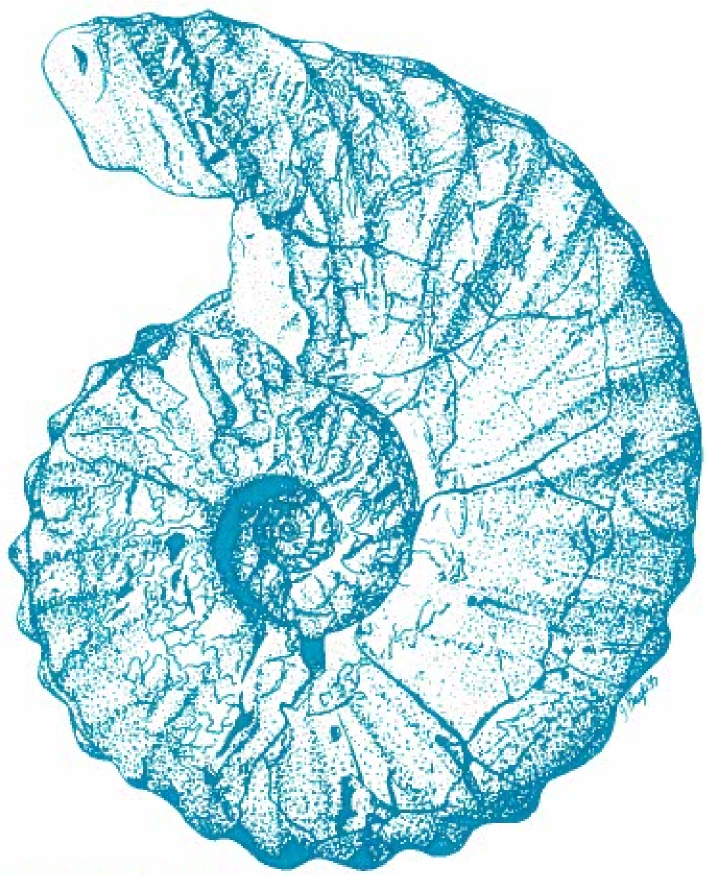
Mid-Cretaceous (Turonian) ammonite fauna from Fence Lake area of west-central New Mexico

by WILLIAM A. COBBAN and STEPHEN C. HOOK



Cibolaites molenaari Cobban and Hook,
from Cibola County, New Mexico

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Stage		Zone	Subzone
Turonian	upper	*Prionocyclus quadratus*	
		Prionocyclus novimexicanus	
		Prionocyclus wyomingensis	*Scaphites ferronensis*
			Scaphites warreni
		Prionocyclus macombi	*Coilopoceras inflatum*
			Coilopoceras colleti
	middle	*Prionocyclus hyatti*	*Coilopoceras springeri*
			Hoplitoides sandovalensis
		Subprionocyclus percarinatus	
		Collignoniceras woollgari	*Collignoniceras woollgari regulare*
			Collignoniceras woollgari woollgari
	lower	*Mammites nodosoides*	
		Vascoceras birchbyi	
		Pseudaspidoceras flexuosum	
Cenomanian (part)	upper	*Neocardioceras juddii*	
		Vascoceras gamai	
		Sciponoceras gracile	
		Metoicoceras mosbyense	
		Calycoceras canitaurinum	
	middle	*Acanthoceras amphibolum*	*Plesiacanthoceras wyomingense*
			Acanthoceras amphibolum amphibolum
			Acanthoceras amphibolum alvaradoense
		Conlinoceras tarrantense	

Abstract

An early Turonian ammonite fauna found chiefly in Cibola County, New Mexico, consists of nine genera and 10 species of which two genera and two species are new. The genera are *Baculites, Tragodesmoceras, Placenticeras, Mammites, Morrowites* (new), *Kamerunoceras, Neoptychites, Fagesia,* and *Cibolaites* (new). Species known elsewhere in the world, but recorded for the first time in North America, are *Kamerunoceras turoniense* (d'Orbigny) and *Fagesia superstes* (Kossmat). *Mammites nodosoides* (Schluter) dates the fauna as early Turonian, and the presence of *Collignoniceras woollgari* (Mantell) just above the level of the Fence Lake fauna suggests a high position in the early Turonian.

Introduction

Molluscan fossils of early Turonian age (table 1) were discovered in 1972 near the top of the Mancos Shale in the Fence Lake area approximately 65 mi (105 km) south of Gallup, New Mexico (fig. 1) by C. M. Molenaar, then with Shell Oil Company, Houston, Texas. Molenaar kindly led E. R. Landis, of the U.S. Geological Survey, and Cobban to the locality, where additional collections were made. That the locality was unusual in having an abundant warm water or Tethyan ammonite fauna became apparent, and many collecting trips were made later by us as well as by other members of the U. S. Geological Survey and the New Mexico Bureau of Mines and Mineral Resources. The collections are of much interest in that they contain two new genera of ammonites as well as two species known from Europe and Africa but previously not recorded from North America.

The specimens described or illustrated in this report are kept in the National Museum of Natural History, Washington, D.C., and have USNM catalog numbers.

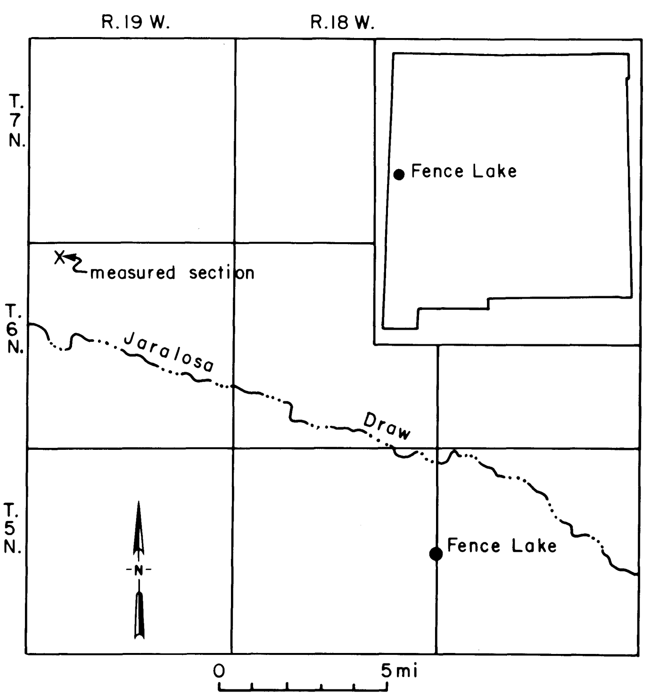

FIGURE 1—MAP OF FENCE LAKE AREA SHOWING JARALOSA DRAW AND LOCATION OF MEASURED SECTION.

ACKNOWLEDGMENTS—New Mexico Bureau of Mines and Mineral Resources personnel who aided in the collecting are O. J. Anderson and J. R. Wright. Besides E. R. Landis and C. M. Molenaar, U.S. Geological Survey personnel who helped in the collecting are L. R. Haschke, E. J. McKay, Marguerite McLellan, and L. N. Robinson. Wendell "Sonny" Briggs, foreman for the Atarque Ranch, kindly gave us permission to collect on the ranch land. R. E. Burkholder, of the U.S. Geological Survey, prepared the specimens and made the photographs.

Composition of molluscan fauna

Species of fossil mollusks in the Fence Lake area are chiefly bivalves and ammonites. Although gastropods are locally abundant, species diversity is very low. Inasmuch as most of the collecting was carried out in an arroyo on the south side of Jaralosa Canyon, 7 mi northwest of Fence Lake (fig. 1); the following list of species from this locality is representative of the fauna. USGS Mesozoic locality D11208 in NE 1/4 sec. 36, T. 6 N., R. 19 W.:

Solemya sp.
Phelopteria gastrodes (Meek)
Plicatula ferryi Coquand
Mytiloides mytiloides (Mantel!)
Ostrea sp. (aff. *Curvostrea rediviva* Coquand)
Pleuriocardia (Dochmocardia) pauperculum (Meek)
Cymbophora holmesi (Meek)
Veniella mortoni (Meek and Hayden)
Pholadomya cf. *P. coloradoensis* Stanton
Dentalium sp.
Gyrodes conradi Meek
Turritella whitei Stanton
Pyropsis coloradoensis Stanton
Paleopsephaea? sp.
Baculites yokoyamai Tokunaga and Shimizu
Tragodesmoceras socorroense Cobban and Hook
Placenticeras cumminsi Cragin
Mammites nodosoides (Schluter)
Morrowites subdepressus Cobban and Hook, n. sp.
M. depressus (Powell)
Kamerunoceras turoniense (d'Orbigny)
Neoptychites cephalotus (Courtiller)
Fagesia superstes (Kossmat)
Cibolaites molenaari Cobban and Hook, n. sp.

Of the above fossils, *Solemya, Pholadomya, Dentaltum, Pyropsis,* and *Fagesia* are represented each by a single specimen at this locality. *Phelopteria, Pleuriocardia, Cymbophora, Tragodesmoceras,* and *Kameruno-*

ceras are represented by only two or three specimens each. The bivalve and gastropod record is biased, however, because the fossil collecting was carried on primarily for the ammonites.

Occurrence and preservation of fossils

Most fossils occur in argillaceous limestone concretions that weather yellowish gray to olive gray or brown. The concretions may form well-defined beds, or they may occur scattered throughout a shale unit. Size of the concretions ranges from an inch or two in length to several feet. Many of the concretions, especially the larger ones, are septarian with dark- to medium-brown calcite veins. The larger concretions may have, in addition to the calcite, white barite. Fossils may occur throughout the concretions and often protrude from them. Oysters and other mollusks that had original calcitic shells are very well preserved, and an occasional oyster has radial color bands. Other mollusks, such as ammonites and gastropods that had aragonitic shells, have poorly preserved shell material, and many specimens are internal molds. Epizoans, usually oysters, encrust some of the larger ammonites, especially *Morrowites.*

Many concretions contain numerous specimens representing a single species. The gastropod *Turritella whitei* Stanton and the bivalve *Veniella mortoni* (Meek and Hayden) often occur in this manner. Other concretions may contain only the bivalve *Mytiloides mytiloides* (Mantell) or an oyster that resembles *Curvostrea rediviva* (Coquand). One concretion had more than 30 specimens of the ammonite *Baculites yokoyamai* Tokunaga and Shimizu.

Aside from mollusks, other fossils are scarce in the concretions. Pieces of fossilized wood much bored by bivalves occur here and there. Fish and anthropod remains are extremely rare. Part of a small fish in one concretion has its scales in place.

Stratigraphic position of fossils

The fossil mollusks described in this report came from the Rio Salado Tongue of the Mancos Shale (the upper part of the Mancos), which in the Fence Lake area is overlain by a cliff-forming unit—the Atarque Sandstone (Pike, 1947; Thompson, 1972). Several stratigraphic sections were measured through the Rio Salado. A section measured on the Atarque Lake 7½-min quadrangle northwest of Fence Lake (fig. 1) is presented here as representative of the Rio Salado and its ammonite sequence. This section is approximately 16 mi (26 km) north-northwest of columnar section 36 of Molenaar (1973, p. 95).

Section measured on steep west slope of mesa capped by Atarque Sandstone in center of E 1/2 sec. 6, T. 6 N., R. 19 W., Cibola County, New Mexico (Atarque Lake 71/2-min quadrangle). Measured by W. A. Cobban, October 8, 1981, using a Jacob's staff.

Atarque Sandstone (part)	ft	inches
18. Sandstone, very fine grained, laminated; weathers to yellowish-tan ledge	3	

Rio Salado Tongue of Mancos Shale	ft	inches
17. Shale, gray, silty, soft	23	
16. Limestone concretions, irregularly shaped, widely spaced; weather yellowish gray		2
USGS Dl 1708: *Collignoniceras woollgari woollgari* (Mantell); *Spathites* aff. *S. subconciliatus* (Choffat)		
15. Shale, gray, silty, soft	18	
14. Limestone concretions, usually 15-18 inches thick and 2 ft in diameter; weather dusky red and light gray; contain very poorly preserved bivalves	1	5
13. Shale, gray, silty, soft	35	
12. Limestone concretions, elongated and usually closely spaced; septarian with thin veins of brown calcite. Many contain numerous specimens of a single bivalve species	1	2
USGS Dl 1707: *Veniella mortoni* (Meek and Hayden)		
11. Shale, gray, silty; contains numerous limestone concretions 2-9 inches in diameter with a bed of larger ones in the lower part. Fossils present throughout unit	19	6
USGS D11706: *Serpula sp.*; *Mytiloides mytiloides* (Mantell); *Camptonectes sp.*; *Plicatula ferryi* Coquand; *Ostrea sp.* (aff. *Curvostrea rediviva* Coquand); *Corbula* cf. *C. kanabensis* Stanton; *Turritella sp.*; *Paleopsephaea? sp.*; *Baculites yokoyamai* Tokunaga and Shimizu; *Placenticeras cumminsi* Cragin; *Morrowites subdepressus* Cobban and Hook, n. sp.; *M. depressus* (Powell); *Neoptychites cephalotus* (Courtiller); *Cibolaites molenaari* Cobban and Hook, n. sp.		
10. Shale, dark-gray, somewhat carbonaceous and jarositic; forms dark band	5	
9. Shale, gray, silty, soft; contains a few small limestone concretions, septarian with light- to medium-brown calcite veins	40	
8. Limestone concretions, mostly several feet in length; some much smaller rounded ones	1	
7. Shale, dark-gray and flaky in lower part; lighter gray and silty in upper part	13	
6. Shale, gray; contains abundant gray- to brownish-weathering limestone concretions, septarian with medium- to dark-brown calcite veins and occasionally white barite	4	
USGS Dl 1560: *Morrowites subdepressus* Cobban and Hook, n. sp.; *M. depressus* (Powell)		
5. Shale, gray, silty; contains a few limestone concretions	20	
4. Limestone concretions, stout, septarian; weather buff		9
3. Shale, gray	5	
2. Limestone concretions, stout, widely spaced, septarian with brown calcite veins; weather buff; contain a few very poorly preserved *Morrowites*	*1*	
1. Shale, gray, calcareous	25 +	
Total thickness of measured *Rio Salado Tongue* of Mancos Shale	213	

Collection localities

The fossils described in this report came from the Rio Salado Tongue of the Mancos Shale at the following localities, which have U.S. Geological Survey Mesozoic locality numbers:

D7073-NE 1/4 sec. 19, T. 4 N., R. 18 W., Catrin County D8429-sec. 1 and NE 1/4 sec. 12, T. 4 N., R. 19 W., Cibola County
D10538-NW 1/4 sec. 28, T. 4 N., R. 18 W., Catrin County
D10939-E 1/2 sec. 28, T. 6 N., R. 19 W., Cibola County
D11208-NE 1/4 sec. 36, T. 6 N., R. 19 W., Cibola County
D11281-NE 1/4 sec. 2, T. 5 N., R. 20 W., Cibola County
D11295-NE 1/4 sec. 35, T. 6 N., R. 19 W., Cibola County
D11338-NW 1/4 sec. 15, T. 5 N., R. 19 W., Cibola County
D11339-center sec. 11, T. 5 N., R. 19 W., Cibola County
D11342-NE 1/4 sec. 2, T. 5 N., R. 19 W., Cibola County
D11344-E 1/2 sec. 28, T. 6 N., R. 19 W., Cibola County
D11509-NE 1/4 sec. 2, T. 4 N., R. 19 W., Cibola County
D11557-NE 1/4 sec. 1, T. 5 N., R. 20 W., Cibola County
D11558-S 1/2 sec. 8, T. 7 N., R. 20 W., Cibola County D1 1560-E½ sec. 6, T. 6 N., R. 19 W., Cibola County D11706-E 1/2 sec. 6, T. 6 N., R. 19 W., Cibola County D11709-SW 1/4 sec. 6, T. 4 N., R. 18 W., Cibola County

Systematic paleontology

Dimensions are given in millimeters (mm), and abbreviations are as follows: D (diameter), U (umbilical diameter), Wb (whorl breadth), Wh (whorl height), Wb: Wh (ratio of whorl breadth to whorl height).

On the suture drawings, the heavy straight line marks the venter or the position of the siphuncle, the lighter solid curved line marks the umbilical seam, and the dashed curve line marks the umbilical shoulder. Some suture drawings have, in addition, the position of tubercles and ribs marked by lines of short dashes. On drawings of whorl sections, the solid line represents the costal section, and the dashed line marks the intercostal section.

Family BACULITIDAE Gill, 1871

GENUS *Baculites* Lamarck, 1799

TYPE SPECIES: *Baculites vertebralis* Lamark, 1801

Baculites yokoyamai Tokunaga and Shimizu
Pl. 1, figs. 1-7

Baculites (Lechites) yokoyamai Tokunaga and Shimizu, 1926, p. 195, pl. 22, fig. 5a, b; pl. 26, fig. 11

Baculites besairiei Collignon, 1931, p. 37, pl. 5, figs. 6, 6a, 7, 7a, 8, 8a, 9; pl. 9, fig. 16

Baculites cf. *B. yokoyamai* Tokunaga and Shimizu. Matsumoto, 1959, p. 118, text fig. 26

Baculites yokoyamai Tokunaga and Shimizu. Matsumoto and Obata, 1963, p. 30, pl. 8, fig. 5; pl. 10, figs. 1-6; pl. 11, figs. 1, 4,; pl. 12, fig. 3; pl. 14, fig. 4; text figs. 72-87

Baculites besairiei Collignon. Collignon, 1965b, p. 18, pl. 420, figs. 1745, 1746

Baculites cf. *B. yokoyamai* Tokunaga and Shimizu. Cobban and Scott, 1972, p. 48, pl. 20, figs. 15-21

——— Hattin, 1975, pl. 8, figs. F-H; Kennedy, 1977, text fig. 17 (1, 2); Hattin, 1977, p. 187, fig. 6 (2); Hattin and Siemers, 1978, text fig. 7 (2)

Baculites yokoyamai Tokunaga and Shimizu. Cobban and Hook, 1979, p. 13, pl. 4, figs. 9, 10

This is a small, straight species that has a low angle of taper, subelliptical cross section, and simple suture. Closely spaced ribs cross the venter with forward arching. The flanks are either smooth or have weak, closely spaced arcuate ribs. In the Western Interior, *B. yokoyamai* ranges entirely through the Turonian.

Baculites are rare in the ammonite collections from the Fence Lake area, although one concretion had fragments of at least 30 individuals. Most specimens are fragments of body chambers. The two largest specimens have diameters of 12.7 and 14.7 mm at the base of the body chamber. Cross sections are very stout and nearly elliptical. Angles of taper are only 1 or 2 degrees. Most specimens less than 6 or 7 mm in whorl height have smooth flanks and venters, but larger specimens usually have closely spaced ventral ribs (6-10 in a distance equal to the whorl height). Several specimens have ribbed venters and smooth flanks (pl. 1, figs. 1, 2). Two individuals combine ventral ribbing with weak flank ribbing (pl. 1, figs. 3-5).

TYPES-Hypotypes USNM 328704-328706

Family MUNIERICERATIDAE Wright, 1952

GENUS *Tragodesmoceras* Spath, 1922

TYPE SPECIES: *Desmoceras clypealoides* Leonhard, 1897

Tragodesmoceras socorroense Cobban and Hook
Pl. 2, figs. 10-14

Tragodesmoceras socorroense Cobban and Hook, 1979, p. 13, pl. 5, figs. 9, 10; pls. 6, 7; pl. 11, fig. 10; text fig. 4

This large involute ammonite has a steep-walled umbilicus and whorls higher than wide. Ornament consists of sigmoidal primary ribs that begin at the umbilical shoulder and weaker secondary ribs that begin at mid-flank. All ribs bend forward on the outer part of the flank and cross the venter as chevrons. Ornament is strongest on juveniles, and ribs may rise into low nodate tubercles on the middle of the venter. The suture is complexly digitate (Cobban and Hook, 1979, pl. 11, fig. 10).

Only four specimens of *T. socorroense* were found in the Fence Lake area. The largest is a phragmocone 143 mm in diameter.

TYPES-Hypotypes USNM 328707, 328708

Family PLACENTICERATIDAE Hyatt, 1900

GENUS *Placenticeras* Meek, 1876

TYPE SPECIES: *Ammonites placenta* DeKay, 1828

This genus includes large, involute ammonites that are usually compressed and have, at least in the juvenile stage, a narrow, flat, or grooved venter generally bounded by ventrolateral clavi arranged alternately. Other ornament may consist of weak falcoid ribs, umbilical bullae or rounded tubercles, and a row of lateral tubercles. The suture has many auxiliaries.

Placenticeras cumminsi **Cragin**

Pl. 3, figs. 12-18; pl. 5, figs. 4, 5

Placenticeras syrtalis (Morton) var. *cumminsi* Cragin, 1893, p. 237

Placenticeras placenta (DeKay)? Stanton, 1893, p. 169, pl. 39, figs. 2 and 3 only [published 1894]

Placenticeras stantoni Hyatt, 1903, p. 214

__________var. *bolli* Hyatt, 1903, p. 214, pl. 40, figs. 3-7; pl. 41, figs. 1-7; pl. 42, figs. 1, 2; pl. 43, figs. 1, 2

Placenticeras pseudoplacenta Hyatt, 1903, p. 216, pl. 43, figs. 3-11; *not* pl. 44

__________var. *occidentale* Hyatt (part), 1903, p. 217, pl. 45, fig. 2 only

Placenticeras stantoni Hyatt. Grabau and Shimer, 1910, p. 219, fig. 1496c, d

Placenticeras cumminsi Cragin. Adkins, 1928, p. 253

Proplacenticeras pseudoplacenta (Hyatt). Cobban and Hook, 1979, p. 14, pl. 8, figs. 1-5 [published 1980]

Cragin (1893, p. 237) did not illustrate his new species, which came from the Britton Formation of Dallas County, Texas. The holotype was said to consist of part of a smooth body chamber attached to the last few chambers of the phragmocone. Most of his description is of the suture. Cragin also briefly described four other specimens, which have some ornament such as umbilical tubercles, midflank ribs, and alternate ventrolateral clavi. The holotype came from a unit of clay-ironstone concretions that yielded *Metengonoceras dumbli* (Cragin), *Sciponoceres gracile* (Shumard), *A llocrioceras annulatum* (Shumard), and *Euomphaloceras (Kanabiceras) septemseriatum* (Cragin; generic names updated by us). The types are thus of late Cenomanian age.

Nine specimens of *Placenticeras* that seem referable to *P. cumminsi* are present in the collections from the Fence Lake area. Only five are preserved well enough for measurements of diameter, breadth, and umbilicus as well as for counts of tubercles. These specimens range in diameter from 27.6 mm to 102.4 mm. Breadth ratios range from 0.26 to 0.33, averaging 0.29, and umbilical ratios range from 0.14 to 0.21, averaging 0.17. Ornament is variable but seems confined to the phragmocone. Nodate umbilical tubercles number four or five per half whorl, and clavate ventrolateral tubercles number 12 to 20 per half whorl, averaging 16.3.

TYPES-Hypotypes USNM 328709-328712

Family ACANTHOCERATIDAE de Grossouvre, 1894

Subfamily MAMMITINAE Hyatt, 1900

GENUS *Mammites* Laube and Bruder, 1887

TYPE SPECIES: *Ammonites nodosoides* Schluter, 1871

Mammites includes medium- to large-sized stout ammonites that have quadrate to rectangular whorl sections, prominent umbilical and inner and outer ventrolateral tubercles on early and middle whorls, and ventrolateral horns on late whorls. The moderately simple suture has a broad, bifid first lateral saddle and narrow, bifid first and second lateral lobes.

Mammites nodosoides **(Schluter)**

Pl. 1, figs. 14, 15; pl. 3, figs. 21, 22; pl. 4, figs. 4-9, 17, 18; pl. 5, figs. 1-3; text fig. 2

For the extensive synonymy, see Wright and Kennedy (1981, P. 75).

Wright and Kennedy (1981, p. 76, 77) have described *Mammites nodosoides* in great detail and have designated a lectotype from the lower Turonian of Mêcholup, Czechoslovakia. The lectotype has a diameter of 190 mm and an umbilical ratio of 0.24. The penultimate whorl has a rectangular cross section, low widely spaced umbilical bullae, weak broad ribs, low rounded inner ventrolateral tubercles, and weak outer ventrolateral clavi that bound a broad smooth venter. A third of a whorl of body chamber is preserved on which the outer ventrolateral clavi disappear and the inner ventrolateral tubercles enlarge into horns.

The suture of *Mammites nodosoides* is fairly simple with broad, bifid first lateral saddle and narrow, bifid first and second lateral lobes (Laube and Bruder, 1887, fig. on p. 230; Pervinquière, 1907, fig. 118; Karrenberg, 1935, pl. 33, figs. 6, 7; Freund and Raab, 1969, fig. 4i).

Seven specimens from the Fence Lake area are referred to *M. nodosoides,* although they show much variation in stoutness and ornament. Four are phragmocones, and the other three include parts of badly preserved and crushed body chambers. One of the phragmocones (pl. 4, figs. 4-6; text fig. 2A) is of much interest in that it is broken in such a way as to expose an inner coil 18 mm in diameter. The inner coil has an umbilical ratio of 0.35 and whorls about as wide as high. The older half of the last whorl of this coil has eight umbilical bullae and twice as many primary and secondary ribs each supporting a nodate inner ventrolateral tubercle and a clavate outer ventrolateral tubercle. Ribs bend forward from the inner ventrolateral tubercle. Attached to the inner coil is half a whorl 48.7 mm in diameter that is very stout with whorls broader than high. Ornament consists of strong nodate to bullate umbilical tubercles numbering five per half whorl and strong nodate inner ventrolateral tubercles and equally prominent clavate outer ventrolateral tubercles, each set numbering seven per half whorl. This outer half whorl resembles *M. nodosoides* var. *spinosa* Basse (1940, p. 458, pl. 7, fig. 2; pl. 9, fig. 2) from Syria and Madagascar (Collignon, 1966, p. 40, pl. 20, figs. 12, 12a) as well as *M. nodosoidesappelatus* Etayo-Serna (1979, p. 85, pl. 13, fig. 1) from Colombia.

The three specimens that have parts of body chambers differ considerably from one another in stoutness. One has whorls higher than wide (pl. 3, figs. 21, 22) like those illustrated by Schluter (1871, pl. 8, figs. 3, 4), and others (pl. 5, figs. 1-3) have whorls wider than high like the specimen illustrated by Petrascheck (1902, pl. 9, figs. 2a, b) as *M. michelobensis* Laube and Bruder. The three specimens, which are unusually small adults, have umbilical ratios of 0.25, 0.29, and 0.31.

Sutures of the Fence Lake specimens are typical of *M. nodosoides*, and all have broad first lateral saddles and narrow lateral lobes (fig. 2) .

Mammites nodosoides seems to range through most of the lower Turonian. In the well-dated stratigraphic section near Pueblo, Colorado, *M. nodosoides* occurs in beds 101, 105, and 118 spanning much of the Bridge Creek Limestone Member of the Greenhorn Formation. The species was listed from these beds as *Mammites nodosoides wingi* Morrow and *Mammites* sp. (Cobban and Scott, 1972, p. 23).

In southwest New Mexico, *M. nodosoides* may occur in beds slightly older than bed 101 of the Pueblo area. In the Cooke's Range, northwest of Deming, New Mexico, the species occurs in the regressive sandstone unit that overlies the marine shale member in the lower part of the Colorado Formation. Here *M. nodosoides* is associated with fragments of a vascoceratid ammonite that may be *Vascoceras (Greenhornoceras) birchbyi* Cobban and Scott, which occurs in bed 97 of the Pueblo section (Cobban and Scott, 1972, p. 23).

TYPES-Hypotypes USNM 328713-328720

GENUS *Morrowites* Cobban and Hook, n. gen.
TYPE SPECIES: *Mammites wingi* Morrow, 1935

Morrowites is a medium- to large-sized stout ammonite that has quadrangular to depressed whorls, broadly rounded to depressed venter, low ribs, umbilical and inner and outer ventrolateral tubercles, and very early whorls smooth except for occasional ribs bounding weak constrictions. The moderately simple suture has an unusually broad, bifid lateral lobe (L). The genus is named in honor of A. L. Morrow for his pioneer studies of the Cenomanian and Turonian ammonites of Kansas. The known range of *Morrowites* is lower Turonian.

In its general appearance, *Morrowites* closely resembles *Mammites*. The two genera readily differ, however, in their sutures and in their early whorls. *Morrowites* has an extremely broad L, whereas *Mammites* has a narrow one. The very early whorls of *Morrowites* are smooth other than for distantly spaced ribs and constrictions, whereas those of *Mammites* have normal ribs and tubercles.

Species that have a very broad lateral lobe like that of *Morrowites* include *Mammites michelobensis* Laube and Bruder (1887, p. 231-232 in part, text fig. on p. 231) from Czechoslovakia and *Mammites dixeyi* Reyment (1955, p. 50, pl. 9, fig. 4; pl. 11, fig. 2a, b; text figs. 20, 21) from the lower Turonian of Nigeria. Among species of other genera, *Pseudaspidoceras footeanum* (Stoliczka, 1864, p. 101, pl. 52, figs. 1, 1a-c, 2, 2a), *Euomphaloceras euomphalum* (Sharpe, 1854, p. 29, pl. 13, figs. 4a-c), and *E. (Kanabiceras) septemseriatum* (Cragin, 1893, p. 240; for suture see Stanton, 1893, pl. 36, fig. 8) have sutures with broad L as in *Morrowites*.

Morrowites wingi (Morrow)
Text figs. 3, 4

Mammites wingi Morrow, 1935, p. 467, pl. 51, fig. 2; pl. 52, fig. 2a-c; text fig. 2

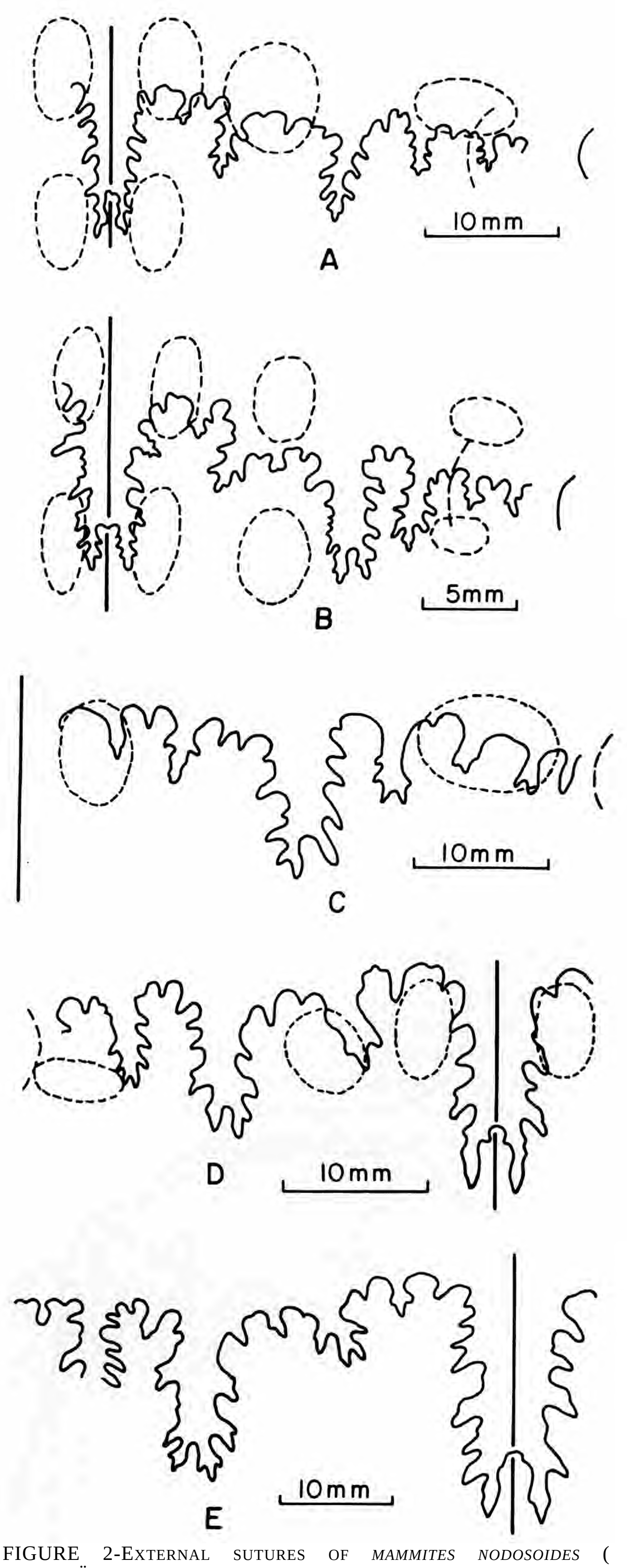

FIGURE 2-EXTERNAL SUTURES OF *MAMMITES NODOSOIDES* (SCHLÜTER). A, Hypotype USNM 328714 (pl. 4, figs. 4-6) at whorl height of 16 mm, from USGS Mesozoic locality D8429. B, Hypo-type USNM 328715 (pl. 4, figs. 7-9) at diameter of 28.5 mm, from same locality. C, Hypotype USNM 328716 (pl. 4, figs. 17, 18) at diameter of 70 mm, from USGS Mesozoic locality D11281. **D, Hypotype** USNM 328713 (pl. 3, figs. 21, 22) at whorl height of 26.5 mm, from USGS Mesozoic locality D11281. E, Hypotype USNM 328720 at whorl height of 37 mm, from unit 11 of Böse (1910, p. 29) near Ciudad Juarez, Chihuahua, Mexico, shown here for comparison.

Mammites rectangulus Morrow, 1935, p. 468, pl. 53, fig. 6; text fig. 6

Mammites nodosoides (Schluter) subsp. *wingi* Morrow. Cobban and Scott, 1972, p. 79, pl. 26, figs. 1-4 only; pls. 31, 32, *not pl.* 33; text fig. 38

———— Hattin, 1975, pl. 8, figs. K-M; Kauffman, 1977, pl. 19, figs. 5, 6

Mammites wingi Morrow. Wright and Kennedy, 1981, p. 79, Pl. 25, fig. 2a, b; text figs. 25, 27

Inasmuch as Morrow's species is selected herein as the type for the new genus *Morrowites,* the holotype will be redescribed in more detail than that presented by Morrow. Side and rear views of the holotype were shown by Morrow (1935, pl. 52, fig. 2b, c) at one-half natural size, and side and front views of it were presented by Cobban and Scott (1972, pl. 31) at natural size.

The holotype, a moderately large phragmocone from the Jetmore Chalk Member of the Greenhorn Limestone of Kansas, has a diameter of 184 mm and an umbilical width of 55.6 mm (U:D of 0.30). The specimen is an internal mold of hard, dense limestone on which parts of sutures are visible. One side of the specimen is fairly well preserved, but the other side is crushed a little and more worn. Only the last whorl is visible; the inner whorls may not be preserved. Most of the last whorl has a cross section higher than wide, but at its larger end, the intercostal section probably was almost as wide as high. The cross section of the larger end, restored from the good, uncrushed side and with the broken ventrolateral tubercles restored, is shown in text fig. 3 along with a section near the smaller end.

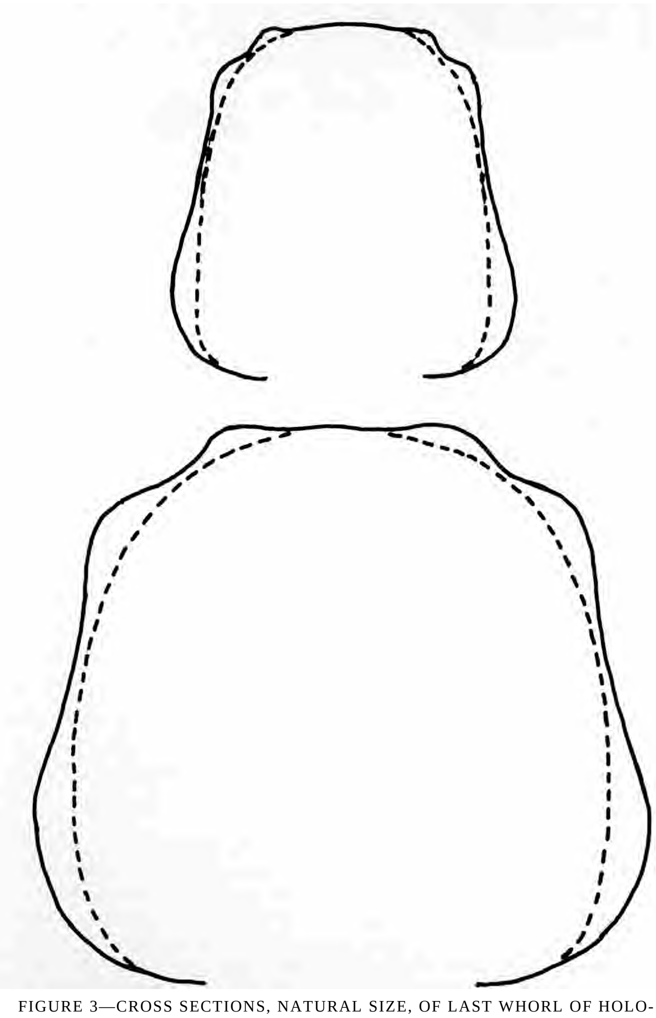

FIGURE 3—CROSS SECTIONS, NATURAL SIZE, OF LAST WHORL OF HOLOTYPE OF *MORROWITES WING!* (MORROW) FROM JETMORE CHALK MEMBER OF GREENHORN LIMESTONE OF CLOUD COUNTY, KANSAS; dashed line is intercostal section, and solid line is costal section.

Ornament on the last whorl of the holotype consists of 10 fairly strong umbilical bullae and 18 moderately strong nodate inner ventrolateral tubercles and an equal number of weaker clavate outer ventrolateral tubercles. The umbilical bullae are located on the lower part of the flank. A low, poorly defined rib extends from each bulla and crosses the flank.

The suture is poorly preserved. A composite drawing based on several sutures on the last third of the outer whorl is shown in text fig. 4. A broad bifid lateral lobe characterizes the suture.

Morrow (1935, pl. 51, fig. 2) also figured a paratype from the Pfeifer Shale Member of the Greenhorn Limestone of Republic County in northern Kansas. The Pfeifer Member overlies the Jetmore Member, which yielded the holotype. The paratype, which has only one fairly good side, has a diameter of 183 mm and an umbilical width of 51 mm (0.28). Ornament on the last half whorl consists of five strong umbilical bullae, seven strong nodate to slightly clavate inner ventrolateral tubercles and seven very weak, clavate outer ventrolateral tubercles. Only traces of the suture are visible.

Morrow did not compare his species to any described species of *Mammites.* After reviewing the general concept of *M. nodosoides* (Schluter) of many authors, Cobban and Scott (1972, p. 79) concluded that *M. wingi* fered from *M. nodosoides* only in the slightly higher ventrolateral tubercle count of the former and in its broader lateral lobe; accordingly, Cobban and Scott regarded *M. wingi* as a subspecies of *M. nodosoides.* Wright and Kennedy (1981, p. 75-79) have just completed a study of many examples of *M. nodosoides* from Europe. These authors believe *M. nodosoides* and *M. wingi* are separate species, and that the former has a more slender whorl section, fewer ribs, and more upward-directed ventrolateral horns on the large adults. The new material from the Fence Lake area reveals great differences in the sutures of *M. nodosoides* and Morrow's *M. wingi* as well as in the ornament on the very early whorls. The two forms are not only separate species but different genera as well.

Mammites rectangulus Morrow (1935, p. 468, pl. 53, fig. 6; text fig. 6), from the lower part of the Jetmore Chalk Member of the Greenhorn Limestone of north-central Kansas, is a crushed *Morrowites wingi.* Only bits of the suture are preserved, but a very broad L is indicated.

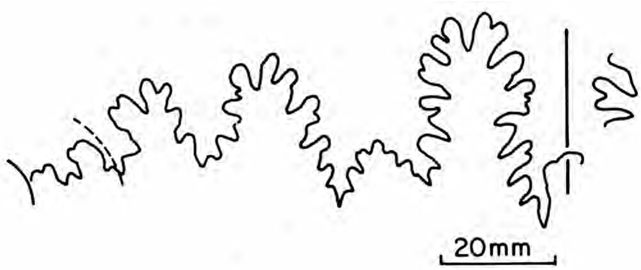

FIGURE 4—EXTERNAL SUTURE OF HOLOTYPE OF *MORROWITES WING!* (MORROW) BASED ON PARTS OF SEVERAL SUTURES.

Morrowites depressus (Powell)
Pl. 6, figs. 1, 2; text fig. 5

Mammites? depressus Powell, 1963b, p. 1228, pl. 168, figs. 1-3; pl. 170, figs. 4, 5; pl. 171, fig. 1; text figs. 5e, 6f-h
______Powell, 1967, p. 313, figs. 2-5
Mammites? sp. Cobban and Scott, 1972, p. 81
Mammites depressus Powell. Young and Powell, 1976, (1978), pl. 2, figs. 3, 5, 6, 9
______Cobban and Hook, 1979, (1980), p. 15, pl. 9; pl. 10, figs. 1-3; text figs. 5, 6

Morrowites depressus (Powell) is a very large evolute ammonite that has very depressed whorls and, in the adult stage, outward-directed ventrolateral horns. The suture is typical of *Morrowites* in having a broad, bifid lateral lobe (L).

The species occurs in the Fence Lake area, but only a few of the smaller specimens were collected. Several large specimens were observed in the field, but none was collected owing to the considerable distance and difficult terrain over which the specimens would have to be carried on foot.

One of the specimens collected (pl. 6, figs. 1, 2) is an unusually small adult that consists of the phragmocone and half a whorl of the body chamber. The diameter at the base of the body chamber is 134 mm. At this point, the intercostal whorl breadth is 81 mm, and the whorl height is 51 mm (Wb:Wh = 1.6). A whorl section a little farther back on the phragmocone is shown in text fig. 5A. Ornament on the last half of the outer whorl of the phragmocone consists of four strong nodate umbilical tubercles, eight strong nodate inner ventrolateral tubercles, and eight smaller nodate outer ventrolateral tubercles. The considerably incised suture (text fig. 5B) recalls the one figured by Laube and Bruder (1887, p. 231) for their *Mammites michelobensis.*

Morrowites depressus was described originally from a bed of limestone concretions 1,420 ft (433 m) above the base of the Ojinaga Formation at Cannonball Hill, Chihuahua, Mexico (Powell, 1963b, p. 1228). Other ammonites from this bed at this locality were figured by Powell (1963b) as *Selwynoceras mexicanum* (Bose), *Spathites rioensis* Powell, *Neoptychites xetriformis* Pervinquière, *N. gourguechoni* Pervinquière, and *ceras sp.* Kennedy and others (1980, p. 570) have shown that *Selwynoceras mexicanum is* a synonym of *Collignoniceras woollgari* (Mantell).

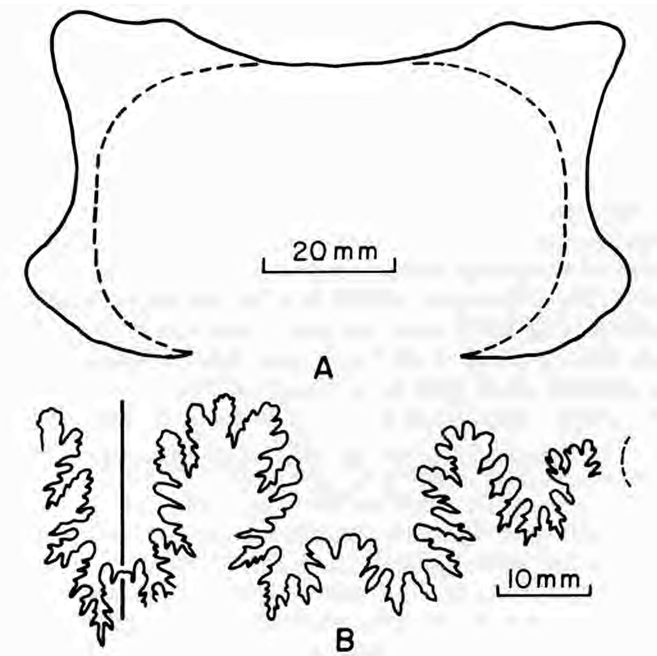

FIGURE 5-WHORL SECTION (A) AT DIAMETER OF 130 MM AND EXTERNAL SUTURE (B) AT DIAMETER OF APPROXIMATELY 87 MM OF SMALL ADULT *OF MORROWITES DEPRESSUS* (POWELL) FROM USGS MESOZOIC LOCALITY Dl 1208 (PL. 6, FIGS. 1, 2); hypotype USNM 328721.

In New Mexico, *M. depressus is* fairly abundant in beds containing the early form of *C. woollgari* associated with *Spathites rioensis* Powell (Cobban and Hook, 1979). One or two of the specimens of *M. depressus* collected in the Fence Lake area may well be float from the *C. woollgari* concretions 35 ft (10.7 m) above the main fossiliferous unit described in this report. Elsewhere in the Western Interior, *M. depressus is* rare. A single specimen has been found in the upper part of the Frontier Formation on the west edge of the Powder River basin in north-central Wyoming, where it was recorded as *Mammites* aff. *M. nodosoides* var. *spinosa* Basse (Hose, 1955, p. 98) and later assigned to *M. depressus* (Cobban and Hook, 1979, p. 15, fig. 6). In southern Utah, some large ammonites that have depressed whorl sections have been found in the Tropic Shale and referred to *Mammites?* cf. *M. depressus* (Lawrence, 1965, p. 78, fig. 4; Lawrence and Stokes, 1965).

TYPE-Hypotype USNM 328721

Morrowites subdepressus
Cobban and Hook, n. sp.
Pl. 1, figs. 8-13; pl. 3, figs. 19, 20; pl. 4, figs. 1-3, 12-16; pl. 7; text figs. 6, 7

Morrowites subdepressus is a large, moderately involute, robust ammonite that has depressed whorls strongly ornamented in most of the juvenile stages and weakly ornamented in the adult stages. The suture is typical of the genus in having a very broad lateral lobe (text fig. 6). Variation within the species is normal rang-

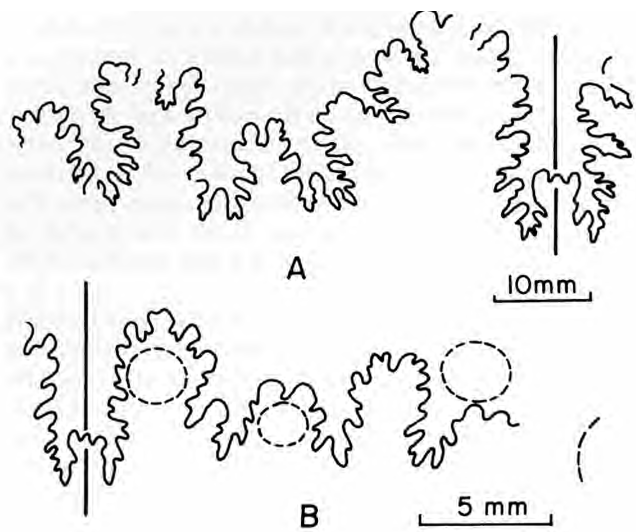

FIGURE 6-EXTERNAL SUTURES OF *MORROWITES SUBDEPRESSUS* COBBAN AND Hook, N. SP. A, Paratype USNM 328730 at whorl height of approximately 47 mm, from USGS Mesozoic locality D8429; B, Paratype USNM 328727 at diameter of 25 mm, from USGS Mesozoic locality D7073.

ing from very stout forms (pl. 1, figs. 8, 9) to more slender forms (pl. 1, figs. 12, 13).

Morrowites subdepressus is fairly abundant in the Rio Salado Tongue of the Mancos Shale in the Fence Lake area. Twenty specimens consisting of a half whorl or more are available for measurements. Two specimens reveal some details of the early whorls. On one individual (pl. 1, figs. 8, 9), the whorl at a shell diameter of about 5 mm has a well-rounded flank and more broadly rounded venter. Ornament is lacking except for a single rib that is strongest on crossing the venter. On the next half whorl, out to a diameter of 7.5 mm, the venter is smooth except for three widely spaced prorsiradiate ribs that arise from umbilical bullae and cross the venter with slight forward arching. Each of these ribs is bounded by weak constrictions on the venter.

On the other specimen (pl. 4, figs. 1-3), the venter is smooth at a diameter of about 14 mm except for a single rib that bears nodate outer ventrolateral tubercles. Less than a quarter of a whorl farther out, at a diameter of about 16 mm, a strong prorsiradiate rib arises below midflank and crosses the venter with forward arching, where it bears nodate outer ventrolateral tubercles and weaker bullate inner ventrolateral tubercles. This rib is preceded by and followed by a weaker rib with fainter tubercles; these weaker ribs are separated from the stronger rib by low constrictions. Ornament soon becomes regular, and by a diameter of 20 mm, inner and outer ventrolateral tubercles are strong, nodate, and about equal in size. At this diameter, umbilical tubercles are strong, nodate, and number four per half whorl.

The rest of the specimens range in diameter from 24-233 mm. Umbilical ratios range from 0.20-0.31, averaging 0.26. Ratios of intercostal whorl height to whorl breadth range from 1.09 to 1.58, averaging 1.34. In half a whorl, umbilical tubercles number three to five, and ventrolateral tubercles number six to 11 (average 8.0) .

The holotype (pl. 7; text fig. 7b) is an internal mold of a phragmocone 165 mm in diameter that has an umbilical width of 45 mm (0.27). Whorls are broader than high with flattened flanks, well-rounded umbilical and ventrolateral shoulders, and very broadly rounded venter (text fig. 7). On the last complete whorl, 11 umbilical tubercles, which are strong and bullate to nodate, are located on the lower part of the flank. On the next inner whorl, these tubercles are more bullate and set nearer the umbilical shoulder. At the beginning of the outer whorl, ventrolateral tubercles consist of prominent nodate inner ones and very weak nodate outer ones. The outer ones disappear by the end of the first quarter of this whorl, but the inner ones persist and number 13 for the whorl. Ribs are lacking.

Morrowites subdepressus has more depressed whorls than *M. wingi* (Morrow), which has whorls higher than wide. Whorl sections of many specimens of *M. subdepressus* overlap similar-sized sections of some individuals of *M. depressus* (Powell), but *M. subdepressus* does not attain the degree of depressed whorls of the latter. In addition, the ventrolateral tubercles of *M. de-pressus* are more prominent.

Morrowites subdepressus is probably widely distributed in the Western Interior. Unfortunately, crushed and distorted specimens cannot be separated from similarly preserved specimens of *M. wingi*. Many ammonites from the upper one-half of the Bridge Creek Limestone Member of the Greenhorn Formation in the Pueblo area of southeast Colorado are either *M. subdepressus* or *M. wingi*. In reference to the stratigraphic section of this member near Pueblo measured by Cob-ban and Scott (1972, p. 23), specimens that are probably *M. subdepressus* occur in bed 105, and crushed specimens that are either this species or *M. wingi* occur in beds 102, 105, and 109. In southwestern Wyoming, distorted specimens that are either *M. subdepressus* or *M. wingi* occur in septarian limestone concretions in the shale unit of the Frontier Formation that underlies the Oyster Ridge Sandstone Member.

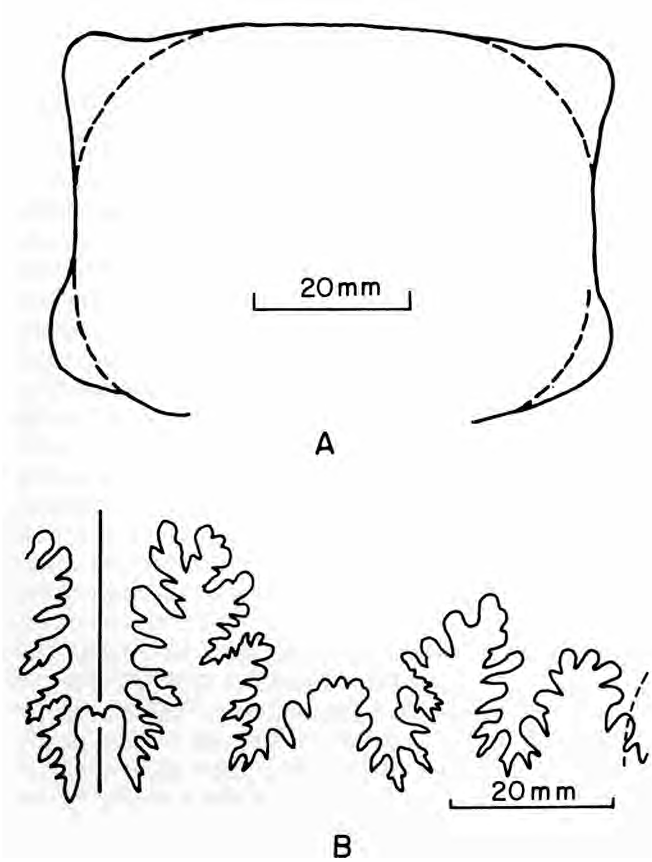

FIGURE 7—WHORL SECTION (A) AT DIAMETER OF 116 MM AND EXTERNAL SUTURE (B) AT DIAMETER OF APPROXIMATELY 98 MM OF HOLOTYPE *OF MORROWITES SUBDEPRESSUS COBBAN* AND Hook, N. SP., FROM USGS MESOZOIC LOCALITY D11208; holotype USNM 328722 (pl. 7).

TYPES—Holotype USNM 328722; paratypes USNM 328723-328730

Morrowites cf. M. dixeyi (Reyment) *Pl. 4, figs. 10, 11*

The lower Turonian ammonite from Nigeria, described by Reyment (1955, p. 50, pl. 9, fig. 4; pl. 11, fig. 2a, b; text figs. 20, 21) as the new species *Mammites dixeyi*, differs from true *Mammites* in having more outer ventrolateral tubercles than inner ones as well as in having an extremely broad lateral lobe (L). The suture is typical of *Morrowites*, and the species seems best assigned to it.

A single specimen from the Fence Lake area resembles *M. dixeyi* in this tubercle arrangement. The specimen, an internal mold 51.4 mm in diameter, consists of a phragmocone and about a quarter of a whorl of body chamber. At the base of the body chamber, the diameter of the shell is 44 mm and that of the umbilicus is 10 mm (0.23). The last half whorl of the specimen has five bullate umbilical tubercles, seven large nodate inner ventrolateral tubercles, and 10 outer ventrolateral ones. On the phragmocone, the outer ventrolateral tubercles are bullate, a little smaller than the inner ones, and more numerous, but on the body chamber, inner and outer ventrolateral tubercles are nodate and equal in size and numbers. The suture is poorly preserved but has a very broad lateral lobe like that shown by Reyment (1955, fig. 20).

TYPE—Figured specimen USNM 328731

Subfamily EUOMPHALOCERATINAE Cooper, 1978
GENUS *Kamerunoceras* Reyment, 1954 TYPE SPECIES: *Acanthoceras eschii* Solger, 1904

Kamerunoceras is a moderately small- to medium-sized evolute ammonite that has stout, rounded to quadrate whorls, and ornament of long, narrow ribs usually bearing fairly small umbilical and inner and outer ventrolateral tubercles. A low siphonal ridge has weak to moderately strong clavate tubercles. Kennedy and Wright (1979a, p. 1165, 1176) gave the range of *Kamerunoceras* as early to middle Turonian, and its origin in *Kanabiceras* Reeside of Late Cenomanian age.

Kamerunoceras turoniense (d'Orbigny)
Pl. 8, figs. 1-5, 9-11; text fig. 8

For the fairly extensive synonymy, the reader is referred to Kennedy and Wright (1979a, p. 1170, 1173)

Kamerunoceras turoniense was originally described as *Ammonites turoniensis* d'Orbigny (1850, p. 190). According to Kennedy and Wright (1979a, p. 1173), d'Orbigny's types and most other French examples came from the Saumur area.

The species is moderate sized (as much as 200 mm in diameter), very evolute (0.35-0.45), and ornamented by long, narrow ribs and small but conspicuous tubercles (Kennedy and Wright, 1979a, p. 1169, 1173-1175, pls. 2-4). Ribs increase in number from 20-22 per whorl in the middle growth stage to 27-28 at maturity, and the umbilical tubercles migrate to an inner flank position as the shell enlarges (Kennedy and Wright, 1979a, p. 1174)
.

Four specimens of *Kamerunoceras turoniense* are present in the collections from the Fence Lake area. Three are phragmocones 67, 73, and about 73 mm in diameter, and the fourth is an unusually small adult of 106 mm diameter. The badly weathered remains of a much larger specimen were observed in the field but not collected. Of the phragmocones, two are suitable for some measurements. One specimen (pl. 8, figs. 1, 2) has an umbilical ratio of 0.46 and fairly well-rounded whorls. Ornament consists of narrow, mostly rectiradiate ribs that extend from the umbilical wall entirely across the flank and onto the ventrolateral shoulder. These ribs, which number 13 in half a whorl, bear small bullate umbilical tubercles located well out on the flank and larger nearly equal-sized nodate to slightly bullate inner and outer ventrolateral tubercles. A low, siphonal ridge is present bearing low clavi equal in number to the ventrolateral tubercles. The other phragmocone (pl. 8, figs. 3, 4) has an umbilical ratio of 0.39 and only eight ribs in half a whorl.

The small adult (pl. 8, figs. 10, 11) has a wide umbilicus, a well-rounded umbilical wall, and stout, rounded whorls. Half a whorl of the body chamber is preserved. The last half whorl of the phragmocone has a diameter of 74.5 mm, an umbilical width of 32.2 mm (0.43), and a rib count of eight. Widely spaced ribs, like those on the phragmocone, are present on the older third of the body chamber, but on the middle third, ribs become weaker, narrower, and more closely spaced. The last part of the body chamber is badly crushed, and only bits of the shell are preserved.

Sutures of the Fence Lake specimens are fairly simple and much like the one illustrated for *K. turoniense* by Kennedy and Wright (1979a, fig. 2). The first lateral saddle is broad and bifid, and the lateral lobe (L) is long, narrow, and trifid to asymmetrically bifid (text fig. 8).

This is the first record of *K. turoniense* from North America. Kennedy and Wright (1979a, p. 1,176) recorded the species from England, France, Spain, Tunisia, the Middle East, and Madagascar.

TYPES—Hypotypes USNM 328732-328735

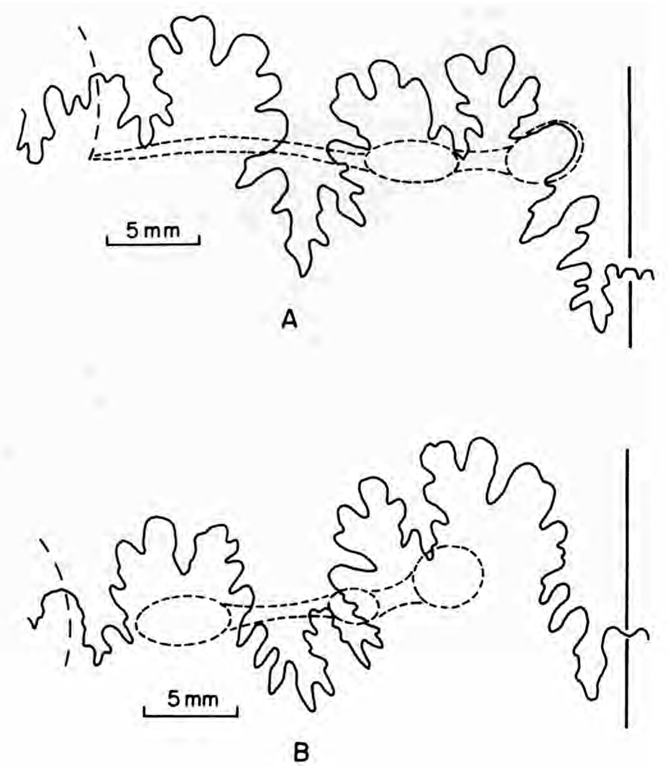

FIGURE 8—EXTERNAL SUTURES OF *KAMERUNOCERAS TURONIENSE* (D'ORBIGNY) FROM USGS MESOZOIC LOCALITY Dl 1208. A, Hypotype USNM 328732 at diameter of 55 mm (pl. 8, figs. 1, 2). B, Hypotype USNM 328733 at diameter of 58 mm (pl. 8, figs. 3, 4).

Family VASCOCERATIDAE H. Douvillé, 1912

Subfamily VASCOCERATINAE H. Douvillé, 1912
GENUS *Neoptychites* Kossmat, 1895
TYPE SPECIES: *Ammonites telinga* Stoliczka, 1865
(= *Ammonites cephalotus* Courtiller, 1860)

The diagnostic features of *Neoptychites* were summarized recently by Kennedy and Wright (1979b, p. 669) as moderate size, very involute shell, high adult whorls, narrowly flattened venter, constricted early whorls followed by a stage with numerous low ribs, generally smooth middle and late stages, and final constricted aperture. Tubercles were said to be absent. *Pseudoneoptychites* Leanza (1967, p. 202) was considered a synonym by Kennedy and Wright, but this genus has umbilical tubercles and is probably a valid genus. The origin of *Neoptychites* is assumed to be *Paravascoceras* Furon (1935, p. 60) according to Kennedy and Wright (1979b, p. 681) .

Neoptychites cephalotus (Courtiller)
Pl. 3, figs. 9-11; pls. 9-12; text fig. 9

For the extensive synonymy, see Kennedy and Wright (1979b, p. 670, 672, 674)

Kennedy and Wright (1979b, p. 674) observed that Courtiller's original description was based on a series of specimens of which three are still extant in the Chateau de Saumur in Saumur, France. These Saumur specimens were redescribed and illustrated by Kennedy and Wright, who also figured three other examples from France. The Saumur specimens as well as many other examples in museums in France seem to have come from the St. Cyr-en-Bourg Fossil Bed, which contains a *Col-lignoniceras woollgari woollgari* fauna of middle Turo-nian age.

Neoptychites cephalotus has three distinct growth stages according to Kennedy and Wright. The earliest whorls are smooth except for about four constrictions per whorl, which are bordered by strong ribs. In the second growth stage, ribs become numerous and are strongest on crossing the venter. In the third stage, all ornament disappears and the whorl assumes a high triangular cross section with narrowly rounded venter. The largest specimen recorded from France by Kennedy and Wright has a diameter of 217 mm.

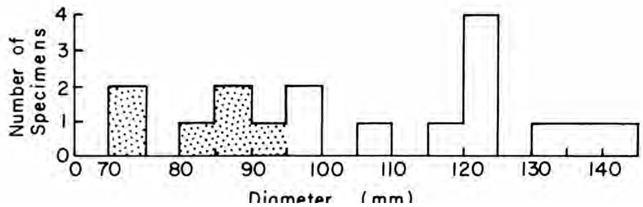

FIGURE 9—HISTOGRAM SHOWING RANGE IN SIZE OF BASE OF ADULT BODY CHAMBERS OF *NEOPTYCHITES CEPHALOTUS* (COURTILLER) FROM FENCE LAKE AREA (USGS MESOZOIC LOCALITIES D11208, D 11281, Dl 1295); stippled columns represent stout specimens that would be referred to *N. xetriformis* Pervinquiére.

Fifty-one specimens of *Neoptychites* from the Fence Lake area are suitable for one or more of the following measurements: diameter and breadth of shell, diameter of umbilicus, diameter of shell at base of adult body chamber, and number of ribs and constrictions per half whorl. Diameters of the specimens range from 41 to 185 mm; breadth ratios range from 0.33 to 0.71, averaging 0. 45, and umbilical ratios range from 0.04 to 0.09, averaging 0.06.

The specimens show considerable variation in stoutness and ornament as well as in size of adults. In general, the specimens fall into two groups, one characterized by stout shells and small size of adults and the other by more slender shells and larger size of adults. Such grouping suggests sexual dimorphism, although the size of adults does not show a clear-cut bimodal pattern like that revealed in a dimorphic study of some Upper Cretaceous scaphites (Cobban, 1969, fig. 3). A histogram showing diameters at base of body chambers and number of specimens is presented in text fig. 9.

The stout specimens are not clearly delineated from the slender forms (text fig. 10), and some individuals seem transitional. The stout forms could be assigned to

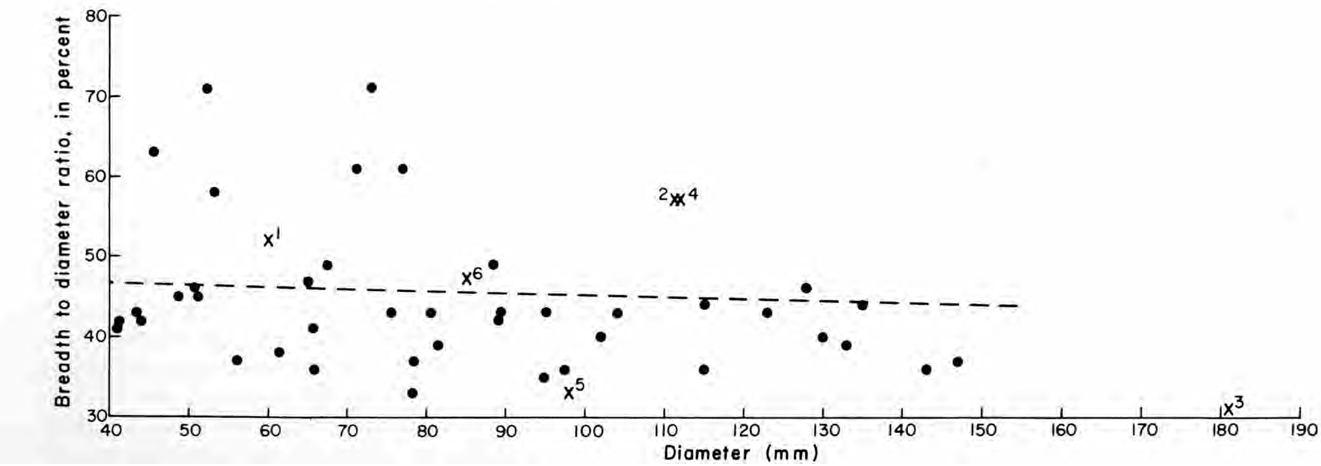

FIGURE 10—SCATTER DIAGRAM SHOWING BREADTH TO DIAMETER RATIOS IN PERCENT FOR ALL MEASURABLE SPECIMENS OF *NEOPTYCHITES* FROM FENCE LAKE AREA (USGS MESOZOIC LOCALITIES D11208, D11281, D11295). Dots above the dashed line could be referred to *N. xetriformis* Pervinquière; rest of dots are more typical of *N. cephalotus* (Courtiller). Crosses with numbers 1-3 refer to measurements of French examples of *N. cephalotus* given by Kennedy and Wright (1979b, p. 674): **1,** *Ammonites santonensis* d'Orbigny now assigned to *N. cephalotus;* 2, paralectotype of *N. cephalotus;* 3, lectotype of *N. cephalotus.* Crosses with numbers 4-6 refer to measurements of specimens assigned to *N. xetriformis* by Kennedy and Wright (1979b, p. 679): **4,** holotype from Tunisia; 5 and 6, French examples.

N. xetriformis Pervinquière (1907, p. 398, pl. 27, figs. 5-7; text figs. 153, 154), which was described from the lower Turonian of Tunisia. Kennedy and Wright (1979b, p. 680) regarded *N. xetriformis* as a distinct species differing from *N. cephalotus* in its smaller size and in its retention of low, broad ribs onto the adult body chamber. These authors, however, noted the occurrence of *N. xetriformis* with *N. cephalotus* and stated that "it is tempting to regard it *[xetriformis]* as the microconch of that species *[cephalotus]* ." Kennedy and Wright did not synonymize the species because they had seen only two French examples of *N. xetriformis* "as opposed to several dozen *N. cephalotus.* " Of the 45 measurable specimens of *Neoptychites* from the Fence Lake area, 12 could be referred to *N. xetriformis* because of their small adult form, stoutness, and retention of ribbing on the adult body chamber. The rest of the specimens are readily referable to *N. cephalotus.* We are, however, regarding the entire assemblage as a single species *(N. cephalotus)* that has the normal range of ammonite variation from small, stout, more strongly ornamented forms to large, slender, more weakly ornamented forms. The degree of stoutness did not enter into Kennedy and Wright's separation of *N. xetriformis* from *N. cephalotus* inasmuch as the holotype of *N. xetriformis* has essentially the same breadth to diameter ratio as one of the paralectotypes of *N. cephalotus* (text fig. 10, numbers 2 and 4) .

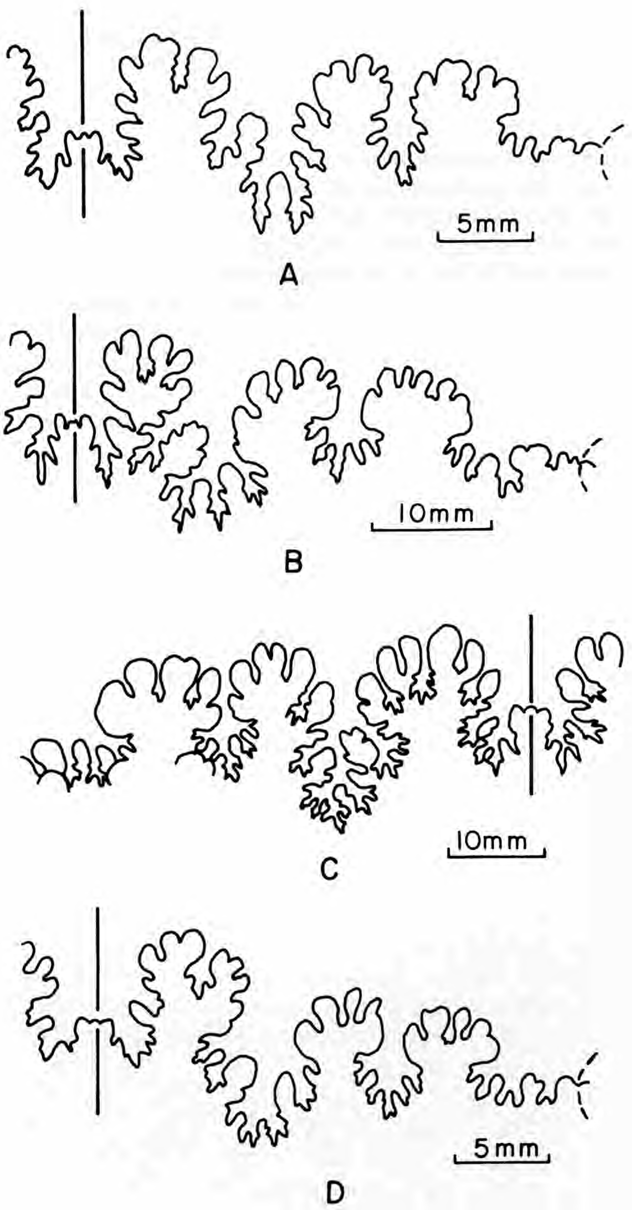

FIGURE 11-EXTERNAL SUTURES OF *NEOPTYCHITES CEPHALOTUS* (COURTILLER) FROM UPPER PART OF MANCOS SHALE IN FENCE LAKE AREA, CIBOLA COUNTY, NEW MEXICO. A, Hypotype USNM 328746 at whorl height of 22 mm, from USGS Mesozoic locality Dl 1281 (pl. 11, figs. 5-7). B, Hypotype USNM 328740 at whorl height of 33 mm, from USGS Mesozoic locality D 11208 (pl. 9, fig. 9; pl. 11, figs. 1, 2). C, Hypotype USNM 328742 at whorl height of 48 mm, from USGS Mesozoic locality D11208 (pl. 10, figs. 1-3). D, Hypo-type USNM 328745 at whorl height of 21.5 mm, from USGS Mesozoic locality Dl 1208 (pl. 11, figs. 3, 4, 9-11).

The specimens from the Fence Lake area show much variation in the ornament on the inner whorls. In general, the more slender specimens have ribbing dominant over constrictions, whereas constrictions are usually dominant over ribbing on the stouter specimens. Ribs are rectiradiate to prorsiradiate, arise on the inner half of the flank, and are strongest on crossing the venter. The ribs number 17-19 per half whorl on the slender specimens and 12-15 per half whorl on the stouter ones. Constrictions number four to eight per whorl and are bordered by strong ribs. On some stout individuals, the area between constrictions may be smooth on part of the whorls and well ribbed on other parts (pl. 11, figs. 5-7). Ribbing weakens and disappears at some diameter between 46 and 57 mm on the slender specimens, whereas it persists weakly onto the body chambers of stout specimens. Constrictions disappear on the slender specimens by a diameter of 46 mm in contrast to diameters of 59-77 mm on stout specimens.

Apertures are preserved on eight individuals, and each has a pronounced broad constriction (pl. 9, figs. 10-12; pl. 11, figs. 9-11; pl. 12) like those on the excellent specimens from India illustrated by Stoliczka (1865, pl. 62) and Kossmat (1895, pl. 21) . Diameters of the entire adult shells can be measured or estimated for only eight individuals. These diameters, in mm, are as follows: stout form, 104, 115, 123; slender form, 127, 140, 146, 147, 185.

Sutures are typical for those of the genus shown by Stoliczka (1865, pl. 61, fig. 1 c; pl. 62, fig. 2), Kossmat (1895, pl. 21, figs. 1c, 2-5), Solger (1904, text figs. 1020) , and Pervinquière (1907, text figs. 152-156). Sutures of three stout specimens (text fig. 11A, B, D) and one slender specimen (text fig. 11C) are presented herein.

GENUS *Fagesia* Pervinquière, 1907
TYPE SPECIES: *Olcostephanus superstes* Kossmat, 1897

This genus was named by Pervinquière (1907, p. 320) in honor of M. de Fages de Latour, Director Général des Travaux publics in Tunisia; it was not named by Spath in 1925 as indicated by Kennedy and Wright (1979b, p. 666). Pervinquière diagnosed the genus as globular shells having a deep umbilicus with vertical walls; ornament in the juvenile and early adult stages usually consisting of a row of umbilical tubercles from which two or three prominent ribs arise and cross the flanks and venter without interruption; later adult stage entirely smooth; and suture having four external saddles and probably three internal ones, the saddles being very elongate and irregularly trifid, and the lateral lobe and the next one being bifid.

Fagesia is widely distributed in rocks of early and middle Turonian age. In North America, the genus has been recorded from Mexico (Bose 1918, p. 184, 186-187, 211-213; Kummel and Decker, 1954, p. 314-315; Powell, 1963a, p. 320-321; Chancellor and others, 1977, p. 92), trans-Pecos Texas (Adkins, 1931, p. 40, 55-56; Powell, 1963a, p. 320), Colorado (Cobban and Scott, 1972, p. 88), and California (Anderson, 1931).

Fagesia superstes (Kossmat)
Pl. 3, figs. 1, 2; pl. 13, figs. 6-11; text fig. 12

Olcostephanus superstes Kossmat, 1897, p. 133, pl. 17, figs. la-c
Fagesia superstes (Kossmat). Pervinquière, 1907, p. 322
Fagesia superstes var. *tunisiensis* Pervinquière 1907, p. 323, pl. 20, figs. la-c, 2a, b
Fagesia superstes var. *spheroidalis* Pervinquiére, 1907, p. 324, pl. 20, figs. 3a, b, 4, A; text fig. 122
Fagesia superstes (Kossmat). Eck, 1909, p. 182
________ Douvillé, 1911, p. 301, fig. 18; Diener, 1925, p. 182; Basse, 1940, p. 459; Wright, 1957b, p. L420, fig. 541-2a, b, c
Fagesia superstes var. *spheroidalis* Pervinquiere. Collignon, 1965a, p. 46, pl. 395
Fagesia superstes var. *tunisiensis* Pervinquière. Thomel, 1969, p. 116, pls. D, E
Fagesia spheroidalis Pervinquière. Matsumoto and Mura-moto, 1978, p. 282, pl. 39, fig. la, b; text fig. 2

The holotype of *Fagesia superstes is* a phragmocone that has very depressed whorls. Kossmat (1897, p. 133) gave the following dimensions: diameter, 100 mm; breadth, 80 mm (0.80); umbilicus, 34 mm (0.34). Kossmat's drawings show 16 umbilical tubercles each giving rise to two prominent prorsiradiate ribs, which cross the venter with forward arching. The moderately complex suture has elongate, narrow, digitate first and second lateral lobes and saddles.

Pervinquière (1907, p. 323, 324, pl. 20, figs. 1-4, A; text fig. 122) described a variety *tunisiensis* that has whorls less depressed than those of Kossmat's *F. superstes* and a variety *spheroidalis* that has whorls more depressed than Kossmat's specimen. Matsumoto and Muramoto (1978, p. 282) considered the variety *spheroidalis* as an independent species.

Pervinquière (1907, pl. 20, figs. la-c, 2a, b) illustrated two specimens of his variety *tunisiensis.* His smaller specimen has a diameter of 29 mm, breadth of 20 mm (0. 69), umbilicus of 10 mm (0.34), and, on the last half whorl, five umbilical tubercles and 15 ribs. His larger specimen has a diameter of 92 mm, breadth of 71 mm (0. 77), umbilicus of 30 mm (0.33), and six umbilical tubercles and 16 ribs on half a whorl.

Fagesia is represented in the collections from the Fence lake area by two moderate-sized phragmocones typical of *F. superstes,* especially the variety *tunisiensis,* and one very small phragmocone that may be a slender variant. The smaller (pl. 13, figs. 7-9) of the two larger specimens is a distorted phragmocone 68 mm in diameter that has a breadth of 57 mm (0.84) and an umbilicus of 21 mm (0. 31) . On the last half whorl, umbilical tubercles number eight, and ribs number 21. The larger specimen, which is undistorted, consists of a stout septate coil 86 mm in diameter that has a septate piece of the next larger whorl attached to it (pl. 13, fig. 6). The inner coil has a breadth of 69.5 mm (0.77) and an umbilicus of 23. 5 mm (0.26). On the last half whorl of this coil, six umbilical tubercles and 16 ribs are present. Part of its external suture is shown in text fig. 12. The smallest specimen, 26.2 mm in diameter, has an umbilical width of 9.5 mm (0.36), 12 strong umbilical tubercles per whorl, and about 25 thick, rounded ribs (pl. 3, fig. 1, 2).

Family COLLIGNONICERATIDAE Wright and Wright, 1951
Subfamily BARROISICERATINAE Basse, 1947
GENUS *Cibolaites* Cobban and Hook, n. gen.
TYPE SPECIES: *Cibolaites molenaari* Cobban and Hook, n. sp.

Strong, nodate umbilical tubercles and equal numbers of clavate siphonal and ventrolateral tubercles characterize this moderate-sized, somewhat involute genus. Ventrolateral tubercles are represented by a single row only. The suture is fairly simple with little-divided broad saddles and narrower rectangular lobes.

Cibolaites is a Turonian homeomorph of the Coniacian *Barroisiceras* de Grossouvre (1893, p. 50) and *Subbarroisiceras* Basse (1946), which differ in having smaller umbilici and crenulate keels. The siphonal tubercles of *Cibolaites* are separated by keel-free interspaces.

The only known species of *Cibolaites, C. molenaari,* is associated with *Neoptychites cephalotus* (Courtiller) and *Fagesia superstes* (Kossmat) of late early Turonian to early middle Turonian age.

Cibolaites molenaari Cobban and Hook, n. sp.
Pl. 2, figs. 1-9; pl. 3, figs. 3-8; pl. 8, figs. 6-8; Pl. 13, figs. 1-5; pl. 14; text fig. 13

Ninety-two specimens from the Fence Lake area were available for measurements of all or most of the follow-

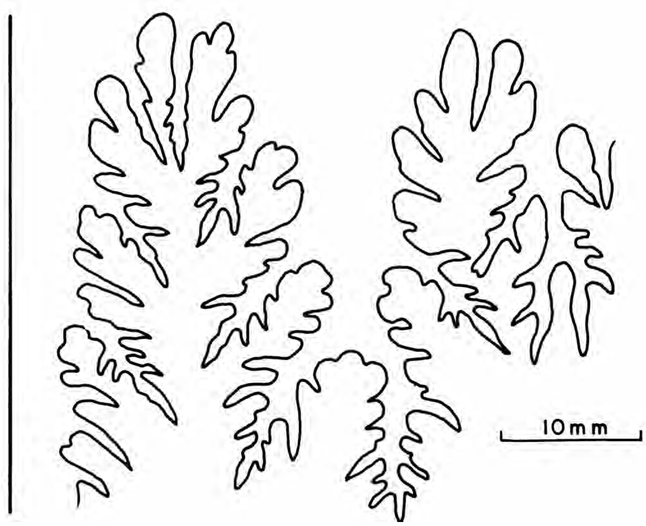

FIGURE 12-PART OF EXTERNAL SUTURE OF *FAGESIA SUPERSTES* (KOSSMAT) FROM UPPER PART OF MANCOS SHALE AT USGS MESOZOIC LOCALITY Dl 1208; hypotype USNM 328750 at diameter of 81 mm (pl. 13, figs. 6, 10, 11).

ing: diameter, breadth, umbilicus, diameter at base of body chamber, and number of umbilical and siphonal tubercles per half whorl.

Whorls less than 5 mm in diameter are smooth and have rounded flanks and venters. At some diameter from 5 to 7 mm, low umbilical bullae arise and number about 14 per whorl (pl. 14, fig. 2). Ventrolateral and siphonal tubercles arise at a diameter of about 10 mm, and ribs appear on the outer part of the flank. As the whorls enlarge, the umbilical tubercles become sparser, nodate, and very strong. Two rectiradiate to prorsiradiate ribs usually arise from each umbilical tubercle and cross the flank to rise again in clavate ventrolateral tubercles. One or two intercalated secondary ribs also rise into ventrolateral clavi. A broad low rib connects opposite ventrolateral clavi and arches forward on the venter where it bears a conspicuous clavate siphonal tubercle. Umbilical tubercles weaken greatly on the body chamber or even disappear, but ribs and ventrolateral and siphonal tubercles persist to the aperture.

All but the earliest whorls have a fastigate cross section that is broadest at the umbilical shoulder (pl. 3, fig. 5). Costal breadth to diameter ratios range from 0.32 0. 63 (average 0.46) with the youngest and oldest specimens having the smaller ratios. Umbilical ratios range from 0.18-0.34 (average 0.25) with most specimens lying in the 0.22-0.27 range. The ratio increases slightly as the shell enlarges.

Forty-six specimens have part of the body chamber. The entire body chamber probably included about two-thirds of a whorl (pl. 14, fig. 14). The specimens show a broad range in size of the base of the body chamber without grouping into two general sizes as would be expected for sexual dimorphism (text fig. 13).

The holotype (pl. 14, figs. 13-15) is a nearly complete internal mold 124 mm in diameter that has an umbilical ratio of 0.30. The flanks on the body chamber are considerably flattened, and the cross section is much higher than wide. Umbilical tubercles on the last septate whorl are strong and nodate and number nine. The umbilical tubercles weaken abruptly at the base of the body chamber and become weak bullae or disappear. Ribs continue on the body chamber to the aperture, but well-defined ventrolateral and siphonal clavate tubercles persist on about the older two-thirds of this chamber and then become weak and nodate.

The suture of *C. molenaari* is characterized by a broad, bifid first lateral saddle; long, narrow, bifid lateral lobe (L); slightly broader second lateral saddle; and much narrower second lateral lobe (text fig. 14).

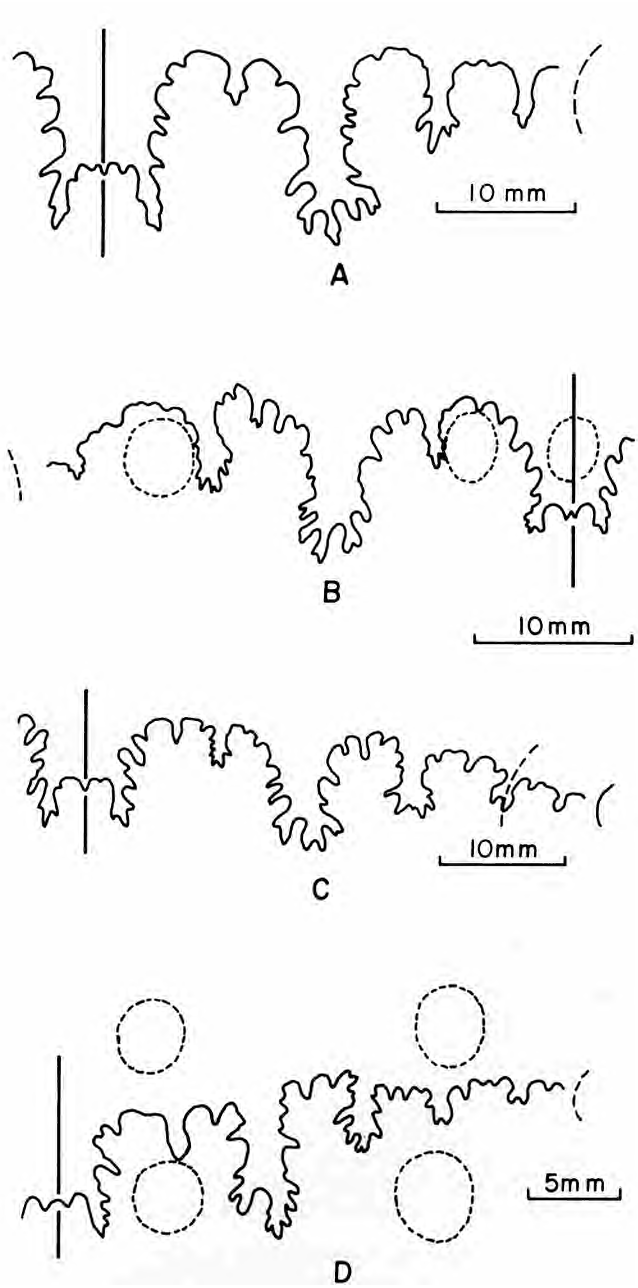

FIGURE 14-EXTERNAL SUTURES OF *CIBOLAITES MOLENAARI* COBBAN AND Hook, N. SP. A, Holotype USNM 238766 at diameter of 60 mm, from USGS Mesozoic locality D11208 (pl. 14, figs. 13-15). B, Para-type USNM 328767 at diameter of 66 mm, from USGS Mesozoic locality D8429. C, Paratype USNM 328760 at whorl height of 28 mm, from USGS Mesozoic locality D11208 (pl. 13, figs. 3-5). **D,** Paratype USNM 329013 at diameter of 60 mm, from USGS Mesozoic locality D8429.

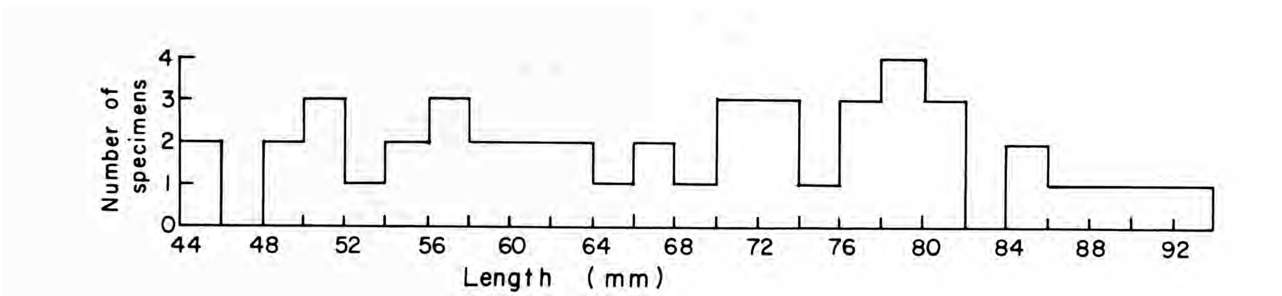

FIGURE 13-HHISTOGRAM SHOWING RANGE IN SIZE OF BASE OF BODY CHAMBERS OF *CIBOLAITES MOLENAARI* COBBAN AND HOOK, N. SP., FROM FENCE LAKE AREA (USGS MESOZOIC LOCALITIES D7073, D8429, D10538, D11208, D11281, D11295, D11342, D11344, D11557, D11558, D11560, D11706).

Cibolaites molenaari shows the normal variation of ammonite species from slender forms having weak ornament (pl. 2, figs. 1-6) to stouter forms having stronger ornament (pl. 2, figs. 7-9).

Aside from the occurrences in the Fence Lake area, *C. molenaari is* known only from a single specimen from the Atarque Sandstone northeast of Truth or Consequences, New Mexico.

The species is named for C. M. Molenaar, both for his discovery of the Fence Lake fauna and for his investigations of mid-Cretaceous stratigraphy of northwest New Mexico.

TYPES—Holotype USNM 328766, paratypes USNM 328752-328767,329013

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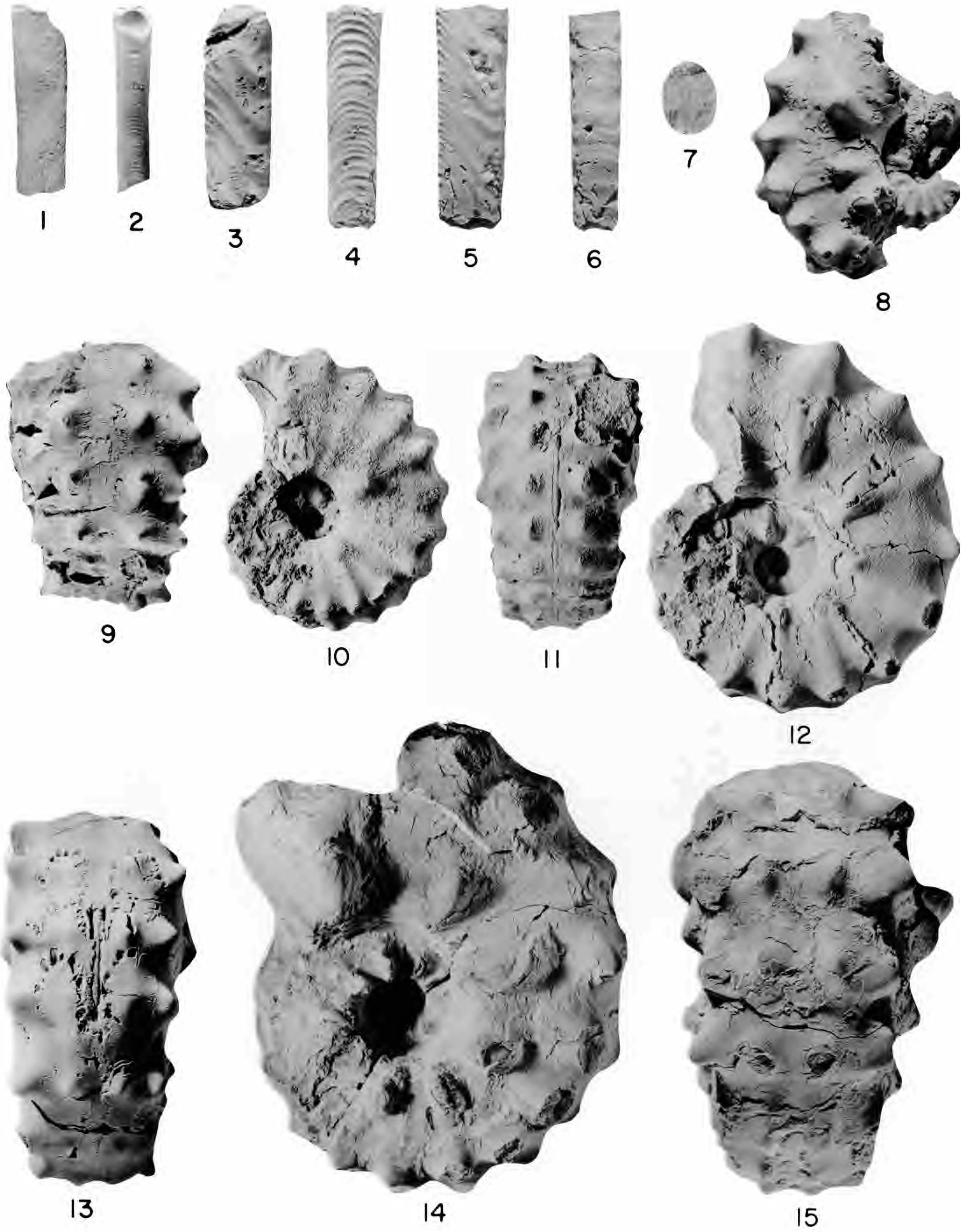
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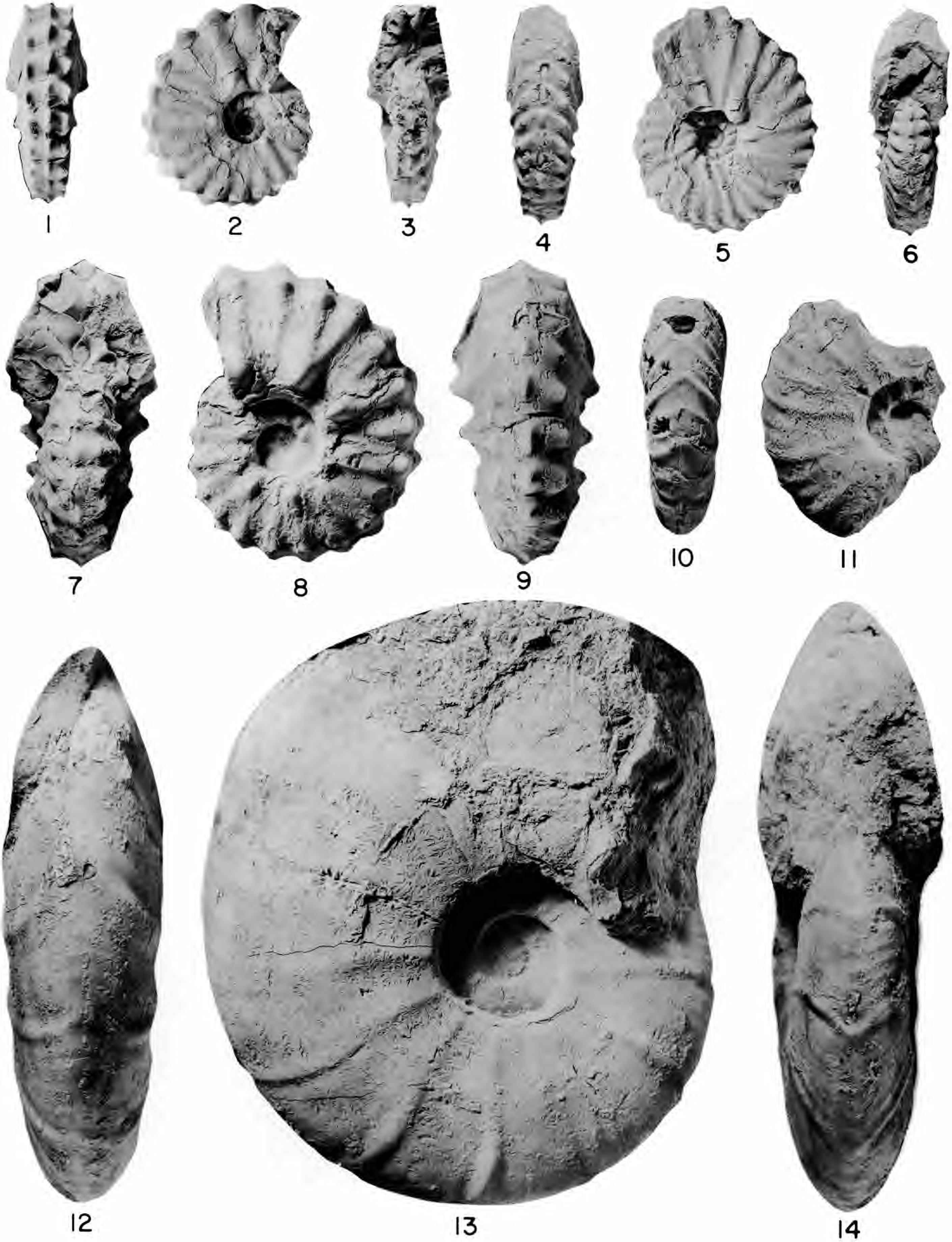
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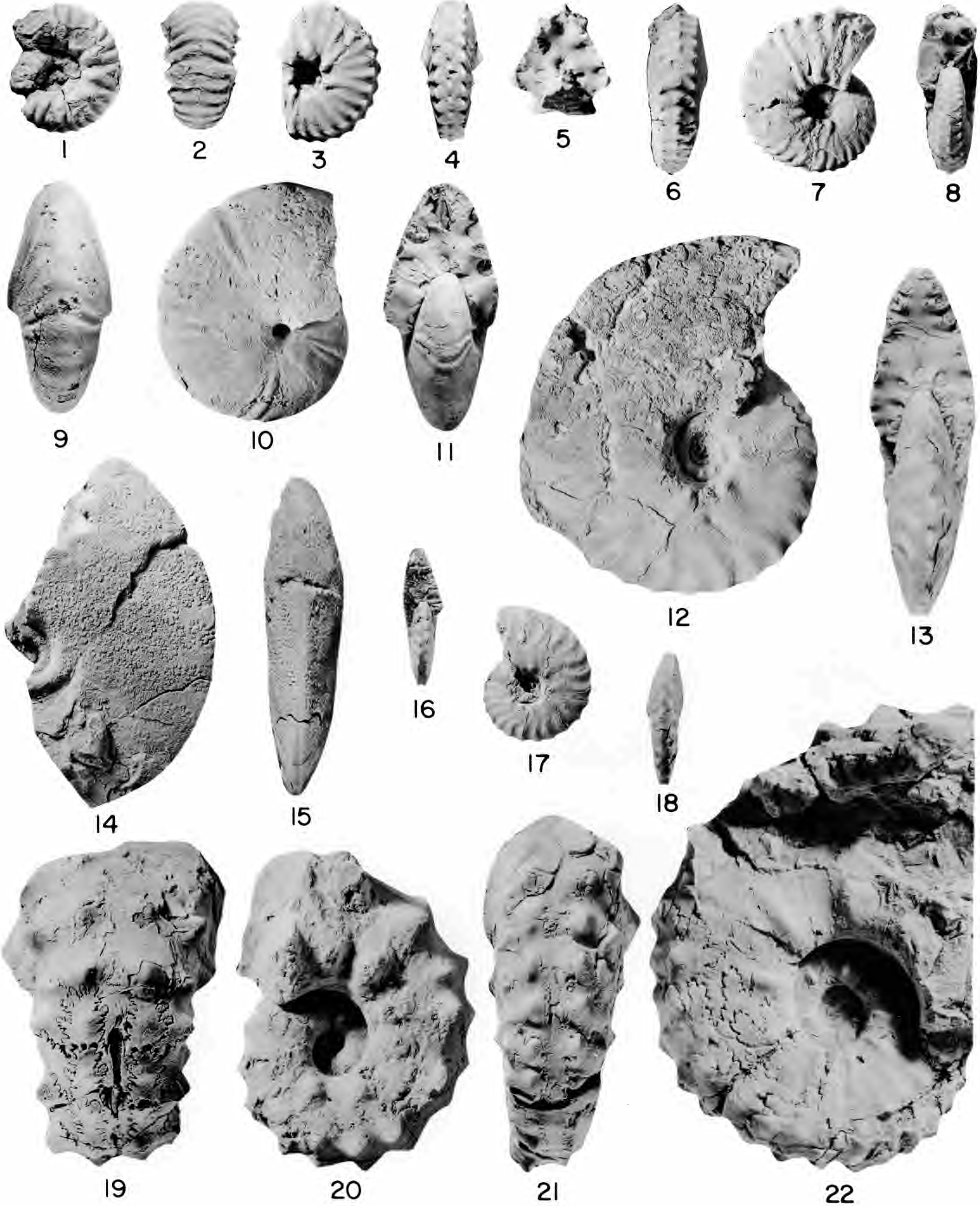
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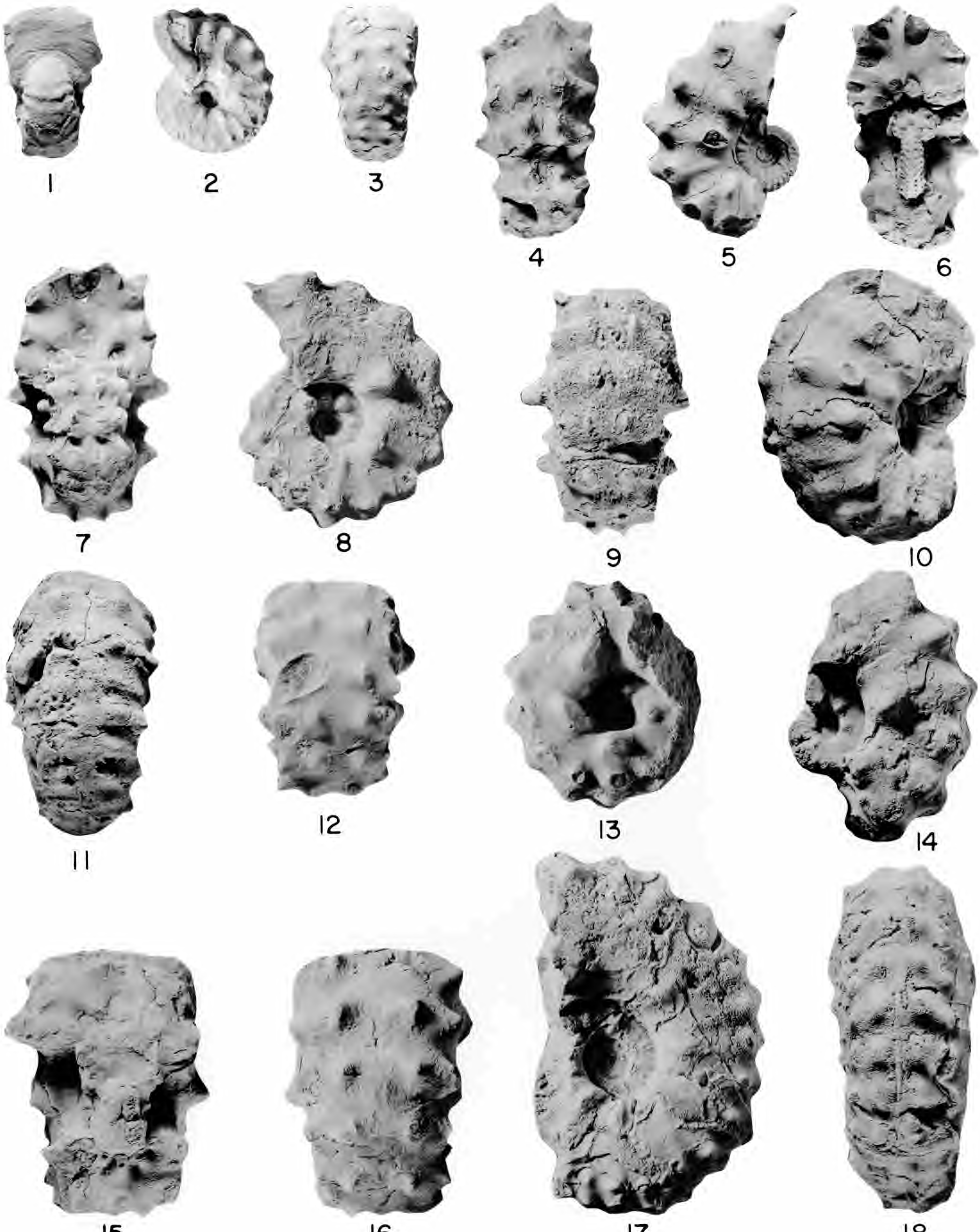
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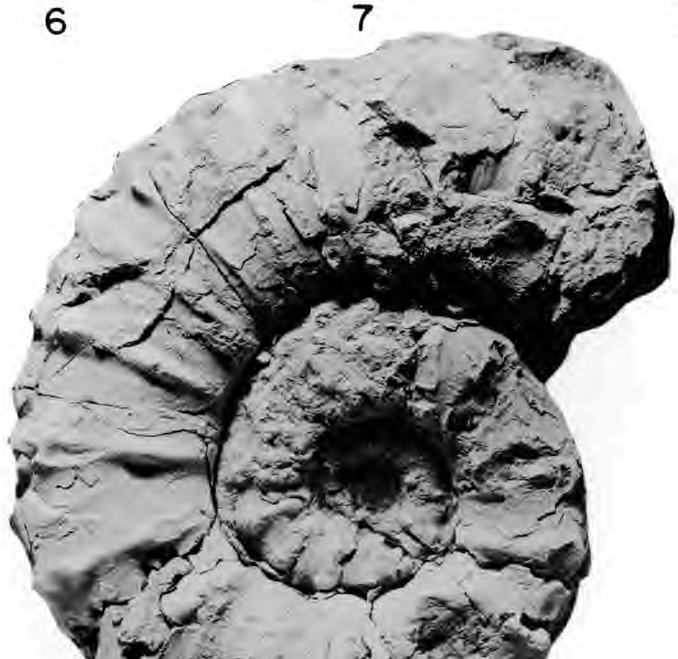
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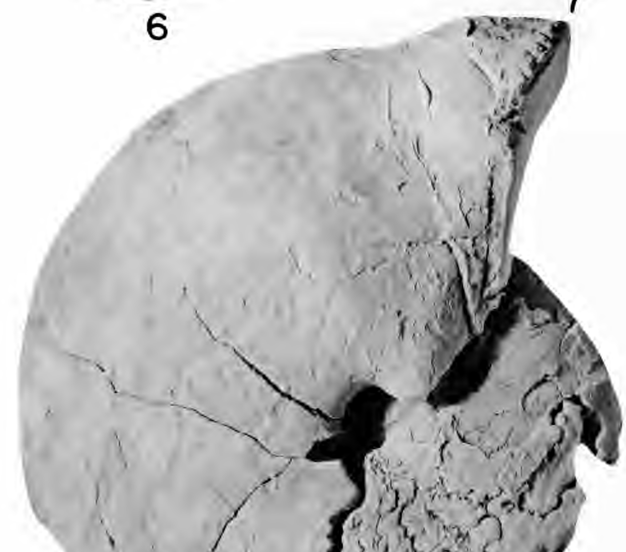

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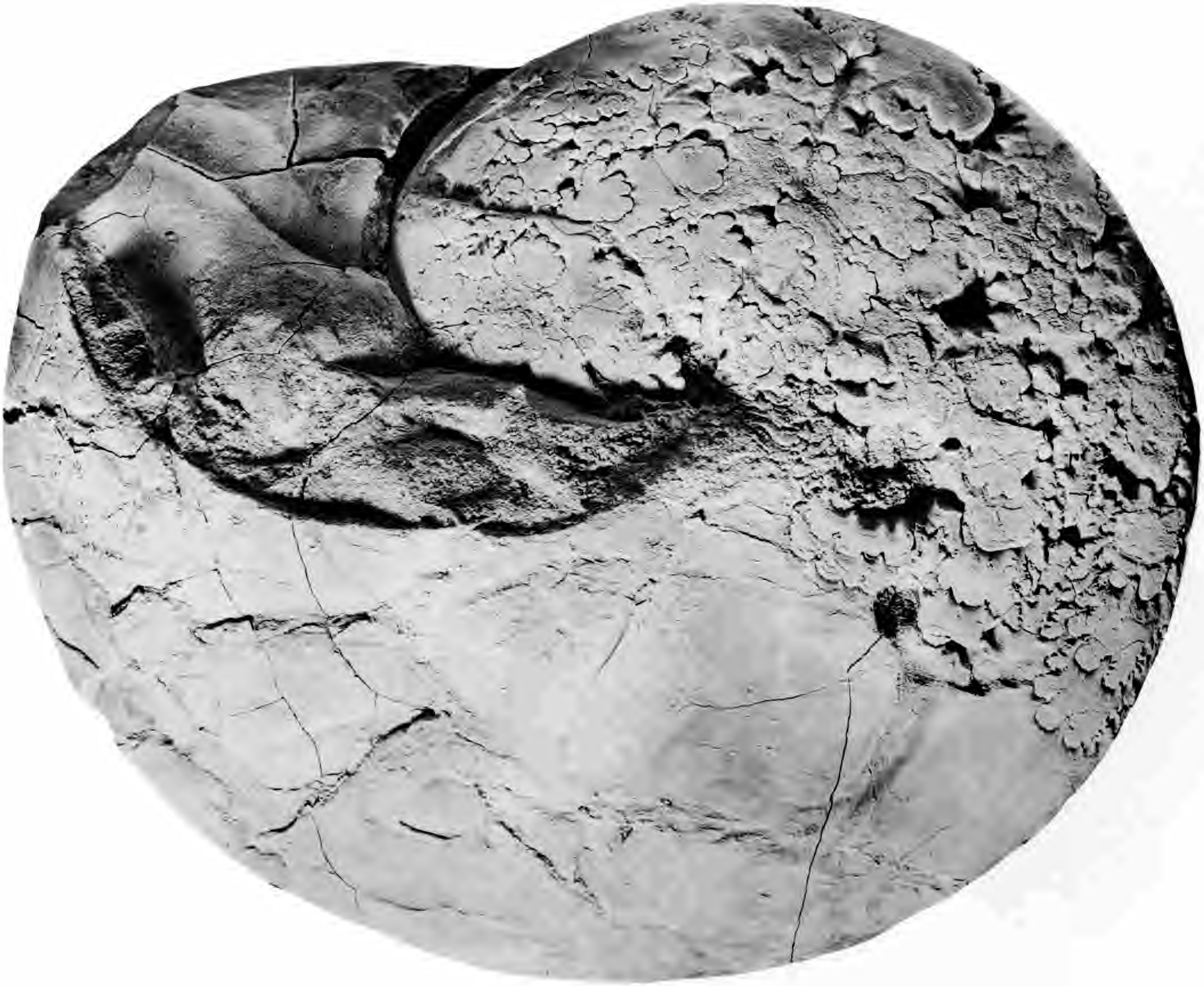

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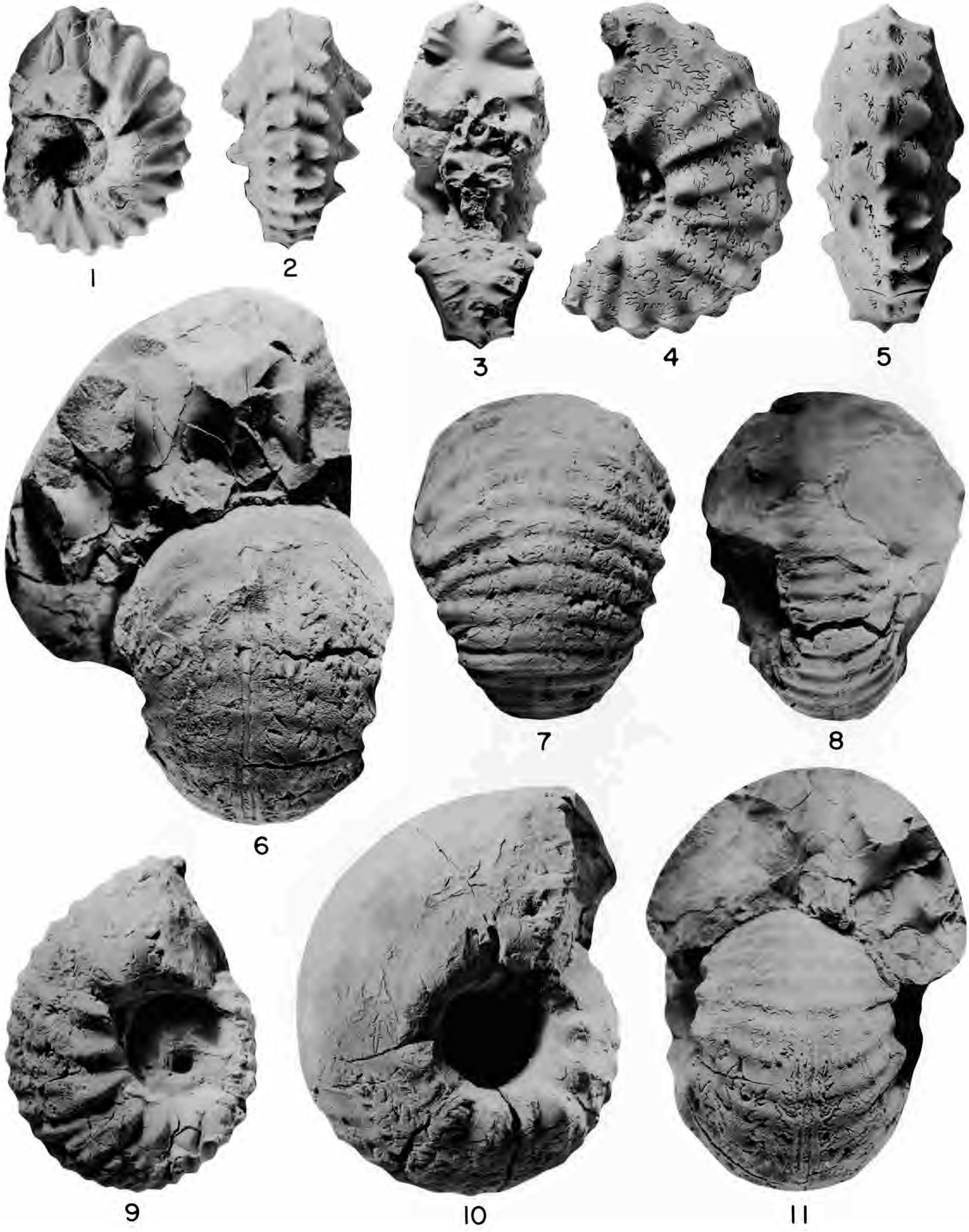
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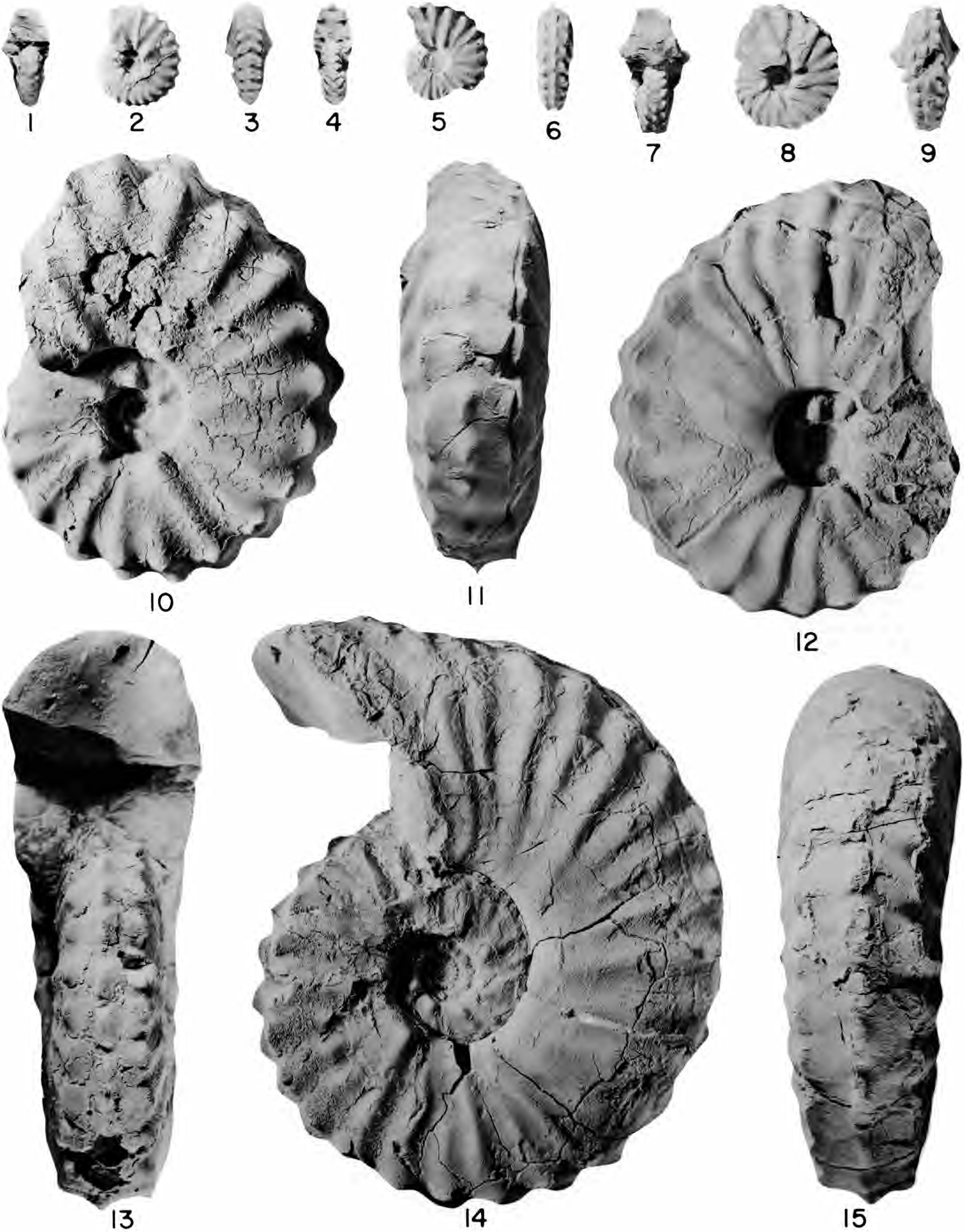
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