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Ammonites from the Weno Limestone (Albian) in Northeast Texas

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ABSTRACT

The Weno Limestone of northeast Texas is an upper Albian unit that has previously been imprecisely dated in terms of the European standard zonal sequence. Ammonite faunas, chiefly from the lower Weno, show it to be equivalent to a part of the lowest *Mortoniceras* (*Subschloenbachia*) *rostratum* Subzone of the highest Albian *Stoliczkaia dispar* Zone of Europe on the basis of the presence of *M. (S.) rostratum* (J. Sowerby, 1817), together with *Engonoceras serpentinum* (Cragin, 1900), *Engonoceras* aff. *subjectum* (Hyatt, 1903), *Cantabrigites* aff. *subsimplex* (Spath, 1933), *Mortoniceras* (*Angolaites*) *drakei* (Young, 1957), *Mortoniceras* (*Angolaites*) *wintoni* (Adkins, 1920), *Stoliczkaia* (*Stoliczkaia*) *argonautiformis* (Stoliczka, 1864),

Neophlycticeras (*Neophlycticeras*) sp., *Anisoceras armatum* (J. Sowerby, 1817), *Anisoceras perarmatum* Pictet and Campiche, 1861, and *Mariella* (*Wintonia*) sp. *Mortoniceras* (*Subschloenbachia*) Spath, 1921, is regarded as the senior synonym of *Durnovarites* Spath, 1932, and *Mortoniceras* (*Angolaites*) Spath, 1932, as the senior synonym of *Drakeoceras* Young, 1957. Most previous studies have interpreted the ammonites of the Weno Limestone as predominantly endemic to Texas. However, *Mortoniceras* (*Angolaites*) was originally described from Angola, *S. (S.) argonautiformis* from southern India, and *M. (S.) rostratum* and the species of *Cantabrigites*, *Neophlycticeras*, and *Anisoceras* from western Europe.

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INTRODUCTION

Correlation of the Albian successions of Texas with those of western Europe has been only partially achieved to date, because of the prevalence of endemic assemblages at some levels, as demonstrated by Young (1972), and because of the lack of a comprehensive revision of faunas, especially those of the upper Albian (see fig. 1 for the names of formations mentioned in the text). In the most recent review of the state of integration of the Texas zonal sequence with that established in Europe, Hancock et al. (1993) were unable to satisfactorily define the base of the highest Albian Zone of *Stoliczkaia dispar* in the Texas sequence. They noted that "... In the J. P. Conlin collections at Denver, there are examples of *M. wintoni* occurring with *M. (Durnovarites)* in the Weno Formation at the Diamond L Ranch in Tarrant County and the B. Bell Farm in Johnson County: *M. (Durnovarites)* is a characteristic subgenus of the Subzone of *Mortoniceras (Durnovarites) perinflatum* at the top of the Albian (= the Vraconian of French authors) (unless one believes that *Mortoniceras rostratum* (J. Sowerby) is also a *Durnovarites*). Similarly, in Travis County, Young (1957) records *M. (Durnovarites) adkinsi* Young from the upper part of his Zone of *Drakeoceras drakei*; in the lower part of the *D. drakei* Zone, he re-

records *M. wintoni*. From these records, it looks as though the base of the *S. dispar* Zone lies somewhere in the Weno Formation in Johnson and Tarrant counties; that it probably corresponds with the base of the *D. drakei* Zone; that the *Mortoniceras rostratum* Subzone (sensu Owen, 1985) of Europe is thin or not separately recognizable in Texas. In the absence of clearer indicators of the *Callihoplites auritus* and *M. rostratum* subzones, this can only be approximate" (ibid, p. 460).

It is the Weno ammonites in the Conlin

UNIT	SUBSTAGE
GRAYSON MARL	LOWER CENOMANIAN (part)
MAIN STREET LIMESTONE	
PAWPAW FORMATION	UPPER ALBIAN (part)
WENO LIMESTONE	
DENTON CLAY	
FORT WORTH LIMESTONE	
DUCK CREEK FORMATION	

Fig. 1. Lithostratigraphy and substage assignment of units mentioned in the text. From Geologic Atlas of Texas, Dallas Sheet, 1972.

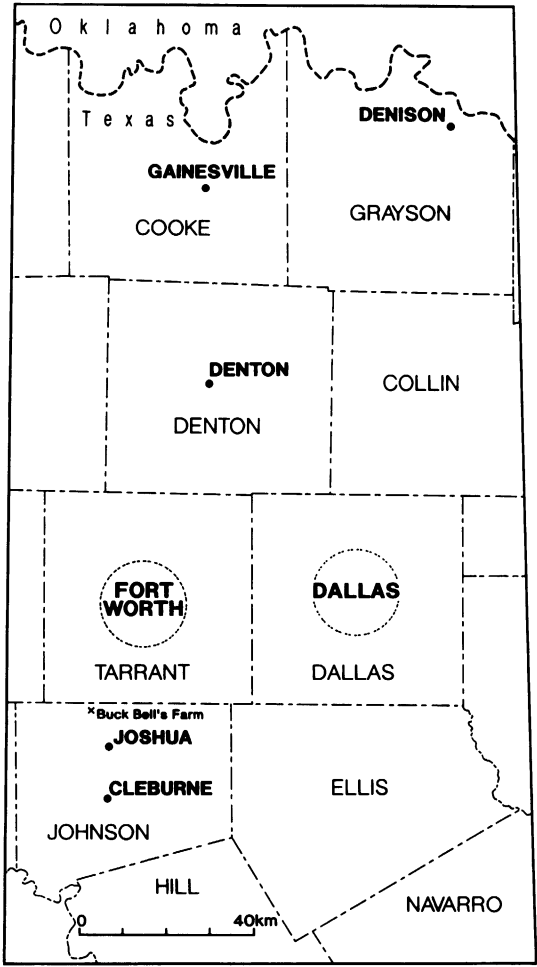


Fig. 2. Map of part of north-central Texas, showing some of the more important localities mentioned in the text.

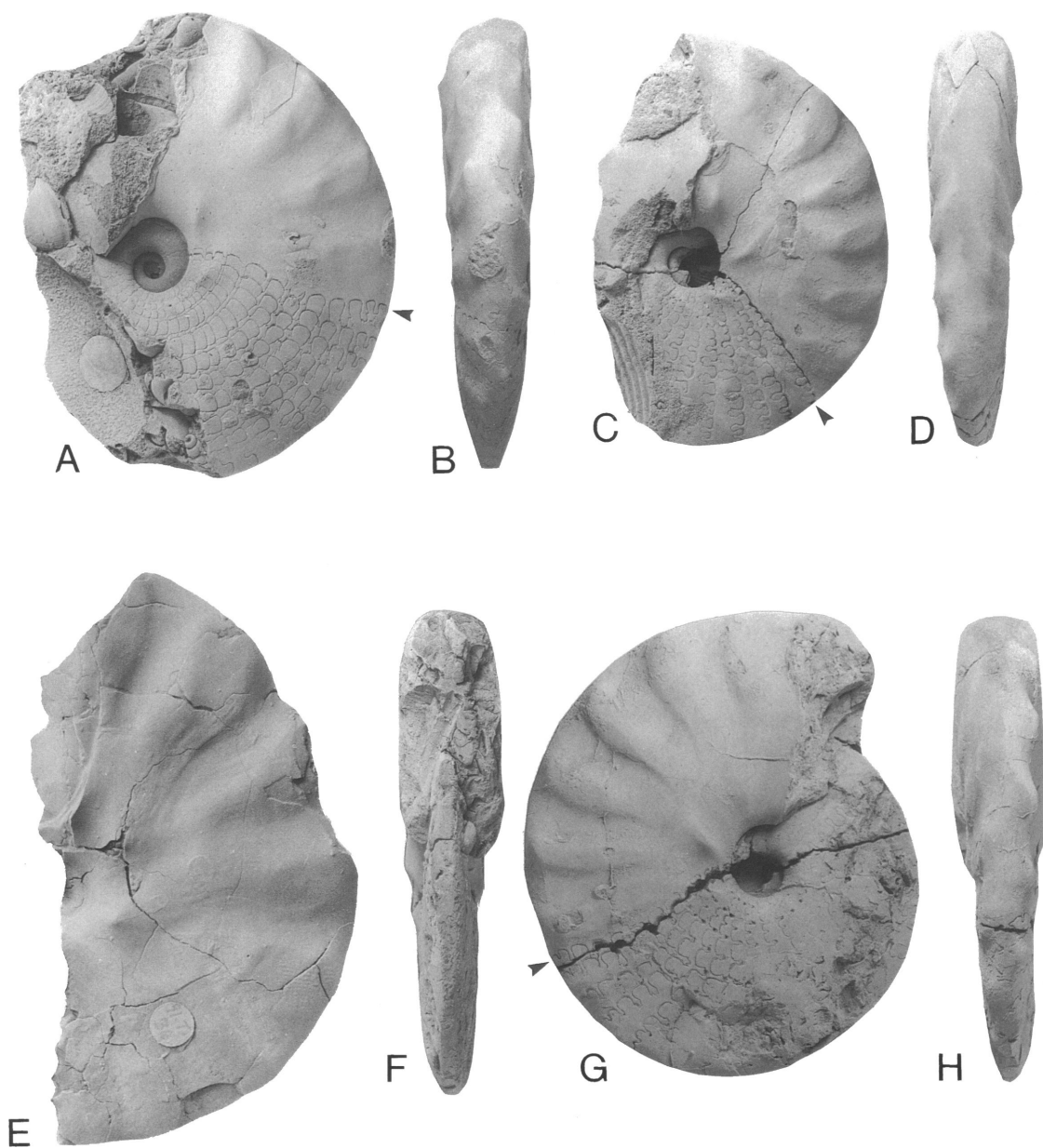


Fig. 3. *Engonoceras serpentinum* (Cragin, 1900). A, B. USNM 29401a, the original of Hyatt (1903: pl. 19, figs. 1, 2), "four and one half miles north of Gainesville, Tex.," Pawpaw Formation. C, D. USNM 29401b, same locality as A, B. E. TMM 21408, the original of Adkins (1928: pl. 19, fig. 1), Weno Limestone near Denison. F–H. USNM 29401c, the lectotype, the original of Cragin (1900: pl. 2, figs. 4–6) and Hyatt (1903: pl. 20, figs. 2–4), Pawpaw Formation near Denison. All figures are $\times 1$.

collection (U.S. Geological Survey, Denver) that form the basis of our present account. The "Durnovarites" from the Weno noted above are fragments of juvenile *Mortoniceras* (*Subschloenbachia*) *rostratum* (J. Sower-

by, 1817). *Subschloenbachia perinflata* Spath, 1922 (p. 113), the type species of *Durnovarites*, is not significantly different from *M. (S.) rostratum*; the two belong to the same subgeneric group, and *Durnovarites* is

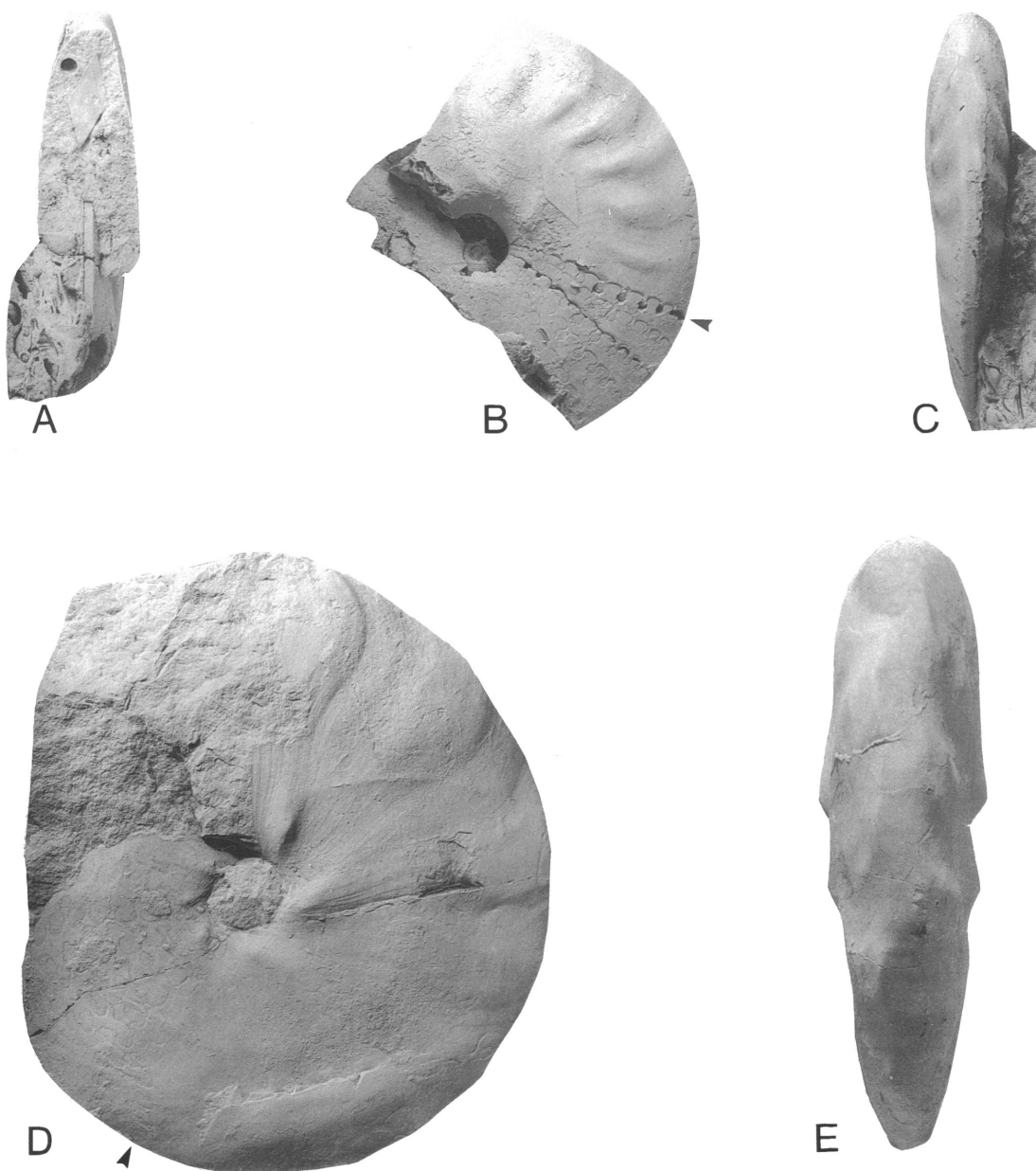


Fig. 4. *Engonoceras serpentinum* (Cragin, 1900). A–C. USNM 29401d, the original of Hyatt (1903: pl. 19, figs. 7, 8), “four and one half miles north of Gainesville, Tex.,” Pawpaw Formation. D, E. USNM 486604, lower Weno Limestone in Sycamore Creek above and below the intersection with Seminary Drive, Fort Worth, Tarrant County. All figures are $\times 1$.

a junior synonym of *Subschloenbachia* Spath, 1921. The lowest *M. (S.) rostratum* Subzone of the uppermost Albian Zone of *Stoliczkaia dispar* is thus well-represented in Texas, contrary to the previous view of Han-

cock et al. (1993). The index species extends down into the Denton Clay below the Weno Limestone near Salado, southern Bell County, on the basis of specimens in the Conlin collection, and into the top 1.5 m of the Fort

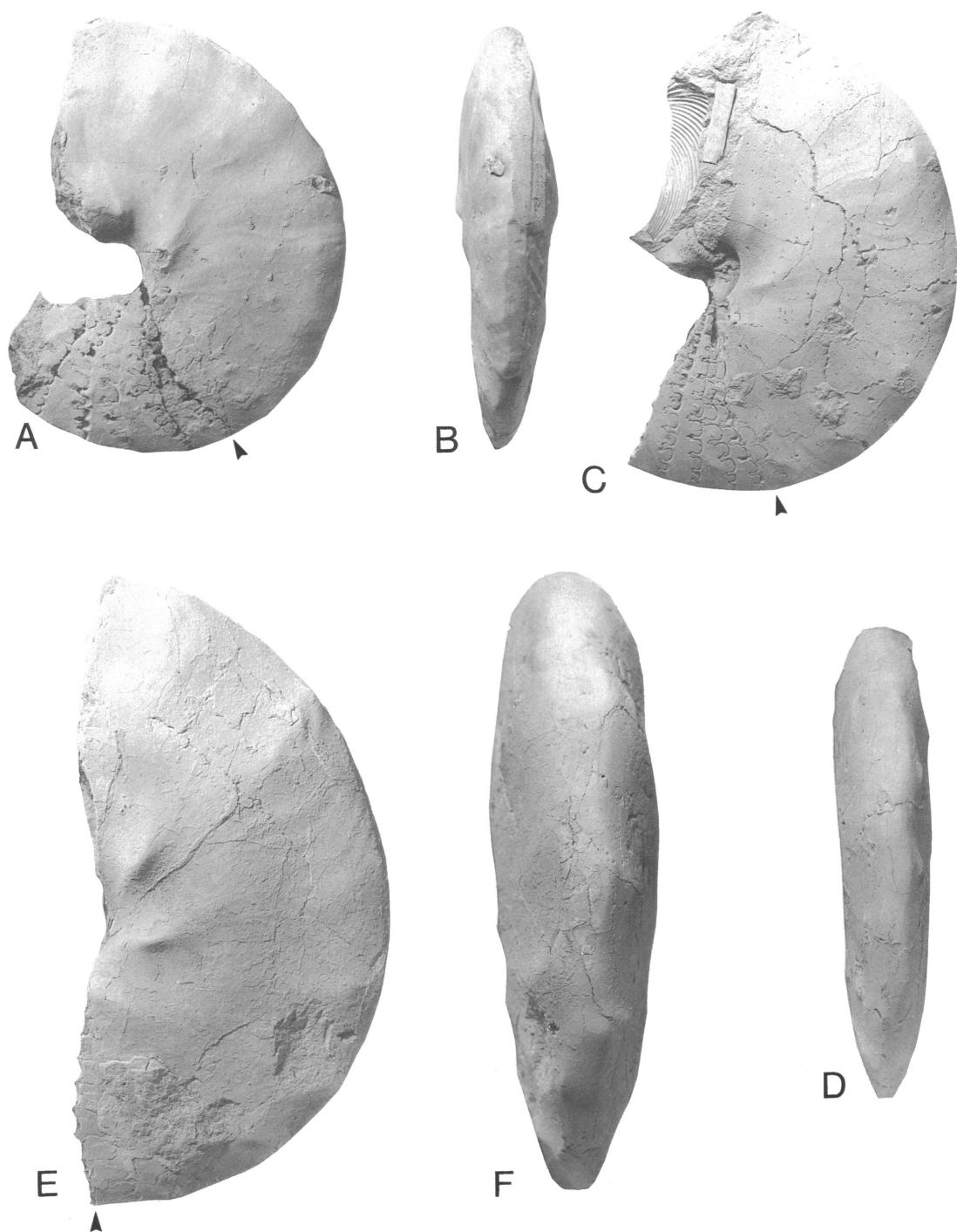
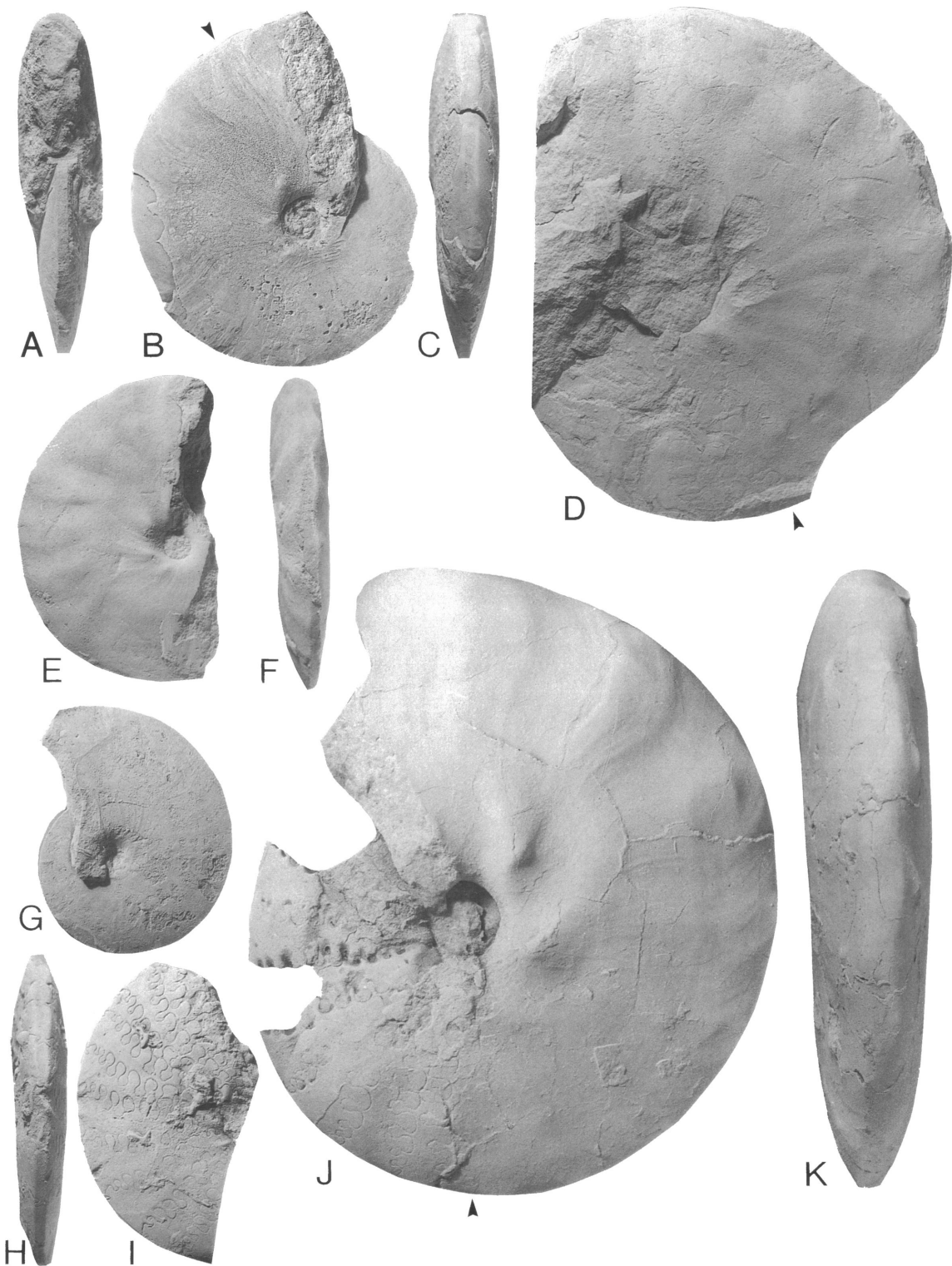


Fig. 5. *Engonoceras serpentinum* (Cragin, 1900). A, B. USNM 486603. C, D. USNM 486601. E, F. USNM 486602. All from the ironstone level in the Weno Limestone at the Gainesville Brick Company Pit, Cooke County. All figures are $\times 1$.



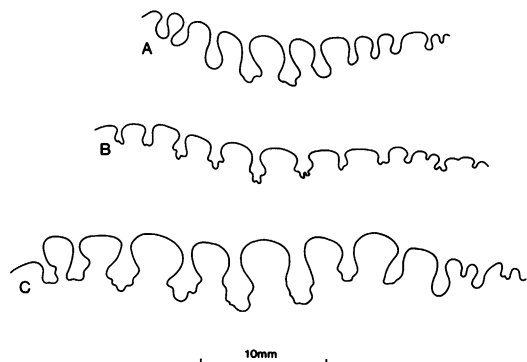


Fig. 7. External sutures of *Engonoceras serpentinum* (Cragin, 1900). A. USNM 486603. B. USNM 486601. C. USNM 486600.

Worth Limestone in Johnson County. *M. (S.) rostratum* co-occurs with specimens of *Mortonicerias (Angolaites) wintoni* and *M. (A.) drakei*, so that the base of the *S. dispar* Zone lies somewhere within the *M. (A.) wintoni* Zone of Young (1957, 1972) and others.

The reader is referred to the works of Hendricks (1967a), McGill (1967), Dixon (1967), and others in the Comanchean (Lower Cretaceous) Stratigraphy and Paleontology of Texas (Hendricks [ed.], 1967b) for detailed accounts of the lithostratigraphy and facies of the Weno Limestone. Figure 1 shows some of the localities mentioned in the text.

CONVENTIONS

The following abbreviations indicate the repositories of specimens cited in the text: OUM: Oxford University Museum, Oxford, U.K. TMM: Texas Memorial Museum collections, Austin, Texas, including those of the Bureau of Economic Geology (BEG). USNM: U.S. National Museum of Natural History, Washington, DC. Dimensions of specimens are expressed in millimeters: D =

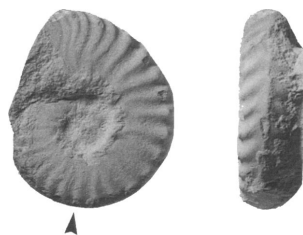


Fig. 8. *Cantabrigites* aff. *subsimplex* (Spath, 1933). USNM 486544, lower Weno Limestone, Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. Both figures are $\times 1$.

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. In descriptions of suture lines, E = external lobe, L = lateral lobe, U = umbilical lobe, and I = internal lobe. Specimens are photographed in the conventional position with the aperture on top, although the authors recognize that the animals would have been oriented differently in life. Arrows on photographs indicate the adapical end of the body chamber where preserved.

SYSTEMATIC PALEONTOLOGY

ORDER AMMONOIDEA ZITTEL, 1884

SUBORDER AMMONITINA HYATT, 1889

SUPERFAMILY HOPLITACEAE H. DOUVILLÉ, 1890

FAMILY ENGONOCERATIDAE HYATT, 1900

(= *Knemiceratidae* Hyatt, 1903: 144; *Neolobitinae* Luppov and Mikhailov in Luppov and Druschits, 1958: 125)

Genus *Engonoceras* Neumayr and Uhlig, 1881

TYPE SPECIES: *Ammonites pierdenalis* von Buch, 1848: 31, pl. 5, figs. 8–10, by the sub-

Fig. 6. A–C, E–K. *Engonoceras serpentinum* (Cragin, 1900). A–C. USNM 486609, lower Weno Limestone 0.8–1.1 km (0.5–0.7 mi) east of the dam on Katy Lake, Tarrant County. E, F. USNM 486608, Weno Limestone on Sycamore Creek, 320 m (300 yards) northeast of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. G. USNM 486606, lower part of Weno Limestone, Fort Worth. H, I. USNM 486607, Weno Limestone southwest of Watauga, Tarrant County. J, K. USNM 486600, Weno Limestone at the Gainesville Brick Pit, Cooke County. D. *Engonoceras* aff. *subjectum* Hyatt, 1903. USNM 486605, Weno Limestone at USGS Mesozoic locality 18575, 8 km (5 mi) northwest of Cleburne, Johnson County. All figures are $\times 1$.



Fig. 9. *Mortoniceras* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). Holotype, OUM K835, the original of J. Sowerby (1817: 163, pl. 173), Upper Greensand of Roke, near Benson, Oxfordshire, U.K. Figure is $\times 1$.

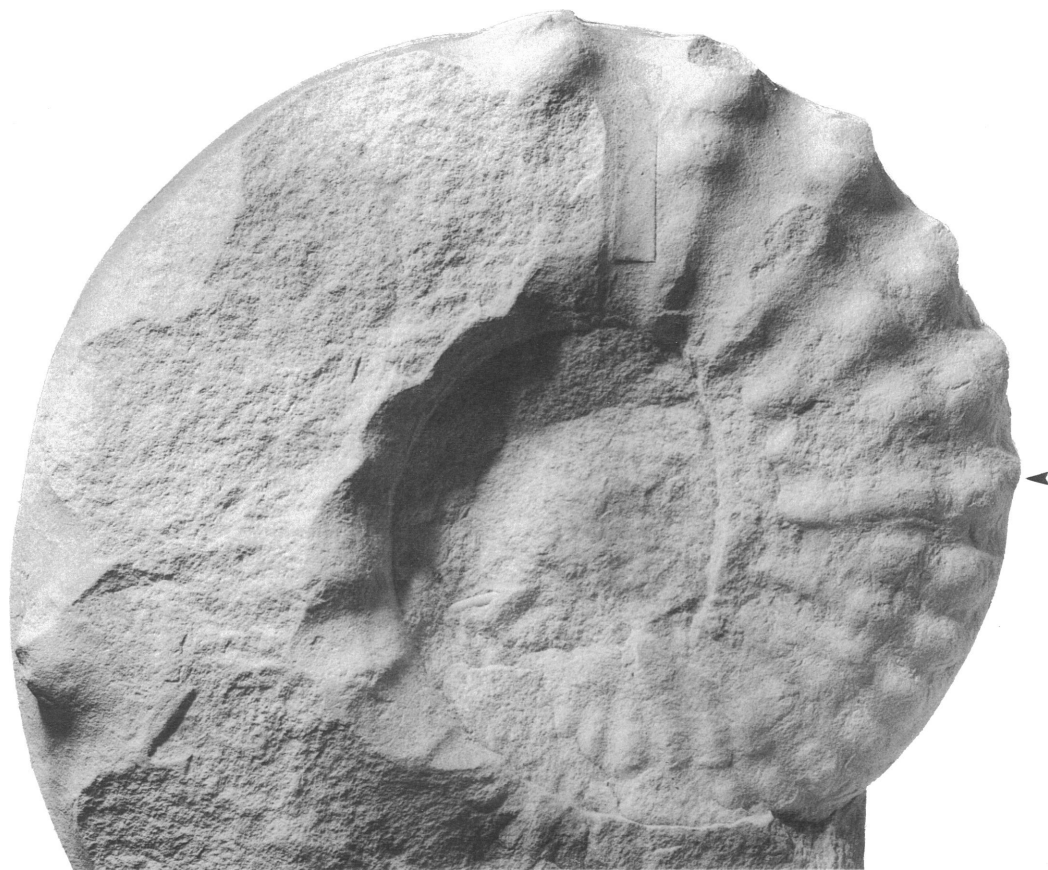


Fig. 10. *Mortoniceras* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). Holotype, OUM K835, the original of J. Sowerby (1817: 163, pl. 173), Upper Greensand of Roke, near Benson, Oxfordshire, U.K. Figure is $\times 1$.

sequent designation of Pervinquier, 1907: 200.

Engonoceras serpentinum (Cragin, 1900)
Figures 3–5, 6A–C, E–K, 7

Sphenodiscus belviderensis var. *serpentinus* Cragin, 1900: 31, pl. 2, figs. 4–6.

Engonoceras serpentinum (Cragin). Hyatt, 1903: 162, pl. 19, figs. 7–14; pl. 20, figs. 1–5.

Engonoceras serpentinum (Cragin). Grabau and Shimer, 1910: 214, fig. 1487a–c.

Engonoceras serpentinum (Cragin). Adkins, 1920: 84, pl. 4, figs. 3, 5–6, 12.

Engonoceras sp. Adkins, 1920: 85, pl. 4, figs. 8–10.

Engonoceras serpentinum (Cragin). Adkins, 1928: 262, pl. 19, fig. 1.

Engonoceras serpentinum (Cragin). Wright, 1957: 388, fig. 507, 2.

?*Engonoceras* cf. *serpentinum* (Cragin). Mancini, 1982: 251, fig. 4i.

Engonoceras serpentinum. Emerson et al., 1994: figs. 36, 37, pars.

Engonoceras serpentinum (Cragin). Wright, 1996: 130, fig. 100, 4.

TYPES: Cragin (1900: 31) referred to the “types” of his variety *serpentinus*; the original of his pl. 2, figs. 4–6 is here designated lectotype. This specimen was refigured by Hyatt (1903: pl. 20, figs. 2–4), and said to be in the Cragin Collection at Colorado College, but is now housed in the USNM collections (fig. 3F–H). It was described by Cragin as being from the Pawpaw clays near Denison in Grayson County.

DESCRIPTION: Coiling of the phragmocone whorls is very involute, with a tiny umbilicus



Fig. 11. *Mortonicerias* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). Holotype, OUM K835, the original of J. Sowerby (1817: 163, pl. 173), Upper Greensand of Roke, near Benson, Oxfordshire, U.K. Figures are $\times 1$.

comprising 10% or less of the diameter, and a ratio of whorl breadth to whorl height of approximately 0.2. The umbilical wall and shoulder form a shallow circumbilical depression. The inner flanks are broadly rounded, with the greatest breadth dorsal of mid-flank; the outer flanks are flattened, and converge to a very narrow tabulate to feebly sulcate venter with sharp edges. The shell is at first smooth; ornament appears on the later phragmocone whorls. There are three or four small, delicate, distant bullae per half whorl, perched on the umbilical shoulder, which give rise to pairs of weak, low, flat ribs. These are falcoid: straight and prorsiradiate across the inner and middle flanks, flexing backward on the outer flanks, and then strengthening and sweeping forward in concave crescentic bulges. Ribs alternate in position on either side of the venter, which becomes markedly sinuous as size increases. Growth lines and striae are present on both ribs and interspaces. Specimens that we presume to be adult microconchs are up to 65 mm in diameter; macroconchs are up to 112 mm in diameter. The adult body chamber broadens markedly (ratio of whorl breadth to whorl height of up to 0.54), umbilical bullae and ribs coarsen, and two rows of minute outer flank tubercles may develop; delicate riblets accompany growth lines and striae. Ventral sinuosity becomes very pronounced.

The suture (fig. 7A–C) is characterized by numerous adventive and auxiliary elements. The saddles are entire except for those closest to the umbilicus, which are bifid; the lobes have few incisions or are entire.

DISCUSSION: The coarse ribs of middle and later growth distinguish large specimens of *Engonoceras serpentinum* from most other species of *Engonoceras* known from the Texas Albian. *Engonoceras* aff. *subjectum*, which also occurs in the Weno Limestone, has distinctive outer flank tubercles. The smooth, very compressed, inner whorls of *E. serpentinum* can be distinguished from those of *Engonoceras bravoense* Böse, 1928 (p. 229, pl. 7, figs. 37–41; pl. 8, figs. 1–8; pl. 12, fig. 8) on the basis of the suture; the saddles of *E. bravoense* tend to be narrower and phylloid and the lobes more deeply and intricately incised.

OCCURRENCE: Weno, Pawpaw, Grayson,



Fig. 12. *Mortonicerias (Subschloenbachia) perinflatum* (Spath, 1922). Holotype, the original of Pictet and Campiche (1859: pl. 22, fig. 3), upper Albian, Ste. Croix, Vaud, Switzerland, in the collections of the Muséum d'Histoire Naturelle de Genève (copy of Wiedmann and Dieni, 1968: pl. 14, fig. 4). Figure is $\times 1$.

and Del Rio formations in north and central Texas.

Engonoceras aff. *subjectum* Hyatt, 1903
Figure 6D

DESCRIPTION: USNM 486605 is a crushed composite mold with a maximum diameter of 86 mm; the last 270° of the outer whorl is body chamber. Coiling is very involute, with the umbilicus comprising 12.8% of the diameter. The umbilicus is shallow, with a low, flattened wall and broadly rounded umbilical shoulder. The whorl section is very compressed, but this has been accentuated by

postmortem crushing. Ornament is well preserved on the last whorl only. Four umbilical bullae per half whorl give rise to groups of two or three low, flat, feebly convex prorsiradiate ribs, as well as growth lines and striae. These ribs strengthen across the flanks, and link to a row of low, feeble, rounded to slightly clavate outer lateral tubercles, 9 or 10 per half whorl. These tubercles give rise to low, flat, concave ribs that are weak on the early parts of the outer whorl, but strengthen markedly on the last quarter whorl. The venter is narrow and concave with sharp ventrolateral shoulders at the

TABLE 1
Dimensions (mm) of *Engonoceras serpentinum* (Cragin, 1900)^a

USNM Specimen	D	Wb	Wh	Wb:Wh	Ud
486606	40.5(100)	7.9(19.5)	23.2(57.3)	0.34	3.5(8.6)
486608	48.3(100)	9.4(19.5)	24.8(51.3)	0.38	4.6(9.5)
486609	54.5(100)	12.8(23.5)	31.6(57.9)	0.41	6.6(12.1)
486601	72.3(100)	15.5(21.4)	35.2(48.7)	0.44	9.5(13.1)
486602	93.8(100)	24.0(25.6)	44.6(47.5)	0.54	—(—)
486600	105.0(100)	25.3(24.1)	61.5(58.6)	0.41	12.3(11.7)

^a D = diameter; Wb = whorl breadth; Wh = whorl height; Ud = umbilical diameter; c = measured in costal section; ic = measured in intercostal section. Figures in parentheses are the dimensions expressed as percentage of the diameter.

smallest visible diameter; it broadens markedly over the last half whorl, where the progressive strengthening of ribs, which alternate in position across the venter, produces a markedly sinuous profile. The poorly preserved suture has elongated entire adventive saddles and little incised lobes.

DISCUSSION: Bituberculate flank ornament, outer flank ribs, and sinuous venter show this specimen to be related to *Engonoceras subjectum* Hyatt, 1903 (p. 168, pl. 21, figs. 2–6; pl. 22, figs. 1–5; see particularly pl. 21, figs. 2, 3). It differs in having outer lateral tubercles, each of which gives rise to one rib rather than a pair. In this respect it resembles *Engonoceras serpentinum*, described above, but this species lacks prominent lateral tubercles.

OCCURRENCE: Weno Limestone, USGS Mesozoic locality 18575, 8 km (5 mi) northwest of Cleburne, Johnson County.

SUPERFAMILY ACANTHOCERATACEAE DE GROSSOUVRE, 1894

FAMILY BRANCOCERATIDAE SPATH, 1934

SUBFAMILY BRANCOCERATINAE SPATH, 1934

Genus *Cantabrigites* Spath, 1933

(=*Cantabrigites* Spath, 1932: 380, nom. nud.)

TYPE SPECIES: *Mortonicer* (*Mortonicer* *as*) *cantabrigense* Spath, 1932: 380, by original designation by Spath, 1933: 436.

DISCUSSION: *Cantabrigites* was originally described as a subgenus of *Mortonicer* Meek, 1876, of which it was regarded as a dwarf offshoot. Scholz (1979), in contrast,

regarded it as a derivative (and subgenus) of *Hystero* *ceras* Hyatt, 1900, of the Brancoceratinae, a view, in part, followed here.

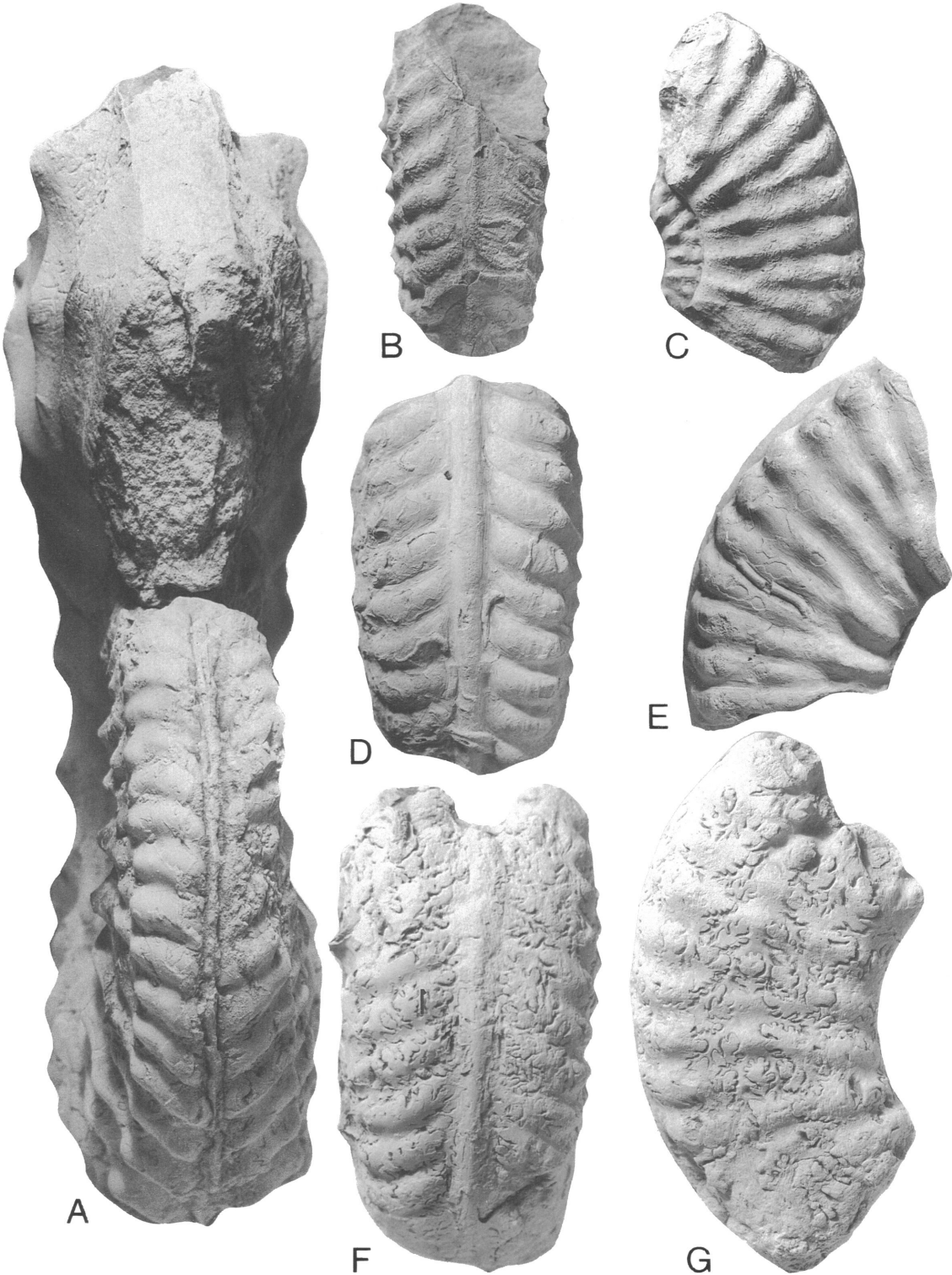
Cantabrigites aff. *subsimplex* (Spath, 1933)
Figure 8

DESCRIPTION: USNM 486544 is a nearly complete adult 26 mm in diameter. Coiling is evolute; the umbilicus comprises 26% of the diameter and is shallow, with a low wall and narrowly rounded umbilical shoulder. The whorl section is compressed, with flat, parallel flanks, broadly rounded ventrolateral shoulders, and an obtusely fastigate to feebly convex venter in intercostal section. Tiny, sharp bullae, seven per half whorl, give rise to pairs of ribs, one rib of each pair less clearly connected to the bulla than the other one. The ribs are weak and feebly prorsiradiate on the inner flank, flex backward, strengthen, and are rectiradiate on the outer flank, and terminate in tiny sharp ventral clavi. There are a few single long or short ribs. The ventral clavi give rise to low, broad ribs that extend across the venter to a low siphonal keel. The specimen appears to be a small adult, and shows a striking modification in ornament prior to the aperture, where the umbilical bullae decline, and the ribs become crowded and flexuous; the inner flank convexity of the ribs suggests the presence of feeble lateral lappets.

DISCUSSION: This specimen is quite unlike any previously described brancoceratid from the Texas Albian, and the first record of the genus from Texas. The persistent ventral clavi and coarseness of ribbing separate it from



Fig. 13. *Mortonicerias* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). USNM 486597, Weno Limestone on Sycamore Creek, 320 m (350 yards) northeast of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. Figure is $\times 1$.



Cantabrigites cantabrigense (Spath, 1933) (p. 438, pl. 41, figs. 3, 4; pl. 45, fig. 4; pl. 46, fig. 8). There are closer similarities to *C. subsimplex* (Spath, 1933) (p. 439, pl. 39, fig. 3; pl. 42, figs. 3, 4; pl. 44, fig. 7), which has well-developed umbilical and ventral tubercles, but is larger, with strong single ribs on the body chamber. The present specimen might conceivably be an adult microconch of *C. subsimplex*, but we cannot prove this. *Cantabrigites minor* (Spath, 1933) (p. 440, pl. 41, figs. 1, 2; pl. 43, fig. 4; pl. 44, fig. 2; pl. 46, fig. 11; text-fig. 152) has lateral tubercles and belongs to the Mortoniceratinae, which may also include forms with inner and outer ventrolateral tubercles, as described by Renz (1968).

OCCURRENCE: Lower Weno Limestone, Buck Bell's Farm, Johnson County.

SUBFAMILY MORTONICERATINAE

H. DOUVILLÉ, 1912

Genus *Mortoniceras* Meek, 1876

TYPE SPECIES: *Ammonites vespertinus* Morton, 1834: 40, pl. 17, fig. 1, by original designation by Meek, 1876: 448.

DISCUSSION: The validity of *Ammonites vespertinus* Morton, 1834 (and of *Mortoniceras* Meek, 1876, as a consequence), has been questioned by some authors. The species is a valid one, and the type specimen was reillustrated by Matsumoto (1960), Branson (1965), and Wright (1996).

Subgenus *Subschloenbachia* Spath, 1921

(= *Durnovarites* Spath, 1932: 380;
Reyericeras Collignon, 1979: 34)

TYPE SPECIES: *Ammonites rostratus* J. Sowerby, 1817: 163, pl. 173, by original designation by Spath, 1921: 284.

DISCUSSION: *Subschloenbachia* was introduced without diagnosis by Spath (1921: 284). In 1932 (p. 380) he regarded it as a

synonym of *Pervinqueria* Böhm, 1910 (p. 152), of which *Ammonites inflatus* J. Sowerby, 1817, is the type species. Wright (1996) has recently placed both *Subschloenbachia* and *Pervinqueria* in the synonymy of *Mortoniceras* (*Mortoniceras*). However, an examination of the type specimen of the type species of *Subschloenbachia* leads us to a different view.

The diagnostic features of *Mortoniceras* (*Mortoniceras*) *vespertinus* include the presence of umbilical, lateral, and ventrolateral tubercles, so that the ribs are trituberculate. Wright (1996: 141, 142) stated that an "outer ventrolateral tubercle [is] commonly perceptible at some stage and in some species, e.g., *M. (M.) rostratum* (J. Sowerby), and may be strong for a short stage, foreshadowing *M. (Durnovarites)*." *M. (Durnovarites)* was characterized, according to Wright (1996: 142), by having a whorl section that is "square to depressed-trapezoidal; from an early stage at least 4 nearly equally spaced tubercles on each rib, the outer one as prominent as the others, and tending to be clavate."

The type species of *Durnovarites* is *Subschloenbachia perinflata* Spath, 1922 (p. 113), proposed by Spath for *Ammonites inflatus* Sowerby of Pictet and Campiche, 1859 (pl. 22, fig. 3). The original figure is highly restored, but the specimen on which it was based was refigured by Renz (1968, pl. 9, fig. 1) and Wiedmann and Dieni (1968, pl. 14, figs. 3, 4), and reproduced here as figure 12; it is the holotype, by monotypy. This specimen is completely septate, and has, as diagnostic features, a massive, depressed whorl section and an ornament in which umbilical bullae give rise initially to pairs, thereafter predominantly single ribs, with a persistent lateral, inner, and outer ventrolateral tubercle. Cooper and Kennedy (1979: 269, figs. 3g, 6i, 62d-i, 63-64) and Scholz (1979: 112, pl. 28,

←

Fig. 14. *Mortoniceras* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). **A.** USNM 486597, Weno Limestone on Sycamore Creek, 320 m (350 yards) northeast of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. **B.** **C.** USNM 486587, lower Weno Limestone on Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. **D.** **E.** USNM 486588, same locality as B, C. **F.** **G.** USNM 486594, lower third of Weno Limestone exposed at the same locality as A. All figures are $\times 1$.

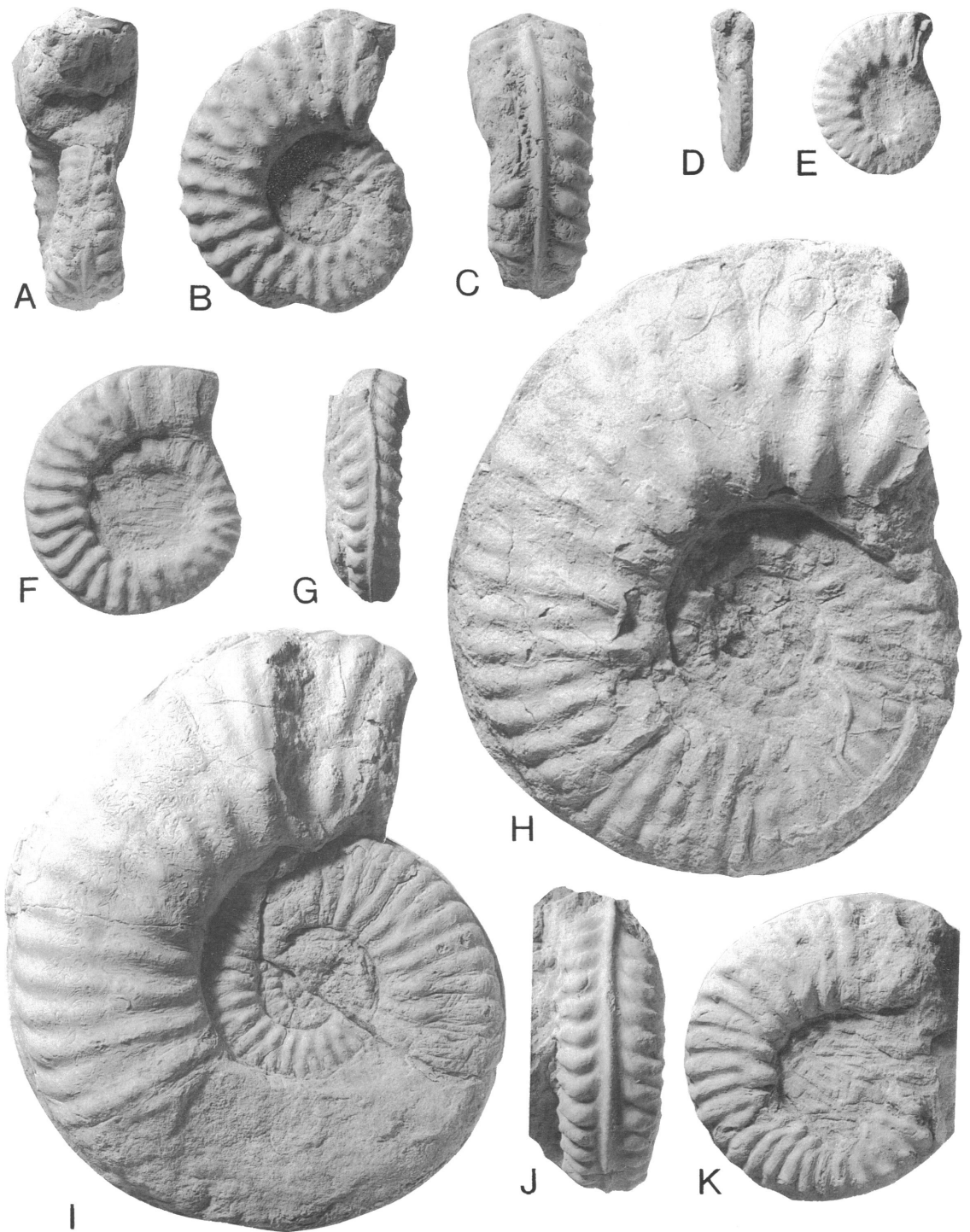


Fig. 15. *Mortonicerias* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). A–C. USNM 486545, Weno Limestone, Village Creek, on the Diamond M Ranch, Fort Worth, Tarrant County. D, E. USNM 486546, lower part of Weno Limestone, 800 m (0.5 mi) east of dam at Katy Lake in southern Fort Worth, Tarrant County. F, G. USNM 486548, Weno Limestone on Sycamore Creek, 320 m (350 yards)

TABLE 2
Dimensions (mm) of *Mortoniceras (Subschloenbachia) rostratum* (J. Sowerby, 1817)^a

USNM Specimen	D	Wb	Wh	Wb:Wh	Ud
486595	86.0(100)	34.5(40.1)	31.8(37.0)	1.08	31.5(36.6)
486596	130.0(100)	—(—)	46.0(35.4)	—	49.0(37.7)
486597c	130.0(100)	54.5(29.3)	63.4(34.1)	0.86	71.2(38.3)
486597ic	130.0(100)	40.0(21.5)	63.4(34.1)	0.63	71.2(38.3)

^a See table 1 for an explanation of symbols.

figs. 1–3; pl. 29, figs. 1, 2, 6; text-figs. 33, 34) also revised the species.

A comparison of the type specimens of *rostratum* and *perinflatum* (figs. 9–11 vs. fig. 12), notably the previously unfigured flank of *rostratum* (fig. 10), indicates that the specimens consist of similar portions of phragmocone starting at the same whorl height, with the holotype of *rostratum* also including the adult body chamber, complete to the aperture. Examining the section of phragmocone common to both holotypes indicates clearly that at the smallest visible diameter both have ribs arising in pairs from umbilical bullae; these ribs are replaced by predominantly primary ribs at a larger diameter, with occasional intercalated ribs. In both specimens, each rib bears an umbilical bulla, an outer lateral tubercle, and an inner and outer ventrolateral tubercle. The chief difference between the two types is the compressed whorl section of the holotype of *rostratum*, which has suffered postmortem compactional crushing, whereas the phosphatized holotype of *perinflatum* retains its original proportions. The characters of the phragmocones of the two type specimens are identical, and in our view they are members of the same species group. The adult body chamber of the holotype of *rostratum* shows the persistence of quadrituberculation onto the adapical few ribs, beyond which a damaged section intervenes; the succeeding ribs indicate that the ventrolateral tubercles have merged. No

adult body chambers of *perinflatum* have been illustrated. We conclude that *rostratum* has all of the characters that can be recognized on the holotype of *perinflatum*, and that *Durnovarites* is a junior synonym of *Subschloenbachia*, as proposed by Scholz (1979). As shown below, the Weno Limestone yields a series of beautifully preserved *Mortoniceras (Subschloenbachia) rostratum* that fully demonstrate the characters of the species.

Mortoniceras (Subschloenbachia) rostratum
(J. Sowerby, 1817)
Figures 9–11, 13–18

Ammonites rostratus J. Sowerby, 1817: 163, pl. 173.
Mortoniceras (Pervinquieria) rostratum (J. Sowerby). Spath, 1932: 400, pl. 36, fig. 6; pl. 38, fig. 4; pl. 39, fig. 4; pl. 40, figs. 1, 7; pl. 42, fig. 2; text-figs. 130f, g; 136, 137e (with synonymy).
Mortoniceras rostratum (J. Sowerby). Cooper and Kennedy, 1979: 280, fig. 70 (with additional synonymy).
Pervinquieria (Subschloenbachia) rostrata (Sowerby, 1817). Scholz, 1979: 111, pl. 26, figs. 1, 2; pl. 27, figs. 1, 2.
Mortoniceras rostratum (J. Sowerby, 1817). Latil, 1995: 72, pl. 1, fig. 1; pl. 2, fig. 1.

TYPE: Holotype, by monotypy, is K835 in the collections of the Oxford University Museum, the original of J. Sowerby, 1817, p. 163, pl. 173, from the upper Albian Upper

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northeast of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. **H.** USNM 486598, Weno Limestone, east of Katy Lake Dam, Fort Worth, Tarrant County. **I.** USNM 486595, lower Weno Limestone on Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. **J, K.** USNM 486547, same horizon and locality as A–C. All figures are ×1.



Fig. 16. *Mortonicerias* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). USNM 486596, basal Weno Limestone in Sycamore Creek, above and below the intersection with Seminary Drive, Fort Worth, Tarrant County. Figures are $\times 1$.



Fig. 17. *Mortoniceras* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). USNM 486549, lower Weno Limestone on Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. Figures are $\times 1$.

Greensand of Roke, 1.5 km NNE of Benson, Oxfordshire, England (figs. 9–11).

DESCRIPTION: We have more than 20 specimens. USNM 486595 and 486598 are phragmocones 86 and 110 mm in diameter, respectively (fig. 15I, H, respectively). Coiling is evolute, with a broad umbilicus comprising 36–37% of the diameter, of moderate depth, with a broadly rounded umbilical wall and shoulder. The intercostal whorl section is slightly compressed, with broadly rounded convergent flanks, more narrowly rounded ventrolateral shoulders, and a broad, flattened venter with a strong siphonal keel.

An estimated 28–30 ribs per whorl arise at the umbilical seam and strengthen across the umbilical wall and shoulder, developing

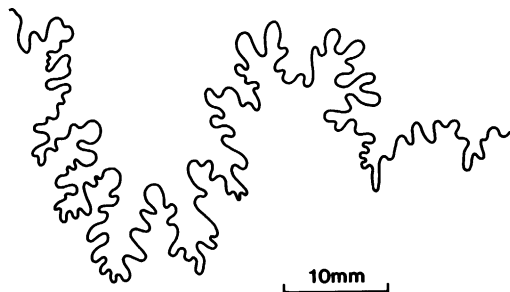


Fig. 18. Partial external suture of *Mortoniceras* (*Subschloenbachia*) *rostratum* (J. Sowerby, 1817). USNM 486549.

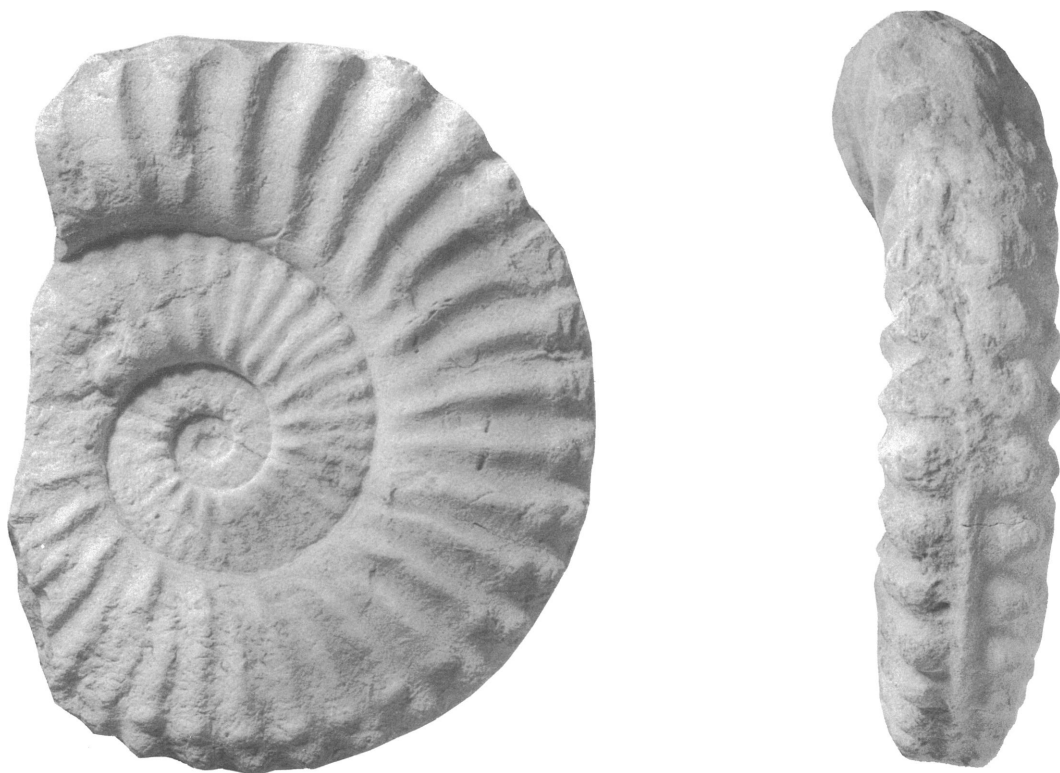


Fig. 19. *Mortonicerias (Angolaites) gregoryi* Spath, 1922. Holotype, BMNH C20066, the original of Spath (1922: pl. 3, fig. 1), upper Albian, Catumbella, Angola. Figures are $\times 1$.

into small umbilical bullae that migrate out from an umbilical to umbilicolateral position through ontogeny. The bullae give rise to pairs of blunt, straight to feebly flexuous prorsiradial ribs. All bear a weak middle to outer lateral tubercle at the smallest visible diameters; this tubercle becomes increasingly prominent through ontogeny. Ribs thicken across the ventrolateral shoulder, sweep forward, and bear poorly defined inner and outer ventrolateral tubercles, the latter separated from the siphonal keel by a smooth zone. Ribs total 48 at a diameter of 105 mm in USNM 486598.

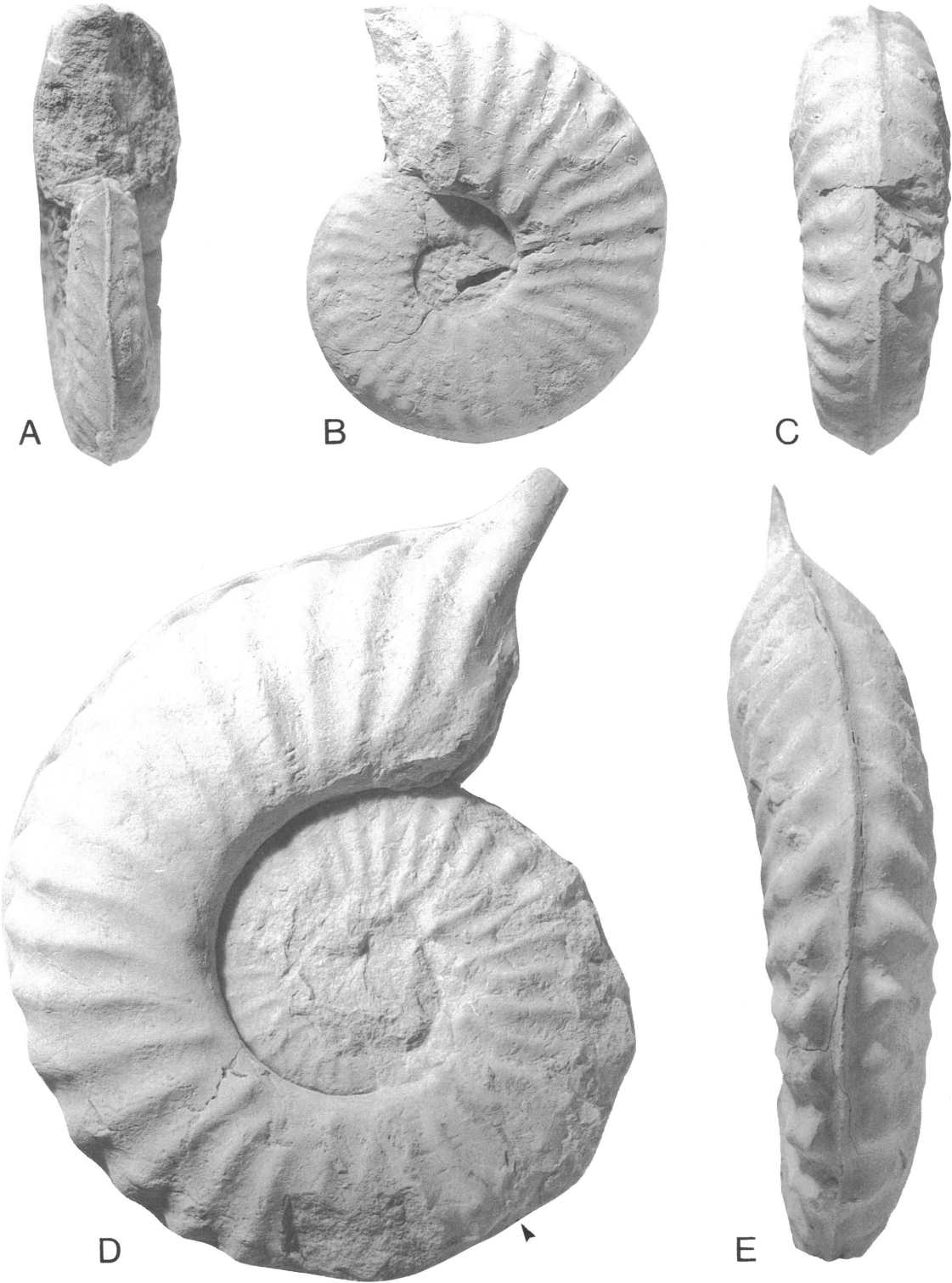
A much larger phragmocone fragment, USNM 486599, has an estimated original diameter of 130 mm. The whorl section is de-

pressed, with an intercostal ratio of whorl breadth to whorl height of 1.03 and a costal ratio of whorl breadth to whorl height of 1.26. The specimen extends almost half a whorl. There are ten strong umbilical bullae that give rise to pairs of very coarse, straight ribs with strong, rounded mid-lateral tubercles. Ribs swell and strengthen markedly across the ventrolateral shoulder, where a single protuberance bears a conical inner and clavate outer ventrolateral tubercle. A smooth zone separates the tubercles from the strong siphonal keel.

USNM 486597 is an adult 180 mm in diameter, lacking only the rostrum (figs. 13, 14A). Ornament of the type described above extends almost to the end of the phragmo-

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Fig. 20. *Mortonicerias (Angolaites) drakei* (Young, 1957). A–C. USNM 486571, Weno Limestone, Fort Worth, Tarrant County. D, E. USNM 486582, Weno Limestone, bed of Sycamore Creek north of Oak Grove road bridge in south Fort Worth, Tarrant County. All figures are $\times 1$.



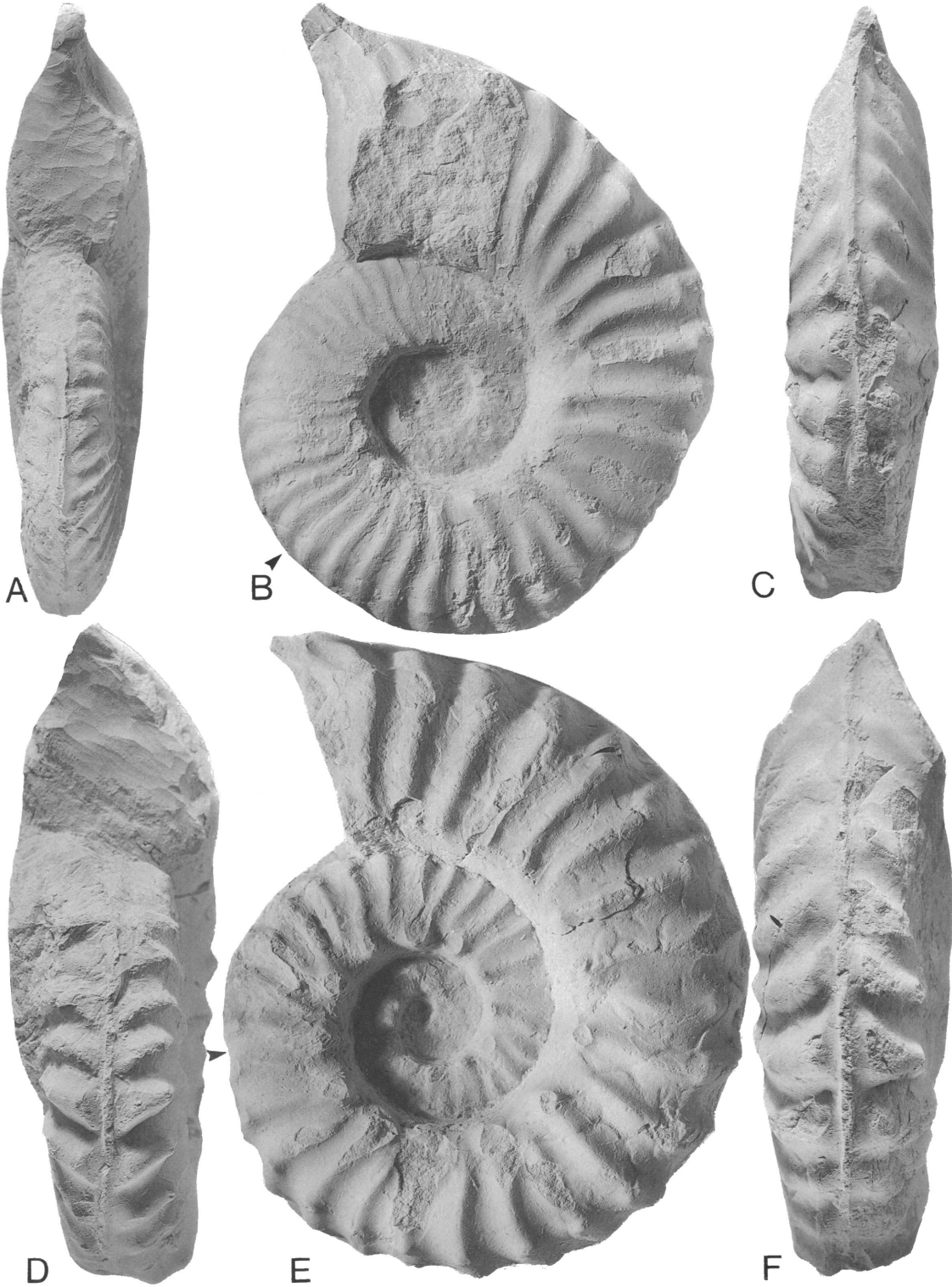


TABLE 3
Dimensions (mm) of *Mortoniceras (Angolaites) drakei* (Young, 1957)^a

USNM Specimen	D	Wb	Wh	Wb:Wh	Ud
486569	39.5(100)	19.0(48.1)	16.0(40.5)	1.19	12.5(31.6)
486570c	59.5(100)	28.0(47.1)	23.0(38.7)	1.21	20.8(35.0)
486571ic	70.5(100)	22.1(31.3)	31.0(44.0)	0.71	18.5(26.2)
486572c	99.0(100)	29.7(30.0)	35.8(36.2)	0.82	34.0(34.3)
486572ic	99.0(100)	27.3(27.6)	35.8(36.2)	0.76	34.0(34.3)
486573c	102.5(100)	31.5(30.7)	38.2(37.3)	0.82	37.5(36.6)
486573ic	102.5(100)	29.0(28.3)	38.2(37.3)	0.76	37.5(36.6)

^a See table 1 for an explanation of symbols.

cone. Beyond this, the ribs coarsen markedly, numbering only ten per half whorl. They become narrow and high, so that the bullae and lateral tubercles become pinched, the latter migrating out to an outer lateral position. The inner and outer ventrolateral tubercles efface, leaving only a single row of ventrolateral nodes that progressively strengthens. The last few ribs preceding the adult aperture show a rapid loss of tubercles, weaken, and crowd markedly, while growth lines and striae become prominent. The base of a dorsal apertural rostrum is preserved, but the greater part of the process is missing.

Some specimens, such as USNM 486594, have a more depressed whorl section (fig. 14F, G). This is an internal mold of a phragmocone fragment with a maximum preserved whorl height of 37.5 mm. Coiling is moderately involute with a deep umbilicus; the umbilical wall is broadly rounded and the umbilical shoulder is more narrowly rounded. The whorl section is depressed, with a ratio of whorl breadth to whorl height of 1.13; the whorl section is trapezoidal, with the greatest breadth close to the umbilical shoulder. Six primary ribs arise at the umbilical seam and strengthen into bullae on the umbilical shoulder. These give rise to pairs of blunt, straight, prorsiradiate ribs, each of which bears a feeble, bullate mid-lateral tubercle and a stronger, conical, inner ventrolateral tubercle. This

ventrolateral tubercle gives rise in turn to a low, blunt, prorsiradiate rib that sweeps forward across the ventrolateral shoulder to a feeble, outer ventrolateral clavus. Ribs weaken beyond this point and define an obtuse chevron along the line of the blunt, coarse siphonal keel.

The suture is deeply incised, with a massive, bifid E/L, narrow, deep L, and large, bifid L/U₂ (fig. 18).

DISCUSSION: Taken out of context, fragments of *M. rostratum* such as USNM 486594 (fig. 14F, G), are easily confused with *Mortoniceras (Subschloenbachia) perinflatum* (Spath, 1922) (see revisions in Cooper and Kennedy, 1979: 269, figs. 3g, 61, 62d–i, 63–64; Scholz, 1979: 112, pl. 28, figs. 1–3; pl. 29, figs. 1, 2, 6; text-figs. 33, 34) of which *Durnovarites adkinsi* Young, 1957 (p. 6, pl. 1, figs. 1–7; pl. 7, fig. 4; text-figs. 1g, k, m) from the Main Street Formation, is a synonym. *M. rostratum* is, however, less markedly depressed.

OCCURRENCE: *M. (S.) rostratum* is the index fossil of the lower *rostratum* Subzone at the base of the *Stoliczkaia dispar* Zone of western Europe, where there are records from England, France, and Hungary. Most of the Texas specimens come from the lower Weno Limestone in Johnson County, but there are also specimens in the Conlin Collection from the ironstone level in the lower Weno Limestone of

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Fig. 21. *Mortoniceras (Angolaites) drakei* (Young, 1957). A–C. USNM 486580, lower Weno Limestone in Sycamore Creek above and below the intersection with Seminary Drive, Fort Worth, Tarrant County. D, F. USNM 486578, Weno Limestone, bed of Sycamore Creek north of Oak Grove bridge in south Fort Worth, Tarrant County. All figures are ×1.



Fig. 22. *Mortonicerias (Angolaites) drakei* (Young, 1957). USNM 486583, Weno Limestone, Mitchell Boulevard near intersection with East Rosedale Street, Fort Worth, Tarrant County. Figures are $\times 1$.

the classic Gainesville Brick Company locality in Cooke County, and from the Denton Clay; specimens in J. P. Conlin's Collection are from the Denton shell bed, 2 mi south of Salado in Bell County, and the top 1.5 m of the Fort Worth Limestone in Johnson County.

Subgenus *Angolaites* Spath, 1932

(*Drakeoceras* Young, 1957: 19;

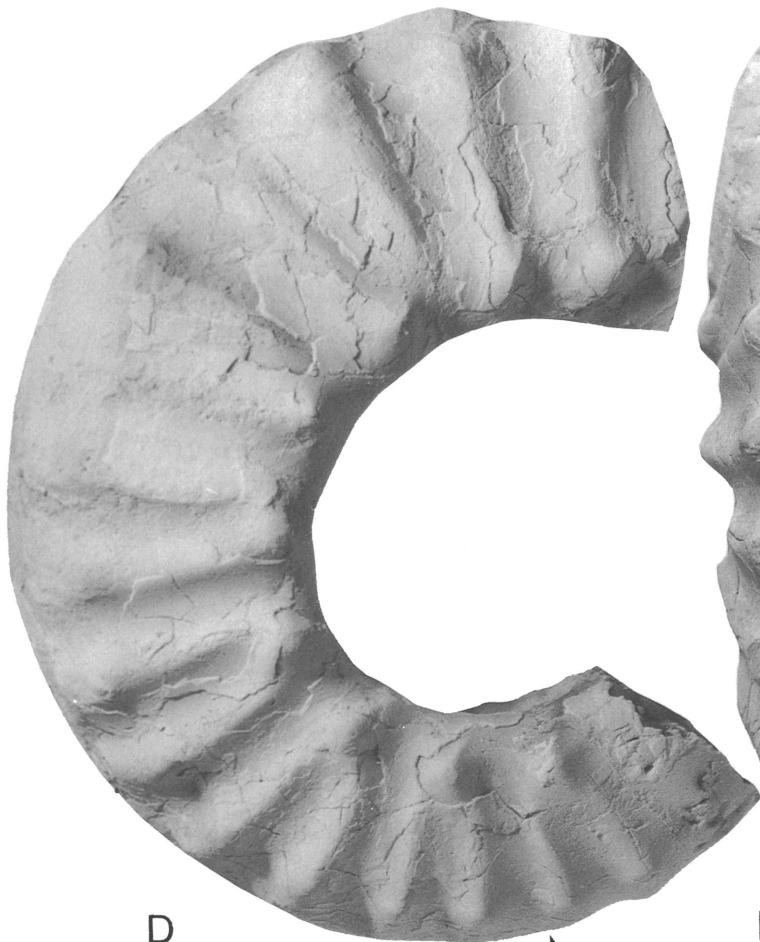
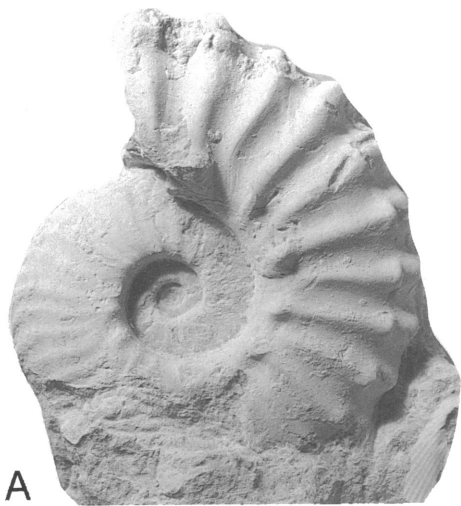
?*Praeangolaites* Collignon, 1979: 41)

TYPE SPECIES: *Pervinquieria gregoryi* Spath, 1922: 127, pl. 3, fig. 1, by original designation by Spath, 1932: 380.

DISCUSSION: In his discussion of *Drakeoceras*, Young (1957: 20) noted "*Angolaites gregoryi* (Spath, 1922), with double shoulder tubercles, in the adult has single, evenly spaced costae, all extending to the umbilicus, whereas in *Drakeoceras*, n.gen., only the last few ribs on the body chamber are of this type. In addition, *Angolaites* possesses a good flank tubercle, never present in *Drakeoceras*". The holotype of *Angolaites gregoryi* is shown in figure 19. It does not have a lateral ("flank") tubercle, removing one of the differences proposed by Young. The ribs

Fig. 23. *Mortonicerias (Angolaites)* sp. between *M. (A.) drakei* (Young, 1957) and *M. (A.) wintoni* (Adkins, 1920). USNM 486593, upper part of lower Weno Limestone, east of the dam at Katy Lake, Fort Worth, Tarrant County.





are indeed single on most of the body chamber of the holotype, but alternately long and short, or arising in pairs from umbilical bul-lae on the phragmocone. Specimens of *Drakeoceras drakei* and its synonyms have inner whorls that differ in no significant respects from those of *Angolaites gregoryi* (compare fig. 19 and fig. 20A–C). In addition, there are some adult body chambers of *D. drakei* in which most of the ribs are long (fig. 20D, E); we believe *D. drakei* to be congeneric with *Angolaites gregoryi*, differences between the two being of specific rather than generic significance. Cooper and Kennedy (1979) regarded *Drakeoceras* as a derivative of *Goodhallites*. They separated *Drakeoceras* from *Angolaites* on the basis of the narrower umbilicus and higher whorls of *Drakeoceras*. In the type species, *A. gregoryi*, the umbilical diameter is 43% of the shell diameter and the whorl height is 32% of the shell diameter. In *D. drakei*, the umbilical diameter averages 33% of the shell diameter and the whorl height ranges up to 44% of the shell diameter. We consider these differences no more than specific and place *Drakeoceras* in the synonymy of *Angolaites*.

Praeangolaites Collignon, 1979 (p. 41; type species, *Praeangolaites galvaei* Collignon, 1979: 42, pl. 20, fig. 3; pl. 21, fig. 1) was said to be characterized by having only a single row of ventrolateral tubercles during early and middle growth, and an inner and outer ventrolateral row at a late stage only; it is doubtfully distinct.

OCCURRENCE: Upper Albian, Texas, Angola, Nigeria.

Mortoniceras (Angolaites) drakei
(Young, 1957)

Figures 20–22, 24A–C, 25C–G, 26A–C, 28

Schloenbachia sp. M. Adkins and Winton, 1920: 34, pl. 5, figs. 1, 4.

Drakeoceras drakei Young, 1957: 26, pl. 3, fig.

2; pl. 4, fig. 1; pl. 6, figs. 1–4; pl. 10, figs. 1, 2, 6, 8; text-figs. 1e, 3d, f, g, m, o.

Drakeoceras georgetownense Young, 1957: 27, pl. 8, fig. 1; pl. 9, fig. 3; text-fig. 1a.

Drakeoceras gabrielense Young, 1957: 22, pl. 3, fig. 3; pl. 7, figs. 2, 3, 5, 6; pl. 10, figs. 3, 7; text-figs. 2h, 3b, c, e, n.

Mortoniceras (Drakeoceras) drakei (Young). Cobban, 1987: B8.

Mortoniceras (Drakeoceras) drakei (Young). Emerson et al., 1994: 123, 365.

Mortoniceras (Drakeoceras) georgetownense (Young). Emerson et al., 1994: 366.

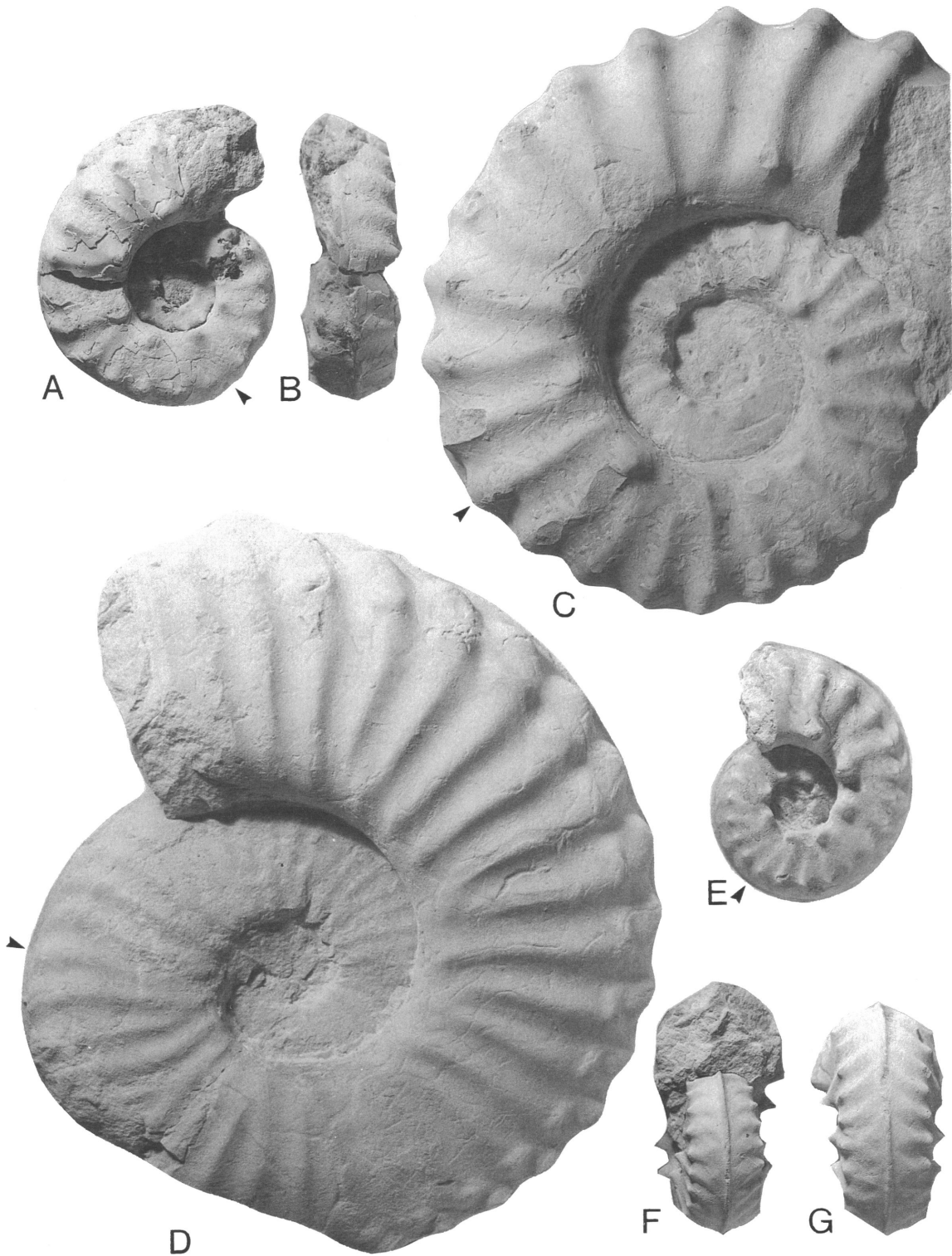
NAME OF THE SPECIES: Under the International Rules of Zoological Nomenclature, all of the *Drakeoceras* species named by Young (1957) are deemed to have been published simultaneously. As first revising authors, we select the name *drakei* for the species.

TYPE: The holotype, by original designation, is TMM BEG 20249, the original of Young, 1957: 26, pl. 10, figs. 2, 6, 8, from the Georgetown Limestone 3.5–4.75 m (10–15 ft) below the top, 3.3 km (2 mi) east of Belton, Bell County, Texas.

DESCRIPTION: We have more than 90 specimens from the Weno Limestone of Johnson and Tarrant counties. The species has highly variable inner whorls and shows a marked size dimorphism. Coiling is very evolute, the umbilicus comprising up to 37% of the diameter. The phragmocone whorls of a compressed, feebly ornamented variant are represented by USNM 486571 (fig. 20A–C). The intercostal ratio of whorl breadth to whorl height is 0.71. The umbilicus comprises 26% of the diameter at 70 mm diameter and is shallow, with a low, rounded, and undercut wall on the mold. The umbilical shoulder is quite narrowly rounded, the flanks feebly convex, the ventrolateral shoulders broadly rounded, and the venter fastigiate at first, becoming flattened later, with a strong siphonal keel. Eighteen primary ribs

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Fig. 24. A–C. *Mortoniceras (Angolaites) drakei* (Young, 1957). A. USNM 486574, Weno Limestone on Sycamore Creek, 320 m (350 yards) northeast of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. B, C. USNM 486570, lower Weno Limestone on Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. D, E. *Mortoniceras (Angolaites) wintoni* (Adkins, 1920). USNM 486592, Weno Limestone, Gainesville Brick Pit, Cooke County. All figures are $\times 1$.



arise at the umbilical seam and strengthen into feeble, prorsiradiate umbilical bullae. These give rise to pairs of ribs while occasional additional ribs intercalate, giving a total of 34–36 ribs per whorl. The ribs are prorsiradiate, straight on the inner flank, convex across the middle flank, and feebly concave on the outer flank. All develop rounded, weakly clavate inner ventrolateral tubercles; each tubercle gives rise to a flattened prorsiradiate rib that forms an obtuse chevron with the keel during early growth. On the later parts of the phragmocone, a row of outer ventrolateral tubercles develops. Inner and outer ventrolateral tubercles are linked by a broad, blunt rib, while a shallow groove separates the outer ventrolateral tubercle from the siphonal keel.

There is a marked coarsening of ornament at the beginning of the adult body chamber, well shown by USNM 486574 (fig. 24A). Adults have up to 36 ribs per whorl. These arise in pairs from small, sharp umbilical bullae that may decline toward the end of the adult body chamber, where ribs tend to become single. Ribs change progressively from flexuous to markedly concave and prorsiradiate. All bear small inner ventrolateral clavi, each of which is linked by a blunt radial rib to a much stronger outer ventrolateral clavus, separated by a groove from the siphonal keel.

Coarse-ribbed variants (figs. 21D–F, 24B, C, 25C, E–G, 26A–C) have depressed whorl sections, 10 or 11 subspinose umbilical tubercles per whorl, and develop inner and outer ventrolateral tubercles from a relatively early stage. There are about 28 ribs per whorl on phragmocones. Adults have about 30 ribs per whorl, arising in pairs from subspinose bullae, with strong inner and outer ventrolateral clavi; the ribs are much less flexuous and concave than in compressed variants. On the last part of the adult body chamber, umbilical

bullae weaken and disappear, and the ribs are all single primaries. Some specimens (USNM 486576, fig. 25C) combine coarse, straight to feebly flexuous prorsiradiate ribs on the outer whorl with very feebly ornamented inner whorls. A number of specimens show the adult aperture. Complete and incomplete adults show a clearly defined size dimorphism. Microconchs are 84–105 mm in diameter at the base of the ventral rostrum. Macroconchs are 125–150 mm in diameter.

The suture (fig. 28) is simple with a broad, bifid E/L, and very narrow, deep, and slender U₂.

DISCUSSION: The abundant specimens before us show a broad range of variation encompassing the much smaller number of specimens that Young (1957) referred to his species *M. (A.) drakei*, *M. (A.) gabrielense*, and *M. (A.) georgetownense*. *M. (A.) dellense* Young, 1957 (p. 25, pl. 7, fig. 1; pl. 10, figs. 4, 5, 9, 10; text-figs. 2j, 3a, h–j) is known only from the lower part of the *Plesioturritites brazoensis* Zone in the Georgetown Limestone according to Young (1957: 26). It appears to have much finer, flexuous ribbing at maturity than is visible in any of the *Weno Mortoniceras (Angolaites)* before us, and may have evolved from *M. (A.) drakei* with feebly ornamented inner whorls through some heterochronous process. *M. (A.) lasswitzii* Young, 1957 (p. 28, pl. 5, fig. 3; pl. 8, fig. 3; pl. 9, fig. 7; text-figs. 2k, 3k) is a coarsely ornamented species with massive umbilical tubercles that reaches a much larger size than *M. (A.) drakei*, as does *M. (A.) maximus* (Lasswitz, 1904) (p. 244 (24), pl. 18 (6), fig. 2; text-fig. 5).

OCCURRENCE: *M. (A.) drakei* ranges throughout the Weno Limestone in north Texas, and also occurs in the underlying Denton Clay. Young (1957) recorded the species from his *Mortoniceras wintoni* to

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Fig. 25. **A, B.** *Mortoniceras (Angolaites) wintoni* (Adkins, 1920). USNM 486590, Weno Limestone, Gainesville Brick Pit, Cooke County. **C–G.** *Mortoniceras (Angolaites) drakei* (Young, 1957). **C.** USNM 486576, coarsely ornamented, robust variant, Weno Limestone, bed of Sycamore Creek southeast of the I. and G.N. Railroad bridge in southern Fort Worth, Tarrant County. **D.** USNM 486584, Weno Limestone on Sycamore Creek, 320 m (350 yards) northwest of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. **E–G.** USNM 486569, juvenile of robust variant, same horizon and locality as D. All figures are $\times 1$.

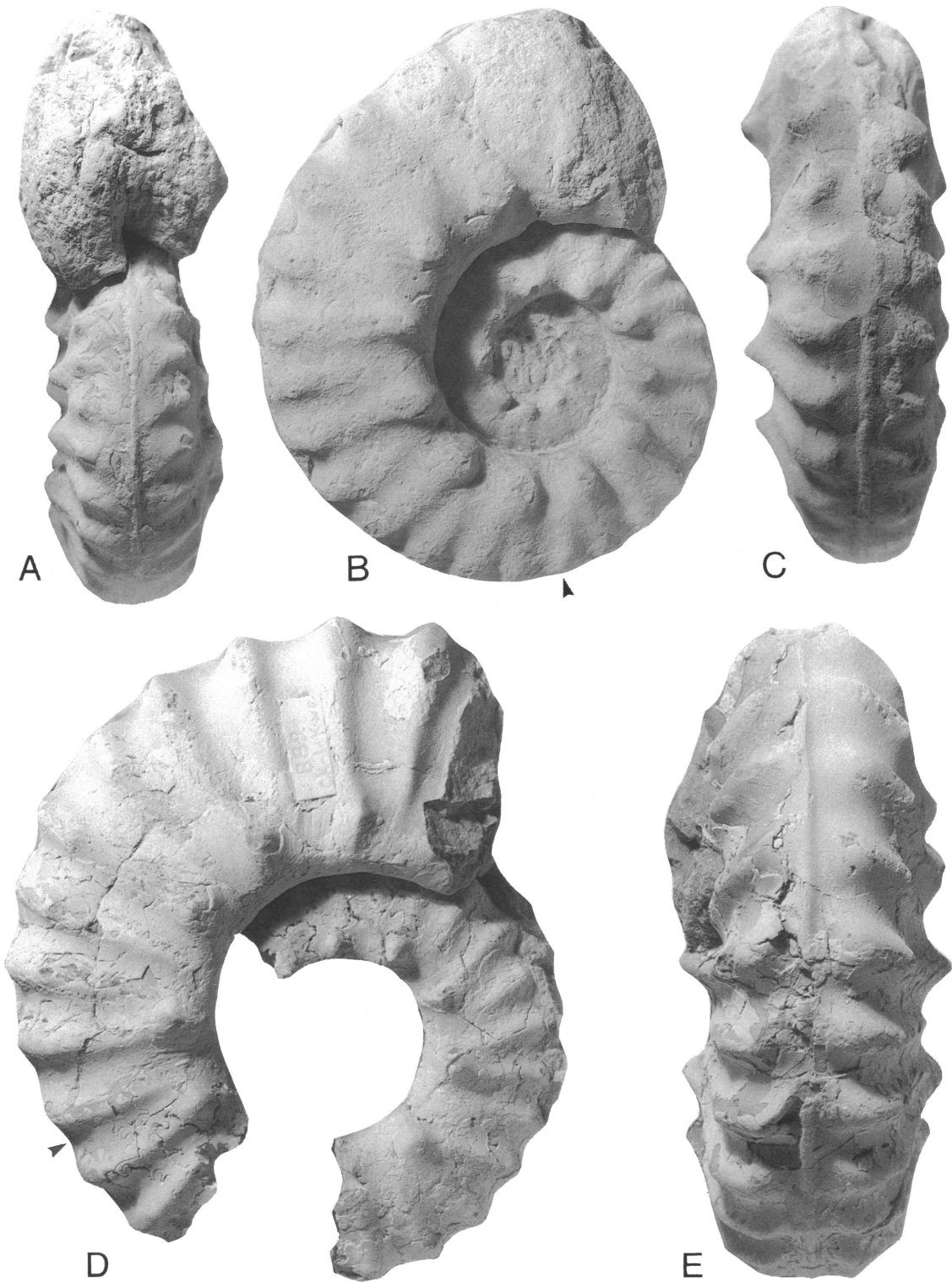


TABLE 4
Dimensions (mm) of *Mortoniceras (Angolaites) wintoni* (Adkins, 1928)^a

USNM Specimen	D	Wb	Wh	Wb:Wh	Ud
486590ic	39.5(100)	—(—)	15.0(38.0)	—	15.5(39.2)
486591ic	106.0(100)	—(—)	39.5(37.3)	—	41.5(39.2)
486592c	133.0(100)	57.0(42.9)	49.5(37.2)	1.15	50.5(38.0)
486592ic	133.0(100)	48.7(36.6)	49.5(37.2)	0.98	50.5(38.0)

^a See table 1 for an explanation of symbols.

Turrilites brazoensis zones and from as far south as Williamson and Bell counties.

Mortoniceras (Angolaites) wintoni (Adkins, 1920)
Figures 24D, E, 25A, B, 26D, E

Schloenbachia sp. *M.* Adkins and Winton, 1920: 34, pl. 5, figs. 1–4.

Schloenbachia wintoni Adkins, 1920: 90, pl. 3, figs. 8–11.

Schloenbachia wintoni Adkins. Winton, 1925: 59, pl. 5, fig. 4.

Pervinquieria wintoni (Adkins). Adkins, 1928: 31, pl. 19, fig. 5.

Mortoniceras (Drakeoceras) wintoni (Adkins). Matsumoto, 1960: 3, fig. 2.

Mortoniceras (Mortoniceras) wintoni Adkins. Emerson et al., 1994: 365.

TYPE: The holotype is the original of Adkins, 1920, pl. 3, figs. 8, 11, from the Weno Limestone near Gainesville, Cooke County, Texas, in the collections of the Texas Christian University, Fort Worth.

DESCRIPTION: USNM 486590 (fig. 25A, B) shows the early growth stages to a diameter of 39.5 mm. Coiling is evolute; the broad umbilicus comprises 39.2% of the diameter, and is moderately deep, with a flattened wall and narrowly rounded umbilical shoulder. The intercostal whorl section is depressed polygonal, with flattened, convergent flanks, and a broad fastigiate venter with siphonal

keel. The costal section is even more depressed, with the greatest breadth at the prominent umbilical bullae. These number eight or nine per half whorl, are subspinose, and perch on the umbilical shoulder. They give rise to coarse, blunt, straight rursiradiate ribs, either singly or in pairs; in addition, there are occasional long, nonbullate ribs, giving a total of approximately 22 ribs per whorl. All ribs bear conical inner ventrolateral tubercles. These give rise, in turn, to low, blunt ribs that extend to the siphonal keel.

Phragmocone whorls to a diameter of 60 mm are shown by an artificial cast taken from USNM 486592 (fig. 24D, E). There are five spinose umbilical bullae per whorl corresponding to fourteen ribs. USNM 486591 (fig. 26D, E) shows the adult phragmocone, extending to an estimated 90 mm diameter. The whorl section is depressed, with an intercostal ratio of whorl breadth to whorl height of 1.15. There are six spinose umbilical bullae and 14 ribs, each of which bears bullate inner and outer ventrolateral tubercles, linked by a strong rib, and separated by a smooth zone from the blunt siphonal keel.

USNM 486592 (fig. 24D, E) shows the adult body chamber at a diameter of 133 mm. Bullae are strong at the beginning of the body chamber, where they give rise to pairs of markedly rursiradiate ribs. Toward the

←

Fig. 26. A–C. *Mortoniceras (Angolaites) drakei* (Young, 1957). USNM 486585, coarse-ribbed variant, Weno Limestone on Sycamore Creek, 320 m (350 yards) northwest of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. D, E. *Mortoniceras (Angolaites) wintoni* (Adkins, 1920). USNM 486591, Weno Limestone, Gainesville Brick Pit, Cooke County. All figures are ×1.

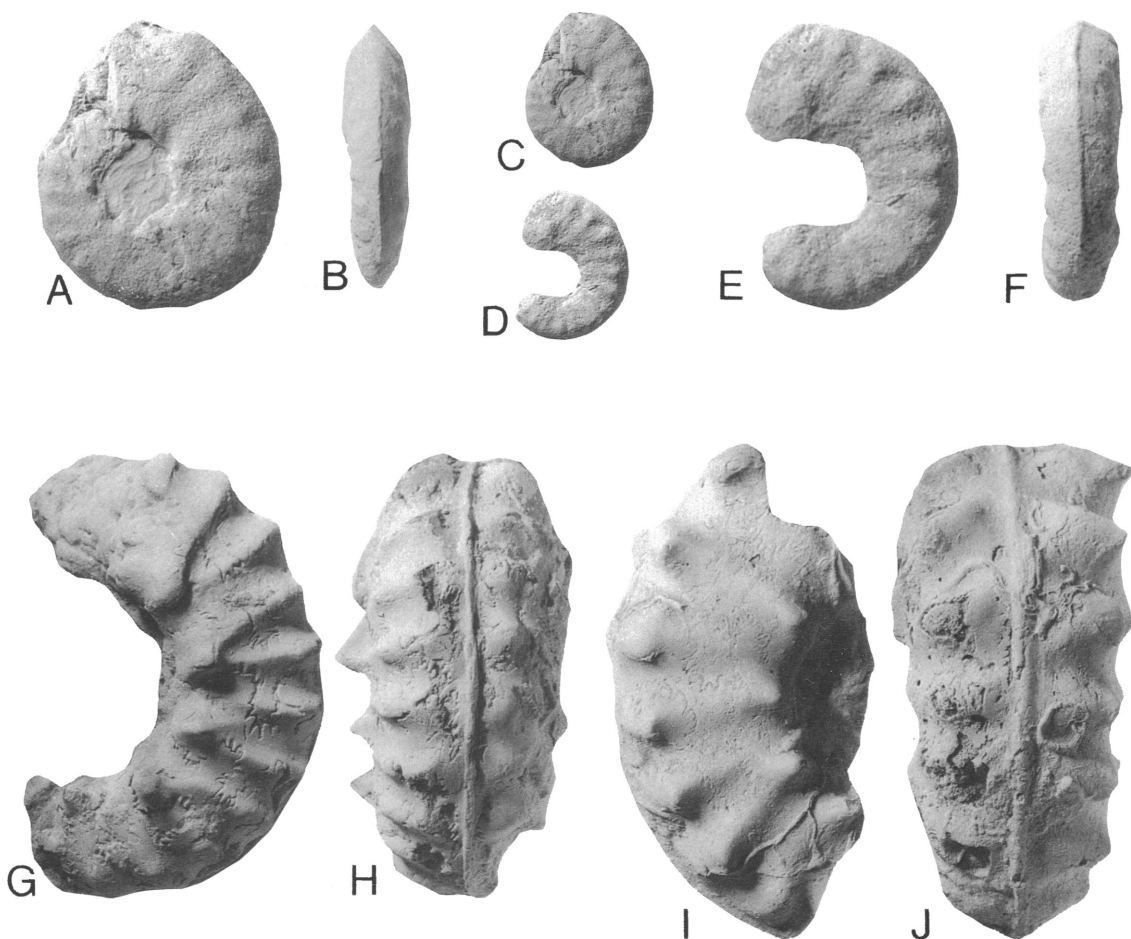


Fig. 27. A–F. *Mortonicerias (Angolaites)* sp. juv., upper Weno Limestone, Glen Garden Country Club, Tarrant County. A–C. USNM 486550. D–F. USNM 486551. G–J. *Mortonicerias (Angolaites)* sp. between *drakei* (Young, 1957) and *wintoni* (Adkins, 1920). G, H. USNM 486553, Weno Limestone, tributary to Rock (Turkey) Creek east of concrete bridge and south of first east-west road south of Tarrant–Johnson County line. I, J. USNM 486552, lower Weno Limestone on Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. Figures A, B, E, F are $\times 2$; the rest are $\times 1$.

adult aperture, the bullae decline and single ribs replace pairs of ribs.

The suture is moderately incised. E is deep with a long medial saddle, E/L is broad and bifid, L is narrow and deep, L/U₂ is small, broad, and bifid, and U₂ is small and bifid.

DISCUSSION: *Mortonicerias (Angolaites) wintoni* differs from *M. (A.) drakei*, the other species of this genus from the Weno Limestone, in having broad, inflated whorls with coarse persistent umbilical bullae and rursi-radiate ribs, which easily separate it from the

compressed and flexuously ribbed form of the latter. Some specimens (e.g., USNM 486593, fig. 23; see also figs. 26A–C, 27G–J) may be transitional between the two in terms of inflation and coarseness of ribbing, combined with strong inner and outer ventrolateral tubercles when adult.

OCCURRENCE: Ironstone facies of the lower Weno Limestone near Gainesville, Cooke County, Texas; Denton Clay, Bell County, Texas. Transitional forms occur in the lower Weno Limestone in Tarrant County.

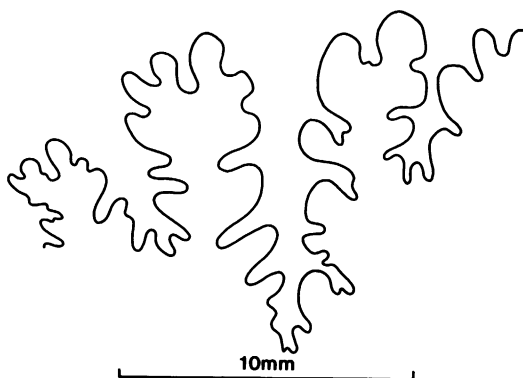


Fig. 28. *Mortonicerias (Angolaites) drakei* (Young, 1957). Partial external suture of USNM 486577.

FAMILY LYELLICERATIDAE SPATH, 1921

SUBFAMILY STOLICZKAIINAE
BREISTROFFER, 1953

Genus and Subgenus *Stoliczkaia*
Neumayr, 1875

(=*Villoutreysia* Casey, 1965: 435, fn. 1)

TYPE SPECIES: *Ammonites dispar* d'Orbigny, 1841: 142, pl. 45, figs. 1, 2, by the subsequent designation of Diener, 1925: 179.

Stoliczkaia (Stoliczkaia) argonautiformis
(Stoliczka, 1864)
Figures 29E–H

Ammonites argonautiformis Stoliczka, 1864: 87, pl. 46, figs. 1, 2.

Stoliczkaia argonautiformis Stoliczka sp. Kossmat, 1895: 196 (100).

Stoliczkaia argonautiformis Stoliczka. Diener, 1925: 179.

Stoliczkaia argonautiformis Stoliczka. Collignon in Besairie, 1936: 193, pl. 18, fig. 9; pl. 21, fig. 9.

Stoliczkaia argonautiformis Stoliczka. Collignon, 1963: 183, pl. 317, fig. 1344.

TYPES: Stoliczka based this species on two individuals, from northeast of Moraviatoor in the Trichinopoly district of south India. The original of his pl. 46, fig. 1 is here designated lectotype of the species.

DESCRIPTION: USNM 486557 (fig. 29G, H) is a 120° sector of the outer whorl with a maximum preserved whorl height of 44 mm. Coiling is very involute, with a tiny umbili-

cus; the umbilical wall is feebly convex and inclined outward and the umbilical shoulder is narrowly rounded. The whorl section is compressed, with a ratio of whorl breadth to whorl height of 0.54, with the greatest breadth dorsal of mid-flank. The inner flanks are feebly convex, the outer flanks flattened and convergent, and the ventrolateral shoulders and venter are broadly rounded. The inner two-thirds of the flanks are smooth, except for a trace of a single very faint, low, broad primary rib. The outermost flanks, ventrolateral shoulders, and venter bear very coarse, even transverse ribs, of which 14 survive on the fragment. The suture has a large bifid E/L, a narrow, deep L, and a narrow L/U₂.

USNM 486556 (fig. 29E, F) may represent the early growth stages of the species. The original diameter was an estimated 30 mm. Coiling is very involute, with a tiny umbilicus; the whorl section is compressed. Ornament consists of coarse ribs on the outermost flanks and venter, as in the larger individual, with occasional well-developed primaries that extend down to the umbilical shoulder.

DISCUSSION: The virtual absence of inner to middle flank ornament and the presence of coarse outermost flank and ventral ornament, together with the very involute coiling and compressed whorl section of the larger fragment closely recall the lectotype, as shown in Stoliczka's figures. In addition, the loss of ornament at the adapertural end of the body chamber and the modification of the whorl section are highly distinctive. The smaller of the Texas specimens is much more coarsely ornamented than the Indian types at the same diameter, resembling, rather, the specimen from Madagascar figured by Collignon in Besairie, 1936 (pl. 18, fig. 9; pl. 21, fig. 9; see also Collignon, 1963, pl. 317, fig. 1344).

OCCURRENCE: Upper Albian of south India and Madagascar. The Texas examples are from the lower Weno Limestone on the Buck Bell Farm in Johnson County.

Genus and Subgenus *Neophlycticeras*
Spath, 1922

(=*Faraudiella* Breistroffer, 1947a: 309;
Eotropitoides Casey, 1965: 462, fn. 1)

TYPE SPECIES: *Ammonites brottianus* d'Orbigny, 1841: 290, pl. 85, figs. 8–10, by original designation.

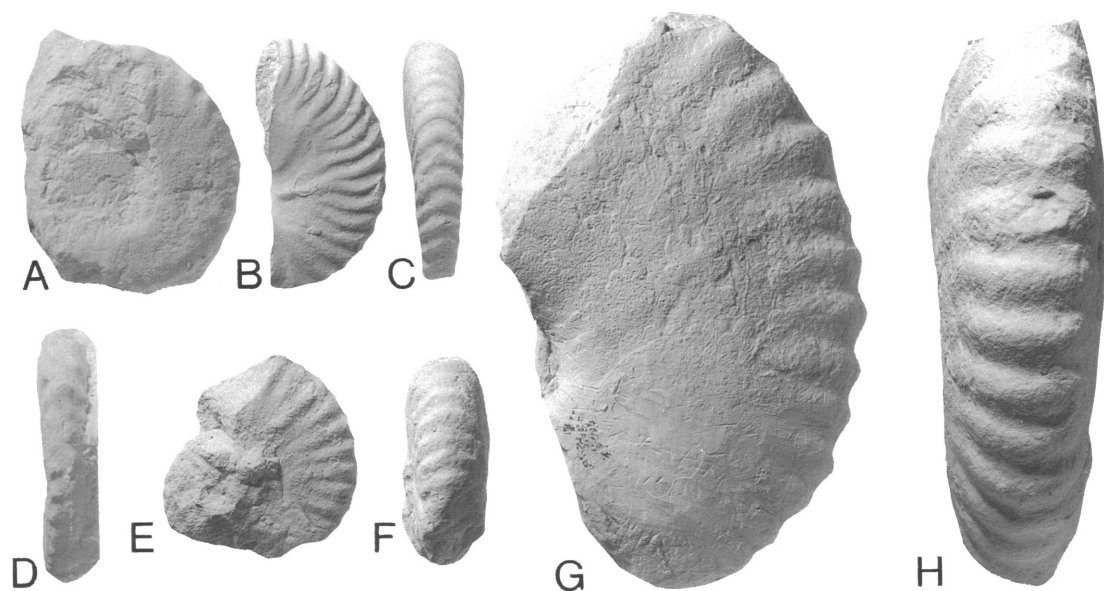


Fig. 29. **A–D.** *Neophlycticeras* (*Neophlycticeras*) sp. **A, D.** USNM 486554, upper 6 ft of Weno Limestone east of Glen Garden, Fort Worth. **B, C.** USNM 486555, Weno Limestone, 6.6 km (4 mi) south of Cleburne, Johnson County. **E–H.** *Stoliczkaia* (*Stoliczkaia*) *argonautiformis* (Stoliczka, 1864). **E, F.** USNM 486556, same locality as fig. 27G, H. **G, H.** USNM 486557, lower Weno Limestone on Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. Figures A, D are $\times 2$; figures B, C, E–H are $\times 1$.

DISCUSSION: See Wright and Kennedy (1994) for a recent discussion of the genus.

Neophlycticeras (*Neophlycticeras*) sp.
Figures 29A–D

DESCRIPTION: There are two crushed specimens. USNM 486554 (fig. 29A, D) is a tiny individual only 16 mm in diameter. Coiling is very evolute; the whorl section is compressed, with subparallel flanks and a fastigate venter. The flanks are ornamented by delicate flexuous ribs that increase by branching and intercalation. All bear small ventral tubercles, linked to a row of siphonal clavi by broad ribs.

USNM 486555 (fig. 29B, C) is a half whorl of body chamber 33 mm in diameter. Coiling is very involute, with a tiny umbilicus. The whorl section is very compressed, but this is in part a result of postmortem crushing. The flanks are subparallel, the ventrolateral shoulders are broadly rounded, and the venter is obtusely fastigate at the adapical end and broadly rounded at the adapertural end of the specimen. Three very widely

separated, feeble umbilical bullae are preserved on the fragment. Each bulla gives rise to one or two strong prorsiradiate ribs that may bifurcate at mid-flank, where additional intercalated ribs arise, giving a total of 18 ribs on the fragment. The ribs flex back and are markedly concave on the outer flank, then flex forward to cross the venter in an obtuse chevron at the adapical end of the specimen, which modifies progressively into a broad convexity at the adapertural end. The ribs thicken markedly on the ventrolateral shoulders and venter. There are poorly differentiated ventrolateral clavi and prominent siphonal clavi at the smallest diameter preserved. These efface progressively, and the merest suggestion of the siphonal row persists to the aperture.

DISCUSSION: The prominent trituberculation shows these specimens to be *Neophlycticeras* (*Neophlycticeras*). The larger specimen has the overall rib style of the type species, but the ribs are more strongly projected and falcoid on the outer flank in this specimen. The change in ornament, notably the



Fig. 30. *Anisoceras armatum* (J. Sowerby, 1817). Holotype, OUM K675a, the original of J. Sowerby (1817: 153, pl. 178), upper Albian Upper Greensand of Roke, near Benson, Oxfordshire. Figure is $\times 1$.

weakening of tubercles on the venter, suggests it may be an adult, and serves to distinguish it from *N. (N.) blancheti* (Pictet and Campiche, 1859) (see revision in Wright and Kennedy, 1994: 563, figs. 2a–m, 6d–f, 7a–h). The smaller specimen is very evolute when compared with all previously described *Neophlycticeras*; the coiling is markedly eccentric, and this may be a pathological condition.

OCCURRENCE: The label for the two specimens reads “Weno marl 4 mi. S. of Cleburne,” Johnson County.

SUBORDER ANCYLOCERATINA WIEDMANN,
1966

SUPERFAMILY TURRILITACEAE GILL, 1871

FAMILY ANISOCERATIDAE HYATT, 1900

Genus *Anisoceras* Pictet, 1854

TYPE SPECIES: *Hamites saussureanus* Pictet in Pictet and Roux, 1847, p. 118, pl. 13, figs. 1–4, by original designation by Pictet, 1854: 705.

Anisoceras armatum (J. Sowerby, 1817)
Figures 30, 31, 32A–C, 33D–F, 36F

Hamites armatus J. Sowerby, 1817: 153, pl. 168.
Anisoceras (Anisoceras) armatum (J. Sowerby, 1817). Cooper and Kennedy, 1979: 200, figs. 13a, b; 14d–e; 16a, c, e, i; 17–19 (with full synonymy).

Anisoceras (Anisoceras) armatum (J. Sowerby). Scholz, 1979: 25 (pars), pl. 2, figs. 1, 5, 7 only.



Fig. 31. *Anisoceras armatum* (J. Sowerby, 1817). OUM K37916a, upper Albian, Upper Greensand, Cuxham, Watlington, Oxfordshire. Figures are $\times 1$.

non *Anisoceras* sp. aff. *armatum* J. Sow. Collignon, 1979: 7, pl. 1, fig. 12.

Anisoceras armatum (J. Sowerby, 1817). Kennedy, 1996: 573, figs. 24d–f, h.

TYPE: The holotype, by monotypy, is K675a in the collections of the University Museum, Oxford, from the upper Albian Upper Greensand of Roke, 1.5 km NNE of Benson, Oxfordshire, U.K., refigured here as figure 30.

DESCRIPTION: Three fragments are referred to this species. USNM 486558 (fig. 32A–C) is a 23 mm long fragment with a maximum preserved whorl height of 9 mm, showing slight helicoid coiling. The whorl section is circular. The dorsum is densely and evenly

ribbed. The ribs strengthen across the dorsolateral margin and are straight and rursi-radiate on the flanks. Pairs of ribs link at bul-late lateral tubercles, which are linked, in turn, by pairs of coarser ribs borne on low swellings to rounded-conical ventral tubercles; ventral tubercles are linked by pairs of ribs across the venter. There are one or two finer, nontuberculate ribs between the tuberculate groups.

USNM 486562 (fig. 33D–F) consists of two shafts and the linking curved sector, most of which is body chamber, with a maximum preserved whorl height of 25 mm. The whorl section is compressed oval, with a ratio of whorl breadth to whorl height of 0.8.

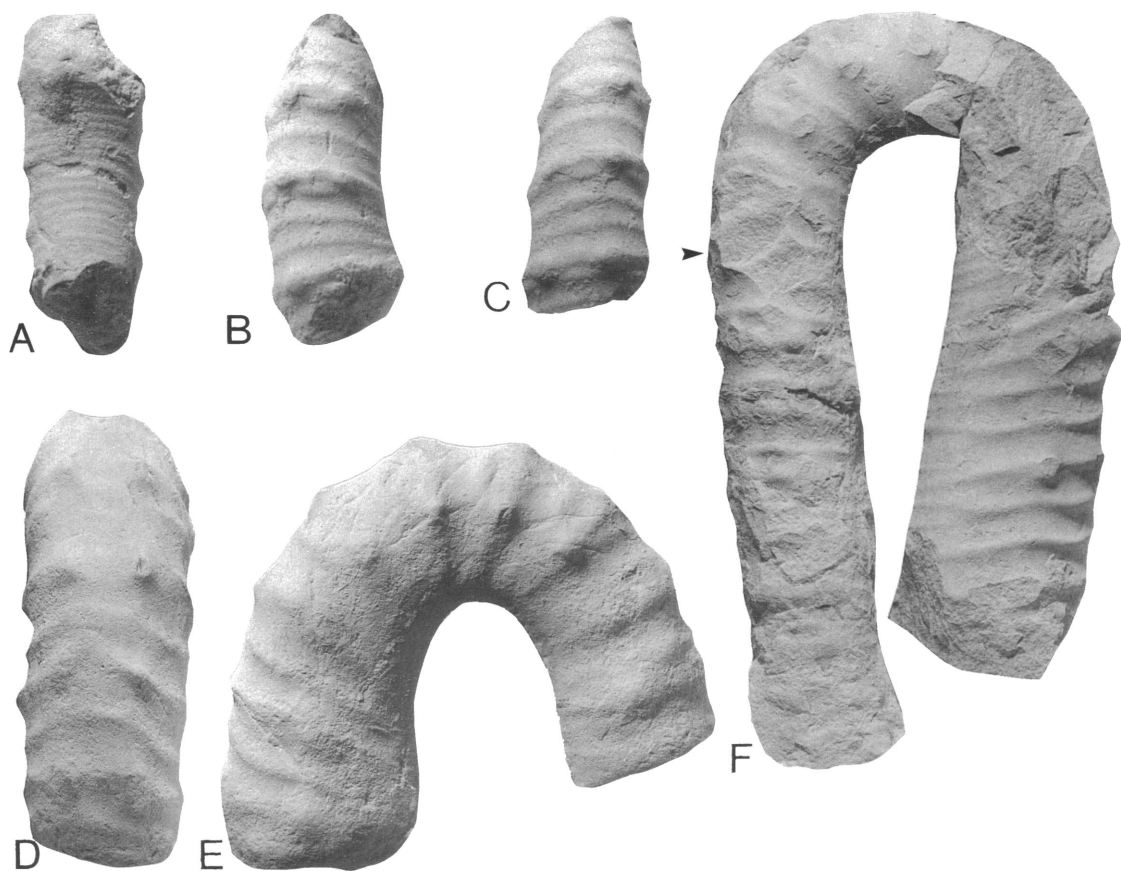


Fig. 32. **A–C.** *Anisoceras armatum* (J. Sowerby, 1817). USNM 486558, Weno Limestone exposed in the Texas and Missouri Railroad cut east of Ball Brothers Trucking Co. in southern Fort Worth, Tarrant County. **D–F.** *Anisoceras perarmatum* Pictet and Campiche, 1861. **D, E.** USNM 486559, Weno Limestone, east bank of Sycamore Creek 0.2 mi northeast of railroad bridge in southern Fort Worth. **F.** USNM 486560, Weno Limestone exposed in Sycamore Creek, 320 m (350 yards) northeast of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. Figures A–C are $\times 2$; Figs. D–F are $\times 1$.

The two shafts are not parallel, converging away from the curved sector. On the penultimate shaft, the dorsum is ornamented by dense, even, delicate ribs; the rib index is 12. Some ribs efface, others strengthen across the dorsolateral margin. Pairs of ribs link at strong, rounded lateral tubercles, which are linked by pairs of ribs to strong ventral clavi, which are linked, in turn, by pairs of ribs across the venter. There are one or two non-tuberculate ribs between tuberculate groups. The ribs change direction from recti- to prorsi- to rursiradial around the curved sector, and are markedly rursiradial on the final shaft. The dorsum is finely and densely

ribbed, with a rib index of up to 20. The ribs linking the tubercles on the flank are coarse and single, not looped, with one or two non-tuberculate ribs between; several of the finer dorsal ribs may join a single flank rib. USNM 486568 (fig. 36F) is a crushed, hook-shaped fragment with replaced shell. It shows that the tubercles were the bases of spines.

DISCUSSION: The holotype of *Anisoceras armatum* (fig. 30) is much larger than the Texas specimens. It shows the diagnostic features of the species: looped ribs joining tubercles, with one or two nontuberculate ribs between, the looping becoming less promi-

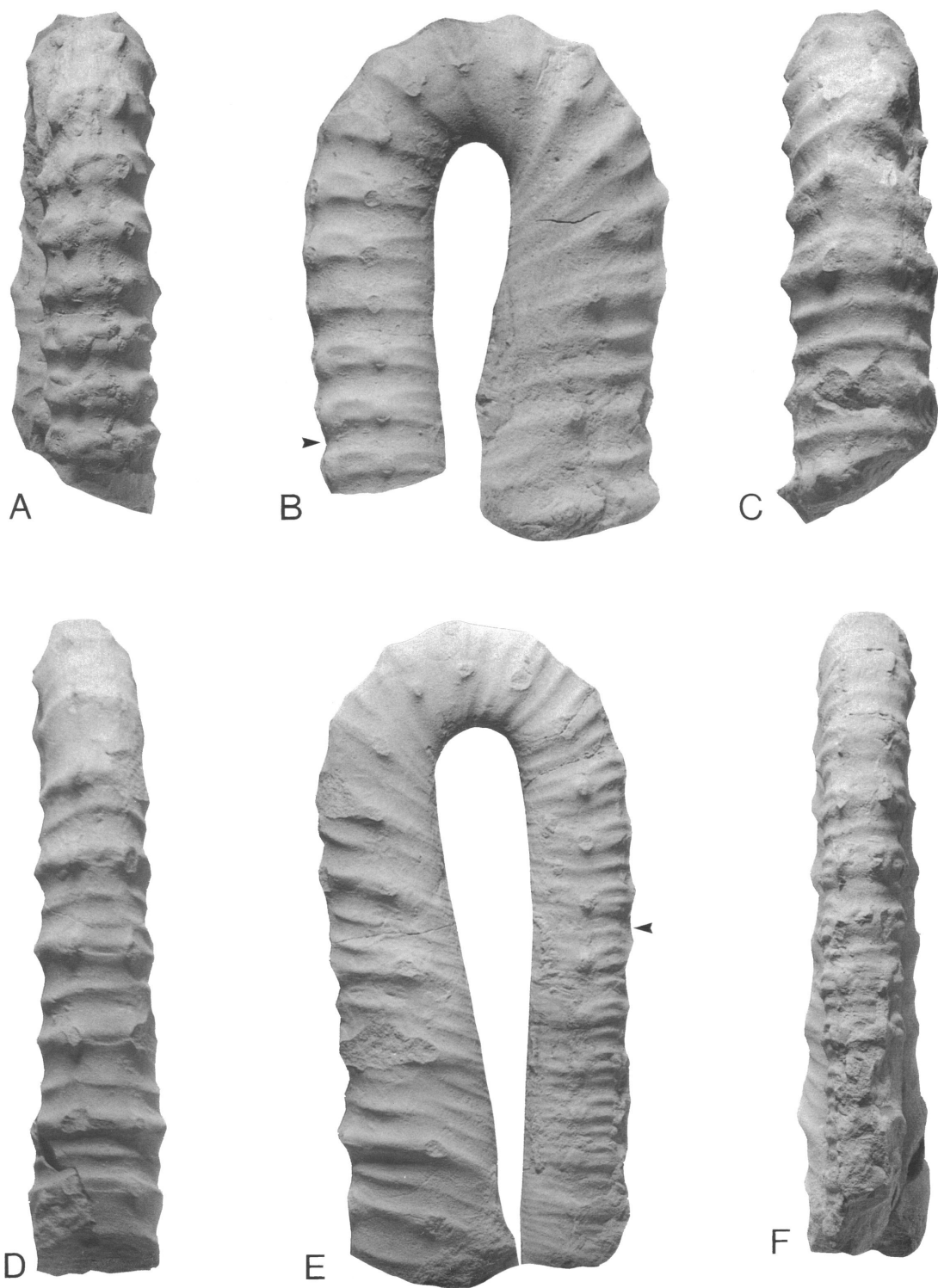


Fig. 33. A–C. *Anisoceras perarmatum* Pictet and Campiche, 1861. USNM 486561, Weno Limestone exposed in Sycamore Creek, 320 m (350 yards) northeast of the I. and G.N. Railroad bridge over the

nent and disappearing on the final shaft. It does not show the delicate dorsal ribbing so conspicuous on the Texas specimens, although this is present on other specimens from close to the type locality (fig. 31). *Anisoceras perarmatum* Pictet and Campiche, 1861, described below, lacks nontuberculate ribs throughout most of its ontogeny, although they develop on the final shaft of the adult body chamber. The two species commonly occur together, and some authors (e.g., Scholz, 1979) have regarded them as conspecific.

OCCURRENCE: Upper Albian, typically *Stoliczkaia dispar* Zone and correlatives, also possibly present in the lower Cenomanian. The geographic range extends from southern England to France, Germany, Switzerland, Hungary, Spain, Zululand (South Africa), Mozambique, south India, and Texas, where it occurs in the Weno Limestone of Tarrant County, and has been recorded from the Duck Creek and Pawpaw formations (Clark, 1965).

Anisoceras perarmatum Pictet and
Campiche, 1861

Figures 32D–F, 33A–C, 34, 35, 36A–E, G–L

Anisoceras perarmatum Pictet and Campiche, 1861: 65, pl. 49, figs. 1–3, 6, 7.

Anisoceras bendirei (Adkins). Clark, 1965: 26, pl. 5, figs. 6–8, 11; text-fig. 7b (with synonymy).

Anisoceras perarmatum Pictet and Campiche, 1861. Cooper and Kennedy, 1979: 196, figs. 12a–h; 13c–d; 14a–c; 15c–f; 16b (with synonymy).

Anisoceras perarmatum Pictet and Campiche, 1861. Scholz, 1979: 25 (pars), pl. 2, figs. 2–4, 6, 8–10.

Anisoceras perarmatum perarmatum Pictet and Campiche. Collignon, 1979: 8, pl. 1, figs. 9–11; pl. 2, fig. 1.

Anisoceras perarmatum angolatum Collignon, 1979: 9, pl. 3, fig. 1.

Anisoceras (*Anisoceras*) *perarmatum perarmatum* Pictet and Campiche. Chiriac, 1981: 65, pl. 4, figs. 6–9; text-fig. 22.

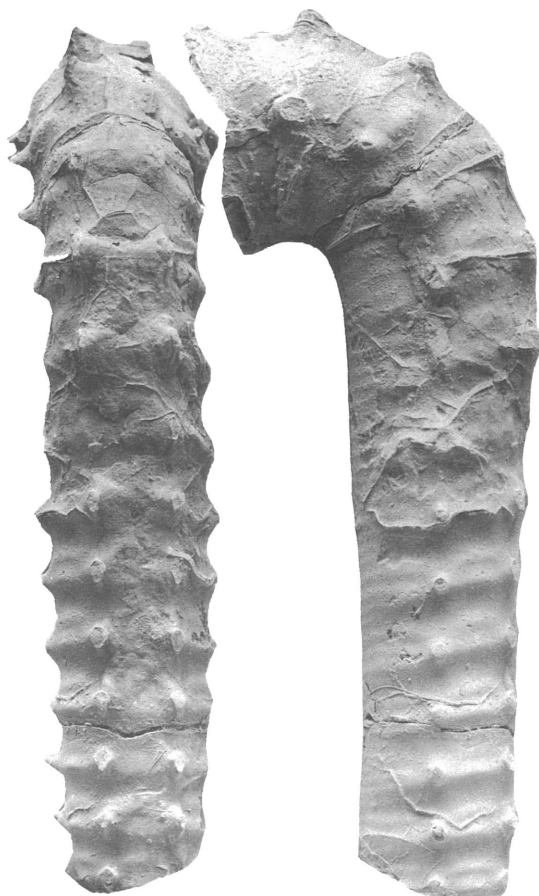


Fig. 34. *Anisoceras perarmatum* Pictet and Campiche, 1861. TMM 20271, the holotype of *Ancylloceras bendirei* Adkins, 1920 (pl. 11, fig. 1), base of the Weno Limestone near Fort Worth, Tarrant County. Figures are $\times 1$.

Anisoceras (*Anisoceras*) *perarmatum dorsocostatum* Chiriac, 1981: 66, pl. 5, fig. 1.

Anisoceras perarmatum (Pictet and Campiche, 1861). Latil, 1995: pl. 8, figs. 2, 3.

Anisoceras perarmatum Pictet and Campiche, 1861. Kennedy, 1996: 571, figs. 23a, e; 24a–c, g.

TYPE: Lectotype, by the subsequent designation of Renz, 1968: 74, is the original of Pictet and Campiche, 1861: pl. 49, fig. 1, no.

←

creek, southern Fort Worth, Tarrant County. **D–F.** *Anisoceras armatum* (J. Sowerby, 1817). USNM 486562, lower Weno Limestone in Sycamore Creek above and below the intersection with Seminary Drive, Fort Worth, Tarrant County. All figures are $\times 1$.



Fig. 35. *Anisoceras perarmatum* Pictet and Campiche, 1861. USNM 486563, lower Weno Limestone in Sycamore Creek above and below the intersection with Seminary Drive, Fort Worth, Tarrant County. Figures are $\times 1$.

21280 in the Musée Géologique de Lausanne, Switzerland, refigured by Renz, 1968: pl. 13, fig. 5.

DESCRIPTION: Twelve specimens are referred to *Anisoceras perarmatum*. All are sections of straight shafts or curved sectors; eight are body chamber fragments of one or

two shafts. Phragmocone fragments have whorl heights of as little as 14 mm; the largest body chamber fragment has a whorl height of 31 mm. The whorl section varies from slightly depressed to slightly compressed (although the latter may be the result of postmortem crushing). The dorsum of

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Fig. 36. A-E, G-L. *Anisoceras perarmatum* Pictet and Campiche, 1861. A, B. USNM 486564, lower Weno Limestone on Buck Bell's Farm, 11 km (6.8 mi) north-northwest of Joshua, Johnson County. C-E. USNM 486565, Weno Limestone 0.8–1.1 km (0.5–0.7 mi) east of the dam at Katy Lake, Tarrant County. G-I. USNM 486566, same horizon and locality as A, B. J-L. USNM 486567, Weno Limestone on Sycamore Creek 320 m (300 yards) northeast of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. F. *Anisoceras armatum* (J. Sowerby, 1817). USNM 486568, same horizon and locality as C-E. All figures are $\times 1$.

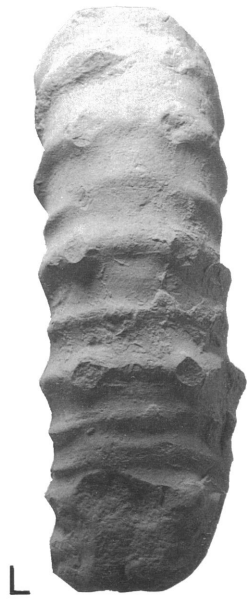
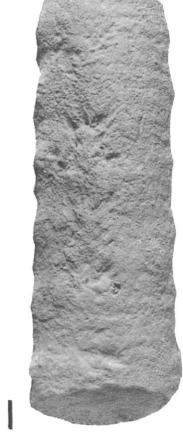
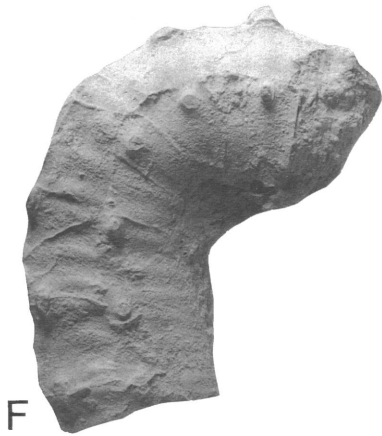




Fig. 37. *Mariella* (*Wintonia*) sp. USNM 486575, cast of a specimen, Weno Limestone, 3 to 3.3 m below the base of the Pawpaw Formation, Sycamore Creek, 320 m (300 yards) northwest of the I. and G.N. Railroad bridge over the creek, southern Fort Worth, Tarrant County. Figures are $\times 1$.

phragmocone fragments and the penultimate shaft of body chambers is ornamented by weak, transverse ribs; the rib index is 8 or more. The ribs link in groups of two or three at strong, rounded lateral tubercles; pairs of coarse transverse ribs link to strong ventral clavi, which are linked, in turn, by pairs of coarse ribs across the venter.

Rib direction changes from recti- to prorsio strongly rursiradiate around the curved sector that links penultimate and final shafts. The looping of ribs between tubercles declines, and is replaced by single coarse ribs on the flank, although looping may persist on the venter. One or two coarse, nontuberculate ribs may intercalate between the tuberculate ones. Delicate dorsal ribs are more numerous than flank ribs, with a dorsal rib index of up to 16. Dorsal ribs link in groups of two or three to the flank ribs, or efface across the dorsolateral margin.

DISCUSSION: Absence of intercalated nontuberculate ribs on the phragmocone and penultimate shaft characterizes the lectotype of *Anisoceras perarmatum*, and serves to separate it from the holotype of *A. armatum*, described above. There are, however, specimens referred to *A. perarmatum* that may have a few intercalated ribs at these growth stages, and are thus intermediate between the two species, causing some authors (e.g., Scholz, 1979) to regard them as conspecific, as noted above. Clark (1965) and others separated *Anisoceras bendirei* (Adkins, 1920)

from *A. perarmatum* on the basis of intermediate ribs on the dorsum, a more rounded, hexagonal whorl shape, and a mid-lateral position of the tubercles; there are said to be one or two nontuberculate ribs between the tuberculate ones on the venter (Clark, 1965: 26). The holotype of *A. bendirei* is shown here in figure 34. It consists of the penultimate shaft and part of the curved section linking to the final shaft. The specimen shows dorsal ribs that are more numerous and finer than those on the flank, tubercles joined by pairs of ribs, and no intercalated ribs on the shaft, all features of the lectotype of *Anisoceras perarmatum* (Renz, 1968: pl. 13, fig. 5), of which we regard it as a synonym.

OCCURRENCE: Upper Albian, *Stoliczkaia dispar* Zone and correlatives, southern England, France, Germany, Switzerland, Spain, North Africa, Nigeria, Angola, Zululand (South Africa), Madagascar, South India, and Texas, where it occurs in the Weno Limestone in Tarrant and Johnson counties, and has been recorded from the Main Street Limestone (Clark, 1965: 26).

FAMILY TURRILITIDAE GILL, 1871

Genus *Mariella* Nowak, 1916

(= *Paraturrilites* Breistroffer, 1947b: 96 (90); *Hemiturrlites* Breistroffer, 1953: 1350; *Bergericeras* Wiedmann, 1962: 224)

TYPE SPECIES: *Turrlites bergeri* (Brongniart, 1822), p. 395, pl. 7, fig. 3, by original designation by Nowak, 1916: 10.

Subgenus *Wintonia* Adkins, 1928(=*Plesioturritiles* Breistroffer, 1953)

TYPE SPECIES: *Wintonia graysonensis* Adkins, 1928: 213, pl. 23, figs. 7–9, by original designation by Adkins, 1928: 213, =*Turritiles bosquensis* Adkins, 1920: 76, pl. 3, figs. 3, 7.

Mariella (*Wintonia*) sp.

Figure 37

Mariella (*Plesioturritiles*) *brazoensis brazoensis* (Roemer). Clark, 1965: 45 (pars), non pl. 14, figs. 3–5; non pl. 16, figs. 1, 6.

DISCUSSION: Clark (1965: 46) noted a single specimen of *M. (W.) brazoensis* from below the Main Street Limestone, found by J. P. Conlin in “south Ft. Worth, Tarrant County, on a high bluff on the east bank of Sycamore Creek. It was found in place 10–11 feet below the Weno-Pawpaw contact, and confirmation of its stratigraphic occurrence is given by Mr. Frank Crane of Dallas, who observed the specimen in place . . .” The original specimen cannot now be found in the Conlin Collection, but a cast survives (USNM 486575). It is of a very battered and distorted fragment from the downturned uncoiled section of the body chamber of an adult *Mariella* (*Wintonia*), with a maximum preserved whorl height of 48 mm. The outer whorl face is feebly convex. There are four rows of coarse tubercles. The upper row lies well above the center of the outer, exposed

whorl face, and is poorly preserved. The second row is displaced adaperturally, and is rounded to feebly elongate. The third row is also displaced adaperturally with respect to the second row; the gap between rows 2 and 3 is greater than that between rows 1 and 2. A broad swelling links to the fourth, conical row, which lies at the junction of outer and inner whorl faces, and gives rise to delicate transverse ribs on the inner whorl face. In our view, the fragment is specifically indeterminate. Whorl profile and distribution of tubercles suggest it belongs to some species other than *M. (W.) brazoensis*.

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