM specimen no.	Whorl height of limb (MM)	Rib index
475039	9.6	4.0
475040	9.0	3.5
475041	8.3	5.0
475042	9.6	4.0
475043	9.7	4.0
475044	10.9	5.0
475045	8.7	4.5
475046	9.2	4.5
475047	9.4	4.0
475048	8.8	5.0
475049	9.9	4.0
475050	8.8	4.0
475051	9.0	4.0
475052	9.8	4.5
475053	9.1	5.0
475054	9.0	4.0
475055	9.2	4.0

Table 2. Rib index of *Spiroxybeloceras kimbroense* gen. & sp. n., from USGS Mesozoic locality 17386.

Ornament consists of narrow, sharp ribs that are prorsiradiate on the smaller limb and rursiradiate on the elbow and on the larger limb. Ribs weaken on the lower part of the flank and become barely discernible on the dorsum. Each rib sharpens into a small nodate tubercle at the margin of the narrow venter and then becomes very weak on crossing the slightly flattened venter. Ribs number four along the venter in a distance equal to the whorl height. The suture is poorly exposed, but, on other specimens, the suture is moderately incised, and lobes and saddles are deeply bifid (Text-fig. 6).

Most specimens curve ventrally a little near the

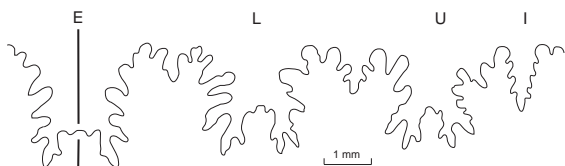


Fig. 6. Suture of *Spiroxybeloceras kimbroense* gen. & sp. n., based on USNM 475058, from the Kimbro nodule zone in the Bergstrom Formation at USGS Mesozoic locality 17386 (Text-fig. 1). **E** is external lobe, **L** is lateral lobe, **U** is umbilical lobe, **I** is internal lobe. Heavy, straight line marks middle of venter

aperture (Pl. 1, Figs 10, 14). The last few ribs may become irregular in height or more closely spaced, and tubercles usually disappear.

Ribs on the older part of the larger limb range from 3.5 to 5 in a distance along the venter equal to the whorl height of the limb. Rib densities (rib indices) for the holotype and most of the paratypes are given in Table 2.

Although the collections from the Kimbro nodule zone contain numerous fragments of the two straight limbs and the elbows, no complete examples of the earliest growth stages are present. A few fragments, such as unfigured paratype USNM 475057, comprise small curved fragments that can be reconstructed into a dorsally curved extension of the smaller straight shaft, followed by a planispiral criocone stage (the earliest ontogenetic stages are preserved in specimens from the *Baculites scotti* Zone of the Pierre Shale of the U.S. Western Interior, to be described elsewhere).

REMARKS: *Spiroxybeloceras kimbroense* gen. & sp. n., closely resembles *Oxybeloceras crassum* (WHITFIELD 1877, p. 45) from the Pierre Shale in its coarse ornament, but the latter has the two limbs closely appressed, resulting in a conspicuous impressed dorsal furrow on the body chamber. The two limbs of *S. crassum* also attain much greater lengths, and the juvenile growth stage is not a loose planispire.

OCCURRENCE: *Spiroxybeloceras kimbroense* gen. & sp. n., is known in Texas only from the Kimbro nodule zone in the Bergstrom Formation in Travis County. The species also occurs in the Annona Chalk in southwestern Arkansas. Specimens are widely distributed in the Western Interior, where they occur in the *Baculites scotti* Zone in the Pierre Shale. The Wenonah Formation in New Jersey contains bits of a heteromorph that could be *S. kimbroense*.

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 texanus* sp. n.  
(Pls 6-7; Text-fig. 7)

1958. *Baculites scotti* COBBAN, noded variant, p. 662, Pl. 90, Figs 5-9; Text-fig. 1c-e.

1994. *Baculites* cf. *B. scotti* COBBAN; KENNEDY & COBBAN, p. 107, Figs 8.18.3, 8.12, 8.17-8.19.

ETYMOLOGY: From Texas.

TYPES: Holotype is USNM 475059, from the Kimbro nodule zone in the Bergstrom Formation at USGS Mesozoic locality 15535 along Cottonwood Creek, Travis County, Texas. Paratypes are USNM 475060-475066 from the same horizon in the Bergstrom Formation at USGS localities 15535, 16145, and 17386.

MATERIAL: Ten uncrushed internal molds of body chambers with or without attached parts of phragmocones.

DIAGNOSIS: A moderate-sized baculite that has a robust cross section, rather high angle of taper in early adult growth stage, and strong ornament of broad, arcuate flank swellings and weak, irregular ventral ribbing.

DESCRIPTION: The holotype (Pl. 6, Figs 4-6), a young adult or possibly a microconch, consists of the adapical half of a body chamber attached to the last four chambers of the phragmocone. The specimen has a length of 91 mm and an angle of taper of  $7^\circ$ . The intercostal cross section is oval; dimensions at the large end are height (H) 29.3 mm and breadth (W) 22.0 mm; at the small end, H = 20.4 mm and W = 14.1 mm. Flanks are very broadly rounded, the dorsum is broadly rounded, and the venter more narrowly rounded. Large, broad, high, crescentic ribs that occupy most of the flank are the dominant ornament. They are spaced at two in a distance equal to the whorl height. Weak, ribs of irregular strength and spacing are present on the venter.

A paratype, USNM 475060 (Pl. 6, Figs 1-3), closely matches the holotype in size, angle of taper, and ornament. Other paratypes (Pl. 6, Figs 7-11) have flank ribs that are slightly narrower and spaced either a little closer or a little wider apart. The smallest specimen (unfigured paratype USNM 475063) is a juvenile and has a whorl height of only 6.1 mm. Another juvenile (unfigured paratype USNM 475066) has a whorl height of 11.7 mm and a whorl breadth of 9.8 mm at its larger end. The largest specimen, a macroconch (Pl. 7; USNM 475064) 172 mm long, is most of a body chamber

with two camerae attached. It has an angle of taper of  $4^\circ$  and ornament typical of the smaller specimens. Most of the aperture is preserved on a macroconch (unfigured paratype USNM 475065) that has a whorl height of 51 mm. The aperture is flared a little but follows the path of the growth lines and ornament, which results in a shallow dorsal projection and a much longer ventral projection of the apertural margin.

The suture of *B. texanus* sp. n. is moderately digitate and is typical of the genus in having symmetrically bifid lobes and saddles (Text-fig. 7).

REMARKS: *Baculites texanus* sp. n. closely resembles its immediate ancestor *B. taylorensis* ADKINS, 1929 (p. 204, Pl. 5, Figs 9-11; see revision in COBBAN & KENNEDY 1994, p. D6, Pl. 3; Pl. 4, Figs 5-17; Text-fig. 7) in its general appearance, but the flank ribs of *B. taylorensis* are usually much narrower and spaced farther apart. The suture of *B. taylorensis* is not quite as digitate, and the lateral lobe has a broad central area.

OCCURRENCE: *Baculites texanus* sp. n. is not a common species. It is known with certainty from the U.S. Gulf of Mexico coastal region only from the Kimbro nodule zone in the Bergstrom Formation in Travis County, Texas (USGS Mesozoic localities 15535, 16145, and 17386). The species occurs sparingly in the Western Interior in the zone of *Baculites scotti* in the Pierre Shale in South Dakota and Colorado. *Baculites texanus* also occurs in the Wenonah Formation in New Jersey.

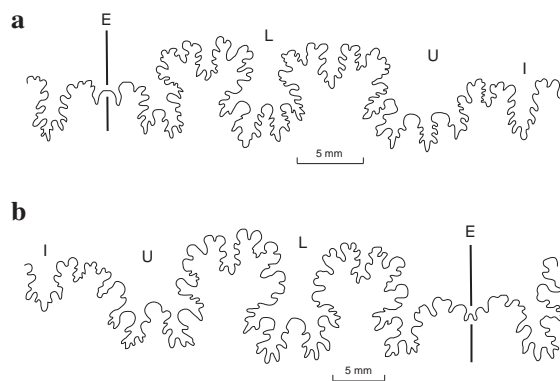


Fig. 7. Sutures of *Baculites texanus* sp. n. from the Kimbro nodule zone in the Bergstrom Formation at USGS Mesozoic locality 15535 (Text-fig. 1). **a** – Holotype, USNM 475059. **b** – Paratype, USNM 475061. **E** is external lobe, **L** is lateral lobe, **U** is umbilical lobe, **I** is internal lobe. Heavy, straight line marks middle of venter

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

TYPE SPECIES: *Trachyscaphites redbirdensis* COBBAN & SCOTT, 1964, p. E7, Pl. 1, Figs 1-7; Text fig. 3, by original designation.

*Trachyscaphites pulcherrimus* (ROEMER, 1841)  
(Text-figs 8-9)

1841. *Scaphites pulcherrimus* ROEMER, p. 91 (pars), non Pl. 14, Fig. 4.

1997. *Trachyscaphites pulcherrimus* (ROEMER, 1841); KENNEDY & KAPLAN, p. 65, Pl. 69, Fig. 1; Pl. 77, Figs. 1-5, 7-10 (with full synonymy).

TYPES: Neotype, selected by KENNEDY (1986, p. 132), is the specimen figured by SCHLÜTER (1872, Pl. 26, Figs 1-3); it is PIB 62 in the Paläontologisches Institut, Bonn.

MATERIAL: Three specimens, TMM 33433 and 37972, and USNM 475068.

DESCRIPTION: The few specimens are adults, but none is complete. Parts of the phragmocones are missing on two specimens that have estimated lengths of 53 and 68 mm (Text-fig. 9). The third specimen, USNM 475068 (not illustrated), is miss-

ing part of the body chamber but has an estimated length of 66 mm. All have narrow body chambers with concave umbilical walls when viewed from the side, and these features suggest that the specimens are microconchs. Ribs are well defined on the younger (adapertural) part of the body chamber

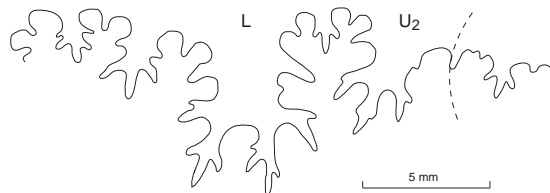


Fig. 8. Most of external suture of *Trachyscaphites pulcherrimus* (ROEMER, 1841) (USNM 475068) from the Kimbro nodule zone in the Bergstrom Formation at USGS Mesozoic locality 17386 (Text-fig. 1). L is lateral lobe, U<sub>2</sub> is second umbilical lobe. Heavy, straight line marks middle of venter. Curved, dashed line marks umbilical shoulder

but are much weaker and irregular on the older part. Five rows of tubercles are present on the phragmocones and on the younger part of the body chambers. Small, nodate siphonal tubercles are present near the aperture on USNM 475068. The suture (Text-fig. 8) is fairly simple; L is symmetrically bifid, U<sub>2</sub> is trifid, and the saddle separating L from E is broad and asymmetrically bifid.

REMARKS: The specimens from the Kimbro concretions seem typical of *T. pulcherrimus* in

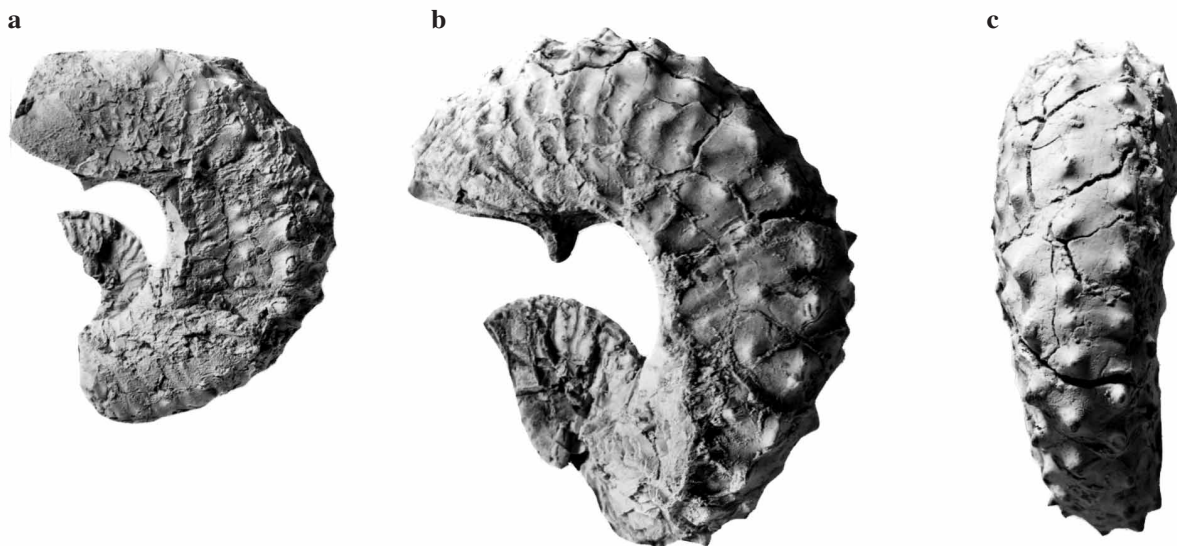


Fig. 9. *Trachyscaphites pulcherrimus* (ROEMER, 1841). a – TMM 37972; b-c – TMM 33433, from 0.6 km northwest of Kimbro, Texas

their flank ornament, but only one individual (USNM 475068) has siphonal tubercles. KENNEDY (1986) and KENNEDY & KAPLAN (1997) illustrated several good examples of the species from Europe that show rather variable development of siphonal tubercles.

**OCCURRENCE:** *Trachyscaphites pulcherrimus* is known in the United States only from the Kimbro concretion zone of the Bergstrom Formation in Texas, from the Wenonah Formation in New Jersey, and the *Baculites scotti* or *B. gregoryensis* Zone of the Gregory Member of the Pierre Shale of South Dakota. The species is confined to the zones of *Bostrychoceras polyplacum* and *Didymoceras donezianum* in the upper part of the Campanian in Europe, where that stage is divided into lower and upper substages only.

### Acknowledgments

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## PLATE 1

**1-18** – *Spiroxybeloceras kimbrowense* gen. & sp. n.

- 1-2 – **Holotype** USNM 475039, from USGS Mesozoic locality 17386
- 3-4 – Paratype USNM 475056, from USGS Mesozoic locality 15535
- 5-6 – Paratype USNM 475040, from USGS Mesozoic locality 17386
- 7-8 – Paratype USNM 475041, from USGS Mesozoic locality 17386
- 9-10 – Paratype USNM 475048, from J.P. CONLIN's locality Tr-7-Kta
- 11-12 – Paratype USNM 475049, from J.P. CONLIN's locality Tr-7-Kta
- 13-15 – Paratype USNM 475046, from USGS Mesozoic locality 17386
- 16-18 – Paratype USNM 475047, from USGS Mesozoic locality 17386

**19-22** – *Placenticerias* sp.

- 19-20 – USNM 475017, from USGS Mesozoic locality 16145
- 21-22 – USNM 475016, from USGS Mesozoic locality 15535

All figures are of natural size

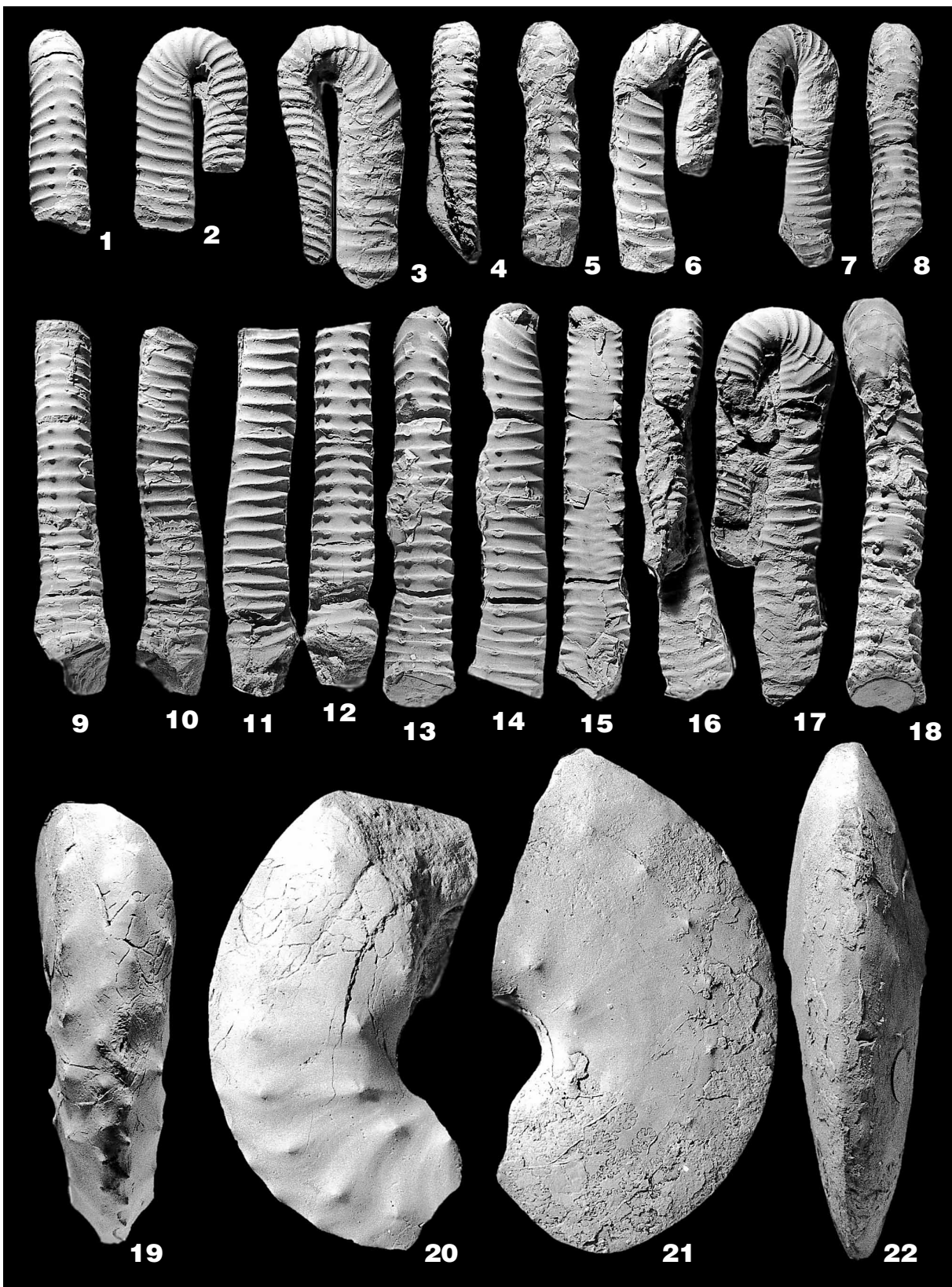




PLATE 2

**1-11** – *Didymoceras binodosum* (KENNEDY & COBBAN, 1993a)

- 1-3 – USNM 475021, from USGS Mesozoic locality 17386
- 4, 7 – USNM 475022, from J.P. CONLIN'S locality Tr-7-Kta
- 5-6 – USNM 475023, from USGS Mesozoic locality 17386
- 8-10 – USNM 475024, from USGS Mesozoic locality 15535
- 11 – USNM 475025, from USGS Mesozoic locality 17386

All figures are of natural size

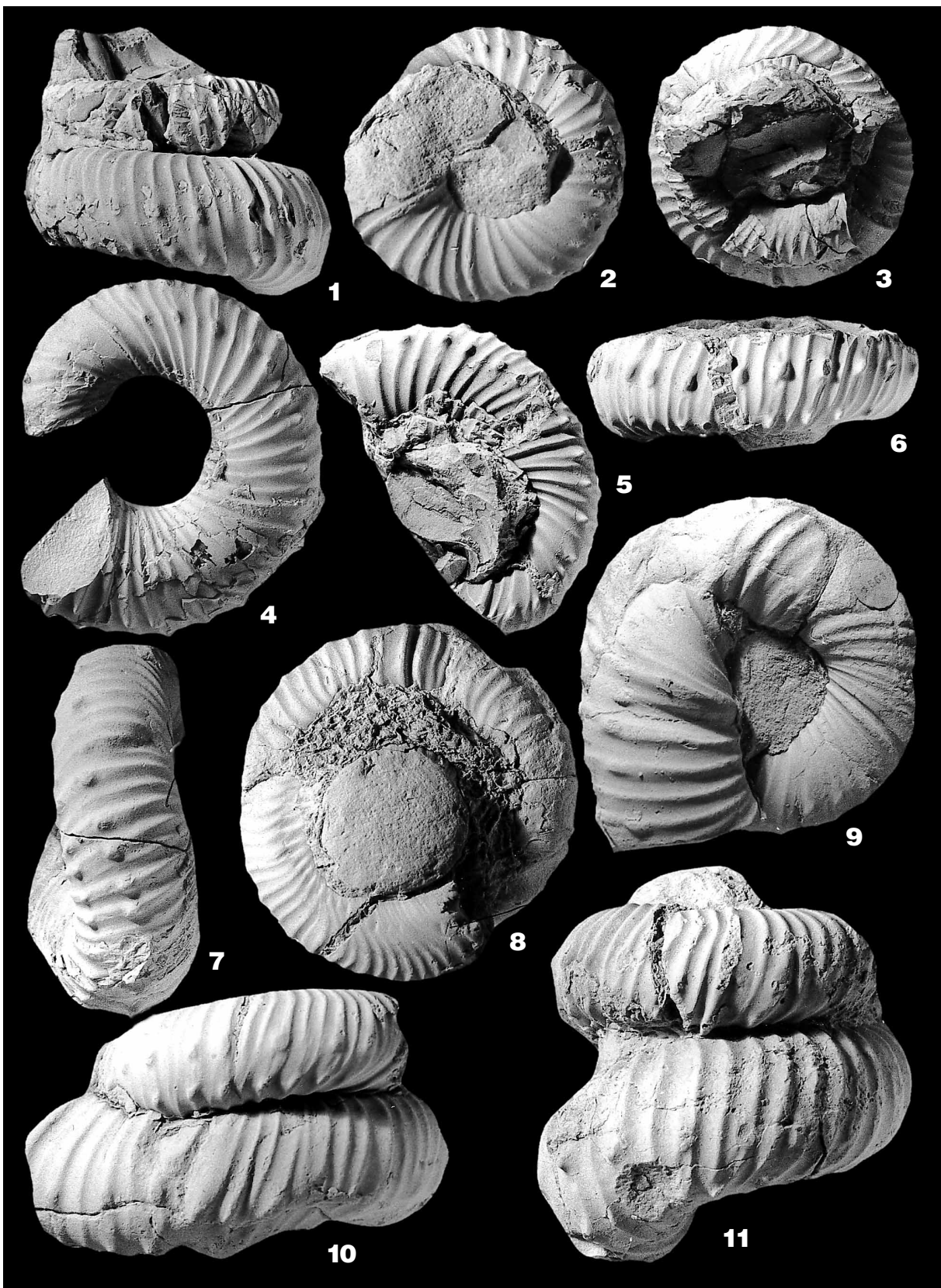


PLATE 3

**1-9** – *Didymoceras binodosum* (KENNEDY & COBBAN, 1993a)

- 1-2 – USNM 475026, from J.P. CONLIN's locality Tr-7-Kta
- 3-4 – USNM 475027, from USGS Mesozoic locality 17386
- 5-6 – USNM 475028, from USGS Mesozoic locality 17386
- 7-9 – USNM 475029, from USGS Mesozoic locality 16145

All figures are of natural size



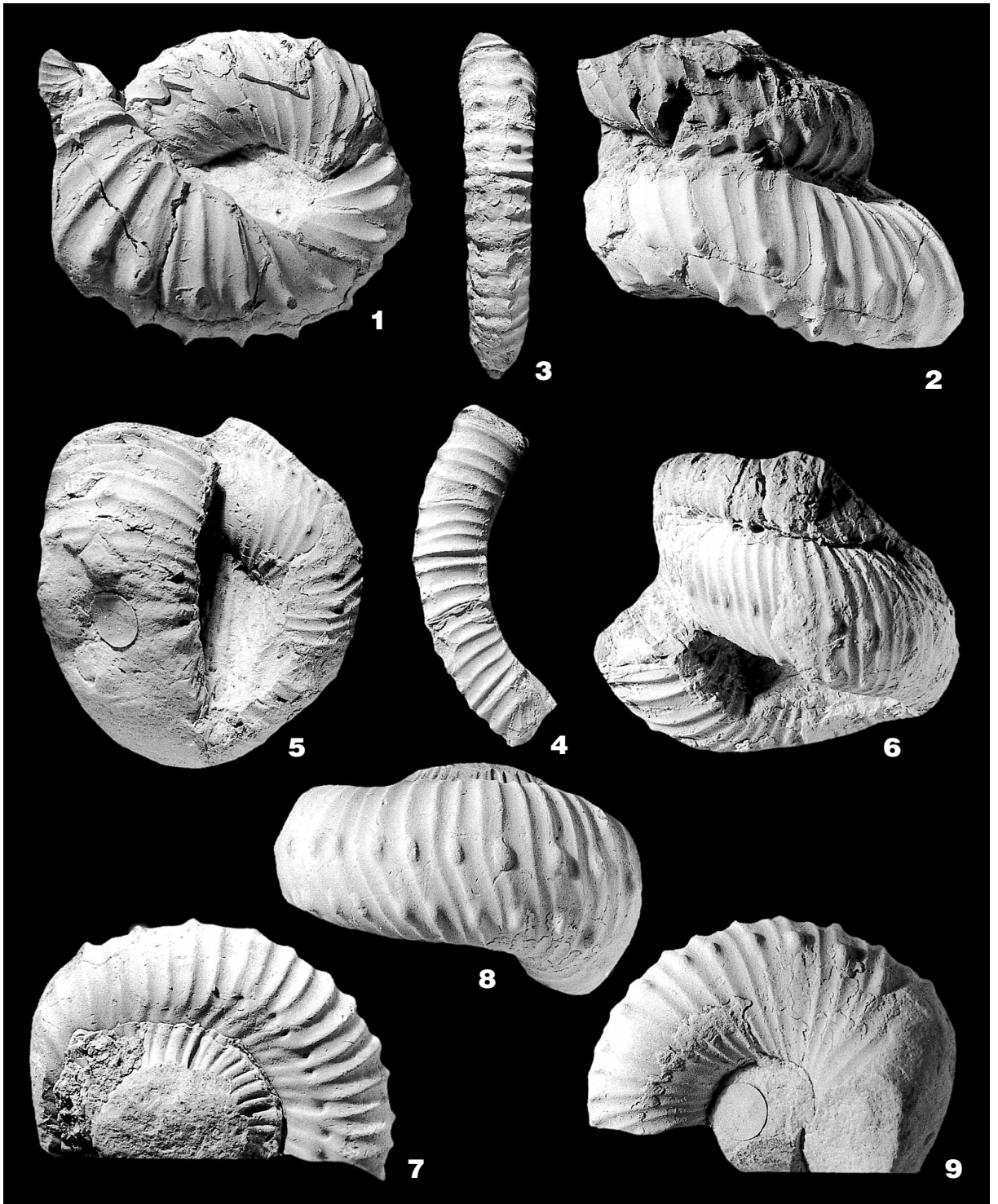




PLATE 4

**1-9** – *Didymoceras binodosum* (KENNEDY & COBBAN, 1993a)

1-3 – USNM 475030, from USGS Mesozoic locality 17386

4-5 – USNM 475031, from USGS Mesozoic locality 15535

6-9 – USNM 475032, from USGS Mesozoic locality 17386

All figures are of natural size

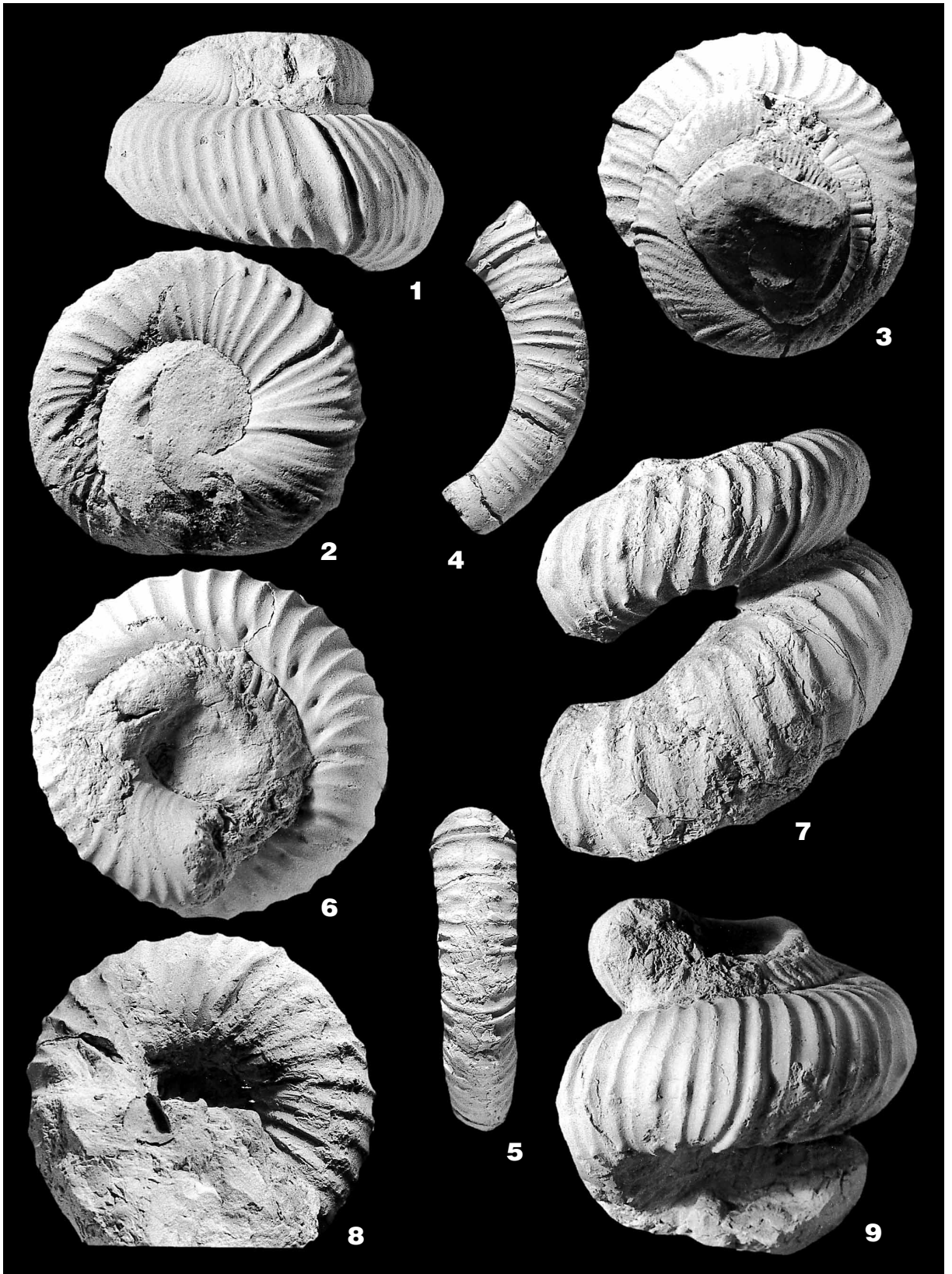


PLATE 5

**1-10** – *Spiroxybeloceras kimbrowense* gen. & sp. n., all from  
USGS Mesozoic locality 17386

- 1-2 – Paratype USNM 475042
- 3-5 – Paratype USNM 475044
- 6-8 – Paratype USNM 475043
- 9-10 – Paratype USNM 475045

**11-20** – *Didymoceras binodosum* (KENNEDY & COBBAN, 1993a)

- 11, 18 – USNM 475033, from USGS Mesozoic locality 17386
- 12 – USNM 475037, from J.P. CONLIN's locality Tr-7-Kta
- 13-14 – USNM 475035, from USGS Mesozoic locality 17386
- 15-16 – USNM 475036, from USGS Mesozoic locality 17386
- 17 – USNM 475034, from USGS Mesozoic locality 17386
- 19-20 – USNM 475020, from USGS Mesozoic locality D1412,  
in the NW1/4NW1/4 sec. 26, T. 7 S., R. 7 E., Fall River  
County, S. Dakota

All figures are of natural size



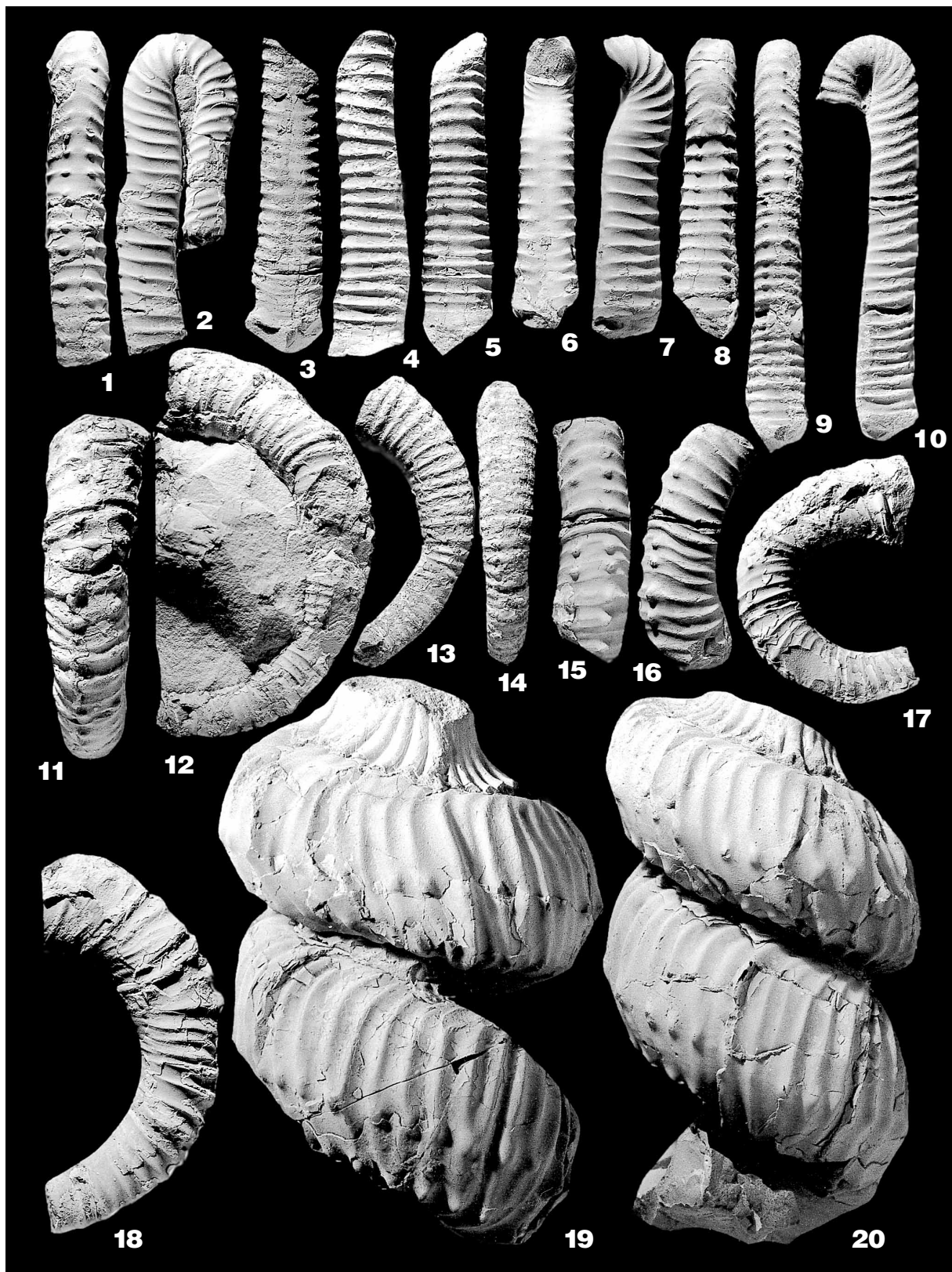




PLATE 6

**1-11** – *Baculites texanus* sp. n.

1-3 – Paratype USNM 475060, from USGS Mesozoic locality 15535

4-6 – **Holotype** USNM 475059, from USGS Mesozoic locality 15535

7-9 – Paratype USNM 475061, from USGS Mesozoic locality 15535

10-11 – Paratype USNM 475062, from USGS Mesozoic locality 16145

All figures are of natural size



PLATE 7

*Baculites texanus* sp. n.

1-3 – Paratype USNM 475064, from USGS Mesozoic locality 16145

All figures are of natural size



