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Pennsylvanian (Morrowan) Gastropods from the Magdalena Formation of the Hueco Mountains, Texas

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ABSTRACT

The Hueco Mountain Magdalena gastropod fauna is important because it is the only known, diverse Pennsylvanian marine fauna occurring in limestones within the continental United States. This faunal element has some ecological continuity with the Permian sequences above it and is unique in having four terrestrial species not previously known to occur in marine sequences. A mixture of land and marine snails has never been observed before in the Paleozoic fossil record. The most common faunal elements in addition to the gastropods include hexactinellid sponges, crinoids, and several types of Foraminifera indicating an offshore environment, and this formation is, in fact, near the eastern margin of the Paleozoic Orogrande basin. The fauna is silicified so that recovery of all ontogenetic stages was possible along with many statistically significant population samples. The following are new species: *Apachella powwowensis, Ferganospira acteonina, Borestus magdalenensis, Borestus texanus, Glyptospira quadriserrata, Trachydomia turbonitella,* and *Stegocoelia* (*Donaldospira*) *nodosa.*

INTRODUCTION

The lower part of the Magdalena Formation (Pennsylvanian: Morrowan) of the Hueco Mountains (west Texas) was deposited in the Orogrande basin possibly in moderately deep water. Because of the high percentage of limestone in the formation, it was probably formed under warm, tropical conditions, which caused it to have an unusual Pennsylvanian gastropod facies for North America. The Magdalena fauna is found in limestone sequences that appear to represent comparable environments to the overlying Permian with its relatively rich gastropod faunas; hence, there is an apparent ecological continuity, or at least similarity, with the superjacent Hueco Formation (Batten, 1989: 24).

Eastern and Central U.S. Gastropod Faunas

In most places in eastern North America where marine gastropods are found in the

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Pennsylvanian, the stratigraphic sequence is composed of coal, sandstone, and shale (cyclothemic), with minor components of limestone representing shallow water, lagoon, and near-shore and nonmarine environments, such as the Van Port Formation in the Allegheny Basin (see Sturgeon, 1964). Gastropod faunas in the Pennsylvanian are overwhelmingly found in shales representing such restricted environments. This is the usual case even in western South America, for example, in Peru where a small gastropod fauna is known from the Tarma group of middle Pennsylvanian age (Newell et al., 1953). Freshwater limestones have produced most of the terrestrial snails in eastern North America.

The most diverse Pennsylvanian gastropod fauna described to date is from the Labette shale and Pawnee limestone of the Henrietta cyclothem (Desmoinesian), at St. Louis, Mo. by J. B. Knight in a series of papers written between 1930 and 1934. He described 32 genera and 144 species, all major groups except the pleurotomarians (Knight, 1930, 1931b, 1932, 1933a, 1933b, 1934a, 1934b); perhaps 15 more genera could be added if Knight had described them.

The Western Interior Gastropod Faunas

The gastropod faunas of the western interior are also primarily found in near-shore or shallow-water facies. In Kansas, Nebraska, and Oklahoma some limestone faunules are present but the most common occurrences are in shales and siltstones such as the Wewoka shale. These extend into north-central Texas and none are cyclothemic (Plummer and Moore, 1921; Schindel, 1982).

A very important fauna near the Magdalena of the Hueco Mountains is from the Flechado Formation near Talpa, New Mexico. This fauna contains more than 90 species of gastropods and certainly is the most diverse of the western Pennsylvanian faunas (Kues, 1984, 1990). This formation consists of shales and siltstones representing deltaic conditions and shallow, muddy, near-shore marine environments (Kues, 1984: 109). Since it is lower Pennsylvanian in age (Morrowan-L. Desmoinesian), it is a partial correlative of the Magdalena. This fauna has many similarities to the McCoy fauna of Colorado (Girty, 1939), the north-central Texas and Oklahoma shales (Plummer and Moore, 1921; Schindel, 1982), and the La Tuna unit of the Magdalena group (which also contains a large gastropod fauna) in the Franklin Mountains (Nelson, 1940).

The Magdalena Fauna

The two horizons sampled here are dominated by small-sized gastropods, along with large and small foraminifera. There are a few clams, a linguloid brachiopod, a few articulate brachiopods, *Chaetetes,* a few crinoid stems, ostracods, and numerous hexactinellid sponge spicules. It is strange that this limestone facies lacks the usual brachiopod-bryozoa dominance, yet the presence of fusulinids, crinoids, and sponges indicates marine conditions (see discussion under Materials and Methods for more information). There is a very curious mixture of gastropod species and genera in this fauna. For example, *Glabrocinculum grayvillensis* (Norwood and Pratten) is a species usually found in shale sequences in most of North America. This is the first time it is reported in a limestone. *Cyclites, Eirlysia,* and *Tapinotomaria* have not been known below the Permian. *Mourlonia* and *Baylea* are more commonly encountered in earlier times. Other genera such as *Phymatopleura, Paragoniozona, Peruvispira,* and *Trepospira* are generalists found in the upper Paleozoic. *Ferganospira* is reported for the first time outside the Russian Permian. Rather startling is the presence of four land and freshwater genera previously known only from nonmarine Pennsylvanian strata. This suggests that there is a mixture of habitats in this assemblage.

The section that contains the two AMNH localities (Section H of King and Knight, 1945) (see Materials and Methods section below) appears to be continuous stratigraphically and structurally because the fusulinid sequence is nearly identical to that in Vinton Canyon in the Franklin Mountains (Clopine et al., 1991).

Materials and Methods

The silicified gastropods described in this report come from two strata from a single

stratigraphic section in the Magdalena Formation at Powwow Canyon in the western part of the Hueco Mountains, about 30 mi due east of El Paso, Texas. The section begins at the base of the hill north of Powwow Tank just north of Texas Highway 62 near the entrance to Powwow Canyon in the northwest corner of section 33, R9E, T24S (31°50′40″N, 106°02′30″W) marked section H on USGS Oil and Gas Preliminary Map number 36, sheets 1 and 2, Western Hueco Mountains (King and Knight, 1945). The section is identified as the lower to upper divisions of the Magdalena Limestone, King and Knight, 1945 (sheet 2). The two strata (AMNH 2015 and 2014) are from the lower division and are probable correlatives of the Morrowan series.

The term "Magdalena" herein is defined as a series of marine limestones, with minor components of shale and siltstone, above the Mississippian Helms Formation and below the Permian Hueco Formation on the west side of the Hueco Mountains, marked at the top by the massive Powwow conglomerate. There is some dispute in the use of the Magdalena here but particularly so in southeastern New Mexico. The type Magdalena is predominantly clastic. The term Magdalena has been applied to Pennsylvanian rocks in nearby Franklin Mountains by Nelson (1940). The section in Vinton Canyon at the north end of the Franklin Mountains is nearly identical to that in Powwow Canyon. Nelson subdivided that section into the Bishop Cap member at the top, the medial Berino, and the lower La Tuna member. Clopine et al. (1991: fig. 11) reported *Millerella* 200 ft above the base and the presence of *Chaetetes* 225 ft above *Millerella* in the La Tuna member. Nelson (1947: 460) recovered a diverse gastropod fauna from the shales in Vinton Canyon, which appear to be similar to the Flechado Formation of New Mexico, but are higher in the section than the equivalent horizons in Powwow Canyon.

Clopine et al. (1991: 173) showed that the Powwow Canyon section was near the eastern edge of the Orogrande Basin during lower Pennsylvanian time. This section is correlated with the Vinton Canyon section of the Franklin Mountains, which has been dated on the basis of fusulinids as the equivalent of the Derryan of New Mexico. The two horizons discussed below contain *Millerella* and *Chaetetes,* thereby falling within the parameters of the La Tuna member of the Vinton Canyon section.

Connolly and Stanton (1983) described a stratigraphic section located directly across highway 62 from Powwow Tank which begins at the contact between the Mississippian Helms Formation and the Lower Magdalena. The basic sequence is a transgressive oolitic grainstone containing a high proportion of phylloid algae.

AMNH locality 2015 in Powwow Canyon is a gray limestone, 11 ft thick, containing numerous chert nodules. These nodules and the limestone commonly contain specimens of *Millerella marblensis, Fusiella,* various textulariid genera, a linguloid brachiopod, hexactinellid sponge spicules, and crinoid fragments in addition to the dominant gastropods. The matrix consists of well-sorted invertebrate fragments about the same size as the majority of the gastropods, along with scattered glass sponge spicules. This suggests an off-shore environment. However, Lane (1981: 200–201) cited evidence of several Pennsylvanian faunas such as those in the Perth Limestone of Indiana where spiculites are associated with coal cyclothems indicating shallower water. However, in much of the Paleozoic, spiculites are suggested to represent off-shore, deepwater niches.

The 2015 limestone is about 30 ft above the gully at the first hill north of Powwow Tank and is identified as unit V of section H, locality 32 of King and Knight (1945), sheet 2 (also see Knight and King (1946) fieldnote #1760, USGS Field Records Library, Denver). The base of the Magdalena was not observed.

AMNH locality 2014 is a 20 ft thick, thin-bedded limestone unit (marked unit AO on King and Knight's section H on sheet 2) containing a large number of chert nodules and rounded heads of *Chaetetes* along with *Spirifer rockymontanus, Marginifera lasallensis,* and *Dictyoclostus* sp. This unit is 217 ft higher in the section than AMNH locality 2015. In Vinton Canyon this unit is 225 ft above the *Millerella* interval.

There is no apparent difference between the two horizons in terms of the composition

of the gastropod faunules but there is a difference in population frequencies. Most gastropods are small embryonic shells. It is puzzling that the gastropods are so similar, while other faunal elements are different between the two horizons.

The gastropods described in this report were collected from outcrops that have a large amount of chert. The specimens were found embedded on the surface of chert nodules and were also contained within the nodules. Lack of shell structure preservation indicates that much of the silica became implaced during, or after, the process of lithification. In addition, the limestone was sampled and later treated by hydrochloric acid. Silicified specimens representing the majority of the material studied, including the four genera of land snails previously known only from nonmarine rocks, were recovered by this method.

As a result of almost complete recovery of every shell that was preserved, many species are represented by large population samples of all age stages. Thus ontogenetic sequences, particularly of shells that have adult whorls covering early ontogeny, can be studied. For example, *Trachydomia turbonitella,* n. sp. has, on the early whorls, an upper and lower outer whorl face series of spiral nodes that are identical to that of the genus *Turbonitella* de Koninck, 1881. Recovery of the complete ontogenetic sequence made it possible to observe that the two rows of nodes become intercalated with additional rows of nodes, which develop into the typical quincunx pattern of *Trachydomia.*

The Magdalena population of over 300 specimens of *Orthonema salteri* Meek and Worthen, 1861, shows that the intrapopulation variation involves what has previously been considered species characters, such as the development of spiral ornament and the shape of the outer whorl face. Thus, *O. salteri* includes forms previously described as separate species. These include *O. bilineatum* Mark, 1912, *O. schucherti* Knight, 1934, *O. conicum* Meek and Worthen, 1866, and *O. werneri,* Knight, 1934, which probably should be synonymized with *salteri.*

A further example of a change in the interpretation of morphology resulting from a population sample that includes all ontogenetic stages is *Soleniscus typicus* Meek and Worthen, 1861. Complete specimens from the earliest stages (about four whorls) to the largest adult (ten or more whorls) show that the aperture is holostomous, that is, without any siphonal notches or channels and without any folds on the columellar lip. The appearance of those features can be seen on broken specimens where they begin about half a whorl back from the aperture. Hence, they may have served some purpose other than guides for the siphonal apparatus, perhaps a pedal function.

A large population sample of *Euconodoma gavinae* Kues shows that there is a medial whorl structure present on some early stages which closely relates this species to *Microdoma.* Thus, I believe that the monospecific genus *Euconodoma* should be considered a synonym of that *Microdoma.*

There are several important changes that have been made in the systematics of the murchisonids. The genus *Goniasma* Tomlin, 1930, and the subgenus *Murchisonia* (*Donaldospira*) Batten, 1966, have been transferred as subgenera to the genus *Stegocoelia.* Both of these groups possess features similar to those of other subgenera of *Stegocoelia* and form a part of a series based on the position of the selenizone in relation to the periphery.

Acknowledgments and Abbreviations

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The following anatomical abbreviations are used: H, shell height (estimated, in most cases, because the protoconch or early whorls are frequently broken off); W, width of the adult shell or the final whorl of the specimen; SPANG, spiral angle (made by a goniometer with cross hairs which intersect the sutures at several succeeding whorls.

SYNOPTIC CLASSIFICATION
(number of specimens studied are given in parentheses)

Order Archeogastropoda
- Suborder Bellerophontina
  - Superfamily Bellerophontacea
    - Family Bellerophontidae McCoy, 1851
      - Subfamily Bellerophontinae McCoy, 1851
        - *Bellerophon* (*Bellerophon*) *graphicus* Moore, 1941 (23)
        - *B.* (*Bellerophon*) *crassus* Meek and Worthen, 1860 (19)
        - *B.* (*Bellerophon*) *graphicus* Moore, 1941 (23)
      - Subfamily Knightitinae Knight, 1956
        - *Retispira bellireticulata* Knight, 1945 (29)
- Suborder Macluritina Cox and Knight, 1960
  - Superfamily Euomphalacea de Koninck, 1881
    - Family Euomphalidae de Koninck, 1881
      - *Euomphalus muricatus* Knight, 1934 (95)
- Suborder Pleurotomariina
  - Superfamily Pleurotomariacea
    - Family Sinuopeidae Wenz, 1938
      - Subfamily Platyschismatidae Wenz, 1938
        - *Colpites minutus* (Sayre), 1930 (1)
    - Family Raphistomatidae Koken, 1896
      - Subfamily Liospirinae Knight, 1956
        - *Trepospira* (*Angyomphalus*) sp. (195)
      - Subfamily Omospirinae
        - ***Baylea kuesi***, new species (55)
        - *Baylea knighti* Weller, 1929 (17)
    - Family Eotomariidae Wenz, 1938
      - Subfamily Eotomariinae Wenz, 1938
        - Tribe Ptychomphalides Wenz, 1938
          - *Mourlonia* sp. (124)
        - Tribe Eotomariides Wenz, 1938
          - *Eirlysia* cf. *reticulata* Batten, 1958 (6)
        - Tribe Glabrocingulides Gordon and Yochelson, 1987
          - *Glabrocingulum* cf. *grayvillensis* Norwood and Pratten, 1855 (11)
      - Subfamily Neilsoniinae Knight, 1956
        - *Apachella* cf. *glabra* Batten, 1989 (1)
        - *Apachella* cf. *turbiniformis* Winters, 1963 (2)
        - ***Apachella powwowensis***, new species (1)
        - *Peruvispira delicata* Chronic, 1949 (3)
        - ***Ferganispira acteonina***, new species (11)
        - Genus and species indet. (3)
    - Family Gosseletinidae Wenz, 1938
      - Subfamily Coelozoninae Knight, 1956
        - *Platyzona* cf. *tornatilis* (Phillips), 1836 (230)
    - Family Phymatopleuridae Batten, 1956
      - *Phymatopleura nodosa* Girty, 1912 (8)
      - ***Borestus magdalenensis***, new species (205)
      - ***Borestus texanus***, new species (2)
      - *Paragoniozona* cf. *multilirata* Nelson, 1947 (1)
    - Family Portlockiellidae Batten, 1956
      - *Tapinotomaria* cf. *crassa* Batten, 1958 (2)
      - *Tapinotomaria globosa* Batten, 1958 (2)
    - Family Lophospiridae Wenz, 1938
      - Subfamily Ruedemanniinae Knight, 1956
        - *Worthenia speciosa* (Meek and Worthen), 1861 (15)
        - *Worthenia* cf. *tabulata* (Conrad), 1835 (1)
- Suborder Murchisoniacea Cox and Knight, 1960
  - Superfamily Murchisoniacea Koken, 1896
    - Family Murchisoniidae Koken, 1896
      - ***Stegocoelia* (*Donaldospira*) *nodosa***, new species (1)
      - *Stegocoelia* (*Taosia*) *copei* (White), 1881 (11)
      - *Stegocoelia* (*Taosia*) *crenulata* (Girty), 1939 (26)
      - *Stegocoelia* (*Hypergonia*) *percostata* (Girty), 1939 (11)
      - *Stegocoelia* (*Goniasma*) *lasallensis* (Worthen), 1890 (1)
- Suborder Trochina Cox and Knight, 1960
  - Superfamily Trochonematacea Zittel, 1895
    - Family Trochonematidae Zittel, 1895

Cyclites cf. *multilineata* Girty, 1908 (4)
Superfamily Platyceratacea Hall, 1859
Family Holopeidae Wenz, 1938
Subfamily Gyronematinae Knight, 1956
Yunnania sp. (1)
Superfamily Microdomatacea Wenz, 1938
Family Microdomatidae Wenz, 1938
Microdoma conicum Meek and Worthen, 1866 (2)
Microdoma gavinae (Kues), 1990 (7)
Glyptospira quadriserrata, new species (3)
Superfamily Anomphalacea Wenz, 1938
Family Anomphalidae Wenz, 1938
Anomphalus verriculiferus (White), 1881 (96)
Suborder Neritopsina Cox and Knight, 1960
Superfamily Neritacea Rafinesque, 1815
Family Neritopsidae Gray, 1847
Subfamily Naticopsinae Gray, 1847
Naticopsis (*Naticopsis*) *judithae* Knight, 1933b (90)
Subfamily Neritopsinae Gray 1847
Trachydomia turbonitella, new species (140)

Order Mesogastropoda
Superfamily Cerithiacea Fleming, 1822
Family Turretellidae Woodward, 1851
Orthonema salteri Meek and Worthen, 1861 (314)
Superfamily Loxonematacea Koken, 1889
Family Pseudozygopleuridae Knight, 1930
Pseydozygopleura (*Pseudozygopleura*) *williamsi* Knight, 1930 (3)
P. (*Pseudozygopleura*) *scitula* (Meek and Worthen), 1860 (46)
P. (*Stephanozyga*) *subnodosa* Knight, 1930 (1)
Family Zygopleuridae Wenz, 1930
Anoptychia sp. (2)
Superfamily Subulitacea Lindstrom, 1884
Family Meekospiridae Knight, 1956
Meekospira peracuta Meek and Worthen, 1861 (40)
Family Subulitidae Lindstrom, 1884
Subfamily Soleniscinae Wenz, 1938
Soleniscus typicus Meek and Worthen, 1861 (34)
Soleniscus variabilis Erwin, 1985 (172)
Strobeus primigenius (Conrad), 1835 (6)
Strobeus poromus Kues, 1990 (1)
Superfamily Rissoacea
Family Hydrobiidae
Xinjiangospira, new species (1)

Subclass Opisthobranchia
Superfamily Acteoninacea d'Orbigny, 1842
Family Acteoninidae Pcelincev, 1960
Girtyspira minuta (Stevens), 1858 (8)
Superfamily Pyramidellacea d'Orbigny, 1840
Family Streptacididae Knight, 1938
Donaldina robusta (Stevens), 1858 (11)
Donaldina stevensana (Meek and Worthen), 1866 (25)
Streptacis whitfieldi Meek, 1872 (6)
Subclass Pulmonata
Superorder Stylommatophora
Order Orthurethra
Superfamily Achatinellacea
Family Tornatellinidae
Subfamily Anthracopupinae Wenz, 1938
Strophella grandaevus (Dawson), 1880 (4)
Strophella sp. (1)
Anthracopupa ohioensis Whitfield, 1887 (4)
Superfamily Partulacea
Family Enidae
Subfamily Dendropupinae Wenz, 1938
Dendropupa vetusta (Dawson), 1855 (9)
Dendropupa sp. (1)

(Total sample size, 2223)

SYSTEMATIC PALEONTOLOGY

Note: unless otherwise designated, all specimens discussed or illustrated are from locality 2015. The synonymies only include citations of name changes. For a complete listing of each species citation of previously described taxa, see Yochelson and Saunders (1967).

ORDER ARCHEOGASTROPODA

SUBORDER BELLEROPHONTINA

DISCUSSION: After studying the bellerophontids over the past thirty some years, it has become increasingly apparent to me that there is very little evidence to substantiate most of the species as valid biological entities. Some species possess unique combinations of features that are easy to isolate with some degree of confidence, for example, *Bellerophon* (*Bellerophon*) *complanatus* Yochelson, 1960. But most are endlessly described from various areas and times without any degree of confidence other than the author's

bravado. The reason for this disorder is the lack of characteristics useful for segregating morphologically distinct groups. I attempted to use shell ultrastructure as an added dimension of morphology (Batten, 1972) but the technology of that time (and even the present time) has not provided any additional meaningful morphology. Therefore, the species described below were placed as close as possible to known species from reasonably close (to the Magdalena) time units.

FAMILY BELLEROPHONTIDAE M'COY, 1851

SUBFAMILY BELLEROPHONTINAE M'COY, 1851

Bellerophon de Montfort, 1808

TYPE SPECIES: *Bellerophon vasulites* de Montfort, 1808.

Bellerophon (*Bellerophon*) *graphicus* Moore, 1941

Figure 1

Bellerophon graphicus Moore, 1941: 127, pl. 1, figs. 1–4.
Bellerophon (*Bellerophon*) cf. *graphicus* Kues, 1991: 222, fig. 2.

DESCRIPTION: Small, globose bellerophontids with rounded to semioval whorl profile over dorsum into umbilici. Selenizone moderately wide, flat-topped, flush to slightly raised above the dorsal surface, with narrow, sharply defined marginal troughs. Growth lines in the form of lamellae somewhat imbricated with gentle slopes dipping posteriorly. Lunulae evenly curved and reflect surface ornament. Slit is probably shallow. Shell is anomphalus with lips thickened near umbilici.

DISCUSSION: This species is similar to *B.* (*B.*) *welshi* Gordon and Yochelson, 1987, in shape of shell and surface ornament but differs in having a broader selenizone with more strongly impressed marginal troughs. It is very similar to those specimens described by Kues (1991) from the Lower Permian Laborcita Formation of the Sacramento Mountains, New Mexico. 20 specimens.

MEASUREMENTS: Figure 1, AMNH 44902, H 6.1 mm, W 5.5 mm.

Bellerophon (*Bellerophon*) *crassus* Meek and Worthen, 1860

Figure 2

Bellerophon crassus Meek and Worthen, 1860.

DESCRIPTION: Small, compressed bellerophontiform shells. Whorl expansion rate moderate, forming an evenly developed, nearly equiangular spiral shell. Selenizone flush to slightly raised above dorsum. Lateral lips slightly reflexed in area of umbilici and nearly straight over dorsum to selenizone where they form a rectangular-shaped sinus. Selenizone is flattened to convex and has straight lunulae with little arcing. Selenizone margins are sharply indented, narrow troughs. Growth lines are slightly imbricated and, on some specimens, clustered into broad, flat ribs. Anomphalus.

DISCUSSION: There is a moderate amount of variation in the selenizone which may be quite flat to slightly raised and convex which alters the appearance of the shell so that the forms with convex selenizones appear more discoid. These specimens are similar to *B.* (*B.*) *parvicristus* Yochelson, 1960, but are more compressed and with weaker growth line development. The sinus is more rectangular than in that species. These specimens differ from the type illustrations in being anomphalus. 19 specimens.

MEASUREMENTS: Figure 2, AMNH 44903, H 4.2 mm, W 3.3 mm, L 5.0 mm.

SUBFAMILY KNIGHTITINAE KNIGHT, 1956

Retispira Knight, 1945

TYPE SPECIES: *Retispira bellireticulata* Knight, 1945.

Retispira cf. *bellireticulata* Knight, 1945

Figure 3

Retispira bellireticulata Knight, 1945: 335–336, pl. 49, fig. 1.

DESCRIPTION: Small bellerophontiform gastropods with equally well-developed revolving and collabral lirae forming reticulate ornament pattern. Whorl profile broadly rounded on dorsum but interrupted by a raised, convex selenizone. Profile becomes flat to concave in the umbilical regions. Narrowly

phaneromphalus to anomphalus. Revolving ornament slightly more strongly developed adjacent to selenizone on upper dorsum. Convex selenizone ornamented by three revolving lirae and well-developed lunulae; bordered by narrow troughs that lack ornament. About 20 equally spaced revolving lirae. Collabral ornament is spaced about the same as revolving elements. No ornament in umbilical regions.

DISCUSSION: The two specimens available for study are nearly identical to that of the type illustrations of Knight, but differ in having somewhat stronger revolving lirae and a more rapid translation rate so that the whorls are less inflated. They are similar to the illustrations of *Retispira* species #2 of Yochelson (1960: pl. 56, figs. 1–3). Knight's type specimens are from the Smithwick Shale (Bendian; Lower Pennsylvanian) of north-central Texas. 29 specimens.

MEASUREMENTS: Figure 3, AMNH 44904, H 3.5 mm, W 3.6 mm.

SUBORDER MACLURITINA

SUPERFAMILY EUOMPHALACEA

FAMILY EUOMPHALIDAE
WENZ, 1938

Straparollus de Montfort, 1810

TYPE SPECIES: *S. dionysii* de Montfort, 1810: 174.

Straparollus (Euomphalus)
J. Sowerby, 1814

TYPE SPECIES: *Straparollus pentangulus* J. Sowerby, 1814.

DISCUSSION: *S.* (*Euomphalus*) and the genus *Amphiscapha,* a closely related subgenus, are commonly found in Pennsylvanian shales. Usually they are represented in faunas as single species.

Straparollus (*Euomphalus*) *muricatus*
Knight, 1934
Figure 4

S. (*Euomphalus*) *muricatus* Knight, 1934a: 160, pl. 21, fig. 3.

DESCRIPTION: Early whorls rounded and slightly depressed below spiral surface. Upper whorl surface flat to gently convexo-concave and terminating at shoulder with a rounded, but sharply bounded carina. Vertical outer whorl face convex to somewhat flattened, indented slightly at bottom of shoulder carina. Whorl base evenly rounded with carina midway between inner suture and periphery. Widely phaneromphalus. Ornament consists of reinforced growth lines.

DISCUSSION: There is considerable variation in the shape of the outer whorl face from quite rounded to almost flat. This variation appears to be ontogenetic since the smaller specimens and the equivalent earlier whorls are more rounded and lack the basal carina. This species is similar to *A. nodibasis* Gordon and Yochelson, 1987, in the general shell features but lacks any of the basal nodes that characterize that species. These specimens differ from the type illustrations in that the outer whorl face is slightly more convex causing the basal carina to be lower on the whorl base. 95 specimens.

MEASUREMENTS: Figure 4, AMNH 44905, H 2.6 mm, W 6.4 mm.

ORDER PLEUROTOMARIINA

SUPERFAMILY PLEUROTOMARIACEA

FAMILY SINUOPEIDAE
WENZ, 1938

SUBFAMILY PLATYSCHISMATIDAE
WENZ, 1938

Colpites Knight, 1936

TYPE SPECIES: *Naticopsis? monifera* White, (1880): 168.

Colpites minutus (Sayre), 1930
Figure 5

Naticopis? minutus Sayre, 1930: 142, pl. 13, fig. 5.
Angyomphalus minutus Knight, 1933a: 55, pl. 8, fig. 5.
Colpites minutus Knight, 1936: 529.

DESCRIPTION: Subglobular, rotelliform shells with prominent subsutural nodes. Whorls embrace on upper selenizone margin. Sutures deeply impressed. Collabral cords form large crescentic subsutural nodes on evenly rounded upper whorl surface. Slightly convex selenizone raised above whorl surface and located just above rounded, ill-defined periphery. Alveozone slightly concave and

obscure. Base is evenly rounded. Phaneromphalus, with one or two spiral threads encircling umbilicus.

DISCUSSION: This single specimen is similar in shape and in the development of the subsutural nodes to *C. striatus* Batten, 1989, but differs in lacking the numerous spiral threads. It is slightly less inflated than the type illustration and the whorls embrace higher on the whorl. One specimen.

MEASUREMENTS: Figure 5, AMNH 44906, H 3.5 mm, W 4.3 mm, SPANG 127°.

FAMILY RAPHISTOMATIDAE

SUBFAMILY LIOSPIRINAE

Trepospira Ulrich *in* Ulrich and Scofield, 1897

TYPE SPECIES: *Pleurotomaria sphaerulata* Conrad, 1842.

Trepospira (*Angyomphalus*) Cossmann, 1916

TYPE SPECIES: *Euomphalus radians* de Koninck, 1843.

DISCUSSION: This subgenus has not been recorded in the Pennsylvanian or Permian, but is relatively common in the Mississippian where most of the previous species have been described. Its chief characteristics are a low-spired, discoid shell with a rapid translation rate, collabral ornament especially well-developed adjacent to the suture, a circumbilical ridge, and a selenizone just below the periphery such that the upper selenizone margin is at the periphery.

Trepospira (*Angyomphalus*) sp.
Figure 6 a, b

DESCRIPTION: Low-spired discoid shells with slightly rounded to compressed whorl profile. Early whorls smooth and rounded. Whorls embrace about one-third the distance between suture and periphery. Selenizone is on base with upper margin forming periphery; it is flush, conforming to whorl surface, and slightly convex. Selenizone margins very fine lirae. Sinus rounded and very shallow. Base rounded and phaneromphalus. Columellar lip reflexed and thickened. Parietal inductura is thin to wanting. Ornament consists of very fine growth lines evenly distributed over shell surface.

DISCUSSION: The shell shape of this species is very similar to those found in all the species of this subgenus. It lacks the two distinguishing features—the collabral ornament adjacent to the suture and the circumbilical ridge. In addition, *T.* (*Angyomphalus*) has not been reported in the Pennsylvanian or Permian (however, Yancey and Erwin, personal commun., have found *Trepospira* in the Permian). The most compelling reason for referring this species to *T.* (*Angyomphalus*) is the position of the selenizone just under the periphery, the shape of the shell and the open umbilicus. No other genus has these features in the pleurotomarians. *Mourlonia* is the closest in the subtle development of the growth lines but it has a selenizone located above the periphery. 195 specimens.

MEASUREMENTS: Figure 6, AMNH 44907, a, H 2.0 mm W 3.8 mm, SPANG 136°; b, H 3.0 mm, W 4.7 mm.

SUBFAMILY OMOSPIRINAE WENZ, 1928

Baylea de Koninck, 1883

TYPE SPECIES: *Trochus yvanii* LeVeille, 1835.

Baylea kuesi, new species
Figure 7

DIAGNOSIS: High-spired shells with a prominent upper whorl surface cord and numerous basal spiral cords.

DESCRIPTION: Moderately high-spired trochiform shells with whorls embracing just below center of alveozone. Three early whorls evenly rounded and almost planispiral. Upper whorl surface slightly concave with prominent spiral cord about ⅓ the distance from sharply defined suture to selenizone. Fine spiral lira midway between this cord and upper selenizone margin. Two well-developed spiral lirae border concave selenizone, which has slightly asymmetrical lunulae. Lower selenizone margin forms periphery of shell. Alveozone strongly to slightly concave with one or two spiral lirae confined to upper half. Lower margin of alveozone on base and equal in development to upper margin. Base flatly rounded with from 8 to 12 spiral cords or

lirae. Anomphalus to minutely phaneromphalus. Columellar lip reflexed and ornament resorbed in parietal region. Collabral ornament consists solely of slightly strengthened growth lines on upper whorl surface adjacent to the selenizone and to lunulae within the selenizone.

DISCUSSION: There is some variation in the shape of the shell with some specimens having a faster rate of whorl expansion forming a lower-spired shell. The alveozone varies from moderately wide and flattened to a more narrow and deeper and concave structure. The basal spiral ornament varies in intensity and seems to be related to variations in shell height. This species differs from such relatively high-spired species as *B. giffordi* (Worthen) in lacking the prominent subsutural and alveozone nodes and by possessing a single cord and lira on the upper whorl surface. 53 specimens.

MEASUREMENTS: Figure 7, holotype, AMNH 44908, H 5.8 mm, W 4.2 mm, SPANG 53°.

ETYMOLOGY: Named for Barry S. Kues.

Baylea knighti (Weller), 1929
Figure 8

Yvania knighti Weller, 1929: 25–27, figs. 5–8.

DESCRIPTION: Relatively low-spired shells with whorls embracing at, or just below, lower alveozone margin. Early whorls smooth, evenly developed. Upper whorl surface slightly concave and almost at a right angle to axis. Well-developed spiral cord adjacent to sharply defined suture. There may be one or two fine spiral lirae between this cord and suture and from one to four lirae between cord and upper selenizone margin. Selenizone margins are sharply formed spiral cords. Alveozone is wide and nearly vertical so that, with the flattened base and nearly horizontal upper whorl surface, the whorl profile is rectilinear. Lower alveozone margin is equal in development to lower selenizone margin. Prominent spiral cord ⅓ distance above lower margin and a less well-developed spiral cord halfway between that cord and lower selenizone margin, so that alveozone is divided into three sections. Between these sections finer spiral lirae may develop. Base is flatly rounded with from 7 to 14 spiral cords or lirae. Minutely phaneromphalus. Columellar lip is reflexed and thickened into a narrow callus. No parietal alteration and no collabral ornament.

DISCUSSION: The Magdalena specimens differ from those described by Weller from the Piasa Limestone of Missouri in that there is but one spiral cord on the upper whorl surface rather than two or three. In addition, the spiral cord on the alveozone in the Magdalena specimens is more fully developed.

There is some variation in the shape and angulation of the upper whorl surface. In some specimens that surface may be flatter and more sloping so that it may form a 45° angle to the axis. This gives some shells a slightly higher spired appearance. Also, the basal spiral ornament may be finer in the higher spired forms. 17 specimens.

MEASUREMENTS: Figure 8, AMNH 44909, H 3.4 mm, W 4.1 mm, SPANG 72°.

FAMILY EOTOMARIIDAE WENZ

SUBFAMILY PTYCHOMPHALINAE WENZ

TRIBE MOURLONIDES YOCHELSON AND DUTRO, 1960

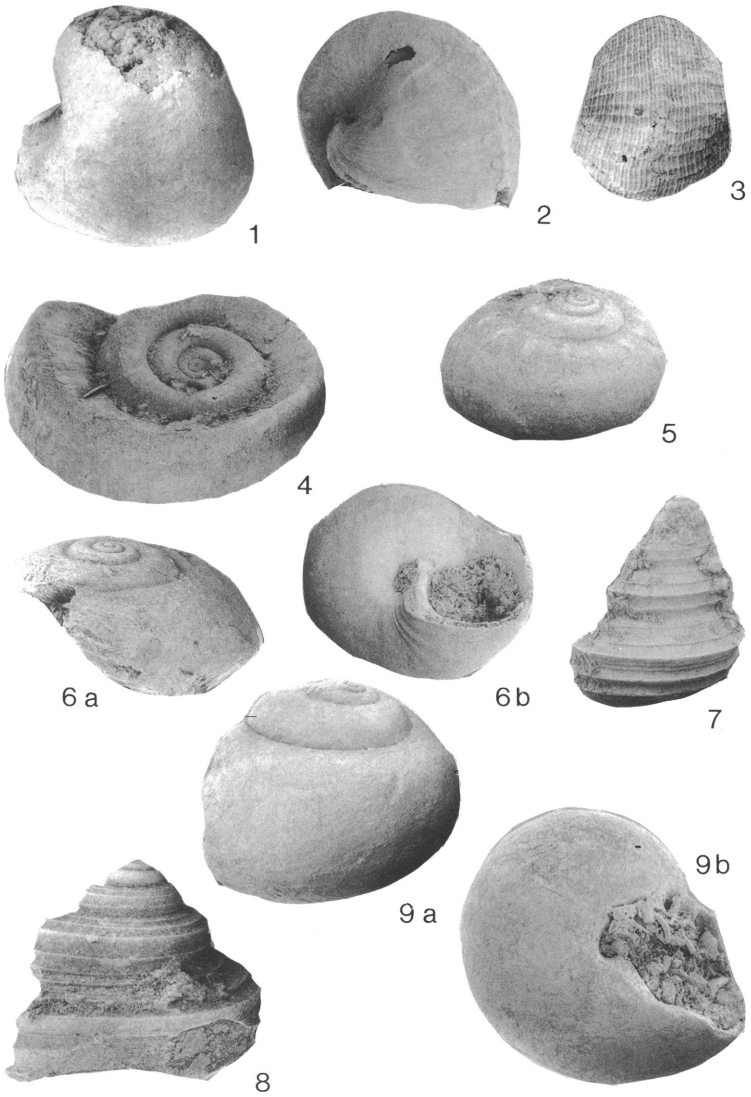
Genus *Mourlonia* de Koninck, 1883

TYPE SPECIES: *Helix carinata* J. Sowerby, 1812.

Mourlonia sp.
Figure 9 a, b

DESCRIPTION: Turbiniform to somewhat compressed and sublenticular shells with rounded to slightly flattened base. Shell generated by a fairly rapid expansion rate. Early whorls orthostrophic and almost planispiral, so that whorls embrace very high on whorl. Sutures contact whorl surface lower on the penultimate and final whorls. Selenizone flush with whorl surface and slightly convex. Margins very faint, narrow troughs with upper margin forming shell periphery, so that selenizone is below periphery. Growth lines are faint to absent. Sinus appears to be relatively deep. Base narrowly phaneromphalus to cryptomphalus. Columellar lip thickened and slightly reflexed.

DISCUSSION: This species differs from *M. venusta* Gordon and Yochelson, 1987, in be-



Figs. 1–9. **1.** *Bellerophon (Bellerophon) graphicus* Moore, AMNH 44902, oblique side view, ×7. **2.** *B. (Bellerophon) crassus* Meek and Worthen, AMNH 44903, oblique side view, ×13. **3.** *Retispira bellireticulata* Knight, AMNH 44904, top view, ×7. **4.** *Euomphalus muricatus* Knight, AMNH 44905, oblique top view, ×7. **5.** *Colpites minutus* (Sayre), AMNH 44906, oblique side view, ×7. **6.** *Trepospira (Angyomphalus)* sp., AMNH 44907, **(a)** oblique side view, ×7, **(b)** basal view, ×10. **7.** *Baylea kuesi,* n. sp., AMNH 44908, holotype, side view, ×6. **8.** *Baylea knighti* Weller, AMNH 44909, side view, ×10. **9.** *Mourlonia* sp. **(a)** AMNH 44910, oblique side view, ×7, **(b)** AMNH 44911, basal view, ×7.

ing lower spired with the selenizone lower on the whorl and with a thickened columellar lip. It is also less globose. The growth lines are so faint that only on a single specimen were they visible near the selenizone. Several specimens show growth lines on the base near the umbilicus. The position of the selenizone is difficult to place on most specimens. This species is unique in having a depressed, nearly planispiral early shell.

I have refrained from naming this species because of the difficulty in observing the

growth lines and selenizone in most specimens. I am unsure whether or not this is due to poor preservation or an unusual lack of development of features associated with the growth lines. 124 specimens.

MEASUREMENTS: Figure 9a, AMNH 44910, H 3.8 mm, W 5.8 mm, SPANG 108°; 9b, AMNH 44911, H 4.8 mm, W 5.8 mm.

TRIBE EOTOMARIIDES
WENZ, 1938

Eirlysia Batten, 1956

TYPE SPECIES: *E. exquisita* Batten, 1956: 233.

Eirylsia cf. *reticulata*
Batten, 1958
Figure 10

Eirlysia reticulata Batten, 1958: 234, pl. 41, figs. 7–17.

DESCRIPTION: Low-trochoid shells with evenly rounded whorl profile. Early whorls smooth and lack ornament. Whorls embrace just below lower selenizone margin. Upper whorl surface convex with strongly developed collabral ribs and fine spiral and collabral threads evenly spread over surface. Moderately wide, concave selenizone bordered by rounded spiral ribs and located just above periphery with lower margin forming periphery. Lunulae reflect collabral ribs of upper whorl surface. Concave alveozone appears to have fine ornament. Base rounded with both spiral and collabral threads evenly formed and distributed. Phaneromphalus.

DISCUSSION: The shell shape, fine reticulate ornament, coarse upper whorl surface collabral ribs, and phaneromphalus base suggest placement of this single specimen within this species. The alveozone is more concave than in the Permian species which is nearly flat. This very small specimen is not well preserved so that further detailing is impossible. One specimen.

MEASUREMENTS: Figure 10, AMNH 44912, H 1.3 mm, W 2.0 mm, SPANG 87°.

TRIBE GLABROCINGULIDES
GORDON AND YOCHELSON, 1987

Glabrocingulum Thomas, 1940

TYPE SPECIES: *Glabrocingulum beggi* Thomas, 1940: 59, pl. 2, fig. 1.

Glabrocingulum cf. *grayvillensis*
(Norwood and Pratten), 1855
Figure 11

Pleurotomaria grayvillensis Norwood and Pratten, 1855: 75, pl. 9, figs. 7 a, b.
Phanerotrema grayvillensis Ulrich and Scofield, 1897: 952.
Glabrocingulum grayvillensis Knight, 1944: 455.

DISCUSSION: Eleven very poorly preserved specimens are assigned to this species. The specimens are low-spired and lenticuliform with whorl embracing just below the selenizone. The larger specimens show some degree of uncoiling. There is a row of subsutural nodes which are formed as interference nodes with one or two spiral cords or threads that are subjacent to the suture. The selenizone is on the shoulder, which forms the periphery. The flatly rounded base is ornamented by noded spiral cords or threads. The base is anomphalus or phaneromphalus. The columellar lip is reflexed and thickened into a large callus. In all of these aspects the specimens appear to be closer to *G. grayvillensis* than to the group of Permian species (see Batten, 1989) or of Mississippian species (see Gordon and Yochelson, 1987). Because ornament details on which species are based are obscured or absent in these specimens, no positive species determination can be made. 11 specimens, loc. 2014.

MEASUREMENTS: Figure 11, AMNH 44913, H 4.5 mm, W 4.8 mm, SPANG 78°.

FAMILY EOTOMARIIDAE
WENZ, 1938

SUBFAMILY NEILSONIINAE
KNIGHT, 1956

Apachella Winters, 1956

TYPE SPECIES: *Apachella translirata* Winters, 1956: 30, pl. 3, figs. 1, 2.

DISCUSSION: The earliest appearance of this genus is in the Tournaisian of Belgium (see Batten, 1989: 24). The present Magdalena occurrence is the earliest report of the genus thus far in North America.

Apachella cf. *glabra* Batten, 1989
Figure 12

Apachella glabra Batten, 1989: 29, pl. 6, figs. 22–24.

DESCRIPTION: High-spired turreted shells with whorls embracing at lower margin of alveozone. Early whorls not preserved. Sutures deep and set in a v-shaped trough. Upper whorl surface slightly convex. Prominent spiral cord in center of whorl surface and spiral thread just below suture. Selenizone forms a 45° angle with axis. Lower selenizone margin marks periphery of shell and is a spiral cord more fully developed than upper margin. Alveozone concave with lower margin rounded and not well defined. Base flatly rounded without ornament. Anomphalus. Collabral ornament of any type is absent or composed of reinforced growth lines over entire surface of shell. Columellar lip reflexed and thickened into concave callus. Lower lip forms a shallow siphonal trough at juncture with the columellar lip.

DISCUSSION: This single specimen differs from types in having a well-developed spiral cord on upper whorl surface, in being lower spired with whorls embracing at lower part of alveozone. It is similar in lacking collabral ornament, possessing a slightly formed siphonal trough, and having a spiral thread near the suture. Five specimens.

MEASUREMENTS: Figure 12, AMNH 44914, H 2.6 mm, W 1.3 mm, SPANG 35°.

Apachella cf. *turbiniformis*
Winters, 1963
Figure 13

Apachella turbiniformis Winters, 1963: 33, pl. 3, figs. 6–8.

DESCRIPTION: Relatively low-spired, trochiform shells with whorls embracing beneath alveozone on base and with rapidly whorl expansion rate. Upper whorl surface convex with well-formed, sharp spiral cords adjacent to suture and spiral thread midway between this cord and upper selenizone margin. Selenizone has well-developed lunulae and growth lines over surface of shell are built up. Selenizone margins sharp spiral cords. Alveozone is narrow and concave with spiral thread just under lower selenizone margin. Lower selenizone margin is at periphery of whorl. Rounded base has 6 spiral cords. Aperture unknown.

DISCUSSION: These specimens are much lower spired than those found in the Permian. They lack any of the subsutural collabral nodes of the Supai types. They are similar in having sharply formed spiral ornament and in the shape and details of the alveozone. Two specimens.

MEASUREMENTS: Figure 13, AMNH 44915, H 2.5 mm, W 2.5 mm, SPANG 57°.

Apachella powwowensis,
new species
Figure 14

DESCRIPTION: Moderately high-spired shell with wide selenizone bisected by a medial lira. Early whorls have stepped profile with upper whorl surface flat to concave. Periphery is at midwhorl and marked by lower selenizone margin, alveozone and base flat. Sutures shallow and sharp. Penultimate and final whorls have rounded profile with spiral cord midway between suture and selenizone. Reinforced growth lines form faint interference nodes at intersection with upper surface cord and selenizone margin. Flat to concave selenizone is bisected by medial lira. Alveozone is flat to concave with lower margin a prominent cord; it is unornamented on earlier whorls but on final whorl it has numerous very fine lirae. Rounded base is ornamented by a series of 10 irregularly spaced and developed lirae. Anomphalus. Whorls embrace on lower margin of alveozone. Columellar lip is arcuate and slightly thickened; no parietal inductura.

DISCUSSION: I am, as usual, very reluctant to base a new species on a single specimen. However, this single specimen sharply differs from other species of the genus, yet in essential features such as the shell shape, position of the selenizone, and major ornament, it belongs to *Apachella,* or close to it. It has a much wider selenizone, which is bisected by a lirae, unknown in any of the other species. The sinus is very shallow. Even more puzzling is the very different early shell, which is turreted and with different ornament. The irregular spiral ornament on the adult shell and the interference nodes are also unique. It clearly is distinct from all other species and, in fact, may be a distinct genus. One specimen.

MEASUREMENTS: Figure 14, holotype, AMNH 44916, H 3.2 mm, W 1.5 mm, SPANG 25°.

ETYMOLOGY: Named for Powwow Canyon on the west side of the Hueco Mountains in west Texas.

Peruvispira Chronic, 1949

TYPE SPECIES: *Peruvispira delicata* Chronic, 1949: 146; 1953: 139.

Peruvispira cf. *delicata*
Chronic, 1949
Figure 15 a, b

Peruvispira delicata Chronic, 1949: 139, pl. 28, figs. 9–12.
Peruvispira delicata Batten, 1989: 35, pl. 8, fig. 1.

DESCRIPTION: High-spired, turreted shell with whorls embracing just below alveozone. Upper whorl surface is convexo-concave. Concave selenizone occupies most of outer whorl face. Lower selenizone margin marks periphery. Narrow alveozone concave with lower margin a spiral cord. Base is rounded. Anomphalus. Columellar lip is thickened into an arcuate callus.

DISCUSSION: These specimens are quite similar to the Peruvian types in the shape of the upper whorl surface, the width of the selenizone and its relation to the outer whorl face, and the turreted appearance of the shell. They differ in having a well-developed alveozone with a lower margin a spiral cord. They differ from the Permian specimens in lacking any collabral ornament. Three specimens.

MEASUREMENTS: Figure 15a, AMNH 44917, H 4.2 mm, W 2.3 mm, SPANG 32°; 15b, AMNH 44918, H 5.8 mm, W 2.8 mm, SPANG 22°.

Ferganispira Likharev, 1967

TYPE SPECIES: *Ferganispira gradussiformis* Likharev, 1967: 51.

DESCRIPTION: High-spired pleurotomarians with a nearly vertical, relatively wide and concave selenizone located just under periphery and marked by upper selenizone margin. Shells slightly pupaeform with whorls embracing on base. Early whorls smooth with embryonic selenizone located midwhorl. Upper whorl surface flat to slightly concave with surface forming a 90° angle with axis. Shell periphery high on whorl and marked by upper selenizone margin. Selenizone relatively wide and concave with upper margin a more strongly developed spiral cord than lower. Outer whorl face nearly vertical, slightly rounded, and sloping inward from periphery. Base is evenly rounded and elongated so that base and outer whorl face occupy most of whorl profile. Anomphalus. Columellar lip is reflexed and thickened to form a narrow callus. Incipient siphonal channel.

DISCUSSION: This is the first reported occurrence of the genus outside the type locality. It is difficult to be sure of the placement of this genus. Based on the shell shape and the position of the selenizone and periphery, it would seem that it should be near *Scalitina* in the Sinuopeids. However, the depth of the slit and the position of the selenizone in this group is unique in that it is situated below the periphery of the shell, a condition uncommon in the pleurotomarians. *Luciellina* Kittl, 1900, has the selenizone below the periphery on the base, but the shell is low-spired and lenticular with the basic structure quite different from this new genus. Some genera of the portlockiellids such as *Tapinotomaria* Batten, 1956, have the selenizone on the periphery but that genus is structurally different in that the axial translation and whorl expansion rates are slower. *Stegocoelia* (*Goniasma*) Tomlin, 1930, also has the selenizone just under the periphery but differs in having the periphery on a keel which is low on the whorl. Some specimens of *Peruvispira delicata* Chronic, 1949, and *Neilsonia laticincta* Batten, 1989, have selenizones located near, or slightly below, the periphery and have similar whorl expansion and axial translation rates to *Ferganispira*—hence I will provisionally place it near those species. Likharev placed the genus in the murchisonids on the basis of being high spired with a selenizone. I believe that the fundamental shape of the whorls, reflecting the size and position of the ctenidia and other organs, is closer to that of the neilsonids. It also has some features similar to *Scalitina* Spriestersbach, 1919, in the shape of the shell and whorl profile but differs in the placement of the selenizone and the lack of secondary deposits over the selenizone.

Ferganispira acteonina,
new species
Figure 16 a, b

DIAGNOSIS: Acteonina-like shells with a vertical selenizone just under the shell pe-

riphery and lacking ornament other than growth lines.

DESCRIPTION: High-spired shell slightly pupaeform. Early two whorls smooth. Third whorl evenly convex with selenizone forming in midwhorl. Adult whorls embrace on base. Upper whorl surface flat to slightly concave or convexo-concave and forms 90° angle with axis. Upper selenizone margin a spiral cord marking shell periphery. Selenizone concave and lower margin weaker in development than upper margin. Outer whorl face evenly convex, gradually becoming more rounded toward base where it forms a continuum. Outer whorl face and base represents 90% of whorl profile. Rounded base marked by several widely spaced spiral threads. Anomphalus. Aperture terminates in shallow siphonal trough. Parietal inductura is thickened.

DISCUSSION: These shells vary somewhat in height, reflecting changes in the rate of axial translation, which may also be variable in constancy since some shells are pupaeform and others normally orthostrophic. Other variations noted are that some specimens are more slender than others, reflecting changes in whorl expansion rates. 12 specimens.

MEASUREMENTS: Figure 16a, holotype, AMNH 44919, H 4.5 mm, W 2.2 mm, SPANG 27°; 16b, paratype, AMNH 44920, H 4.0 mm, W 2.1 mm, SPANG 23°.

ETYMOLOGY: Named for the genus *Acteonina* d'Orbigny, 1850.

Genus and species indeterminate (neilsonid)
Figure 17

DESCRIPTION: Trochiform shells with concave selenizone located well above shell periphery. First three whorls smooth and evenly rounded. Upper whorl surface rounded with spiral cord adjacent to sharply defined and deep suture. Concave selenizone bordered by sharp, almost flangelike spiral cords. A spiral cord equal in width to selenizone is subjacent and forms shell periphery. Six or more spiral threads are on rounded base and become progressively finer toward the unbilicus. Phaneromphalus. Columellar lip is partially reflexed.

DISCUSSION: The placement of the selenizone high on the whorl of these three trochiform specimens is unusual within the pleurotomarians. Only within the neilsoniids is such an arrangement of the selenizone known. In particular, the genus *Sagena* Koken, 1891, from the Triassic of the Alps is similar (see Batten, 1989: pl. 5, fig. 16). However, the illustrated specimen is much lower spired than any member of the subfamily. Since it is relatively well preserved, more specimens may be found in the future that might determine its taxonomy. 3 specimens, loc. 2014.

MEASUREMENTS: Figure 17, AMNH 44921, H 1.5 mm, W 1.6 mm, SPANG 64°.

FAMILY GOSSELETINIDAE WENZ, 1938

SUBFAMILY COELOZONINAE KNIGHT, 1956

Platyzona Knight, 1945

TYPE SPECIES: *Pleurotomaria trilineata* Hall, 1858.

DISCUSSION: As discussed in Batten (1966: 43–44) there are two groups of species in the Carboniferous. The *P. tornatilis* (Phillips), 1836, group has dominant spiral ornament. The *P. cirriformis* (J. Sowerby), 1817, group lacks or has reduced ornament. Only the spirally ornamented type is found in the Magdalena and is sporadically found in the North American upper Paleozoic. The only other published report of the genus in the Pennsylvanian is *P. broadheadi* (White), 1880, by Knight, 1945: 579, which is spirally ornamented. In the overlying Permian the dominant forms have spiral ornament and are much higher spired or are uncoiled and have a medial spiral element on the selenizone (Batten, 1989: 39–41).

Platyzona cf. *tornatilis* (Phillips), 1836
Figure 18

Pleurotomaria tornatilis Phillips, 1836: 228, pl. 15, fig. 25.
Platyzona tornatilis Batten, 1966: 43–44.

DESCRIPTION: Moderately high-spired, trochiform shells with evenly inflated whorls. Whorls embrace just below selenizone. Sutures deeply recessed. Upper whorl surface has narrow flattened space adjacent to suture

and from 2 to 10 or more spiral threads. These threads are unevenly developed and unevenly arranged due to interference with growth lines, reflecting a thin, wavy outer apertural lip. Very wide selenizone occupies whorl periphery and is flat-to-convex, conforming to whorl surface. Lunulae are formed by reinforced growth lines. Margins are slightly stronger spiral threads. 15 or more spiral threads are on rounded base. Phaneromphalus.

DISCUSSION: These specimens very closely resemble the types of *P. tornatilis* (Phillips), 1836, in all details. The most noticeable variation in the Magdalena population is in the whorl embracement, which usually is just below the lower selenizone margin but may be much lower down on the outer whorl surface forming a high-spired shell. The most important variation, however, is the development of the spiral ornament. The spiral threads may be narrow and sharply formed or broad and rounded. They may be evenly spaced across the whorl and numerous or restricted to two threads just above the selenizone. This wide variety of spiral ornament was noted in *P. tornatilis* populations in the Lower Carboniferous of Europe by Batten (1966: 44). 230 specimens.

MEASUREMENTS: Figure 18, AMNH 44922, H 7.0 mm, W 6.5 mm, SPANG 63°.

FAMILY PHYMATOPLEURIDAE
WENZ, 1938

Phymatopleura Girty, 1936

TYPE SPECIES: *Orestus nodosus* Girty, 1912: 137.

Phymatopleura nodosa
(Girty), 1912
Figure 19

Orestus nodosus Girty, 1912: 137.
Phymatopleura nodosa Knight, 1941: 244.

DESCRIPTION: Trochiform to turbiniform shells with sharply developed nodose ornament. Early whorls smooth, spiral ornament appears at third whorl. Upper whorl surface flattened with fine spiral lirae at fourth whorl, with fine spiral lirae developed on outer whorl surface. Sutures deeply recessed. Adult whorl upper whorl surface evenly rounded with two or three spiral cords forming sharp nodes with collabral ornament. Outer whorl face evenly rounded to flattened and moderately wide to narrow. Selenizone margins are rounded spiral lirae. Lunulae form interference nodes with medial spiral thread. Upper selenizone margin marks shell periphery. Selenizone slopes downward and inward. A spiral cord just under selenizone forms strongly developed nodes with collabral ornament. Flatly rounded base has five or more spiral cords which may have intercalated threads. Anomphalus or narrowly phaneromphalus. Aperture unknown.

DISCUSSION: These specimens differ from the type described from the Wewoka Formation of Oklahoma in lacking the strong subsutural nodes and having two or three evenly spaced and developed spiral cords on the upper whorl surface. In addition, they are more trochiform and higher spired. 8 specimens, loc. 2014.

MEASUREMENTS: Figure 19, AMNH 44923, H 2.8 mm, W 2.5 mm, SPANG 68°.

Borestus Thomas, 1940

TYPE SPECIES: *B. wrighti* Thomas, 1940: 54, pl. 3, fig. 1.

DISCUSSION: This genus ranges in age from Tournasian through the lower Permian. It is uncommonly found in a number of Pennsylvanian shale horizons in north-central Texas and Oklahoma.

Borestus magdalenensis,
new species
Figure 20

DIAGNOSIS: Relatively high-spired turreted shells with an ornamented subsutural spiral cord and a medial selenizone thread.

DESCRIPTION: Turreted shells with somewhat variable axial translation rate and whorl expansion rate. Sutures deeply impressed and whorls embrace below lower margin of outer whorl face. Upper whorl surface slightly concave to convexo-concave, sloping 45° downward to shoulder. Noded subsutural spiral cord. Outer whorl face vertical with upper margin forming shoulder, marked by a rounded, noded, spiral rib. Flat selenizone slightly depressed beneath whorl surface and marked by spiral lirae. It occupies half of

whorl face and has a medial lirae (the only spiral ornament). It is bounded by narrow troughs which compose rest of outer whorl face. Lunulae well marked and interference nodes form at medial spiral lira connections. Lower margin of outer whorl face marked by spiral rib less developed than shoulder. Base is flatly rounded with about 12 spiral threads with faint interference nodes with the weakly developed collabral ornament. Phanerom-phalus. Columellar lip reflexed and thickened into narrow callus and parietal inductura a smooth, depressed surface.

DISCUSSION: The collabral ornament is faint but on some specimens nodes are prominent at intersections with spiral elements. There is some variation in the height of the shell depending on the rates of axial translation and whorl expansion. The higher spired specimens seem to have a greater development of collabral ornament. The lower spired specimens have a more open umbilicus. This species is distinct from *B. chesterensis* Meek and Worthen, 1861, by being higher spired and with weaker collabral ornament and fewer, coarser spiral elements. 205 specimens.

MEASUREMENTS: Figure 20, holotype, AMNH 44924, H 4.0 mm, W 3.5 mm, SPANG 59°.

ETYMOLOGY: Named for the Magdalena Formation.

Borestus texanus, new species
Figure 21 a, b

DIAGNOSIS: Turbiniform shells without surficial ornament.

DESCRIPTION: Turbiniform, moderately low spired shells with a relatively low axial translation and rapid whorl expansion rates. Whorls embracing on spiral cord forming lower margin of outer whorl face. Upper whorl surface flat to slightly convexo-concave; terminates at periphery in well-developed spiral cord. Vertical outer whorl face narrow with flat selenizone occupying most of face. Selenizone margins are equal size spiral troughs. Narrow, shallow troughs adjacent to selenizone make up rest of outer whorl face. Lower margin of outer whorl face has spiral cord equal in size to upper margin. Base flattened with slightly reinforced growth lines and very faint spiral threads. Phanerom-phalus. Aperture unknown.

DISCUSSION: Three well-preserved specimens are very distinctive. They differ from *B. magdalenensis* in being lower spired and without any collabral ornament. Two spiral cords mark the outer whorl face and constitute the only spiral ornament on the shell. The shells are similar to the type species, *B. wrighti* Thomas, 1940, in the shape of the shell but lack the reticulate ornament. Three specimens.

MEASUREMENTS: Figure 21a, holotype, AMNH 44925, H 6.2 mm, W 5.5 mm, SPANG 46°; 21b, paratype, AMNH 44926, H 1.7 mm, W 1.7 mm, SPANG 54°.

ETYMOLOGY: Named for the state of Texas.

Paragoniozona Nelson, 1947

TYPE SPECIES: *Paragoniozona nodilirata* Nelson, 1947: 460, pl. 65, fig. 2 a–c.

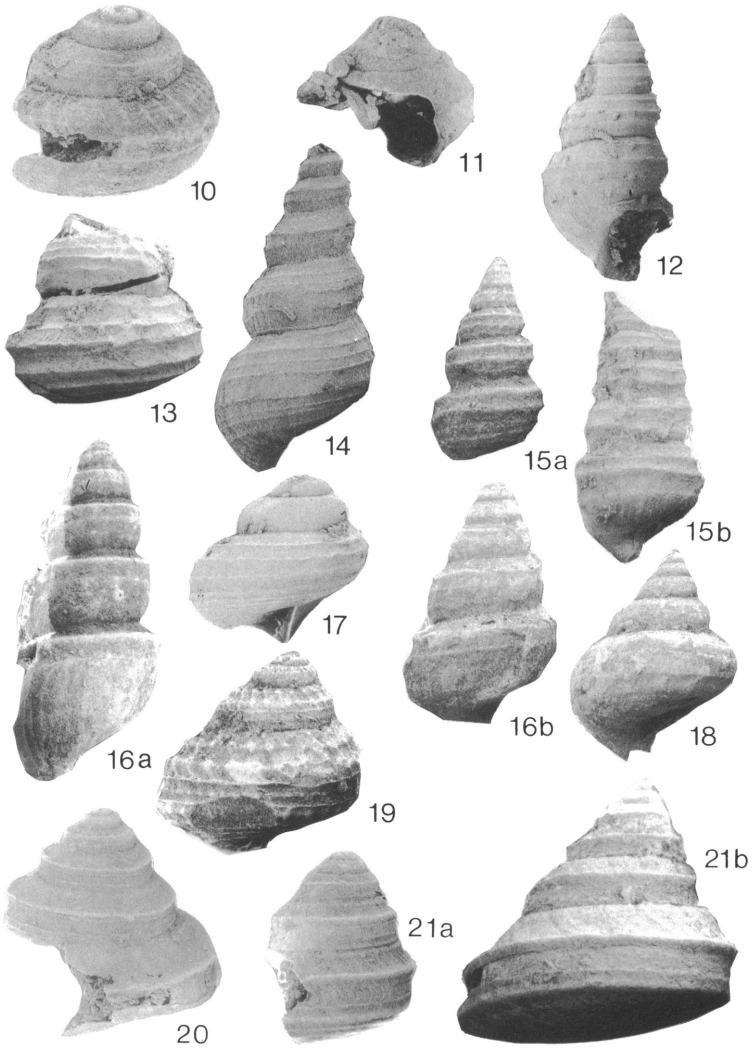
Paragoniozona cf. *multilirata*
Nelson, 1947
Figure 22

Paragoniozona multilirata Nelson, 1947: 460, pl. 65, fig. 4 a–e.

DESCRIPTION: Turbiniform shells with a prominent, noded, subsutural cord. Early whorls are absent. Upper whorl surface flat to slightly convex with faint ridge or depression at midwhorl. Well-developed, elongate, collabral nodes on subsutural spiral cord; one or more faint spiral threads just below this cord and a stronger thread below them. Central raised or depressed area and rest of whorl surface lack ornament. Selenizone is on periphery, which is low on whorl. Selenizone margins are spiral lirae, sharply formed. Several spiral threads on convex selenizone; collabral threads form interference nodes with spiral elements. Base is flat, apertural details unknown.

DISCUSSION: This single specimen differs from the type in being somewhat lower spired and by having a strongly formed subsutural cord. The type lacks collabral ornament. Both have a distinct unornamented lower portion of the outer whorl surface. One specimen, loc. 2014.

MEASUREMENTS: Figure 22, AMNH 44927, H 4.0 mm, W 4.5 mm, SPANG 67°.



Figs. 10–21. **10.** *Eirylsia* cf. *reticulata* Batten, AMNH 44912, oblique side view, ×17. **11.** *Glabrocingulum grayvillensis* Norwood and Pratten, AMNH 44913, oblique side view, ×7. **12.** *Apachella* cf. *glabra,* Batten, 1989, AMNH 44914, side view, ×14. **13.** *Apachella* cf. *turbiniformis,* Winters, AMNH 44915, side view, ×11. **14.** *Apachella powwowensis,* n. sp., AMNH 44916, holotype, side view, 14. **15.** *Peruvispira delicata* Chronic, **(a)** AMNH 44917, side view, ×7, **(b)** AMNH 44919, side view, ×7. **16.** *Ferganospira acteonina,* n. sp., **(a)** AMNH 44919, holotype, side view, ×11, **(b)** paratype AMNH 44920, side view, ×8. **17.** Neilsonid species, indeterminate, AMNH 44921, loc. 2014, side view, ×14. **18.** *Platyzona* cf. *tornatilis* (Phillips), AMNH 44922, side view, ×6. **19.** *Phymatopleura nodosa* (Girty), AMNH 44923, loc. 2014, side view, ×10. **20.** *Borestus magdalensis,* n. sp., AMNH 44924, holotype, loc. 2014, oblique side view, ×7. **21.** *Borestus texanus,* n. sp., **(a)** AMNH 44925, holotype, side view, ×7, **(b)** AMNH 44926, paratype, side view, ×11.

FAMILY PORTLOCKIELLIDAE
BATTEN, 1956

Tapinotomaria Batten, 1956

TYPE SPECIES: *T. rugosa* Batten, 1956: 42.

Tapinotomaria crassa
Batten, 1958.
Figure 23

Tapinotomaria crassa Batten, 1958: 190, pl. 33, fig. 3.

DESCRIPTION: Globose to turreted shells with strongly developed ornament. Sutures deeply impressed and whorls embrace on, or just below upper selenizone margin. Upper whorl surface slightly convex with a medial spiral cord and a lower spiral cord which, in part, form the periphery of the shell. Collabral cords form nodes at the intersection of spiral cords. Upper selenizone margin and superjacent spiral cord form periphery so that concave selenizone slants downward on base. Lunulae well developed. Base flatly rounded with six prominent spiral lirae, equally well developed and spaced. Hemiomphalus. Columellar lip is reflexed.

DISCUSSION: These two fragments most resemble *T. crassa* Batten, 1958, from the Cathedral Mountain formation (USNM loc. 702) in the shell shape, presence of two spiral cords on the upper whorl surface and 6 spiral lirae on the base, strongly developed collabral ornament over the course of the shell surface, and the reflexed columellar lip. Undescribed specimens from the Pennsylvanian of north central Texas are additional evidence of the presence of the genus in the Pennsylvanian. 2 specimens.

MEASUREMENTS: Figure 23, AMNH 44928, H 2.2 mm, W 3.0 mm, SPANG 85°.

Tapinotomaria globosa
Batten, 1958
Figure 24

Tapinotomaria globosa Batten, 1958: 187, pl. 32, figs. 1–11.

DESCRIPTION: Trochiform shells with inflated whorls. Early whorls smooth. Whorl profile evenly inflated. Sutures sharp and deep. Upper whorl surface has five spiral cords evenly distributed. Cord immediately adjacent to suture weaker in development. Selenizone just below periphery. Whorls embrace on lower margin of selenizone. Base evenly inflated with well-developed spiral cords equal like those on upper whorl surface.

DISCUSSION: These shells are very similar to the specimen illustrated in Batten, 1958, pl. 32, fig. 1, from the lower Permian Hueco Formation. Two specimens.

MEASUREMENTS: Figure 24, AMNH 44929, H 4.4 mm, W 4.5 mm, SPANG 57°.

FAMILY LOPHOSPIRIDAE
WENZ, 1938

SUBFAMILY RUEDEMANNIINAE
KNIGHT, 1956

Worthenia de Koninck, 1883

TYPE SPECIES: *Turbo tabulata* Conrad, 1835: 267.

Worthenia speciosa
(Meek and Worthen), 1861
Figure 25

Pleurotomaria speciosa Meek and Worthen, 1861.

DESCRIPTION: Trochiform shells with well-developed spiral and collabral ornament. Early whorls smooth, evenly inflated with selenizone located at midwhorl periphery. Flat selenizone bordered by two prominent spiral threads. Upper whorl surface convexo-concave with from two to eight or more evenly spaced and developed spiral threads. Narrow flattened platform adjacent to suture. Prominent collabral threads or cords form interference nodes with spiral ornament. Selenizone on shoulder is flat with two spiral margin threads. Collabral ornament forms lunulae and interference nodes with medial spiral cord so that selenizone appears convex. Concave alveozone has one to four spiral threads. Hemiomphalus. Flatly rounded base has numerous spiral threads. Columellar lip is reflexed and thickened into a callus. Ornament is resorbed on parietal surface.

DISCUSSION: This species belongs to the *W. speciosa* group of species; they maintain a flat or even concave selenizone which is heavily ornamented to form an apparent convex selenizone (see Batten, 1989: 47). These Magdalena specimens fall within the morphological range of *W. speciosa* (Meek and Worthen),

1861, but differ in having a less pronounced subsutural platform and slightly less well-developed collabral ornament particularly near the suture. There is some variation in the number and development of spiral threads. 15 specimens.

MEASUREMENTS: Figure 25, AMNH 44930, H 3.3 mm, W 3.4 mm, SPANG 65°.

Worthenia cf. *tabulata*
(Conrad), 1835
Figure 26

Turbo tabulata Conrad, 1835: 267, pl. 12, fig. 1.
Worthenia tabulata Ulrich *in* Ulrich and Scofield, 1897: 949.

DESCRIPTION: Shell relatively high-spired and gradate. Early whorls smooth and evenly inflated. Sutures sharp but shallow. Upper whorl surface of adult shell concave with well-developed subsutural, noded, spiral cord. Prominent noded selenizone forms shoulder. Alveozone flat to slightly concave. Whorls embrace just below alveozone on base. Base flatly rounded. Collabral ornament composed of slightly reinforced growth lines except on upper whorl surface spiral cords where they are more strongly developed.

DISCUSSION: This single specimen has a shell shape that is midway between the trochiform *W. speciosa* and the tabulate *W. tabulata.* The concave upper whorl surface is different from *W. speciosa,* which is convexo-concave, and *W. tabulata,* which is more flattened. The most obvious difference is the much reduced collabral and spiral ornament. One specimen.

MEASUREMENTS: Figure 26, AMNH 44931, H 2.8 mm, W 3.2 mm, SPANG 57°.

SUPERFAMILY MURCHISONIACEA
KOKEN, 1896

FAMILY MURCHISONIIDAE
KOKEN, 1896

Stegocoelia Donald, 1889

TYPE SPECIES: *Murchisonia* (*Stegocoelia*) *compacta* Donald, 1889: 624.

DISCUSSION: *Stegocoelia* is distinct in being turreted with a well-developed periphery (carina of authors) medially placed or low on the whorl and having a quadrate apertural outline with a straight and reflexed columellar lip. The lower margin of the selenizone is just above the periphery. A siphonal notch is usually at the juncture of the lower lip and the columellar lip. Most species are anomphalus. *Donaldospira* possesses these features plus having the selenizone exactly at the periphery; therefore, this subgenus properly belongs within *Stegocoelia.* This would complement the series of subgenera where the selenizone varies in relation to the periphery, for example, *S.* (*Taosia*) has the selenizone well above the periphery, *S.* (*Hypergonia*) has the selenizone at the periphery with the lower margin marking the periphery. To complete the series, I am placing the genus *Goniasma* Tomlin, 1930, as a subgenus of *Stegocoelia. Goniasma* has all the subgeneric features associated with *Stegocoelia* but the selenizone lies just under the periphery with its upper margin marking the periphery.

Stegocoelia (*Donaldospira*)
Batten, 1966

TYPE SPECIES: *Murchisonia pertusa* de Koninck, 1883.

DISCUSSION: Batten (1966: 68) placed this subgenus as a member of *Murchisonia* D'Archiac and Verneuil, 1841, because of the centrally located selenizone. Most species of *Murchisonia* have rounded whorl profiles with the periphery at the middle of the whorl marked by the selenizone. Very few species are turreted. Therefore, *Donaldospira* should be considered a subgenus of *Stegocoelia.*

This is the first report of the subgenus in the Pennsylvanian. The type species is from the lower Carboniferous of Europe and an additional species was described from the Permian: *S.* (*D.*) *malaysia* Batten, 1985.

Stegocoelia* (*Donaldospira*) *nodosa,
new species
Figure 27

DIAGNOSIS: Turreted shells with a wide, noded selenizone at the periphery.

DESCRIPTION: Early whorls unknown. Upper whorl face convexo-concave with four or five equally spaced and developed spiral lirae. Collabral ornament consists of reinforced growth lines. Medially placed periphery marked by large spiral cord with wide, convex selenizone with strongly formed lunulae appearing as nodes. Outer whorl face has well-

developed spiral cord separated from selenizone by a trough. Bottom of outer whorl face marked by a large spiral cord. Whorls embrace just below this cord. Flattened base has three to five spiral lirae. Apertural features are unknown.

DISCUSSION: This species is unique in that it has strongly developed lunulae on the selenizone, resembling *S.* (*T.*) *crenulata* Girty, 1939. In addition, the spiral ornament is much more fully formed than in the two other known species.

This single fragment is beautifully preserved with growth lines showing the critical features. I am reluctant to name a new species based on a fragment, but all features necessary to recognize a valid species are present. One specimen.

MEASUREMENTS: Holotype, Figure 27, AMNH 44935, H 2.8 mm (broken), W 2.1 mm.

ETYMOLOGY: Nodus, Latin for knot.

Stegocoelia (*Taosia*) Girty, 1939

TYPE SPECIES: *Murchisonia copei* White, 1881: 31.

Stegocoelia (*Taosia*) *copei*
(White), 1881
Figure 28

Murchisonia copei White, 1881: 31.
Taosia copei Girty, 1939: 22.
Stegocoelia (*Taosia*) *copei* Knight et al., 1960: I293.

DESCRIPTION: Turreted shells with peripheral unornamented carinae. Upper whorl face flat to slightly concave or slightly convex. Medially placed selenizone bordered by spiral cords. Periphery low on whorls, and marked by a prominent spiral cord that has no collabral noding. Base flatly rounded to rounded. Large spiral cord just under periphery and just under that cord whorls embrace. One or more spiral cords or lira are found below large subperipheral cord. Anomphalus. Columellar lip is straight and there may be a siphonal notch.

DISCUSSION: This species is very similar to *S.* (*T.*) *crenulata* Girty, 1939, in the position of the selenizone on the upper whorl surface, the tendency for the whorl profile to vary from strongly turreted to more rounded, and the lack of collabral ornament (except for the noding on the carina in that species). It differs in having spiral ornament on the base and with the periphery slightly higher on the whorl, at least on the Magdalena specimens. 11 specimens.

MEASUREMENTS: Figure 28, AMNH 44936, H 5.0 mm, W 2.3 mm, SPANG 29°.

Stegocoelia (*Taosia*) *crenulata*
(Girty), 1939
Figure 29 a, b

Taosia crenulata Girty, 1939: 26, figs. 8–11.
Stegocoelia (*Taosia*) *crenulata* Yochelson and Saunders, 1967: 213.

DESCRIPTION: High spired, turreted shells with noded periphery. Early whorls smooth and rounded. Sutures sharp and deeply inset. Upper whorl face concave, concavo-convex, or convex with a broad, flat selenizone located in middle of face, bordered by two spiral cords. No collabral ornament. Periphery low on the whorl and marked by a large spiral cord, which may be on a sharp keel or ill-defined on rounded whorl. It is strongly noded with elongated nodes extending onto upper whorl face and base. Nodes follow track of growth lines. Base flatly rounded to rounded. Large spiral cord just under periphery and whorls embrace just beneath it. Anomphalus.

DISCUSSION: As noted by Girty (1939: 26), the height of the shell is quite variable. The lower spired the shell, the less prominent the periphery and the more rounded the whorl profile (fig. 29b).

The higher spired the shell the more prominent is the periphery with the upper whorl surface concavo-convex or concave with a more flattened base (fig. 29a). The Magdalena specimens are very similar to the types from the Laborcita Formation in La Luz Canyon, New Mexico in upper whorl face features except that they lack an extra subsutural spiral cord. The most conspicuous difference is on the base, which Girty described as having coarse spiral cords, seemingly absent on the Magdalena specimens. 26 specimens.

MEASUREMENTS: Figure 29a, AMNH 44937, H 5.5 mm, W 3.2 mm, SPANG 22°; 29b, AMNH 44938, H 7.0 mm, W 2.7 mm, SPANG 16°.

Stegocoelia (*Hypergonia*)
Donald, 1892

TYPE SPECIES: *Murchisonia quadricarinata* M'Coy, 1844.

Stegocoelia (*Hypergonia*) *percostata*
(Girty), 1939
Figure 30

Taosia percostata Girty, 1939: 25–26, figs. 12–14.
Stegocoelia (*Taosia*) *percostata* Yochelson and Saunders, 1967.
Stegocoelia (*Taosia*) *percostata* Kues, 1991.

DESCRIPTION: Turreted forms with well-developed spiral ornament on base. Upper whorl surface flat to slightly concave. There may or may not be a spiral lirae just below suture. Sutures shallow. Upper margin of selenizone is a spiral cord as is lower margin at periphery. Periphery is either a sharp keel, giving the shell a more turreted appearance, or marked only by lower selenizone margin cord, making the shell whorl profile more rounded. Just below periphery there is a large spiral cord below which the whorls embrace. Two or more spiral cords on the flatly rounded to rounded base. Anomphalus. Columellar lip straight and at juncture with lower lip there may be a siphonal trough.

DISCUSSION: The presence of the selenizone immediately above the periphery indicates that this species properly belongs to the subgenus *Hypergonia.* The Magdalena specimens are similar to the paratype—figure 14 of Girty (1939)—which has well-developed basal spiral ornament and a subsutural spiral lirae. There is some variation in the whorl profile ranging from strongly turreted with a well-developed keel and a concave upper whorl surface to a more rounded profile with a less well-developed periphery. 11 specimens.

MEASUREMENTS: Figure 30, AMNH 44939, H 5.0 mm, W 2.4 mm, SPANG 24°.

Stegocoelia (*Goniasma*)
Tomlin, 1930

Goniospira Girty, 1915.
Goniasma Tomlin, 1930: 23, for *Goniospira* Girty, 1915.

TYPE SPECIES: *Murchisonia lasallensis* Worthen, 1890: 141, pl. 25, fig. 2.

DISCUSSION: As discussed above, I believe the characters that separate the other subgenera of *Stegocoelia* apply equally to this subgenus. The generic features of a high-spired, turreted shell with a pronounced mid-whorl to low whorl periphery with a selenizone located near the periphery apply to this subgenus. The distinctive subgeneric feature which serves to separate *S. Goniasma* from *S. Hypergonia,* for example, is the placement of the selenizone just below the periphery.

Stegocoelia (*Goniasma*) *lasallensis*
(Worthen), 1890
Figure 31

Murchisonia lasallensis Worthen, 1890: 141, pl. 25, fig. 7.
Goniospira lasallensis Girty, 1903: 457.
Goniasma lasallensis Girty, 1939: 30.

DESCRIPTION: High-spired, turreted shells with wide selenizone located immediately below sharply formed periphery. Sutures deep, narrowly defined, sharply depressed. Upper whorl surface evenly concave and ornamented only by growth lines. Periphery marked by shoulder at midpoint of whorl profile and is most conspicuous feature of shell. Selenizone concave with periphery serving as upper margin. Lower margin a spiral cord much weaker than upper margin. Alveozone concave and sloping downward. Lower margin marked by a spiral cord about equally well-developed as lower selenizone margin. Whorls embrace on lower alveozone margin. No collabral ornament. Base is absent.

DISCUSSION: This fragment of three whorls is very distinct and can be placed in this species with confidence. It differs from the illustrations of Girty (1939) from the Magdalena of La Luz Canyon, New Mexico, in having a sharper, narrower periphery and a wider selenizone. It is identical in all respects to that of the types illustrated by Knight (1941: pl. 42, fig. 6) This species is reported by Kues (1984) from the Flechado Formation. One specimen.

MEASUREMENTS: Figure 31, AMNH 44940, H 5.4 mm (broken), W 3.6 mm, SPANG 26°.

SUPERFAMILY TROCHONEMATACEA
ZITTEL, 1895

FAMILY TROCHONEMATIDAE ZITTEL, 1895

Cyclites Knight, 1940

TYPE SPECIES: *Pleurotomaria multilineata* Girty, 1908.

DISCUSSION: This genus is predominantly known from species in the Permian; see Yochelson (1956). As far as I am aware, this is the earliest occurrence of the genus.

Cyclites cf. *multilineata* (Girty), 1908
Figure 32 a–c

Pleurotomaria multilineata Girty, 1908: 468, pl. 33, fig. 25.
Cyclites multilineata Knight, 1940: 311.

DESCRIPTION: Trochiform specimens with fine spiral ornament. Whorls embrace at midwhorl shell periphery. Upper whorl surface flat to slightly convex and at a right angle to axis. 5 to 10 fine spiral threads are evenly spread over this surface and collabral undulations somewhat more sharply defined toward suture. There may be a subsutural spiral thread or cord. Outer whorl face flat to slightly concave with 10 spiral threads evenly spaced and forming a right angle with upper whorl surface. Shell periphery is on lower half of this face. Base flatly rounded with from 10–15 fine spiral threads evenly spaced but becoming finer toward the umbilicus. Phaneromphalus. Aperture unknown but growth lines swing back on upper whorl surface to shoulder and forward from shoulder on outer whorl face, so that a v-shaped notch is formed at shoulder.

DISCUSSION: The three specimens illustrated are very similar to the type species from the Guadalupian of west Texas. I am provisionally placing them in this species because of the time discrepancy. Morphologically they are distinct from *C. costatus* Yochelson, 1956, in having finer ornament and being higher spired. It is interesting that the four specimens, while having many of the attributes of this species, differ in significant respects from each other. For example, the specimen in figure 32b has a distinct concave alveozone, whereas the other two have a flat alveozone. Figure 32c is higher spired because the whorls embrace lower on the base. 4 specimens.

MEASUREMENTS: Figure 32a, AMNH 44932, H 2.2 mm, W 2.8 mm, SPANG 74°; 32b, AMNH 44933, H 1.9 mm, W 2.2 mm, SPANG 80°; 32c, AMNH 44934, H 3.4 mm, W 3.1 mm, SPANG 56°.

SUPERFAMILY PLATYCERATACEA HALL, 1859

FAMILY HOLOPEIDAE WENZ, 1938

SUBFAMILY GYRONEMATINAE KNIGHT, 1956

Yunnania Mansuy, 1912

TYPE SPECIES: *Yunnania termieri* Mansuy, 1912: 104, pl. 19, fig. 1.

DISCUSSION: The genus *Yunnania* has become a catchall category for species with trochiform, moderately high-spired shells, having rounded whorls, with dominant spiral cords scattered evenly across the whorls and which are found sporadically in Upper Paleozoic faunas.

Yunnania sp.
Figure 33

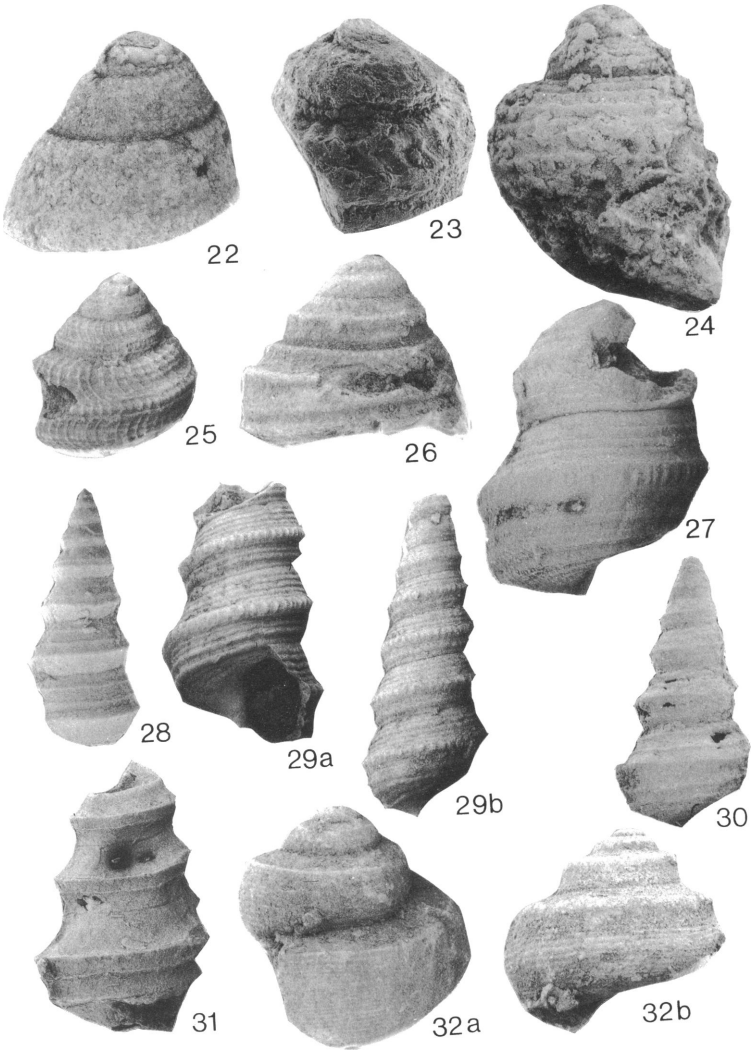
DESCRIPTION: Moderately high-spired, trochiform shells with evenly rounded whorls. Whorls embrace on third spiral cord beneath midwhorl periphery. Sutures deeply impressed. Rounded upper whorl surface has five well-developed and evenly spaced spiral cords. Rounded base beneath periphery has eight spiral cords. Aperture and umbilicus not preserved.

DISCUSSION: This single specimen is very similar to the European Carboniferous *Y. semicancellata* de Koninck, 1881, in the shell shape and spiral ornament but lacks the cancellate collabral ornament on the upper whorl surface. It also resembles *Y. leavenworthana* (Hall), 1856, from the Salem fauna (Mississippian) of Indiana in the shell shape and whorl profile, but has fewer and more fully developed spiral cords. One specimen.

MEASUREMENTS: Figure 33, AMNH 44941, H 2.6 mm, W 2.6 mm, SPANG 63°.

SUPERFAMILY MICRODOMATACEA WENZ, 1938

FAMILY MICRODOMATIDAE WENZ, 1938



Figs. 22–32b. **22.** *Paragoniozona* cf. *multilirata* Nelson, AMNH 44927, loc. 2014, oblique side view, ×8. **23.** *Tapinotomaria* cf. *crassa* Batten, AMNH 44928, oblique side view, ×14. **24.** *Tapinotomaria globosa* Batten, AMNH 44929, apertural view, ×7. **25.** *Worthenia speciosa* (Meek and Worthen), AMNH 44930, oblique side view, ×7. **26.** *Worthenia tabulata* (Conrad), AMNH 44931, side view, ×10. **27.** *Stegocoelia* (*Donaldospira*) *nodosa,* n. sp., AMNH 44935, holotype, side view, ×14. **28.** *S.* (*Taosia*) *copei* (White), AMNH 44936, side view, ×7. **29.** *S.* (*Taosia*) *crenulata* (Girty), **(a)** AMNH 44397, apertural view, ×7, **(b)** AMNH 44938, side view, ×6. **30.** *S.* (*Hypergonia*) *percostata* (Girty), AMNH 44939, side view, ×8. **31.** *S.* (*Goniasma*) *lasallensis* (Worthen), AMNH 44940, side view, ×7. **32** *Cyclites* cf. *multilirata* (Girty), **(a)** AMNH 44932, oblique side view, ×13, **(b)** AMNH 44933, side view, ×14.

Microdoma Meek and Worthen, 1867

TYPE SPECIES: *Microdoma conicum* Meek and Worthen, 1867: 269. = *Euconodoma* Kues, 1990.

DISCUSSION: McLean (1981) has proposed that this genus and the other microdomatids be associated more closely with the trochaceans solely on the grounds that they are trochacean in superficial appearance. This suggestion was adopted by Erwin (1988a) on other grounds. I would suggest that the group

of Triassic and Jurassic genera which are relatively high-spired with one or more spiral cords on the upper whorl surface and have relatively thin shells that appear to lack nacreous layers, such as *Diplochilus* Wohrmann, 1894, *Proconulus* Cossmann, 1918, and *Trypanotrochus* Cossmann, 1918, are more closely associated with the microdomatids of the Paleozoic. It seems to me that a revision of the Triassic and Jurassic trochid systematics including these and Paleozoic microdomatid genera should be made. In the meantime, I will continue to recognize the microdomatids as a distinct superfamily.

Kues (1990: 254) proposed a new genus *Euconodoma* for a new species, *E. gavinae,* a microdomatid from the Flechado Formation (mid-Pennsylvanian) of New Mexico. The principal distinguishing feature was a single, noded spiral cord on the low periphery reduced to absent collabral ornament except for transverse costae restricted to the early whorls. In addition, there are infrequently observed subsutural nodes. Previously described species of *Microdoma* consistently have collabral ornament well developed from early ontogeny onward until the gerontic stages. Importantly, there are three major spiral elements on the whorl surface that are variously developed and form the basis, in part, for species recognition. There is no question that *E. gavinae* represents an extreme version of the *Microdoma* theme in that there is no persistent collabral ornament and there is a dominant single, noded spiral cord on the adult whorls. However, the discovery of spiral grooves and a raised ridge on the midwhorl surface of some Magdalena specimens of *E. gavinae* (see fig. 35b) suggests that there is an incipient separation into three spiral units. This, along with the abovementioned transverse costae, indicates that there is a genetic continuity between *E. gavinae* and the species of *Microdoma.* This conclusion is partly reinforced by the analysis of Kues (1990: 256) of *Microdoma ornatus* Sayre (1930), which seems to be an intermediate stage between the full-blown ornamentation of *M. conicum* and the reduced ornament of *E. gavinae.* Therefore, I will consider this species to be an extreme end of the *Microdoma* spectrum, rather than as a monotypic, separate genus.

Microdoma conicum
Meek and Worthen, 1866
Figure 34

Microdoma conica Meek and Worthen, 1866: 269.
Microdoma conicum Knight, 1933a: 48–49.

DESCRIPTION: High-spired, turbiniform shells with three adult sets of spiral nodes. Protoconch is smooth and rounded. Sutures sharp but shallow. Juvenile shells with a flattened outer whorl face with evenly spaced and developed collabral cords. Periphery is low on whorl and marked by broad, rounded spiral cord. At 6th to 7th whorls collabral cords are broken up by two spiral grooves dividing whorl surface into three equal portions. By 8th whorl, whorl profile becomes somewhat inflated and collabral cords become elongated nodes. By 10th whorl whorl profile is rounded and nodes are rounded and symmetrical. Peripheral spiral cord is subdued. Base is flatly rounded and ornamented by growth lines alone. Phaneromphalus, hemiomphalus, or cryptomphalus. Columellar lip is reflexed and apertural margins are thin.

DISCUSSION: The types of this species from the St. David Limestone of Illinois are missing. This group of specimens conforms very closely to the description and illustrations of Knight (1933a: 48–49, pl. 9, figs. a–i) from the Labette Shale (Pennsylvanian of Missouri). Those illustrations show variation of the spiral height as measured by the spiral angle of 22 to 45°. There is much variation in the insertion time of the spiral grooves that cause the collabral cords to be broken up into nodding from the 3rd to the 6th whorls. The Magdalena specimens show collabral cord development in the early whorls from just a few coarse cords that are widely spaced to many fine lirae closely spaced on the 2nd to 5th whorls. In gerontic specimens, the whorl profile becomes rounded with the reduction in the size of the nodes on the whorl surface and the disappearance of the spiral grooves. There is much variation in the timing of the appearance of the cords, the spiral grooves, and the rounding of the whorls. These features are different from such European species as *M. triserrata* Batten, 1966, where the collabral and spiral ornament are consistently well developed throughout most of the ontogeny. 24 specimens.

MEASUREMENTS: Figure 34, AMNH 44942, H 8.2 mm, W 5.0 mm, SPANG 40°.

Microdoma gavinae (Kues), 1990
Figure 35 a, b

Euconodoma gavinae Kues, 1990: 255–256, fig. 9–19.

DESCRIPTION: High-spired, turbiniform shells with noded, spiral cord on low periphery. Early whorls smooth and rounded to flattened. Adult outer whorl face flat to either slightly concave to convex. Periphery very low on whorl and marked by large, noded, spiral cord. Whorls embrace just under cord. Uncommonly, there is a row of very weak subsutural nodes. There may be two spiral grooves located on midwhorl surface separating a slightly raised ridge. Final whorl on large specimens is rounded with a weakening of nodes and spiral cord. Base is flatly rounded. Minutely phaneromphalus to cryptomphalus. Columellar lip is short, straight, slightly reflexed.

DISCUSSION: The Magdalena specimens differ from those described by Kues in being higher spired (26–37° Magdalena vs. 43–47°) and without any early whorl ornament. In addition, some specimens show spiral grooves and a raised area in midwhorl, and the whorl profile and base are more rounded. Since the Magdalena shells are found stratigraphically and geographically adjacent to the Flechado and are similar in most features, I assume the Magdalena material to be a subset of *M. gavinae.* 72 specimens.

MEASUREMENTS: Figure 35a, AMNH 44943, H 6.2 mm, W 3.8 mm, SPANG 34°; 35b, AMNH 44944, H 2.7 mm, W 1.7 mm, SPANG 31°.

Glyptospira Chronic, 1952

TYPE SPECIES: *Glyptospira cristulata* Chronic, 1952: 127–128.

DISCUSSION: This genus appears to be closely related to *Microdoma.* See Erwin (1988a) for a phylogenetic analysis of the Permian species.

Glyptospira quadriserrata,
new species
Figure 36

DIAGNOSIS: Turbiniform shells with four spiral elements above the low periphery.

DESCRIPTION: Early whorls are smooth and rounded. Suture sharp but shallow. Upper whorl face flattened with a subsutural, somewhat flattened ramp. Four equally spaced and developed spiral lirae have well-developed nodes aligned with growth lines. Fourth spiral element marks periphery, low on whorl. One or more intercalated spiral lirae are restricted to third or fourth spiral cords. Whorls embrace just under periphery. Base is flatly rounded. Six or more noded spiral cords on base are less well-developed than those on upper whorl surface. Anomphalus or cryptomphalus. Columellar lip is reflexed and thickened into a callus. Parietal surface is smooth with resorbed ornament.

DISCUSSION: The Magdalena specimens differ from all other species in having four equally spaced and developed spiral lirae which form large interference nodes on the upper whorl face. These spiral and collabral lirae are weakly developed except at their intersections. It is difficult to assess the position of these specimens in light of Erwin's (1988a) phylogenetic analysis of *Glyptospira. Microdoma,* the outgroup that he used, has a basic tripartite division of the upper whorl surface, as does his plesiomorphic species of lower Permian *Glyptospira.* The more derived species such as *G. huecoenesis* Erwin, 1988a, have two spiral elements above the periphery. Thus, *G. quadriserrata* is a plesiomorphic species possibly, as presently understood, a precursor to the later species of *Glyptospira.* 3 specimens.

MEASUREMENTS: Figure 36, AMNH 44945, H 7.2 mm, W 6.0 mm, SPANG 53°.

ETYMOLOGY: *Quattuor,* Latin, for four; *serra,* Latin for saw.

SUPERFAMILY ANOMPHALACEA
WENZ, 1938

FAMILY ANOMPHALIDAE
WENZ, 1938

Anomphalus Meek and Worthen, 1867

TYPE SPECIES: *Anomphalus rotalus* Meek and Worthen, 1867: 268.

Anomphalus verruculiferus
(White), 1881
Figure 37 a, b

Rotella verruculiferus White, 1881: 32, pl. 4, fig. 7.
Anomphalus verruculiferus Yochelson, 1956: 252–253.

DESCRIPTION: Rotelliform shells with a massive umbilical callus. Very low-spired shells with whorls embracing on upper whorl surface. Upper whorl face gently rounded. Outer whorl face slightly flattened with ill-defined shoulder and basal angulation that marks low periphery. Base is flatly rounded. Early whorls are phaneromphalus, adults are cryptomphalus. Columellar lip begins to swell at fourth whorl to form a callus, by adult whorl callus has expanded to umbilical boss and is most prominent feature of shell; columellar fold low on columellar lip.

DISCUSSION: The most unique feature of this species is the very large umbilical boss. In other shell features it is somewhat similar to *A. vanescens* Yochelson, 1956, and *A. umbilicatus* Knight, 1933. The presence of an ill-defined shoulder and basal angulation serves to further separate this species. Kues (1984) reported this species from the Flechado Formation near Taos, New Mexico. 94 specimens.

MEASUREMENTS: Figure 37a, AMNH 44946, H 3.5 mm, W 6.3 mm, SPANG 132°; 37b, AMNH 448947, H 2.0 mm, W 5.0 mm.

SUBORDER NERITOPSINA
COX AND KNIGHT, 1960

SUPERFAMILY NERITACEA
RAFINESQUE, 1815

FAMILY NERITOPSIDAE
GRAY, 1815

SUBFAMILY NATICOPSINAE
GRAY, 1815

Naticopsis (*Naticopsis*)
M'Coy, 1946

TYPE SPECIES: *Naticopsis griffithi* M'Coy, 1844.

Naticopsis (*Naticopsis*) *judithae*
Knight, 1933
Figure 38 a, b

Naticopsis judithae Knight, 1933b: 382, pl. 44, fig. 7.

DESCRIPTION: High-spired fusiform to subovate shells. Whorl profile evenly rounded to somewhat flattened on upper whorl surface and angulate around periphery. Periphery midwhorl to low on whorl. Whorls embrace well above periphery. Growth lines near suture may be reinforced or there may be lirae. Columellar lip lunulate with large parietal callus near upper portion which may be ornamented in parietal area with either pustules or ridges.

DISCUSSION: The Magdalena specimens are quite similar to the types, particularly in the shape of the shell and the height of the spire. There is considerable variation in the whorl profile ranging from flattened above the low periphery and somewhat flattened beneath the periphery to evenly rounded with a midwhorl periphery. Subsutural lirae are present in half the specimens. 90 specimens.

MEASUREMENTS: Figure 38a, AMNH 44948, H 4.5 mm, W 4.3 mm, SPANG 96°; 38b, AMNH 44949, H 2.8 mm, W 2.1 mm, SPANG 90°.

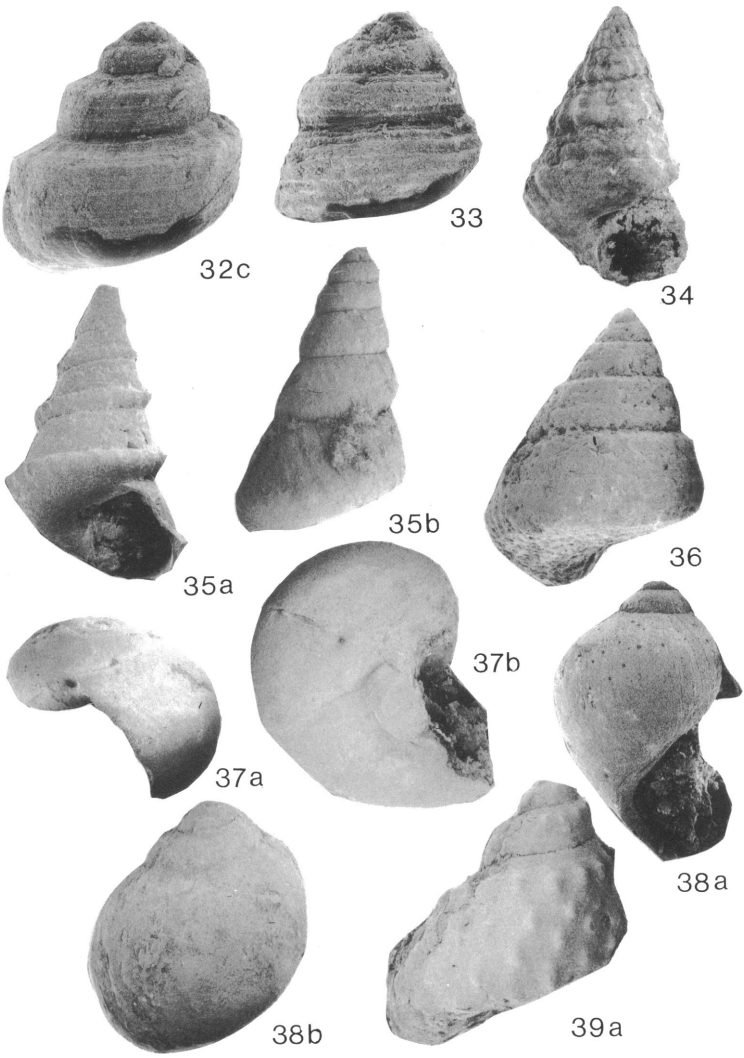
SUBFAMILY NERITOPSINAE
GRAY, 1847

Trachydomia
Meek and Worthen, 1866

TYPE SPECIES: *Naticopsis nodosa* Meek and Worthen, 1860: 463.

DISCUSSION: In the initial examination of the Magdalena Neritopsinae, I isolated two groups of specimens. One group has a subsutural and a lower outer whorl face row of spiral nodes; I assigned it to the genus *Turbonitella*. The other group has multiple spiral rows of nodes on the outer whorl face and it obviously belongs to the genus *Trachydomia*. As the study progressed, I noted that the *Trachydomia* species is relatively high-spired, revealing more of the early whorl outer whorl face. The early whorls have two rows of nodes on the outer whorl face, the same as the species of *Turbonitella*. Further examination showed that the *Turbonitella* species was, in fact, merely immature specimens of *Trachydomia*.

This conclusion certainly reinforces Knight's (1933b: 364) observation that both genera are very closely related and that *Trachydomia* probably arose from *Turbonitella* although, at the present time, I am not suggesting a neotenous origin.



Figs. 32c–39a. **32c.** *Cyclites* cf. *multilirata* (Girty), AMNH 44934, side view, ×11. **33.** *Yunnania* sp., AMNH 44941, ×11. **34.** *Microdoma conicum* Meek and Worthen, AMNH 44942, apertural view, ×5. **35.** *Microdoma gavinae* Kues, **(a)** AMNH 44943, apertural view, ×7, **(b)** AMNH 44944, side view of embryonic whorls, ×14. **36.** *Glyptospira quadriserrata,* n. sp., AMNH 44945, loc. 2014, holotype, side view, ×6. **37.** *Anomphalus verriculiferus* (White), **(a)** AMNH 44946, oblique apertural view, ×7, **(b)** AMNH 44947, basal view, ×6. **38.** *Naticopsis* (*Naticopsis*) *judithae* Knight, **(a)** AMNH 44948, apertural view, ×7, **(b)** AMNH 44949, oblique side view, ×14. **39.** *Trachydomia turbonitella,* n. sp., **(a)** AMNH 44950, holotype, side view, ×7.

Trachydomia turbonitella,
new species
Figure 39 a–c

DIAGNOSIS: Relatively high-spired, naticiform shells with rows of coarse nodes.

DESCRIPTION: Early whorls evenly rounded and unornamented. 3rd to 4th whorls may have a subsutural trough bounded by sharply defined suture and row of nodes rounded or elongated into asymmetric costae which may extend down to periphery. Whorls embrace just above midwhorl. Another row of nodes is present at base of outer whorl face. By 4th to 5th whorls, an additional, weaker row of

nodes appears just above lower whorl face row. By 5th to 6th whorls (the adult whorls) additional midwhorl rows appear so that evenly developed rows of nodes are present across whorl face. Rows are arranged quincunxially. Base is evenly rounded with, in some cases, an additional row of nodes. Columellar lip is swollen with a callus that extends and thickens into parietal region.

DISCUSSION: This species is similar to *T. whitei* Knight, 1933b, in the development and arrangement of the nodes but differs in the presence of two rows of nodes in the early ontogeny, a unique feature not known in any other species of *Trachydomia.*

This species is one of the most variable within the family. The whorl profile varies from an evenly rounded to concavo-convex outer whorl face which may be interrupted by a subsutural ramp variable in shape and development. In addition, the upper spiral row of nodes may be relatively weak with rounded nodes to sharply asymmetrical costae in which the upper portion is spinose. The lower spiral row may be weaker than the upper. The rows of nodes are added rather abruptly and usually progressively from the lower part of the outer whorl face upward. The position on the whorl where intercalation takes place varies from specimen to specimen. 140 specimens.

MEASUREMENTS: Holotype, figure 39a, AMNH 44950, H 5.1 mm, W 4.8 mm, SPANG 67°; paratype, 39b, AMNH 44951, H 4.3 mm, W 3.4 mm, SPANG 52°; paratype, 39c, AMNH 44952, H 7.0 mm, W 5.5 mm, SPANG 56°.

ETYMOLOGY: Named for the genus *Turbonitella* de Koninck, 1881.

ORDER MESOGASTROPODA THEILE, 1925

SUPERFAMILY CERITHIACEA FLEMING, 1822

FAMILY TURRITELLIDAE WOODWARD, 1851

Orthonema Meek and Worthen, 1862

TYPE SPECIES: *Eunema*? *salteri* Meek and Worthen (1861).

DISCUSSION: For a complete review of this genus see Erwin (1985, 1988c).

Orthonema salteri Meek and Worthen, 1860

Figure 40 a, b

Eunema? *salteri* Meek and Worthen, 1860: 464.
Orthonema salteri Meek and Worthen, 1866: 381.
= *O. conicum* Meek and Worthen, 1866: 270.
O. bilineatum Mark, 1912: 316.
O. schucherti Knight, 1934b: 441.
O. werneri Knight, 1934b: 441.

DESCRIPTION: High-spired, turreted shells with flat to concave outer whorl faces. Early whorls are smooth. Third to fourth whorls have large spiral cord at midwhorl with spiral lira just under it. By fifth to sixth whorls, these spiral elements migrate to base of outer whorl face and an upper subsutural spiral cord appears. By seventh whorl (beginning of adult phase) upper, subsutural cord becomes dominant spiral element and forms border of outer whorl face. Sutures sharp and deep. Upper whorl face narrow and concave to flat with one or two spiral lirae on adult whorls. Outer whorl face flat to concave and is unornamented. Whorls embrace just under lower outer whorl face spiral cord, where there may be additional spiral lira. Base flatly rounded and unornamented except by slightly reinforced growth lines. Columellar lip arcuate; siphonal notch at junction with lower lip. Anomphalus.

DISCUSSION: There is much variation in the rate of axial translation so that the whorl width/whorl height ratio varies from compressed to rectilinear. This variation results in a tighter coil with more numerous whorls, or a looser coil with fewer whorls on the shell. Adult shells vary from 10 to 18 whorls. Because of the large size of the Magdalena population, we can assess some of the interpopulation variation such as the axial translation rate, which is observed in the position of the whorl embracement. In this species it ranges from being positioned on the lower marginal cord of the outer whorl face to approximately ¼ the distance down on the base. This causes the shell to be more or less high-spired and to appear cylindrical to turreted. Other variations include the shape of the whorl profile, from slightly convex to strongly concave. This is due to the actual shape of the surface as opposed to an apparent shape resulting from a stronger or weaker development of the bor-

dering spiral elements. The appearance and development of the spiral cords on the immature stages of the shell are also quite variable, as is the shape and strength of the growth lines.

The differences between *O. salteri, O. bilineatum* Mark, 1912, *O. werneri* Knight, 1934, *O. conicum* Meek and Worthen, 1866, and *O. schucherti* Knight, 1934 are (even by Knight's descriptions of 1934) minor. Now that we have an adequate population sample of one of the species, it is obvious that the species differences used by Knight (such as the relative development of the upper and lower spiral cords and the growth line strength) are, in fact, interpopulation variations. Thus I would consider those species synonymous with *O. salteri.* 314 specimens.

MEASUREMENTS: Figure 40a, AMNH 44953, H 6.5 mm, W 2.1 mm, SPANG 22°; 40b, AMNH 44954, H 3.5 mm, W 1.4 mm, SPANG 22°.

SUPERFAMILY LOXONEMATACEA KOKEN, 1889

FAMILY PSEUDOZYGOPLEURIDAE KNIGHT, 1930

DISCUSSION: I will continue to retain the most parsimonious taxonomy of this group, see Batten (1985: 11–12).

Pseudozygopleura Knight, 1930

TYPE SPECIES: *Loxonema semicostata* Meek, 1872: 174.

Pseudozygopleura (*Pseudozygoleura*) *williamsi* Knight, 1930
Figure 41 a, b

Pseudozygopleura (*Pseudozygopleura*) *williamsi* Knight, 1930: 36, pl. 1, figs. 3 a–c.

DESCRIPTION: Elongate, conical, high-spired shells without adult ornament other than growth lines. Protoconch heterostrophic at about 90° from adult axis. Three postembryonic whorls have arcuate collabral costae with indication at midwhorl of spiral element. Adult whorl profile is slightly inflated with broad periphery low on whorl. Whorls embrace just below periphery on basal margin. Growth lines slightly arcuate. Anomphalus. Base evenly rounded.

DISCUSSION: These specimens are very close, in most respects, to Knight's description and illustrations. There is some variation in the whorl profiles. The illustrated specimen (fig. 41) shows a less inflated whorl with a less pronounced low periphery than the other two specimens. The heterostrophic protoconch is unique, not seen in any other species. It should be noted here that the pseudozygopleurid nuclear shells of this subfamily are orthostrophic but highly differentiated from the later whorls. Knight's illustration of this species seems to indicate that the protoconch was missing, a likely event considering that it would have been raised above the rest of the whorls and easily broken off. It should be mentioned that it is totally unknown to have a heterostrophic nuclear shell in any of the loxonematids. In part, this may be an artifact of preservation. Three specimens.

MEASUREMENTS: Figure 41, AMNH 44955, H 3.0 mm, W 1.3 mm, SPANG 25°.

Pseudozygopleura (*Pseudozygopleura*) *scitula* (Meek and Worthen), 1861
Figure 42

Loxonema scitula Meek and Worthen, 1860: 464.
Zygopleura scitula (Girty), 1915: 182.
Pseudozygopleura (*Pseudozygopleura*) *scitula* Knight, 1930.
= *P.* (*Pseudozygopleura*) *sinuosior* Knight, 1930: 42.
P. (*Pseudozygopleura*) *schucherti* Knight, 1930: 46.
P. (*Pseudozygopleura*) *condrai* Knight, 1930: 39.

DESCRIPTION: High-spired shells with well-developed, arcuate costae. Early whorls with strongly arcuate, fine axial lirae. Adult whorl profile varies from slightly inflated, evenly convex whorl with midwhorl periphery to strongly, unevenly inflated whorl with low periphery and flattened band adjacent to suture. Well-developed axial costae arcuate with subsutural portion almost vertical, becoming increasingly arcuate on more convex portion of whorl surface. More inflated whorls have more flattened base. Costae become weaker on base and disappear near columellar lip. Anomphalus. Columellar lip is thickened into a narrow callus.

DISCUSSION: There are several important variant patterns to be observed in this pop-

ulation. The whorl profile ranges from slightly convex and even to strongly inflated with a low periphery. In the latter condition, the costae in the flattened band adjacent to the suture are weak to absent and are in maximum development on the periphery. The costae are coarse and less numerous on the whorl surface compared to those on the less inflated whorls, which are finer and more numerous. This population conforms closely to that described by Knight from the St. Louis Outlier (Knight, 1930: 11–12). *P. (P.) condrai* Knight, 1930, *P. (P.) schucherti* Knight, 1930, and *P. (P.) sinuosior* Knight, 1930, clearly have features that overlap with those in this species; the first two species were described from a single specimen each. Based on the variant pattern described above, I believe that *P. (P.)*? n. sp. described by Kues (1991: 228) should also be considered a member of this species. 46 specimens.

MEASUREMENTS: Figure 42, AMNH 44956, H 4.2 mm, W 2.1 mm, SPANG 27°.

Pseudozygopleura (Stephanozyga) subnodosa Knight, 1930
Figure 43

Pseudozygopleura (Stephanozyga) subnodosa Knight, 1930: 62, pl. 4, fig. 1.

DESCRIPTION: Whorl profile convexo-concavo-convex. Area adjacent to suture convex with arcuate, widely spaced transverse lirae. Midwhorl region concave and ornamented by reinforced growth lines. Lower third of whorl strongly convex with well-developed transverse costae on periphery which are extensions of subsutural lirae. Costae become weak and disappear on flatly rounded base. Base has reinforced growth lines for ornamentation. Narrowly phaneromphalus.

DISCUSSION: This species is represented here by a single fragment of an adult whorl. *P. (S.) nodosa* Girty, 1915, differs in that the transverse costae are more extensively developed over the whorl surface. See Kues (1990: 256) for a full discussion of the taxonomic relationships, based on the common occurrence of this species in the Flechado Formation of New Mexico. This fragment differs from those previously illustrated in that the upper third of the whorl is convex with well-developed lirae. One specimen.

MEASUREMENTS: Figure 43, AMNH 44957, W 3.0 mm.

FAMILY ZYGOPLEURIDAE WENZ, 1938

Anoptychia Koken, 1892

TYPE SPECIES: *Melania supraplecta* Munster, 1841, SD Kittl, 1894, non Cossmann, 1909.

DISCUSSION: I am reluctant to place the three specimens described below into the well-known Mesozoic genus *Anoptychia.* However, the ontogenetic sequence and the entire morphology is nearly identical to the Triassic species *A. eotriassica* Batten and Stokes, 1986. No upper Paleozoic pseudozygopleurid remotely approaches any of the features described below, except for the presence of collabral cords on the second whorl.

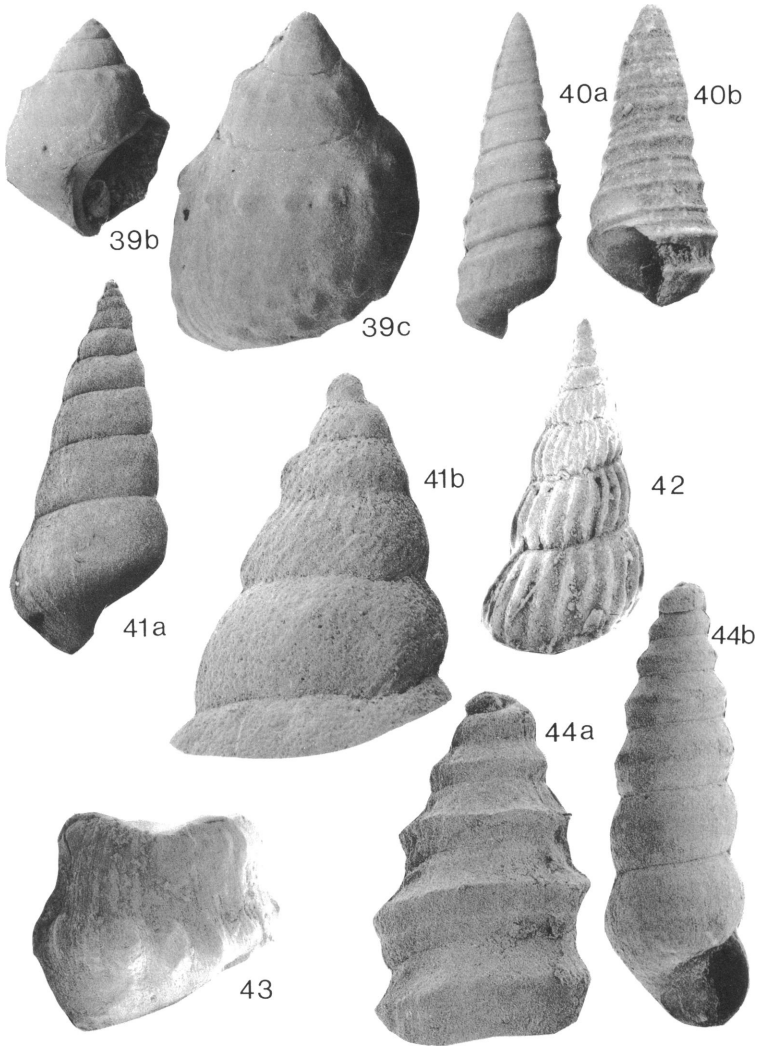
Anoptychia sp.
Figure 44 a, b

DESCRIPTION: Embryonic whorl globose and unornamented. Second whorl has well-developed collabral cords persisting through third whorl, which develops an angulate midwhorl periphery with a cord. Collabral cords reduced to growth lines at fourth whorl and spiral cord located midway between periphery and lower suture. Angulate periphery and lower cord disappear in adult whorls, which are evenly inflated and lack ornament except for growth lines. Whorls embrace at basal margin. Base is evenly rounded. Anomphalus.

DISCUSSION: These specimens are identical in most respects to *A. eotriassica.* The only significant difference is that the present species loses the angulate periphery at the seventh whorl whereas in *A. eotriassica* it is lost at the tenth whorl. However, there is a considerable difference in size; the average adult length of *A. eotriassica* is over 10.0 mm. In addition, the latter species is phaneromphalus. Three specimens.

MEASUREMENTS: Figure 44a, AMNH 44958, H 2.6 mm, W 1.0 mm, SPANG 21°; 44b, AMNH 44959, H 2.5 mm, W 1.1 mm, SPANG 15°.

SUPERFAMILY SUBULITACEA LINDSTROM, 1884



Figs. 39b–44b. **39**b, c. *Trachydomia turbonitella,* n. sp., **(b)** AMNH 44951, paratype, early whorls showing the upper and lower whorl row of nodes, side view, ×7, **(c)** AMNH 44952, paratype, immature shell showing the intercalated third row of nodes on the lower part of the fifth whorl, side view, ×7. **40.** *Orthonema salteri* Meek and Worthen, **(a)** AMNH 44953, side view, ×7. **(b)** AMNH 44954, side view showing the well-developed spiral lirae just under the suture, ×13. **41.** *Pseudozygopleura* (*Pseudozygopleura*) *williamsi* (Knight), AMNH 44955, **(a)** side view, ×17, **(b)** enlarged early whorls showing the asymmetrical embryonic whorl and the collabral costae on the immature whorls, ×70. **42.** *P.* (*Pseudozygopleura*) *scitula* (Meek and Worthen), AMNH 44956, oblique side view, ×11. **43.** *P.* (*Stephanozyga*) *subnodosa* Knight, AMNH 44957, side view of fragment, ×12. **44.** *Anoptychia* sp., **(a)** AMNH 44959, side view of early whorls, ×35, **(b)** AMNH 44958, apertural view of mature specimen, ×21.

FAMILY MEEKOSPIRIDAE
KNIGHT, 1956

Meekospira Ulrich *in*
Ulrich and Scofield, 1897

TYPE SPECIES: *Eulima? peracuta* Meek and Worthen, 1860: 466.

DISCUSSION: Erwin (1988b: 67) thoroughly discussed the taxonomic and systematic placement of *Meekospira,* concluding that there is evidence to resolve the problem of relationships. I will continue to recognize the separation of this genus from the siphonate genera included in the Subulitidae.

Meekospira peracuta
(Meek and Worthen), 1860
Figure 45

Eulima? peracuta Meek and Worthen, 1860: 466.
Meekospira peracuta Knight, 1932: 195.

DESCRIPTION: Subconical, subfusiform shells. Whorl profile flat to gently convex giving overall shell slightly convex, conical shape. Sutures are sharply defined, but shallow. Periphery is very low on whorl and at lower whorl margin. Whorls embrace at or just below periphery. Base is flatly rounded. Anomphalus. Columellar lip is arcuate and reflexed such that it is thickened into a narrow, convex callus. No ornament other than very fine growth lines.

DISCUSSION: This very conservative species is present, but relatively uncommon, in many Pennsylvanian faunas. In most populations, the most obvious variation is the slight changes in convexity of the whorl profile. It is present in the Flechado Formation of New Mexico. 40 specimens.

MEASUREMENTS: Figure 45, AMNH 44960, H 4.4 mm, W 2.2 mm, SPANG 25°; largest specimen (not illustrated), H 14.0 mm, W 5.0 mm, SPANG 22°.

FAMILY SUBULITIDAE
LINDSTROM, 1884

SUBFAMILY SOLENISCINAE
WENZ, 1938

Soleniscus Meek and Worthen, 1860

TYPE SPECIES: *Soleniscus typicus* Meek and Worthen, 1860: 467, subsequent designation by Knight, 1941.

DISCUSSION: Erwin (1988b: 61) has reviewed much of the important morphology of this genus, including the presence and nature of a siphonal fold and siphonal notch. It is of great interest that these features are not visible in the aperture of unbroken shells in the type species, *S. typicus.* In fact, the aperture is holostomus in contrast to most shells of snails that are siphonate! The sample of *S. typicus* found in the Magdalena includes complete specimens representing all stages of ontogeny, each complete specimen is holostomous and without any indication of any columellar folds or siphonal notches. Thus the so-called siphonal fold and notch are apparently nonfunctional as exterior siphonal features and are formed later. Perhaps this condition represents an intermediary stage leading to the siphonate condition; some species of this genus apparently have a siphonal channel and columellar fold developed at the functional aperture, such as *S. variabilis* Erwin, 1988b.

Soleniscus typicus
Meek and Worthen, 1960
Figure 46

Soleniscus typicus Meek and Worthen, 1860: 467.

DESCRIPTION: Slender, fusiform shells with moderately rapid axial translation rate so that sutures form acute angle to axis. Whorl profile convex to slightly inflated. Sutures shallow but sharply defined. Base is rounded. Anomphalus. Aperture of adult is subovate. Siphonal fold very weak, low on columella, not developed on outer columellar lip. No siphonal notch on aperture.

DISCUSSION: As discussed above, it is quite puzzling that on unbroken specimens, regardless of size or maturity, there is no evidence of any siphonal fold or notch in the aperture. Hence we must conclude that these are secondary features which may have functions other than siphonal.

This population is similar to that illustrated by Knight (1931b) from the Labette Shale. Variation includes changes in height of spire, width of shell, and convexity of the whorl profile. 20 specimens.

MEASUREMENTS: Figure 46, AMNH 44961, H 6.5 mm, W 2.0 mm, SPANG 27°.

Soleniscus variabilis Erwin, 1988
Figure 47

Soleniscus variabilis Erwin, 1988b: 62.

DESCRIPTION: Elongate to subovate, fusiform shells. Whorl profile evenly to strongly inflated with obscure periphery low on whorl. Whorls embrace at, or well below, periphery. Sutures sharply defined but shallow. Base elongate, rounded. Anomphalus. Aperture teardrop-shaped with well-developed siphonal channel at junction of lower and columellar lip. Well-developed columellar fold just above channel. Outer lip, as well as entire shell, is thin.

DISCUSSION: As mentioned by Erwin (1988b: 62), there is considerable variation in the shell shape resulting from changes in the axial translation rate, whorl embracement, and degree of whorl inflation. In contrast to some Permian populations, the aperture of unbroken specimens shows the presence of a columellar fold and siphonal channel at the functional aperture. 172 specimens.

MEASUREMENTS: Figure 47, AMNH 44692, H 3.9 mm, W 2.0 mm, SPANG 52°.

Strobeus de Koninck, 1881

TYPE SPECIES: *Strobeus ventricosus* de Koninck, 1881: 26 by subsequent designation of Cossmann, 1909: 102. = *Ianthinopsis* Meek and Worthen, 1866; *Sphaerodoma* Keyes, 1889.

DISCUSSION: See Erwin (1988b) for a recent review of the nomenclature of this genus.

Strobeus primigenius
(Conrad), 1835
Figure 48

Stylifer primigenia Conrad, 1835: 267.
Sphaerodoma primigenia Girty, 1915: 208.
Soleniscus (*Macrocheilina*) *primigenius* Knight, 1931b: 207.

DESCRIPTION: Fusiform to inflated fusiform shells with receding axial translation rate causing coeloconoid shell shape. Whorl profile is evenly inflated so that periphery is essentially at midwhorl or slightly lower. Final whorl is formed at increased whorl expansion rate so that it is somewhat larger than other whorls. Whorls embrace at the broad periphery. Anomphalus. Aperture is teardrop-shaped. Parietal lip is coated with fine callus extending onto columellar lip. Sharply formed columellar fold forms acute angle with axis.

DISCUSSION: The Magdalena population sample conforms closely to the description and illustrations from the Pennsylvanian by Knight (1931b) and others. This species is the most commonly encountered in the Pennsylvanian. It differs from *S. paludiniformis* (Hall) in the changes of the axial translation rate and the lower whorl embracement.

MEASUREMENTS: Figure 48, AMNH 44963, H 6.5 mm, W 4.2 mm, SPANG 56°.

Strobeus poromus Kues, 1990
Figure 49

Strobeus poromus Kues, 1990: 257.

DESCRIPTION: Rotund shell with sharp, narrow spire and enlarged, evenly inflated body whorl. Sutures are sharp and shallow. Whorls embrace high on whorl, above broad periphery. Aperture is subovate. Anomphalus. Columellar lip arcuate with large, low fold. Lower lip broken. No parietal inductura visible.

DISCUSSION: The shell shape and the placement of the columellar fold suggest placing this single specimen in this species. It lacks the well-developed inductura found in the types. It differs from *S. primigenius* in being lower spired and with a more highly developed columellar fold. This species was described by Kues from the Flechado Formation. One specimen.

MEASUREMENTS: Figure 49, AMNH 44964, H 2.6 mm, W 2.6 mm, SPANG 91°.

SUBCLASS OPISTHOBRANCHIA

ORDER CEPHALASPIDEA
FISCHER, 1883

SUPERFAMILY ACTEONINACEA
D'ORBIGNY, 1842

FAMILY ACTEONINIDAE
PCELINCEV, 1960

Girtyspira Knight, 1936

TYPE SPECIES: *Bulimella canaliculata* Hall, 1856: 29.

DISCUSSION: Erwin has placed this genus and family in the order Cephalaspidea Fi-

scher, 1883, and raised the Opisthobranchia to a subclass level following Kolmann and Yochelson (1976) and Erwin (1988c: 573). See also Kolmann and Yochelson (1976) for further discussion.

Girtyspira minuta (Stevens), 1858
Figure 50

Loxonema minuta Stevens, 1858: 260.
Acteonina minuta Meek and Worthen, 1873: 594.
Girtyspira minuta Knight, 1936: 524.

DESCRIPTION: Very small, fusiform to somewhat turreted shells. Protoconch orthostrophic. Whorl profile evenly inflated and periphery slightly below midwhorl. Whorls embrace just below periphery resulting in a somewhat high-spired shell. Sutures sharp and deep. Subsutural ramp may be present. Aperture is teardrop-shaped. Holostomous. Anomphalus. Parietal inductura thin and arcuate. No ornament, folds or sinuses present.

DISCUSSION: The most obvious variation is the development of a subsutural ramp on some specimens. The ramp varies from just a slight flattening of the whorl adjacent to the suture to a relatively wide, somewhat convex platform. Several specimens lack any evidence of a ramp. Those specimens tend to have a slightly more inflated whorl profile. All the features noted in this sample are present in the population described by Knight (1932: 198). It should be emphasized that the specimens in this sample that have the nuclear whorls preserved are not heterostrophic. Eight specimens.

MEASUREMENTS.: Figure 50, AMNH 44965, H 4.4 mm, W 1.7 mm, SPANG 32°.

ORDER ?ENTOMATAENIATA
COSSMANN, 1896

SUPERFAMILY PYRAMIDELLACEA
D'ORBIGNY, 1840

FAMILY STREPTACIDIDAE
KNIGHT, 1931

DISCUSSION: See Erwin (1988c: 571–572) for a recent review of this and related taxa.

Donaldina Knight, 1933

TYPE SPECIES: *Aclisina grantonensis* Donald, 1898: 60.

DISCUSSION: Knight (1931a: 9) pointed out that the ornament of revolving lirae varies considerably from specimen to specimen so that species grouping must be based on other features, or at least other features in combination with ornament.

The two groups of specimens belonging to this genus in the Magdalena are easily separable on the basis of shell shape and the whorl profile plus the relative degree of ornament development.

Donaldina robusta (Stevens), 1858
Figure 51

Aclis robusta Stevens, 1858: 259.
Aclisina robusta Keyes, 1889: 240.
Donaldina robusta Knight, 1944: 463.

DESCRIPTION: Moderately high-spired, turreted shells. Sutures sharp and deep. Upper whorl face flattened to concave adjacent to suture. Shoulder is marked by revolving cord. Periphery is high on whorl, just below shoulder. Outer whorl face flattened to slightly convex, sloping toward axis, and ornamented by two revolving cords evenly spaced and developed. Some specimens have a few additional revolving lirae on outer whorl face and base. Lower cord marks base. Whorls embrace just below lower margin of outer whorl face. Base flatly rounded and ornamented by one or two revolving cords. Anomphalus. Columellar lip straight and reflexed. Parietal inductura is thickened and ornament is resorbed within plane of aperture. Shallow siphonal notch at junction of columellar and lower lips.

DISCUSSION: These specimens show relatively little variation. There is either one or two revolving cords on the base. The upper flattened portion of the whorl profile varies from narrow and flat to wide and concave giving those shells a more turreted appearance. The Magdalena specimens differ from those illustrated by Knight (1931: pl. 1) in having stronger, less numerous revolving ornament and being more turreted. 11 specimens.

MEASUREMENTS: Figure 51, AMNH 44966, H 5.2 mm, W 2.5 mm, SPANG 26°.

Donaldina stevensana
(Meek and Worthen), 1866
Figure 52

Turritella? *stevensana* Meek and Worthen, 1866: 382.
Aclisina stevensana Keyes, 1895: 202.
Donaldina stevensana Knight, 1933a: 58.

DESCRIPTION: High-spired shells with evenly formed revolving ornament. Sutures sharp and deep. Whorl profile mostly evenly inflated. Whorls embrace on base well below midwhorl periphery. Ornament consists of evenly spaced and developed revolving lira. Some specimens lack ornament on upper third of whorl. Anomphalus. Columellar lip straight and reflexed. Parietal inductura thin and ornament resorbed within plane of aperture on parietal surface.

DISCUSSION: There is considerable variation in the height of the shell resulting from changes in the axial translation and whorl expansion rates. Slower translation rates result in a higher-spired shell with more whorls (14 or more versus 9–10 on the lower-spired forms). The revolving ornament may be evenly spaced over the whorl or absent on the upper third of the whorl. If absent, the whorl surface may be somewhat flattened.

These specimens conform closely to those illustrated by Knight (1931: pl. 1. 25) specimens.

MEASUREMENTS: Figure 52, AMNH 44967, H 5.9 mm, W 1.8 mm, SPANG 16°.

Streptacis Meek, 1872

TYPE SPECIES: *Streptacis whitfieldi* Meek, 1872: 173.

DISCUSSION: The distinguishing feature of *Streptacis* from *Donaldina* is the lack of any spiral ornament. Collabral ornament is restricted to slightly reinforced growth lines.

Streptacis whitfieldi Meek, 1872
Figure 53 a, b

Streptacis whitfieldi Meek, 1872: 173.

DESCRIPTION: Slender, high-spired orthostrophic shells. Early whorls heterostrophic with varying degrees of axial tilt, are more loosely coiled. Adult whorl profile evenly inflated to slightly angulate with midwhorl periphery. Growth lines form v-shaped, broad sinus culminating at periphery. Sutures sharp and deep. Base rounded and whorls embrace on base. Aperture ovate with slight siphonal notch.

DISCUSSION: The Magdalena specimens are similar to that illustrated by Knight (1931a: pl. 2, fig. 1). There is some variation in the whorl profile varying from evenly rounded to slightly angulate. The whorl embracement is somewhat variable, causing a slightly higher or lower shell. 6 specimens.

MEASUREMENTS: Figure 53a, AMNH 44968, H 2.2 mm, W 0.8 mm, SPANG 17°; 53b, AMNH 44969, H 1.5 mm, W 0.6 mm, SPANG 18°.

?SUPERFAMILY RISSOACEA

DISCUSSION: Solem and Yochelson (1979: 28) cited the occurrence of several species, for example, *Hydrobia gondwanica* Cox (1953) from the Karroo System of southern Rhodesia, that may be freshwater forms; they were not sure of the taxonomic placement of those species. Yu and Zhu (1990: 60) reported several genera and species from a marlite, which is presumably freshwater, from the upper Permian Xiaolongkou Formation in the southeastern Junggar Basin, Xinjiang, China. They erected the new genus *Xinjiangospira* for two species discussed below. The earliest appearing species that are without question basommatophorans (freshwater pulmonates) appear in the late Jurassic of Europe.

?FAMILY HYDROBIIDAE

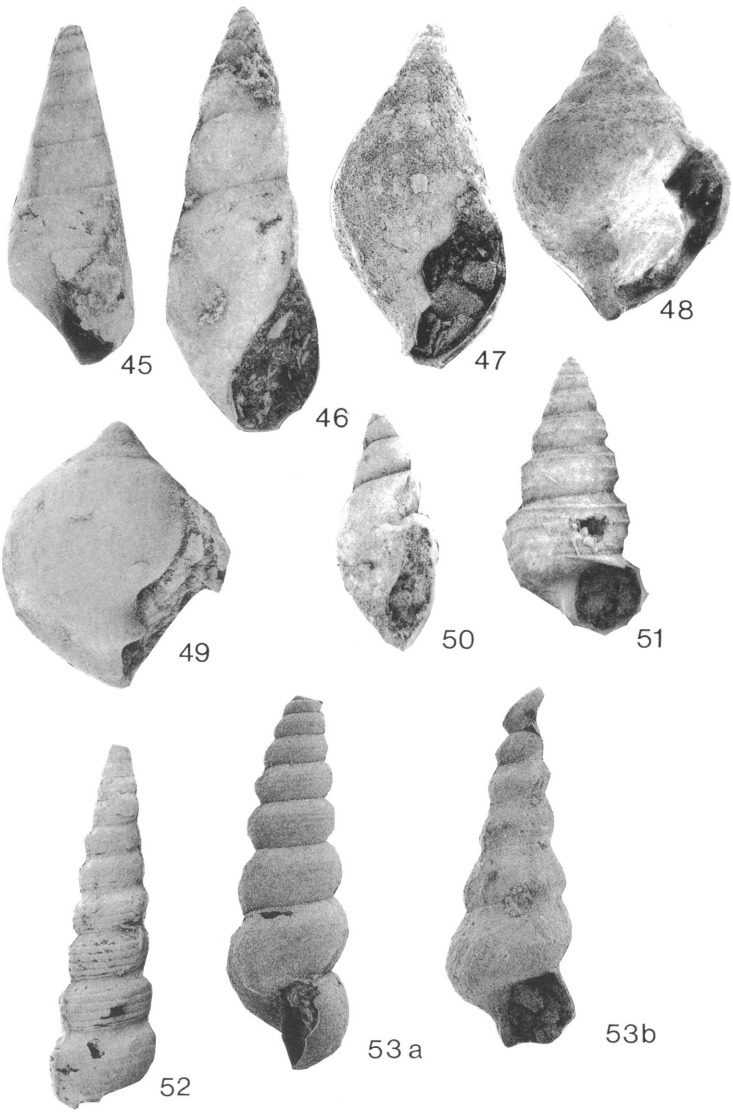
?*Xinjiangospira* Yu and Zhu, 1990

TYPE SPECIES: *Xinjiangospira rotundata* Yu and Zhu, 1990: 56–60, pl. 2, figs. 1–5.

DISCUSSION: Yu and Zhu have erected this genus based on a number of specimens, some of which they attributed to *H. gondwanica* Cox, 1953. Each species has a deviated embryonic shell, rounded whorls, and rather sharply defined sutures. The shells are thin and the aperture without teeth or barriers. The columellar lip is thin and there are no columellar thickenings or signs of resorption. *X. gondwanica* is higher-spired than the type species, *X. rotundata.*

Xinjiangospira, new species
Figure 59 a, b

DESCRIPTION: Pupaeform shell with early



Figs. 45–53b. **45.** *Meekospira peracuta* (Meek and Worthen), AMNH 44960, apertural view, ×11. **46.** *Soleniscus typicus* Meek and Worthen, AMNH 44961, apertural view, ×9. **47.** *Soleniscus variabilis* Erwin, 1985, AMNH 44962, apertural view, ×13. **48.** *Strobeus primigenius* (Conrad), AMNH 44963, apertural view (left portion of aperture is obscured by a broken piece of shell), ×7. **49.** *Strobeus poromus* Kues, 1990, AMNH 44964, apertural view, ×12. **50.** *Girtyspira minuta* (Stevens), AMNH 44965, apertural view, ×8. **51.** *Donaldina robusta* (Stevens), AMNH 44966, apertural view, ×7. **52.** *Donaldina stevensana* (Meek and Worthen), AMNH 44967, side view, ×8. **53.** *Streptacis whitfieldi* Meek, **(a)** AMNH 44968, apertural view, ×22, **(b)** AMNH 44969, apertural view, note low whorl periphery and heterostrophic nuclear whorls, ×33.

whorls slightly depressed and heterostrophic. Protoconch and first whorl smooth and almost planispiral. Second and third whorls orthostrophic with prominent collabral cords. Sutures sharply defined and deeply impressed. Whorl profile evenly inflated with broad periphery low on whorl. Third and fourth whorls have fine, irregular spiral threads. Adult whorl axis is at 20° from early whorl axis. Slowing of axial translation rate causes pupaeform shell shape. Adult whorls evenly inflated with broad midwhorl periphery. Faint collabral lirae in addition to growth lines. Whorls embrace beneath basal margin. Base evenly rounded. Hemiomphalus. Aperture holostomous. Columellar lip straight and reflexed. No parietal deposits, barriers, or folds. Shell and aperture thin.

DISCUSSION: The most distinctive feature of this single shell is the heavily corded early shell canted at a 10° angle from the adult shell. The adult shell has a faster, but variable, axial translation rate. It differs from species of *Dendropupa* in having a more rapid axial translation rate and in having a heterostrophic embryonic shell. *Anthracopupa* and *Strophella* have apertural barriers or columellar folds. It is similar to *X. rotundata* Yu and Zhu, 1990, in size, general shape, details of the early whorls, growth line pattern, and details of the aperture. It differs in having a lower axial translation rate. Because this Magdalena occurrence represents a single shell, I will not attribute it to the Chinese species. One specimen.

MEASUREMENTS: Figure 59 a, b, AMNH 44979, H 2.7 mm, W 1.3 mm, SPANG (adult) 19°.

SUBCLASS PULMONATA

SUPERORDER STYLOMMATOPHORA

DISCUSSION: The three previously known species described below are terrestrial pulmonates that are widely distributed in eastern North America; see Solem and Yochelson (1979) for a complete Upper Paleozoic study of this group. To find these species in a clearly offshore marine fauna is unique and it appears that the only explanation is that the specimens have been washed into the marine basin from some nearby land mass. I am fully aware of the possibility of outcrop contamination, realizing the problem that Walcott generated when he described (1884) Cretaceous pulmonates in freshwater Cretaceous limestone resting on Pennsylvanian deposits in such a way that it appeared a part of the Pennsylvanian sequence (see F.S. MacNeil, 1931, for the correction).

The specimens described below were recovered as siliceous residues from limestone blocks taken from continuous strata containing marine fossils exclusively. The blocks were dissolved in hydrochloric acid and the specimens that were recovered from the residues are completely silicified. Each species is represented by one to four specimens, in contrast to the occurrence of the species in the eastern terrestrial deposits where they are found with large number of individuals. Further, they are assignable to described Pennsylvanian species. Hence, it seems unlikely that they can be considered as contaminants from later or earlier deposits. Since land masses are nearby, I lean toward the specimens being washed into the basin of deposition. It is of interest to note that these are the first reported Upper Paleozoic nonmarine snails from west of the Mississippi River (Yochelson, personal commun., 1993).

SUPERFAMILY ACHATINELLACEA

FAMILY TORNATELLINIDAE

SUBFAMILY ANTHRACOPUPINAE WENZ, 1938

Strophella Dawson, 1895

TYPE SPECIES: *Strophites grandaevus* Dawson, 1880: 413.

DISCUSSION: Knight (1941: 341) and others placed this genus in subjective synonymy with *Dendropupa* Owen, 1861, primarily because of external shell features such as ornament; early whorls and the apertural features were unknown. However, the shell shape, unique collabral lirae, whorl profile, and the presence of apertural folds (barriers) suggest that *S. grandaevus* (described below) be excluded from *Dendropupa.* The single most compelling reason for recognizing this genus is the highly distinctive coarse ribbing; ribs are widely spaced and with the sides vertical and parallel and the tops flattened or slightly rounded. The shell shape also is quite differ-

ent from that of *Dendropupa* in being higher-spired with a much lower whorl expansion rate. No other described nonmarine snail of the Paleozoic is similar because most have ribbing that is much finer, with the ribs more closely spaced and asymmetrically shaped. The Magdalena specimens have the aperture preserved; their apertural barriers differ from those of other genera.

Strophella grandaevus
(Dawson), 1880
Figure 54 a, b

Strophites grandaevus Dawson, 1880: 413.
Strophella grandaeva Dawson, 1895: 94.
Dendropupa grandaevus Yochelson and Saunders, 1967.
?*Dendropupa grandaevus* Solem and Yochelson, 1979: 14.

DESCRIPTION: High-spired, somewhat pupaeform shells with strongly formed collabral lirae. Early whorls are low-spired and seemingly with a heterostrophic nucleus. Whorl embracement migrates from midwhorl to outer portion of base. Whorl profile is gently and evenly inflated from shallow sutures to umbilical region. Collabral lirae extend from suture to umbilical region; they are flat-topped with nearly vertical sides. Base is gently rounded. Anomphalous. There are two apertural teeth. Lower tooth located at junction of arcuate columellar lip and parietal surface; it extends at an angle into aperture and is a sharply defined, concave ridge. Second tooth is midway between first tooth and outer lip, higher on aperture. It is a short, elongate node. Both teeth seem to be extensions of a collabral lira.

DISCUSSION: Apparently the only example of this species is that of Dawson, reillustrated by Solem and Yochelson (1979: pl. 1, fig. 4). The Magdalena specimens are similar to the few preserved whorls that are illustrated, but are far better preserved and more complete. I have been able to document the apertural features, which include unique apertural barriers. The collabral lirae are unusual in being nearly rectilinear in outline, similar to that of the type illustrations. Several specimens of *Dendropupa vetusta* have similar lirae but they are much finer and more widely spaced. 4 specimens.

MEASUREMENTS: Figure 54 a, b, AMNH 44970, H 4.7 mm, W 1.5 mm, SPANG 16°.

Strophella? sp.
Figure 56 a, b

DESCRIPTION: Pupaeform shell with collabral lirae and apertural barriers. Protoconch is missing on this single specimen. Whorls are slightly inflated with a low periphery. They embrace immediately below basal margin. Base evenly rounded. Hemiomphalus, collabral lirae become more intensely developed in and around umbilicus. Earlier whorls appear (from broken specimens) to be narrowly phaneromphalus. Columellar lip is very thin and reflexed with a fold or barrier in medial region. Parietal inductura is very thin and there is a medial barrier. Outer lip is thin.

DISCUSSION: The shell shape of this specimen is similar to that of species of *Dendropupa,* and *Anthracopupa ?dunkardana* Stauffer and Schroyer, 1920, as illustrated by Solem and Yochelson (1979: pl. 1, figs. 11, 12). The lectotype shown is a juvenile of five whorls. The umbilicus is hemiomphalus and the shell is very thin, as is the Magdalena specimen. However, the lectotype lacks the apertural barriers. In addition, the Magdalena specimen is 50% larger. One specimen.

MEASUREMENTS: Figure 56 a, b. AMNH 44973, H 6.4 mm, W 2.5 mm, SPANG 30°.

Anthracopupa Whitfield, 1881

TYPE SPECIES: *Anthracopupa ohioensis* Whitfield, 1881: 126.

DISCUSSION: Solem and Yochelson (1979: 20) have thoroughly discussed the type species and its relation to other groups.

Anthracopupa ohioensis
Whitfield, 1881
Figure 55 a, c

Anthracopupa ohioensis Whitfield, 1881: 126, figs. 1–4.

DESCRIPTION: Pupaeform shells without ornament, or with reduced ornament. Early whorls very low spired, almost planispiral. Whorl profile evenly inflated with ill-defined periphery low on whorl. Sutures sharply defined and deep. Whorls embrace just below periphery. Ornament, if present, is growth

lines alone. Axial translation rate slows with growth, producing a pupaeform shell. Anomphalus. Base is rounded. Aperture is subquadrate with a broad siphonal notch at junction of lower and columellar lips. Low, rounded columellar fold just above notch. Large bladelike fold at junction of columellar lip and parietal surface, which projects at 90° to surface into aperture and perpendicular to coiling direction of shell.

DISCUSSION: There is relatively wide range of variation in the shell shape, shell thickness, adult thickening and flaring of the apertural margin and, most particularly, the development of the apertural, columellar, and parietal "barriers" or teeth. Solem and Yochelson (1979: 16–20) fully illustrated these variant patterns. Some figures show, for example, a tooth on a thickened outer lip which the Magdalena and other specimens lack. However, these specimens do fall well within the range of the species and, in fact, are very close to the morphological complex found on the holotype. The most important feature of the Magdalena specimens is the large, bladelike parietal fold or barrier that projects at right angles to the coiling direction into the aperture. It is like no other described in the literature. They differ from the types of *A. ohioensis* in having very fine ornament and a more strongly developed parietal barrier. The types differ from such genera as *Strophella* (which has the folds parallel to the coiling direction) in having the folds perpendicular to the coiling direction. Adult specimens of some of the types have a thickened, somewhat flared aperture with a medial tooth on the outer lip. The Magdalena specimens seemingly are immature and lack those features. The most obvious variation involves changes in the height of the shell resulting from axial translation rate changes.

Solem and Yochelson (1979: 15–20) have made an insightful study of the variant patterns involving populations of several related species in the Permian and Pennsylvanian and concluded that this species has a very wide range of morphological features. 4 specimens.

MEASUREMENTS: Figure 55 a, b, AMNH 44971, H 2.9 mm, W 1.6 mm, SPANG 34°; 55c, AMNH 44972, H 2.7 mm, W 1.6 mm, SPANG 38°.

SUPERFAMILY PARTULACEA

FAMILY ENIDAE

SUBFAMILY DENDROPUPINAE WENZ, 1938

Dendropupa Owen, 1861

TYPE SPECIES: *Pupa vetusta* Lawson, 1855: 270.

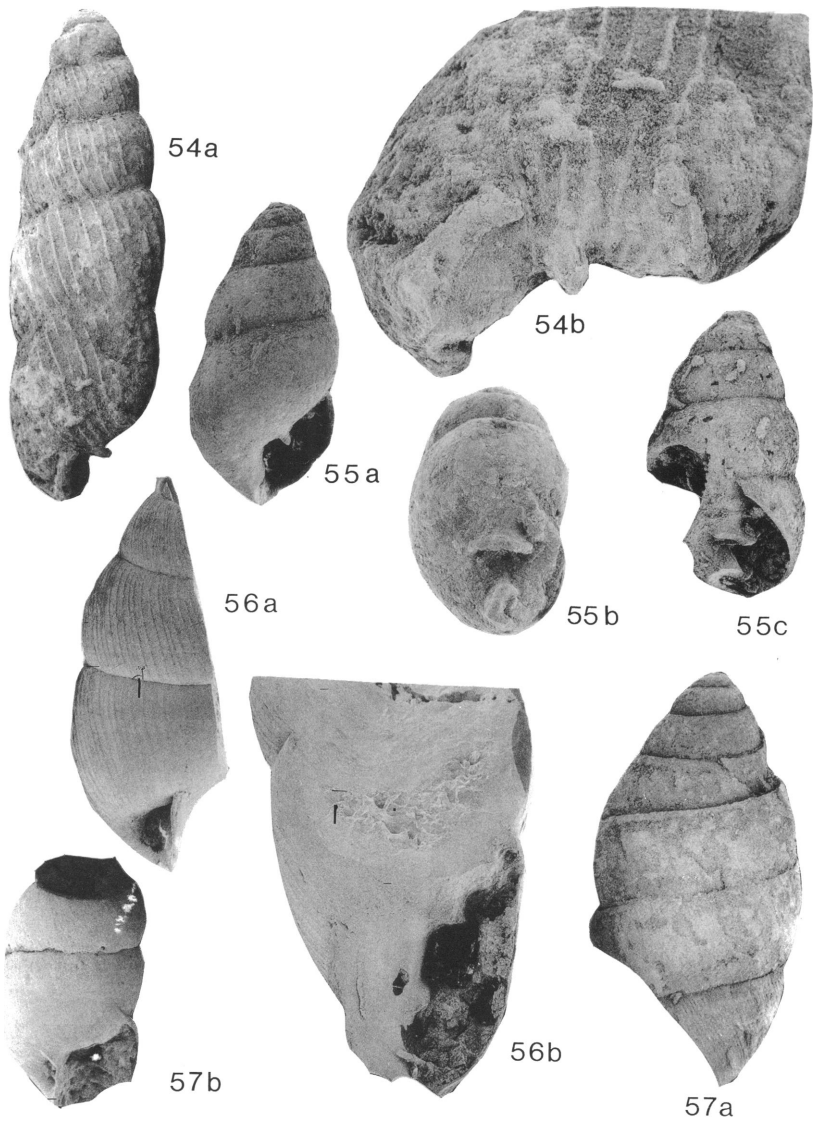
DISCUSSION: The species described below is better preserved than any specimen illustrated to date, so that apertural details are available. It is interesting to note that *D. vetusta* lacks any apertural barriers such as teeth or folds. The penultimate whorls appear to have a hollow columella that was described by Solem and Yochelson (1979: 11) but the Magdalena specimens do not have any internal barriers, as shown in their figure 11, preserved.

Dendropupa vetusta (Dawson), 1855
Figure 57 a, b

Pupa vetusta Dawson, 1855: 270.
Dendropupa vetusta Henderson, 1935: 149.

DESCRIPTION: Robust, pupaeform shells with well-developed axial lirae. Shell shape varies from almost orthostrophic to pupaeform. Early whorls smooth with evenly inflated whorls seemingly orthostrophic. Adult whorl profile is evenly inflated. Sutures sharply defined and deep. Whorls embrace at or below midwhorl periphery. Collabral lirae sharp and evenly developed from suture to umbilicus. Base is rounded. Minutely phaneromphalus to cryptomphalus. Columellar lip is reflexed and a thin callus extends into parietal inductura, which is thick and covers ornament. Very slight thickening of inductura near junction of parietal lip and upper lip. No other apertural thickening such as teeth or folds. Broken specimens reveal a hollow columella on the penultimate whorl; no internal barriers were seen.

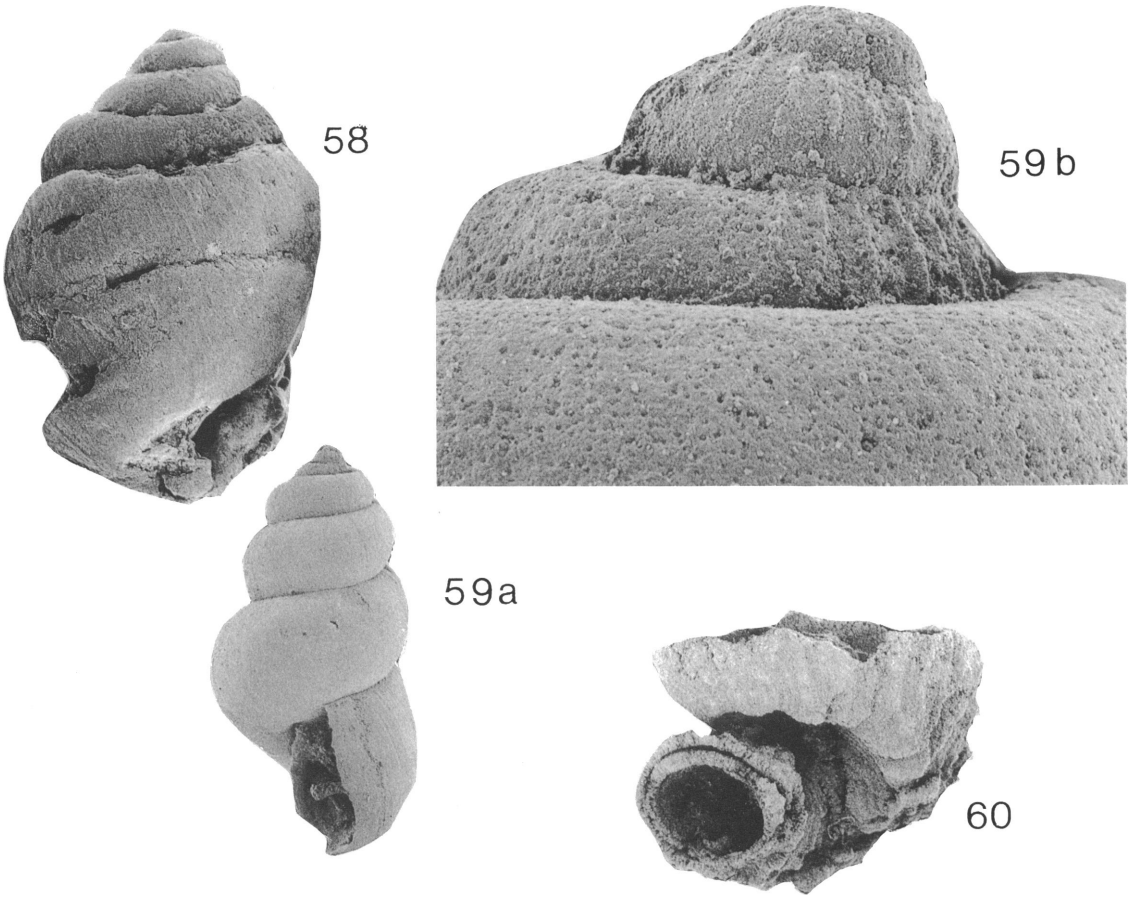
DISCUSSION: As suspected by Knight (1941: 198), there are no apertural teeth or folds. The Magdalena specimens are the first to show a fairly complete aperture. This species differs from *S. grandaevus* in lacking apertural teeth and in being more robust owing to a faster whorl expansion rate, with weaker, more widely spaced collabral ornament. As in the



Figs. 54–57. **54.** *Strophella grandaevus* (Dawson), 1880, AMNH 44970, **(a)** side view, ×14, **(b)** oblique apertural view, ×35 showing columellar callus and apertural barrier. **55.** *Anthracopupa ohioensis* Whitfield, 1881, **(a)** AMNH 44971, apertural view, ×14, **(b)** same specimen, oblique basal view showing concave apertural barrier, ×14, **(c)** AMNH 44972, apertural view, ×14. **56.** *Strophella* sp., AMNH 44973, **(a)** side view of broken specimen, ×9, **(b)** enlarged apertural view showing apertural barriers, ×14. **57.** *Dendropupa vetusta* (Dawson), 1855, **(a)** AMNH 44974, apertural view, ×7, **(b)** AMNH 44975, side view, note fine collabral threads on the final whorl, ×7.

other dendropupid species, the axial translation rate slows with growth, causing the pupaeform shape. Solem and Yochelson (1979: fig. 1) show internal umbilical barriers from a cross section of a specimen from the type lot. The silicified nature of preservation is such that I was unable to discover such a barrier in the specimens available. There is some variation in ornament development ranging from growth lines to moderately well-developed costae. 9 specimens.

MEASUREMENTS: Figure 57a, AMNH



Figs. 58–60. **58.** *Dendropupa* sp., AMNH 44976, side view of distorted specimen showing collabral ornament, ×9. **59.** *Xinjiangospira,* n. sp., AMNH 44979, **(a)** side view, ×14. **(b)** detail of embryonic whorls, ×140. **60.** worm tube, AMNH 44978, apertural view, ×15.

44974, H 8.2 mm, W 4.1 mm, SPANG 56°; 57b, AMNH 44975, H (broken), W 3.1 mm, SPANG 42°.

Dendropupa sp.
Figure 58

DISCUSSION: This single specimen differs from illustrated specimens and Magdalena specimens of *D. vetusta* by having strong collabral lirae. There is a sharp decline of the axial translation rate. In addition, the whorls embrace at the basal margin and the whorl expansion rate is much slower. All of these characteristics result in a more strongly developed pupaeform shape. One specimen.

MEASUREMENTS: Figure 58, AMNH 44976, H 5.5 mm, W 3.7 mm, SPANG 55°.

PHYLUM ?ANNELIDA

Spirorbis anthracosia
Whitfield, 1891
Figure 60

DISCUSSION: This single specimen matches rather closely the illustration of this species in Shimer and Schrock (1944: pl. 92, figs. 9, 10). The collabral costae alternate with finer

lirae and are irregular. The flat top is irregular and there is no evidence of what object it was originally attached to. One specimen.

MEASUREMENTS: Figure 60, AMNH 44878, H 2.0 mm, W 2.2 mm.

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