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Maastrichtian Ammonites from the Severn Formation of Maryland

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ABSTRACT

The Severn Formation (Darton, 1891) is the youngest unit of Cretaceous age in Maryland, and is referred to the upper Maastrichtian *Nephrolithus frequens* nannofossil zone. This formation yields an ammonite assemblage of *Sphenodiscus lobatus* (Tuomey, 1856), *Sphenodiscus pleuriseptа* (Conrad, 1857), *Glyptoxoceras rugatum* (Forbes, 1846), *Baculites vertebralis* Lamarck, 1801, *Eubaculites latecarinatus* (Brunnschweiler, 1966), *Discoscaphites conradi* (Morton, 1834), *D. gulosus* (Morton, 1834), and *Jeletzkytes nebrascensis* (Owen, 1852). It has elements in common with the highest marine Maastrichtian *J. nebrascensis* zone of the Western Interior (*S. lobatus, D. conradi, D. gulosus,* and *J. nebrascensis*); the upper Maastrichtian of western Europe (*B. vertebralis*); and the Maastrichtian of Zululand (South Africa), Madagascar, and western Australia (*E. latecarinatus*).

INTRODUCTION

The Severn Formation (Darton, 1891) (equivalent to the Monmouth Formation, see Brouwers and Hazel, 1978; Minard, 1980; Olsson et al., 1988) is the youngest unit of Cretaceous age in Maryland (figs. 1, 2), where it rests with a marked unconformity on older Cretaceous sediments and is in turn overlain unconformably by the Paleocene Brightseat and Aquia formations and in places by the Miocene part of the Chesapeake Group or Pleistocene deposits (see reviews in Owens et al., 1977; Brouwers and Hazel, 1978; Minard, 1980). The Severn Formation is up to 14 m (42 ft) thick in outcrop and consists largely of massive, bioturbated, clayey, silty, fine to medium sand that is

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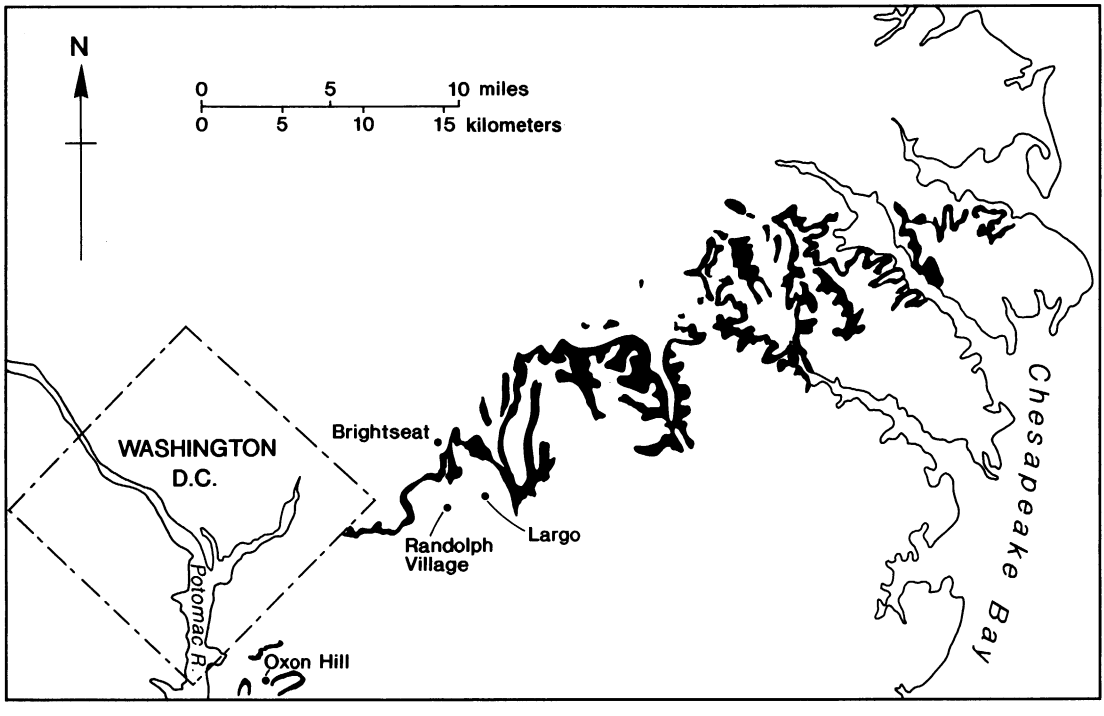

Fig. 1. Locality map showing the outcrop of the Severn Formation in the study area (after Clark, 1916).

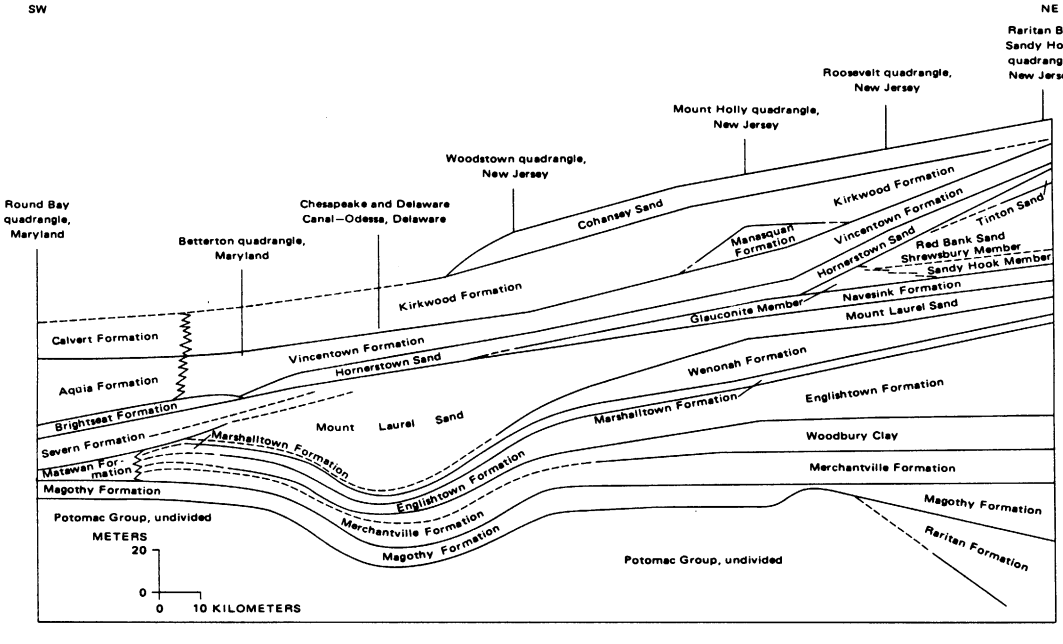

Fig. 2. Stratigraphic relationships of Cretaceous and Tertiary formations from Round Bay, Maryland, to Raritan Bay, New Jersey (from Minard, 1980).

equivalent to the Mount Laurel Sand, Navesink Formation, Red Bank Sand, and Tinton Sand of New Jersey, according to Minard (1980, table 1). The higher parts of the Severn Formation contain large calcareous concretions that are crowded with beautifully preserved molluscs retaining aragonitic shell, as well as molds. Little has been previously published about the ammonite assemblage. Gardner (1916) recorded *Sphenodiscus lobatus* (Tuomey, 1856) and *Discoscaphites conradi* (Morton, 1834), whereas Landman and Waage (1993) recorded *Jeletzkytes nebrascensis* (Owen, 1852) and *Discoscaphites gulosus* (Morton, 1834). Extensive construction and road building during the last 25 years have created a series of temporary exposures producing fossils that have added greatly to our knowledge of the assemblage of the Severn Formation, as described below.

AGE OF THE SEVERN FORMATION

The Severn Formation yields diagnostic fossils of several ages. Nannofossils from the entire Severn Formation indicate the *Nephrolithus frequens* zone (N. F. Sohl, pers. comm., 1990), zone CC26 of Perch-Nielsen (1985). This is the highest, most widely recognized Cretaceous nannofossil zone and indicates an upper upper Maastrichtian horizon equivalent to the upper part of the *Gansserina gansseri* or the *Abathomphalus mayaroensis* planktonic foraminiferal zone (Bolli et al., 1985, fig. 1). However, the index species of the *mayaroensis* zone has never been found in outcrop in the Atlantic and Gulf Coastal Province according to Brouwers and Hazel (1978), who also give details about the ostracodes and dinoflagellates. The gastropod faunas were studied by Sohl (1977: 533, text-fig. 5), who showed that the levels yielding the ammonites described below belong to his highest *Haustator bilira* gastropod assemblage zone (Sohl, 1960: 8), which is in the upper part of the *Exogyra costata* oyster zone. All these data are compatible with the evidence of the ammonite assemblage, which consists of *Sphenodiscus lobatus* (Tuomey, 1856), *S. pleurisepta* (Conrad, 1857), *Glyptoxoceras rugatum* (Forbes, 1846), *Baculites vertebralis* (Lamarck, 1801), *Eubaculites latecarinatus* (Brunnschweiler, 1966), *Discoscaphites conradi* (Morton, 1834), *D. gulosus* (Morton, 1834), and *Jeletzkytes nebrascensis* (Owen, 1852).

Of these species, only one, *Baculites vertebralis,* can be used to correlate the Severn Formation assemblage with the Northwest European succession, where this species occurs in the upper Maastrichtian *Belemnitella junior* and *Belemnella casimirovensis* zones. The presence of the co-occurring *Sphenodiscus pleurisepta, S. lobatus, Discoscaphites conradi,* and *D. gulosus* suggests a correlation with some part of the Prairie Bluff Chalk in Alabama and Mississippi (Cobban and Kennedy, 1995) and the Corsicana Formation in northeast and central Texas (Kennedy and Cobban, 1993). *S. lobatus, D. conradi, D. gulosus,* and *J. nebrascensis* occur together in the highest marine Maastrichtian of the Western Interior, the *J. nebrascensis* zone. *Eubaculites latecarinatus* is an upper, but not uppermost, Maastrichtian species in south India, western Australia, Zululand (South Africa), and Madagascar. The sum of evidence thus suggests that the Severn Formation occupies a horizon high in the Maastrichtian, but slightly below the top of the stage as shown by Brouwers and Hazel (1978, fig. 10).

CONVENTIONS

The following abbreviations indicate the repositories of specimens mentioned in the text: AMNH, American Museum of Natural History, New York; ANSP, Academy of Natural Sciences of Philadelphia, Philadelphia; BMNH, Natural History Museum, London; MAPS, Monmouth Amateur Paleontologists Society, West Long Branch, New Jersey; USNM, U.S. National Museum of Natural History, Washington, D.C. Casts of some of the specimens are retained in Denver. The suture terminology is that of Kullmann and Wiedmann (1970), with E = external lobe, L = lateral lobe, U = umbilical lobe, I = internal lobe, and L/U = saddle separating L and U. Whorl dimensions are D = diameter, Wb = whorl breadth, Wh = whorl height, and Ud = umbilical diameter. The rib index is the number of ribs occupying a distance equal to the whorl height at the midpoint of the interval counted. Arrows on photographs

indicate the adapical end of the body chamber, where preserved. Most of the specimens are photographed in the conventional position with the aperture on top although the authors recognize that the animal would have been oriented differently in life.

LOCALITIES

The following localities are mentioned in the text:

USGS Mesozoic locality 28858, Severn Formation, Central Avenue, within cloverleaf exit to Beltway (Interstate 495), Prince Georges County, Maryland.

USGS Mesozoic locality 28888, Severn Formation, excavations west of bridge on the Beltway (Interstate 495) over Central Avenue, Prince Georges County, Maryland.

USGS Mesozoic locality 29083, Severn Formation, cut on Landover Road, between the Beltway (Interstate 495) and Palmer Highway, Prince Georges County, Maryland.

USGS Mesozoic locality 32775, Severn Formation, Landover Mall, Prince Georges County, Maryland.

USGS Mesozoic locality D9716, Severn Formation, Central Avenue, Randolph Village, Prince Georges County, Maryland.

USGS Mesozoic locality D12226, Severn Formation, excavations for shopping center on south side of Central Avenue just west of the Beltway (Interstate 495), Randolph Village, Prince Georges County, Maryland.

SYSTEMATIC PALEONTOLOGY

ORDER AMMONOIDEA ZITTEL, 1884

SUBORDER AMMONITINA HYATT, 1889

SUPERFAMILY ACANTHOCERATACEAE DE GROSSOUVRE, 1894

FAMILY SPHENODISCIDAE HYATT, 1900

Genus *Sphenodiscus* Meek, 1871

TYPE SPECIES: *Ammonites lenticularis* Owen, 1852: 579 (non Young and Bird, 1828: 269, fig. 5), by original designation, = *Ammonites lobata* Tuomey, 1856: 168.

Sphenodiscus lobatus (Tuomey, 1856)

Figures 3–8, 9A–I, 10

Ammonites lenticularis Owen, 1852: 579, pl. 8, fig. 5.

Ammonites lobata Tuomey, 1856: 168.

Sphenodiscus lobatus (Tuomey, 1856). Cobban and Kennedy, 1995: 12, figs. 6.2, 6.3, 8.4, 8.6–8.11, 12.18, 12.19, 16.16, 16.17 (with full synonymy).

TYPE: The holotype, from Noxubee County, Mississippi, is lost (fide Stephenson, 1941: 434).

MATERIAL: There are more than 30 specimens in the AMNH, MAPS, USGS, and USNM collections.

DESCRIPTION: Juveniles have an oxyconic shell with a ratio of whorl breadth to whorl height of approximately 0.35 (table 1), and an acute venter that extends to the beginning of the adult body chamber. Phragmocones attain approximately 320 mm in diameter. Internal molds are smooth or bear low, distant folds or sickle-shaped striae and riblets on the outer flank. Where the shell is preserved, ornament consists of delicate falcoid growth lines. The suture (figs. 9A–I, 10) has a trifid first lateral saddle, and up to 10 auxiliary saddles on the umbilical lobe, eight of which may have entire terminations; the remaining saddles are subdivided to varying degrees, some broad-stemmed and little incised, and others narrow-necked and subphylloid.

DISCUSSION: The great majority of *Sphenodiscus* from the Severn Formation match the above description. The sutures show wide variation, and seem to be of little taxonomic value. Consequently, we place in synonymy the various smooth or near-smooth North American *Sphenodiscus* of Maastrichtian age, including *S. lenticularis intermedius, S. lenticularis mississippiensis, S. beecheri, S. stantoni, S. lobatus allisonensis,* and *S. tirensis,* as discussed elsewhere (Cobban and Kennedy, 1995). The presence of two rows of flank tubercles easily distinguishes *S. pleurisepta* (Conrad, 1857), described below.

Less easily resolved is the relationship between *S. lobatus* and the earliest named smooth *Sphenodiscus siva* (Forbes, 1846) (p. 110, pl. 7, fig. 6) (see revision in Kennedy and Henderson, 1992a: 434, pl. 15, figs. 6–13, text-figs. 6b, d–e), from the upper Maas-

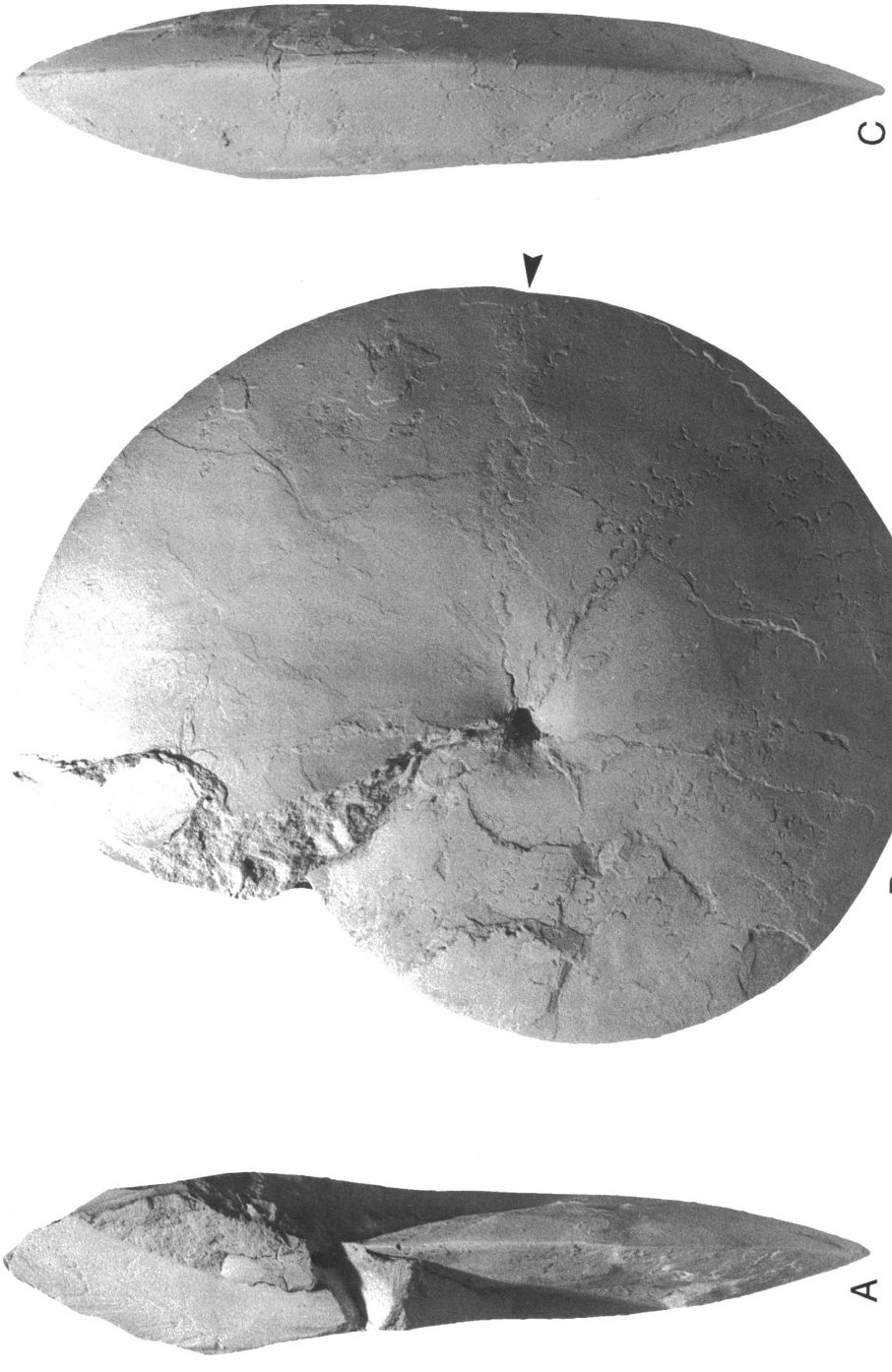

Fig. 3. *Sphenodiscus lobatus* (Tuomey, 1856), MAPS A2002d1, Severn Formation, Largo, Prince Georges County, Maryland. **A,** Apertural; **B,** right lateral; **C,** ventral. All figures are ×1.

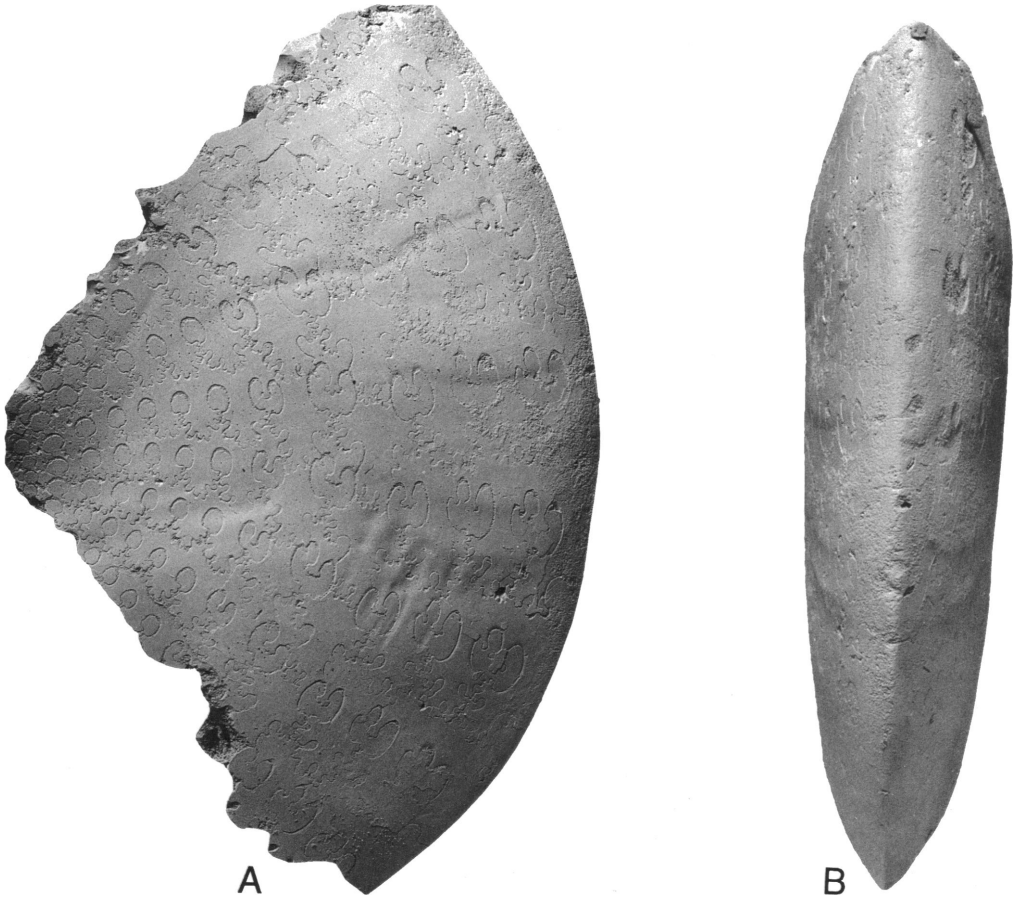

Fig. 4. *Sphenodiscus lobatus* (Tuomey, 1856), USNM 486445, Severn Formation, USGS Mesozoic locality D9716. **A,** Right lateral; **B,** ventral. All figures are ×1.

trichtian Valudavur Formation of Pondicherry, south India. The species *S. siva* is based on two syntypes; at diameters of 64 and 65 mm, they have a ratio of whorl breadth to whorl height of 0.38. The surface of the shell is smooth except for delicate prorsiradiate growth lines, which are only conspicuous near the umbilical margin. E is broad and shallower than L, which is asymmetrically trifid, and is flanked by saddles with slender axial zones and phylloid terminations. The five outer saddles are denticulate in the suture illustrated by Kossmat (1895: pl. 22, fig. 2), with five entire terminations on the umbilical lobe. The combination of narrow stems and deep incision of the saddles does not find a precise match in the specimens from the Severn Formation, but sutures are so variable in the American material that this may be of no consequence. The Indian specimens are too small and too few to permit use of the specific name *siva* for the American material with any degree of confidence; we keep them separate at this time.

Equally difficult to establish is the relationship between *S. lobatus* and *S. binkhorsti* (Böhm, 1898) (see revision in Kennedy, 1987: 177, pl. 16, fig. 23; pl. 17, figs. 1, 2; pl. 18, figs. 1–4, 6, 7; pl. 19, figs. 5, 6; pl. 20, figs. 1, 6–8; pl. 30, figs. 10–12; text-fig. 8a–c), from the upper Maastrichtian of western Europe. The lectotype of *S. binkhorsti* has a ratio of whorl breadth to whorl height of 0.37 at a diameter of 73 mm; a larger specimen 158 mm in diameter has a ratio of whorl breadth to whorl height of 0.30. Most specimens are smooth internal molds; a few show faint radial striae, especially on the body chamber,

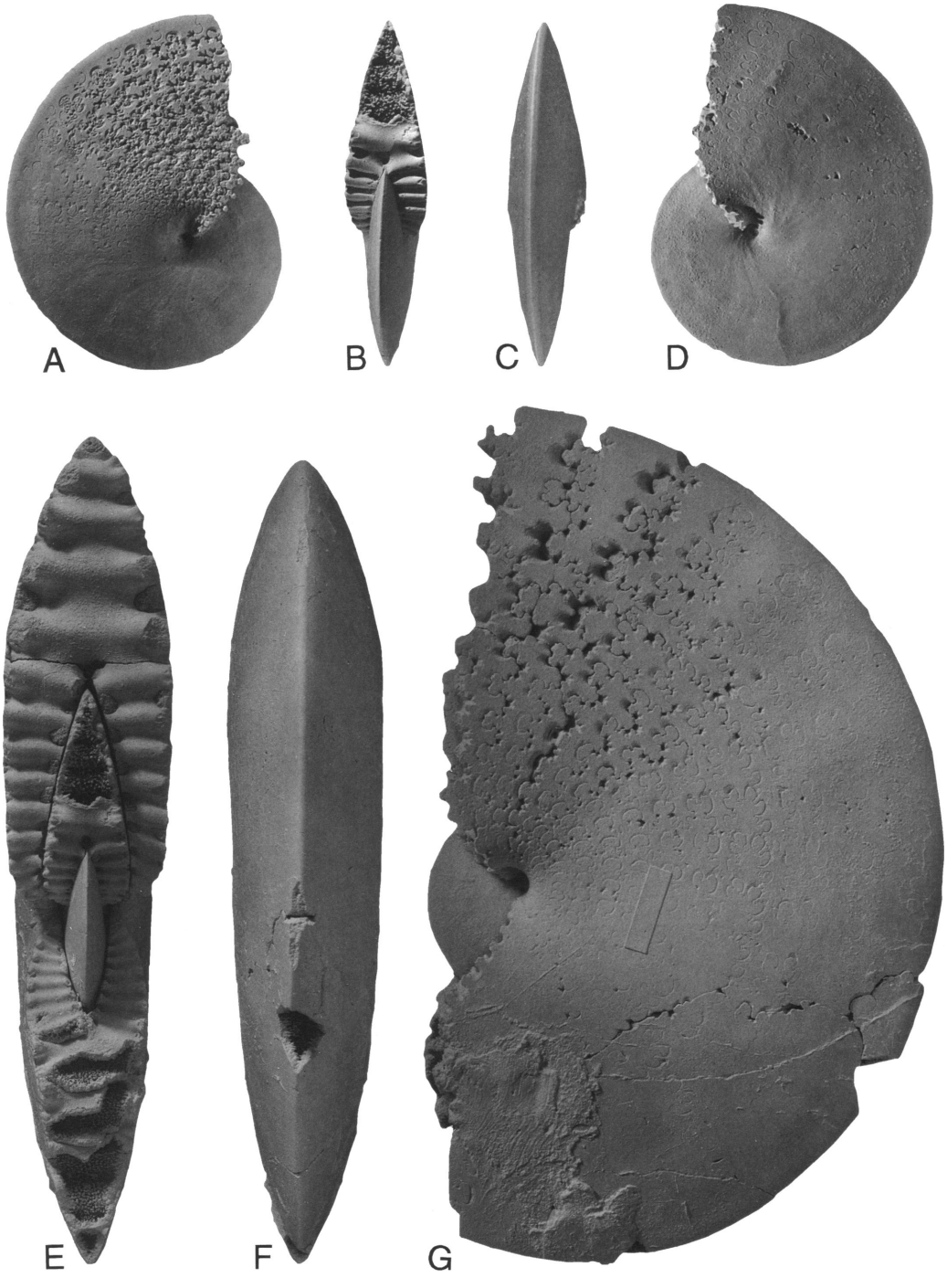

Fig. 5. *Sphenodiscus lobatus* (Tuomey, 1856), USNM 494875, Severn Formation, USGS Mesozoic locality 28858. **A–D.** Inner whorls. **A,** Left lateral; **B,** apertural; **C,** ventral; **D,** right lateral. **E–G.** Outer whorls. **E,** Apertural; **F,** ventral; **G,** right lateral. All figures are ×1.

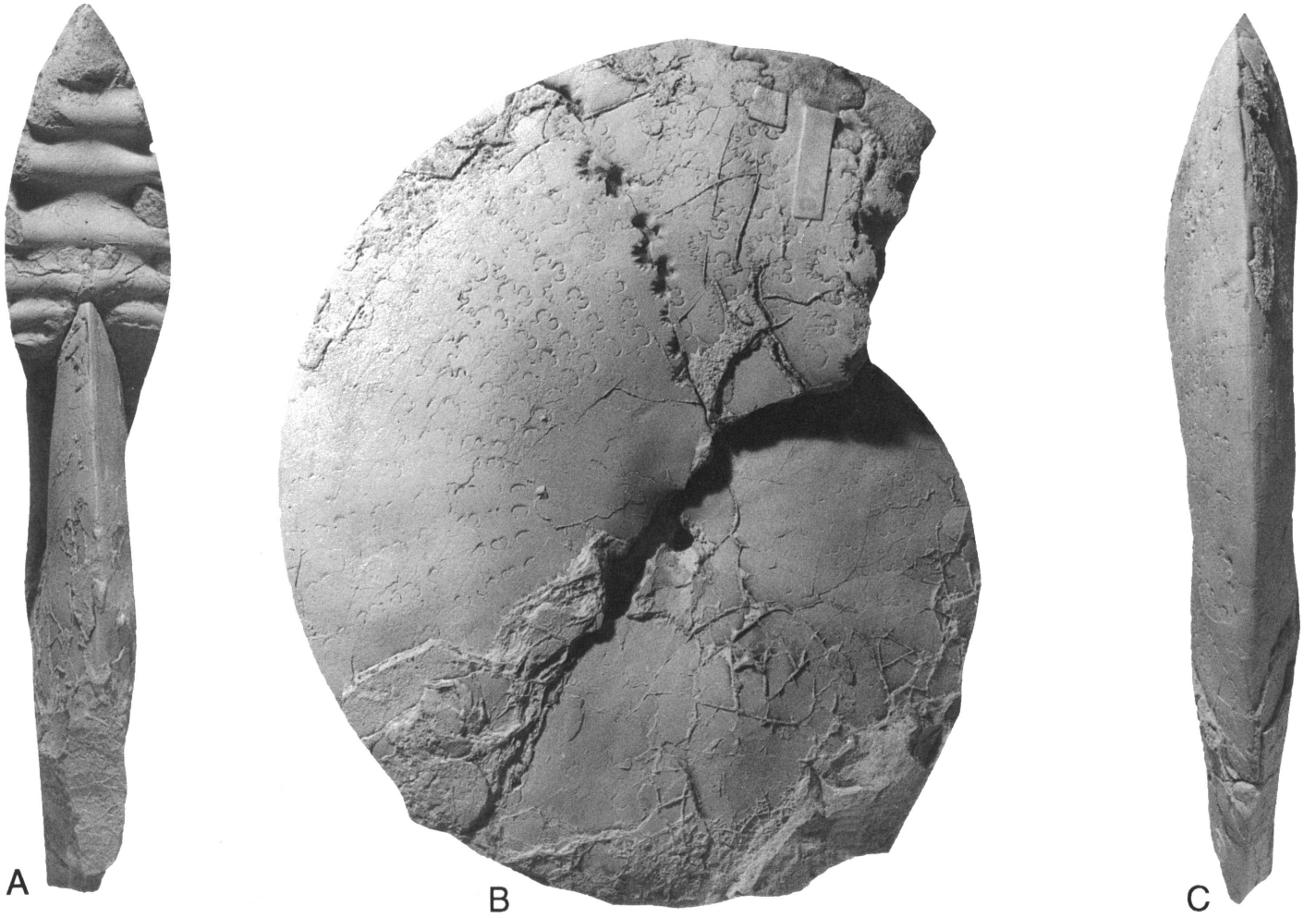

Fig. 6. *Sphenodiscus lobatus* (Tuomey, 1856), MAPS A2002d2, Severn Formation, excavation for sports arena just east of the Beltway (Interstate 495), 1.5 km northwest of Largo, Prince Georges County, Maryland. **A,** Apertural; **B,** left lateral; **C,** ventral. All figures are ×1.

TABLE 1
Dimensions (mm) of *Sphenodiscus lobatus* (Tuomey, 1856)[a]

Specimen	D	Wb	Wh	Wb:Wh	Ud
MAPS A2002d4	51.8	10.4 (20.1)	31.4 (60.6)	0.33	2.3 (4.4)
MAPS A2002d3	100.2	20.4 (20.4)	55.0 (54.9)	0.37	3.0 (3.0)
MAPS A2002d1	119.1	22.3 (18.7)	67.6 (56.8)	0.33	4.0 (3.4)
MAPS A2002d2	125.5	24.3 (19.4)	68.6 (54.7)	0.35	3.9 (3.1)
MAPS A2002d7	199.0[b]	38.7 (19.4)[b]	112.3 (56.4)[b]	0.34[b]	7.6 (3.8)[b]
MAPS A2002b6	317.5[b]	82.2 (25.9)[b]	180.0 (56.7)[b]	0.46[b]	9.6 (3.0)[b]
USNM 28858	124.2	24.9 (20.0)	68.4 (55.1)	0.36	5.1 (4.1)[b]
AMNH 45396	309.5[b]	67.0 (21.6)[b]	177.0 (57.2)[b]	0.38[b]	8.6 (2.8)[b]

[a] D = diameter; Wb = whorl breadth; Wh = whorl height; Ud = umbilical diameter. Figures in parentheses are dimensions as a percentage of diameter.
[b] Estimate.

TABLE 2
Dimensions (mm) of *Sphenodiscus pleurisepta* (Conrad, 1857)[a]

Specimen	D	Wb	Wh	Wb:Wh	Ud
USNM 486449	130.2	26.3 (20.2)	68.3 (52.4)	0.38	8.0 (6.1)
MAPS A2049b2	121.6	22.6 (18.6)[b]	65.7 (54.0)	0.34	7.2 (5.9)
MAPS A2049a1	140.0	32.2 (23.0)	75.4 (53.8)	0.43	8.9 (6.4)

[a] D = diameter; Wb = whorl breadth; Wh = whorl height; Ud = umbilical diameter. Figures in parentheses are dimensions as a percentage of diameter.
[b] Estimate.

and occasional crescentic folds on the outer flank. As with *S. siva, S. binkhorsti* may be conspecific with *S. lobatus,* but there is not enough material to be certain.

OCCURRENCE: Escondido Formation in Trans-Pecos Texas and northern Mexico; Corsicana Formation in northeast Texas; upper part of Ripley Formation in Mississippi; Prairie Bluff Chalk in Alabama and Mississippi; Providence Sand in the Chattahoochee River area, Alabama and Georgia; upper part of Peedee Formation in North Carolina; Severn Formation in Maryland; and Red Bank Sand and Tinton Sand in New Jersey. In the Western Interior the species occurs in the *Hoploscaphites nicolletii* and *Jeletzkytes nebrascensis* zones, and may also be present in the underlying *H. birkelundi* zone.

Sphenodiscus pleurisepta (Conrad, 1857)

Figures 9J, 11–14

Ammonites pleurisepta Conrad, 1857: 159, pl. 15, fig. 1.
Sphenodiscus pleurisepta (Conrad, 1857). Cobban and Kennedy, 1995: 12, fig. 8.5 (with full synonymy).
Sphenodiscus pleurisepta (Conrad, 1857). Kennedy et al., 1996: 11, figs. 4A, 5–12.

TYPE: The holotype is USNM 9888, said to be from "Jacun, 3 miles below Laredo," but probably from the Escondido Formation of the Rio Grande region, probably Maverick County, Texas (Stephenson, 1941, 1955).

MATERIAL: There are three specimens in the MAPS and USNM collections.

DESCRIPTION: MAPS A2049b2 (fig. 11) is an entirely septate oxycone 121.6 mm in diameter with a ratio of whorl breadth to whorl height of 0.34. The shallow umbilicus comprises 5.9% of the diameter with a low wall and narrowly rounded umbilical shoulder. The greatest whorl breadth is just outside midflank. The inner flanks are feebly concave, the inner parts of the outer flanks are broadly convex, and the outermost flanks are convergent with a bluntly acute venter. Eight midlateral bullae are present at the smallest visible diameter, but decline and efface on

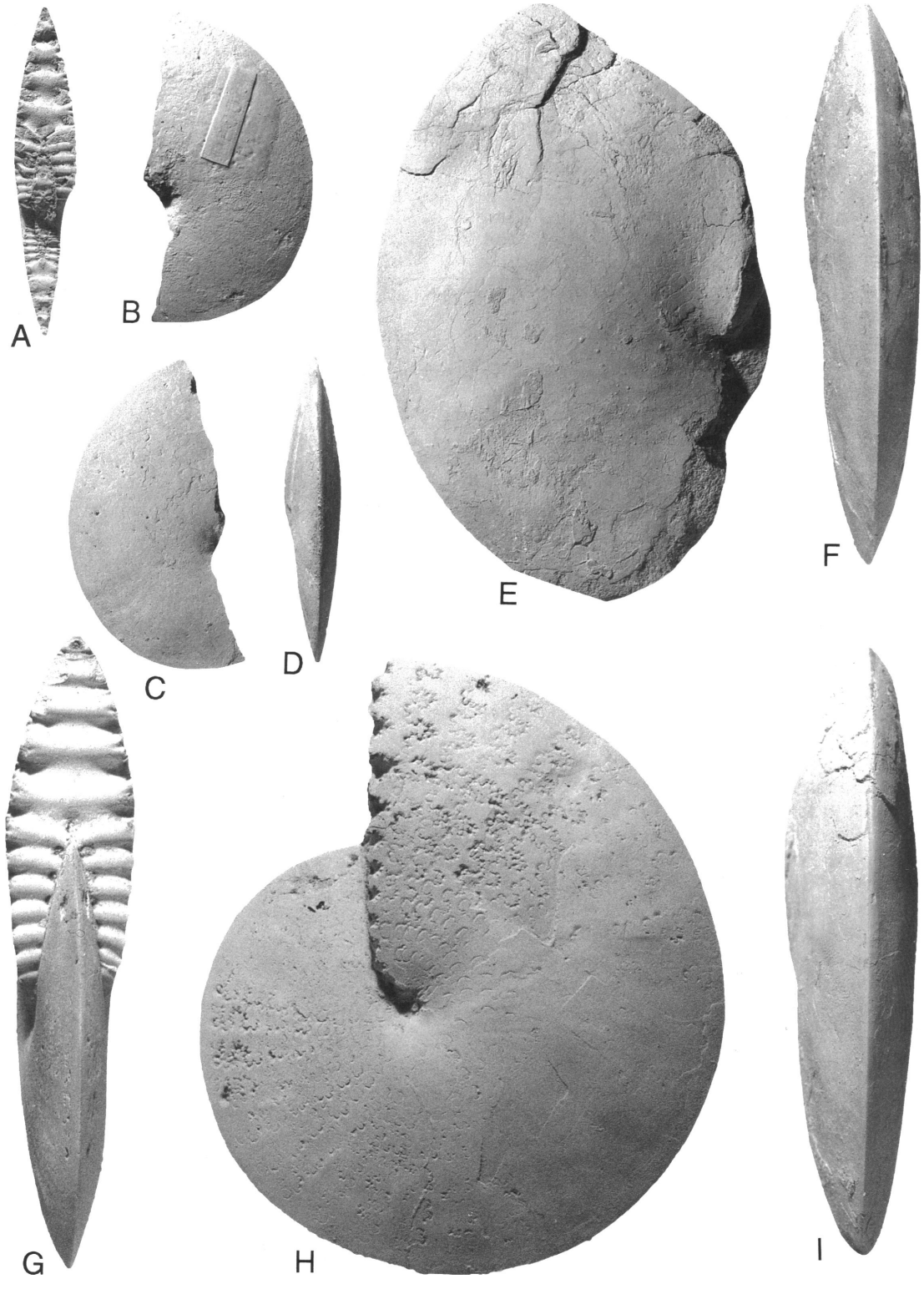
A
B
C
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Fig. 8. *Sphenodiscus lobatus* (Tuomey, 1856), AMNH 45396, right lateral, Severn Formation, exposures behind shopping center on south side of Central Avenue, just west of the Beltway (Interstate 495), Randolph Village, Prince George County, Maryland. Figure is ×0.54 (actual diameter is 309.5 mm).

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Fig. 7. *Sphenodiscus lobatus* (Tuomey, 1856), **A–D.** MAPS A2002d4, Severn Formation, Largo, Prince Georges County, Maryland. **A,** Apertural; **B,** right lateral; **C,** left lateral; **D,** ventral. **E, F.** MAPS A2002b5, Severn Formation, exposures behind shopping center on south side of Central Avenue, just west of the Beltway (Interstate 495), Randolph Village, Prince Georges County, Maryland. **E,** Left lateral; **F,** ventral. **G–I.** MAPS A2002d3, Severn Formation, Largo, Prince Georges County, Maryland. **G,** Apertural; **H,** right lateral; **I,** ventral. All figures are ×1.

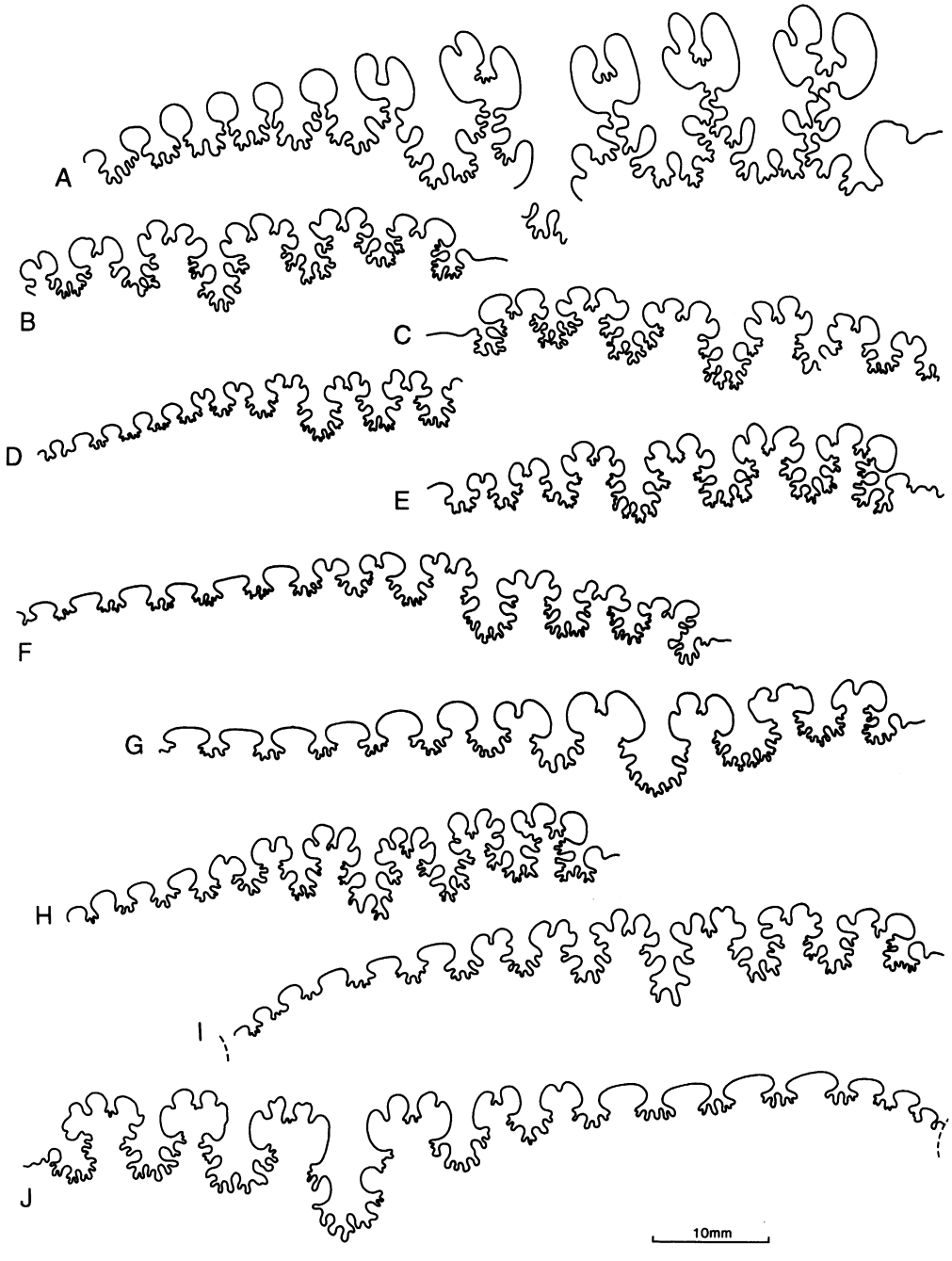


Fig. 9. **A–I.** Sutures of *Sphenodiscus lobatus* (Tuomey, 1856). **A.** USNM 486445, Severn Formation, USGS Mesozoic locality D9716. **B–D.** MAPS A2002d1, Severn Formation, Largo, Prince Georges County, Maryland. **E.** USNM 486446, Severn Formation, USGS Mesozoic locality D12226. **F, H, I.** MAPS A2002d3, Severn Formation, Largo, Prince Georges County, Maryland. **G.** USNM 486447, Severn Formation, USGS Mesozoic locality D9716. **J.** Suture of *Sphenodiscus pleurisepta* (Conrad, 1857), USNM 486449, Severn Formation, tributary to Cattail Brook, 1 km (0.6 mi) southwest of intersection of Sheriffs and Brightseat roads, Brightseat, Prince Georges County, Maryland.

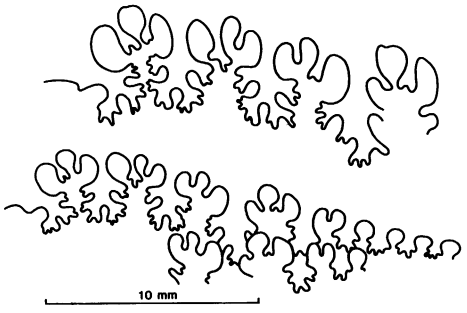


Fig. 10. Sutures of *Sphenodiscus lobatus* (Tuomey, 1856), MAPS A2002d4, Severn Formation, Largo, Prince Georges County, Maryland.

the succeeding half whorl. Each bulla is linked to the umbilical wall via a low broad rib that weakens to a mere stria at the umbilical shoulder. One or two low, broad, concave prorsiradiate ribs arise from each midlateral bulla and extend across the outer flank. At the smallest visible diameter, they strengthen into outer lateral bullae, from which ribs sweep forward over the outer flank and decline towards the venter. Outer lateral bullae assimilate into the ribs as size increases, and the last half whorl is ornamented by 10 low, broad, sickle-shaped ribs; the straight "hafts" of the sickles are weak on the innermost flanks, but strengthen at midflank; the concave "blade" is broad and

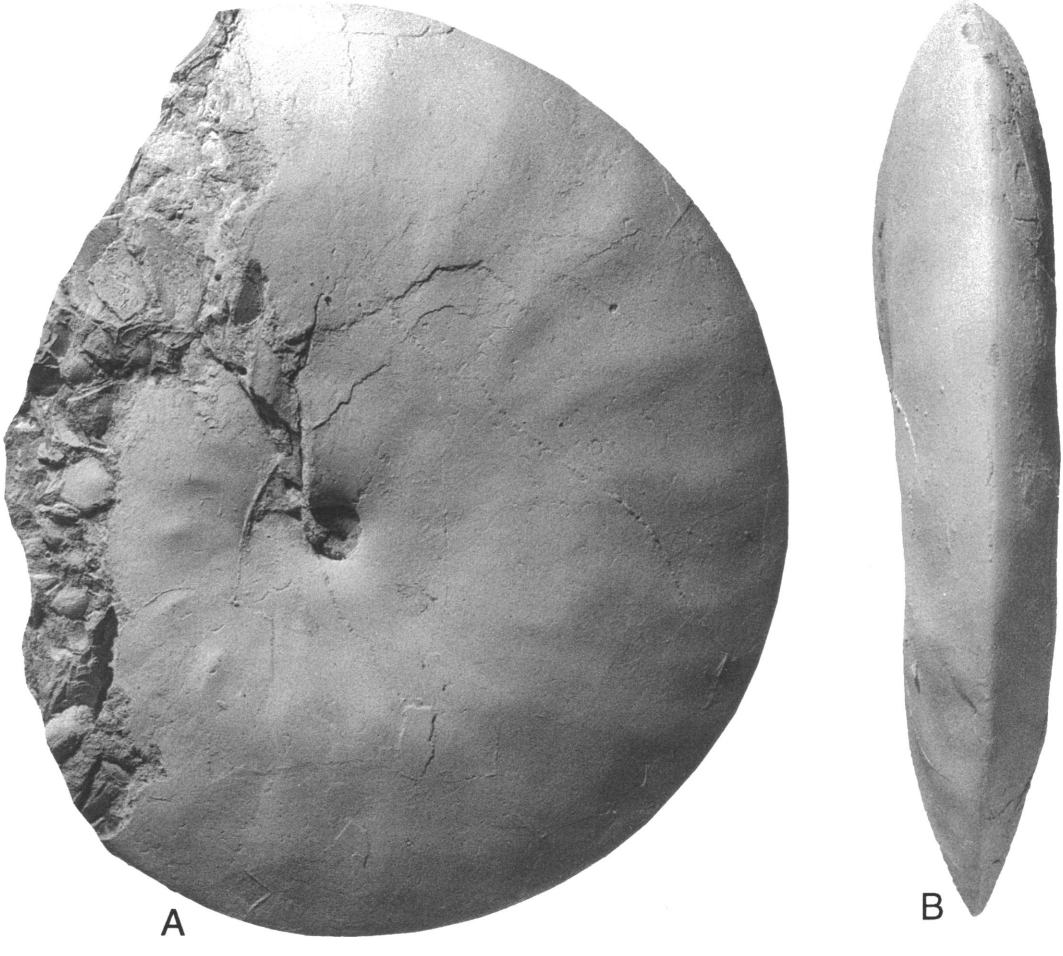


Fig. 11. *Sphenodiscus pleurisepta* (Conrad, 1857), MAPS A2049b2, Severn Formation, Largo, Prince Georges County, Maryland. **A,** Right lateral; **B,** ventral. All figures are ×1.

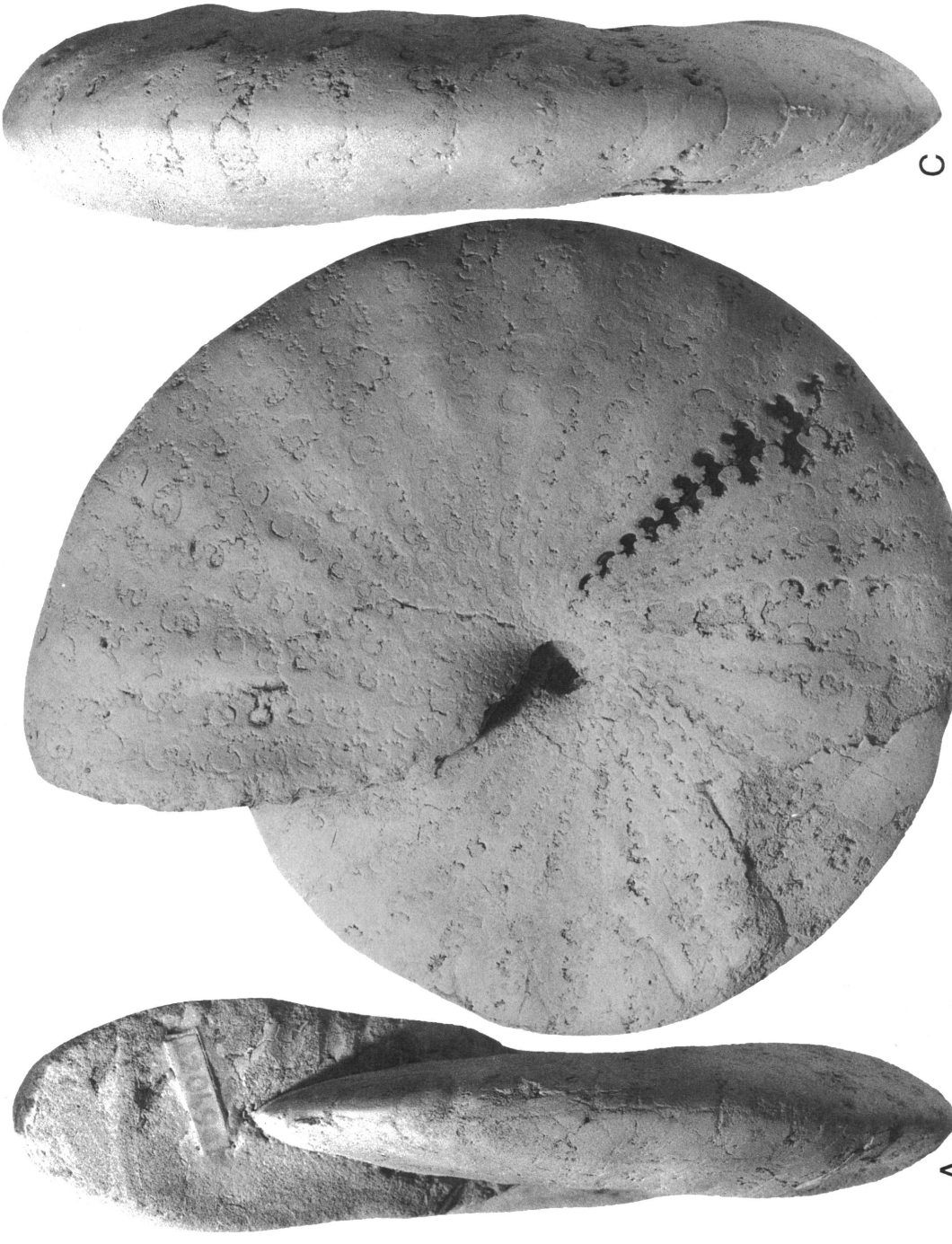


Fig. 12. *Sphenodiscus pleurisepta* (Conrad, 1857), MAPS A2049a1, Severn Formation, Oxon Hill, Prince Georges County, Maryland. **A,** Apertural; **B,** right lateral; **C,** ventral. All figures are ×1.

Fig. 13. *Sphenodiscus pleurisepta* (Conrad, 1857), USNM 486449, Severn Formation, tributary to Cattail Brook, 1 km (0.6 mi) southwest of intersection of Sherriffs and Brightseat roads, Brightseat, Prince Georges County, Maryland. **A,** Ventral; **B,** left lateral. All figures are ×1.

strong on most of the outer flank but declines markedly near the venter.

MAPS A2049a1 (fig. 12) is a completely septate internal mold 140 mm in diameter that is even stouter than the previous specimen (MAPS A2049b2). The whorl section is lanceolate initially but broadens as size increases so that the ratio of whorl breadth to whorl height ultimately attains 0.43. The umbilical shoulder is narrowly rounded, the inner flanks are concave, and the outer flanks are convex. Ornament on the outer whorl consists of coarse, distant, feebly concave folds, 18 per half whorl, which strengthen at the inner and outer ends into weak bullae. USNM 486449 (fig. 13) also seems to belong here, although it is less obviously binodose.

The suture (figs. 9J, 14) is variable, even within the same specimen (compare figs. 14A and C), with both broad and narrow-stemmed saddles; terminations are variably incised and commonly phylloid. As many as 10 entire adventitious saddles are present on the umbilical lobe.

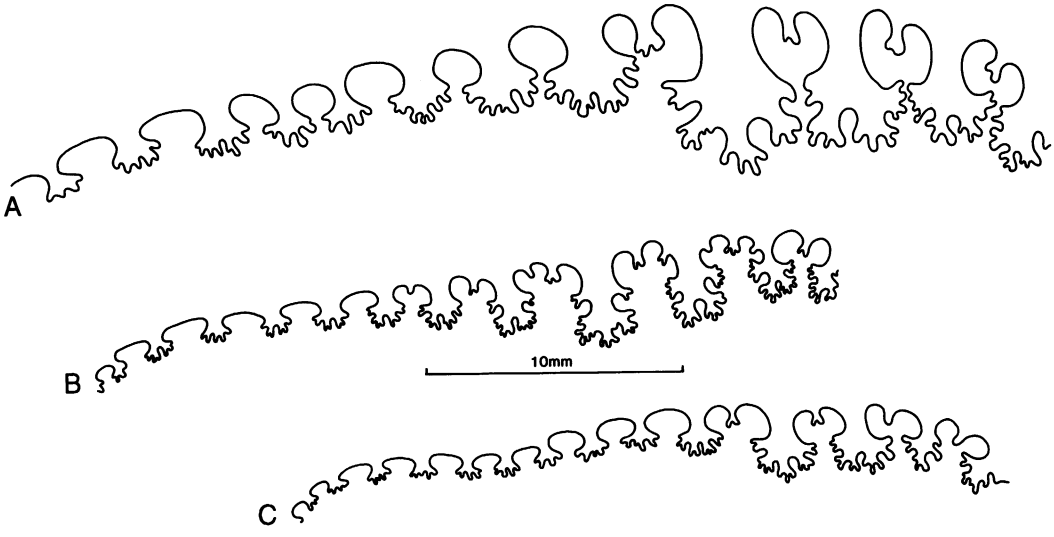


Fig. 14. Sutures of *Sphenodiscus pleurisepta* (Conrad, 1857). **A, C.** MAPS A2049a1, Severn Formation, Oxon Hill, Prince Georges County, Maryland. **B.** MAPS A2049b2, Severn Formation, Largo, Prince Georges County, Maryland.

DISCUSSION: Two rows of flank tubercles, plus the much stouter whorl section, distinguish this species from *S. lobatus.*

OCCURRENCE: Escondido Formation in Trans-Pecos Texas and northern Mexico; Corsicana Formation in northeast Texas; Prairie Bluff Chalk in Mississippi and Alabama; Owl Creek Formation in Missouri, Mississippi, and Tennessee; Severn Formation in Maryland; *Baculites clinolobatus* zone, Pierre Shale in Colorado; *Hoploscaphites birkelundi* zone, Fox Hills Formation in Colorado and Wyoming.

SUBORDER ANCYLOCERATINA WIEDMANN, 1966

SUPERFAMILY TURRILITACEAE GILL, 1871

FAMILY DIPLOMOCERATIDAE SPATH, 1926

SUBFAMILY DIPLOMOCERATINAE SPATH, 1926

Genus *Glyptoxoceras* Spath, 1925

TYPE SPECIES: *Hamites rugatus* Forbes, 1846: 116, pl. 11, fig. 6, by original designation.

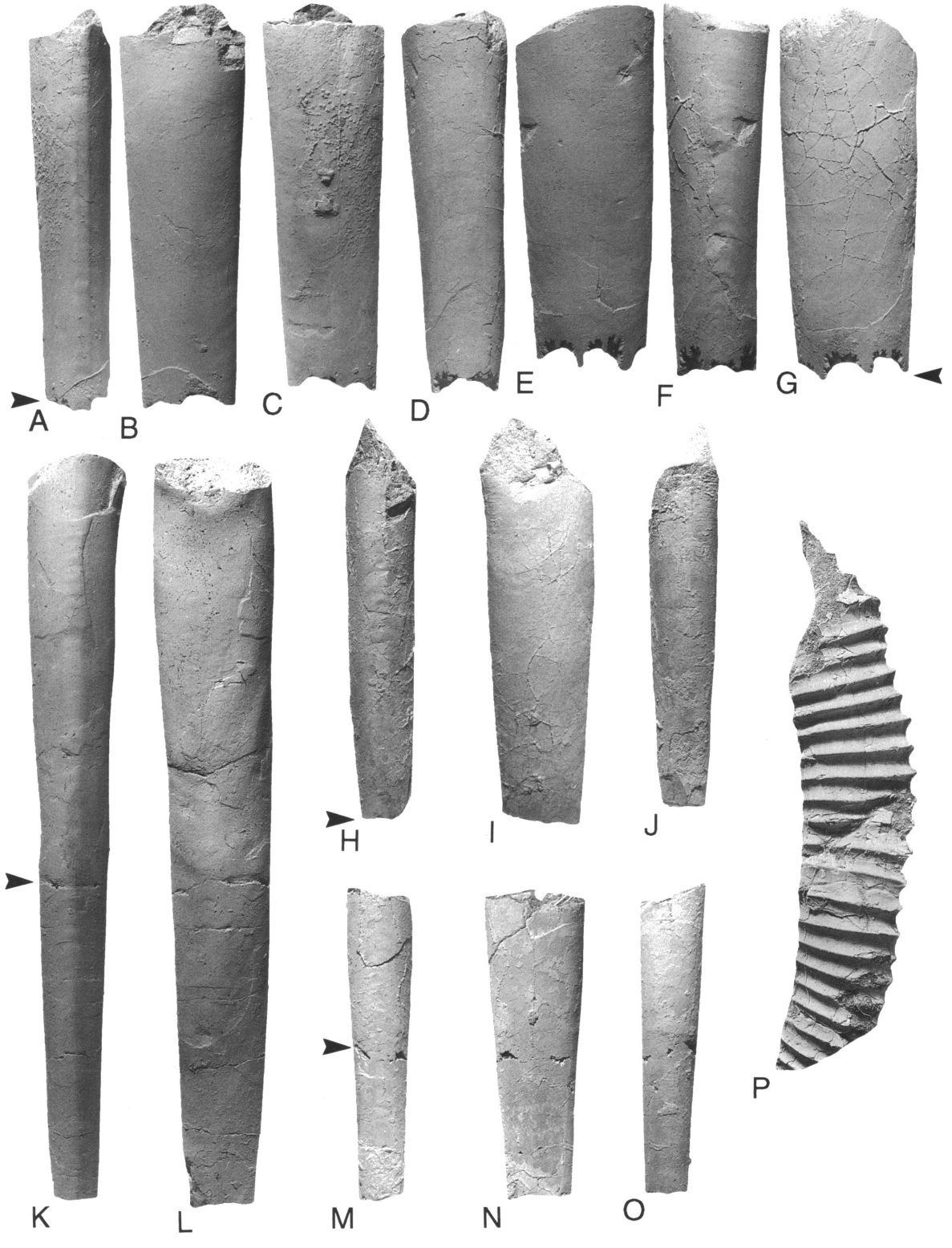
Glyptoxoceras rugatum (Forbes, 1846)

Figure 15P

Hamites subcompressus Forbes, 1846: 116, pl. 11, fig. 6.
Hamites subcompressus D'Orbigny, 1850: 216.
Hamites rugatus Forbes, 1846: 117, pl. 11, fig. 2.
Hamites rugatus Forbes. D'Orbigny, 1850: 216.
Hamites nereis Forbes, 1846: 117, pl. 10, fig. 7.
Hamites nereis Forbes. D'Orbigny, 1850: 216.
Glyptoxoceras rugatum (Forbes, 1846). Henderson et al., 1992: 145, figs. 8–13 (with full synonymy).

→

Fig. 15. **A–D, K, L.** *Eubaculites latecarinatus* (Brunnschweiler, 1966). **A–D.** MAPS A2053a1, Severn Formation, excavation for sports arena just east of the Beltway (Interstate 495), 1.5 km northwest of Largo, Prince Georges County, Maryland. **A,** Ventral; **B,** left lateral; **C,** right lateral; **D,** dorsal. **K, L.** MAPS A2053a2, same horizon and locality as **A–D. K,** Ventral; **L,** right lateral. **E–J, M–O.** *Baculites vertebralis* Lamarck, 1801. **E–G.** MAPS A2035b3, same horizon and locality as **A–D. E,** Left lateral; **F,** ventral; **G,** right lateral. **H–J.** USNM 486452, USGS Mesozoic locality D9716. **H,** Ventral; **I,** right lateral; **J,** dorsal. **M–O.** USNM 486450, Severn Formation, USGS Mesozoic locality D9716. **M,** Ventral; **N,** left lateral; **O,** dorsal. **P.** *Glyptoxoceras rugatum* (Forbes, 1846), USNM 486448, upper 30 cm of Severn Formation, behind Hampton Mall Shopping Center, southwest corner of intersection of Beltway (Interstate 495) and Central Avenue, Prince Georges County, Maryland. All figures are ×1.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Glyptoxoceras rugatum (Forbes, 1846). Kennedy and Henderson, 1992b: 695, pl. 1, figs. 1, 2, 5–16; pl. 2, figs. 10, 11, 14–29; pl. 3, figs. 1–3; pl. 4, figs. 2, 12–15; text-fig. 1a, e (with additional synonymy).

TYPE: Lectotype, designated by Kennedy and Henderson (1992b) is BMNH C51110, the original of Forbes (1846: pl. 11, fig. 2) from the Valudavur Formation of Pondicherry, south India.

MATERIAL: There is one well-preserved fragment of a body chamber that retains its original shell.

DESCRIPTION: USNM 486448 is a slightly crushed, gently curved fragment 92 mm long with a maximum whorl height of 20.3 mm. The whorl section is elliptical. Ornament consists of narrow, sharp, rectiradiate, single ribs that are narrower than the interspaces; the rib index is 5.

DISCUSSION: USNM 486448 matches the south Indian type material of *G. rugatum* as well as comparable-sized fragments from Western Australia described by Henderson et al. (1992). See Kennedy and Henderson (1992b) and Henderson et al. (1992) for a full account of this species and its synonyms, plus differences from other species.

OCCURRENCE: Maastrichtian, Severn Formation in Maryland; south India; Brazil; Chile(?); Western Australia; northern Spain; southeast France; and the Maastricht area in The Netherlands and Belgium.

FAMILY BACULITIDAE GILL, 1871

Genus *Baculites* Lamarck, 1799

TYPE SPECIES: *Baculites vertebralis* Lamarck, 1801: 103, by subsequent designation by Meek, 1876: 391.

Baculites vertebralis Lamarck, 1801

Figures 15E–J, M–O, 16A–F, I–K, 17, 18

Baculites vertebralis Lamarck, 1801: 103.

Baculites vertebralis Lamarck, 1801. Kennedy, 1986: 57, pl. 11, figs. 6–11; pl. 12, figs. 1–6; text-figs. 3a–d, 7d–f, 8 (with synonymy).

Baculites vertebralis Lamarck, 1801. Kennedy, *in* Kennedy et al., 1986: 1012, pl. 1, figs. 8, 9.

Baculites vertebralis Lamarck, 1801. Kennedy, 1987: 187, pl. 19, figs. 1–4, 7–10; pl. 20, figs. 3–5; pl. 28, figs. 2, 7–10, 14–16; pl. 29, figs. 1–5; pl. 30, figs. 1–9; text-figs. 11a, b, 12 (with full synonymy).

TYPE: Lectotype, by the subsequent designation of Kennedy (1986: 57), is the original of Faujas-Saint-Fond (1799: pl. 21, figs. 2, 3).

MATERIAL: There are 20 specimens in the MAPS, USGS, and USNM collections.

DESCRIPTION: The expansion rate is moderate in early and middle growth, thereafter decreasing. The whorl section is compressed ovoid with ratios of whorl breadth to whorl height of 0.56–0.72; the dorsum is more broadly rounded than the venter. In most specimens, the surface of internal molds is ornamented by growth lines and striae only, rarely by delicate riblets or coarse folds. All of these features follow an asymmetrically concave course on the flanks; they cross the dorsum in a broad convexity, indicating the presence of a short dorsal rostrum at the aperture. The ventral projection of the ornament extends far beyond the dorsal projection; the ornament crosses the venter in a broad convexity that defines a long ventral rostrum at the apertural margin. Riblets are best developed on the ventral flanks, and may be quite coarse and irregular on the venter. The suture (figs. 17, 18) has narrow rectangular bifid lobes and saddles.

DISCUSSION: Whorl section, ornament, and suture conform to those of the European *Baculites vertebralis,* revised at length by Kennedy (1986, 1987). The feebly ornamented individuals find a match in material from the Calcaire de Kunrade of Kunrade, Limburg, The Netherlands (Kennedy, 1987, pl. 29, figs. 13–15; pl. 30, figs. 7–9), as do specimens with coarse folds and constrictions (Kennedy, 1987, pl. 27, figs. 10–12). *Baculites vertebralis* is easily distinguished from *Baculites anceps* Lamarck, 1822 (see revision in Howarth, 1965: 363, pl. 4, fig. 4; pl. 5, figs. 4, 5; pl. 6, figs. 1–5; text-figs. 2, 3, 5–12; Kennedy, 1986: 58, pl. 11, figs. 12–14; pl. 12, figs. 7–11; text-figs. 3e–h, 7a–c), which has a tear-shaped whorl section with an acute venter.

OCCURRENCE: In western Europe this species occurs in the upper Maastrichtian *Belemnitella junior* and *Belemnella casimirovensis* belemnite zones. There are records from the Maastricht area of Limburg, The Netherlands; the Cotentin Peninsula, Manche, France; Petites Pyrénées, Haute Ga-

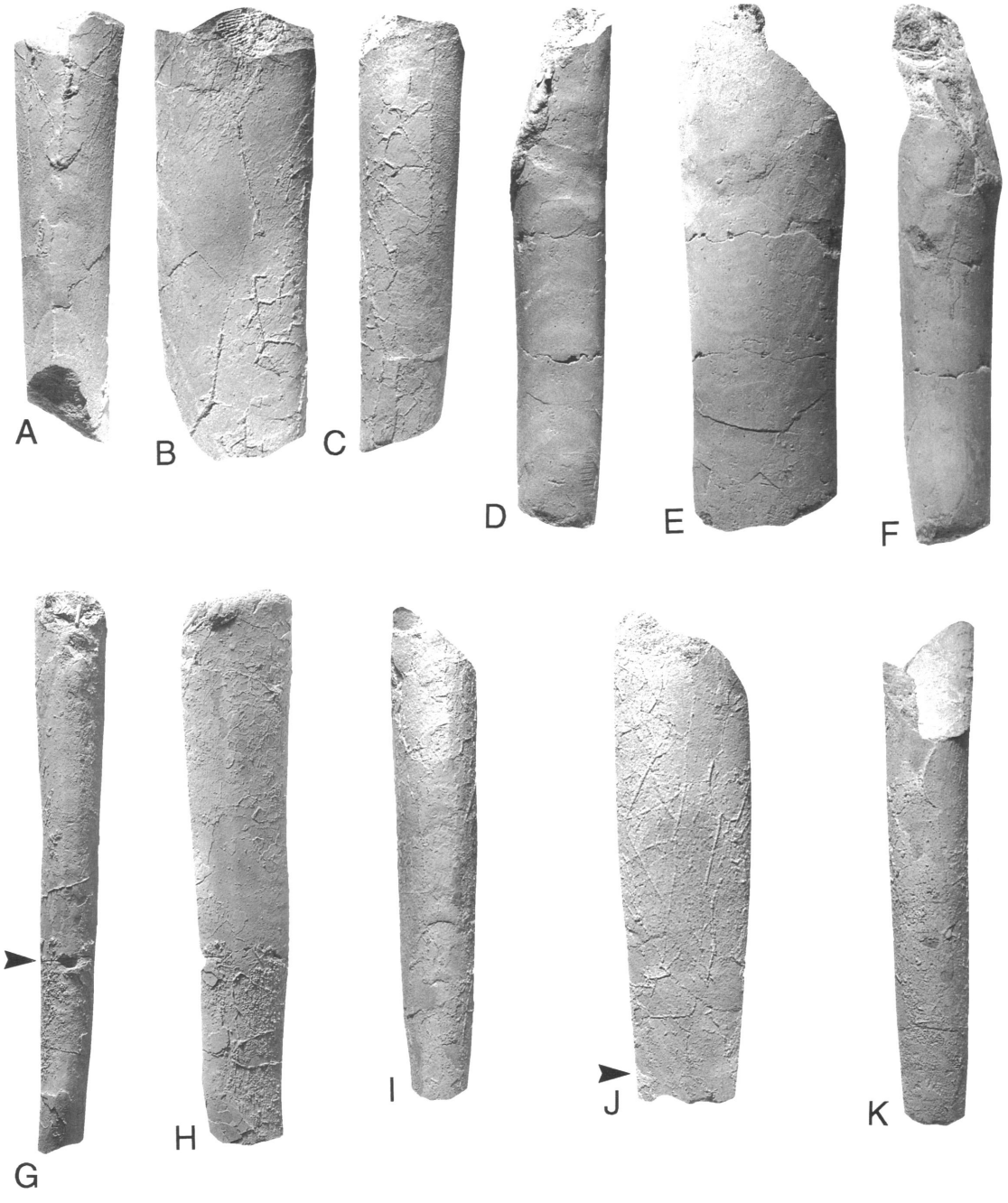

Fig. 16. **A–F, I–K.** *Baculites vertebralis* (Lamarck, 1801). **A–C.** USNM 486451, USGS Mesozoic locality D9716. **A,** Ventral; **B,** left lateral; **C,** dorsal. **D–F.** MAPS A2035a1, Severn Formation, excavation for sports arena, just east of the Beltway (Interstate 495), 1.5 km northwest of Largo, Prince Georges County, Maryland. **D,** Dorsal; **E,** right lateral; **F,** ventral. **I–K.** USNM 452707, Severn Formation, USGS Mesozoic locality D9716. **I,** Ventral; **J,** left lateral; **K,** dorsal. **G, H.** *Eubaculites latecarinatus* (Brunnschweiler, 1966), MAPS A2053a3, same locality and horizon as **D–F. G,** Ventral **H,** left lateral. All figures are ×1.

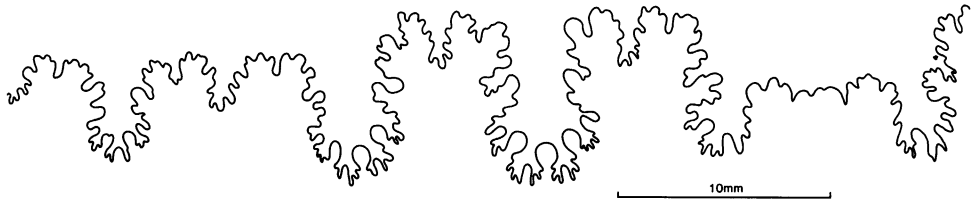

Fig. 17. Suture of *Baculites vertebralis* Lamarck, 1801, MAPS A2035a1 (see fig. 16**D–F**).

ronne, France; Limburg, Belgium; Denmark; southern Sweden; northern Germany; Poland; southern Russia; Ukraine; Turkmenia; Kazakstan; Tunisia; and the Severn Formation in Maryland.

Genus *Eubaculites* Spath, 1926

TYPE SPECIES: *Baculites vagina* var. *Ootacodensis* Stoliczka, 1866: 199, pl. 90, fig. 14, by original designation.

Eubaculites latecarinatus (Brunnschweiler, 1966)

Figures 15A–D, K, L, 16G, H, 19

Eubaculites otacodensis (Stoliczka). Spath, 1940: 49 (*pars*), pl. 1, figs. 3a, b; text-fig. 1b.

Giralites latecarinatus Brunnschweiler, 1966: 33, pl. 3, figs. 13, 14; pl. 4, figs. 1–5; text-figs. 17, 18.

Giralites quadrisulcatus Brunnschweiler, 1966: 35, pl. 4, figs. 11–14; text-fig. 20.

Eubaculites ambindensis Collignon, 1971: 18, pl. 646, fig. 2393.

Eubaculites latecarinatus (Brunnschweiler). Klinger, 1976: 91, pl. 40, fig. 1; pl. 41, fig. 3; pl. 42, figs. 2, 6; pl. 43, figs. 3, 4; text-figs. 11d, e.

Eubaculites latecarinatus (Brunnschweiler). Klinger and Kennedy *in* Klinger et al., 1980: 296, figs. 2a–c, 3a–d, 4a–c, 5b.

Eubaculites latecarinatus (Brunnschweiler, 1966). Henderson et al., 1992: 159, figs. 22L–N, 23N–P.

Eubaculites latecarinatus (Brunnschweiler, 1966). Klinger and Kennedy, 1993: 238, figs. 26A, 39–41, 42B, C, 43–49, 50A, 52A.

TYPE: The holotype, by original designation, is the original of Brunnschweiler (1966: pl. 4, figs. 2–4) from the Maastrichtian of western Australia.

MATERIAL: There are three specimens in the MAPS collections.

DESCRIPTION: MAPS A2053a1 is a body chamber with a maximum length of 65.9 mm, a maximum whorl height of 22.5 mm, and a ratio of whorl breadth to whorl height of 0.67 (fig. 15A–D). The dorsum is broad and flattened, the dorsal flanks are broadly rounded, the ventral flanks are flattened and convergent, and the venter is narrow and tabulate with sharp margins. Ornament consists of growth lines and delicate riblets that are broadly convex on the dorsum and markedly concave on the dorsal half of the flanks; they project strongly forward and are straight on the ventral flank and transverse on the venter. The suture is poorly preserved (fig. 19) with a broad, deeply incised bifid U, narrower, asymmetrically bifid L/U, and narrow I.

DISCUSSION: Lack of lateral flank ornament distinguishes *Eubaculites latecarinatus* from *E. carinatus* (Morton, 1834) (p. 44, pl. 13, fig. 1) and its synonyms (see revision in Henderson et al., 1992; Klinger and Kennedy, 1993). *Eubaculites vagina* (Forbes, 1846) (p. 114, pl. 10, fig. 4) (see revision in Kennedy

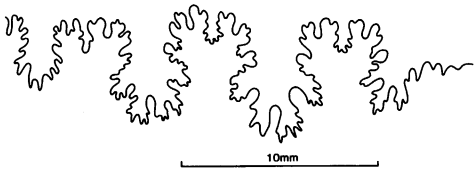

Fig. 18. Suture of *Baculites vertebralis* Lamarck, 1801, USNM 486453, Severn Formation, USGS Mesozoic locality D9716.

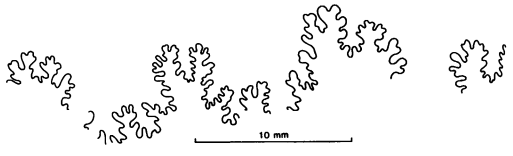

Fig. 19. Suture of *Eubaculites latecarinatus* (Brunnschweiler, 1966), MAPS A2053a1 (see fig. 15**A–D**).

and Henderson, 1992b) has two rows of flank tubercles, as does *E. labyrinthicus* (Morton, 1834) (p. 44, pl. 18, fig. 10), which also has a fastigate rather than tabulate venter. *Eubaculites ootacodensis* (Stoliczka, 1866) (p. 199, pl. 90, fig. 14) is similarly distinguished. *Eubaculites simplex* (Kossmat, 1895) (p. 156 *pars,* pl. 19, figs. 13a, b; non pl. 19, figs. 14a, b; see revision in Henderson et al., 1992) is smooth or ornamented by faint dorsal undulations, but much more compressed than *E. latecarinatus,* with a fastigate to very narrowly tabulate venter.

OCCURRENCE: Maastrichtian of south India, western Australia, Zululand (South Africa), and Madagascar; Severn Formation of Maryland.

SUPERFAMILY SCAPHITACEAE GILL, 1871

FAMILY SCAPHITIDAE GILL, 1871

SUBFAMILY SCAPHITINAE GILL, 1871

Genus *Discoscaphites* Meek, 1870

TYPE SPECIES: *Ammonites conradi* Morton, 1834: 39, pl. 16, fig. 3, by original designation.

Discoscaphites conradi (Morton, 1834)
Figure 20B–J

Ammonites conradi Morton, 1834: 39, pl. 16, fig. 3.

Discoscaphites conradi (Morton, 1834). Landman and Waage, 1993: 194, figs. 149–166 (with synonymy).

Discoscaphites conradi (Morton, 1834). Cobban and Kennedy, 1995: 29, figs. 10.2, 12.4, 12.5, 12.12–12.14, 19.1–19.19, 20.3–20.7, 20.21, 20.22, 22.1–22.4.

TYPE: The holotype is ANSP 5155 from the Prairie Bluff Chalk at Prairie Bluff, Alabama.

MATERIAL: There are four specimens in the MAPS and USNM collections.

DESCRIPTION: A highly variable and markedly dimorphic species. Two well-preserved pragmocones are shown in figure 20D–G. Coiling is very involute. The flanks are flattened and subparallel, the ventrolateral shoulders are rounded, and the venter is flattened. Delicate primary ribs are straight and prorsiradiate on the inner flanks, flex backward around midflank, where they increase by branching and intercalation, and strengthen and sweep forward on the outermost flank and ventrolateral shoulder. There are delicate, conical inner ventrolateral tubercles, each of which is linked by a well-developed rib to a delicate outer ventrolateral clavus. Clavi vary from alternate to opposite, and each is linked across the venter by a low, broad rib.

The phragmocone of a probable macroconch is shown in figure 20B, C. It has much coarser ribbing and shows feeble umbilical bullae and traces of outer lateral tubercles extending to an estimated diameter of 36 mm. A complete but crushed macroconch is shown in figure 20H–J. The umbilical wall of the body chamber is convex. When viewed from the side, the line of the wall is straight, concealing part of the umbilicus of the phragmocone. Flank ornament is poorly preserved, but delicate outer lateral, and inner and outer ventrolateral tubercles can be detected. Delicate, crowded ribs develop near the adult aperture, and there is a marked apertural constriction.

DISCUSSION: See Landman and Waage (1993) for an account of the extensive Western Interior material referred to this species, and Cobban and Kennedy (1995) for a discussion of the material from the Prairie Bluff Chalk.

OCCURRENCE: The type material is from the Prairie Bluff Chalk. The species is known from this unit in both Alabama and Mississippi; the Corsicana Formation in northeast Texas; the Arkadelphia Marl in southwest Arkansas; the Severn Formation in Maryland; and the *Hoploscaphites nicolletii* and *Jeletzkytes nebrascensis* zones in the Fox Hills Formation in North and South Dakota.

Discoscaphites gulosus (Morton, 1834)
Figures 20K–O, 21D, E

Ammonites Conradi var. (A) *gulosus* Morton, 1834: 39, pl. 16, fig. 2.

Ammonites Conradi var. (B) *petechialis* Morton, 1834: 39, pl. 16, fig. 1.

Ammonites Conradi var. (C) *navicularis* Morton, 1834: 40, pl. 19, fig. 4.

Discoscaphites gulosus (Morton, 1834). Landman and Waage, 1993: 212, figs. 156, 157, 159, 160, 167–180 (with synonymy).

Discoscaphites gulosus (Morton, 1834). Cobban and Kennedy, 1995: 29, figs. 10.4, 10.5, 19.20–

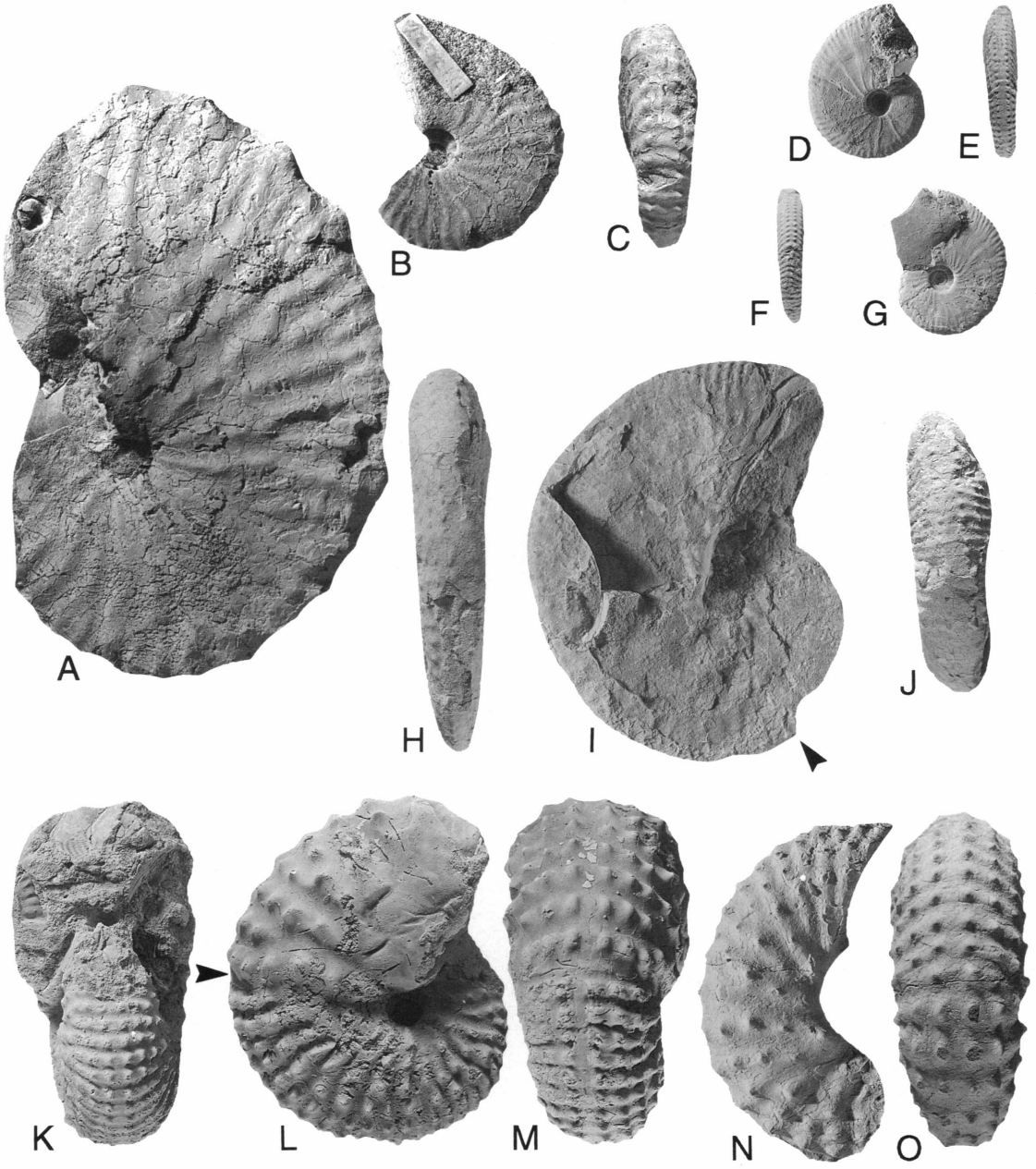

Fig. 20. **A.** *Jeletzkytes nebrascensis* (Owen, 1852), USNM 486454, Severn Formation, USGS Mesozoic locality 28888, right lateral. **B–J.** *Discoscaphites conradi* (Morton, 1834). **B, C.** USNM 486461, Severn Formation, USGS Mesozoic locality D12226. **B,** Right lateral; **C,** ventral. **D, E.** MAPS A2031a2, Severn Formation, exposures behind shopping center on south side of Central Avenue, just west of the Beltway (Interstate 495), Randolph Village, Prince Georges County, Maryland. **D,** Left lateral; **E,** ventral. **F, G.** MAPS A2031b3, Severn Formation, Oxon Hill, Prince Georges County, Maryland. **F,** Ventral; **G,** right lateral. **H–J.** MAPS A2031b1, Oxon Hill, Prince Georges County, Maryland. **H,** Ventral; **I,** left lateral; **J,** ventral hook. **K–O.** *Discoscaphites gulosus* (Morton, 1834). **K–M.** MAPS A2025a1, Severn Formation, Brightseat, Prince Georges County, Maryland. **K,** Apertural; **L,** left lateral; **M,** ventral. **N, O.** MAPS A2025a2, same horizon and locality as **K–M. N,** Left lateral; **O,** ventral. All figures are ×1.

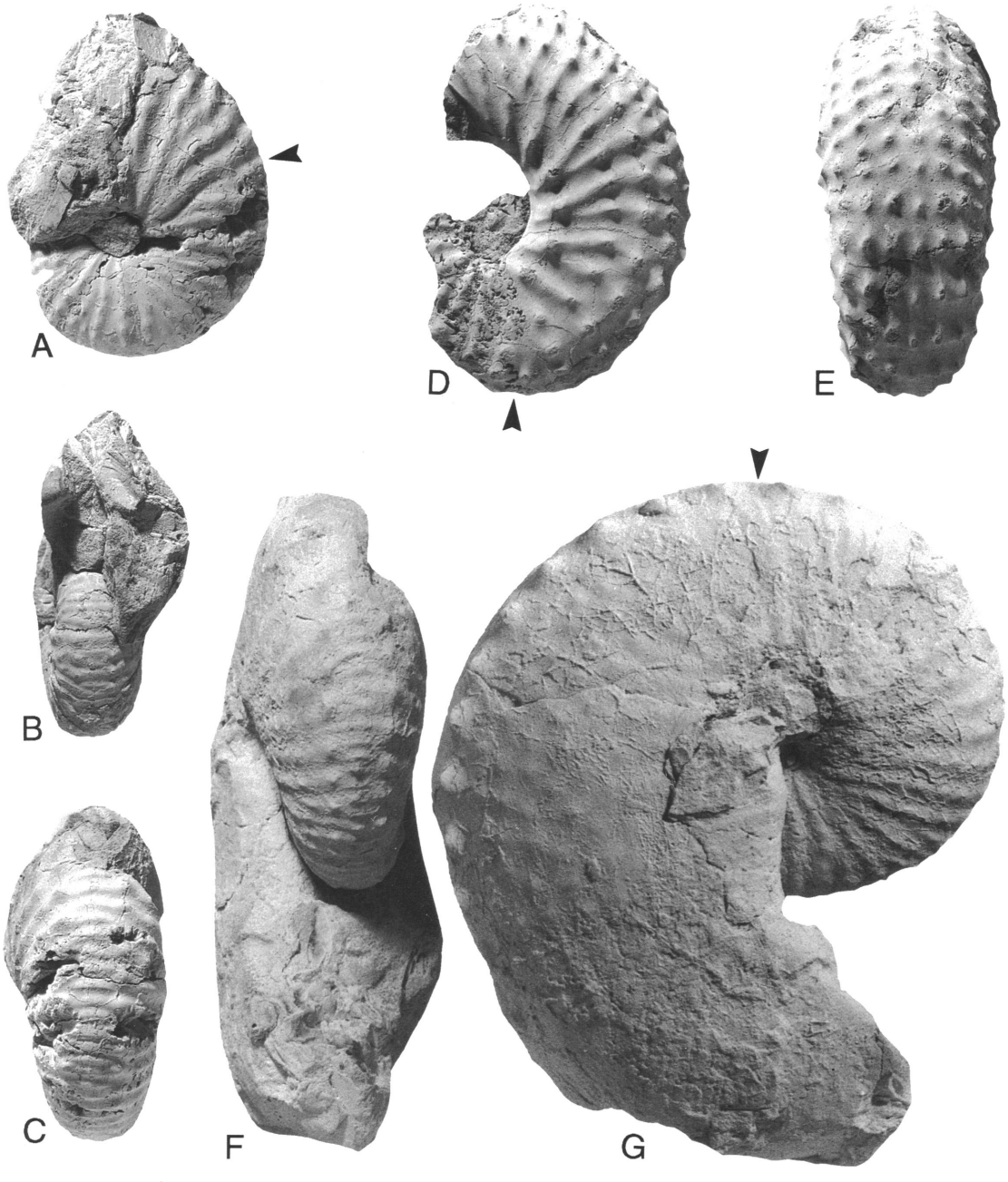

Fig. 21. **A–C, F, G.** *Jeletzkytes nebrascensis* (Owen, 1852). **A–C.** USNM 486458, Severn Formation, USGS Mesozoic locality D9716. **A,** Right lateral; **B,** apertural; **C,** ventral. **F, G.** MAPS A2026a4, Severn Formation, Largo, Prince Georges County, Maryland. **F,** Apertural; **G,** right lateral. **D, E.** *Discoscaphites gulosus* (Morton, 1834), USNM 486460, Severn Formation, USGS Mesozoic locality 32775. **D,** Right lateral; **E,** ventral. All figures are ×1.

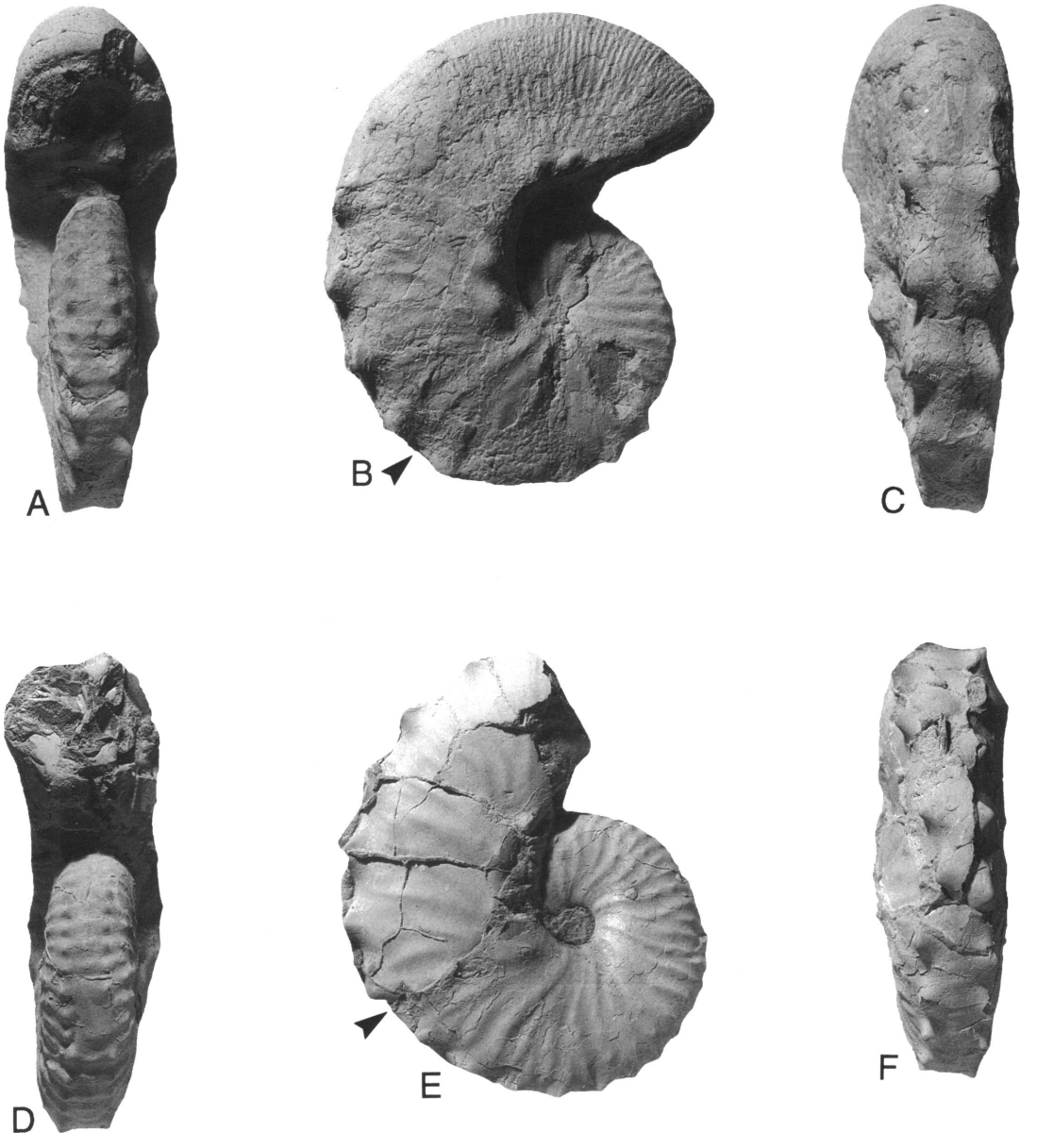

Fig. 22. *Jeletzkytes nebrascensis* (Owen, 1852). **A–C.** MAPS A2026a1, Severn Formation, Largo, Prince Georges County, Maryland. **A,** Apertural; **B,** left lateral; **C,** ventral. **D–F.** MAPS A2026a2, same horizon and locality as **A–C. D,** Apertural; **E,** left lateral; **F,** ventral. All figures are ×1.

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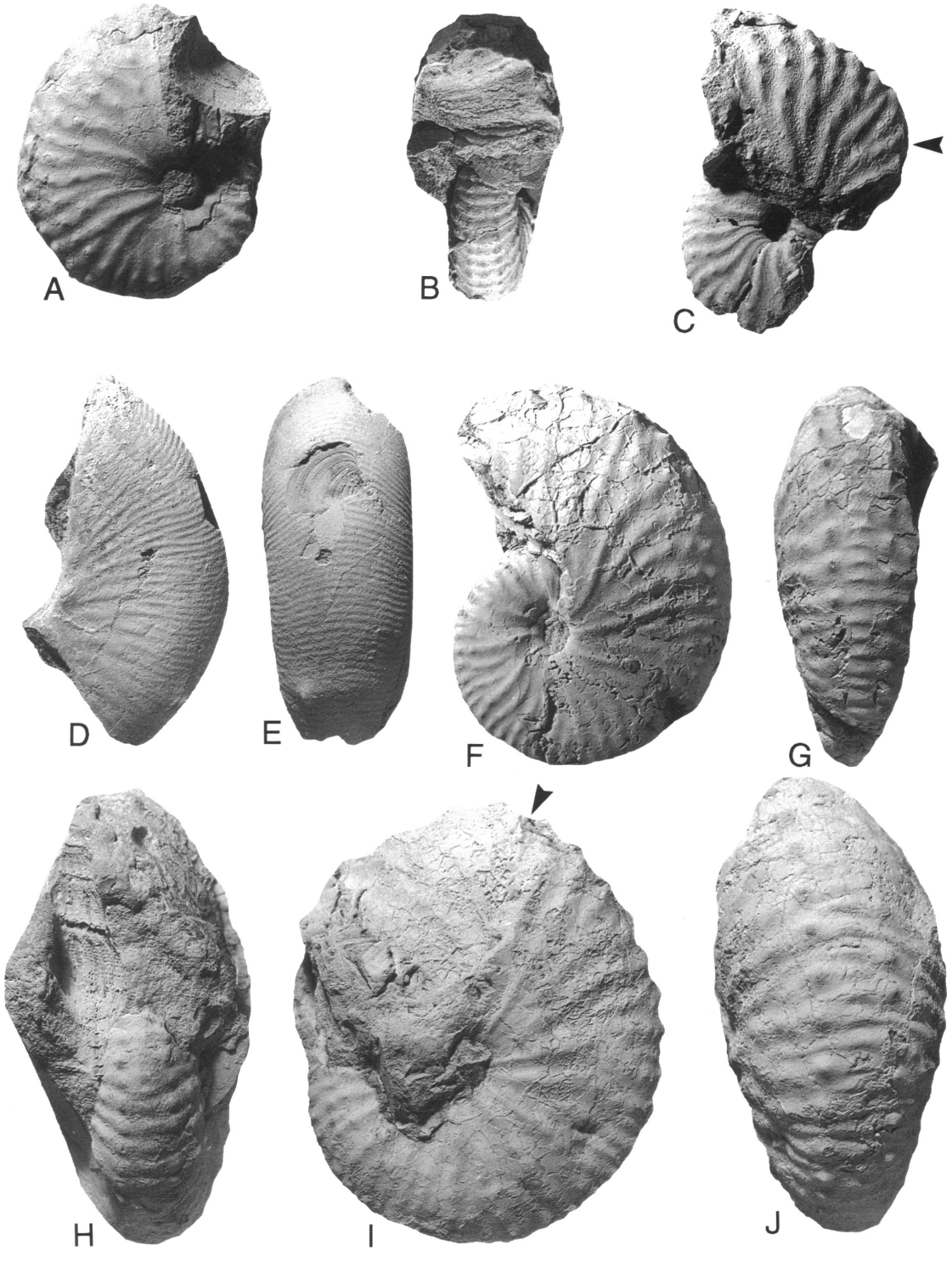
Fig. 23. *Jeletzkytes nebrascensis* (Owen, 1852). **A.** USNM 486455, Severn Formation, USGS Mesozoic locality 32775, left lateral. **B, C.** USNM 486456, Severn Formation, USGS Mesozoic locality D9716. **B,** Apertural; **C,** right lateral. **D, E.** USNM 486459, Severn Formation, USGS Mesozoic locality 29083. **D,** Right lateral; **E,** ventral. **F, G.** USNM 486457, Severn Formation, USGS Mesozoic locality D9716. **F,** Right lateral; **G,** ventral. **H–J.** MAPS A2026a3, Severn Formation, Largo, Prince Georges County, Maryland. **H,** Apertural; **I,** right lateral; **J,** ventral. All figures are ×1.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19.24, 20.2, 20.8–20.12, 20.14–20.17, 21.18–21.21.

TYPE: The holotype is ANSP 51552 from the Prairie Bluff Chalk at Prairie Bluff, Alabama.

MATERIAL: There are four specimens in the MAPS and USNM collections.

DESCRIPTION: A macroconch phragmocone (fig. 20K–M) has a rounded whorl section with a tiny conical umbilicus. Coarse ribs arise, either singly or in pairs, from umbilical bullae, and bear conical midlateral and two rows of outer lateral tubercles. These latter tubercles give rise to pairs of stronger ribs that bear inner and outer ventrolateral clavi. This specimen has only part of the adult body chamber preserved. A microconch body chamber is shown in figure 21D, E; it develops a row of siphonal tubercles. Another microconch body chamber is shown in figure 20N, O. Part of a moderately incised suture is illustrated in figure 21D.

DISCUSSION: See Landman and Waage (1993) for a revision of the abundant Western Interior material referred to this species, and Cobban and Kennedy (1995) for a discussion of the material from the Prairie Bluff Chalk.

OCCURRENCE: The type material is from the Prairie Bluff Chalk in Alabama. The species occurs in the same unit in Mississippi; the Corsicana Formation in northeast Texas; the Severn Formation in Maryland; and the *Hoploscaphites nicolletii* and *Jeletzkytes nebrascensis* zones in the Fox Hills Formation in North and South Dakota.

Genus *Jeletzkytes* Riccardi, 1983
(= *Karlwaageites* Cooper, 1994)

TYPE SPECIES: *Scaphites nodosus* Owen, 1852: 481, pl. 8, fig. 4, by original designation.

Jeletzkytes nebrascensis (Owen, 1852)
Figures 20A, 21A–C, F, G, 22–24

Ammonites nebrascensis Owen, 1852: 577, pl. 8, fig. 3; pl. 8a, fig. 2.

Jeletzkytes nebrascensis (Owen, 1852). Landman and Waage, 1993: 161, figs. 120–140 (with full synonymy).

TYPE: Lectotype, by the subsequent designation of Landman and Waage (1993: 161) is USNM 20242, the original of Owen (1852: 577, pl. 8, fig. 3; pl. 8a, fig. 2) (refigured by Landman and Waage, 1993, fig. 120D), from the "Fox Hills, Nebraska."

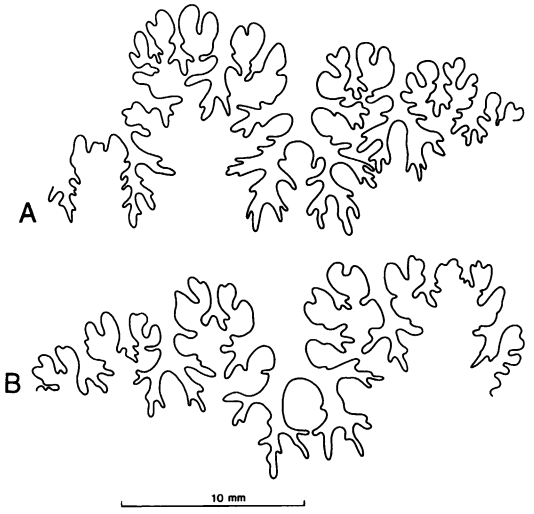

Fig. 24. **A, B.** Sutures of *Jeletzkytes nebrascensis* (Owen, 1852). **A.** USNM 486458, Severn Formation, USGS Mesozoic locality D9716. **B.** MAPS A2026a2, Severn Formation, Largo, Prince Georges County, Maryland.

MATERIAL: There are 10 specimens in the MAPS, USGS, and USNM collections.

DESCRIPTION: Microconch phragmocones are compressed and involute with a tiny, deep umbilicus (Ud = 14% of diameter), and a ratio of whorl breadth to whorl height of 0.66. The umbilical wall is flattened, and the umbilical shoulder is narrowly rounded. The flanks are flattened and subparallel, the ventrolateral shoulders are broadly rounded, and the venter is flattened. Seven to 12 weak to strong primary ribs per whorl arise at the umbilical seam either singly or in pairs. Ribs increase by branching or intercalation both high and low on the flanks to yield 24 ribs per whorl at the ventrolateral shoulder. Ribs are straight and prorsiradiate on the inner and middle flanks and feebly concave on the outer flanks, where they broaden markedly. There are bullate outer lateral and inner ventrolateral tubercles and much stronger ventrolateral clavi. One or two coarse, convex ribs link offset ventrolateral clavi across the venter in a zig-zag fashion, and may be accentuated into siphonal bullae. The body

chamber is compressed and has a concave umbilical wall that follows a concave course when viewed from the side, revealing the umbilicus of the phragmocone. There are up to eight umbilical tubercles, which are elongated parallel to the umbilical margin; they are strong on the shaft, but weaken markedly on the final hook. These tubercles give rise to pairs of narrow, prorsiradiate ribs that increase by branching and intercalation and loop to strong ventrolateral clavi. These clavi disappear abruptly on the final hook (figs. 22A–C, 23D, E), which is covered by dense, crowded, delicate prorsiradiate ribs that are straight on the flanks; these ribs arise in groups from the umbilical bullae and increase by branching and intercalation. They cross the venter in a very shallow convexity. A complete microconch is 66 mm long (fig. 22A–C).

Macroconch phragmocones are very involute, with a tiny deep umbilicus, a compressed whorl section, a narrowly rounded umbilical shoulder, flattened to feebly convex flanks, and broadly rounded ventrolateral shoulders and venter. Primary ribs, 10–12 per whorl, arise at the umbilical seam and strengthen across the umbilical wall. Flexuous and prorsiradiate on the flanks, ribs branch around midflank; both long and short intercalated ribs also develop, yielding a total of 36–40 ribs per whorl at the ventrolateral shoulder. Primary ribs bear umbilicolateral tubercles; there are up to four rows of flank tubercles, plus inner and outer ventrolateral tubercles, with the outer ventrolateral row being the most prominent. Strong transverse ribs link outer ventrolateral tubercles across the venter. In some cases, a rib passes across the venter and declines on the shoulder opposite the tubercle. In other cases, ventral ribs loop or zig-zag between tubercles.

MAPS A2026a4 (fig. 21F, G) is an adult macroconch 104.4 mm long. The body chamber is compressed, with an umbilical bulge partially concealing the umbilicus of the phragmocone; the umbilical wall is convex and the course of the wall is straight when viewed from the side. Ribbing is weak compared to tubercles, of which there are at least four rows on the middle and outer flanks, with strong ventrolateral clavi linking pairs of ribs. The venter is broad, slightly convex, and ornamented by feeble convex riblets looping and intercalating between clavi.

The suture (fig. 24A, B) is deeply incised, with a broad-stemmed, asymmetrically bifid E/L, and a deep, bifid L with long prongs and a large median element.

DISCUSSION: Early *Jeletzkytes,* including the type species *J. nodosus* (Owen, 1852), are globose, with only two rows of tubercles (umbilical and ventrolateral; see illustrations in Riccardi, 1983). Additional rows appear on the body chamber of *J. criptonodosus* Riccardi, 1983 (p. 28; for illustrations of macroconchs, see pl. 6, fig. 10; pl. 7, figs. 1, 2; pl. 8, figs. 7–9; text-figs. 25–27; for illustrations of microconchs, see pl. 11, figs. 1–21; text-figs. 28–31) of the *Baculites baculus* and *B. grandis* zones of the U.S. and Canadian Western Interior, but it is only above the *Baculites clinolobatus* zone that multituberculate species like *J. nebrascensis* appear. These species are fully described and discussed by Landman and Waage (1993).

OCCURRENCE: *Jeletzkytes nebrascensis* zone, Fox Hills Formation in North and South Dakota and Nebraska; Severn Formation in Maryland.

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