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William A. Cobban

1977, pp. 213-220. https://doi.org/10.56577/FFC-28.213

in:

San Juan Basin III (northwestern New Mexico), Fassett, J. F.; James, H. L.; [eds.], New Mexico Geological Society 28 th Annual Fall Field Conference Guidebook, 319 p. https://doi.org/10.56577/FFC-28

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FOSSIL MOLLUSKS OF THE DAKOTA SANDSTONE AND INTERTONGUED MANCOS SHALE OF WEST-CENTRAL NEW MEXICO

W. A. COBBAN
U.S. Geological Survey
Denver, Colorado

INTRODUCTION

The Dakota Sandstone intertongues with the Mancos Shale in west-central New Mexico. Along the south flank of the San Juan Basin, the following nomenclature has been applied to this intertongued sequence (Landis and others, 1973a, b):

(Top)
Twowells Sandstone Tongue of Dakota Sandstone
Whitewater Arroyo Shale Tongue of Mancos Shale
Paguate Sandstone Tongue of Dakota Sandstone
Clay Mesa Shale Tongue of Mancos Shale
Cubero Sandstone Tongue of Dakota Sandstone
Oak Canyon Member of Dakota Sandstone
(Bottom)

Fossil marine mollusks are abundant in all of the units except the lower part of the Oak Canyon Member. The fossils reveal an early Late Cretaceous age; the Twowells Sandstone Tongue and the Whitewater Arroyo Shale Tongue are late Cenomanian; and the rest of the members are middle Cenomanian. Palynomorphs from the lower part of the Oak Canyon Member were assigned an Albian age by R. H. Tschudy (in Landis and others, 1973a, p. J21), but Tschudy now regards the assemblage as Cenomanian (personal commun., June 1977).

LOCALITIES OF ILLUSTRATED FOSSILS

The fossil mollusks shown in Figures 2-5 are from 28 localities in west-central New Mexico and 1 in southern Utah. The New Mexico localities, numbered 1 to 28 on Figure 1, are listed below. Numbers in parentheses are U.S. Geological Survey Mesozoic localities.

1 (D6191). South side of Tse Bonita Wash in the SW¼ sec. 2, T. 16 N., R. 21 W. Lower part of Twowells Sandstone Tongue.

2 (D9240). Near Manuelito in the SE¼ sec. 19, T. 14 N., R. 20 W. Brown-weathering sandstone concretions in Twowells Sandstone Tongue.

3 (D6182). NW¼ sec. 15, T. 4 N., R. 20 W. Middle of Paguate Sandstone Tongue.

4 (D6184). Same locality as 3. Concretionary limestone bed near base of Whitewater Arroyo Shale Tongue.

5 (D7345). NE¼SE¼ sec. 8, T. 15 N., R. 13 W. Top of a sandstone underlying Whitewater Arroyo Shale Tongue.

6 (D5759). SW¼SE¼ sec. 24, T. 15 N., R. 13 W. About 10 feet (3 m) below top of Whitewater Arroyo Shale Tongue.

7 (D7335). SE¼SE¼ sec. 31, T. 15 N., R. 12 W. Twowells Sandstone Tongue.

8 (D7332). Drainage ditch near center of sec. 5, T. 14 N., R. 12 W. Paguate Sandstone Tongue.

9 (D7328). NE¼NE¼ sec. 25, T. 15 N., R. 12 W. Upper part of Paguate Sandstone Tongue.

10 (D6131). NE¼ sec. 4, T. 7 N., R. 10 W. Base of Twowells Sandstone Tongue.

11 (D6781). SW¼ sec. 6, T. 8 N., R. 9 W. Brown-weathering limestone concretions in Clay Mesa Shale Tongue.

12 (D5741). Sharp road bend in the SE¼SW¼ sec. 27, T. 10 N., R. 8 W. Limestone concretion in upper part of Whitewater Arroyo Shale Tongue.

13 (D2048). NE¼ sec. 23, T. 9 N., R. 8 W. Cubero Sandstone Tongue.

14 (D2053). Deadmans Rock in the NE¼NE¼ sec. 7, T. 8 N., R. 7 W. Dark-brown-weathering ferruginous sandstone concretions in Oak Canyon Member.

15 (D7364). Two miles (3.2 km) west of Acoma Pueblo in the SE¼ SW¼ sec. 30, T. 8 N., R. 7 W. Gray limestone concretion 10 feet (3 m) above base of Clay Mesa Shale Tongue.

16 (D5329). SE¼ sec. 36, T. 8 N., R. 8 W. Brown-weathering calcareous siltstone concretion 62 feet (19 m) above base of Oak Canyon Member.

17 (D5330). Same locality as 16. Lower part of Cubero Sandstone Tongue.

18 (D5332). Same locality as 16. Limestone concretion 25 feet (7.6 m) above base of Clay Mesa Shale Tongue.

19 (D6794). North side of Paradise Canyon in the SE¼NW¼ sec. 24, T. 7 N., R. 8 W. Brown-weathering silty limestone concretion 80 feet (24 m) above base of Oak Canyon Member.

20 (D7084). Three miles (4.8 km) north of Laguna in the SE¼NE¼ sec. 20, T. 10 N., R. 5 W. Brown-weathering sandstone concretions in Paguate Sandstone Tongue.

21 (D5344). Bottom of arroyo in the NW¼NE¼ sec. 29, T. 11 N., R. 5 W. Glauconitic calcareous sandstone concretion about 50 feet (15 m) below top of Whitewater Arroyo Shale Tongue.

22 (D5366). NE¼ sec. 29, T. 12 N., R. 3 W. Brown-weathering sandy limestone concretion 66 feet (20 m) above base of Oak Canyon Member.

23. Rio Puerco about 10 miles (3 km) north of San Ignacio. Oak Canyon Member.

24. Southwest of San Ysidro. Paguate Sandstone Tongue.

25 (D5806). Bernalillito Arroyo in the SW¼ sec. 21, T. 15 N., R. 1 W. Dark-brown-weathering calcareous sandstone bed in Oak Canyon Member.

26 (D5815). About 1½ miles (2.4 km) N. 30° E. of Ojito Tank. Oak Canyon Member.

27 (D5380). About ½ mile (0.8 km) south of Chamisa Vega Spring in T. 17 N., R. 1 W. Clay Mesa Shale Tongue.

28 (D5392). SW¼SW¼ sec. 36, T. 19 N., R. 1 W. Twowells Sandstone Tongue.

STRATIGRAPHIC CORRELATIONS

Oak Canyon Member

The Oak Canyon Member, 74 feet (22.6 m) thick near Laguna, consists of sandstone, siltstone and shale with minor amounts of limy siltstone and bentonite. Depositional environments range from open-marine to fluviatile. Open-marine conditions existed only during deposition of the upper half of the member, and the oldest Cretaceous mollusks in the U.S. Geological Survey's collections from the San Juan Basin are from this part. Here, most of the fossils occur in vast numbers and in great variety in dark-brown-weathering, ferruginous, limy concretionary siltstone near the base of the upper half of the member. The collections of the U.S. Geological Survey from this ferruginous siltstone unit contain 34 species of bivalves, 11 species of gastropods, and 5 species of ammonites. Among the more common fossils are the bivalves *Pinna petrina* White (fig. 2, N), *Camptonectes symmetricus* Herrick and Johnson (fig. 2, D), *Plicatula arenaria* Meek (fig. 2, O), *Exogyra columbella* Meek (fig. 2, E-G), *E. aquillana* Stephenson (fig. 2, H), and *Psilomya* aff. *P. concentrica* (Stanton) (fig. 2,

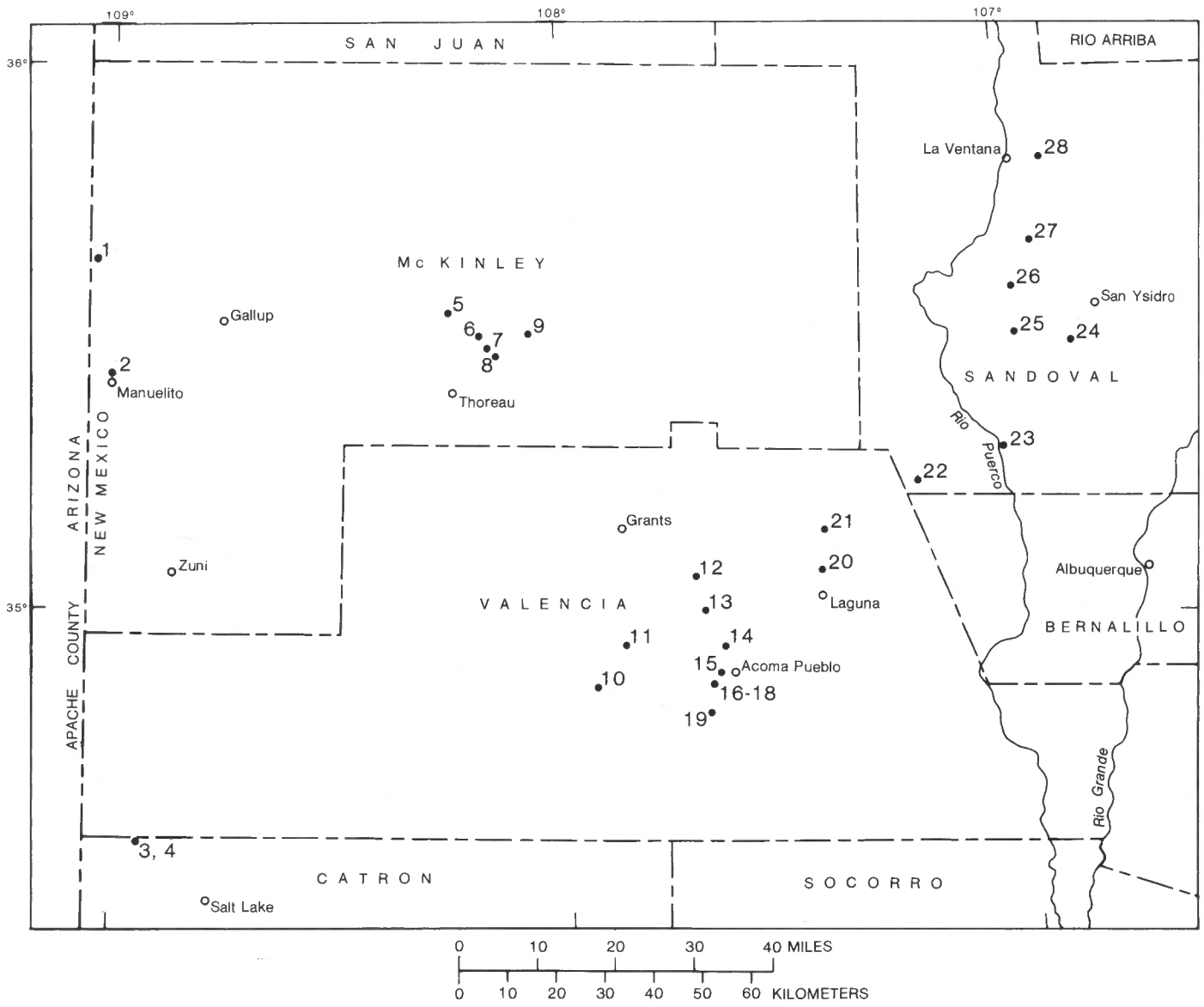


Figure 1. Localities of fossils from west-central New Mexico illustrated in Figures 2-5.

Figure 2. Fossils, natural size, from the Oak Canyon Member. A-C, Exogyra *aff.* E. columbella *Meek, two left valves from loc. 14 (A, B, USNM 239673; C, USNM 239672); D,* Camptonectes symmetricus *Herrick and Johnson, left valve, USNM 239731, from loc. 22; E-G,* Exogyra columbella *Neek, two left valves (E, F, USNM 239667 from loc. 14; G, USNM 239668 from loc. 16); H,* Exogyra aquillana *Stephenson, left valves, USNM 239676, from loc. 26; I,* Turrilites acutus *Passy, USNM 239744, from loc. 23; J, K,* Psilomya *aff.* P. concentrica *(Stanton), right and left valves, USNM 239730, 239729, from loc. 22; L,* Calycoceras (Conlinoceras) tarrantense *(Adkins), USNM 239762, from loc. 14; M,* Arrhoges modesta *(Cragin)?, USNM 239743, from loc. 25; N,* Pinna petrina *White, USNM 239614, several strongly ribbed fragments associated with* Exogyra columbella *from loc. 19; O,* Plicatula arenaria *Meek, USNM 239635, many conspicuously plicate specimens associated with fragments of* Pinna petrina *from loc. 19.*

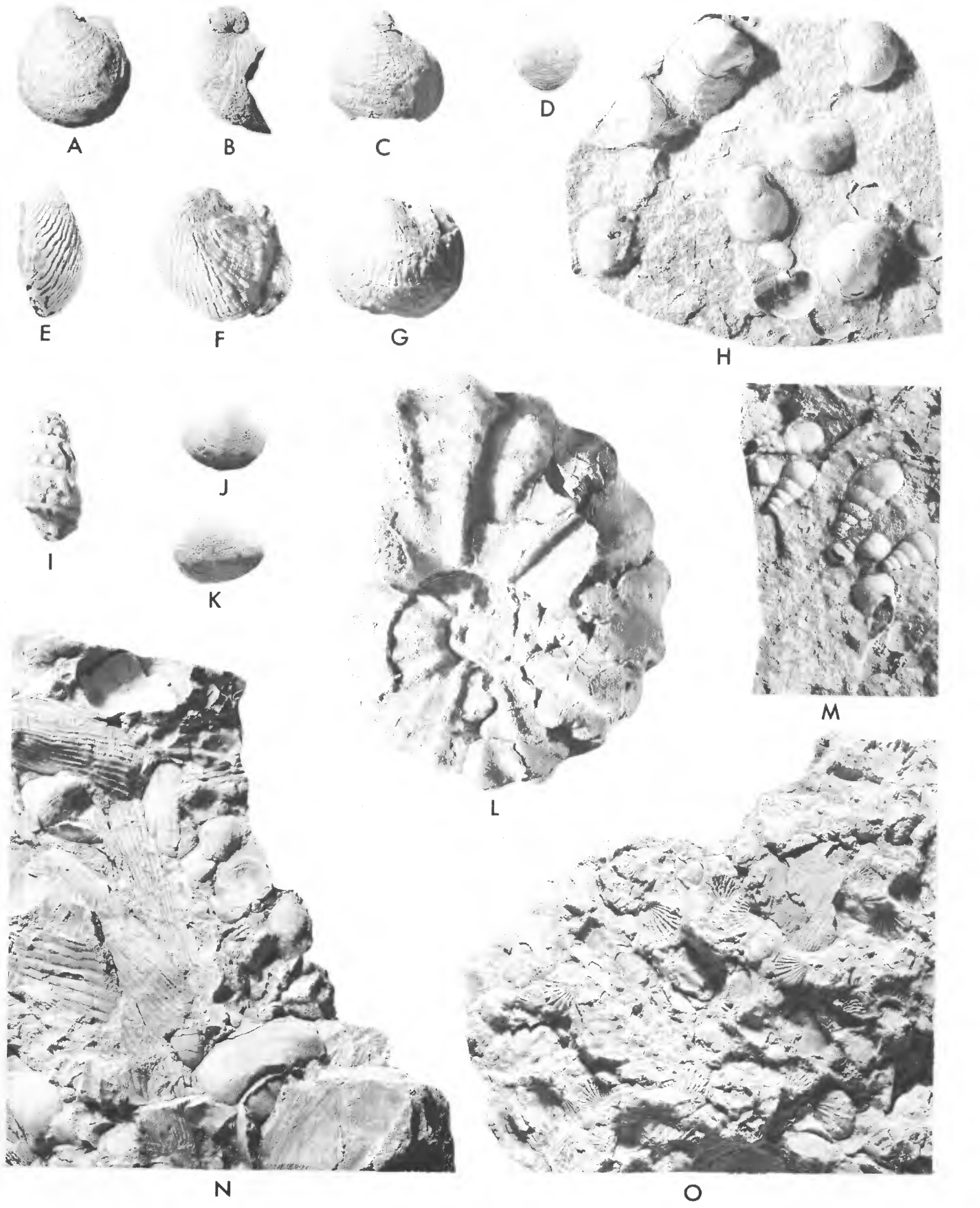


Figure 2.

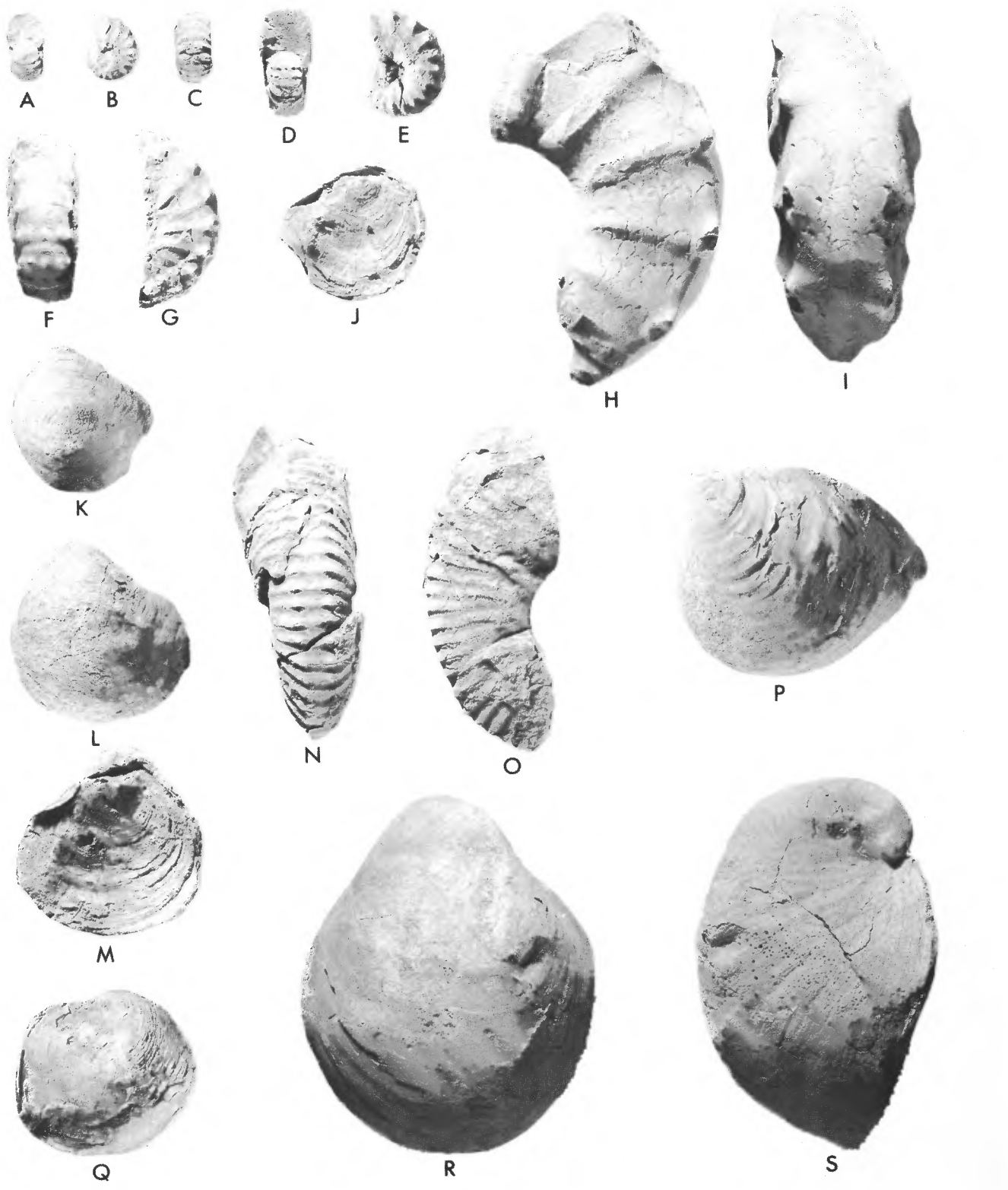


Figure 3. Fossils, natural size, from the Clay Mesa Shale Tongue and Cubero Sandstone Tongue. A-I, Acanthoceras alvaradoense *Moreman (A-E, views of parts of the inner whorls of a specimen, USNM 239771, from loc. 18; F-I, parts of the inner and outer whorls of a larger phragmocone, USNM 239773, from loc. 15); J-M,* Pycnodonte *cf.* P. kellumi *(Jones) from loc. 11 (J, K, both valves of USNM 239652; L, M, both valves of USNM 239653); N, O,* Tarrantoceras rotatile *Stephenson, ventral and lateral views of USNM 239756 from loc. 27; P,* Inoceramus arvanus *Stephenson, left valve, USNM 239630 from loc. 27; Q-S,* Exogyra *n. sp. (Q, right valve, USNM 239685 from loc. 17; R, S, left valve, USNM 239687 from loc. 13).*

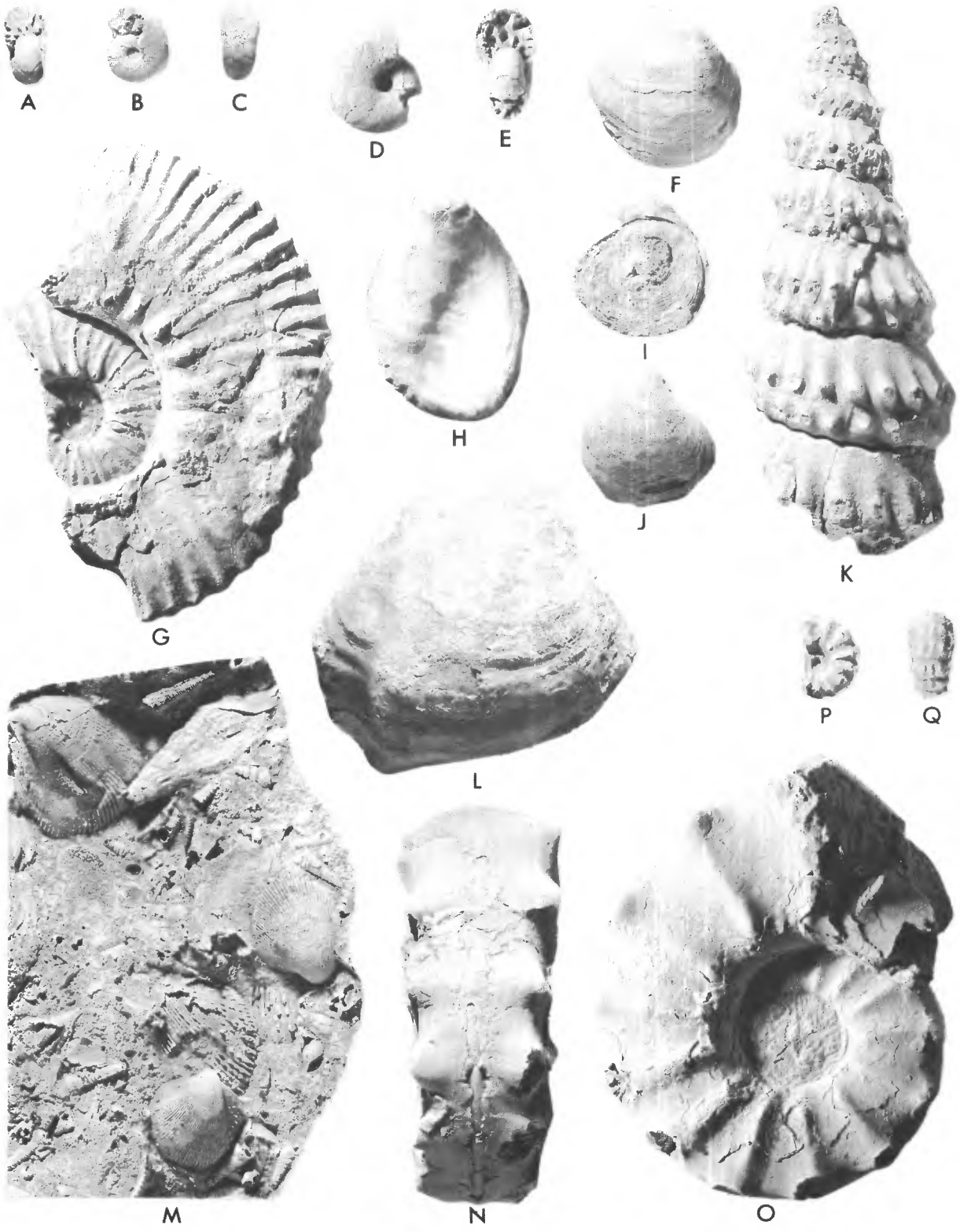


Figure 4. Fossils, natural size, from the Paguate Sandstone Tongue. A-E, Desmoceras (Pseudouhligella) *aff.* D. japonicum *Yabe from loc. 9 (A-C, inner whorls, USNM 239752; D, E, inner whorls, USNM 239753); F,* Pycnodonte *cf.* P. kellumi *(Jones), left valve, USNM 239656 from loc. 3; G,* Tarrantoceras rotatile *Stephenson, USNM 239783 from loc. 24; H,* Ostrea beloiti *Logan, internal mold of left valve, USNM 239715 from loc. 9, I, J,* Exogyra levis *Stephenson, both valves, USNM 239680 from loc. 8; K,* Turrilites acutus americanus *Cobban and Scott, USNM 239750 from loc. 20; L,* Inoceramus rutherfordi *Warren, right valve, USNM 239626 from loc. 9; M,* Granocardium enstromi *(Bergquist) associated with the gastropods* Turritella shuleri *Stephenson? and* Helicaulax*? sp., USNM 239725 from loc. 5; N-Q,* Acanthoceras amphibolum *Morrow (N, O, USNM 239770 from loc. 20; P, Q, USNM 239767 from loc. 9).*

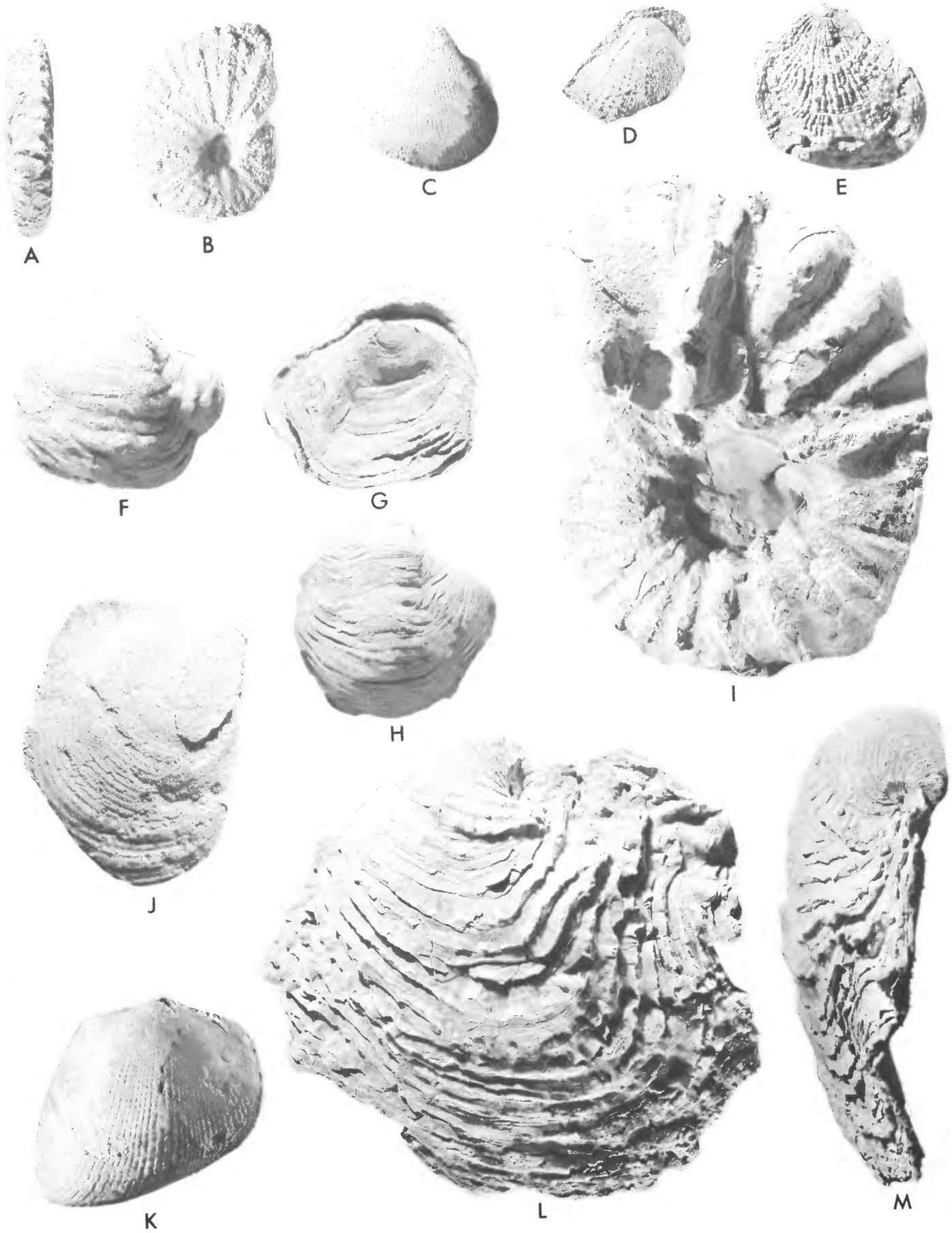


Figure 5.

J, K), and the gastropod *Arrhoges modesta* (Cragin)? (fig. 2, M). The abundance of the gastropod in the Rio Puerco valley was the source of the terminology "gastropod zone" of Herrick and Johnson (1900, p. 187). Other fossils that are locally abundant include a small exogyra that has fine radial costae (fig. 2, A-C); *Inoceramus eulessanus* Stephenson; *I.* cf. *I. macconnelli* Warren; and species representing the bivalve genera *Nuculana, Limatula, Granocardium, Aphrodina* and *Parmicorbula;* as well as species of the gastropod genera *Turritella, Cerithium, Gracilata, Gyrodes* and *Actaeon.* Ammonites are uncommon but include *Turrilites acutus* Passy (fig. 2, I), *Desmoceras* sp., *Calycoceras* (*Conlinoceras*) *tarrantense* (Adkins) (fig. 2, L), *Borissiakoceras compressum* Cobban and *Johnsonites sulcatus* Cobban.

Many of the fossil mollusks of the upper half of the Oak Canyon Member are known from the Woodbine Formation of Texas. Most of the mollusks recorded from the Thatcher Limestone Member of the Graneros Shale of southeastern Colorado (Cobban and Scott, 1972, p. 8, 11, 12, 27, 29) also occur in the Oak Canyon Member.

Cubero Sandstone Tongue

The Cubero Sandstone Tongue, 50 feet (15.2 m) thick near Laguna (fig. 1), is chiefly very fine grained to fine-grained sandstone with locally much siltstone and clay shale. Carbonaceous material is common. Fossils are fewer and much less diverse than in the underlying Oak Canyon Member. U.S. Geological Survey collections include 19 bivalve species, 1 gastropod species and 2 ammonite species. Nearly all the species in the Cubero Sandstone Tongue range up from the Oak Canyon Member; among these are *Pinna petrina* White, *Inoceramus eulessanus* Stephenson, *I.* cf. *I. macconnelli* Warren, *Plicatula arenaria* Meek, *Exogyra columbella* Meek, *E.* aff. *E. columbella* Meek, *E. aquillana* Stephenson, *Arrhoges* cf. *A. modesta* (Cragin), *Turrilites acutus* Passy and *Calycoceras* (*Conlinoceras*) *tarrantense* (Adkins). A large, smooth, undescribed exogyra (fig. 3, Q-S) may be restricted to the Cubero Sandstone Tongue.

Clay Mesa Shale Tongue

Medium- to dark-gray clayey shale to sandy shale largely make up the Clay Mesa Shale Tongue, which is 70 feet (21.3 m) thick in the Laguna area. Gray- to brown-weathering septarian limestone concretions are usually present.

Fossils other than pycnodonts are not common and the member contains the fewest species of mollusks of any of the intertongued units of Dakota Sandstone and Mancos Shale. The U.S. Geological Survey's collections include only nine species of bivalves and three species of ammonites.

Some limestone concretions contain many specimens of a pycnodont herein referred to as *Pycnodonte* cf. *P. kellumi* (Jones) (fig. 3, J-M). These specimens may represent the form described by Jones (1938, p. 107, pl. 3, figs. 3-5) as *Gryphaea washitaensis* Hill var. *kellumi* Jones from the Indidura Formation of Coahuila, Mexico. Jones illustrated two specimens that differ from *Gryphaea washitaensis* Hill (1889, p. 11; Hill and Vaughan, 1898, p. 59, pls. 19-23) by having less convexity, a longer hingeline and a broader umbo. Jones' specimens seem best regarded as a separate species assigned to *Pycnodonte.* A few specimens assigned to *P.* cf. *P. kellumi* are also in the collections from the Oak Canyon Member.

Other bivalves that first appear in the Clay Mesa Shale Tongue, but range higher, include *Exogyra trigeri* Coquand, *E. levis* Stephenson, and *Ostrea beloiti* Logan. *Inoceramus arvanus* Stephenson (fig. 3, P) occurs sparingly in the member and may be restricted to it. Ammonites from the unit are *Acanthoceras alvaradoense* Moreman (fig. 3, A-I), *Tarrantoceras rotatile* Stephenson (fig. 3, N, O), and *Euomphaloceras* aff. *E. cunningtoni* (Sharpe).

Paguate Sandstone Tongue

Very fine grained to fine-grained sandstone with some interbedded siltstone largely makes up this unit, which is 62 feet (18.9 m) thick at its type locality near Laguna. Fossiliferous dark-brown-weathering sandstone concretions are common and conspicuous. The Paguate Sandstone Tongue contains a greater variety of mollusks than any of the intertongued Dakota and Mancos units. Collections of the U.S. Geological Survey contain 25 species of bivalves, 27 species of gastropods, 9 species of ammonites and 1 nautiloid.

Common bivalves that may be confined to the Paguate Sandstone Tongue include *Idonearca blanpiedi* Stephenson, *Phelopteria?* cf. *P. aquilerae* (Böse), *Inoceramus rutherfordi* Warren (fig. 4, L), and *Aphrodina* cf. *A. munda* (Stephenson). An unusual occurrence is a single specimen of the European *Neithea* cf. *N. sexcostata* (Woodward). *Pycnodonte* cf. *P. kellumi* (Jones) (fig. 4, F), *Exogyra trigeri* Coquand, *E. levis* Stephenson (fig. 4, I, J) and *Ostrea beloiti* Logan (fig. 4, H) persist on up from the underlying Clay Mesa Shale. Important bivalves that first appear in the Paguate Sandstone Tongue, but range higher, are *Exogyra* cf. *E. oxyntas* (Coquand), *Granocardium trite* (White) and *G. enstromi* (Bergquist) (fig. 4, M).

The abundant gastropod fauna includes representatives of the genera *Turritella, Perissoptera, Cassiope, Helicaulax?, Vascellum, Anchura, Lispodesthes, Paleopsephaea, Carota, Avellana, Hillites?, Euspira?, Gyrodes, Ringicula* and *Fictoacteon* (N. F. Sohl, written commun., 1967-1975). *Turritella shuleri* Stephenson? (fig. 4, M) is one of the more numerous species. Ammonites that seem to be restricted to the Paguate Sandstone Tongue are *Turrilites acutus americanus* Cobban and Scott (fig. 4, K), *Desmoceras* (*Pseudouhligella*) aff. *D. japonicum* Yabe (fig. 4, A-E), *Paracompsoceras landisi* Cobban, *Acanthoceras amphibolum* Morrow (fig. 4, N-Q), *Pleisiacanthoceras* aff. *P. wyomingense* (Reagan), *Pseudocalycoceras* n. sp. and *Borissiakoceras reesidei* Morrow. *Tarran-*

Figure 5. Fossils, all but I natural size, from the Whitewater Arroyo Shale Tongue and Twowells Sandstone Tongue. A, B, Metoicoceras *sp., USNM 239779 from loc. 28; C, D,* Granocardium trite *(White) (C, internal mold of a left valve, USNM 239720 from loc. 10; D, latex cast of an imprint of a left valve, USNM 239722, in very fine grained sandstone from the type locality in southern Utah); E,* Plicatula *cf.* P. ferryi *Coquand, USNM 239639 from loc. 4; F-H,* Pycnodonte *aff.* P. kellumi *(Jones) (F, G, both valves, USNM 239663 from loc. 1; H, left valve, USNM 239665 from loc. 7); I,* Calycoceras? canitaurinum *(Haas), X½, USNM 239754 from loc. 12; J,* Inoceramus prefragilis *Stephenson, right valve, USNM 239631 from loc. 2; K,* Idonearca depressa *White, right valve, USNM 239609 from loc. 21; L, M,* Exogyra trigeri *(Coquand), left valve, USNM 239707 from loc. 6.*

toceras rotatile Stephenson (fig. 4, G) ranges on up from the Clay Mesa Shale Tongue.

Whitewater Arroyo Shale Tongue

The Whitewater Arroyo Shale Tongue, 90 feet (27.4 m) thick near Laguna, is chiefly soft dark-gray shale and siltstone containing a few thin layers of bentonite and yellow-weathering limestone concretions. Fossils are moderately abundant in the shale and in the concretions. The U.S. Geological Survey collections contain 19 species of bivalves, 2 species of gastropods and 8 species of ammonites.

Bivalves that range up from the Paguate Sandstone Tongue, but no farther, include *Pycnodonte* cf. *P. kellumi* (Jones), *Exogyra* cf. *E. oxyntas* (Coquand), *Ostrea beloiti* Logan and *Granocardium enstromi* (Bergquist). Important bivalves that first appear in the Whitewater Arroyo Shale Tongue, but range up into the overlying Twowells Sandstone Tongue, include *Idonearca depressa* White (fig. 5, K), *Inoceramus prefragilis* Stephenson and *Plicatula* cf. *P. ferryi* Coquand (fig. 5, E). Splendid specimens of *Exogyra trigeri* Coquand (fig. 5, L, M) are found free in the shale. The sparse gastropods represent *Anchura* and *Crommium*, and the ammonites are species of *Turrilites*, *Stomohamites*, *Tarrantoceras*?, *Calycoceras*? and *Metoicoceras*. *Calycoceras*? *canitaurinum* (Haas) (fig. 5, I), which first appears in the upper part of the Whitewater Arroyo Shale Tongue, is a guide fossil to the Zone of *Dunveganoceras pondi* Haas.

Twowells Sandstone Tongue

Cliff-forming, very fine grained to fine-grained sandstone mostly forms this unit, which is 74 feet (22.6 m) thick near Laguna. Fossils are abundant either as free individuals in the sandstone or as parts of sandstone concretions. The U.S. Geological Survey collections include 21 species of bivalves, 2 species of gastropods and 5 species of ammonites.

The most common bivalve is an undescribed pycnodont that was derived from *Pycnodonte* cf. *P. kellumi* (Jones) by attaining a slightly larger size, by developing a more pronounced posterior sulcus, and by having more conspicuous concentric ornamentation or squamae. This species, herein referred to as *Pycnodonte* aff. *P. kellumi* (Jones) (fig. 5, F-H), ranges on up into the basal part of the main body of the Mancos Shale. The species has been listed as *Gryphaea newberryi* Stanton (for example, Pike, 1947, p. 32) or as *"Gryphaea" newberryi* (broad form) (Landis and others, 1973a, p. J4, J25, J28, J31, J32, J36; 1973b, p. 29). *Pycnodonte* aff. *P. kellumi* gave rise to *P. newberryi* (Stanton, 1893, p. 60, pl. 5, figs. 1-5) by becoming more inrolled, by developing a narrower umbo, and by having a more conspicuous posterior sulcus.

Common bivalves that range into the Twowells Sandstone Tongue from the underlying Whitewater Arroyo Shale Tongue are *Idonearca depressa* White, *Inoceramus prefragilis* Stephenson (fig. 5, J), *Plicatula* cf. *P. ferryi* Coquand, *Exogyra trigeri* Coquand, *E. levis* Stephenson and *Granocardium trite* (White) (fig. 5, C, D). *Pinna petrina* White is fairly numerous, and a plicate oyster, *Lopha staufferi* (Bergquist), is locally common. *Cerithiopsis* and *Anchura* are the only gastropods in the U.S. Geological Survey collections.

Among the ammonites, *Calycoceras*? *canitaurinum* (Haas) and a related form, *C.*? cf. *C.*? *canitaurinum* range on up from the Whitewater Arroyo Shale Tongue. *Calycoceras obrieni* Young and *Inoceramus ginterensis* Pergament have been found high in the Twowells Sandstone Tongue.

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