

COLOR PATTERNS ON PENNSYLVANIAN GASTROPODS FROM OHIO¹

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Abstract. Gastropods are among the more common fossil forms with preserved color patterns. Numerous species of Carboniferous gastropods have been previously reported in Europe and North America including 9 species from the Pennsylvanian of Ohio. Our collections of Pennsylvanian gastropods, made over the past several years, contain specimens representing 11 species with remnants of color patterns, 9 not previously reported from Ohio. The color patterns of 4 of these species, *Ianthinopsis intercalaris?* (Meek & Worthen), *Palaeostylus* (*Paleostylus*) n. sp., *Palaeostylus* (*Pseudozygopleura*) n. sp. 1 and *Palaeostylus* (*Pseudozygopleura*) n. sp. 2, have not been described before. Comparisons were made between Ohio gastropods with color patterns, or closely related forms, and those reported elsewhere. Variation in patterns were noted and illustrated where possible.

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Preserved color patterns in fossils have been intermittently reported since Bruguière (1792) illustrated specimens of the bivalve *Gryphaea*, with radiating brown bands, from the Cretaceous of Ireland. Over 200 reports describing or illustrating color patterns on fossils have been published since that date, a large number of which pertain to gastropods, one of the more common groups of organisms in which patterns are preserved.

Paleozoic examples of this type of preservation are not as uncommon as might be expected. Newton (1907) gives a summation of European occurrences of color pattern preservation, noting 13 Paleozoic species of cephalopods, pelecypods and gastropods, three of which are gastropods of Carboniferous age. Foerste (1930), in a summary paper of known occurrences of cephalopods, brachiopods, gastropods and bivalves with preserved color, lists 44 Paleozoic species of gastropods, with 33 being of Carboniferous age. Since 1930, specimens of at least 22 Paleozoic species of gastropods, with color patterns preserved, have been described in the literature; 11 are from the Pennsylvanian of North America. Gas-

tropod species previously reported from the Pennsylvanian strata of Ohio have been described by Sturgeon (1964), *Bellerophon* (*Pharkidonotus*) *percarinatus* (Conrad) and *Euconospira turbiniformis* (Meek & Worthen); Lee (1971), *Euconospira turbiniformis* (Meek & Worthen); Morningstar (1922), *Naticopsis* (*Marmolatella*) *pulchella* n. sp.; Webb (1972), *Euconospira riddelli* (Shumard), *Leptotygyma virgatum* (Knight), *Bellerophon* (*Pharkidonotus*) *percarinatus* (Conrad), *Bellerophon* (*Bellerophon*) *graphicus* Moore, *Knights* (*Cymalospira*) sp., and *Ianthinopsis paludinaeformis* (Hall); and, Hoare and Sturgeon (1976), *Baylea* sp. [= *Callistadia* n. sp.].

Continued collecting of Pennsylvanian invertebrates in the Ohio Pennsylvanian by the authors and their students has uncovered specimens representing 11 species with preserved color patterns, 9 of which have not been previously reported from Ohio, and 4 species, *Ianthinopsis intercalaris?* (Meek & Worthen), *Paleostylus* (*Paleostylus*) n. sp., *Paleostylus* (*Pseudozygopleura*) n. sp. 1 and *P.* (*Pseudozygopleura*) n. sp. 2 that have not been previously described with preserved patterns. In several cases these 11 species were represented by single specimens

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but there were several instances where several specimens were present, providing information as to the variability of the color pattern within the species. Variation from previously described patterns for a species was noted and is listed under the color pattern descriptions.

The figures were produced by drawings made directly from specimens or from photographs of specimens. Most specimens were incomplete or distorted. Some generalized reconstruction was necessary to indicate the general form or whorl profile of specimens but when major portions of the shell were missing, they were not added. Only the basic shell form and major features of ornamentation have been indicated so that the color pattern, indicated by stippling, is not obscured. The pattern represented in the drawings is as preserved and no attempt was made to reconstruct a total pattern. Descriptions and illustrations of the new species indicated herein are being published separately. Repositories for the illustrated specimens are given in the figure legends as: The Ohio State University, OSU; Ohio University, OU; Bowling Green State University, BGSU.

COLLECTING LOCALITIES

- Cp-3. The Columbiana Limestone at the abandoned Brookwood Mine (type locality for the Columbiana), SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 29, Perry Township, Columbiana County, Ohio. Salem 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from the mine dump.
- CS1-1. The Lower Mercer Limestone and Shale exposed in a roadcut on the north side of U.S. 36, 1.6 mi. east of jct. with Ohio 93, NE $\frac{1}{4}$ sec. 1, approx. 2.0 mi. northeast of West Lafayette, Lafayette Township, Coshocton County, Ohio. Fresno 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from a 1.0 foot shale zone just above the Lower Mercer Limestone.
- Ga-1. The Cambridge Limestone and Shale exposed in a small abandoned quarry, W $\frac{1}{2}$ SE $\frac{1}{4}$ sec. 25, approx. 1.0 mi. northeast of New Concord, Adams Township, Guernsey County, Ohio. Bloomfield 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from shale masses on the spoil banks.
- Gwe-1. The Cambridge Limestone and Shale exposed in the large abandoned John Gress & Sons quarry, NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 2, north of U.S. 40 and 0.25 mi. east of New Concord, Westland Township, Guernsey County, Ohio. New Concord 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from the shale on the spoil banks.
- Jmi-2. The Vanport Limestone and Shale exposed at a small abandoned drift mine on the north side of Buffer Run, S center sec. 24, Milton Township, Jackson County, Ohio. Mulga 7 $\frac{1}{2}$ ' Quadrangle. Specimens were collected from the 0.5 foot shale zone just above the Vanport Limestone.
- Lluc-1. The Lower Mercer Limestone exposed at an undescribed and uncertain locality near Flint Ridge, Ohio.
- Mp-2. The Vanport Limestone exposed at the Carbon Limestone Co. quarries, 0.75 mi. south of U.S. 224 and just west of the Ohio-Pennsylvania state line near Kansas Corners, Poland Township, Mahoning County, Ohio. Campbell 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from weathered limestone blocks.
- No-4. The Portersville Shale exposed in roadcut on the east side of U.S. 21, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, Olive Township, Noble County, Ohio. Caldwell South 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from shale exposure.
- Pr-3. The Lower Mercer Limestone exposed in the B & O RR cut, NW $\frac{1}{4}$ sec. 10, at Somerset, Reading Township, Perry County, Ohio. Somerset 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from weathered blocks of limestone.
- Ty-3. The Putnam Hill Limestone and Shale exposed in a small abandoned borrow pit and strip mine of the Zoar Mining Co., NW $\frac{1}{4}$ sec. 17, south of New Philadelphia, York Township, Tuscarawas County, Ohio. New Philadelphia 7 $\frac{1}{2}$ ' Quadrangle. Specimens collected from a 1-2 foot shale zone just above the Putnam Hill Limestone.

DISCUSSION OF COLOR PATTERNS

The preservation of color patterns on fossil specimens commonly shows variation within a species. In some instances this variation probably is caused by incomplete preservation of the pattern on a particular specimen. In other cases the variation appears to be biologically controlled. It is doubtful that any of these specimens show true coloration, as present during life, but only remnants of the original color as a result of preservation vagaries. Preservation may account for the differences in cases of apparent reversal of dark and light bands on specimens of the same species.

Bellerophon (*Bellerophon*) *graphicus* Moore. Three specimens were described by Webb (1972) from the Cambridge Shale at locality Gwe-1. The pattern consists of a broad concentration of dark

gray pigment along the median portion of the shell which does not extend into the umbilical areas. Anteriorly, the pigment is interpreted by a V-shaped non-pigmented zone which is followed by a V-shaped pigmented zone and then, a nonpigmented zone with the V's of the pattern open anteriorly (figs. 1 and 2).

Bellerophon (Pharkidonotus) percarinatus (Conrad). One specimen from the Columbiana Limestone at locality Cp-3 was described by Sturgeon (1964). The pattern consists of wide revolving dark bands on each side of the shell which are located closer to the lateral margins than to the median line. The bands on this specimen, are 2.0 mm in width with distinct margins and are darker in the outer portion of the band (fig. 5). Four additional small specimens from the Cambridge Shale from localities Gwe-1 and Ga-1 have indications of the same general pattern but with reversed placement of light and dark bands (figs. 3 and 4).

Knightites (Cymatospira) sp. Webb (1972) described a number of specimens from the Portersville Shale at locality No-4 in which the selenizone is occupied by a darker color of shell material which was thought to possibly represent a color pattern. Examination of the specimens in question does not substantiate Webb's interpretation.

Straparollus (Amphiscapha) catilloides (Conrad). Three specimens, collected from the Cambridge Shale at localities Gwe-1 and Ga-1, show a concentration of dark brown pigmentation on the carinae located on the upper and lower shoulders of the whorls (fig. 7). Kemp (1957) notes the same type of pigment concentration on euomphalids in the Permian of Texas as does Knight (1934) in specimens of this genus from the Pennsylvanian of Missouri.

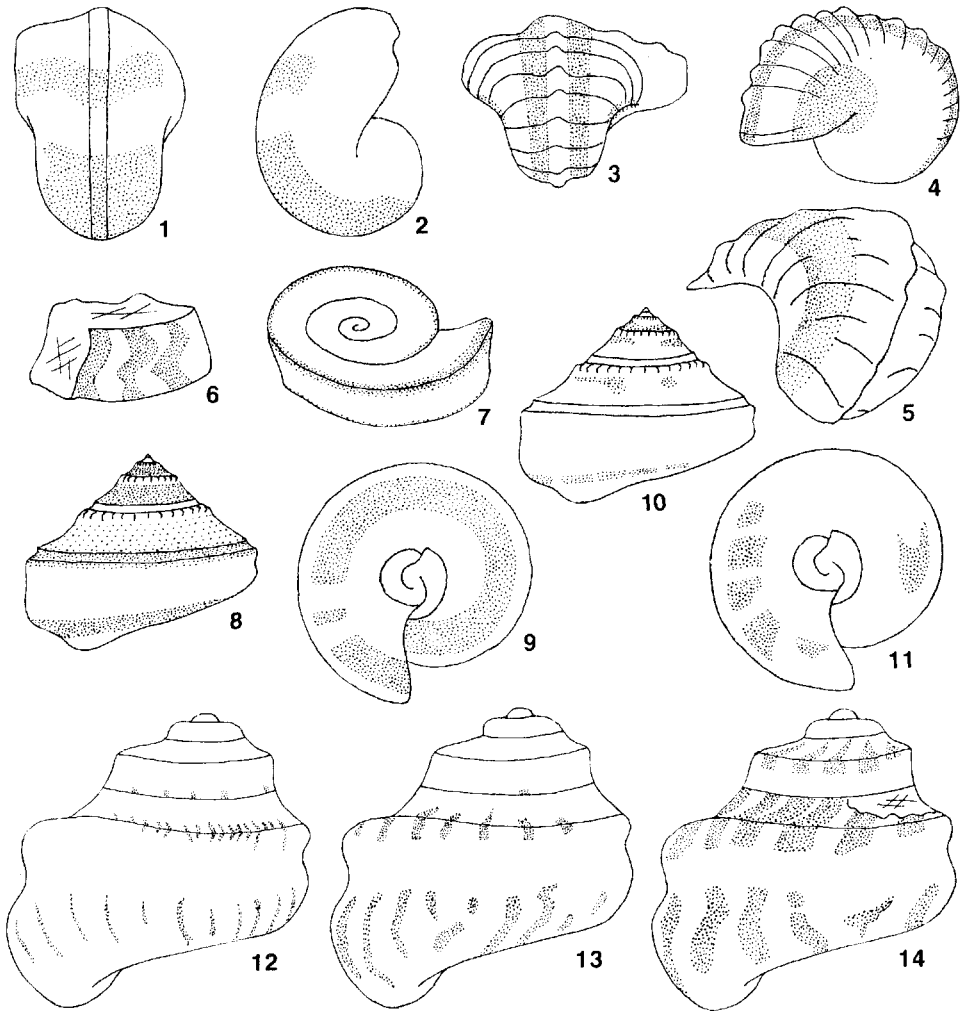
Callistadia n. sp. A population of 177 specimens from the Putnam Hill Shale at locality Ty-3 contains 120 specimens showing color patterns. The pattern consists of transverse sinuous dark gray bands of variable width and spacing which cross the ramp from the upper suture and extend onto the lateral surface where they are interrupted at a concave zone before extending onto the whorl base (figs. 12-14). Variability in pattern

is continuous for the population. A few specimens have reddish-brown bands. A single specimen of this species, with a color pattern, is known from the Lower Mercer Shale at locality CSI-1 and a large population, with preserved color patterns, has been found in the Vanport Shale at locality Jmi-2.

Euconospira turbiniiformis (Meek & Worthen). Two specimens are known, one each from the Lower Mercer Limestone at locality LLuc-1 and the Vanport Limestone at locality Mp-2. The former was described by Lee (1971) and is a poorly preserved fragment from which it is difficult to interpret the color pattern although it shows a variable transverse zigzag pattern. The Vanport specimen was described by Sturgeon (1964) and shows a series of transverse zigzag bands of variable width and spacing. The bands reach from the upper to the lower sutures with the V's pointing towards the aperture at the lower suture and towards the protoconch at the upper suture (fig. 6).

Euconospira riddelli (Shumard). One specimen from the Cambridge Shale, from an unknown locality in Lawrence County, was discussed by Webb (1972). The preservation and fragmental nature of the specimen did not allow description or illustration of the color pattern. The specimen has been subsequently misplaced in the OU collections.

Glabrocingulum (Glabrocingulum) grayvillense (Norwood and Pratten). A large number of specimens, collected from the Cambridge Shale at localities Gwe-1 and Ga-1, show at least partial color pattern preservation. The most distinct portion of the pattern is a relatively broad spiralling dark band on the base of the whorl. The band is centrally located and occupies one-third to one-half the whorl width. In several instances the band is interrupted to form a series of patches or dashes as it approaches the aperture (figs. 9 and 11). Some specimens also show a dark narrow band extending from just below the selenizone to the upper margin of the selenizone and may have a ramp completely colored, although more lightly than the band at the selenizone, except for the band of nodes adjacent to the upper suture (fig. 8).



FIGURES 1 and 2. *Bellerophon* (*Bellerophon*) *graphicus* Moore. Dorsal and lateral views, x2.6, Cambridge Shale, Gwe-1, OU-29498.

FIGURES 3-5. *Bellerophon* (*Pharkidonotus*) *percarinatus* (Conrad). 3, 4, dorsal and lateral views, x2.6, Cambridge Shale, Ga-1, BGSU-4163; 5, oblique dorsal view, x3.5, Columbiana Limestone, Cp-3, OSU-19612. Specimen illustrated in figures 3 and 4 illustrates reversed light-dark banding as opposed to specimen in figure 5.

FIGURE 6. *Euconospira turbiniiformis* (Meek & Worthen). Lateral view of a partial whorl, x1.3, Vanport Limestone, Mp-2, OSU-19764.

FIGURE 7. *Straparolus* (*Amphiscapha*) *cattiloides* (Conrad). Oblique view, x2.6, Cambridge Shale, Ga-1, BGSU-4164.

FIGURES 8-11. *Glabrocingulum* (*Glabrocingulum*) *grayvillense* (Norwood & Pratten). Figures 8 and 9, lateral and basal views, x4.0, BGSU-4165; Figures 10 and 11, lateral and basal views, x4.0, BGSU-4166 Cambridge Shale, Ga-1. Views of two specimens showing variation in patterns, in part probably due to preservation differences.

FIGURES 12-14. *Callistadia* n. sp. Lateral views of three specimens showing variation in pattern, x20.0, Putnam Hill Shale, Ty-3, OSU-30390, 30388, 30382.

Other specimens show little or no difference in color in the area of the selenizone or on the ramp surfaces (fig. 10).

Naticopsis (Marmolatella) pulchella (Morningstar). One specimen from the Lower Mercer Limestone at locality Pr-3, described by Morningstar (1922) and Lee (1971), is still available for study. The observable pattern consists of a series of revolving bands with three dark brown bands separated by lighter brown bands. A light band is present just below the upper suture followed by a dark band of approximately equal width, a narrower light band, a second wider dark band, a second wider light band and then a third very narrow dark band just above mid-whorl. The lower part of the whorl appears to be light (fig. 15). Most of the body whorl is crushed and extensions of the pattern into this area cannot be determined. Both Morningstar (1922) and Webb (1972) note only the two broad upper dark bands.

Knight (1933) reillustrated Morningstar's specimen without description but the narrow third (lower) dark band can be faintly seen in his illustration (Pl. 44, fig. 3). He also notes revolving bands on neanic specimens of *Naticopsis wortheni* Knight and *N. virgata* Knight from the Pennsylvanian of Missouri but the spacing and distribution of the revolving bands is different in both of these species as well as being different from *N. (M.) pulchella*. Squires (1976) describes and illustrates ephebic specimens of *N. (Naticopsis) wortheniana* Knight from the Pennsylvanian Buckhorn asphalt in Oklahoma which have a pattern of revolving dark bands separated by light-colored bands, the pattern, in terms of band width and spacing, showing some variability and differ from *N. (M.) pulchella* in being wider and extending much lower on the whorl profile.

Palaeostylus (Pseudozygopleura) n. sp.
1. Several hundred specimens collected from the Cambridge Shale at locality Ga-1 show a color pattern. The preserved pattern consists of one narrow revolving band of grayish-blue to dark brown or reddish-brown color located at the sutural line so that it is commonly exposed above the lower suture but partially covered by the succeeding whorl

(fig. 17). The rest of the shell has a very light color. Knight (1930) describes numerous color patterns in pseudozygopleurids from the Pennsylvanian of Missouri. *Paleostylus (Pseudozygopleura) tenuivirga* Knight has a pattern of one narrow dark band located at the sutural line which closely approaches that of this species from Ohio.

Palaeostylus (Pseudozygopleura) n. sp.
2. About 200 specimens were collected from the Cambridge Shale at locality Ga-1. A few specimens show retention of a color pattern which consists of a broad revolving light brown band at mid-whorl bordered by narrower light bands between it and the upper and lower sutures (fig. 16). A broad light brown revolving band may also be present on the base of the whorls. Knight (1930) does not describe any pattern for species of the subgenus *Pseudozygopleura* which matches that of the specimens described above. He does indicate that some species of the subgenus *Paleostylus* have a similar pattern in the Pennsylvanian of Missouri.

Palaeostylus (Palaeostylus) n. sp. Approximately 100 specimens were collected from the Cambridge Shale at locality Ga-1. Many of the specimens show a preserved pattern consisting of a relatively broad brown revolving band located at mid-whorl and bordered by narrower light bands which extend to the upper and lower sutures respectively (fig. 18). Knight (1930) describes four species of this subgenus from the Pennsylvanian of Missouri with color patterns. The pattern of *P. (P.) wortheni* Knight seems to be most similar to that of this species from Ohio.

Leptoptygma virgatum (Knight). Webb (1972) described and illustrated specimens from the Cambridge Shale and Limestone from locality Gwe-1 with a preserved pattern which consists of two dark spiralling bands separated by a centrally located light-colored band. One dark band borders the upper suture and is more prominent, the other extends above the lower suture and may be partially to completely covered by succeeding whorls. The bands increase in width towards the aperture (fig. 19). Knight (1931) described and illustrated speci-

mens of this species from the Pennsylvanian of Missouri with a dark nucleus (protoconch) and two dark revolving bands. One dark band lies below the upper suture and is separated from it by a narrower light band and the second dark band extends slightly above the lower suture but is mainly covered by succeeding whorls.

Ianthinopsis intercalaris? (Meek & Worthen). One large specimen, collected from the Cambridge Shale at locality Ga-1, shows transverse bands of dark brown pigmentation which start at or just below the upper suture and more or less parallel the growth lines on the shell. The bands vary in width and spacing with some apparently interrupted on the central portion of the body whorl, while others are continuous across the whorl. Some bands extend into the umbilical area (fig. 20).

Ianthinopsis primogenius (Conrad). One specimen, collected from the Cambridge Shale at locality Ga-1, shows a color pattern consisting of transverse dark grayish-blue bands on the body whorl which vary in width and spacing. The bands begin at the upper suture and curve away from and then back towards

the aperture before ending well above mid-whorl. They appear again below mid-whorl as chevron-shaped bands terminating above the umbilical area (fig. 21). Knight (1931) describes specimens of this species from the Pennsylvanian of Missouri as having a uniform dark gray to black coloration.

Ianthinopsis paludinaeformis (Hall). Webb (1972) described and illustrated specimens from the Cambridge Shale at locality Gwe-1. More than a dozen specimens subsequently collected from the Cambridge Shale at localities Ga-1 and Gwe-1, and two specimens from the Porterville Shale at locality No-4, show retention of color patterns. A considerable amount of variation exists in the pattern although the pattern is consistently composed of revolving bands. A relatively narrow light or dark band, more commonly the former color, occurs just below the upper suture. Below this is either a narrow band of the opposite shade or the rest of the whorl surface is of the opposite shade. On some specimens the second band may move up to the upper suture in latter whorls. Occasionally three bands are present with a narrow upper dark band, a narrow in-

EXPLANATION OF FIGURES 15-28

FIGURE 15. *Naticopsis (Marmolatella) pulchella* (Morningstar). Oblique view of holotype, x3.3, Lower Mercer Limestone, Pr-3, OSU-15311. Revolving dark bands cannot be seen on later portion of body whorl because of preservation.

FIGURE 16. *Palaeostylus (Pseudozygopleura)* n. sp. 2. Lateral view of specimen without a second band on the base of the whorl, x10.0, Cambridge Shale, Ga-1, BGSU-4167.

FIGURE 17. *Palaeostylus (Pseudozygopleura)* n. sp. 1. Lateral view, x6.7, Cambridge Shale, Ga-1, BGSU-4168.

FIGURE 18. *Palaeostylus (Paleostylus)* n. sp. Lateral view, x10.0, Cambridge Shale, Ga-1, BGSU-4169.

FIGURE 19. *Leptotygyma virgatum* (Knight). Lateral view showing only a small indication of the lower band which may or may not appear above the lower suture, x4.0, Cambridge Shale, Gwe-1, OU-29435.

FIGURE 20. *Ianthinopsis intercalaris?* (Meek & Worthen). Lateral view, x2.0, Cambridge Shale, Ga-1, BGSU-4170.

FIGURE 21. *Ianthinopsis primogenius* (Conrad). Lateral view, x3.0, Cambridge Shale, Ga-1, BGSU-4171.

FIGURES 22-26. *Ianthinopsis paludinaeformis* (Hall). Lateral views of five specimens showing pattern variation; Figure 22, x.66, Portersville Limestone, No-4, OU-29436; Figure 23, x2.6, Cambridge Shale, Gwe-1, OU-29437; Figure 24, x2.6, Cambridge Shale, Gwe-1, BGSU-4172; Figure 25, x2.6, Cambridge Shale, Gwe-1, BGSU-4173; Figure 26, x2.6, Cambridge Shale, Ga-1, BGSU-4174.

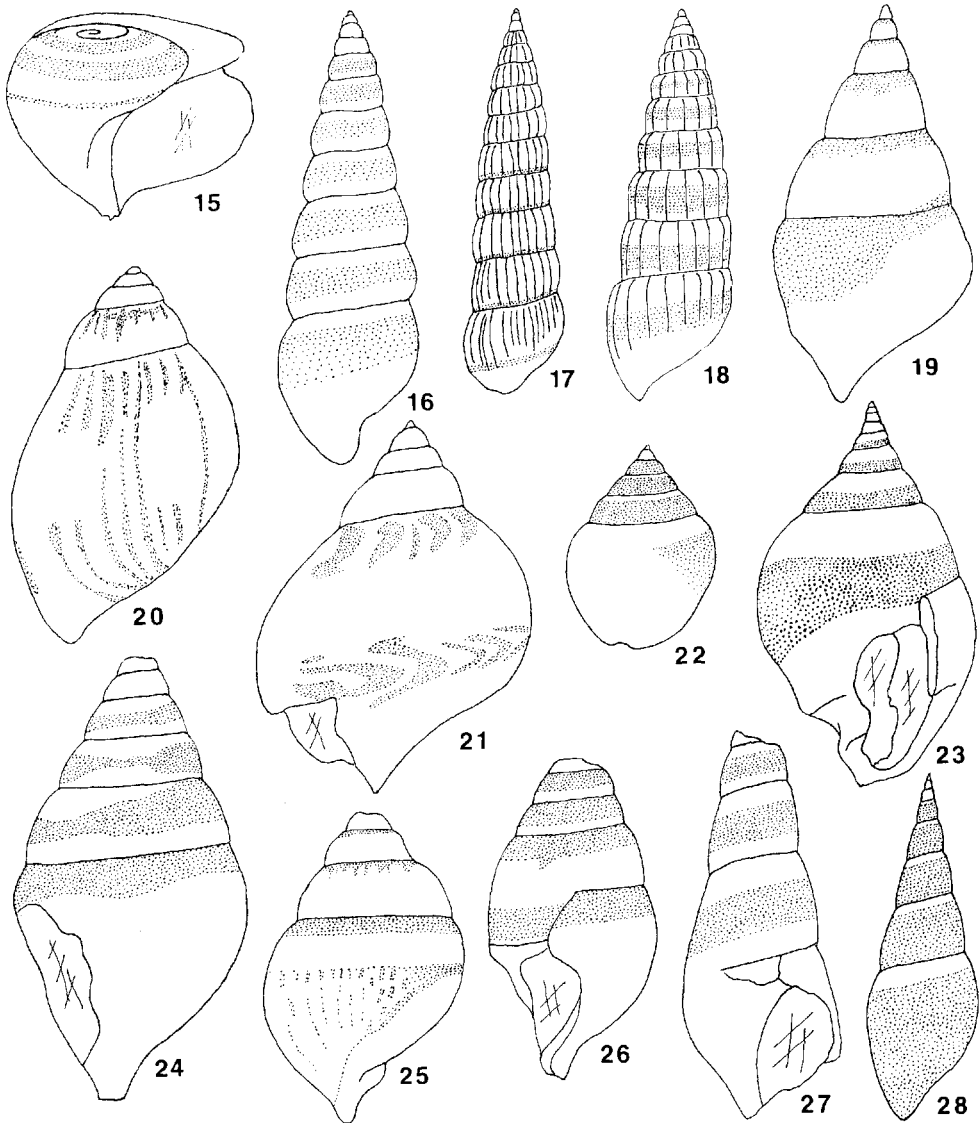
FIGURE 27. *Meekospira peracuta* (Meek & Worthen). Lateral view, x4.7, Cambridge Shale, Ga-1, BGSU-4175.

FIGURE 28. *Soleniscus typicus* (Meek & Worthen). Lateral view, x2.0, Cambridge Shale, Ga-1, BGSU-4176.

intermediate light band and the entire lower two-thirds of the whorl being a third band of dark color (figs. 22-26). Knight (1931) describes specimens of this species from the Pennsylvanian of Missouri as being uniformly dark gray to black.

Meekospira peracula (Meek & Worthen). One specimen, collected from the Cambridge Shale at locality Ga-1, retains a color pattern. A narrow light gray band is present just below the upper

suture and a second light gray band of equal width is just above the lower suture. The intervening band is light brown in color and is slightly wider than either of the light bands and fades out on the body whorl (fig. 27). Knight (1932) describes specimens of this species from the Pennsylvanian of Missouri as having a narrow dark band below the upper suture followed by an intermediate light band and a lower dark band which is bisected by the lower suture. Apparently the



FIGURES 15-28

patterns of the specimens from Ohio and Missouri are the same with the preserved dark-light color relationship of the bands being reversed.

Soleniscus typicus (Meek & Worthen). One specimen, collected from the Cambridge Shale at locality Ga-1, has a preserved pattern. The pattern, which is faint, consists of a broad light brown revolving band extending from the lower suture, or below it, to near the upper suture from which it is separated by a narrow light band (fig. 28). The body whorl shows the dark band extending to the abapical end of the shell. Knight (1931) describes the color pattern of this species, from specimens in the Pennsylvanian of Missouri, as being a uniform dark gray to almost black.

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