



Paleontology, stratigraphy and biostratigraphy of the upper Cretaceous Lewis Shale near Waterflow, San Juan County, New Mexico

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PALEONTOLOGY, STRATIGRAPHY AND BIOSTRATIGRAPHY OF THE UPPER CRETACEOUS LEWIS SHALE NEAR WATERFLOW, SAN JUAN COUNTY, NEW MEXICO

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Abstract—Marine invertebrate fossils collected from the lower and upper parts of the Lewis Shale near Waterflow, New Mexico are of late Campanian age. The fauna from the lower part includes cf. *Anisomyon* sp., "*Inoceramus*" *subcircularis*, "*Inoceramus*" (*Endocostea*) *barabini*, and *Baculites* sp. Invertebrates are abundant in small limestone concretions in a 6-m-thick interval in the upper part of the Lewis Shale and include the following taxa: cf. *Anisomyon* sp., "*Inoceramus*" (*Endocostea*) *barabini*, *Eutrephoceras dekayi*, *Baculites* sp., *Placenticeras placenta*, *Placenticeras syrtale*, and *Didymoceras nebrascense*. The occurrence of *D. nebrascense* is particularly important because it indicates the presence of the *Didymoceras nebrascense* zone, which is of early late Campanian age. The *Didymoceras nebrascense* zone also occurs in the Lewis Shale on the eastern side of the San Juan Basin, New Mexico and in the Pierre Shale in northeastern New Mexico.

INTRODUCTION

In northwestern New Mexico, the Upper Cretaceous Lewis Shale has a moderate outcrop belt around the San Juan Basin. Collections of marine invertebrates were made on the western side of this outcrop belt, north of the San Juan River near Waterflow, New Mexico.

Few studies have been conducted on the invertebrate paleontology of the Lewis Shale in New Mexico and Colorado. Reeside (1924) listed invertebrates collected from the Lewis Shale on the western side of the San Juan Basin; specifically, on the south side of the San Juan River near Liberty, New Mexico, at the mouth of Coal Creek (Upper Chaco River) in New Mexico, and in Colorado. Cobban et al. (1974) documented the presence of at least 11 ammonite zones in the Lewis Shale on the eastern side of the San Juan Basin. Lucas and Sealey (1992) reported briefly on invertebrates from the Lewis Shale near Mesa Portales, New Mexico.

In this paper, we describe invertebrate collections made from the lower and upper parts of the Lewis Shale near Waterflow, San Juan County, New Mexico (Fig. 1), and assess their biostratigraphic significance. NMMNH refers to the New Mexico Museum of Natural History and Science, Albuquerque; and USNM to the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

LOCALITIES AND STRATIGRAPHY

The fossils reported here were collected from the Lewis Shale from outcrops east of The Hogback, just north of New Mexico Highway 550 and west of Waterflow (Fig. 1). We identified 36 collecting localities in the outcrop belt of the Lewis Shale in sections 13, 24 and 25, T30N, R16W and sections 27, 33 and 34, T30N, R16W, San Juan County. The latter area encompasses localities stratigraphically low (near the base of) in the Lewis Shale, whereas the more northeasterly sections encompass localities stratigraphically high in the Lewis Shale (Fig. 1).

The Lewis Shale east of The Hogback is about 165 m thick according to Strobell et al. (1980). It rests with apparent conformity on dark yellowish orange to brown, fine-grained, trough-crossbedded and ripple-laminated sandstone of the Cliff House Sandstone. Similar lithologies are present in the basal Pictured Cliffs Sandstone, which conformably overlies the Lewis Shale. Most of the Lewis Shale is light gray, dark gray and olive gray bentonitic shale. Thin, ripple-laminated ledges of yellow to brown calcarenite and yellow to gray limestone concretions (often septarian) are subordinate rock types throughout the formation. Fossil localities in the Lewis Shale east of The Hogback documented here are either low in the formation (*Inoceramus*-dominated localities about 55 m above the Cliff House-Lewis contact) or very high in the unit (*Didymoceras nebrascense* zone, 150–156 m above its base) (Fig. 1).

PALEONTOLOGY

Lower Lewis Shale

cf. *Anisomyon* sp.

A single, fairly complete specimen (Fig. 2A) of a limpet-like, patelliform gastropod is tentatively assigned to *Anisomyon* sp. This specimen is simi-

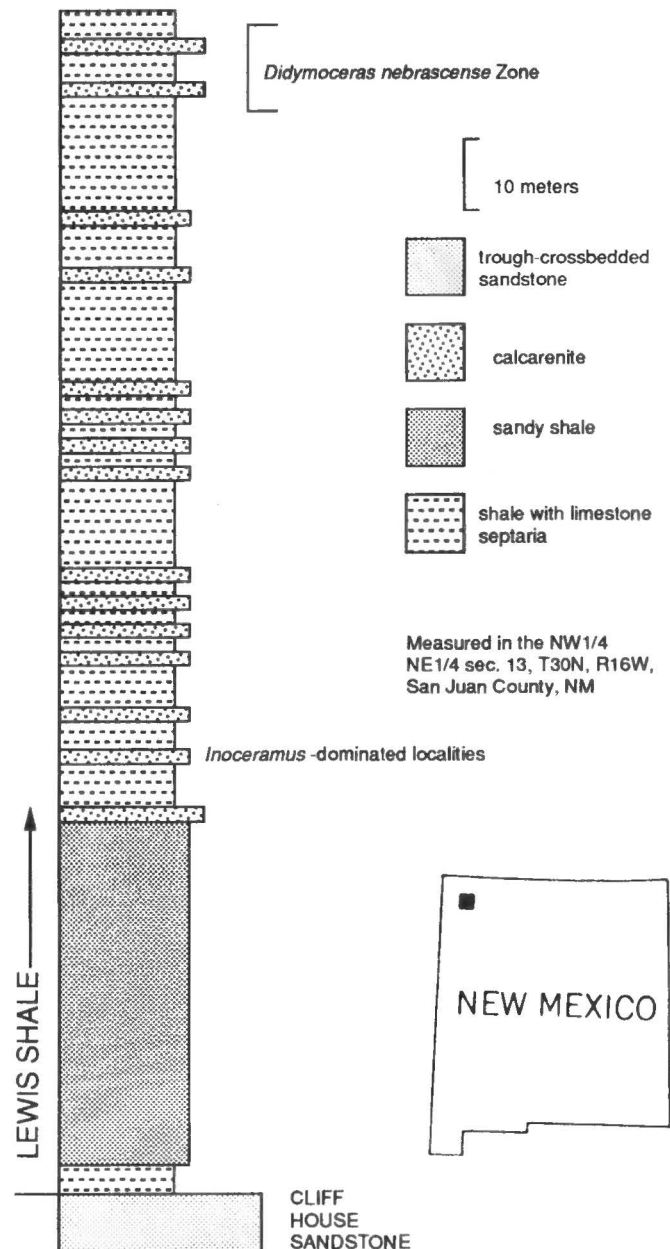


FIGURE 1. Index map and measured stratigraphic section of most of the Lewis Shale exposed east of The Hogback, indicating fossiliferous horizons.

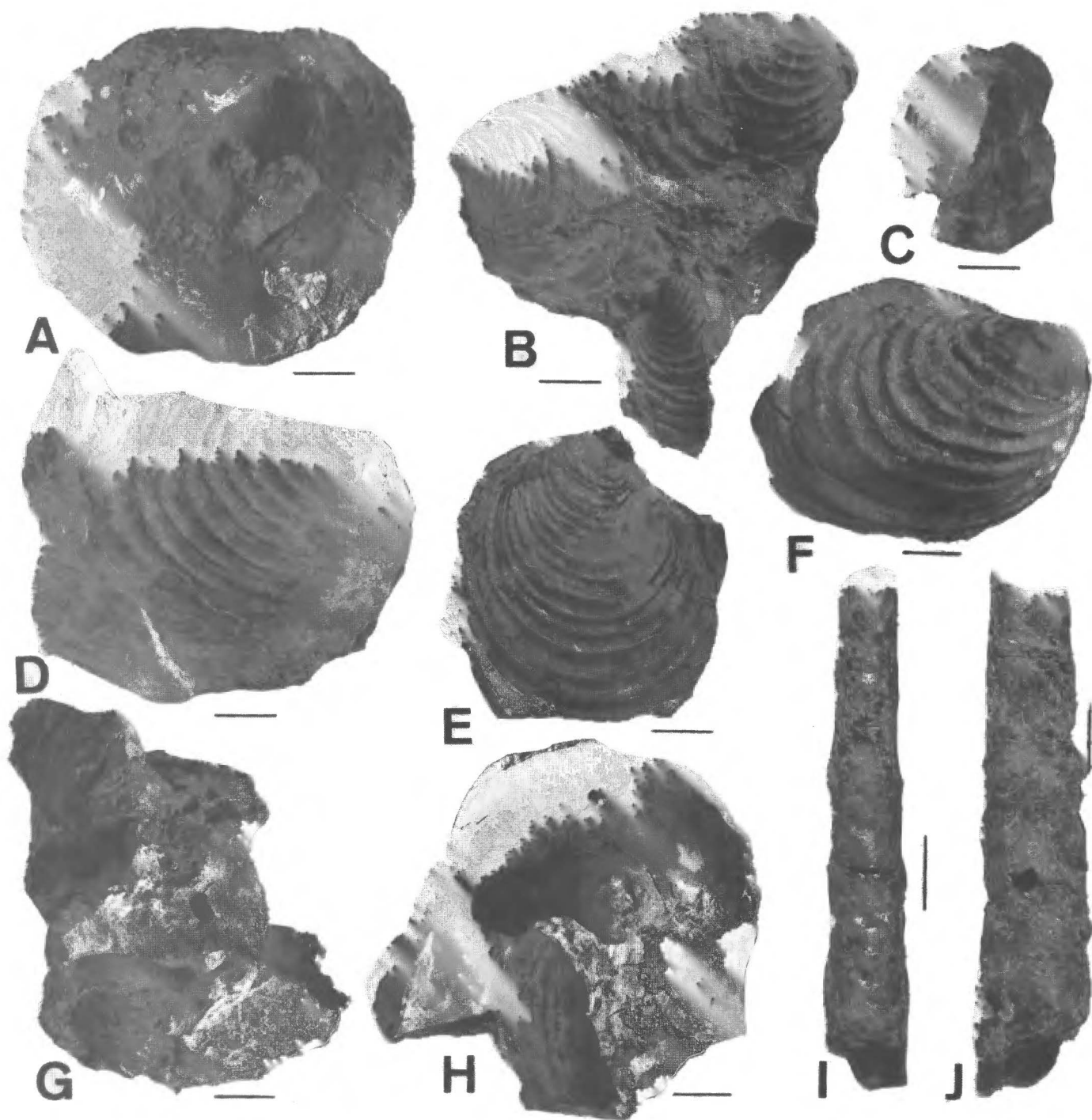


FIGURE 2. Molluscs from the lower (A, B, D, E) and upper (C, F-J) Lewis Shale near Waterflow, New Mexico. A, cf. *Anisomyon* sp., apical view (NMMNH P-26186), locality L-3362. B, "*Inoceramus*" *subcircularis* (NMMNH P-26184) from locality L-3362, group of three right valves. C, cf. *Anisomyon* sp., apical view (NMMNH P-26185), locality L-3297. D, "*Inoceramus*" (*Endocostea*) *barabini* (NMMNH P-26181) from locality L-3362, right valve. E, "*Inoceramus*" *subcircularis* (NMMNH P-26183) from locality L-3362, left valve. F, "*Inoceramus*" (*Endocostea*) *barabini* (NMMNH P-26182) from locality L-3305, right valve. G-H, *Eutrephoceras dekeyi*, (NMMNH P-26177) lateral (G) and anterior (apertural) (H) views, from locality L-3369. I-J, *Baculites* sp. (NMMNH P-26165), ventral (I) and lateral (J) views, from locality L-3300. Bar scales = 10 mm.

lar in general shell morphology to *Anisomyon* (Sohl, 1967, pl. 8, figs. 11, 14), but lacks muscle scars; therefore we are cautious in our assignment. The shell possesses a prominent, anteriorly oblique summit, located anterior to center, nearly concave anterior slopes, convex posterior slopes, and one obscure, radiating ridge on the posterior slope. The surface is relatively smooth with fine, concentric growth lines visible on parts of the shell. The base of the shell is almost circular with a diameter of 4.8 cm. *Anisomyon*

alveolus Meek and Hayden was listed by Lee (1917, p. 48) as occurring in the upper part of the Pierre Shale near Cimarron, New Mexico.

"*Inoceramus*" *subcircularis* (Meek)

Three right valves (Fig. 2B) are almost circular in general outline, with fairly heavy, widely separated concentric folds. The beak is not very prominent and rises slightly above the hinge line. "*I.*" *proximus* Tuomey differs

from our specimens in its finer, more closely spaced folds. "*I.*" *vanuxemi* Meek and Hayden differs in its less distinct concentric folds, more circular outline, and much larger size. Several NMMNH specimens range in length from 3.5 cm to 7.5 cm. Our specimen is almost identical to a cast of USNM 479 of "*I.*" *subcircularis* (cotype) from the Pierre Shale on the Yellowstone River near Miles City, Montana.

"*Inoceramus*" (*Endocostea*) *barabini* Morton

A fairly complete shell (Fig. 2D) consisting of two articulated valves, with the posterior ends broken, is assigned to "*Inoceramus*" (*Endocostea*) *barabini*, on the basis of its transversely ovate form, long, straight hinge line, and fairly prominent concentric undulations. The relatively small beak rises little above the hinge line. Our specimen is similar to a cast of USNM 477 of "*I.*" *barabini* from the Pierre Shale of Montana, but is not quite as bulbous in the umbonal region. Only a few shells of "*I.*" (*Endocostea*) *barabini* were collected from the lower part of the Lewis Shale.

Baculites sp.

A weathered fragment (NMMNH P-26167, locality L-3363), missing the outer part of the shell, but with parts of the suture line readily visible, is assigned to *Baculites* sp. The moderately incised suture pattern of the NMMNH specimen has its closest resemblance to *B. obtusus* Meek (Meek, 1876, text-fig. 58, p. 406; Cobban, 1962, p. 707). The *Baculites obtusus* zone is of early middle Campanian age (Cobban, 1993, fig. 4, p. 444). A few other specimens of *Baculites* were collected from the lower part of the Lewis Shale in this region but are also not identifiable to the specific level.

Upper Lewis Shale

cf. *Anisomyon* sp.

A single incomplete specimen (Fig. 2C) of cf. *Anisomyon* sp. has a broken suboval base, patelliform shape, a summit with the apex curved upward, and a smooth shell with very faint growth lines. The posterior slope is convex with one radiating ridge visible. The apex is small and has at least four distinct furrows radiating from it. A smoother shell and the abruptly pointed and posteriorly curved apex are some ways in which *Anisomyon* differs from *Patella* (Meek, 1876, p. 286).

"*Inoceramus*" (*Endocostea*) *barabini* Morton

A small variety of "*Inoceramus*" (*Endocostea*) *barabini* is very abundant at the upper Lewis localities we sampled. The illustrated specimen (Fig. 2F) consists of two articulated valves with the posterior ends missing, but complete specimens are compressed and rounded posteriorly, as in "*I.*" (*Endocostea*) *barabini*. These specimens are almost identical to cast USNM 477 of "*I.*" *crispi* var. *barabini* but are approximately half the size. This small variety of "*I.*" (*Endocostea*) *barabini* is very abundant at the localities we sampled. C. M. Bauer collected, and T. W. Stanton identified "*I.*" *barabini*, from near the top of the Lewis Shale, 5 mi southeast of Liberty, New Mexico (Reeside, 1924, p. 17).

Eutrephoceras dekayi (Morton)

A single nautiloid shell (Figs. 2G-H), is assigned to *Eutrephoceras dekayi* (Morton), on the basis of the transversely broad aperture, the siphuncle being nearest to the inner side, and its small size (maximum diameter of 55 mm). Our specimen differs from *E. elegans* (Sowerby) in the position of the siphuncle and its smaller size. *Eutrephoceras alcesense* Reeside and *E. thomi* Reeside differ from NMMNH P-26177 in their more laterally compressed apertures and much larger size (240 mm and 220 mm respectively) (Reeside, 1927). Sealey and Lucas (1991) described a specimen of cf. *Eutrephoceras dekayi* from the upper part of the Pierre Shale in the Turkey Creek Canyon area, west of Cimarron, New Mexico.

Baculites sp.

Several specimens of *Baculites* (Figs. 2I-J) were collected from the upper part of the section, but we are reluctant to identify them to the specific level due to their incomplete nature. They display a moderate degree of taper, distinct nodes on the flanks, ovate cross section, and a suture of moderate complexity. Oblique ribs are visible on the flanks closer to the venter, and weak ribbing is also visible on the venter.

Placentoceras placenta (Dekay)

Two small, laterally compressed inner volutions of *Placentoceras* (Figs. 3A,B,E,F) are assigned to *P. placenta* (Dekay). Both possess flat, narrow venters with fine tubercles. Small nodes on the umbilical shoulder, small nodes on the flanks, and a lack of costae are other features shared with *P. placenta*. *P. meeki* Boehm is distinguished from *P. placenta* by the absence of a median lateral line of nodes, a narrower venter and more complex suture (Reeside, 1927, p. 30). Our specimens possess a suture pattern similar to that of *P. placenta*. Lucas and Sealey (1992, p. 26) reported the occurrence of *P. placenta* from the Lewis Shale near Mesa Portales.

Placentoceras syrtale (Morton)

Placentoceras syrtale is relatively abundant in the upper Lewis Shale near Waterflow (Figs. 3C,D,G-J). All are moderately stout forms with weak costae, prominent nodes on the flanks near the venter, and prominent nodes on the umbilical shoulder. Their broad, flat venters possess fine, prominent tubercles. Specimens NMMNH P-26175 and NMMNH P-26176 have relatively simple suture patterns, which are identical to that of *P. syrtale*. *Placentoceras intercalare* Meek differs from *P. syrtale* in its ribbing being obscure or absent, and in having more complex, moderately incised sutures, and the lateral nodes situated more mid-flank (Reeside, 1927, p. 33). The occurrence of *P. syrtale* was also reported by Lucas and Sealey (1992, p. 26) from the Lewis Shale near Mesa Portales.

Didymoceras nebrascense (Meek and Hayden)

Didymoceras nebrascense is locally abundant in the upper Lewis Shale near Waterflow, New Mexico. NMMNH specimens collected from this part of the section clearly demonstrate features that characterize *D. nebrascense*. *D. nebrascense* is distinguished from *D. stevensoni* and *D. cheyennense* by its finer, more closely spaced ribs. The lack of an impressed area where adjacent whorls made contact further distinguishes our specimens from *D. stevensoni*.

NMMNH P-26169 (Figs. 4A-B) is an almost complete early whorl section of *D. nebrascense*. The earliest part with straight limbs is missing. It is characterized by fine, closely spaced, recurved costae, a high degree of taper, and a few distinguishable nodes on the venter. NMMNH P-26169 is similar to an equivalent part of a whorl section illustrated by Whitfield (1902, pl. 26, fig. 3).

NMMNH P-26168 (Figs. 4C-D) is part of a middle whorl section. It possesses fine, closely spaced costae and a row of nodes on each side of the venter, as in *D. nebrascense* (Gill and Cobban, 1973, p. 7). This specimen demonstrates a moderate degree of taper to this part of the whorl section.

A partial, final, recurved whorl section (NMMNH P-26170, Fig. 4E), is assigned to *Didymoceras nebrascense*. The ribbing is relatively coarse compared to earlier whorls, but is relatively finer and more closely spaced compared to an equivalent section of *D. stevensoni* (Whitfield) or *D. cheyennense* (Meek and Hayden). There are two rows of large nodes on the venter. NMMNH P-26170 demonstrates no distinguishable taper to this part of the whorl section.

BIOSTRATIGRAPHY

Specimens of *Didymoceras nebrascense* have also been collected from the Lewis Shale on the eastern side of the San Juan Basin, New Mexico (Cobban et al., 1974) and in the Pierre Shale in northeastern New Mexico (Cobban, 1976). The *Didymoceras nebrascense* zone is of early late Campanian age. The co-occurrence of "*Inoceramus*" (*Endocostea*) *barabini* indicates the presence of this inoceramid range zone, which is in part, a temporal correlative of the *Didymoceras nebrascense* zone (Kauffman et al., 1993, fig. 11, p. 418).

The occurrence of *Didymoceras nebrascense* thus indicates an early late Campanian age for the upper part of the Lewis Shale north of the San Juan River near Waterflow, New Mexico. The lower part of the Lewis Shale here may correlate to the *Baculites obtusus* zone of early middle Campanian age. The presence of *Didymoceras nebrascense* suggests correlation with part of the Lewis Shale on the eastern side of the San Juan Basin, New Mexico and the Pierre Shale in northeastern New Mexico.

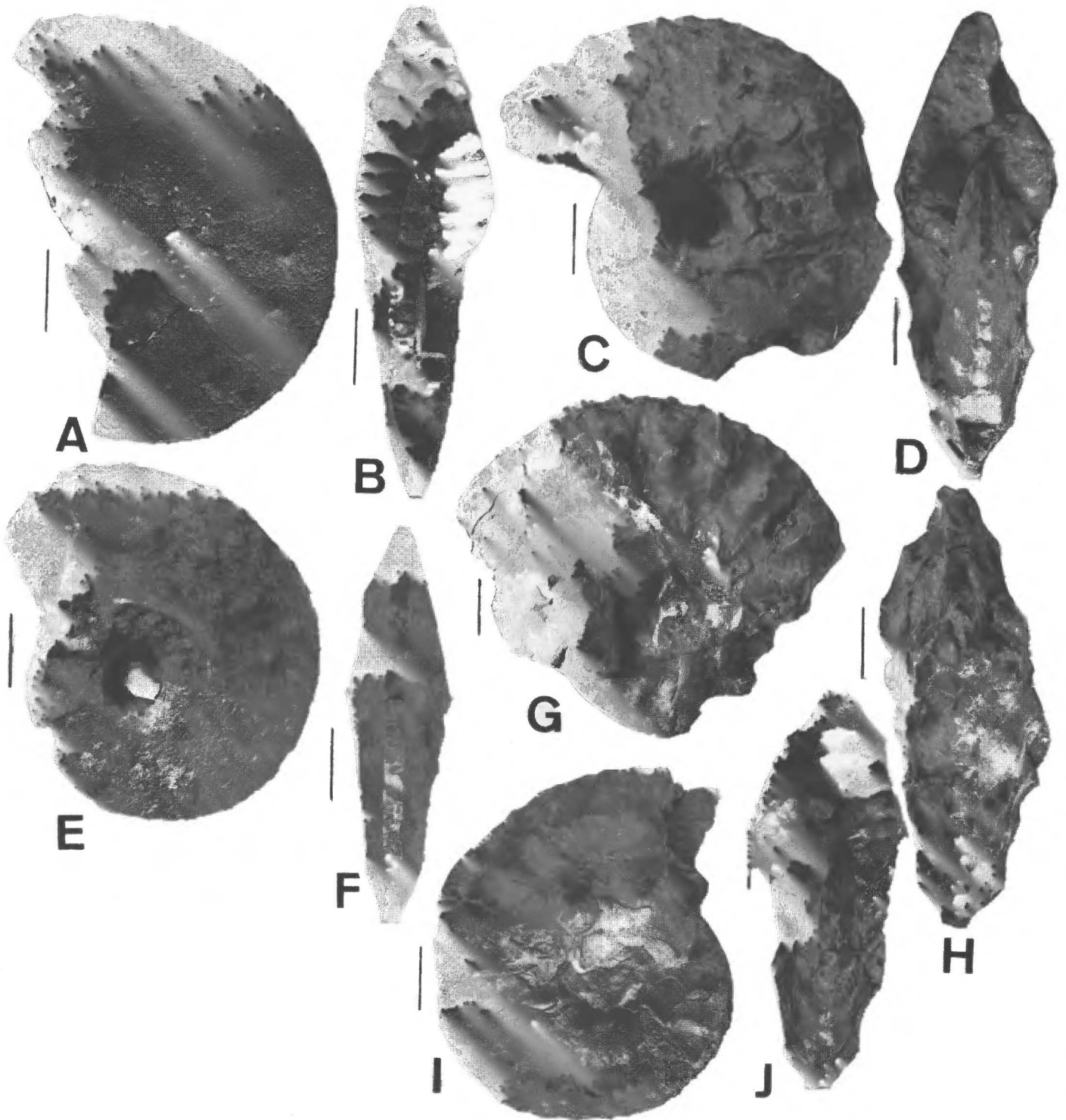


FIGURE 3. Specimens of *Placenticerus* from the upper Lewis Shale near Waterflow, New Mexico. A–B, *Placenticerus placenta*, lateral (A) and anterior (cross-sectional) (B) views, NMMNH P-26173 from locality L-3359. C–D, *Placenticerus syrtale*, lateral (C) and anterior (apertural) (D) views, NMMNH P-26174 from locality L-3370. E–F, *Placenticerus placenta*, lateral (E) and posterior (F) views, NMMNH P-26172 from locality L-3297. G–H, *Placenticerus syrtale*, lateral (G) and posterior (H) views, NMMNH P-26176 from locality L-3376. I–J, *Placenticerus syrtale*, lateral (I) and anterior (J) views, NMMNH P-26175 from locality L-3375. Bar scales = 10 mm.

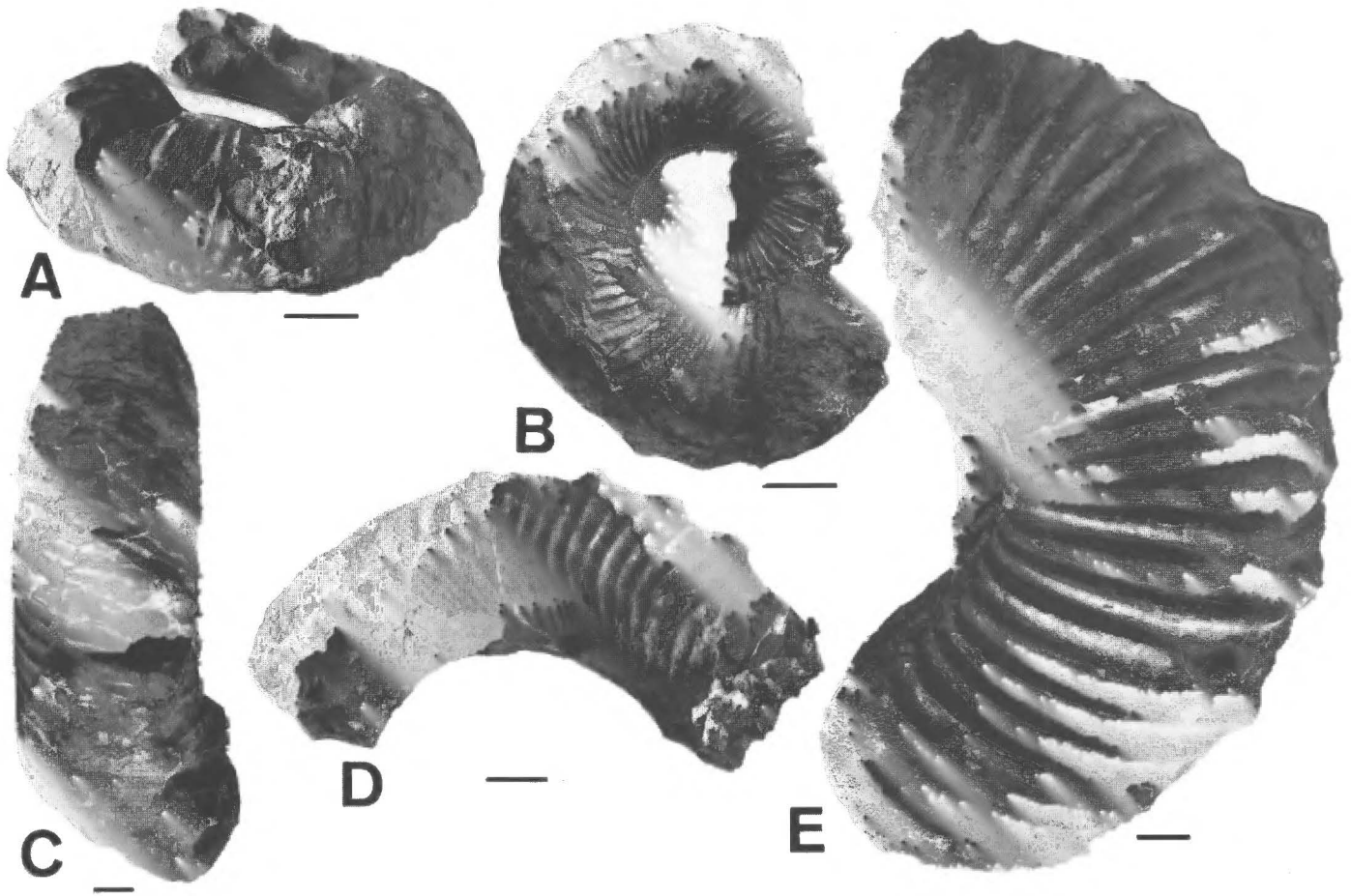


FIGURE 4. Specimens of *Didymoceras nebrascense* from the upper Lewis Shale near Waterflow, New Mexico. A–B, Ventral (A) and bottom (B) views of an early whorl section, NMMNH P-26169 from locality L-3360. C–D, Ventral (C) and lateral (D) views, NMMNH P-26168 from locality L-3264. E, Lateral view, NMMNH P-26170 from locality L-3365. Bar scales = 10 mm.

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