



## ***Some pelecypods and scaphopods from the lower Wolfcampian (Basal Permian) Laborcita Formation, Sacramento Mountains, New Mexico***

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## SOME PELECYPODS AND SCAPHOPODS FROM THE LOWER WOLFCAMPIAN (BASAL PERMIAN) LABORCITA FORMATION, SACRAMENTO MOUNTAINS, NEW MEXICO

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**Abstract**—Fifteen pelecypod and two scaphopod species from the lowest Wolfcampian Laborcita Formation are described and illustrated. These represent the majority of pelecypods and all of the scaphopods observed in the formation; neither group has been studied previously. Two new species, *Nuculavus arcuata* and *Nuculavus menuda*, are established; others are present but available material is insufficient to formally define them. These molluscs are subsidiary elements of gastropod-dominated assemblages from two intervals in the Laborcita Formation. Dark gray shale/siltstone lithologies near Tularosa are dominated by nuculoids, whereas gray to tan limestone and calcareous shale strata in La Luz Canyon contain a more diverse pelecypod assemblage that includes *Myalina* (*Orthomyalina*) *subquadrata*, *Permophorus*, *Astartella* and *Wilkingia* in addition to several nuculoid taxa. Only two of the 15 pelecypod taxa treated here occur at both localities, reflecting considerably different environmental conditions in which the two assemblages lived. Most of the nuculoids are small to minute in size. The majority of pelecypod taxa and both scaphopods are species previously known from Middle to Upper Pennsylvanian strata, or are clearly derived from Pennsylvanian species. Aside from the new species noted here, the only "typically Permian" pelecypod with no Pennsylvanian record is *Nuculavus levatiformis*. In both the Tularosa and La Luz assemblages, infaunal species are far more abundant than epifaunal forms.

### INTRODUCTION

The Lower Permian Laborcita Formation in the Sacramento Mountains of south-central New Mexico contains diverse marine invertebrate assemblages composed mainly of molluscs. Gastropods are especially abundant in these assemblages (Kues, 1991, this volume), and pelecypods are moderately common. This pelecypod fauna has not been studied previously. Knowledge of North American late Paleozoic pelecypods is based mainly on studies of Pennsylvanian faunas and some groups of late Wolfcampian and younger pelecypods. Few early Wolfcampian pelecypod assemblages have been documented. In this paper, most of the larger and more abundant Laborcita pelecypods, together with the scaphopods, are described and illustrated, and several new species are recognized. Other species in addition to those discussed here were observed in the Laborcita collections, but they are represented by few and fragmentary specimens, making it desirable to delay documenting them until better specimens become available. Study of the fragmentary pectinaceans was not attempted.

Specimens discussed here are in the paleontology collections of the Department of Geology, University of New Mexico (UNM), the New Mexico Museum of Natural History (NMMNH), Albuquerque, and the U.S. National Museum of Natural History (USNM), Washington, D.C.

### STRATIGRAPHIC CONTEXT AND LOCALITIES

The Laborcita Formation was named and comprehensively studied by Otte (1959). It is a sequence of marine to nonmarine facies transitional between the predominantly marine limestones of the underlying Virgilian Holder Formation and the thick overlying terrestrial red beds of the Wolfcampian Abo Formation. The formation crops out prominently for a distance of approximately 29 km along the lower western slopes of the northern Sacramento Mountains, and attains a maximum thickness of about 230 m near the northern end of its exposure. The Laborcita Formation is coeval with the Bursum Formation in much of central New Mexico, and with the Red Tanks Member of the Madera Formation in the Lucero uplift area southwest of Albuquerque. However, both of the latter units are much thinner than the Laborcita Formation, and consist primarily of nonmarine red-bed units with minor marine limestones, in contrast to the greater proportion of marine strata within the Laborcita Formation. The relatively great thickness of the Laborcita Formation reflects deposition of sediments from the Pederal uplift (a late Paleozoic, north-south-trending positive area immediately east of the study area), westward into the rapidly subsiding Orogrande Basin (Jordan, 1975).

Based on preliminary identifications of marine invertebrates, includ-

ing fusulinids, Otte (1959) believed that the Laborcita Formation was primarily of early Wolfcampian age, with the lower 27 m being late Virgilian. Further study of the fusulinids (Steiner and Williams, 1968) indicated that the entire formation is Wolfcampian. The fusulinid fauna is most closely related to that of the Admire and Council Grove Groups in Kansas, and the Pueblo and Moran Formations of north-central Texas. Laborcita fusulinids suggest a post-Gaptank but pre-Neal Ranch age relative to the classic west Texas Permian sequence (Steiner and Williams, 1968). Strata coeval with the Laborcita are apparently not preserved in the Glass Mountains area, where an unconformity separates the Gaptank from the Neal Ranch (Cooper and Grant, 1972).

Laborcita pelecypods discussed in this paper were collected from four localities, three near the confluence of La Luz and Fresnal Canyons, and one just east of the town of Tularosa (Fig. 1). The northernmost La Luz Canyon locality (locality 11-M-1 of Otte, 1959; UNM locality 1321) is about 200 m north of Otero County Road A-59, 2.7 km east of the town of La Luz, in NW<sup>1</sup>/<sub>2</sub> sec. 30, T15S, R11E. The pelecypods were collected from about a 5-m-thick interval of tan to gray calcareous shales and limestones about 87 m above the base of the formation. The two other La Luz Canyon localities are within the same interval, but a short distance south of A-59 and just east of the Fresnal Canyon road, in NE<sup>1</sup>/<sub>4</sub> SW<sup>1</sup>/<sub>4</sub> SW<sup>1</sup>/<sub>4</sub> sec. 29, T15S, R11E (NMMNH locality L-00837) and NE<sup>1</sup>/<sub>4</sub> NW<sup>1</sup>/<sub>4</sub> NW<sup>1</sup>/<sub>4</sub> sec. 32, T15S, R11E (NMMNH locality L-00843). The Tularosa locality (M-1 of Otte, 1959; UNM locality 1320) is the well-known shale quarry a short distance south of US Highway 70 and 2.9 km east of Tularosa, in SW<sup>1</sup>/<sub>4</sub> SW<sup>1</sup>/<sub>4</sub> sec. 21, T14S, R9E. The quarry shales are dark gray to greenish gray and are overlain by a sequence of tan to light gray silty shales. This interval is about 25 m above the base of the Laborcita Formation.

### PREVIOUS STUDIES

Fossils from the Laborcita Formation were first reported by Herrick (1900, pls. 2, 3), who illustrated but did not describe about 25 invertebrate species, including several pelecypods. This fauna, "of decided Permian facies, though well-known Carboniferous forms extend throughout" (Herrick, 1900, p. 121), was collected from near the base of an indefinitely located shale sequence north and east of Tularosa, possibly the interval exposed at the quarry east of Tularosa mentioned above. Herrick illustrated the following pelecypods from strata now included in the Laborcita Formation: *Pseudomonotis* sp. (pl. 2, fig. 1), *Aviculopecten* cf. *A. coxanus* Meek and Worthen, 1860 (pl. 2, fig. 3), *Pseudomonotis radialis* (Phillips, 1834) (pl. 2, fig. 4), undetermined pelecypod (pl. 2, fig. 5), *Edmondia* sp. (pl. 2, fig. 20), *Myalina per-*

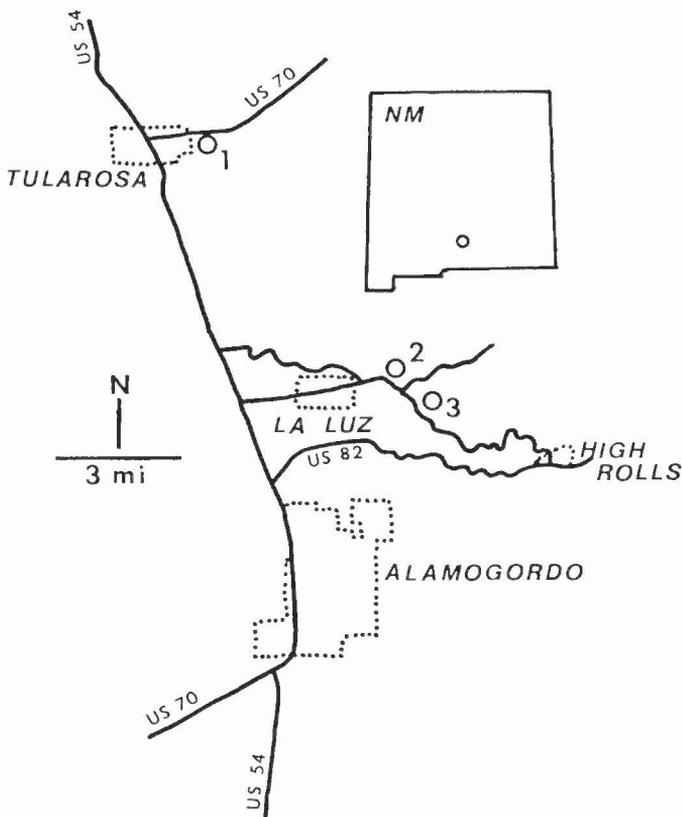


FIGURE 1. Laborcita Formation localities. 1, Tularosa quarry (UNM locality 1320); 2, La Luz Canyon (UNM locality 1320); 3, NMMNH La Luz Canyon localities (NMMNH localities L-00837 and L-00843).

*miana* (Swallow, 1858) (pl. 2, fig. 24), *Sedgwickia topekaensis* (Shumard, 1860) (pl. 2, fig. 28), *Aviculopecten occidentalis* (Shumard, 1855) (pl. 3, figs. 1, 2), and *Pseudomonotis hawni* (Meek and Hayden, 1858) (pl. 3, fig. 3).

Herrick's hand-drawn illustrations are primitive by today's standards, and because the taxa were not described and the specimens were later destroyed (in a fire that consumed the building in which they were stored on the UNM campus, in 1910), it is difficult to be certain of the identity of many of these species. *Pseudomonotis radialis* (Phillips) is a European species, *Myalina permiana* (Swallow) is unrecognizable (Newell, 1942), and the specimen identified as *Sedgwickia topekaensis* (Shumard) is probably *Wilkingia terminale* (Hall, 1852). Herricks' (1900) paper is little known; Otte (1959) did not mention it in his summary of previous stratigraphic and paleontologic studies of the Laborcita Formation, and Newell (1937, 1942) did not cite it in his monographic studies of late Paleozoic pectinacean and mytilacean pelecypods. The only other published reference to Laborcita pelecypods known to me is Bowsher's identification (in Otte, 1959) of a Wolfcampian *Myalina*.

### PELECYPODS

Ordinal and familial placement of the genera and species discussed here follows the Treatise (Cox et al., 1969) in most cases. Citations in synonymies include only those that postdate or are omitted from previously published complete synonymies for each species. Table 1 indicates the number of specimens of each taxon collected from the four Laborcita localities.

Order **Nuculoida** Dall, 1889  
 Family **Nuculidae** Gray, 1824  
 Genus **Nuculavus** Chernyshev, 1947

Cox et al. (1969) considered *Nuculavus* a synonym of *Nuculopsis*, but McAlester (1968) and Yancey (1978) treated them as separate genera and that classification is followed here. *Nuculavus* includes small subtriangular nuculids with fine concentric ornamentation and a somewhat

TABLE 1. Number of specimens of taxa discussed in text, from each of the four Laborcita Formation localities. 1, Tularosa quarry (UNM locality 1320); 2, La Luz locality UNM 1321; 3, La Luz locality NMMNH L-00837; 4, La Luz locality NMMNH L-00843.

| SPECIES   | LOCALITIES |    |    |    |
|---|------------|----|----|----|
|   | 1          | 2  | 3  | 4  |
| <b>PELECYPODS</b>   |            |    |    |    |
| <i>Nuculavus levatiformis</i> (Walcott)                           | -          | 9  | -  | -  |
| <i>Nuculavus arcuata</i> n. sp.                                   | 28         | 13 | 1  | -  |
| <i>Nuculavus menuda</i> n. sp.                                    | 8          | -  | -  | -  |
| <i>Anthraconeilo?</i> n. sp.                                      | 4          | -  | -  | -  |
| <i>Anthraconeilo?</i> sp.   | -          | 2  | -  | -  |
| <i>Paleyoldia glabra</i> (Beede and Rogers)                       | -          | 7  | 9  | 3  |
| <i>Polidevcia bellistriata</i> (Stevens)                          | 41         | -  | -  | -  |
| <i>Myalina</i> ( <i>Orthomyalina</i> ) <i>subquadrata</i> Shumard | -          | 15 | -  | -  |
| <i>Schizodus</i> sp.  | -          | 4  | 3  | -  |
| <i>Permophorus</i> aff. <i>P. tropidophorus</i> (Meek)            | -          | 4  | 41 | 23 |
| <i>Astartella concentrica</i> (Conrad)                            | -          | 7  | -  | -  |
| <i>Astartella</i> sp. (small)                                     | 4          | 7  | -  | -  |
| <i>Unklesbayella</i> n. sp.                                       | 1          | -  | -  | -  |
| <i>Unklesbayella</i> sp.  | 1          | -  | -  | -  |
| <i>Wilkingia terminale</i> (Hall)                                 | -          | 1  | -  | -  |
| <b>SCAPHOPODS</b>   |            |    |    |    |
| <i>Prodentalium</i> aff. <i>P. sublaeve</i> (Hall)                | 17         | 32 | 8  | 2  |
| <i>Plagioglypta annulostrata</i> (Meek and Worthen)               | 52         | -  | -  | -  |

posteriorly situated beak. Species of the genus *Nuculopsis* are more elongate to subquadrate, have thicker shells and typically lack definite concentric ribs (Yancey, 1978). The type species of *Nuculopsis*, *N. girtyi* Schenck, 1934, is abundant and widespread in the Pennsylvanian and Early Permian of North America, but is not present in the Laborcita collections discussed here.

*Nuculavus levatiformis* (Walcott, 1884)  
 Figs. 2.1 to 2.4

See Yancey (1978) for synonymy.

**Discussion**—This common and widespread Lower Permian species is rare in the Laborcita Formation in La Luz Canyon (UNM locality 1321). The valves are subtriangular, only moderately inflated, with evenly rounded posterior and anterior margins and gently convex anterodorsal and posterodorsal margins. The Laborcita specimens are relatively small, none exceeding 5 mm in length (Table 2), and the height/length ratio of typical specimens varies from slightly less to slightly greater than one. The beaks are moderately elevated and inclined posteriorly. Ornamentation consists of low, nearly evenly spaced concentric ribs. A few specimens are more elongate than normal (Fig. 2.4) and have height/length ratios of 0.75 to 0.80 instead of approximately one. Such variation in shape within assemblages of *N. levatiformis* is not unusual (see Winters, 1963; Yancey, 1978, for examples). This species is also present in the Red Tanks Member, Madera Formation, of the Lucero uplift area. Its stratigraphic range in the western United States is from the base of the Wolfcampian through the Leonardian.

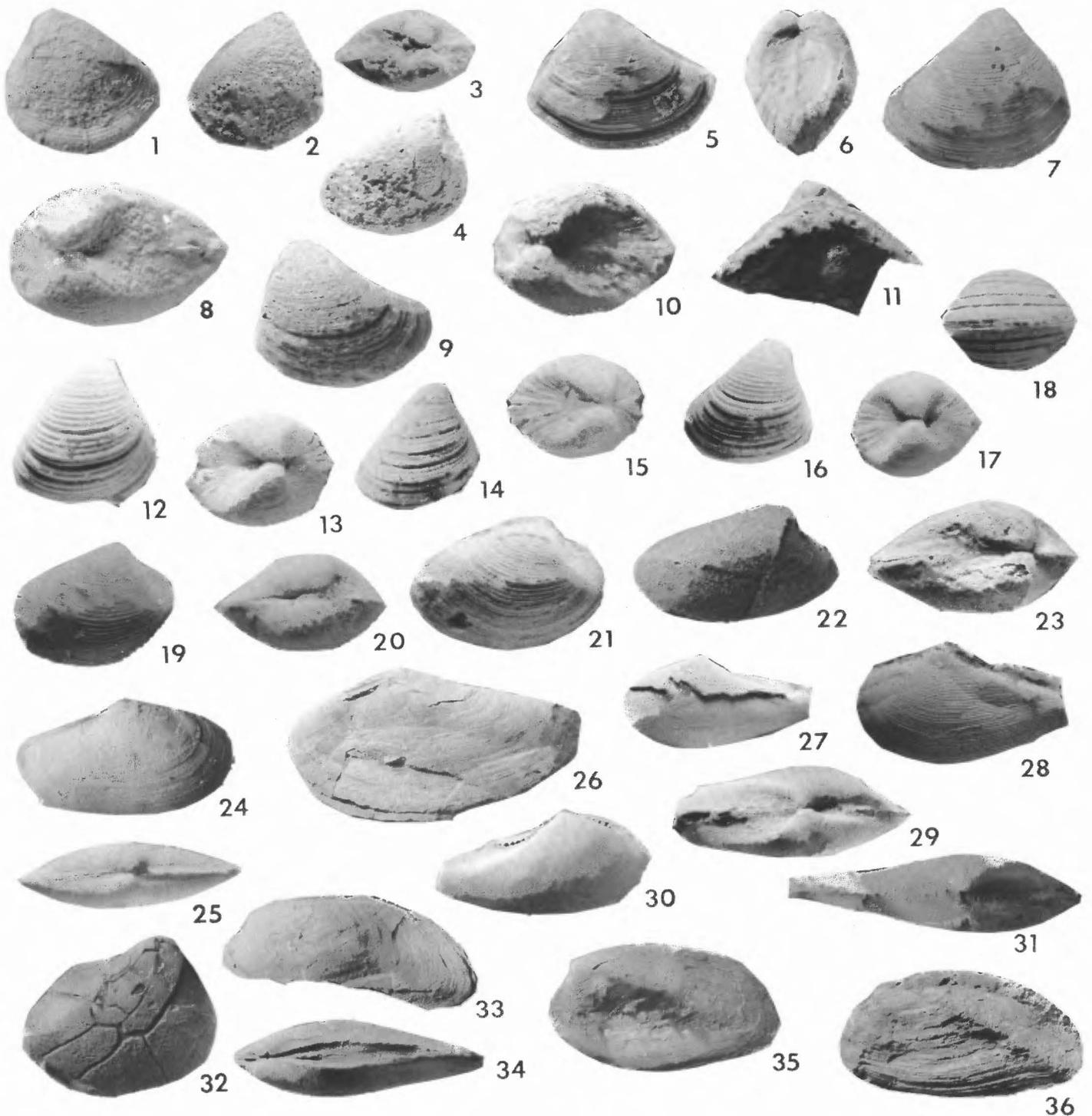


FIGURE 2. Pelecypods from the Laborcita Formation. Figures 1–4, 8, 9, 10, 22, 23, 32 from La Luz locality UNM-1321; 24–26, 35 from La Luz locality NMMNH L-00837; 33, 34, 36 from La Luz locality NMMNH L-00843; all others from Tularosa quarry. 1–4, *Nuculavus levatiformis* (Walcott); 1, right valve, UNM 11,224,  $\times 6$ ; 2, 3, left valve and dorsal (anterior to left) view, UNM 11,223,  $\times 5.75$ ; 4, left valve, UNM 11,226,  $\times 6.75$ . 5–11, *Nuculavus arcuata*, n. sp.; 5, 6, right valve and front view, UNM 11,230 (holotype),  $\times 5.5$ ; 7, left valve, UNM 11,228 (paratype),  $\times 5.5$ ; 8, dorsal view, UNM 11,239 (paratype),  $\times 7.5$ ; 9, 10, right valve and dorsal (anterior to right) view, UNM 10,904 (paratype),  $\times 5.5$ ; 11, hinge line and dentition, right valve, UNM 11,238,  $\times 9$ . 12–18, *Nuculavus menuda*, n. sp.; 12, 13, left valve and dorsal (anterior to left) view, UNM 10,907 (paratype),  $\times 10$ ; 14, 15, left valve and dorsal (anterior to left) view, USNM 447,217 (paratype),  $\times 9$ ; 16–18, left valve, dorsal (anterior to left) and bottom views, UNM 10,909 (holotype),  $\times 9$ . 19–21, *Anthraconeilo?* n. sp.; 19, 20, right and dorsal (posterior to left) views, UNM 10,863,  $\times 8.75$ ; 21, right valve, UNM 10,864 (paratype),  $\times 9$ . 22, 23, *Anthraconeilo?* sp., right valve and dorsal (anterior to right) views, UNM 10,911,  $\times 6$ . 24–26, *Paleyoldia glabra* (Beede and Rogers); 24, 25, right valve and dorsal (anterior to left) views, NMMNH P-16003-1,  $\times 2.5$ ; 26, left valve view of a partly crushed specimen, NMMNH P-16003-2,  $\times 2.5$ . 27–31, *Polidevcia bellistriata* (Stevens); 27, left valve view of steinkern with dorsal part of shell adhering, UNM 11,265,  $\times 3.5$ ; 28, left valve, UNM 11,267,  $\times 3.5$ ; 29, dorsal view (anterior to right), UNM 11,269,  $\times 5$ ; 30, right valve view of steinkern, showing hinge teeth, UNM 11,264,  $\times 4.75$ ; 31, dorsal view (anterior to right) of steinkern, showing molds of interlocked teeth, UNM 11,268,  $\times 6.5$ . 32, *Schizodus* sp., right valve view of steinkern, UNM 10,847,  $\times 1.5$ . 33–36, *Permophorus* aff. *P. tropidophorus* (Meek); 33, 34, left valve of incomplete specimen, and dorsal view (anterior to left), NMMNH P-16007-1,  $\times 2$ ; 35, left valve of partly crushed specimen, NMMNH P-16007-5,  $\times 2$ ; 36, left valve of partly crushed specimen with rugose growth lamellae, NMMNH P-16007-4,  $\times 2$ .

TABLE 2. Measurements (in mm) of *Nuculavus levatiformis* (Walcott), from the Laborcita Formation, La Luz Canyon (UNM locality 1321). H, height; L, length; W, width of articulated specimen; AD, distance of beak from anterior end; D, angle of divergence of antero- and posterodorsal margins.

| Specimen    | H   | L   | W   | AD  | D   | H/L  | W/L  | AD/L |
|-------------|-----|-----|-----|-----|-----|------|------|------|
| UNM 11,223  | 3.7 | 4.1 | 2.3 | 2.5 | 75° | 0.90 | 0.56 | 0.61 |
| UNM 11,224  | 4.2 | 4.5 | -   | 2.6 | 84° | 0.93 | -    | 0.58 |
| UNM 11,225a | 3.3 | 3.0 | 1.8 | 1.8 | 78° | 1.10 | 0.60 | 0.60 |
| UNM 11,225b | 3.9 | 3.7 | 2.0 | 2.2 | 80° | 1.05 | 0.54 | 0.59 |
| UNM 11,225c | 3.8 | 4.0 | -   | 2.7 | 84° | 0.95 | -    | 0.68 |
| UNM 11,226  | 3.0 | 3.8 | 2.1 | 3.0 | 77° | 0.79 | 0.55 | 0.79 |
| UNM 11,227  | 2.7 | 3.6 | 2.0 | 2.7 | 77° | 0.75 | 0.56 | 0.75 |

*Nuculavus arcuata* n. sp.

Figs. 2.5 to 2.11

**Diagnosis**—Shell small, subtriangular, inflated, with length exceeding height and anterior umbonal slope gently concave in lateral profile, curving gently from beaks to a rather pointed anterior margin.

**Description**—Shell small (up to 7 mm long), subtriangular, with moderately to strongly inflated umbos; shell height about 80% of length; maximum width of articulated valves typically more than half and less commonly up to three-fourths of length, occurring slightly anterior to beaks and about one-third of distance from dorsal to ventral margin; beaks moderately high, incurved, acutely rounded, slightly opisthogyrate, nearly touching, situated about 60% of distance from anterior to posterior end; posterodorsal margin steeply sloping, gently convex, slightly raised along hinge line, meeting ventral margin at a rather acutely rounded posteroventral corner; anterodorsal margin sloping at an angle of about 45° down from horizontal, with a straight, slightly elevated hinge line; anterior umbonal slope strongly rounded, curving slightly as it descends ventrally, imparting a concave shape to anterodorsal margin; anterior margin slightly extended, rather pointed; divergence of antero- and posterodorsal margins averaging 90°; escutcheon short, oval, depressed immediately behind beaks but becoming gently convex distally; lunule widely spindle-shaped, slightly depressed, flat, bordered prominently by sharply rounded anterior umbonal slopes; ventral valve margin evenly and moderately convex; ornamentation consisting of numerous fine, closely spaced concentric ribs that fade abruptly to obscurity on margins of lunule and escutcheon; one or two strong growth annulations present on lower half of some valves; valve interior incompletely known; posterior teeth numbering at least seven, of which the two nearest the beak are small, narrow and vaguely arcuate, the next two thicker and strongly chevron-shaped, and the last three thick and rectangular to square in shape; anterior teeth numbering at least six, increasing in size and changing from elongate bars to subtriangular, sharp-tipped projections away from beak area.

Measurements are given in Table 3.

**Discussion**—Specimens assigned to *Nuculavus arcuata* vary significantly in valve shape and width. Most specimens appear somewhat elongate, with a concave anterodorsal margin and a moderately extended, upwardly pointed anterior margin. A few specimens (Fig. 2.7) are higher and more evenly triangular in shape, with a nearly straight anterodorsal margin. The width/length (W/L) ratio of typical specimens ranges from about 0.50 to 0.65. Several unusually inflated specimens, with W/L ratios of 0.65 to 0.75, are included in this species (Figs. 2.9, 2.10) because they represent extremes at the wide end of a gradational continuum, and because other valve features are very similar to typical specimens. One small valve fragment (Fig. 2.11) displays the hinge teeth in the beak area. The presence of a resilifer could not be documented; if present, it is covered with matrix.

This species is distinguished from other late Paleozoic *Nuculavus* species by its gently concave anterior umbonal slope. The more evenly

TABLE 3. Measurements (in mm) of *Nuculavus arcuata*, n. sp., from the Laborcita Formation. H, holotype; P, paratype; other abbreviations as in Table 2.

| Specimen                     | H   | L   | W   | AD  | D    | H/L  | W/L  | AD/L |
|------------------------------|-----|-----|-----|-----|------|------|------|------|
| Tularosa locality (UNM 1320) |     |     |     |     |      |      |      |      |
| UNM 11,228 (P)               | 4.8 | 5.7 | 3.8 | 3.5 | 80°  | 0.84 | 0.67 | 0.61 |
| UNM 11,229 (P)               | 5.1 | 6.5 | 3.6 | 4.1 | 88°  | 0.78 | 0.55 | 0.63 |
| UNM 11,230 (H)               | 4.5 | 5.8 | 3.2 | 3.4 | 90°  | 0.78 | 0.55 | 0.59 |
| UNM 11,232                   | 5.0 | 6.2 | 4.0 | 3.8 | 88°  | 0.81 | 0.65 | 0.61 |
| UNM 11,233 (P)               | 5.6 | 7.0 | -   | 4.5 | 92°  | 0.80 | -    | 0.64 |
| UNM 11,234                   | 5.3 | 6.7 | 3.3 | 4.2 | 91°  | 0.79 | 0.49 | 0.63 |
| UNM 11,235 (P)               | 4.8 | 6.6 | 3.5 | 4.3 | 108° | 0.73 | 0.53 | 0.65 |
| UNM 11,236                   | 4.3 | 5.2 | 2.7 | 3.2 | 87°  | 0.83 | 0.52 | 0.62 |
| UNM 11,237                   | 3.8 | 4.4 | 2.6 | 2.7 | 86°  | 0.86 | 0.56 | 0.61 |
| UNM 10,903 (P)               | 4.8 | 5.5 | 4.1 | 3.8 | 79°  | 0.87 | 0.75 | 0.69 |
| USNM 447,216 (P)             | 4.2 | 5.2 | 3.0 | 3.3 | 86°  | 0.81 | 0.58 | 0.63 |
| Mean                         |     |     |     |     | 89°  | 0.81 | 0.59 | 0.63 |
| La Luz Canyon (UNM 1321)     |     |     |     |     |      |      |      |      |
| UNM 11,239 (P)               | 3.8 | 5.0 | 3.2 | 3.1 | 86°  | 0.76 | 0.64 | 0.62 |
| UNM 11,240a                  | 3.5 | 4.4 | 2.5 | 2.7 | 91°  | 0.80 | 0.57 | 0.61 |
| UNM 11,240b                  | 3.5 | 4.6 | 2.7 | 2.8 | 92°  | 0.76 | 0.59 | 0.61 |
| UNM 11,240c                  | 3.3 | 4.0 | 2.6 | 2.5 | 93°  | 0.83 | 0.65 | 0.62 |
| UNM 11,240d                  | 3.1 | 4.0 | 2.5 | 2.8 | 96°  | 0.78 | 0.63 | 0.70 |
| UNM 11,240e                  | 3.6 | 4.4 | 2.7 | 2.8 | 98°  | 0.82 | 0.61 | 0.64 |
| UNM 10,904 (P)               | 4.6 | 5.7 | 4.2 | 3.5 | 79°  | 0.81 | 0.74 | 0.61 |
| UNM 11,241                   | 4.6 | 4.8 | 3.1 | 3.3 | 73°  | 0.96 | 0.65 | 0.69 |
| Mean                         |     |     |     |     | 89°  | 0.82 | 0.64 | 0.64 |

triangular specimens approach the shape and proportions of *N. croneisi* (Schenck, 1934), a common Middle and Upper Pennsylvanian species (see Schenck, 1934, pl. 7, figs. 1-4; Hoare et al., 1979, pl. 1, figs. 15-17). However, *N. croneisi* (which includes the species identified as *N. parva* [McChesney, 1859] by earlier workers) is smaller, possesses an essentially straight anterodorsal margin, and has orthogyrate instead of slightly opisthogyrate beaks. The unusually wide specimens of *N. arcuata* are similar to *N. wewokana* (Girty, 1911) in some characters, but that species is smaller, more evenly triangular, and possesses a strongly elevated posterodorsal hinge line.

**Collections**—Twenty-eight specimens from the Laborcita Formation at the Tularosa locality; 13 specimens from La Luz Canyon (UNM locality 1321).

**Etymology**—Latin, *arcuatus*, curved.

**Type specimens**—Holotype, UNM 11,230; paratypes, UNM 11,228, 11,229, 11,233, 11,235, 11,239, 10,903, 10,904, USNM 447,216.

*Nuculavus menuda* n. sp.

Figs. 2.12 to 2.18

**Diagnosis**—Shell very small, inflated, trigonal, about as high as long, with prominent elevated opisthogyrate beaks located two-thirds to three-quarters of distance to posterior end, poorly defined lunule and escutcheon, and bold, closely spaced concentric lirae and several larger growth annulations.

**Description**—Shell very small (less than 3 mm long), trigonal, about as high as long; maximum width about three-fourths of shell length, occurring a little anterior to beaks and slightly above mid-height; beaks relatively high, sharp, incurved, opisthogyrate, nearly touching, situated two-thirds to three-fourths of distance from anterior to posterior end; posterodorsal margin sloping strongly ventrally, slightly concave, rounding smoothly into ventral margin; anterodorsal margin straight,

sloping ventrally a little less abruptly than posterodorsal margin, rounding into a moderately acute anteroventral margin; divergence of postero- and anterodorsal margins averaging 65°; escutcheon very poorly defined; lunule elongate, slightly depressed, becoming progressively shallower anteriorly away from beaks, bordered by relatively sharply rounded anterior umbonal margins; ventral margin evenly and moderately convex; ornamentation consisting of strong, evenly and closely spaced concentric ribs, which become larger, more widely separated and less evenly spaced ventrally, ventral half of valve also displaying stronger, concentric, overlapping lamellae that produce wrinkle-like growth annulations; interior of valves unknown.

Measurements are given in Table 4.

**Discussion**—*Nuculavus menuda* differs from *N. levatiformis* (Walcott) in being smaller, wider, and having a straight rather than a conspicuously convex anterodorsal margin. *Nuculavus levatiformis obliqua* (Girty, 1909), a small variant from the Yeso Formation of southern New Mexico, is comparable in size and the acute angle at which its antero- and posterodorsal margins meet, but its anterodorsal margin is convex. *Nuculavus triangularis* (Sayre, 1930), a small, triangular species from the Missourian of Kansas, is similar to *N. menuda* in shell proportions, width-length ratio, angle of dorsal margin divergence (70°), beak shape, and poorly defined lunule and escutcheon. However, the ventral margin of *N. triangularis* is nearly straight, rather than evenly convex, and the valve surface is nearly smooth, in contrast to the boldly ornamented surface of *N. menuda*. Compared to *N. croneisi* (Schenck), *N. menuda* has a smaller, higher shell, with sharper, more elevated beaks. *Nuculavus wewokana* (see Girty, 1915: Desmoinesian of Oklahoma) is similar in size, but has a more sharply defined lunule and escutcheon, a straight or slightly convex posterodorsal margin, somewhat wider beaks, and a broader angle of dorsal margin divergence. *Nuculavus arcuata*, with which *N. menuda* occurs in the Laborcita Formation, is larger, more elongate, has a distinctly concave antero-dorsal margin, and its dorsal margins diverge at about 90°.

**Collections**—Eight specimens from the Laborcita Formation, Tularosa quarry.

**Etymology**—Spanish, *menudo*, tiny.

**Type specimens**—Holotype, UNM 10,909; paratypes, UNM 10,905, 10,907, 10,910, USNM 447,217.

Family **Malletiidae** Adams and Adams, 1858

Genus ***Anthraconeilo*** Girty, 1911

***Anthraconeilo?*** n. sp.

Figs. 2.19 to 2.21

**Description**—Shell very small, elongate-oval in shape, inflated at umbos; length about 1.5 times height; width greater than one-half length; maximum shell width at umbos, a little in back of beaks and about one-third of distance from dorsal to ventral margin; beaks moderately high, incurved, gibbous, strongly prosogyrate, nearly touching, situated about one-third of distance from anterior to posterior margins; posterodorsal margin straight, gently sloping to evenly and broadly convex posterior margin; anterodorsal margin gently convex, with hinge line slightly elevated, rounding evenly into relatively acutely convex anterior margin, which is thus equal in convexity or sharper than posterior

margin; ventral margin moderately convex, with greatest convexity about at mid-length; escutcheon lacking; posterior umbonal slope broadly rounded, not differentiated from general valve curvature; anterior umbonal slope rather sharply concave in lateral profile, bordering a shallow lunule bisected by elevated hinge line; ornamentation consisting of fine, evenly spaced concentric ribs, numbering about 12/mm across central part of valve, with flat, wider interspaces, but much finer and more closely spaced toward beak; internal valve features unknown.

Measurements are given in Table 5.

**Discussion**—Only four specimens of this distinctive little species, all from the Tularosa clay pit, are available. Generic placement is highly tentative. None of the specimens display evidence of taxodont dentition or other internal valve features, and interpretation of the produced portion of the valve as posterior is problematical. The general outline of the shell, with beaks situated nearer to one end and incurved toward the closer margin (anterior, as used here) may indicate an affinity with *Anthraconeilo*. However, typical species, such as *A. taffiana* Girty, 1911, and *A. mcchesneyana* (Girty, 1910), from the Pennsylvanian and Permian respectively, are larger, more laterally compressed, and have more subdued concentric ornamentation (see McAlester, 1968; Yancey, 1978). The small size of these specimens suggests that they might be juveniles of a species having a somewhat different adult shape (Yancey, personal comm., 1991). The rather inflated valves and elongate outline also resemble *Nuculavus anodontoides* (Meek, 1871) (see Girty, 1915; Hoare et al., 1979), but that species is much larger and bears less prominent concentric ribs. Because the nature of the dentition is unknown, it is also possible that these Laborcita specimens are not nuculoids.

***Anthraconeilo?*** sp.

Figs. 2.22, 2.23

**Description**—Shell small (about 6 mm long), elongate, with inflated umbos; height and width a little greater than half the length; maximum width occurring a little posterior to beaks and high on the umbos, producing a heart-shaped cross section at the beaks; beaks elevated, tumid, incurved, nearly touching, strongly prosogyrate, situated about one-fourth of distance from anterior to posterior end; anterior margin evenly and somewhat acutely convex; posterodorsal margin straight to very slightly convex, sloping gently and rounding gradually into posterior margin, which is slightly more broadly convex than anterior margin; ventral margin gently and evenly convex; lunule and escutcheon lacking; hinge line slightly elevated; about five interlocked, relatively long hinge teeth exposed on each valve by weathering posterior to beaks; ornamentation obscure, apparently consisting of low concentric growth lines and occasional stronger annulations but lacking definite concentric ribs.

Measurements are given in Table 6.

**Discussion**—Two weathered specimens from La Luz Canyon (UNM locality 1321) represent this species. The faint indication of taxodont dentition along the hinge line of one specimen suggests that these are nuculoids, but the generic assignment of *Anthraconeilo* is questionable. The shells are elongate, with anteriorly (?) situated beaks, and somewhat resemble *Anthraconeilo* in outline. However, they differ from typical species of that genus in having more pronounced and strongly curved beaks and more inflated umbos. These specimens are lower and longer

TABLE 4. Measurements (in mm) of *Nuculavus menuda*, n. sp., from the Laborcita Formation, Tularosa quarry (UNM locality 1320). H, holotype; P, paratype; other abbreviations as in Table 2.

| Specimen         | H   | L   | W   | AD  | D   | H/L  | W/L  | AD/L |
|------------------|-----|-----|-----|-----|-----|------|------|------|
| UNM 10,905 (P)   | 2.2 | 2.3 | 1.7 | 1.6 | 65° | 0.96 | 0.74 | 0.70 |
| UNM 10,907 (P)   | 2.5 | 2.7 | 2.0 | 1.8 | 68° | 0.93 | 0.74 | 0.67 |
| UNM 10,908       | 2.7 | 2.6 | -   | 1.7 | -   | 1.04 | -    | 0.65 |
| UNM 10,909 (H)   | 2.4 | 2.4 | 1.9 | 1.8 | 65° | 1.00 | 0.79 | 0.75 |
| UNM 10,910 (P)   | 2.7 | 2.7 | 2.0 | 2.1 | 63° | 1.00 | 0.74 | 0.78 |
| USNM 447,217 (P) | 2.3 | 2.5 | 2.0 | 1.6 | 66° | 0.92 | 0.80 | 0.64 |

TABLE 5. Measurements (in mm) of *Anthraconeilo?* n. sp., from the Laborcita Formation, Tularosa quarry (UNM locality 1320). Abbreviations as in Table 2.

| Specimen   | H   | L   | W   | AD  | H/L  | W/L  | AD/L |
|------------|-----|-----|-----|-----|------|------|------|
| UNM 10,863 | 2.2 | 3.2 | 1.8 | 1.1 | 0.69 | 0.56 | 0.34 |
| UNM 10,864 | 2.6 | 3.7 | 2.0 | 1.2 | 0.70 | 0.54 | 0.32 |
| UNM 10,865 | 2.4 | 3.7 | 2.2 | 1.2 | 0.65 | 0.59 | 0.32 |
| UNM 11,618 | 1.9 | 2.5 | 1.5 | 0.8 | 0.76 | 0.60 | 0.32 |

TABLE 6. Measurements (in mm) of *Anthraconeilo?* sp., from the Laborcita Formation in La Luz Canyon (UNM locality 1321). Abbreviations as in Table 2.

| Specimen   | H   | L   | W   | AD  | H/L  | W/L  | AD/L |
|------------|-----|-----|-----|-----|------|------|------|
| UNM 10,911 | 3.2 | 5.8 | 3.2 | 1.6 | 0.55 | 0.55 | 0.28 |
| UNM 10,912 | 3.8 | 6.0 | 3.2 | 1.3 | 0.63 | 0.53 | 0.22 |

than specimens referred to *A.?* n. sp. above, and bear less prominent concentric ornamentation. No known genus of late Paleozoic nuculoid seems suitable as a repository for shells of this type, but more specimens in a better state of preservation are needed to definitely assess their taxonomic status.

Family **Nuculanidae** Adams and Adams, 1858

Genus ***Paleyoldia*** Lintz, 1958

***Paleyoldia glabra*** (Beede and Rogers, 1899)

Figs. 2.24 to 2.26

*Yoldia glabra* Beede and Rogers, 1899, p. 133, pl. 34, figs. 4a, 4b; Beede, 1900, p. 153, pl. 21, figs. 4a, 4b; Girty, 1915, p. 126, pl. 13, figs. 9–15; Plummer and Moore, 1921, pl. 13, figs. 32–34, pl. 19, figs. 16–18; (?)Morningstar, 1922, p. 207; Morgan, 1924, pl. 48, figs. 11, 11a; Sayre, 1930, p. 107, pl. 9, figs. 1–3.

*Paleyoldia glabra*, Lintz, 1958, p. 110, pl. 16, figs. 14, 15, text-fig. 2; McAlester, 1968, p. 42, pl. 33, figs. 1–13; Kues, 1984a, fig. 4.3.

**Description**—Shell of moderate size (up to 20+ mm long), elongate, compressed laterally, with length about twice the height; beaks centrally located, small, low, opisthogyrate, nearly touching; anterodorsal margin very gently convex, lacking lunule, sloping slightly to merge with evenly and somewhat acutely rounded anterior margin; posterodorsal margin straight to slightly concave, with hinge line raised into a low keel and surrounded by an obscure, elongate, slightly depressed escutcheon; posterior portion of valve extended, somewhat lower than anterior part and nearly vertically truncate at slightly convex posterior margin; ventral margin moderately convex anteriorly, becoming straight toward posterior end of valve, with a slight obscure emargination just posterior to umbo; valves laterally compressed, with uninflated umbos; shell width less than one-third of shell length; ornamentation consisting of somewhat irregular, narrow to widely spaced concentric lirae, which may become manifested as regular step-ribs toward ventral margin, and by numerous, very fine (10+/mm) concentric lirae superimposed on the larger growth annulations; internal shell features unknown.

Measurements are given in Table 7.

**Discussion**—The shape and proportions of the Laborcita specimens agree well with Pennsylvanian representatives described by previous workers. Most specimens identified as *Paleyoldia glabra* display regular, fairly closely spaced concentric striae. However, the holotype was described by Beede and Rogers (1899) as having an almost smooth shell, with traces of obscure distant concentric lirae. Similar, slightly weathered specimens are present in the Laborcita collections from La Luz Canyon (e.g., Fig. 2.24); these display only a few, widely separated growth annulations. Specimens with better preservation of the shell surface (Fig. 2.26) have rather irregularly but widely spaced ribs and

TABLE 7. Measurements (in mm) of *Paleyoldia glabra* (Beede and Rogers) from the Laborcita Formation, La Luz Canyon (NMMNH localities L-00837 and L-00843). Abbreviations as in Table 2.

| Specimen                  | H    | L    | W   | AD  | L/H  | W/L  | AD/L |
|---------------------------|------|------|-----|-----|------|------|------|
| NMMNH P-16003-1 (L-00837) | 8.0  | 15.2 | 4.9 | 7.4 | 1.90 | 0.32 | 0.49 |
| NMMNH P-16003-2 (L-00837) | 11.0 | 20.5 | -   | 9.3 | 1.86 | -    | 0.45 |
| NMMNH P-16003-3 (L-00837) | 9.5  | 19.0 | -   | 9.5 | 2.00 | -    | 0.50 |
| NMMNH P-16003-4 (L-00837) | 7.0  | 13.5 | 3.9 | 6.7 | 1.93 | 0.29 | 0.50 |
| NMMNH P-16004-1 (L-00843) | 8.8  | 16.2 | -   | 7.8 | 1.84 | -    | 0.48 |

second-order, much finer, very closely spaced concentric lirae that are ubiquitous across the valves. The effect of these two ranks of ornamentation is quite different from that of the regular concentric ornamentation of most Pennsylvanian specimens assigned to *P. glabra*. McAlester (1968) noted that despite differences in ornamentation, specimens traditionally referred to *P. glabra* were probably conspecific with Beede and Rogers' (1899) now unavailable holotype. This may not be the case; most specimens assigned to *P. glabra* in the past may represent a different species. Better understanding of the species of *Paleyoldia* would be greatly aided by a thorough restudy of the genus. The shape, size and ornamentation of the Laborcita specimens, especially slightly worn individuals, closely resemble the description and illustrations of the holotype of *P. glabra*, and assignment to that species is made with confidence.

Yancey (personal comm., 1991) pointed out that the larger specimens (e.g., Fig. 2.26) resemble specimens of *Anthraconeilo taffiana* Girty, 1911. The two species can be distinguished by the direction of beak curvature. The beaks of *P. glabra* are opisthogyrate, pointing toward the extended posterior end of the valve, whereas the beaks of *Anthraconeilo* are prosogyrate, pointing toward the higher, blunt anterior margin.

Nineteen specimens from all three La Luz Canyon localities were examined.

Genus ***Polidevcia*** Chernyshev, 1951

***Polidevcia bellistriata*** (Stevens, 1858)

Figs. 2.27 to 2.31

See Hoare et al., 1979 for synonymy, as *Phestia bellistriata*.

*Polidevcia bellistriata*, Yancey, 1978, p. 332, pl. 9, figs. 10–13.

*Phestia bellistriata*, Kues, 1984, fig. 4.5.

**Discussion**—All of the Laborcita specimens are from the Tularosa locality. Most are steinkerns of articulated individuals less than 10 mm long (Table 8); a few have all or some of the shell preserved. In general, these specimens are distinguished by their broadly convex anterior margin, relatively low, nearly straight, extended posterior portion of the valve, and relatively high, sharp, slightly opisthogyrate beaks, situated about 40% of the distance from the anterior to posterior end of the shell. Ornamentation consists of fine, regular, closely spaced, concentric step-ribs that increase in size ventrally. The area along the hinge line posterior to the beaks is an elongate, depressed escutcheon, bisected by a sharp central ridge at the contact of the two valves. Although the escutcheon is devoid of the regular ornamentation, some specimens display about eight fine, faint lirae radiating from the beak area across each half of the escutcheon (Fig. 2.29). On some steinkerns, molds of interlocked teeth form a zigzag line along the hinge line (Fig. 2.31). As many as 13 teeth are indicated in back of the beak, and seven or eight in front of it.

*Polidevcia bellistriata* has been reported by many authors from Atokan through Virgilian Pennsylvanian strata and ranges to the top of the Wolfcampian (Yancey, 1978). The Laborcita specimens are relatively small, but otherwise display the characteristic features of the species.

TABLE 8. Measurements (in mm) of *Polidevcia bellistriata* (Stevens) from the Laborcita Formation, Tularosa quarry (UNM locality 1320). Abbreviations as in Table 2.

| Specimen   | H   | L     | W   | AD  | H/L  | W/L  | AD/L |
|------------|-----|-------|-----|-----|------|------|------|
| UNM 11,264 | 4.0 | 7.5   | 2.2 | 3.1 | 0.53 | 0.29 | 0.41 |
| UNM 11,265 | 4.5 | 8.8+  | 2.9 | 3.8 | 0.49 | 0.32 | 0.41 |
| UNM 11,266 | 5.1 | 9.0   | 3.2 | 3.9 | 0.57 | 0.36 | 0.43 |
| UNM 11,267 | 5.7 | 10.0+ | -   | 4.1 | 0.52 | -    | 0.37 |
| UNM 11,268 | 4.1 | 7.5+  | 2.2 | 3.0 | 0.49 | 0.27 | 0.36 |
| UNM 11,269 | 5.1 | 8.7+  | 3.1 | 3.3 | 0.59 | 0.36 | 0.38 |

On some specimens the posterior portion of the shell is unusually elongate. Some authors have distinguished such forms as separate subspecies or species (e.g., Girty, 1915; Hoare et al., 1979), but they appear to be intraspecific morphs of the typical form in the Laborcita fauna.

Order **Pterioida** Newell, 1965

Family **Myalinidae** Frech, 1891

Genus **Myalina** de Koninck, 1842

Subgenus **Orthomyalina** Newell, 1942

**Myalina (Orthomyalina) subquadrata** Shumard, 1855

Fig. 3.1

See Hoare et al., 1979, for synonymy.

**Discussion**—Fragments of these large and distinctive shells are common at the La Luz localities. The best preserved specimen, a left valve,

has a hinge-line length of approximately 80 mm. The hinge margin curves with strong but even convexity into the posterior margin. Slight deflection of growth lamellae defines a very shallow sinus along the posterior margin, just below the hinge line. The beaks are relatively narrow and pointed, and the anterior shell margin is strongly concave. Concentric, evenly spaced growth lamellae become more irregular and rugose toward the posterior margin of the shell. The Laborcita specimens agree well in most features with representatives from the central United States (see Newell, 1942). However, the illustrated specimen displays a slightly sharper and more extended beak and has a less developed posterior sinus than is typical of Midcontinent specimens.

*Myalina (Orthomyalina) subquadrata* is confined to a narrow stratigraphic interval encompassing approximately the upper one-third of the Virgilian and lower one-fourth of the Wolfcampian sequence in Kansas (Newell, 1942). The species is also present in the lower part of the

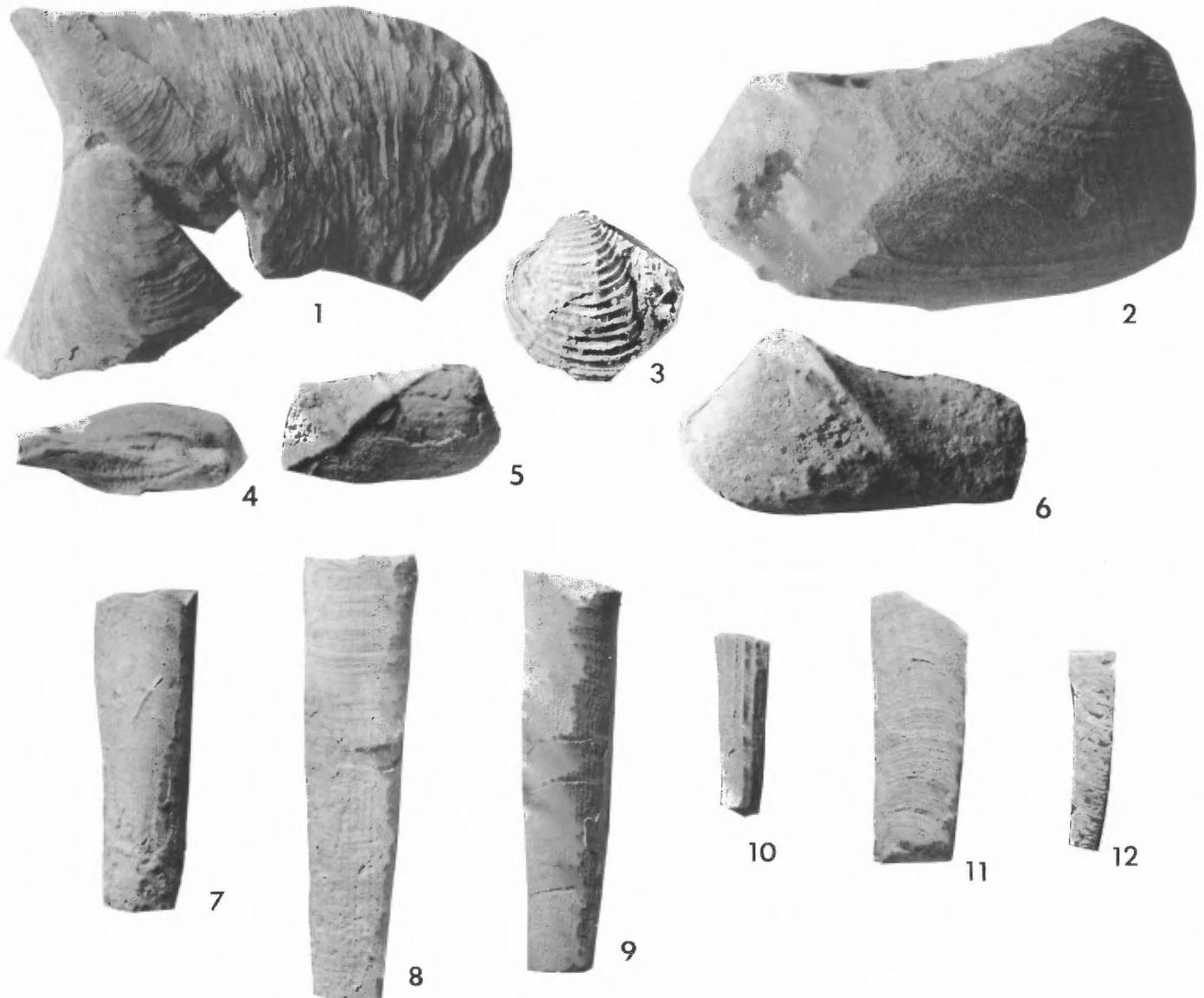


FIGURE 3. Bivalves from the Laborcita Formation. Figures 3–6, 11, 12 from Tularosa quarry; all others from La Luz locality 1321. 1, *Myalina (Orthomyalina) subquadrata* Shumard, partial left valve exterior, UNM 10,848,  $\times 1$ . 2, *Wilkingia terminale* (Hall), partial steinkern, right valve, UNM 10,849,  $\times 1$ . 3, *Astartella concentrica* (Conrad), left valve, UNM 11,263,  $\times 2.5$ . 4, 5, *Unklesbayella* n. sp., dorsal (anterior to right) and right valve views, UNM 10,842,  $\times 5.5$ . 6, *Unklesbayella* sp., left valve, partially covered with matrix, UNM 10,843,  $\times 4.75$ . 7–10, *Prodentulum* aff. *P. sublaeve* (Hall); 7, shell fragment, UNM 10,898,  $\times 1$ ; 8, shell fragment, UNM 10,900,  $\times 2$ ; 9, shell fragment, UNM 10,901,  $\times 1.5$ ; 10, shell fragment from near apex of shell, UNM 10,902,  $\times 3$ . 11, 12, *Plagioglypta annulostrata* (Meek and Worthen), shell fragments, UNM 10,868 and UNM 10,866, both  $\times 4.5$ .

Red Tanks Member, Madera Formation, in the Lucero uplift area, where it occurs in large numbers as the dominant species in thin, nearshore shale beds.

**Order Trigonioida** Dall, 1889  
 Family **Schizodidae** Newell and Boyd, 1975  
 Genus **Schizodus** de Verneuil and Murchison, 1844  
*Schizodus* sp.  
 Fig. 2.32

**Discussion**—Laborcita specimens are of small to medium size and are characterized by a wide, high umbo, slightly prosogyrate beaks situated about one-fourth the distance from anterior to posterior end, and a moderately extended posterior portion of the shell. The elevated posterodorsal margin slopes only slightly for a short distance behind the beaks, then bends rather abruptly at the end of the hinge line before descending to the broadly rounded posterior margin. The posterior umbonal ridge is fairly sharply rounded. The surface of the shell of some specimens displays faint, closely spaced growth lines. The best preserved specimen, a right valve (Fig. 2.32), is 21.2 mm long, 16.9 mm high (length/height = 1.25), and 7.8 mm wide.

The shape of these specimens does not exactly correspond to any described Late Pennsylvanian or Early Permian species. *Schizodus ulrichi* Worthen, although variable, tends to have a more evenly convex posterodorsal margin without the angular bend at the end of the hinge line, and displays a more acutely rounded posterior margin (see Newell and Boyd, 1975). *Schizodus* cf. *S. wheeleri* (Swallow), reported by Mudge and Yochelson (1962) from the Lower Permian of Kansas, has a more posteriorly truncated shell and more upright, centrally located beaks, features that may place it in *S. alpinus* (Hall). A wide variety of other forms has been assigned to *S. wheeleri*, a species whose exact characteristics are uncertain (Mudge and Yochelson, 1962). Most of these are more extended posteriorly and have a sharper posterior margin than the Laborcita specimens, and the angular bend in the posterodorsal margin occurs farther from the beaks. This is true, for example, of the steinkern figured as *S. wheeleri*? by Girty (1909, pl. 10, fig. 6), from the Yeso Formation of New Mexico. *Schizodus hareii*? of Sayre (1930), from the Missourian of Kansas, has a more acutely rounded posterior margin and more centrally located beaks than the Laborcita specimens. Some Missourian specimens described as *S. wheeleri* (Hoare et al., 1979, pl. 12, figs. 6–9) closely resemble the Laborcita specimens. *Schizodus texanus* Clifton, a common, widespread Permian species of the western United States, is more posteriorly extended and has a sharper posterior margin than the Laborcita form (see Newell and Boyd, 1975).

**Order Veneroida** Adams and Adams, 1856  
 Family **Permophoridae** van de Poel, 1959 (1895)  
 Genus **Permophorus** Chavan, 1954  
*Permophorus* aff. *P. tropidophorus* (Meek, 1875)  
 Figs. 2.33 to 2.36

See Hoare et al., 1979, for synonymy.

**Description**—Shell elongate, medium-sized (up to 25 mm long), moderately wide at umbos; length 1.6 to 1.9 times height; beaks small, low, prosogyrate, located about 15% of distance from anterior to posterior end; anterodorsal margin gently concave, sloping ventrally at an angle of 45° or less; anterior margin rather acutely convex; posterodorsal margin straight to very gently convex, bending gradually to moderately abruptly downward to posterior margin, which slopes gradually to form acutely rounded posteroventral edge; ventral margin gently convex, with greatest convexity posterior to beak area; lunule small, oval, moderately deep; escutcheon elongate, shallow, spindle-shaped, well defined by a single narrow costa along each side, with a narrow ligament rising along its center at the hinge line; valve surface marked by a prominent posterior umbonal ridge, extending from beak to posteroventral margin; posterodorsal area above ridge gently concave, unornamented or with one obscure radial lira in center; ornamentation consisting of fine to somewhat rugose, closely spaced growth lines and occasional, irregular larger growth annulations on some specimens, bending sharply at posterior umbonal ridge; internal valve features unknown.

Measurements are given in Table 9.

TABLE 9. Measurements (in mm) of *Permophorus* aff. *P. tropidophorus* (Meek) from the Laborcita Formation, La Luz Canyon (NMMNH localities L-00837 and L-00843). Abbreviations as in Table 2.

| Specimen                  | H    | L    | W   | AD  | L/H  | W/L  | AD/L |
|---------------------------|------|------|-----|-----|------|------|------|
| NMMNH P-16007-2 (L-00837) | -    | 19.4 | 6.8 | 2.4 | -    | 0.35 | 0.12 |
| NMMNH P-16007-5 (L-00837) | 11.0 | 19.5 | -   | 1.7 | 1.77 | -    | 0.09 |
| NMMNH P-16007-1 (L-00843) | -    | 20.0 | -   | 2.6 | -    | -    | 0.13 |
| NMMNH P-16007-3 (L-00843) | 14.5 | 23.3 | -   | 2.6 | 1.61 | -    | 0.11 |
| NMMNH P-16007-4 (L-00843) | 10.5 | 19.9 | -   | 4.0 | 1.90 | -    | 0.20 |

**Discussion**—All Laborcita specimens are articulated, but either incomplete or distorted severely by lateral compression. The incomplete specimens invariably lack the ventral and sometimes the posterior margins of the valves, with generally good preservation of the thicker dorsal portions of the shell. This species most closely resembles the Middle–Upper Pennsylvanian *Permophorus tropidophorus* (Meek), especially in size, general shape and proportions of the valves, and in the nature of the posterior umbonal ridge and posterodorsal area. However, the posterior margin of the Pennsylvanian *P. tropidophorus* tends to be less attenuated, with a relatively sharp bend from the posterodorsal to posterior margin, and a rather steep slope ventrally to the posteroventral corner. The posterodorsal-to-posterior-margin bend of the Laborcita specimens is much less abrupt and in some specimens is very gradual. The posterior margin slopes more gradually to form a more acutely rounded posteroventral corner. In addition, *P. tropidophorus* typically has a single prominent radial rib within the posterodorsal area (see Meek, 1875; Beede, 1900; Morningstar, 1922), whereas most of the Laborcita specimens display no ornamentation, and only a few have an obscure radial lira in this area. This may be a new species derived from *P. tropidophorus*, but better preserved specimens are required to be certain that the differences noted above are consistent and significant at the species level.

Family **Astartidae** d'Orbigny, 1844  
 Genus **Astartella** Hall, 1858  
*Astartella concentrica* (Conrad, 1842)  
 Fig. 3.3

See Hoare et al., 1979, for synonymy.

*Astartella concentrica*, Kues, 1984a, fig. 4.25.

**Discussion**—A few relatively large specimens of *Astartella* fall within the range of variation of *A. concentrica*, a common Middle to Upper Pennsylvanian species. The length of the best preserved specimen is 10.5 mm and its height is 9.5 mm. These specimens are characterized by truncate anterior and posterior margins, a strongly concave anterodorsal margin, and sharp, high, widely and regularly spaced concentric ribs. From the tip of the beak on the best preserved specimen there are six ribs in 1 mm, eight ribs in 2 mm, and 10 ribs in 3 mm. The interspaces between the ribs are about three times the width of a single rib and bear numerous, very fine, regular concentric lirae. The beaks are narrow, moderately high, and strongly prosogyrate. A few of the larger specimens, questionably assigned to *A. concentrica*, display similar ornamentation but are more produced at the anterior and posterior margins.

Several poorly preserved small specimens represent a second species of *Astartella* in the Laborcita Formation. These have a more elongate shape, and denser concentric ribs than *A. concentrica*.

**Order Pholadomyoida** Newell, 1965  
 Family **Megadesmidae** Vokes, 1967  
 Genus **Unklesbayella** Hoare, Sturgeon and Kindt, 1978

The megadesmid genus *Unklesbayella* was established by Hoare et al. (1978) for *Allorisma geinitzi* Meek, 1867, a small, elongate pelecypod characterized externally by anterior, prosogyrate beaks, a strong posterior umbonal ridge, compressed posterodorsal area, and ornamentation consisting of radiating and concentric rows of fine pustules. *Unklesbayella geinitzi* ranges from Atokan to upper Missourian strata in the central and eastern United States (Hoare et al., 1978, 1979), and

is the only species currently assigned to the genus. Two additional early Wolfcampian species, present in the Laborcita Formation at the Tularosa locality, are described below. Both species are represented by a single specimen. The first, *U. n. sp.*, is complete, although part of the shell is exfoliated. The second species, *U. sp.*, is considerably larger but less well preserved. *Unklesbayella geinitzi* (Meek) lacks a lunule, but both Laborcita species appear to possess one, and the original generic concept is modified slightly to include species having a shallow lunule.

*Unklesbayella n. sp.*  
Figs. 3.4, 3.5

**Description**—Shell small (about 6 mm long), about twice as long as high; beaks low, moderately wide, prosogyrate, situated between 10 and 15% of distance from anterior to posterior margins; umbos moderately inflated, so that widest part of valve is above mid-height and a little behind beaks; anterodorsal margin slightly concave, sloping sharply ventrally from beaks to meet a moderately convex anterior margin; crest of posterior umbonal ridge bearing a prominent sharp keel that extends slightly sinuously to posteroventral corner of valve, thus marking border between relatively inflated anterior portion of valve and a compressed posterodorsal area behind umbonal ridge; hinge line behind beaks straight, long, meeting posterior margin at a sharp, obtuse angle of about 115°; posterior margin truncate, straight, descending ventrally and slightly posteriorly from dorsal to ventral margin; ventral margin gently convex, virtually parallel to dorsal margin, with a slight emargination about 40% of distance from anterior to posterior ends; escutcheon narrow, spindle-shaped, depressed, bordered on each side by a small, gently arcuate rib that extends from near the beaks most of distance to posterior end of hinge line; lunule shallow, subround; posterodorsal area strongly compressed, with two obscure radiating wrinkles and closely spaced, irregular growth lines; ornamentation of main part of valve obscure because of exfoliation, but including several radiating rows of fine pustules in front of umbonal ridge and concentric rows of finer pustules across anterior part of valve; internal valve structures unknown.

The only known specimen (UNM 10,842) is 5.9 mm long, 2.8 mm high, and the articulated valves are 2.1 mm wide.

**Discussion**—This species shares with *Unklesbayella geinitzi* (Meek) most of the characteristic features of the genus, and the two species are of similar size, possess muted radial wrinkles and coarse growth lines on the posterodorsal area, and finely pustulate ornamentation across the remainder of the valve. *Unklesbayella n. sp.* differs in having more elongate valves, with a more extended and larger posterodorsal region, a sharp keel rather than an acutely rounded costa on the posterior umbonal ridge, and somewhat smaller, lower, and more anteriorly situated beaks. In addition, the truncate posterior margin of *U. geinitzi* is nearly vertical, and forms approximately a right angle with the dorsal margin and an obtuse angle with the ventral margin. The posterior margin of *U. n. sp.*, in contrast, slopes posteriorly from the dorsal to ventral margin, forming an obtuse angle with the dorsal margin and a right or slightly acute angle with the ventral margin. As noted above, *U. geinitzi* lacks a lunule, whereas *U. n. sp.* possesses a shallow one. This Laborcita specimen almost certainly represents a new species. However, because the range of variation within the species cannot be studied, relationships with *U. geinitzi* (Meek) cannot definitely be evaluated. Thus, this species is not formally named here.

*Unklesbayella sp.*  
Fig. 3.6

**Discussion**—This articulated specimen, from the Laborcita Formation at the Tularosa clay pit, differs significantly from *Unklesbayella geinitzi* and *U. n. sp.* However, much of the shell is covered with matrix, which cannot be removed without risk of damaging the specimen. The shell is posteriorly extended, and almost twice as large as the other two species, attaining a length of 11.0 mm, a height of 5.8 mm, and a width of 4.0 mm. The umbos are moderately inflated and the beaks are fairly wide, low, and slightly prosogyrate. They are situated between 25 and 30% of the distance from the anterior to posterior ends of the valve and thus are much more posteriorly located

than the beaks of *U. n. sp.* The posterior umbonal ridge bears a small, sharp rib that curves gently downward across the valve to the posteroventral corner. The posterodorsal area is covered with adhering sediment, but is strongly compressed, and the posterior margin is slightly convex, vertical, and meets both the dorsal and ventral margins at approximately right angles. Details of the escutcheon are not clearly visible, but it appears to resemble that of *U. n. sp.* A very shallow lunule is present between sharply curved anterior margins of the umbos. Ornamentation consists of fine radiating pustulate lirae across the central part of the valve, similar to *U. geinitzi* (Meek); the anterior region is exfoliated but displays numerous fine pustules.

This species is clearly different from *U. n. sp.* in its larger size, squared-off posterior margin, less pronounced umbonal rib, and especially in the more centrally located beaks. It is larger and more elongate, and has a more extended posterodorsal area, than *U. geinitzi*. More specimens are required in order to ascertain the details of the hinge line, posterodorsal area and ornamentation, but this specimen appears to represent a third species of *Unklesbayella*.

Family **Pholadomyidae** Gray, 1847  
Genus **Wilkingia** Wilson, 1959  
*Wilkingia terminale* (Hall, 1852)  
Fig. 3.2

See Hoare et al., 1979, for synonymy.

*Wilkingia terminale*, Kues, 1984a, fig. 4.27.

**Discussion**—A few incomplete steinkerns from the La Luz localities are as much as 85 mm long and are characterized by their large size, elongate shape, strongly curved, prosogyrate beaks situated close to the anterior margin, and coarse, fairly regular, concentric growth annulations. Radial rows of small papillae are preserved on portions of some steinkerns. *Wilkingia terminale* is one of the most common late Paleozoic pelecypod species, ranging through the Pennsylvanian and into the Wolfcampian across much of North America. This species is also present in the Red Tanks Member of the Madera Formation in the Lucero uplift area of central New Mexico.

## SCAPHOPODS

Yancey (1978) summarized the taxonomy of most North American late Paleozoic scaphopod species and noted that nearly all Paleozoic scaphopods belong to *Prodentalium* or *Plagioglypta*, with the former genus predominating in the Carboniferous and Permian. *Prodentalium* is characterized generally by large, thick, nearly straight shells bearing a high density of undulatory, locally strongly bent longitudinal ribs. *Plagioglypta* is typically smaller, with thinner shells that lack longitudinal ribbing but bear conspicuous growth lines. *Prodentalium canna* (White), the most commonly reported Permian species, was originally assigned to *Plagioglypta*, but is now known to possess the longitudinal ribbing characteristic of *Prodentalium* (Yancey, 1973). Many Pennsylvanian scaphopods originally described as species of *Dentalium* are likewise placed in *Prodentalium*. However, forms with widely spaced longitudinal ribs confined to the apex of the shell belong to *Dentalium* (*Paleodentalium*), as defined by Gentile (1974).

Order **Dentalioida** Palmer, 1974  
Family **Dentaliidae** Gray, 1847  
Genus **Prodentalium** Young, 1942  
*Prodentalium* aff. *P. sublaeve* (Hall, 1877)  
Figs. 3.7 to 3.10

*Dentalium sublaeve*, Yochelson & Saunders, 1967, p. 15 (see for earlier synonymy).

*Dentalium* sp. Mudge & Yochelson, 1962, p. 94, pl. 17, fig. 20.

*Prodentalium sublaeve*, Yancey, 1978, p. 307.

"*Dentalium*" *sublaeve*, Kues, 1984a, fig. 4.30.

**Description**—Shell straight, circular in cross section, relatively large, attaining an estimated length of 150 mm (based on rate of taper and comparisons of fragments of overlapping sizes); largest fragment about

50 mm long, tapering from 15 to 10.5 mm in diameter; shell thickness about 2 mm at a diameter of 15 mm; ornamentation consisting of numerous longitudinal ribs varying from 2.2 to 3.4 per mm at a shell diameter of 5 to 7.5 mm and from 1.6 to 2.2 ribs per mm at a diameter of 10 to 15 mm; spacing and shape of ribs changing with growth as follows: at early part of shell (diameter = 2–3 mm) ribs sharp, separated by interspaces two to three times as wide, numbering 2 to 2.5 per mm, becoming more rounded and more closely spaced as new ribs are intercalated, so that ribs and interspaces are of approximately equal width at diameters of 5 to 10 mm; this trend culminating on the wide end of large specimens in broadly rounded, somewhat flattened ribs with much narrower interspaces; ribs locally deflected or slightly interrupted where crossed by fine concentric growth lines and occasional more pronounced growth annulations; growth lines inclined moderately away from perpendicular to axis of shell growth.

**Discussion**—These scaphopod fragments clearly have the ornamentation characteristic of *Prodentalium*, and the estimated size of complete shells approximates that of *P. canna* (Yancey, 1978), rather than the larger (300+ mm long) shells of *P. raymondi* (e.g., Young, 1942; Miller, 1949; Toomey, 1957; Tenery and Rowett, 1979). It is unlikely that fragments indicating a larger size escaped detection, for these would have been more conspicuous on the outcrop than the numerous smaller fragments that were collected. Further, numerous scaphopod fragments identical to those of the Laborcita Formation have been collected from the coeval Red Tanks Member, Madera Formation, in the Lucero uplift area, more than 200 km northwest of La Luz Canyon. These fragments also indicate a maximum length of about 150 mm. However, *P. canna* possesses finer, denser ribs at all growth stages, especially in the early part of the shell, where rib density is 5–6 ribs per mm at a diameter of 5 mm (Yancey, 1978).

Comparison of the Laborcita specimens was made with fragments of *P. raymondi* Young collected from the Desmoinesian Flechado Formation, at or near the type locality near Taos, New Mexico. The latter species typically has slightly denser ribs, but otherwise there are no significant differences. In both groups of specimens, variation in rib density is rather great, both from specimen to specimen and at different points around the circumference of a shell at a given diameter on the same specimen.

Small Pennsylvanian scaphopod shell fragments having sharp, widely spaced ribs have generally been referred to *P. sublaeve* (e.g., Girty, 1915; Kues, 1984a). Hall's (1858) original description and illustrations of this species (as *Dentalium obsoletum*) also noted the widely spaced ribs. The connection of numerous small Laborcita fragments possessing widely spaced ribs (e.g., Fig. 3.10) with larger specimens having broader, more closely spaced ribs is partly inferential, because specimens displaying the transition from wide to relatively narrow interspaces are not common. However, one fragment with a diameter of 4 mm does possess sharp, widely spaced ribs, between which one or two slightly smaller ribs have appeared by intercalation, producing a density pattern closer to that observed on larger shells. This observation, together with the generally low rib density at all stages of growth, suggests that the Laborcita specimens are most closely related to *P. sublaeve*, a species characterized by 2–3 ribs per mm along the length of the shell (Yancey, 1978).

Hall's (1858, pl. 29, figs. 16, 17) illustrations of large specimens of *P. sublaeve* (50 mm long, with a maximum diameter of 9 mm) appear to indicate that the ribs remain sharper and more widely spaced with growth than is the case with the Laborcita specimens. As noted above, the ribs of the Laborcita shells become progressively wider, with narrower interspaces, and closely approach the pattern characteristic of *P. raymondi*. These Laborcita scaphopods may represent an undescribed species, but because of the fragmentary nature of the specimens, and insufficient information regarding variability in the rib patterns of *P. sublaeve* and related species, this is not certain.

Collections include 32 specimens from La Luz Canyon (UNM locality 1321), and 17 small specimens from the Tularosa quarry. An additional 90 specimens from Tularosa are too weathered or encrusted to assign confidently, but they also probably belong to this species.

Genus *Plagioglypta* Pilsbry and Sharp, 1897  
*Plagioglypta annulostrata* (Meek and Worthen, 1870)  
 Figs. 3.11, 3.12

See Yochelson and Saunders, 1967, for synonymy.

**Discussion**—About 50 fragments of a small, thin-shelled scaphopod lacking longitudinal ribs but bearing fine annual lirae are present in the Laborcita collections from the Tularosa locality. The largest fragment is about 10 mm long, with a maximum diameter of about 3 mm. All of the specimens are straight to very gently arcuate, and many are somewhat compressed, producing a cross section that may be round to slightly oval. The annular ornamentation typically consists of fine, sharp lirae separated by interspaces one to two times the width of a single lira, and numbering about 6 to 9/mm. These lirae are oriented obliquely, at an angle averaging about 20° away from the axis of shell growth. Expression of the lirae varies considerably. Some specimens have closely spaced fine lirae and a few narrow fragments display larger lirae with narrow interspaces. Significant variation in density and expression of the lirae may occur on a single specimen.

*Plagioglypta annulostrata* has been reported from strata of Late Mississippian (Elias, 1957), Pennsylvanian (Meek and Worthen, 1873; Girty, 1915), and Late Permian (Walter, 1953) age. Typically, the shells are small, comparable in size to those of the Laborcita Formation, although Plummer (1950, pl. 8, fig. 17) tentatively applied the name to a large fragment from the Mississippian of Texas. Most small, late Paleozoic scaphopods with conspicuous annular ornamentation have been included in this species; detailed studies of variation in ornamentation patterns would probably indicate that more than one species is represented.

## DISCUSSION

Although not all of the Laborcita pelecypod taxa have been studied, some general observations on the fauna can be made. The taxa described in this paper comprise most of the pelecypod specimens and most of the diversity in the Laborcita collections. Approximately 250 pelecypod specimens were examined, a small number compared to the more than 7000 gastropods collected from the same localities with an equal level of collecting effort. None of the pelecypod species is particularly abundant, and obviously pelecypods were relatively minor constituents of these gastropod-dominated assemblages.

As is true of the gastropods (Kues, 1991, this volume), the pelecypod fauna of the Tularosa locality differs significantly from that of the La Luz localities (Table 1). Only two of the 15 taxa discussed here were found in both areas. While further collecting might lessen this dissimilarity somewhat, it does seem clear that the strata studied in the two areas reflect different depositional environments, and that contrast in ecological conditions was responsible for the differences in the pelecypod faunas. Certainly, the light gray to tan limestones and calcareous shales of the La Luz localities reflect a different depositional environment than the dark gray shales and siltstones yielding most of the Tularosa specimens. Otte (1959) summarized the variety of facies within the Laborcita Formation, noting that open marine to littoral to non-marine environments are represented, and that lateral facies transitions are common throughout the formation. The higher diversity and abundance of epifaunal stenohaline invertebrates like brachiopods, fusulinids, echinoids, crinoids and bryozoans at the La Luz Canyon localities suggest offshore, shallow, open marine conditions. The dark lithologies at the Tularosa quarry, on the other hand, may have been deposited in more restricted, nearer-shore environments receiving high rates of clastic input from neighboring nonmarine environments (Otte, 1959). More detailed studies of Laborcita facies and faunas will clarify the ecological preferences of the two major pelecypod faunas.

Nuculoids are a conspicuous element of the Laborcita pelecypod assemblages at the Tularosa and La Luz localities. At the Tularosa quarry they comprise most of the pelecypod specimens and four of the seven species recorded from that locality. The nuculoid contribution is considerably less in the La Luz collections, where they represent perhaps one-quarter to one-third of the diversity (counting taxa not included in

this study) and about the same percentage of the total specimens. Many of the nuculoids represent new taxa, and most are unusually small in size, including species like *Polidevcia bellistriata*, which are known from larger Pennsylvanian specimens. This suggests the possibility that some intervals of the Laborcita Formation bear a dwarfed fauna (Yancey, personal comm., 1991). Because the specimens described here were collected from the surface of outcrops rather than directly from the sedimentary strata, this possibility remains to be investigated.

Kues (1991, this volume) noted that the Laborcita gastropods have, in general, stronger affinities to Pennsylvanian species than to later Wolfcampian and younger Permian forms. The same is true of the pelecypods, and the two Laborcita scaphopod species were also first described from the Pennsylvanian. Most of the pelecypod species that are not new are Middle to Upper Pennsylvanian species that range into the lower Permian in New Mexico and elsewhere (e.g., *Paleyoldia glabra*, *Polidevcia bellistriata*, *Permophorus* aff. *P. tropidophorus*, *Astartella concentrica*, *Wilkingia terminale*). *Myalina* (*Orthomyalina*) *subquadrata* has a restricted range of late Virgilian to early Wolfcampian in the Midcontinent, and its occurrence in the Laborcita Formation is thus consistent with an earliest Wolfcampian age for the Laborcita faunas.

The relatively large number of new species present in the Laborcita Formation perhaps should not be surprising, given the paucity of studies of early Wolfcampian pelecypods (with the exception of pectinaceans and mytilaceans) in North America. For example, the pelecypods of the Wolfcampian cyclothemic sequences of the Midcontinent, from Nebraska to north-central Texas, have received little attention. The new Laborcita species described here are most closely related to and apparently derived from Pennsylvanian species. The only "typically Permian" pelecypod observed is *Nuculavus levatiformis*, which is widespread geographically in the Lower Permian but has not been reported from strata of Pennsylvanian age. Clearly, changes in pelecypod faunas from the Late Pennsylvanian to the earliest Permian were slight; no more significant, for example, than between stages of the Pennsylvanian.

The pelecypods and scaphopods of the Laborcita Formation are similar to a coeval fauna from the Red Tanks Member, Madera Formation, in the Lucero uplift, some 200 km northwest of the Tularosa-La Luz area. The Red Tanks fauna has not been intensively studied, but it is known to include *M. (O.) subquadrata*, *N. levatiformis* and *P. bellistriata* (Kues, 1984b), as well as scaphopods identical to those discussed here as *Prodentarium* aff. *P. sublaeve*. Lithological variation in units yielding pelecypods is greater in the Red Tanks Member than in the Laborcita intervals studied here, and the total diversity of the Red Tanks pelecypod fauna is probably greater. The only detailed study of Late Pennsylvanian pelecypods from the New Mexico area is Bird's (1968) study of the Gaptank fauna of west Texas. None of the species he described, however, were observed in the Laborcita Formation.

In both the Tularosa and La Luz Laborcita assemblages, infaunal pelecypods are far more abundant than epifaunal forms. All of the nuculoids, as well as *Schizodus*, *Permophorus*, *Astartella*, *Wilkingia* and *Unklesbayella* were either burrowing or endobysate pelecypods (Hoare et al., 1979). Among the pelecypods, only the relatively few pectinaceans and myalinids were obviously epifaunal inhabitants of Laborcita marine environments. Scaphopods, which are fairly abundant, were semi-infaunal and may have lived almost completely buried in the substrate. In view of the fact that most elements of the Laborcita invertebrate faunas have not been studied, it is premature to speculate on the overall composition and structure of Laborcita communities and the contribution of pelecypods and scaphopods to them. However, it is tempting to consider that the vast numbers of gastropods that inhabited the seafloor preserved in the two Laborcita horizons sampled in this study may have excluded most epifaunal pelecypods.

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