



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

Barry S. Kues

1991, pp. 221-230. <https://doi.org/10.56577/FFC-42.221>

*in:*

*Geology of the Sierra Blanca, Sacramento, and Capitan Ranges, New Mexico*, Barker, J. M.; Kues, B. S.; Austin, G. S.; Lucas, S. G.; [eds.], New Mexico Geological Society 42<sup>nd</sup> Annual Fall Field Conference Guidebook, 361 p. <https://doi.org/10.56577/FFC-42>

---

*This is one of many related papers that were included in the 1991 NMGS Fall Field Conference Guidebook.*

---

### **Annual NMGS Fall Field Conference Guidebooks**

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual [Fall Field Conference](#) that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

### **Free Downloads**

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

### **Copyright Information**

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

*This page is intentionally left blank to maintain order of facing pages.*

## SOME GASTROPODS FROM THE LOWER WOLFCAMPAN (BASAL PERMIAN) LABORCITA FORMATION, SACRAMENTO MOUNTAINS, NEW MEXICO

BARRY S. KUES

Department of Geology, University of New Mexico, Albuquerque, New Mexico 87131-1116

**Abstract**—Twenty of the most common and conspicuous gastropods from two intervals of the Laborcita Formation east of the towns of Tularosa and La Luz are briefly discussed and illustrated. Although the faunas of both intervals are dominated by gastropods, few of these earliest Permian snail taxa have been studied previously. Assemblages near La Luz are in gray to tan limestone and calcareous shale lithologies, and are dominated numerically by specimens of bellerophontids (especially *Retispira*, *Goniasma*, *Stegocoelia* (*Taasia*), *Pseudozygopleura* (*Pseudozygopleura*)? and *Soleniscus*?). In contrast, the dark gray shale and siltstone sequence at the Tularosa quarry yielded a fauna consisting mainly of *Glabrocingulum* (*Glabrocingulum*), *G.* (*Ananias*) and *Amphiscapha*. Several common species in both collections are undescribed, but are closely related to, and probably descended from, known Middle–Late Pennsylvanian taxa. The Laborcita gastropod faunas are most similar to those of the coeval Red Tanks Member, Madera Formation, in central New Mexico some 200 km northwest of the Laborcita localities. Many other (mostly small) species of gastropods have been collected from the Laborcita Formation in addition to those discussed here; studies of them are in progress.

### INTRODUCTION

Some intervals within the Lower Permian Laborcita Formation exposed in the Sacramento Mountains of south-central New Mexico contain diverse marine invertebrate assemblages composed mainly of molluscs. Gastropods are especially abundant in these assemblages, yet have been little studied. Better understanding of these earliest Wolfcampian gastropods would help to fill a modest hiatus in our knowledge of North American gastropod evolution. Numerous Middle and Upper Pennsylvanian faunas, mainly from the central and eastern United States, have been described, and many groups of middle and upper Wolfcampian and younger Permian gastropods from the Southwest are well known from the studies of Chronic (1952), Yochelson (1956, 1960), Batten (1958, 1964), Winters (1963), Erwin (1988a–c) and others.

In this paper, most of the larger and more abundant gastropod taxa in the Laborcita Formation are briefly discussed and illustrated. Detailed systematic treatment of these taxa is not pursued here; rather, the intention is to document them sufficiently to justify the identifications, and provide a general guide to the most common species. Several of these species are new, and will be formally described and named elsewhere (Kues, in preparation). Numerous smaller-sized species, mainly from bulk sediment samples, are omitted from consideration.

Specimens discussed here are deposited in the paleontology collections of the Department of Geology, University of New Mexico (UNM) and the New Mexico Museum of Natural History (NMMNH).

### 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 stratigraphically and temporally 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. Both of the latter units are much thinner than the Laborcita Formation, and consist primarily of nonmarine red-bed units interbedded 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 late Paleozoic Pedernal uplift immediately to the east, into the rapidly subsiding Orogrande basin to the west (Jordan, 1975).

Based on preliminary identifications of marine invertebrates, including 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 gastropods 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>4</sub> sec. 30, T15S, R11E. The gastropods 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 in the Sacramento Mountains were first reported by Herrick (1900, pl. 2), who illustrated but did not describe about 25 invertebrate species, including several gastropods. These specimens were collected from an indefinitely located shale sequence north and east of Tularosa, possibly the interval exposed at the quarry mentioned above. Because of the rather primitive, hand-drawn nature of the illustrations, lack of descriptions, and subsequent unavailability of the specimens for examination, it is difficult to be certain of the identity of these species. Herrick's invertebrate specimens from New Mexico were stored in Hadley Hall, on the UNM campus, which was completely destroyed by fire in 1910 (Northrop, 1966). Herrick (1900) illustrated the following gastropod taxa from strata now included in the Laborcita Formation: *Bellerophon* sp. (pl. 2, fig. 2; probably

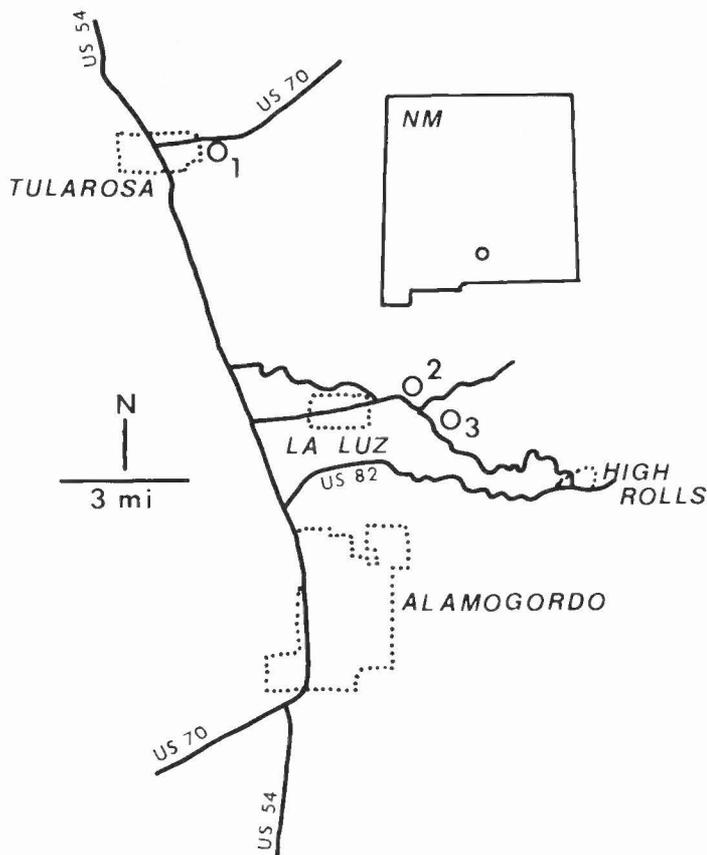


FIGURE 1. Laborcita Formation localities. 1, Tularosa quarry (UNM locality 1320); 2, La Luz Canyon locality (UNM locality 1321); 3, NMMNH La Luz Canyon localities (NMMNH locality L-00837 and L-00843).

*Retispira tenuilineata* of this paper), *Pleurotomaria* cf. *P. subdecussata* Geinitz (pl. 2, fig. 9), *P. marcouiana* Geinitz (pl. 2, fig. 10; now *Glabrocingulum* [*Ananias*] *marcouianum*), *Euomphalus*? sp. (pl. 2, fig. 15; probably *Amphiscapha*), and "undetermined" gastropods (pl. 2, fig. 17, probably *Naticopsis*; pl. 2, figs. 18, 19, unidentifiable steinkerns, possibly of subulitids). Otte (1959) summarized subsequent studies of Laborcita paleontology and stratigraphy; however, without mention of Herrick (1900), or of Girty's work, discussed below. Most of these studies focused on cephalopods from the Tularosa locality (e.g., Böse, 1920; Miller, 1932), which appeared to these workers to be Pennsylvanian but later were shown to be typical Wolfcampian forms (Furnish and Glenister, 1971).

Five late Paleozoic gastropod species have been described previously from the Sacramento Mountains. Girty (1937) established *Pleurotomaria planicostata* (now referred to *Shansiella*; Yochelson and Saunders, 1967) and *Phanerotrema pretiosum*, which appears to be a species of *Glabrocingulum* (*Glabrocingulum*), from the Abo(?) Formation near the road in the lower part of Grapevine Canyon, in the south part of the range. The actual stratigraphic position of these species is uncertain. The strata of this area belong to the Pennsylvanian Gobbler Formation, of Morrowan? to middle Missourian age (Pray, 1961). Only in the upper part of Grapevine Canyon, far beyond the road mentioned by Girty, does the Abo unconformably overlie the Gobbler. The Abo is restricted to nonmarine clastic red beds and therefore is not the source of these gastropods. Without more definite locality information or additional specimens, it seems most likely that the two species are from the Gobbler Formation and are no younger than Missourian in age.

Later, Girty (1939) described two additional new species (*Taosisa crenulata* and *T. percostata*) and one other species, *Goniasma lasalensis* (Worthen), from Upper Pennsylvanian or Lower Permian rocks in La Luz Canyon. Pray (1949, p. 62) noted that this locality is a short distance north of US-82, west of the village of High Rolls, and is in

the Lower Permian Bursum (now Laborcita) Formation. Otte (1959) included a list of gastropod taxa identified by Arthur Bowsher from Otte's La Luz Canyon and Tularosa localities. This list refers to numerous new species, and I have found Bowsher's identifications to be accurate. These specimens are at the U.S. National Museum (Yochelson, written comm., 1991), but were not examined during this study.

## THE GASTROPODS

### *Euphemites* n. sp. 1

Figs. 2.1 to 2.3

This medium-sized species is characterized by its tightly coiled, rather globose shape, strong geniculation just beyond the aperture, laterally compressed early portion of the body whorl, wide, depressed selenizone, and ornamentation consisting of up to about 10 broad, low, spiral lirae with one or two finer intercalated lirae between some of the larger lirae. These lirae extend but a short distance beyond the aperture and become obsolescent at a relatively great distance from the umbilical areas. Typical specimens are 20 to 25 mm long. *Euphemites* n. sp. 1 resembles *E. graffhami* (Moore, 1941), from the mid-Virgilian of Kansas, but differs in its compressed early body whorl, less prominent primary spiral lirae, and greater number of finer lirae. It resembles to a lesser degree the Leonardian *E. imperator* (Yochelson, 1960), which is larger, less geniculate, possesses more inductural lirae and has a more inflated body whorl. *Euphemites* n. sp. 1 is a reasonable early Wolfcampian descendant of *E. graffhami*. Conspecific specimens are present in the Red Tanks Member, Madera Formation.

### *Euphemites* n. sp. 2

Figs. 2.4 to 2.6

A second species of *Euphemites* in the Laborcita Formation is apparently restricted to the Tularosa locality. All specimens are incomplete and lack the anterior shell margin and lateral lips; many are flattened or otherwise distorted. Most are small, but a few exceed 20 mm in length. The shell is slightly compressed and evenly rounded along the median periphery. Many specimens display a downward compactional bend or break in the anteriormost area of the preserved shell, suggesting that this portion of the shell was thin. Inductural lirae extend apparently quite far beyond the aperture toward the anterior margin of the shell. These lirae are bold, narrow, sharp, widely spaced, and number at least 24 on smaller specimens and up to 28 or more on larger individuals. Interspacing between the lirae are two to four times the width of a single lirate, and their width increases anteriorly and toward the umbilical regions. Most of the central lirae are continuous, but toward the flanks of the shell some lirae die out and new ones are intercalated. Because the smooth anterior surface of the shell is seldom preserved, the nature of the selenizone cannot be ascertained satisfactorily. It appears to be poorly defined and flush with the adjacent shell surface. The umbilical area is slightly depressed, but a true umbilicus is absent.

Such morphological features as could be examined on these incomplete specimens suggest that this is a new species. Shell shape and size, and the numerous fine inductural lirae are similar in some respects to the Lower Permian *E. exquisitus* Yochelson and *E. batteni* Yochelson (Yochelson, 1960). However the number of lirae and the width of the interspaces between them is greater on *E. n. sp. 2*, and *E. exquisitus* is further differentiated by the presence of a conspicuous umbilical depression or a small umbilicus. *Euphemites luxuriosus* Yochelson has many fine lirae, but these are much less pronounced, more closely spaced, and do not extend as far anteriorly as on *E. n. sp. 2*. *Euphemites regulatus* Moore, from the Virgilian of Kansas (Moore, 1941), closely resembles this Laborcita species, but possesses a smooth area on the shell surface separating the lirate inductura and coinductura, a feature lacking in *E. n. sp. 2*.

### *Bellerophon* (*Bellerophon*) aff. *B. (B.) graphicus* Moore

Figs. 2.7 to 2.9

The few, small- to medium-sized specimens of *Bellerophon* (*Bellerophon*) in the Laborcita collections are typically poorly preserved and

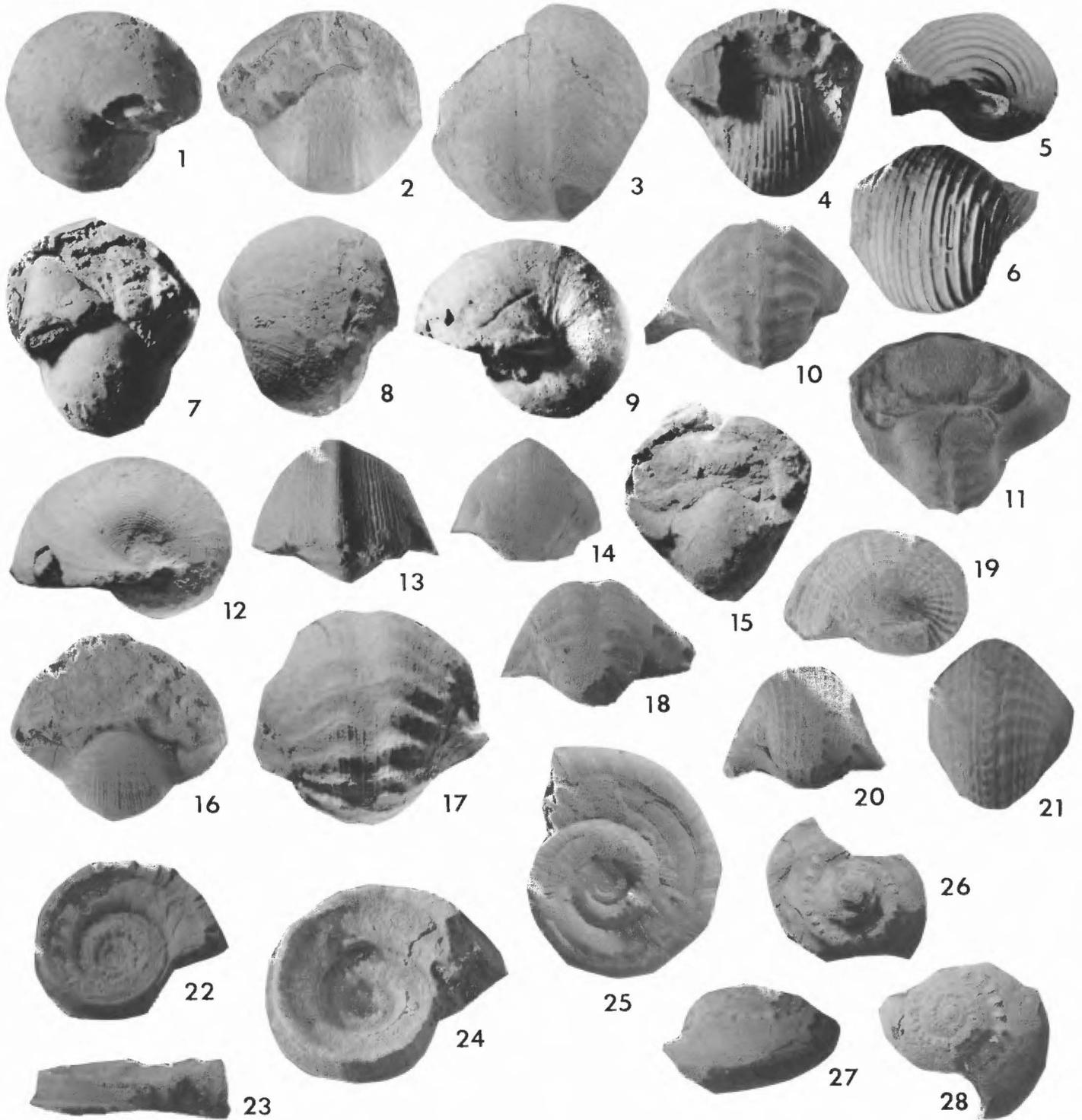


FIGURE 2. Gastropods from the Laborcita Formation. Figures 4–6, 22–28 from Tularosa quarry; figures 10–11 from La Luz Canyon locality L-00843; all others from La Luz Canyon locality 1321. 1–3, *Euphemites* n. sp. 1; side, apertural and top view of UNM 11,241,  $\times 1.5$ . 4–6, *Euphemites* n. sp. 2; 4, 5, apertural and side views of UNM 11,243; 6, top view, UNM 11,244, all  $\times 3$ . 7–9, *Bellerophon* (*Bellerophon*) aff. *B. (B.) graphicus* Moore, apertural, top and side views of UNM 11,245,  $\times 2.5$ . 10, 11, *Pharkidonotus* sp., posterior and apertural views, UNM 10,353,  $\times 1$ . 12–15, *Retispira tenuilineata* (Gurley); 12, 13, side and front views, showing unusually elevated selenizone, UNM 11,246,  $\times 2.5$ ; 14, back view, UNM 11,247,  $\times 2$ ; 15, apertural view, UNM 11,248,  $\times 2.5$ . 16–18, *Retispira eximia* Yochelson; 16, apertural view, UNM 10,345,  $\times 2.5$ ; 17, 18, top and back views, UNM 10,346,  $\times 2.5$  and  $\times 2$ , respectively. 19–21, *Retispira* n. sp.; 19, side view, UNM 11,249,  $\times 2.5$ ; 20, back view, UNM 11,250,  $\times 2$ ; 21, top view, UNM 11,251,  $\times 2$ . 22–25, *Amphiscapha* aff. *A. subrugosa* (Meek and Worthen); 22, 23, oblique top and apertural side views, UNM 11,253,  $\times 3$ ; 24, 25, oblique top and bottom views, UNM 11,252,  $\times 4$ . 26–28, *Trepsispira* aff. *T. illinoisensis* (Worthen); 26, top view of incomplete specimen, UNM. 10,896,  $\times 2.3$ ; 27, 28, top and side views of incomplete specimen, UNM 10,897,  $\times 2.5$ .

incomplete. The shell is anomphalous, nearly hemispherical in longitudinal cross section, and somewhat laterally compressed. It bears a moderately wide, flat selenizone that is slightly elevated above the adjacent shell surface throughout growth. The lateral lips are thickened and slightly reflexed near their junction with the umbilical region, and expand laterally to form a relatively low, reniform aperture. The best preserved specimen is 14.6 mm long, 13.2 mm wide at the aperture, and 11.3 mm high, but one incomplete specimen is about 23 mm long. The surface of the shell bears regular, delicate, narrow, flat, transverse lamellae that are slightly raised anteriorly and separated from adjacent lamellae by fine, incised grooves. This ornamentation is obscure on weathered specimens but quite conspicuous on well-preserved individuals.

The Laborcita specimens are similar to *Bellerophon* (*Bellerophon*) *graphicus* (Moore, 1941), from the mid-Virgilian of Kansas, in size, shape and most other shell features. They differ in being slightly more compressed laterally and in possessing more distinctly lamellate ornamentation. Of the numerous southwestern Lower Permian species described by Yochelson (1960), *B. (B.) parvicristus* (from the Hueco, Wolfcamp and correlative formations) appears most similar to the Laborcita species. However, *B. (B.) parvicristus* expands anteriorly to a greater extent (apertural width generally exceeds shell length), and its selenizone is flush with the shell surface early in growth, rather than being elevated at all growth stages. Also, *B. (B.) parvicristus* attains a much larger size than the Laborcita specimens.

Distinctly lamellate ornamentation has been reported on numerous late Paleozoic species of *Bellerophon*, including some southwestern Lower Permian forms. Gordon and Yochelson (1987) discussed the range of variation in *Bellerophon* ornamentation and concluded that the nature of ornamentation may have taxonomic utility at the species level, in conjunction with other characters.

The Laborcita specimens are conspecific with more abundant specimens occurring in the Red Tanks Member, Madera Formation, and possibly also with common, lamellately ornamented individuals from the Virgilian of the Jemez Springs area, north-central New Mexico. They appear to represent a slightly later development of *B. (B.) graphicus* morphology, and perhaps are best considered a temporal subspecies of that species.

#### *Pharkidonotus* sp.

Figs. 2.10, 2.11

An incomplete but otherwise well preserved specimen from locality NMMNH L-00843 in La Luz Canyon is the only well preserved representative of this genus in the collections. This shell is marked by a high, narrow median carina, adjacent parallel wide troughs, sharp nodes on the medial terminations of the transverse undulations, and a widely flaring aperture. The median carina is higher than the node rows, and is nodose only through about the first third of its distance on the body whorl. The selenizone on the crest of the carina is narrow, gently convex, and well defined. A prominent, laterally elongate inductural callus is present just inside the aperture, and the shell is minutely phanerocephalous.

The specimen resembles the tricarinate, nodose form of the common Pennsylvanian *Pharkidonotus percarinatus* (Conrad). The name *P. tricarinatus*, considered a nomen dubium by Yochelson (1960), has been used by some authors for shells of this type. However, the Laborcita specimen differs in being phanerocephalous instead of anomphalous, is somewhat larger (maximum apertural width is 40+ mm), and possesses a narrow, mainly non-nodose carina instead of a relatively broad, strongly nodose carina. Permian species of *Pharkidonotus* are typically tricarinate (Yochelson, 1960), but differ from *P. "tricarinatus"* and the Laborcita specimen in having the median carina lower than the node rows and in having a less pronounced inductural callus.

Several workers (e.g., Girty, 1915; Weller, 1929) have discussed the considerable variability of *P. percarinatus*, including intergradation between the typical and tricarinate forms within the same Pennsylvanian assemblages. The Laborcita form appears to represent an Early Permian derivative of the tricarinate *P. percarinatus* stock. However, because

*P. percarinatus* displays high variability, and the variation in the Laborcita species is unknown, its exact status cannot be determined at present.

#### *Retispira tenuilineata* (Gurley)

Figs. 2.12 to 2.15

These finely ornamented bellerophontids are among the most common gastropods at the La Luz Canyon localities but are rare in the Tularosa quarry. The shell is evenly curved in lateral profile, without a conspicuous inductural callus, and bears a prominent, deep, circular umbilicus that is bordered along its ventral margin by slightly reflexed lateral lips. The shell surface slopes gently away from the median selenizone and then more steeply across the umbilical areas. The aperture is moderately wide, but its width does not exceed the length of the shell. The selenizone varies in expression, from an elevated, moderately convex median ridge with indistinct borders to a very gently convex band flush with the adjacent shell surface and bordered by a single sharp lira along each side. Whorl ornamentation consists of many fine, sharp spiral lirae, fairly regularly arranged and separated by interspaces up to twice as wide. These lirae number about 35 to 40 on each side of the body whorl, and tend to be more closely spaced near the selenizone. Transverse ornamentation is restricted to fine growth lines and occasional widely spaced lirae that cross the spiral lirae without interrupting them.

Weller (1929), Yochelson (1960) and Sturgeon (1964) discussed the possible synonymy of *Retispira tenuilineata* (Gurley), *R. meekiana* (Swallow) and *R. marcouiana* (Geinitz). The first name has been used by recent workers because the types of the other two species are either lost or have not been studied since the original description.

The most conspicuous variation among specimens of *R. tenuilineata* from the Laborcita Formation occurs in the development of the selenizone. On a slight majority of the specimens it is a gently elevated, slightly convex ridge, which may become a pronounced arch toward the aperture of some large specimens. On other individuals, the selenizone is slightly convex but essentially flush with or even slightly depressed below the adjacent shell surface throughout growth, and is bordered by a fine lira along each side. Intermediate states between these two extremes are not uncommon.

Retispiras of this type, bearing fine spiral lirae but obscure transverse ornamentation, form a distinctive group of species that ranges from the Mississippian to the Permian. Rollins (1975) questionably recognized *R. tenuilineata* in strata as old as Early Mississippian, but those specimens differ significantly from Pennsylvanian specimens in having the umbilicus almost completely covered by the lateral lips and in possessing a more broadly expanded aperture. The apparently long range of the species has led to suggestions that homeomorphy might be involved, and that after additional study it might prove possible to subdivide *R. tenuilineata* into separate species based on the presence of an elevated or flat selenizone (Rollins, 1975). Pennsylvanian forms described as *R. tenuilineata* have a selenizone varying from flush or slightly depressed (e.g., the Virgilian type specimens of Gurley [1884], illustrated by Girty [1915] and Weller [1929], and Sayre's [1930] Missourian specimens) to distinctly elevated (Hoare, 1961, Desmoinesian of Missouri). Both variants have been reported in Desmoinesian assemblages in Oklahoma (Girty, 1915) and Ohio (Sturgeon, 1964). Given the intergradation between the two selenizone morphologies and the absence of any other distinguishing shell features in the Laborcita assemblages, taxonomic separation on this basis is not justified. Gordon and Yochelson (1987) discussed other shell characters, such as nature of the umbilical area, development of transverse lirae, and apertural features, that would also require attention in assessing the variability and possible taxonomic subdivision of a long-ranging species like *R. tenuilineata*.

#### *Retispira eximia* Yochelson

Figs. 2.16 to 2.18

Yochelson (1960) thoroughly described this species, based mainly on specimens from the Hueco Limestone. The slightly older specimens

from the Laborcita Formation differ little from the rather variable Hueco examples. This species is characterized by its widely expanded aperture (maximum width is significantly greater than shell length), narrow selenizone depressed below the whorl surface, and ornamentation consisting of prominent transverse undulations in opposition across the selenizone, crossed by numerous fine spiral lirae. The Laborcita specimens differ from those of the Hueco Limestone only in being about one-third smaller in size. None of the Laborcita specimens exceed 20 mm in length, whereas the largest Hueco specimens are nearly 30 mm long.

Small individuals display finer ornamentation than large specimens. On the small specimens, transverse undulations on the early part of the body whorl are sharp, about equal in size to the spiral lirae, and are closely spaced. They become gradually broader, larger and more widely spaced with growth. The spiral lirae on specimens of all sizes are typically in two ranks, with small secondary lirae between rather widely spaced primary lirae. Spiral ornamentation crosses the transverse undulations without change in shape or development of nodes. Selenizone ornamentation is moderately variable, but typically consists of three to five faint spiral lirae and closely spaced, arcuate growth lines. On a few specimens, growth lines in older parts of the selenizone may be raised into fine lunulae.

*Retispira eximia* is moderately common in the Laborcita Formation at the La Luz Canyon localities. It occurs with, but is much less abundant than, *Retispira* n. sp. Both species also occur, in about the same relative abundance, in the Red Tanks Member, Madera Formation, in the Lucero uplift area of New Mexico.

***Retispira* n. sp.**

Figs. 2.19 to 2.21

*Retispira* n. sp. is the most abundant bellerophonid gastropod at the La Luz Canyon localities. The species is relatively small (maximum length is about 15 mm) and possesses a strong inductural callus in the aperture, which produces a geniculate whorl profile. The shell is somewhat compressed laterally, expands only moderately with growth, and its lateral lips are curved around the lower margin of a prominent, deep umbilicus. An elevated median selenizone is marked by nodose lunulae, and the surface of the shell is strongly ornamented with spiral lirae of two ranks, crossed by larger, sharp-crested transverse undulations, producing distinct nodes at their intersection points.

This species differs from *Retispira eximia* in having the selenizone elevated rather than depressed, stronger ornamentation (including narrower, sharper transverse undulations), more pronounced inductural callus, and more compressed shell. *Retispira* n. sp. is mostly closely related to, and probably descended from *R. nodocostatus* (Gurley) from the Missourian-Virgilian of Illinois. That species has fewer, larger, and more widely spaced transverse undulations and its selenizone is elevated only during early growth stages (Yochelson, 1960). *Retispira* n. sp. is also a common constituent of gastropod assemblages in the Red Tanks Member, Madera Formation, in the Lucero uplift area of central New Mexico.

***Amphiscapha* aff. *A. subrugosa* (Meek and Worthen)**

Figs. 2.22 to 2.25

*Amphiscapha* has been considered a subgenus of *Straparollus* by some workers (e.g., Knight et al., 1960) but is here treated as a genus, following Yochelson (1956). *Amphiscapha* is common in the Laborcita Formation at the Tularosa locality but was not observed at the La Luz Canyon sites. Specimens are relatively small, typically less than 12 mm in diameter. They are characterized by a well-developed keel at the outer margin of the upper whorl surface, a flat to concave outer whorl surface, and a rounded flange extending laterally from the base. The crest of the keel is relatively smooth on the earlier whorls, but becomes distinctly crenulated or lamellate on the body whorl. The spire of the shell is deeply concave and the base is flat to shallowly depressed.

The Laborcita specimens are closely related to *Amphiscapha muricata* Knight (Midcontinent, Virgilian to Wolfcampian), and to *A. subrugosa* (Meek and Worthen), from Desmoinesian to upper Virgilian strata in

the Midcontinent. The basal flange and smooth, high keel on the earlier whorls are similar to *A. muricata*, which presumably led Bowers (in Otte, 1959) to identify the Laborcita form as that species. However, *A. muricata* bears a smooth, wall-like keel throughout growth, instead of developing a crenulated keel on the last whorl, and has a somewhat lower, flatter shell. *Amphiscapha subrugosa* possesses a crenulated dorsal keel, best developed on the last whorl, but displays only an incipient basal flange that is generally more rugose than on the Laborcita specimens (see Knight, 1934; Yochelson, 1956). Thus, the Laborcita form is in some respects intermediate morphologically between the other two species. Its proper taxonomic status is probably as a late, distinctive subspecies of *A. subrugosa* that evolved in the Southwest while *A. muricata* was evolving in the Midcontinent.

***Treospira* cf. *T. illinoisensis* (Worthen)**

Figs. 2.26 to 2.28

Seventeen incomplete, poorly preserved specimens from the Tularosa clay pit document the occurrence of *Treospira* in the Laborcita Formation. The largest fragment suggests a width of about 25 mm for the entire shell. Most specimens have been severely dorso-ventrally compressed, and appear to have a relatively high spire above the discoidal body whorl. However, two undistorted specimens (e.g., Figs. 2.27, 2.28) display a very low spire consisting of about four whorls, and a gently convex upper whorl profile. It is likely that compression forced the upper whorl surfaces downward around a thick, rigid columella, thereby causing the earlier whorls to appear to project upward more than they actually did in the undistorted shell.

The shells bear a row of conspicuous subsutural nodes, which vary considerably in shape (from circular and rather low to transversely elongate and narrow, with high, sharp crests), and in spacing. The nodes number about 24 to 33 per whorl, and give way laterally to prosocline growth lines. The selenizone is situated at the periphery of the upper whorl surface; it is moderately wide, convex, and covered by the upper surface of the succeeding whorl. The umbilicus is completely filled by a thick callus.

The undistorted specimens are similar to *T. illinoisensis* in most features, such as the low spire, number of subsutural nodes, and gently convex upper whorl surface. The nodes of this species are typically circular rather than predominantly elongate, but variability in this feature appears to be relatively great. Bowers (in Otte, 1959) also identified *T. cf. T. illinoisensis* in the Laborcita Formation at the Tularosa locality. *Treospira sphaerulata* (Conrad) possesses an elevated subsutural ridge bearing the nodes and is higher spired than the Laborcita specimens. *Treospira discoidalis* Newell, from the Missourian of the Midcontinent, is larger and much higher spired.

***Glabrocingulum* (*Glabrocingulum*) n. sp.**

Figs. 3.1 to 3.3

This species is abundant in the Laborcita Formation at the Tularosa locality, and is a fairly typical representative of the subgenus in general shell shape and ornamentation. The shell is of medium size (up to 14 mm wide) and low spired, with the upper whorl surface extending nearly to the peripheral selenizone of the preceding whorl. Spiral ornamentation on the upper whorl surface consists of a strong, raised, nodose ridge immediately below the suture, a much smaller nodose lira beneath, and two additional subnodose to sharp lirae above the selenizone. The sides and base of the whorl bear numerous nodose, widely spaced spiral lirae, with smaller lirae between them. Transverse ornamentation, except for growth lines, is lacking. The base of the body whorl is characterized by a prominent, thick, inductural callus, which partially fills the umbilicus and is marked by a moderately deep central pit.

*Glabrocingulum* (*Glabrocingulum*) n. sp. resembles *G. (G.) grayvillense* (Norwood and Pratten) and related species in general shell shape, proportions and ornamentation. The Laborcita species, however, is mostly closely allied to a small group of Late Pennsylvanian and Early Permian species that also possess an umbilical callus. This group includes *G. (G.) beedei* (Mark) from the Missourian of Ohio, *G. (G.)*

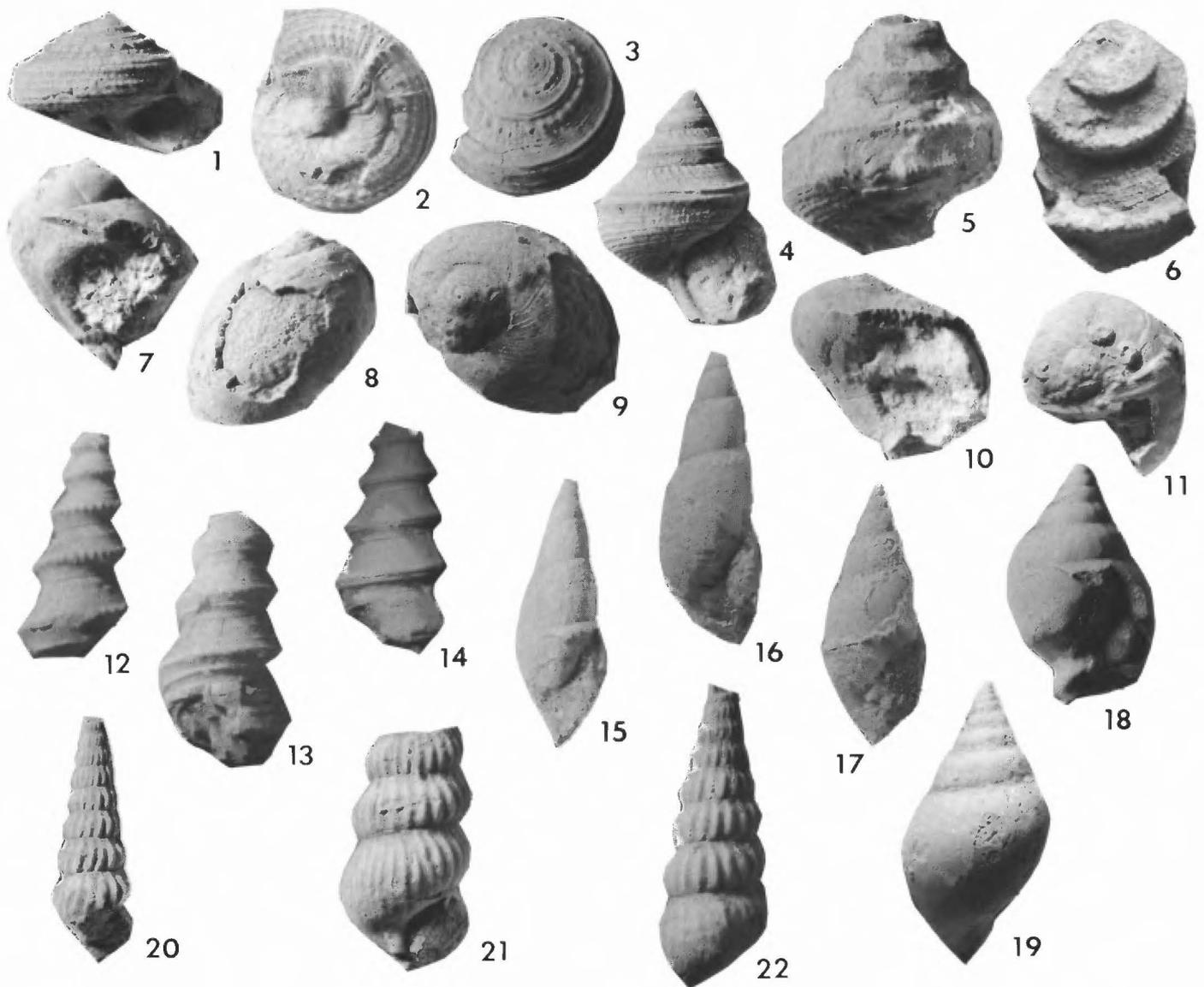


FIGURE 3. Gastropods from the Laborcita Formation. Figures 1–6, 18–19 from Tularosa quarry; figures 15–16 from La Luz locality L-00843; all others from La Luz locality I321. 1–3, *Glabrocingulum (Glabrocingulum)* n. sp.; 1, 2, apertural view and bottom view, showing umbilical callus, UNM 11,254,  $\times 2.5$ ; 3, oblique top view, UNM 11,255,  $\times 2.5$ . 4, *Glabrocingulum (Ananias)* n. sp., apertural view, UNM 11,256,  $\times 4$ . 5, 6, *Worthenia tabulata* (Conrad); 5, adapertural view of an incomplete, matrix-covered specimen, UNM 10,854,  $\times 1.5$ ; 6, oblique top view of an incomplete specimen, UNM 10,855,  $\times 1.5$ . 7–9, *Naticopsis (Jedria) meeki* Knight; 7, apertural view, UNM 10,860,  $\times 2$ ; 8, adapertural view, UNM 10,861,  $\times 2$ ; 9, top view, UNM 10,859,  $\times 3$ . 10, 11, *Naticopsis (Naticopsis) subovata* Worthen; 10, apertural view, UNM 10,856,  $\times 2$ ; 11, top view of a shell bearing spirorbid worms, UNM 10,858,  $\times 2$ . 12, *Stegocoelia (Taosia) crenulata* (Girty), incomplete specimen, UNM 10,821,  $\times 2.5$ . 13, *Stegocoelia (Taosia) percostata* (Girty), incomplete specimen, UNM 10,819,  $\times 3$ . 14, *Goniasma lasallensis* (Worthen), incomplete specimen, UNM 10,817,  $\times 2.5$ . 15–17, *Soleniscus?* sp.; 15, apertural view, NMMNH P-16,005,  $\times 4$ ; 16, apertural view, NMMNH P-16,006,  $\times 4$ ; 17, apertural view, UNM 11,257,  $\times 4$ . 18, 19, *Strobus paludinaeformis* (Hall), apertural view, UNM 10,846 and adapertural view, UNM 10,845,  $\times 1.5$ . 20–22, *Pseudozygopleura (Pseudozygopleura)?* n. sp., apertural views, UNM 11,260 and 11,261, and adapertural view, UNM 11,262,  $\times 2.5$ .

*ornatum* (Sayre) from the Missourian of Kansas, and *G. (G.) coronatum* (Chronis) from the Leonardian of Arizona. Mudge and Yochelson (1962) reported a similar form from the Virgilian of Kansas and noted that it resembles specimens from the Bursum (now Laborcita) Formation of New Mexico. The Laborcita species differs from all of these species in details of ornamentation and development of the callus. It also occurs in the Red Tanks Member, Madera Formation, of the Lucero uplift area, New Mexico.

*Glabrocingulum (Ananias)* n. sp.

Fig. 3.4

Specimens of this moderately high-spired species are by far the most abundant gastropods in the Laborcita Formation at the Tularosa clay

pit. The shell is gradate, with a pleural angle averaging  $69^\circ$ , and attains a maximum height of about 12 mm. Ornamentation of the upper whorl surface includes numerous fine spiral lirae and larger prosocline transverse lirae that take the form of thickened riblets beneath the suture, and produce subnodose swellings where they cross the spiral lirae. There is moderate variation in the relative development and expression of these lirae and riblets. The outer face and base of the whorls are adorned with many conspicuous spiral lirae and equal to less well developed transverse lirae, forming low nodes at their intersection points. The aperture is large, nearly round, and bordered by a gently reflexed, thickened columellar lip that may form a narrow umbilical chink on some specimens.

*Glabrocingulum (Ananias)* n. sp. most closely resembles the upper

Desmoinesian to Virgilian species *G. (A.) welleri* (Newell), which is very likely its ancestor. *Glabrocingulum (Ananias) welleri* attains a much larger size than the Laborcita species, and its ornamentation is subtly different, involving subequal transverse and spiral lirae, more acute nodes, and little development of subsutural riblets. *Glabrocingulum (Ananias)* n. sp. also has been collected from the Red Tanks Member, Madera Formation, in the Lucero uplift area, but is not nearly as common in gastropod assemblages there as it is in the Laborcita Formation.

***Worthenia tabulata* (Conrad)**

Figs. 3.5, 3.6

A few, incomplete, poorly preserved specimens of this common Pennsylvanian species were collected from the Laborcita Formation at the Tularosa clay pit. The largest specimen (Fig. 3.5), mostly covered with matrix, is about 23.5 mm high, but is missing the early whorls. This species is characterized by its relatively large, gradate shell, with the height of the vertical lower whorl face about equaling the height of the sloping upper surface, by its prominent nodose selenizone on the angulation between the upper and lower surfaces, and by its subnodose, cancellate pattern of collabral and spiral ornamentation. *Worthenia tabulata* is common in Desmoinesian through Virgilian strata of the United States, but as far as I am aware has not previously been reported from the Lower Permian. The Laborcita specimens display no significant differences from Pennsylvanian examples.

***Naticopsis (Jedria) meeki* Knight**

Figs. 3.7 to 3.9

The few poorly preserved specimens assigned to *Naticopsis (Jedria) meeki* are of moderate size (10 to 25 mm high), with shell height about equaling width, and a low spire above a large body whorl. The pleural angles of three measured specimens range from 117° to 130°. The whorl profile of smaller specimens is strongly convex, but in larger individuals the profile becomes flattened beneath a strongly rounded shoulder a little below the suture. On the largest specimen, this area forms a broad, slightly concave band above midwhorl. The upper whorl surface is ornamented by conspicuous, fine, closely spaced, strongly prosocline lirae separated by sharply incised narrow grooves. These become less prominent along the whorl sides, being manifested as rather pronounced growth lines ventrally to the aperture. The aperture is subround, and its inner margin is covered by a moderately swollen inductural band that is slightly curved for most of its length but more strongly convex near the base of the columellar lip. Several specimens display faint to prominent transverse riblets on the inductural band.

The features noted above agree closely with the distinctive characters of *Naticopsis (Jedria) meeki*, described by Knight (1933) from the upper Desmoinesian of Missouri and upper Missourian of Kansas. The Mid-continent specimens have a more pronounced spiral groove along the upper half of the whorls, and somewhat smaller pleural angles than the Laborcita specimens. Development of transverse inductural riblets is variable on both the Missouri and New Mexico specimens.

The Laborcita specimens of *Naticopsis (Jedria) meeki* are about the same size as *N. (Naticopsis) subovata* Worthen, with which they co-occur, but are distinguished by their slightly higher spires, flattened rather than strongly convex whorl sides, and by the presence of subsutural transverse lirae. Also, the parietal/columellar inductural band is swollen and ornamented on *N. (J.) meeki*, whereas on *N. (N.) subovata* the inductural layer is flatter, thinner and lacks transverse riblets. *Naticopsis (Jedria) meeki* is present at the La Luz Canyon and Tularosa localities.

***Naticopsis (Naticopsis) subovata* Worthen**

Figs. 3.10, 3.11

Several poorly preserved, incomplete shells from the La Luz locality are characterized by moderate size (shell height up to about 25 mm), a very low spire, and a large inflated body whorl. The aperture is large and nearly round, and the inner apertural margin is marked by a broad, flat, gently arcuate but thin inductural band that comprises the colu-

mellar and parietal portions of the inner lip, and widens conspicuously toward the top of the aperture. The spire barely rises above the body whorl, which displays a gently convex to nearly flat upper surface before becoming strongly convex across the remainder of its height. These shells have about four whorls and a pleural angle averaging about 150°. Ornamentation is limited to gently prosocline growth lines that are accentuated immediately below the suture, but without development of collabral threads or striae.

Although all specimens are incomplete, the features noted above allow assignment to *Naticopsis (Naticopsis) subovata*, as described by Knight (1933) from the Upper Pennsylvanian of Missouri and Kansas. Mudge and Yochelson (1962) reported this species from the upper Virgilian of Kansas; the Laborcita specimens are its youngest known occurrence.

***Stegocoelia (Taosia) crenulata* (Girty)**

Fig. 3.12

*Stegocoelia (Taosia) crenulata* is a high-spined, carinate species first described by Girty (1939) from the Laborcita at La Luz Canyon. Its most distinctive feature is a prominent spiral carina composed of closely spaced, vertically elongate nodes, which divides the whorl into a broad upper and a restricted lower surface. The relatively wide selenizone is situated a short distance above the carina and is bordered on each side by a fine lira. On many specimens a faint third lira is present between the selenizone and the upper suture, and a few specimens also display an obscure lira within the selenizone. The lower whorl surface has a thin lira, typically visible just above the lower suture.

None of the specimens available to Girty were complete or possessed the earlier whorls. Several specimens in my collections consist of the first seven to ten whorls. The protoconch consists of three moderately inflated smooth whorls. A smooth carina and the two selenizone-bounding lirae (or at least the lower of the two) typically develop on the fourth whorl, and by the sixth whorl the carina has become fully nodose. On a few specimens development of the nodes was delayed until the seventh or eighth whorl. Carina strength and the angle made at the carina by intersection of the upper and lower whorl surfaces increase gradually with growth. Young specimens consisting of nine whorls are about 6.5 mm high and 3.0 mm wide. A large shell fragment consisting of the last 3.5 whorls is about 17.5 mm high. Although no large Laborcita specimens are complete, mature shells must have possessed 15 or more whorls and attained a height of about 30 mm.

Although rather uncommon in the Laborcita Formation, *Stegocoelia (Taosia) crenulata* is abundant in the coeval Red Tanks Member, Madera Formation, in the Lucero uplift area.

***Stegocoelia (Taosia) percostata* (Girty)**

Fig. 3.13

Girty (1939) initially established *Stegocoelia (Taosia) percostata* on the basis of incomplete specimens from the Laborcita Formation in La Luz Canyon. The species is distinguished by its high-spined, carinate shell, and the pattern of its ornamentation. A sharp spiral carina divides each whorl into a broad, flat, gently sloping upper surface and a restricted, more steeply sloping lower surface. A sharp lira is present about one-third of the distance from carina to upper suture, and marks the upper limit of the selenizone. A faint lira occurs higher on the upper surface on some specimens. The lower whorl surface is marked by two strong lirae, the lowermost at the lower suture. The base of the body whorl is ornamented by about five additional conspicuous lirae. All available specimens of *S. (T.) percostata* are incomplete. Based on fragments, the species grew to a height of about 25 mm.

Girty (1939) was not able to describe the early whorls of *S. (T.) percostata*, but a few specimens in my Laborcita collections provide additional information. The conical protoconch consists of three smooth, moderately inflated whorls. Two spiral lirae appear on the fourth whorl, the higher of the two becoming increasingly extended and carinate on successive whorls. A third lira, bounding the upper margin of the selenizone above the carina, appears a whorl or two later. The first 10 whorls of a small Laborcita specimen measure 9.0 mm high and 4.0 mm wide.

Girty's (1939) *Laborcita* specimens are the only previously well documented occurrence of this species. However, it also is present in the Red Tanks Member, Madera Formation, in the Lucero uplift area. A closely related or conspecific form is rare in the Desmoinesian of north-central New Mexico (Kues, 1984).

***Goniasma lasallensis* (Worthen)**

Fig. 3.14

Specimens of *Goniasma lasallensis* from La Luz Canyon were described in detail by Girty (1939). This high-spined species is characterized by a prominent spiral carina at the whorl periphery, about two-thirds of the distance from the upper to lower suture, and by a smaller lira immediately below and recessed inward from the carina. These border the margins of the selenizone, which appears as a shallow, narrow furrow. The upper whorl surface lacks lirae, and a single lira is present at the base of each whorl. On some specimens this lira is covered by the succeeding whorl, but more often is exposed at the lower suture. The prominent carina imparts a strongly angular shape to the whorl profile. Among several hundred specimens examined, moderate variation occurs in the angle made by the intersection of the upper and lower whorl surfaces at the carina, the shape of the upper whorl surface (ranging from concave to flat), the degree of constriction at the sutures, and in the width and depth of the selenizone. A few specimens possess faint additional lirae on the lower whorl surface below the selenizone. No complete, fully grown specimens are present in the Laborcita collections, but the species attained an estimated maximum height of approximately 25 mm, judging from large, incomplete shell fragments.

None of Girty's (1939) specimens retained the early whorls. However, a suite of about 20 small specimens from the Red Tanks Member, Madera Formation in central New Mexico possess the first six or seven whorls of the shell, and add information about the morphology of Wolfcampian representatives of this species. The protoconch consists of three or four smooth, inflated whorls, the initial whorl being somewhat flattened. The carina and underlying lira appear abruptly on the fourth whorl. On the earliest three to five teleoconch whorls the selenizone is a relatively wide, elevated band. The lirae bounding it are equally pronounced and project to about an equal distance out from the whorl surface. On some specimens the lower lira rather than the upper projects farthest and forms the periphery. Thus, the nature of the selenizone changed with growth, from a relatively wide elevated band situated between two subequal lirae, to a progressively narrower groove beneath the upper lira, which expanded to become the prominent carina of mature whorls. In addition, the pleural angle of the small shells averages about 35°–40°, in contrast to the 25°–30° of a fully grown shell, suggesting that whorl expansion rate decreased significantly with growth. In New Mexico, *G. lasallensis* ranges from the Desmoinesian to Wolfcampian (Kues, 1985).

***Pseudozygopleura* (*Pseudozygopleura*)? n. sp.**

Figs. 3.20 to 3.22

Several pseudozygopleurid taxa are present in the Laborcita Formation, but the one species discussed here is by far the largest and most abundant. All specimens are incomplete and lack the protoconch whorls; thus assignment to *Pseudozygopleura* is tentative. The largest fragment observed includes the last seven whorls and is 19.0 mm high. Based on reconstruction from numerous fragments of different sizes, a mature specimen would be about 28 to 30 mm high. The pleural angle of this high-spined species averages about 23°, and a complete shell consists of at least 16 whorls. Early whorls have a very gently and evenly convex profile and bear strong, nearly straight, closely spaced, slightly opisthocline transverse costae that extend from the upper to lower suture. Later whorls, beginning at a diameter of about 2 mm, become strongly convex and pendant, and bear shorter, broad, sharp-crested, arcuate costae. The number of costae is 18 to 22 per whorl on most specimens, and does not change significantly with growth. Costae become obsolescent on the body whorl of larger shells.

Few late Paleozoic pseudozygopleurids attain the large size of the Laborcita species, although much larger specimens are known from

younger Permian strata in the Permian Basin (Erwin, written comm., 1991). *Pseudozygopleura* (*Pseudozygopleura*) *girtyi* Knight and *P. (P.) plummeri* Knight have gently convex, nonpendant whorl profiles and their costae are virtually straight throughout growth. This Laborcita species most closely resembles *P. (P.) scitula* (Meek and Worthen), from the Desmoinesian and Missourian of the central and eastern United States. However, on the later whorls, the convexity and pendant profile is not as well developed, the curvature of the costae is not as pronounced, and the sutures are not as depressed as they are in *P. (P.)? n. sp.* Morphologically, *P. (P.) scitula* would appear to be a reasonable ancestor of the Laborcita species. *Pseudozygopleura* (*Pseudozygopleura*)? n. sp. also is present in the Red Tanks Member, Madera Formation, where it is a dominant element of gastropod assemblages. A very similar form occurs in the Hueco Formation (Erwin, written comm., 1991).

***Soleniscus?* sp.**

Figs. 3.15 to 3.17

These narrow, fusiform, relatively small shells are common in the Laborcita Formation at the La Luz Canyon localities. Confident identification is precluded by the lack of preservation of the anterior end of the aperture on all specimens. The most nearly complete specimens possess six to eight whorls and range from about 5 to 14 mm in height. A large fragment suggests a maximum height of nearly 20 mm. Typically, shell height is nearly three times maximum shell width, and body whorl height represents about two-thirds of the total height. The whorls are smooth, gently convex, and obscurely shouldered beneath the shallow sutures. Pleural angles of fully grown shells averages 29°. The aperture is narrowly teardrop-shaped, expands anteriorly with a fairly abrupt bend from the parietal to columellar lip, and apparently terminated in a small notch. The columellar lip is slightly thickened and gently curved. Most specimens, including some with much of the outer lip stripped away, display no evidence of a columellar fold. On a few specimens a small, obscure flange projecting from the columellar lip may represent a very small, low fold.

These specimens are probably a small species of *Soleniscus*, in which the columellar fold is low and less well developed than is usual in the genus. They resemble *S. diminutus* Erwin, from the Hueco Formation, in their small size, narrow shape and relatively low aperture. However, because details of the anterior portion of the aperture and nature of the columellar fold (if present) are not clear on the Laborcita specimens, it is also possible that these shells represent a genus, such as *Bulimorpha* or *Ischnoptygma*, with a narrow, *Soleniscus*-like shell but different columellar fold morphology.

***Strobus paludinaeformis* (Hall)**

Figs. 3.18, 3.19

Most of the larger subulitids in the Laborcita Formation are of medium size (up to about 35 mm high) and have a tapering, moderately high spire above a moderately inflated body whorl. The shape and proportions of these shells agree well with the common Middle to Upper Pennsylvanian species *Strobus paludinaeformis*. The specimens are all incomplete and rather poorly preserved, but a few display an obliquely oriented, relatively sharp siphonal fold on the columellar lip identical to that of *S. paludinaeformis*. *Strobus girtyi* (Erwin, 1988a), from Leonardian and Guadalupian strata of the southwestern United States, is similar in shape and character of the columellar lip, but is smaller and ornamented by numerous strong spiral threads. The partial steinkern figured by Girty (1909, pl. 11, fig. 6) as *Soleniscus* aff. *S. altomensis* Worthen from the Abo (= Bursum) Formation at Abo Pass, central New Mexico, may also be *S. paludinaeformis*.

At least one other subulitid species of comparable size, but with a more inflated body whorl and smaller spire, is present in the Laborcita collections, but specimens are too poorly preserved for identification. *Strobus paludinaeformis* also occurs in the Red Tanks Member, Madera Formation, in the Lucero uplift area.

## DISCUSSION

Study of the diverse Laborcita gastropod faunas is at an early stage. In addition to species discussed above, many other smaller species have been noted from the La Luz Canyon and Tularosa localities. Another paper, currently nearing completion, will provide formal descriptions of new species briefly discussed here, and of others as well. Although our knowledge of these faunas is still incomplete, some general observations may be made.

First, the taxonomic composition and relative abundance of gastropod species differs considerably at the La Luz and Tularosa localities. Assemblages from the La Luz localities are dominated by bellerophontids (especially *Retispira*), with large numbers of *Goniasma*, *Stegocoelia* (*Taosia*), *Pseudozygopleura* (*Pseudozygopleura*)? and *Soleniscus* (Table 1). In contrast, more than 90% of the specimens collected from the Tularosa quarry are *Glabrocingulum* (*Glabrocingulum*), *G. (Ananias)* and *Amphiscapha*. Detailed comparison of the composition and relative abundance of taxa in the two assemblages must await completion of studies on all species in each assemblage. Further, the relative abundances of some taxa have probably been affected by previous collecting. The Tularosa locality is easily accessible and has been a well-known fossil-collecting site for decades, whereas the La Luz Canyon localities are less familiar and less accessible. Previous collecting has probably depleted the Tularosa locality of many specimens of larger species, biasing the apparent composition and abundance relationships in that assemblage toward smaller species. For example, Bowsher (in Otte, 1959) listed both *Euphemites* and *Strobeus paludinaeformis* (both relatively large taxa) as being abundant at the Tularosa locality, together with the other three taxa mentioned above, but specimens of those taxa are not common now.

The differences between the La Luz Canyon and Tularosa assem-

TABLE 1. Number of specimens of taxa discussed in text, by locality. 1, Tularosa quarry (UNM locality 1320); 2, La Luz Canyon locality UNM 1321; 3, La Luz Canyon locality NMMNH L-00837; 4, La Luz Canyon locality NMMNH L-00843.

SPECIES	LOCALITIES			
	1	2	3	4
<i>Euphemites</i> n. sp. 1	-	6	-	3
<i>Euphemites</i> n. sp. 2	20	-	-	-
<i>Bellerophon</i> aff. <i>B. graphicus</i> Moore	3	5	-	-
<i>Pharkidonotus</i> sp.	1	1	-	-
<i>Retispira tenuilineata</i> (Gurley)	10	265	236	97
<i>Retispira eximia</i> Yochelson	-	76	53	13
<i>Retispira</i> n. sp.	3	370	456	246
<i>Amphiscapha</i> aff. <i>A. subrugosa</i> (Meek and Worthen)	475	-	-	-
<i>Treospira</i> cf. <i>T. illinoisensis</i> (Worthen)	17	-	-	-
<i>Glabrocingulum</i> ( <i>Glabrocingulum</i> ) n. sp.	800+	-	-	-
<i>Glabrocingulum</i> ( <i>Ananias</i> ) n. sp.	2,800+	25	-	-
<i>Worthenia tabulata</i> (Conrad)	3	-	-	-
<i>Naticopsis</i> ( <i>Jedria</i> ) meeki Knight	-	6	-	-
<i>Naticopsis</i> ( <i>Naticopsis</i> ) subovata Worthen	4	7	-	-
<i>Stegocoelia</i> ( <i>Taosia</i> ) crenulata (Girty)	-	61	1	-
<i>Stegocoelia</i> ( <i>Taosia</i> ) percostata (Girty)	-	77	19	14
<i>Goniasma lasallensis</i> (Worthen)	-	545	114	78
<i>Pseudozygopleura</i> ( <i>Pseudozygopleura</i> )? n. sp.	-	95	-	-
<i>Soleniscus</i> ? sp.	-	80	16	22
<i>Strobeus paludinaeformis</i> (Hall)	24	5	15	8

blages, however, are too great to be explained by incomplete studies and collection bias. As there is little difference in the ages of these assemblages, contrasting ecological conditions must be the major factor responsible for the differences between them. Certainly, the light gray to tan limestones and calcareous shales bearing the gastropods at the La Luz localities reflects a different depositional environment than the dark gray shale and siltstone yielding most of the Tularosa specimens. Otte (1959) summarized the variety of facies within the Laborcita Formation, noting that open marine to littoral to nonmarine 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 gastropod faunas recognized above.

Many Laborcita gastropod species are also present in the Red Tanks Member, Madera Formation, in the Lucero uplift area, some 200 km northwest of the Tularosa-La Luz area. The Red Tanks gastropod fauna is probably not as diverse as that of the Laborcita Formation, and specimens are typically not as well preserved. Taxonomic similarity of many gastropods and bivalves, together with other biostratigraphic evidence, strongly indicates that the gastropods in these units lived contemporaneously, in earliest Wolfcampian time. Most Red Tanks gastropods have been collected from medium to dark gray limestones, and the relative abundance of the various species differs from that observed in both the La Luz and Tularosa Laborcita assemblages. Moreover, there are taxonomic differences as well; some species appear to be restricted to one or the other of these units. Further study and comparisons of the Red Tanks and Laborcita faunas is in progress.

Bowsher (in Otte, 1959) noted that the Laborcita gastropods have strong Pennsylvanian affinities, an observation supported by the present study. Many of the new species recognized in the Laborcita Formation are most similar to Midcontinent Late Pennsylvanian species, and appear to be derived from them. Other Laborcita species represent known Pennsylvanian species that persisted into the beginning of the Permian in New Mexico. The only named Permian species discussed here that are not presently known to occur in the Late Pennsylvanian are *Retispira eximia*, *Stegocoelia* (*Taosia*) crenulata and *S. (T.) percostata*. Thus, this preliminary study of Laborcita gastropods supports the idea that the transition from Late Pennsylvanian to Early Permian time produced few significant or abrupt changes in gastropod faunas. In this context, however, it is worth noting that many Pennsylvanian-Permian gastropod species are presently known from only one or a few localities, and exact stratigraphic ranges for most species have yet to be determined. Much remains to be done to better document the temporal and geographic distribution of known species, the occurrence of new species, the composition of faunas inhabiting various marine environments, and evolutionary changes in these faunas through the late Paleozoic.

## ACKNOWLEDGMENTS

I thank Ellis Yochelson and Douglas Erwin, both at the U.S. National Museum of Natural History, for reviewing an earlier version of this paper. Kenneth Kietzke collected the NMMNH specimens and Ruby Williamson, NMMNH, kindly made them available for study.

## REFERENCES

- Batten, R. L., 1958, Permian Gastropoda of the southwestern United States, 2. Pleurotomariacea: Portlockiellidae, Phymatopleuridae, and Eotomariidae: Bulletin, American Museum of Natural History, v. 114, art. 2, p. 157-246.
- Batten, R. L., 1964, Some Permian gastropods from eastern Arizona: American Museum Novitates, no. 2165, 16 p.
- Böse, E., 1920, On ammonoids from the Abo sandstone of New Mexico and the age of the beds which contain them: American Journal of Science, ser. 4, v. 49, p. 51-60.
- Chronic, H., 1952, Molluscan fauna from the Permian Kaibab Formation, Wal-

- nut Canyon, Arizona: Geological Society of America Bulletin, v. 63, p. 95–165.
- Cooper, G. A. and Grant, R. E., 1972, Permian brachiopods of West Texas, I: Smithsonian Contributions to Paleobiology, no. 14, 231 p.
- Erwin, D. H., 1988a, Permian Gastropoda of the southwestern United States: Subulitacea: Journal of Paleontology, v. 62, p. 56–69.
- Erwin, D. H., 1988b, Permian Gastropoda of the southwestern United States: Cerithiacea, Acteonacea and Pyramidellacea: Journal of Paleontology, v. 62, p. 566–575.
- Erwin, D. H., 1988c, The genus *Glyptospira* (Gastropoda: Trochacea) from the Permian of the southwestern United States: Journal of Paleontology, v. 62, p. 868–879.
- Furnish, W. M. and Glenister, B. F., 1971, Permian Gonioloboceratidae (Ammonoidea): Smithsonian Contributions to Paleobiology, no. 3, p. 301–312.
- Girty, G. H., 1909, Paleontology of the Manzano Group: U.S. Geological Survey, Bulletin 389, p. 41–136.
- Girty, G. H., 1915, The fauna of the Wewoka Formation of Oklahoma: U.S. Geological Survey, Bulletin 544, 353 p.
- Girty, G. H., 1937, Three Upper Carboniferous gastropods from New Mexico and Texas: Journal of Paleontology, v. 11, p. 202–211.
- Girty, G. H., 1939, Certain pleurotomariid gastropods from the Carboniferous of New Mexico: Washington Academy of Science Journal, v. 29, p. 21–36.
- Gordon, M., Jr. and Yochelson, E. L., 1987, Late Mississippian gastropods of the Chainman Shale, west-central Utah: U.S. Geological Survey, Professional Paper 1368, 112 p.
- Gurley, W. F. E., 1884, New Carboniferous fossils, Bulletin 2: Danville, Illinois, Privately Published, 12 p.
- Herrick, C. L., 1900, The geology of the white sands of New Mexico: Journal of Geology, v. 8, p. 112–125.
- Hoare, R. D., 1961, Desmoinesian Brachiopoda and Mollusca from southwest Missouri: Missouri University Studies, v. 36, 262 p.
- Jordan, C. F., 1975, Lower Permian (Wolfcampian) sedimentation in the Orogrande basin, New Mexico: New Mexico Geological Society, Guidebook 26, p. 109–117.
- Knight, J. B., 1933, The gastropods of the St. Louis, Missouri, Pennsylvanian outlier; 6, the Neritidae: Journal of Paleontology, v. 7, p. 359–392.
- Knight, J. B., 1934, The gastropods of the St. Louis, Missouri, Pennsylvanian outlier; 7, the Euomphalidae and Platyceratidae: Journal of Paleontology, v. 8, p. 139–162.
- Knight, J. B., Batten, R. L. and Yochelson, E. L., 1960, Descriptions of Paleozoic gastropods; in Moore, R. C. (ed.), Treatise on Invertebrate Paleontology, Part I, Mollusca 1: Geological Society of America and University of Kansas Press, p. 1169–1331.
- Kues, B. S., 1984, Pennsylvanian stratigraphy and paleontology of the Taos area, north-central New Mexico: New Mexico Geological Society, Guidebook 35, p. 107–114.
- Kues, B. S., 1985, Gastropods from the Wild Cow Formation (Upper Pennsylvanian), Manzano Mountains, New Mexico: New Mexico Geology, v. 7, p. 11–15.
- Miller, A. K., 1932, A Pennsylvanian cephalopod fauna from south-central New Mexico: Journal of Paleontology, v. 6, p. 59–93.
- Moore, R. C., 1941, Upper Pennsylvanian gastropods from Kansas: Kansas Geological Survey Bulletin, v. 38, p. 121–164.
- Mudge, M. R. and Yochelson, E. L., 1962, Stratigraphy and paleontology of the uppermost Pennsylvanian and lowermost Permian rocks in Kansas: U.S. Geological Survey, Professional Paper 323, 213 p.
- Northrop, S. A., 1966, University of New Mexico contributions in geology, 1898–1964: University of New Mexico Publication in Geology, no. 7, 152 p.
- Otte, C., Jr., 1959, Late Pennsylvanian and Early Permian stratigraphy of the northern Sacramento Mountains, Otero County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 50, 111 p.
- Pray, L. C., 1949, Fourth day—November 9, 1949, Road log—Alamogordo to El Paso: West Texas Geological Society, Guidebook, Field Trip No. 5, p. 52–64.
- Pray, L. C., 1961, Geology of the Sacramento Mountains escarpment, Otero County, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 35, 144 p.
- Rollins, H. B., 1975, Gastropods from the Lower Mississippian Wassonville Limestone in southeastern Iowa: American Museum Novitates, no. 2579, 35 p.
- Sayre, A. N., 1930, The fauna of the Drum Limestone of Kansas and western Missouri: Kansas University Science Bulletin, v. 19, p. 75–202.
- Steiner, M. B. and Williams, T. E., 1968, Fusulinidae of the Laborcita Formation (Lower Permian), Sacramento Mountains, New Mexico: Journal of Paleontology, v. 42, p. 51–60.
- Sturgeon, M. T., 1964, Allegheny fossil invertebrates from eastern Ohio—Gastropoda: Journal of Paleontology, v. 38, p. 189–226.
- Weller, J. M., 1929, On some of Gurley's unfigured species of Carboniferous *Bellerophon*: Illinois State Academy of Science Transactions, v. 21, p. 313–325.
- Winters, S. S., 1963, Supai Formation (Permian) of eastern Arizona: Geological Society of America, Memoir 89, 99 p.
- Yochelson, E. L., 1956, Permian Gastropoda of the southwestern United States, 1. Euomphalacea, Trochonematacea, Pseudophoracea, Anomphalacea, Craspedostomacea, and Platyceratacea: Bulletin, American Museum of Natural History, v. 110, art. 3, p. 179–276.
- Yochelson, E. L., 1960, Permian Gastropoda of the southwestern United States, 3. Bellerophontacea and Patellacea: Bulletin, American Museum of Natural History, v. 119, art. 4, p. 205–294.
- Yochelson, E. L. and Saunders, B. W., 1967, A bibliographic index of North American late Paleozoic Hyolitha, Amphineura, Scaphopoda, and Gastropoda: U.S. Geological Survey, Bulletin 1210, 271 p.