Additions to the Fauna of the Raritan Formation (Cenomanian) of New Jersey

By LLOYD WILLIAM STEPHENSON

A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

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Descriptions and illustrations of fossils of Late Cretaceous age; mostly pelecypods and gastropods

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ABSTRACT

Fossils collected by Roger C. Baker, geologist, Ground Water Branch of the Water Resources Division, United States Geological Survey, in 1940–41, from the lower part of the Raritan formation (Upper Cretaceous) in clay pits at Sayreville, New Jersey, include a new genus, *Naritra*, nine new species, and one new variety. They are: *Barbatia? cuniculana*, *Nemodon obesus*, *Ostrea (Alectryonia) jerseiana*, *Plicatula ferrata*, *Naritra pollicifformis*, *Opis? elevata* var. *biangulata*, *Linearia lirulifera*, *Lirpsa? lepida*, *Voysa? cuniculana*, and *Paladmete pristina*.

Five previously described species in the list from Sayreville, two of them questionably identified, are common to the Woodbine formation of Texas. These are: *Cliona retiformis* Stephenson, *Idonearca blanpiedi* Stephenson?, *Phelopteria dalli* (Stephenson)?, *Ostrea soleniscus* Meek, and *Caryocorbula? ovisana* Stephenson.

Species in the list common to a fauna obtained from a sample of marl dredged from a depth of 200 fathoms on Banquereau Bank, off Nova Scotia, are: *Phelopteria dalli* (Stephenson)?, and *Anchura pontana* Stephenson. *Turritella bakeri* Richards belongs to a group of noded Turritellas that occur in both the Woodbine formation and at the Banquereau Bank locality. The new varietal form, *Opis? elevata biangulata*, is very closely related to *O.? elevata* Stephenson from the Woodbine formation.

Supplementary descriptions of several species previously described by H. G. Richards from the clay pits at Sayreville are given.

The evidence afforded by the collections from the clay pits at Sayreville indicates that the Raritan formation, particularly the lower part, corresponds approximately in age to the Woodbine formation (Cenomanian) of Texas, and to the sample of shell marl dredged from the Atlantic Ocean on Banquereau Bank, off Nova Scotia.

INTRODUCTION

The two collections of fossils used in the preparation of this paper were made by Roger C. Baker, geologist, Ground Water Branch of the Water Resources Division, U. S. Geological Survey, at Sayreville, Middlesex County, New Jersey, in 1940–41. One of the collections (USGS 19013) was obtained from "impure siderite nodules near the upper portion of the Woodbridge member of the Raritan formation," (quoted from collector's label) in a clay pit of the Sayre and Fisher Brick Co. The other collection (USGS 19014) came from "nodules of impure siderite(?) in the upper portion largely of the Woodbridge member of the Raritan formation," in the southern pit (south of the railroad track) of the New Jersey Clay Products Co. In both collections the concretions are sandy and contain an abundance of fine muscovite mica flakes, and in both, most of the original siderite has been oxidized to hematite and limonite. In collection 19013, the weathered surfaces have been leached to light-gray micaceous sand. The two collections seem to have come from essentially the same zone.

Previous to 1943 only 8 species of mollusks had been recorded from the Raritan formation. That year H. G. Richards (1943, p. 15–32, pls. 4–7) published a paper in which he briefly reviewed the history of the development of knowledge concerning the formation and its contained flora and fauna. He added the names of 20 species and 2 varieties not previously recorded from the formation. Thirteen of the species and the two varieties were new and were named and described by him in the paper cited; the others had been previously recorded from stratigraphically higher Upper Cretaceous formations. The new species and varieties were obtained from the clay pits at Sayreville. In addition to the named species, Richards recorded the following specifically unidentified genera that had not previously been reported from the formation: *Pinna* Linné, *Exogyra* Say, *Anchura* Conrad, and *Fasciolaria* Lamarck.

The Raritan formation is the basal formation of the Upper Cretaceous series, as that series is developed in New Jersey. The lithologic character of the formation as it occurs in outcrop, is described in detail by H. B. Kümmel and G. N. Knapp (1904, p. 161–203). The formation in Middlesex County is composed of 240 to 290 feet of exceedingly irregularly bedded sands and clays. The sands include nearly pure quartz sand, and micaceous, lignitic, and arkosic sands; some of the

arkosic sands are suitable for the manufacture of firebrick. The clay layers and lenses are variable in thickness and composition and include many commercially important bodies of stoneware clay, fire clay, terra-cotta clay, and brick clay.

According to Kümmel and Knapp (1904, p. 164), the sands and clays of the Raritan formation are generally considered to have accumulated under broad estuarine conditions, and the few fossils known from the formation at that time are considered to have lived in brackish waters. Later collections, including those described in the present paper, belong definitely to species that inhabited shallow marine waters. It would appear, therefore, that open-sea conditions existed while part or all of the formation was being deposited. Most of the fossils described by Richards (1943), and all of those described in the present paper, came from the clay pits at Sayreville. The zone which yielded the fossils is in the upper part of the bed which is known commercially as the Woodbridge clay. This clay bed lies stratigraphically well above the base and considerably below the middle of the Raritan formation.

The additions to the fauna of the Raritan formation, here recorded, are of interest partly because 1 genus, 9 of the species, and 1 variety are new to science, and partly because at least 8 of the species afford confirmatory evidence that the Raritan formation is about the age of the Woodbine formation (Cenomanian) of Texas. The present material exhibits more clearly certain features not preserved on some of the specimens described by Richards, and these additional features are here described and figured. One species, *Geloina? tenuidens* (Whitfield), which was referred questionably to *Rangia* Des Moulins by Whitfield (1885), Weller (1907), and Richards (1943), is here redescribed on the basis of new information about the hinge features.

A complete list and a table of distribution of the molluscan species from the Raritan formation known to Richards in 1943 is given on page 31 of his paper.

LIST OF SPECIES AND THEIR SIGNIFICANCE

A list of the fossil forms treated in the present paper follows. All are mollusks except *Cliona retiformis* Stephenson, which is a sponge.

List of genera and species from Sayreville, treated in this paper

[*Indicative of Woodbine age]

Class Spongiae:
- **Cliona retiformis* Stephenson

Class Pelecypoda:
- *Barbatia? cuniculana* Stephenson, n. sp.
- *Breviarca?* sp. A
- *Breviarca?* sp. B
- **Idonearca blanpiedi* Stephenson?
- *Nemodon obesus* Stephenson, n. sp.
- *Pinna?* sp.
- *Pedalion?* sp.
- **Phelopteria dalli* (Stephenson)?
- *Ostrea (Alectryonia) jerseiana* Stephenson, n. sp.
- **Ostrea soleniscus* Meek
- *Exogyra* sp.
- *Pecten (Camptonectes)* sp.
- *Plicatula howelli* Richards
- *Plicatula ferrata* Stephenson, n. sp.
- *Naritra polliciformis* Stephenson, n. gen. and sp.
- *Geloina? tenuidens* (Whitfield)
- **Opis? elevata biangulata* Stephenson, n. var.
- *Fulpia?* sp.
- *Cardium* sp. A
- *Cardium* sp. B
- *Cardium* sp. C
- *Cardium (Granocardium?)* sp.
- *Callistina? johnsoni* (Richards)
- *Linearia lirulifera* Stephenson, n. sp.
- **Caryocorbula? ovisana* Stephenson
- *"Corbula"* sp.

Class Scaphopoda:
- *Dentalium* sp.

Class Gastropoda:
- *Petropoma? raritanum* (Richards)
- *Helicacanthus?* sp. A
- *Helicacanthus?* sp. B
- *Lirpsa? lepida* Stephenson, n. sp.
- **Turritella bakeri* Richards
- *"Pyrgulifera"* sp.
- *Voysa? cuniculana* Stephenson, n. sp.
- **Anchura pontana* Stephenson
- *Lispodesthes?* sp.
- *Strepsidura?* sp. A
- *Strepsidura?* sp. B
- *Aliofusus? sayrei* Richards
- *Paladmete pristina* Stephenson, n. sp.
- *Pirsila?* sp.

The species in the list that are regarded as affording either direct or indirect evidence of the Woodbine (Cenomanian) age of the fauna are marked with an asterisk (*). Five of these species are identified, two of them questionably, with Woodbine species. One new variety, *Opis? elevata biangulata,* is closely related to the typical *O.? elevata* Stephenson from the Woodbine formation. The genus *Opis* Defrance is rare in the American Cretaceous, if indeed a true representative is present at all. The species *Phelopteria dalli* (Stephenson) was originally recorded as a member of a fauna considered to be of Woodbine age; the holotype was found in a piece of sandy shell marl dredged from a depth of 200 fathoms on Banquereau Bank[1] east of Nova Scotia (Dall, 1925, p. 213–218; Stephenson, 1936b, p. 384–404). The species is also recorded from the Woodbine formation. *Turritella bakeri* Richards be-

[1] Name used by the Department of Mines and Resources of Canada.

longs to a group of noded Turritellas that has not been reported in America from beds of the Upper Cretaceous series younger than Cenomanian; representatives of the group are present in both the Woodbine and Banquereau Bank faunas. The type of *Anchura pontana* Stephenson is from the Banquereau Bank locality. Among the species listed by Richards from the Raritan formation is the gastropod *Avellana pelagana* Stephenson, the type of which came from Banquereau Bank.

The fauna from the clay pits in the Raritan formation at Sayreville, N. J., affords satisfactory evidence of the Woodbine (Cenomanian) age of the clay, known commercially as the Woodbridge fire clay. The evidence also indicates that this clay corresponds in age to a sample of shell marl dredged from a depth of 200 fathoms on Banquereau Bank, east of Nova Scotia.

The fauna from the Woodbridge fire clay affords no evidence for or against a recently expressed opinion that the Arundel and Patapsco formations of the Maryland-Delaware area should be classed with the Upper Cretaceous, rather than with the Lower Cretaceous series, as has been the accepted correlation for many years. Proponents of this new age assignment are H. E. Vokes (1949, p. 129–133), and W. B. Spangler and J. J. Peterson (1950, p. 8, 62–71). Vigorous opponents of this new age assignment, and at the same time, proponents and defenders of the older correlations, are M. E. Johnson and H. G. Richards (1952, p. 2150–2160), and Erling Dorf (1952, p. 2161–2184).

Spangler and Peterson (1950, p. 8, 15–21) express the opinion that the Raritan formation of New Jersey includes beds of both the Upper Cretaceous (Cenomanian) and Lower Cretaceous (Albian) series. According to Kümmel and Knapp (1904, p. 163) the estimated maximum thickness of the Raritan formation in Middlesex County is 390 feet. They assign the Woodbridge fire clay to a position low in the formation, presumably below the middle. This must mean that the thickness of the Cretaceous sediments between the fire clay and Triassic basement cannot be more than 200 feet, and is probably less than 150 feet. These sediments, composed of irregularly bedded sands and clays, are accepted by all geologists who have studied them as forming a part of one unbroken geologic unit. They are of a kind that would be expected to be deposited rapidly. Since the fauna contained in the Woodbridge fire clay is of Woodbine age (Cenomanian), and since the Woodbine formation is not the lowest geologic unit of the Cenomanian, the Albian age of the beds forming the lower part of the Raritan formation seems highly improbable. They are probably of Cenomanian age.

SYSTEMATIC DESCRIPTIONS

Class SPONGIAE

Family CLIONIDAE

Genus CLIONA Grant, 1826

Cliona retiformis Stephenson

Plate 6, figure 1

[1953]. *Cliona retiformis* Stephenson, U. S. Geol. Survey Prof. Paper 242, p. 50, pl. 8, figs. 1–3, 1952.

The ferruginous casts of sponge borings which appear to be essentially like those of *Cliona retiformis* Stephenson, from the Woodbine formation of Texas, are present on the internal mold of a shell of *Ostrea soleniscus* Meek, and on the imprint of a fragment of a thick unidentified shell. The original description of the species, quoted below, applies equally well to these New Jersey casts, except that the meager available material does not display as great a variety of growth patterns as the Texas material. The boring sponges of the genus *Cliona* are commensal on their host, using the enclosing shell for protection only. The following is quoted from Professional Paper 242, p. 50:

> The young sponges entered the shell through numerous circular openings of their own making, which range in diameter from 0.1 mm or less to about 0.5 mm. Once inside the shell the young sponges bored laterally, the individuals often meeting and fusing to form colonial assemblages. The borings are extremely irregular, ranging from small to relatively large tubes, swelling at intervals to still larger irregular ovate- or jug-shaped cavities. The pattern may be that of an open lacework of labyrinthine passages or a dense mesh of tubes and turnip-shaped intercommunicating cavities. The surface of the cast is finely stippled, a feature which appears to be characteristic of the genus.

Types.—Holotype, USNM 105068, from the Euless member of the Woodbine formation of Texas; paratypes from the Woodbine formation include USNM numbers 105069–105072; 1 figured plesiotype from the Raritan formation, USGS 19014, USNM 108611; 1 unfigured example from the same source, USNM 108612.

Class PELECYPODA

Family ARCIDAE

Genus BARBATIA Gray, 1842

Barbatia? cuniculana Stephenson, n. sp.

Plate 6, figures 2–5

Shell of medium size, elongate-subtrapezoidal, moderately inflated, very inequilateral, equivalve. Beaks prominent, incurved, prosogyrate, situated about one-fifth the length of the shell from the anterior end; umbonal region broad. A very broad, shallow depression extends from the umbo downward and obliquely backward to the ventral margin, centering a little in advance of midlength. The umbonal ridge forms a broadly

rounded swell extending to the lower posterior extremity. Dorsal margin long, straight; anterior margin evenly and rather sharply rounded; ventral margin nearly straight or even broadly concave centrally, curving upward at each end; posterior margin sharply rounded below at end of umbonal ridge, broadly rounded and inclined strongly forward above. Entire surface covered with fine, somewhat irregular radiating costae, narrower than the interspaces; the costae increase only slightly in size toward the margins and new costae are added by intercalation. Concentric growth lines are weak and inconspicuous except at resting stages, which may appear at irregular intervals as rather deep, conspicuous grooves.

Dimensions of a paratype, an internal mold of a right valve: Length 30.6 mm, height 16.5 mm, convexity 5.5 mm.

The cardinal area is amphidetic, long and narrow; and incomplete impressions in molds show the presence of several chevron-shaped ligamental grooves. The hinge is long and narrow; the central part is not clearly preserved but presumably it bears small, transverse teeth; each end of the hinge widens and arches down slightly and bears several small teeth that trend obliquely downward and inward. The adductor scars are small and weakly or obscurely impressed on the internal molds.

Types.—Holotype, USNM 108613; 3 figured paratypes, USNM 108614; 8 unfigured paratypes, USNM 108615. All are from the southern pit of the New Jersey Clay Products Co., Sayreville, N. J. (USGS 19014).

Genus BREVIARCA Conrad, 1872

Breviarca? sp. A

Plate 6, figures 6, 7

Five internal molds and part of one external mold of a small bivalve species in the collection from the southern pit of the New Jersey Clay Products Co. (USGS 19014), are questionably referred to the genus *Breviarca* Conrad. The shell is short-subtrapezoidal in outline, inequilateral, equivalve, moderately inflated. Beaks rather sharply pointed, incurved, and situated about at the midlength. Umbonal ridge angular and the steeply descending posterodorsal slope flattish. Anterior margin sharply rounded; ventral margin nearly straight; posterior margin angular below, nearly straight and inclined forward above. Small evenly spaced concentric ridges cover the main surface and are crossed by weak, closely spaced radiating lines, producing an obscure, finely punctate ornamentation; the posterodorsal slope is marked only by fine, obscure radial lines. The hinge is short, arches down at each end, and bears small teeth that are oblique downward and inward. The internal mold of a right valve shown in plate 6, figure 6, measures: Length 10 mm, height 6.8 mm, convexity about 1.5 mm. Two figured specimens, USNM 108616; four unfigured specimens, USNM 108617.

Breviarca? sp. B

Plate 6, figure 8

An internal mold of the right valve of a short, relatively high, compressed taxodont bivalve in the collection from the southern pit of the New Jersey Clay Products Co. (USGS 19014) is too incompletely preserved for accurate generic and specific determination. In size and form it resembles the species *Breviarca perovalis* (Conrad) from the Snow Hill marl member of the Black Creek formation, Snow Hill, N. C. (Conrad, appendix A, p. 3, pl. 1, fig. 4, *in* Kerr, 1875). The external mold is not available but the shell is probably smooth. The incomplete internal mold measures: Length 16.5+ mm, height about 16 mm, convexity about 3 mm. USNM 108618.

Family CUCULLAEIDAE

Genus IDONEARCA Conrad, 1862

Idonearca blanpiedi Stephenson?

Plate 6, figure 9

[1953]. *Idonearca blanpiedi* Stephenson, U. S. Geol. Survey Prof. Paper 242, p. 63, pl. 11, figs. 1–4, 1952.

One incomplete internal mold from a clay pit of the Sayre and Fisher Brick Co. (USGS 19013) possesses a form strongly suggestive of *Idonearca blanpiedi* Stephenson from the Woodbine formation of Texas. The mold indicates an inflated right valve possessing a prominent subangular umbonal ridge, elongated in the posteroventral direction, and a long, steep posterodorsal slope. No radial ribbing is apparent and the shell was probably smooth. The mold as preserved measures: Length 41+ mm, height about 30 mm, convexity 7+ mm.

Types.—Holotype, USNM 105146; paratypes, USNM 105147-105149; questionable example from New Jersey, figured, USNM 108619.

Genus NEMODON Conrad, 1869

Nemodon obesus Stephenson, n. sp.

Plate 6, figures 10–15

Shell large for the genus, elongated, plump, higher and plumper at the rear than at the front, inequilateral, equivalve. Beaks prominent, incurved, prosogyrate, situated about 0.35 the length of the shell from the anterior end. Umbonal region broad. The umbonal ridge forms a broadly rounded sinuous swell extending from the beak to the lower posterior extremity. A broadly rounded rather conspicuous depression extends

from the beak obliquely downward and rearward to the ventral margin, centering about midway of the length. Dorsal margin straight, about 0.7 the length of the shell; anterior margin evenly rounded; ventral margin straight or very broadly concave centrally, curving up sharply at each end; posterior margin rather sharply rounded at end of umbonal ridge, very broadly rounded and inclined forward above. The internal molds have impressed upon them from the external molds, weak, irregular concentric growth lines and narrow ridges, and weak radiating ribs; the latter are strongest and coarsest on the posterodorsal slope; on some specimens and parts of specimens radiating ribs are obscure or wanting.

Dimensions of the largest cotype, which is slightly mechanically compressed: Length 38 mm, height 20.5 mm, convexity about 7.5 mm. A nearly complete internal mold measures: Length 29.5 mm, height about 16 mm, thickness 12.5 mm.

Incomplete impressions of the cardinal area and hinge are preserved on several of the internal molds, and these indicate the presence of chevron-shaped ligamental grooves and 1, 2, or 3 teeth elongated parallel to the hinge line on each end of the hinge. Impressions of the adductor scars are scarcely discernible on the internal molds; evidently the scars were not deeply inset in the shell.

Among described species of *Nemodon* this species appears to be nearest to *N. brevifrons* Conrad, from the Snow Hill marl member of the Black Creek formation (upper Campanian), Snow Hill, N. C. Conrad's species has a shorter hinge, is less strongly inflated along the umbonal ridge, is more extended in the posteroventral direction, and has a somewhat weaker development of radiating ribs.

Types.—Five figured cotypes, USNM 108620; 10 unfigured cotypes, USNM 108621. From southern pit of New Jersey Clay Products Co., Sayreville, N. J. (USGS 19014).

Family PINNIDAE

Genus PINNA Linné, 1758

Pinna? sp.

Plate 6, figure 16

The internal mold of a fragment of an elongate, narrow, moderately convex shell, questionably referred to *Pinna* Linné, bears the weak impressions of fine, somewhat irregular longitudinal markings. These markings are finer and less regular than the markings on a fragment illustrated by Richards (1943, p. 23, pl. 5, fig. 5). This specimen is from a clay pit of the Sayre and Fisher Brick Co., Sayreville. USNM 108622 (USGS 19013).

Family PEDALIONIDAE

Genus PEDALION Solander, 1770

Pedalion? sp.

Plate 6, figure 17

The impression of a short section of a hinge, probably the rear portion, with transverse ligamental pits, from the southern pit of the New Jersey Clay Products Co. (USGS 19014), suggests the hinge of some member of the family Pedalionidae, possibly the genus *Pedalion* Solander. The impression includes 4 pits ranging in width from 1.5 to 2 mm and separated by spaces about 1 mm wide; the curved inner edges of the pits project slightly into the inner cavity of the shell. USNM 108623.

Family PTERIIDAE

Genus PHELOPTERIA Stephenson, 1953

Phelopteria dalli (Stephenson)?

Plate 6, figures 18, 19

1936. *Pteria? dalli* Stephenson, Geol. Soc. America Bull., v. 47, p. 389, pl. 3, figs. 19, 20.

[1953]. *Phelopteria dalli* (Stephenson). Stephenson, U. S. Geol. Survey Prof. Paper 242, p. 68, pl. 14, figs. 4–14, 1952.

This species is represented in the collection from the southern pit of the New Jersey Clay Products Co. (USGS 19014) by incomplete internal molds only, including 5 left valves and 1 right valve. The left valves range in size from a small shell 10+ mm long to one 30+ mm long, and the right valve pertains to a large shell 50+ mm long. In form these molds are similar to, if not identical with, *Phelopteria dalli* (Stephenson), a species dredged from a depth of 200 fathoms in the Atlantic Ocean on Banquereau Bank off the east coast of Nova Scotia. Two of the incomplete molds, a left valve and a right valve, are shown in the illustrations.

Types.—Holotype, YPM (Yale Peabody Museum) 14811; 8 paratypes, YPM 14812; plesiotypes from the Woodbine formation, Texas, USNM 105168–105173; 2 questionable examples from the Raritan formation, Sayreville, N. J., figured, USNM 108624; 4 questionable examples, unfigured, USNM 108625.

Family OSTREIDAE

Genus OSTREA Linné, 1758

Subgenus ALECTRYONIA Fischer, 1807

Ostrea (Alectryonia) jerseiana Stephenson, n. sp.

Plate 6, figure 20

This species is represented in the collection from the southern pit of the New Jersey Clay Products Co. (USGS 19014) by the incomplete imprint of one individual. The imprint is of a subcircular shell,

probably a left valve, with 5 or 6 prominent sharp-ridged, radiating, diverging costae, rather narrowly V-shaped in cross section. This type of sculpture is rare in American Upper Cretaceous oysters, the species nearest to it being *Ostrea travisana* Stephenson from the upper part of the Austin chalk in Texas (Stephenson, 1936a, p. 4, pl. 2, fig. 5; pl. 3, figs. 1–5). The Texas species is much larger than the New Jersey species, is elongated downward and to the rear, and the ribs are less sharply angulated on the crests.

The New Jersey specimen measures approximately: Length 37 mm, height 35 mm, convexity 8 mm.

Oysters having the prominent, sharp-ridged type of sculpture exhibited by *Ostrea jerseiana* are represented in the Cretaceous of Europe and northern Africa by a score or more of species ranging in age from Neocomian to Campanian. Of these the following occur in beds of Cenomanian age: *Ostrea cameleo* H. Coquand (Roto magian, Algeria), *O. syphax* H. Coquand (Rotomagian, Mediterranean region), *O. tisnei* H. Coquand (Provencian, southern France), and *O. meslei* H. Coquand (Provencian, southern France).

Holotype.—USNM 108626. From the southern pit of the New Jersey Clay Products Co., Sayreville, N. J.

Ostrea soleniscus Meek

Plate 6, figures 21, 22

1871. *Ostrea soleniscus* Meek, Am. Philos. Soc. Proc., v. 11, p. 430.

For complete synonymy see Stephenson, 1952, U. S. Geol. Survey Prof. Paper 242, p. 74, [1953].

Several internal molds and one external mold in the collections from Sayreville are interpreted as representing the species *Ostrea soleniscus* Meek. Of these, one external mold which pertains to the right valve of a relatively small individual (pl. 6, fig. 21), seems most significant (USGS 19013). Although incomplete, this imprint obviously indicates a flattish, narrowly elongate shell bearing a series of somewhat irregular growth ridges or lamellae; in form and surface markings this shell was similar to the right valve of one of Meek's cotypes from Bear River City, Wyo. The dimensions of this imprint are: Length about 20 mm, height about 40 mm.

The individuals of *O. soleniscus* are exceedingly variable in outline and form. Some individuals assume an inflated exogyroid form in the umbonal region of the left valve, simulating that of the ostreid genus *Exogyra* Say; 4 of the internal molds from the southern pit of the New Jersey Clay Products Co. indicate left valves having this form (pl. 6, fig. 22); one of the molds formed within the 2 valves of a small individual indicates a flattish shell lacking an exogyroid form. The large figured mold of a left valve measures: Length 48+ mm, height 51 mm, convexity 24 mm.

Types.—Meek's 4 cotypes (USNM 7780) from the Frontier formation (Cenomanian) at Bear River City, Wyo., are large incomplete greatly elongated examples of the species; one of them possesses the exogyroid form in the umbonal region. Examples of the species as it occurs in the Woodbine formation (Cenomanian) of Texas are illustrated by Stephenson (1952, pl. 16, figs. 1–4; pl. 17, figs. 7–10). One plesiotype from a clay pit of the Sayre and Fisher Brick Co., USNM 108627 (USGS 19013); 1 unfigured example (juvenile) from the same locality, USNM 108628; one plesiotype from the southern pit of the New Jersey Clay Products Co., USNM 108629 (USGS 19014); 8 unfigured examples from same source as the preceding, USNM 108630.

Genus EXOGYRA Say, 1820

Exogyra sp.

Four internal molds of left valves, from the southern pit of the New Jersey Clay Products Co., appear to be true representatives of the genus *Exogyra* Say (USGS 19014). They are indeterminate specifically as they do not show surface features. The largest example measures: Length about 30 mm, height 35 mm, convexity about 13 mm. USNM 108631.

Family PECTINIDAE

Genus PECTEN Müller, 1776

Subgenus CAMPTONECTES (Agassiz, M. S.) Meek, 1864

Pecten (Camptonectes) sp.

Plate 7, figures 1, 2

The subgenus *Camptonectes* Agassiz is represented in the collection from the southern pit of the New Jersey Clay Products Co. (USGS 19014) by incomplete portions of two left valves, one external the other internal, showing the umbonal area, including the ears. The ears and dorsal slopes bear fine radiating ribs of the kind characteristic of this subgenus. This is a compressed form of the genus in which the low flattish ribs curve away from the central part of the shell to the anterior and posterior margins. The internal mold indicates a shell estimated to be about 35 mm long and 35 or 40 mm high. The external mold pertains to a smaller individual. USNM 108632.

Compared with species of *Camptonectes* in the Woodbine formation of Texas the ribbing is similar to that of *P. (C.) ellsworthensis* Stephenson (1952, p. 80, pl. 19, figs. 5, 6).

Family SPONDYLIDAE

Genus PLICATULA Lamarck, 1801

Plicatula howelli Richards

Plate 7, figures 3–5

1943. *Plicatula howelli* Richards, Acad. Nat. Sci. Phila. Proc., v. 95, p. 25, pl. 4, fig. 6.

The southern pit of the New Jersey Clay Products Co. yielded numerous imprints of *Plicatula howelli* Richards in the form of both internal and external

molds (USGS 19014). The state of preservation is poor and none of the specimens includes the complete impression of an individual. However, the material exhibits some features not mentioned in the original description. Several poorly preserved internal molds of right valves with ribs faintly impressed upon them, were obtained in one of the Sayre and Fisher clay pits at Sayreville (USGS 19013).

The species is irregular in form, outline, and ornamentation, but in general the outline is subcircular to broadly subovate, and the form ranges from compressed to moderately inflated. Both valves bear numerous spinose ribs, the ones on the right valve being fewer and coarser than those on the left valve. Parts of the surfaces of right and left valves are shown in the illustrations. The ribs are narrow and bear spines, which are upfolds of growth lamellae, at intervals of 1 to 2 mm along their crests; on the right valve the interspaces between the ribs are a little wider than the ribs; on the left valve the ribs and interspaces are of about equal width. The holotype illustrated by Richards appears to be the imprint of part of the surface of a right valve. The species attains a maximum dimension of about 25 mm, but most individuals are smaller than that.

Several of the internal molds show the imprints of the characteristic crural ridges of *Plicatula;* these diverge inward, on either side of the submerged resilifer. The adductor scar is large, subcircular, and situated about at midheight and well back of midlength.

Types.—Holotype, New Jersey State Museum 10475; paratype, ANSP (Acad. Nat. Sci. Phila.) 15665. The holotype is from one of the clay pits (not designated) at Sayreville. Fifteen or more specimens from the southern pit of the New Jersey Clay Products Co. may be considered topotypes; 3 of these (plesiotypes) are figured, USNM 108633; the others bear the USNM number 108634; 1 imprint from Sayre and Fisher clay pit, USNM 108635; 2 imprints on a piece of rock from same pit, USNM 108636.

Plicatula ferrata Stephenson, n. sp.

Plate 7, figure 6

One incomplete external mold from one of the Sayre and Fisher clay pits at Sayreville (USGS 19013) is referred to the genus *Plicatula* Lamarck. Although incomplete the surface features appear to be well enough portrayed by the imprint in the ferruginous matrix to justify a specific designation. The mold indicates a shell only moderately inflated, probably pertaining to a left or smaller valve. It appears to have been subcircular in outline. The surface is covered with numerous, closely spaced, narrow, irregular radiating ribs whose crests bear tiny irregular nodes; on parts of the surface the ribs bear small, short spines formed by the upfolding of growth lamellae. The ribs increase in number in the marginal direction, with little increase in size, by the intercalation of new ribs in the gradually widening interspaces. Concentric growth ridges are weakly developed at wide intervals.

Dimensions of the mold: Length about 30 mm, height about 30 mm, convexity about 4 mm.

The surface markings on this species are similar to those on *Plicatula woodburyensis* Weller (1907, p. 485, pl. 52, figs. 8, 9), but its radiating ribs are more strongly developed and the nodes on the crests of its ribs are smaller and weaker.

Holotype.—USNM 108637.

Family POLLICIDAE

Genus NARITRA Stephenson, n. gen.

Type species: *Naritra polliciformis* Stephenson.
Etymology: By anagram from *Raritan.* Gender feminine.

This new genus is based on internal molds of a smooth pelecypod having a form closely simulating that of *Pollex obesus* Stephenson, from the Woodbine formation of Texas (1952, p. 94, pl. 23, figs. 14–20), but possessing hinge characters sufficiently different from the hinge of that species to necessitate referring the molds to a different genus. However, the hinge as impressed on the molds appears to be closely enough related to that of *Pollex* to justify the reference of the species to the family Pollicidae Stephenson.

The ligament is external, opisthodetic, and attached to a well developed nymph. In the hinge of the right valve of *Pollex* the oblique anterior cardinal presents two cusps on its crest, a forward or inner large one and an outer rather weak one, the two cusps separated by a low sag; in the hinge of the right valve of *Naritra,* as represented by a rubber cast made from the imprint of the hinge of the left valve, a weak cusp and a middle cardinal tooth are both wanting, and their place is taken by a deep medial socket. In *Pollex* the oblique posterior cardinal is of median strength while in *Naritra* the posterior cardinal is small and obscure and appears to be attached to the inner side of the anterior end of a long lateral tooth, which is the inner element of a pair of lateral claspers; in *Pollex* the anterior end of this element is distant from the posterior cardinal, reaching only to the posterior end of the nymph. In both genera the outer element of the claspers is formed by the thin margin of the shell. There is no anterior lateral dentition. A deep socket in front of the anterior cardinal and a pair of distant posterior claspers appear to be common features of the two genera, as are also the position and strength of the nymphs. In the left valve of *Naritra,* as represented by an imprint, a prominent anterior cardinal tooth fits into the deep anterior socket, and a prominent medial cardinal into the middle socket. A slender

lateral tooth, which fits into the claspers of the right valve, extends forward beneath the nymph nearly to the beak.

Naritra polliciformis Stephenson, n. sp.

Plate 7, figs. 7–9

Six incomplete internal molds of a bivalve mollusk, 4 of right valves and 2 of left valves, in the collection from the southern pit of the New Jersey Clay Products Co. (USGS 19014), are suggestive in outline and form of the species *Pollex obesus* Stephenson, from the Woodbine formation of Texas (Stephenson, 1952, pl. 23, figs. 14–20) but, as previously stated, they possess hinge features that necessitate referring them to a different genus.

Shell elongate-subovate, plump, inequilateral, equivalve. Umbonal region broad, beaks nonprominent, incurved, prosogyrate, situated about 0.25 the length of the shell from the anterior extremity. There is a broad, very shallow radial depression extending from the beak to the ventral margin at about its midlength. Umbonal ridge broadly rounded and slightly humped centrally. The surface appears to be essentially smooth.

The holotype, the best preserved mold of a right valve (pl. 7, fig. 7), measures: Length 36+ mm, height 20 mm, convexity 6 mm.

The features of the hinge, as revealed by an imprint of one left valve, are described under the generic heading. The adductor scars and pallial sinus cannot be seen clearly on the molds.

Types.—Holotype, a right valve, USNM 108638; 1 paratype figured to show the hinge, USNM 108639; 4 unfigured paratypes, USNM 108640.

Family PLEUROPHORIDAE?

Genus GELOINA Gray, 1842

[Proposed as a subgenus of *Polymesoda* Rafinesque]

Geloina? tenuidens (Whitfield)

Plate 7, figures 10–14

1886. *Gnathodon? tenuidens* Whitfield, U. S. Geol. Survey Mon. 9 (New Jersey Geol. Survey, Paleontology ser., v. 1), p. 27, pl. 2, figs. 7–10.

1907. *Rangi a? tenuidens* (Whitfield). Weller, New Jersey Geol. Survey, Paleontology ser., v. 4, p. 635, pl. 73, figs. 6–8.

1943. *Rangia? tenuidens* (Whitfield). Richards, Acad. Nat. Sci. Phila. Proc., v. 95, p. 21, pl. 4, fig. 2; pl. 5, fig. 1.

The external features of this species have been well described by the authors cited in the synonymy; only very incomplete hinge features, however, were available to them. The two specimens here figured are from the Sayre and Fisher clay pit at Sayreville (USGS 19013) and presumably are topotypes. The incomplete hinge here illustrated (pl. 7, figs. 11, 12) obviously does not pertain to *Rangia* Des Moulins; as preserved, it is not adequate to permit of a satisfactory determination of its generic relationships. It is here provisionally referred to *Geloina* Gray, a Recent genus inhabiting the Philippine seas, with whose hinge features it appears to be in fair agreement. A more complete hinge would probably provide a basis for erecting a new genus to contain this species. All of the available material is in the form of internal molds with the incremental lines more or less clearly impressed upon them.

The shell is of medium size, broadly subovoid to subtrigonal in outline, short and plump; impressed upon the molds are rather conspicuous irregular concentric growth lines, which become more pronounced on the dorsal slopes. There is no umbonal ridge and no radial markings.

Dimensions of the larger of the two specimens here figured: Length 47 mm, height 43 mm, thickness about 42 mm. The smaller specimen measures: Length 40 mm, height 40 mm, thickness 37 mm. The state of preservation does not permit of very accurate measurements.

The imprint of the hinge as partly preserved shows 3 well-developed cardinal teeth in the left valve (pl. 7, fig. 11), of which the middle one is thick, prominent, apparently faintly bifid, and somewhat oblique to the rear; the anterior one is smaller, trigonal, and nearly direct; the posterior one is narrow, very oblique, and less prominent than the middle one. A deep, narrow, trigonal socket separates the anterior from the middle cardinal, and a long, deep, oblique trigonal socket separates the middle from the posterior cardinal. There is evidence of an approximate anterior lateral tooth about 5 mm long and some evidence of a distant lateral posterior. A rubber cast made from the imprint just described (pl. 7, fig. 12) shows in the right valve a well-developed oblique bifid posterior cardinal, and a short, narrow, nearly direct tooth separated from the posterior one by a deep, wide, trigonal socket; in front of the second tooth is a somewhat shallower trigonal socket, beyond which, toward the front, the features of the hinge are not clearly shown; there is probably an anterior cardinal.

Types.—New Jersey State Museum 7794 (plesiotype), 8839 (1 of the cotypes), and 10462 (plesiotype); Acad. Nat. Sci. Phila. 15657; USNM 108641 (2 plesiotypes=topotypes).

Family ASTARTIDAE

Genus OPIS Defrance, 1825

Opis? elevata biangulata Stephenson, n. var.

Plate 7, figures 15, 16

This varietal form is represented by 3 relatively small incomplete internal molds, 2 right valves and

1 left valve, from the southern pit of the New Jersey Clay Products Co. (USGS 19014).

Shell subtriangular in outline, strongly inflated, inequilateral, equivalve, with the umbonal region high and narrow. Both the anterodorsal and posterodorsal slopes are abruptly steep; the former forms an angular junction with the main surface near the beak, becoming subangular to sharply rounded away from the beak; and the latter forms an angle (=umbonal ridge) with the main surface from the beak to the posterior extremity. Beaks very prominent, strongly incurved, prosogyrate. Impressions on the main surface of the holotype show the presence of small, closely spaced, fairly regular concentric ribs.

In form, outline, and surface features this variety is obviously closely related to the typical *O.? elevata* Stephenson (1952, p. 96, pl. 22, figs. 2–6). In the latter the umbonal ridge is sharply angular and the anterodorsal slope consistently rounds over into the main lateral surface in the five available examples. In this varietal form the umbonal ridge is angular and the anterodorsal slope joins the main surface at a sharp or somewhat rounded angle, as consistently shown by the three examples. In addition the varietal form is narrower in the umbonal region.

Dimensions of the holotype, a right valve: Length (estimated) 23 mm, height about 24 mm, convexity 12 mm

The hinge and other internal features are not preserved in the available material.

Types.—Holotype, USNM 108642; 2 unfigured paratypes, USNM 108643.

Family CYRENIDAE

Genus FULPIA Stephenson, 1946

Fulpia? sp.

Two internal molds, one representing a medium-size left valve and the other a juvenile right valve, from the southern pit of the New Jersey Clay Products Co. (USGS 19014), suggest by their form the bivalve genus *Fulpia* Stephenson. The hinge impressions are too incomplete to permit of the certain identification of the genus. The imprint of a small fragment from the anterior slope of a right valve records concentric growth lining very much like that of *Fulpia*. The larger mold measures: Length 17 mm, height about 19 mm, convexity 7 mm. USNM 108644.

Family CARDIIDAE

Genus CARDIUM Linné, 1758

Cardium sp. A

Plate 7, figure 17

The imprint of the exterior surface of a rather large *Cardium*, covering parts of the anterior slope and the main part of the side of a shell interpreted to be a right valve, probably pertains to an undescribed species. It was obtained in the southern pit of the New Jersey Clay Products Co. (USGS 19014). The ribs are narrow, prominent, and total 23 on the fragment, which includes approximately half the surface bordering the anterior and ventral margins; the crests are not well enough recorded in the imprint to show whether or not they were spinose. The interspaces are wider than the ribs and are nearly smooth except toward the outer margin where they become somewhat roughened by low concentric growth ridges. The shell is estimated to have been between 45 and 50 mm long and perhaps a little higher than long. USNM 108645.

Cardium sp. B

The internal mold of a small *Cardium* (USGS 19014) is too incomplete for specific identification. Faint impressions of numerous radiating ribs are present on the mold. The approximate dimensions of the mold are: Length 11 mm, height (estimated) 14 mm, convexity 4 mm. USNM 108646.

Cardium sp. C

One internal mold with radial ribs impressed upon it, from a pit of the Sayre and Fisher Brick Co. (USGS 19013), is of medium size, has a rounded umbonal ridge, and bears numerous (30+) narrow, closely spaced ribs. In size and form this mold is similar to *Cardium longstreeti* Weller from the Wenonah sand of New Jersey (Weller, 1907, p. 579, pl. 63, figs. 21, 22), but the umbonal ridge is more direct and the ribs are more numerous. The mold measures: Length about 21 mm, height 23+ mm, convexity 4+ mm. USNM 108647.

Cardium (Granocardium?) sp.

Two small internal molds from a clay pit of the Sayre and Fisher Brick Co. (USGS 19013) appear to belong to the subgenus *Granocardium* Gabb. One of them exhibits about 24 narrow radiating ribs with rows of very obscure spine scars in the interspaces. The other one, about the same size, is smooth except for very faint impressions of the ribs. These molds may belong to *Cardium* (*Granocardium*) *sayrei* Richards, but the ribs as preserved are not flat-topped, and the outline appears to be less elongated in the direction of the height. The most complete mold measures approximately: Length 10 mm, height 11.5 mm, convexity 3 mm. USNM 108648.

Family VENERIDAE

Genus CALLISTINA Jukes-Brown, 1908

Callistina? johnsoni (Richards)

Plate 7, figures 18–21

1943. *Aphrodina johnsoni* Richards, Acad. Nat. Sci. Phila. Proc., v. 95, p. 24, pl. 4, figs. 3, 4.

Two internal molds, one with the concentric sculpture impressed upon it, and the other showing an obscure impression of the pallial sinus, appear to be identical with *Aphrodina johnsoni* Richards. These are from a clay pit of the Sayre and Fisher Brick Co. (USGS 19013). The pallial sinus on *Aphrodina* Conrad is rather long and broadly rounded at the inner end, whereas this feature on the mold just mentioned is short and subtrigonal, and is therefore more like the pallial sinus on the genus *Callistina* Jukes-Brown. The hinge and ligamental features are not preserved.

The internal mold shown in plate 7, figure 19, measures: Length 30 mm, height 26 mm, thickness 15.5 mm.

Four species of *Callistina* Jukes-Brown have been recorded from the Woodbine formation of Texas (1952, p. 105–108), as follows: (1) *Callistina lamarensis* (Shumard), (2) *C.* (*Larma*) *munda* Stephenson, (3), *C.* (*Larma*) *taffi* (Cragin), and (4) *C.* (*Larma*) *alta* Stephenson. Compared with *C.? johnsoni*: the first of the Woodbine species averages smaller and is much smoother; the second is of comparable size and outline but possesses less regular and more weakly developed concentric ribs; the third species has closely similar concentric markings but the proportion of length to height is greater; and the fourth, though similarly marked, is much higher in proportion to its length.

Types.—Holotype from Sayreville, NJSM (New Jersey State Museum) 10454; paratype from the same place, NJSM 10446; 2 plesiotypes (=topotypes), USNM 108649.

Family TELLINIDAE

Genus LINEARIA Conrad, 1860

Linearia lirulifera Stephenson, n. sp.

Plate 7, figures 22–25

Internal and external molds of this species are common in the southern pit of the New Jersey Clay Products Co. (USGS 19014). The shell, as indicated by molds, is of medium size, subovate elongate, compressed, subequilateral, equivalve. Beaks slightly prominent, incurved, very slightly prosogyrate, situated centrally. Umbonal ridge broadly rounded. Main lateral surface most inflated centrally above the mid-height, rounding off gently to the anterior and ventral margins. Posterodorsal slope flattish. Anterodorsal margin broadly arched, descending; anterior margin rounded less than a semicircle; ventral margin broadly rounded; posterior margin rounding up uniformly, meeting the hinge line at an obtuse angle; posterodorsal margin long, straight, gently descending. The two dorsal margins meet at the beak at an angle of about 130 degrees.

The lateral surface between the dorsal slopes bears numerous narrow, sharply defined, regularly spaced concentric lirae, separated by wider interspaces; near the beak these number 5 to the millimeter in the radial direction but increase in coarseness to about 2 to the millimeter near the ventral margin; these lirae merge into growth lines only on the posterodorsal slope, and become weaker forward on the anterodorsal slope. The latter slope bears 8 to 10 or more, relatively strong, radiating lirae, noded at the intersections with the concentric lirae; away from the beak the number of lirae increases by the introduction of secondary lirae in the interspaces. The posterodorsal slope and umbonal ridge are ornamented with similar radiating ribs which number as many as 20 near the posterior margin; these become weaker forward from the umbonal ridge and the main lateral surface exhibits only weak to obscure radial lining.

Dimensions of the incomplete holotype, a left valve: Length 23+ mm, height 17.5 mm, convexity about 4 mm.

The available material affords only imperfect, incomplete imprints of the hinge features. The internal mold of the holotype, however, indicates the presence of a pair of cardinal teeth in the right valve directed obliquely forward and downward, and short, distant anterior and posterior laterals in the left valve—features characteristic of the genus *Linearia* Conrad. Other internal features are not clearly registered on the molds.

Types.—Holotype, USNM 108650; 2 figured paratypes, USNM 108651; 15 unfigured paratypes, USNM 108652.

Family CORBULIDAE

Genus CARYOCORBULA Gardner, 1926

Caryocorbula? ovisana Stephenson

Plate 7, figure 26

[1953]. *Caryocorbula ovisana* Stephenson, U. S. Geol. Survey Prof. Paper 242, p. 129, pl. 32, figs. 9–15, 1952.

This species is represented by one incomplete external mold of a right valve from the southern pit of the New Jersey Clay Products Co. (USGS 19014). The following description is based on this specimen. Shell small, subtrigonal in outline, strongly inflated. Beak not preserved but obviously incurved and situated well forward of the midlength Umbonal ridge curved, obtusely subangular in cross section. Posterodorsal

slope steep, sinuous, divided centrally by a low radial ridge; the surface between this ridge and the umbonal ridge is broadly concave. Anterior margin sharply rounded; ventral margin broadly rounded; posterior margin subangular below at end of umbonal ridge, followed above by a short truncation inclined forward. Surface regularly ornamented with pronounced concentric ridges which toward the margin number 8 or 9 in a radial distance of 5 mm. The ribs end abruptly rearward near the umbonal ridge, beyond which, on the posterodorsal slope, only growth lines are present.

Dimensions of the external mold, which lacks a little of including the full length: Length 11+ mm, height about 7 mm, convexity about 3 mm.

I can detect no differences that would justify considering this species distinct from the Texas species.

Types.—Holotype, USNM 105535; 151 paratypes, USNM 105536a-d (figured) and 105537 (unfigured); 1 plesiotype from New Jersey, USNM 108653.

Genus CORBULA Lamarck, 1799

"Corbula" sp.

Plate 7, figures 27, 28

Three internal molds of left valves, 1 internal mold of a right valve, and 1 internal mold of both valves in place together, from the southern pit of the New Jersey Clay Products Co. (USGS 19014), probably represent an undescribed species of *"Corbula."* Two incomplete external molds of a left valve from the same source appear to pertain to the same species. The species is of medium size, plump, inequilateral, slightly inequivalve, the right valve being the larger; the middle and anterior parts of the shell are most inflated and the posterior part is sharply constricted. The beaks are situated a little in advance of the midlength. Anterior margin sharply rounded narrower than a semicircle; ventral margin broadly rounded; posterior margin subangular below with a short truncation inclined forward above; posterior margin descending, nearly straight or slightly concave upward. The surface of the left valve, as shown by two incomplete external molds, bears small, fairly regular concentric ribs numbering about three to the millimeter in the radial direction. The anterior adductor is small and is attached to a raised platform, the posterior adductor is larger, and is attached to a raised platform bordered by a sharp carina which overhangs the interior of the shell. Dimensions of the largest internal mold, a right valve: Length 12 mm, height 9 mm, convexity about 3.5 mm. Two figured specimens USNM 108654; five unfigured specimens, USNM 108655.

Class SCAPHOPODA

Family DENTALIIDAE

Genus DENTALIUM Linné, 1758

Dentalium sp.

One internal mold of a tube having the form of *Dentalium* Linné, from a pit of the Sayre and Fisher Brick Co. (USGS 19013), is 14 mm long, 1.5 mm in diameter at the small end, and 3.5 mm in diameter at the large end. The tube is gently curved, increases regularly in diameter, and as preserved appears smooth. USNM 108656.

Class GASTROPODA

Family TURBINIDAE?

Genus PETROPOMA Gabb, 1877

Petropoma? raritanum (Richards)

Plate 8, figures 1, 2

1943. *Avellana? raritana* Richards, Acad. Nat. Sci. Phila. Proc., v. 95, p. 28, pl. 5, fig. 16.

The external mold of this species, here illustrated, and 2 internal molds are from the southern pit of the New Jersey Clay Products Co. (USGS 19014). The external mold is incomplete but appears to be in a somewhat better state of preservation than the holotype as originally figured. With the meager material available it does not seem possible to definitely determine the generic relationships of the species, but it is obviously not closely related to *Avellana* Orbigny, to which the author questionably referred it. The species probably belongs in the family Turbinidae; the form and sculpture suggest that it is more closely related to (though probably not generically identical with) the genus *Petropoma* Gabb (1877, p. 281, 282, pl. 40, fig. 8) than it is to *Turbo petholatus* Linné, the genotype of *Turbo* Linné. The latter is a recent species in Philippine waters. Gabb's type species, *Petropoma peruanum*, is from the so-called Gault (Albian, not Lias) of Peru. (See Gerhardt, 1897, p. 92, pl. 2, figs. 1a–e). *P. peruanum* is small, only about 7 mm high.

The description of the external features, which follows, is based on a rubber cast made from the external mold of a topotype. Shell of medium size; spire low, protoconch not preserved; whorls 2½ or 3, plumply and evenly rounded, rapidly expanding; sutures deeply impressed. Axial ribs wanting. The body whorl bears at least 15 spiral ribs which differ considerably in strength, and are separated by interspaces wider than the ribs. At a stage about half a whorl back from the aperture the succession of ribs from above downward is as follows: 1 weak rib near the suture,

then 3 strong ribs, 1 very weak rib, 1 strong rib, 1 weak rib, 1 strong rib, 1 rib of medium strength, 1 strong rib at the periphery, 1 weak rib on the base just below this, 1 strong rib, followed below on the base by 3 successively smaller ribs. All the smaller ribs from near the periphery to the suture above are introduced by intercalation and increase in strength forward toward the aperture.

Starting with one small rib just below the periphery all the ribs on the upper part of the body whorl bear nodes or short spines; the spines are on the larger ribs and are formed by upfolds of growth lamellae, open toward the front; the nodes and spines are spaced at nearly regular intervals of 1 to 1.5 mm. As previously stated the first rib below the periphery on the base is noded; all the other ribs on the base are smooth. The upper 6 or 7 ribs of the body whorl are exposed on the later stage of the penultimate whorl. Traced backward toward the apex these exposed ribs become weaker and die out at or near the earliest stage of the penultimate whorl, beyond which to the apex the surface of the shell is smooth. The growth lines trend strongly forward on the upper part of the body whorl.

Dimensions of the figured rubber cast: Height 11+ mm, diameter 19 mm.

This species appears to be related to *Turbo? newberryi* (Cragin). The holotype of Cragin's species is believed to be lost, and the plesiotype (USNM 103134) figured by T. W. Stanton (1947, p. 56, pl. 49, figs. 5, 6) is rather poorly preserved. However, in form and sculpture it is similar to Richard's species and the two may belong to the same genus.

Types.—Holotype, New Jersey State Museum 10541; topotype figured, USNM 108657; 2 unfigured topotypes (internal molds), USNM 108658.

Family TROCHIDAE?

Genus HELICACANTHUS Dacqué, 1938

Helicacanthus? sp. A

Plate 8, figures 3, 4

Three imprints of parts of the spire and two incomplete internal molds of a small gastropod, from the southern pit of the New Jersey Clay Products Co. (USGS 19014), are referred questionably to *Helicacanthus* Dacqué. The shell is low-spired with imprints of about 2½ whorls of the spire preserved. Spiral angle about 90°. The suture is closely appressed in the early stages, but opens out a little in the later stages; it is closely bordered below by a narrow upraised spiral rim. The penultimate whorl bears an angular spiral rib about midway of its exposed flank, and a second angular spiral at the periphery of the body whorl is partly concealed by that whorl in its forward growth. Very obscure fine spiral lining can be detected. Fine, sharp growth lines are strongly oblique toward the front on the flanks of the whorls. The internal molds indicate a fairly wide umbilical opening. The greatest diameter of the largest internal mold is about 12 mm. The available specimens are inadequate for either generic or specific assignment, and it is doubtful if their reference to *Helicacanthus* is correct. One figured example, USNM 108659; four unfigured examples, USNM 108660.

Helicacanthus? sp. B

Plate 8, figure 5

This species is represented by 1 internal and 1 external mold, both incomplete, from the same source as the preceding (USGS 19014). It is similar to *Helicacanthus?* sp. A in form, suture, and character and direction of the growth lines, but differs in that there are 3 angular spiral ribs instead of 2, the lower one of which is partly concealed by the body whorl in its forward growth. Obscure fine spiral lining is present over most of the surface. The species appears to be closely related to the shell from the Mentor formation (Washita age), 12 miles southwest of Salina, Kansas, which Meek called *Margarita mudgeana* (1876, p. 300). One figured example, USNM 108661; one unfigured example, USNM 108662.

Family TRICHOTROPIDAE

Genus LIRPSA Stephenson, 1953

Lirpsa? lepida Stephenson, n. sp.

Plate 8, figures 6–13

This species is represented at the southern pit of the New Jersey Clay Products Co. (USGS 19014) by many external and internal molds some of which show the form and sculpture of the shell more clearly than others. Shell of medium size with low spire and rapidly expanding whorls; spiral angle 75° to 80° on different individuals. Suture of medium depth, closely appressed in earlier stages, becoming loosely coiled in the adult stage. Form and attitude of protoconch not determined. Whorls 2 or 3. Body whorl large; side gently convex in profile, sloping steeply from suture to a carinated shoulder which may also be considered the periphery; base below the periphery steep, gently convex. Exposed part of penultimate and antepenultimate whorls gently convex.

The surface sculpture varies greatly on different individuals. The fine rather weak spiral ribbing of the holotype contrasts conspicuously with that of other specimens which exhibit widely separated stronger ribs with finer ribbing between them. If one were to consider the extremes of rib features only there would

be little or no hesitancy in recognizing more than one species; but there are intermediate patterns of rib development, and since they all occur together in the same bed they appear to be merely individual variants of the same species. Several of the variants are shown in the illustrations. On the holotype the whole surface is covered with fine closely spaced spiral ribs, with one on the periphery (shoulder) a little stronger than any of the others. Fine as is the ribbing there is a definite tendency to alternation in the size of the ribs with the regularity of the alternations broken in places by the intercalation of tiny tertiary ribs as the shell grew forward; this irregularity is especially noticeable on the body whorl. The ribs bear small rather closely spaced nodes that appear to bear some relationship to the intersection of the transverse growth lines. The nodes are most sharply developed on the exposed part of the penultimate whorl, and are weakest on the body whorl above the periphery. On different individuals widely spaced ribs become relatively enlarged and conspicuous, an extreme example being that shown in plate 8, figure 10. On these larger ribs there is a tendency for growth lamellae to form short upturned hollow spines the openings of which face forward toward the aperture. The growth lines cross the base to the periphery with a slight forward inclination and continue across the upper part of the body whorl with a somewhat stronger inclination toward the front, becoming a little coarser near the suture.

The external and internal molds do not show clearly the features of the aperture, lips, and columella, but the aperture is obviously large and subquadrate in outline. There is evidence in the internal molds of the presence of a narrow umbilicus. In form and profile the species is similar to the genus *Lirpsa* Stephenson from the Templeton member of the Woodbine formation in Lamar County, Texas. It appears to be nearest to the species *Lirpsa teres* Stephenson (1952, p. 152, 153, pl. 36, figs. 1–7). It differs from the Woodbine species in its stronger development of spiral sculpture, in the absence of a prominent, sharply angular spiral rib, and in its apparently narrower umbilicus.

The available external and internal molds do not lend themselves to accurate measurement but the dimensions of the incomplete external mold of one of the paratypes are: Height 21.2+ mm, diameter 17+ mm. This appears to be a little less than maximum size.

The species is similar in form to *Trichotropis koninckii* (Muller) from Upper Cretaceous greensand at Vaals, Netherlands and near Aachen, Germany, as figured by Holzapfel, (1888, p. 149, pl. 15, figs. 6–9).

Types.—Holotype, USNM 108663; 5 paratypes figured, USNM 108664; 12 selected unfigured paratypes, USNM 108665.

Family TURRITELLIDAE

Genus TURRITELLA Lamarck, 1799

Turritella bakeri Richards

Plate 8, figures 14–17

1943. *Turritella bakeri* Richards, Acad. Nat. Sci. Phila. Proc., v. 95, p. 29, pl. 6, fig. 3)

The specimens referable to this species are poorly or incompletely preserved. Nineteen internal molds of medium to adult size, with surface features incompletely impressed on some of them and wanting on others, are available from a reddish ferruginous, micaceous sandstone layer, weathering grayish, in a clay pit of the Sayre and Fisher Brick Co., at Sayreville (USGS 19013). Two external molds, showing fairly clearly the surface features of 5 or 6 of the smaller whorls toward the apex, are present in the collection from the ferruginous sandstone in the southern pit of the New Jersey Clay Products Co., at Sayreville. (USGS 19014). Both of these pits are in the upper part of the Woodbridge fire clay in the Raritan formation.

All the specimens in these collections that are well enough preserved to show the surface features belong to a group of Turritellas whose spiral ribs bear beads or nodes; nodose Turritellas have not been reported in America in beds of the Upper Cretaceous series younger than Cenomanian. It is assumed that all of the available specimens in the Sayreville pits belong to one species, though the poor preservation of some of them may not fully justify this assumption.

The two small imprints illustrated in plate 8, figures 16 and 17, indicate a high-spired shell with closely appressed whorls gently convex on the sides, each whorl bearing four primary spiral ribs, with a smaller secondary spiral in each interspace; the sutural depression is of moderate depth. The primary spirals bear relatively coarse, dull nodes, those on the uppermost spiral of some specimens being coarser than those on the other spirals; the secondary spirals appear to be nearly smooth. On some of the larger specimens additional secondary spirals become intercalated in the interspaces, as many as 4 or 5 being present in 1 interspace on some of the larger whorls. As growth of the individual proceeds some of the secondaries may become larger and bear nodes. The periphery of the body whorl rounds over to a steeply descending base.

Dimensions of the tallest available specimen (plesiotype) shown in plate 8, figure 14: Height 43+ mm, diameter 12.5 mm.

Turritella bakeri is closely related to *T. thomsonina* Stephenson and *T. macneili* Stephenson, both from Banquereau Bank off the coast of Nova Scotia (1936, p. 399–401, pl. 5, figs. 13, 14), but it has fewer and more coarsely noded spiral ribs than either of them. It is intermediate in profile between the nearly flat whorls

of the former and the more convex whorls of the latter. Because of the poor state of preservation of *T. bakeri* I find it difficult to make a critical comparison between it and *T. shuleri* Stephenson, from the Woodbine formation (Stephenson, 1952, p. 153, pl. 36, figs. 14–19). The two are similar in spiral angle, in the profile of the whorls, in the depth of the sutural depressions, and in the general pattern of the spiral ribbing; however, the nodes on the former appear to be coarser and more squarish than those on the latter.

Types.—Holotype, New Jersey State Museum 10575; 2 plesiotypes (=topotypes) from a clay pit of the Sayre and Fisher Brick Co., USNM 108666 (USGS 19013); 2 plesiotypes (=topotypes) from the southern pit of the New Jersey Clay Products Co., USNM 108667 (USGS 19014); 17 unfigured topotypes, USNM 108668 (USGS 19013).

Family THIARIDAE

Genus PYRGULIFERA Meek, 1871

"Pyrgulifera" sp.

Plate 8, figure 18

The incomplete, rather poor imprint of one gastropod, from a clay pit of the Sayre and Fisher Brick Co. (USGS 19013), is compared questionably with *Pyrgulifera* Meek, a usually nonmarine genus. Only a portion of the body whorl and a distorted fraction of the penultimate whorl are preserved. The imprint shows seven rather weak axial ribs on a little less than half a turn of the body whorl; these ribs are strongest above, where they are slightly concave in trend toward the front, and become weaker and convex to the front as they pass down over the broadly rounded periphery, becoming very weak to obscure, low on the base. The suture above is deeply impressed, and four axials are present on the part of the penultimate whorl preserved. Numerous closely spaced weak spiral ribs cross the axials, at the intersections of which are small nodes. The inner lip is formed of a rather thick band of callus. USNM 108669.

Family CERITHIIDAE

Genus VOYSA Stephenson, 1953

Voysa? cuniculana Stephenson, n. sp.

Plate 8, figure 19

The one available external mold of this species is from the southern pit of the New Jersey Clay Products Co. (USGS 19014). Shell small with turreted spire of medium height, spiral angle about 26°. Protoconch not preserved. Whorls 5 or 6, closely appressed, suture deeply impressed. Body whorl with three strong, narrow spiral ribs above the periphery, a weak spiral at the periphery, followed below on the base by a strong bifid spiral, a simple spiral of medium strength, and a weak spiral at the lowest part shown in the cast. The periphery is rounded and the base steep. The three strong ribs on the body whorl above the periphery continue well developed rearward on the flanks of the earlier whorls; the lower one is the largest, the middle one is of medium strength, and the upper one is the weakest. Transverse to the spirals are numerous, closely spaced sharp growth ridges which are most conspicuously developed where they cross the relatively wide interspaces. The trend of the growth ridges is convex toward the aperture on the base and broadly concave toward the aperture above the periphery. The features of the aperture are not preserved.

Dimensions of the holotype: Height 7+ mm, diameter 3.5 mm.

This species appears to be closely related to *Voysa? craticula* Stephenson from the Lewisville member of the Woodbine formation of Texas (Stephenson, 1952, p. 174, pl. 39, figs. 23–26). In form, in the number of spiral ribs, and in the development of the transverse growth ridges the two species are very much alike, but the spiral ribs of *V.? cuniculana* are conspicuously narrower, spaces between the ribs are wider, and the forward-facing concavity in the trend of the growth ridges above the periphery is not so deep.

Type.—Holotype, USNM 108670.

Family APORRHAIDAE

Genus ANCHURA Conrad, 1860

Anchura pontana Stephenson

Plate 8, figures 20, 21

1936. *Anchura pontana* Stephenson, Geol. Soc. America Bull., v. 47, p. 401, pl. 5, figs. 15, 16.

?1943. *Anchura raritanensis* Richards, Acad. Nat. Sci. Phila. Proc., v. 95, p. 27, pl. 5, fig. 15.

I can detect no essential difference between the specimens from the Raritan formation here figured and the holotype of *Anchura pontana* Stephenson from Banquereau Bank. They differ in preservation, the shell substance of the latter being preserved, whereas the former are internal molds with the surface features impressed upon them, though lacking the sharpness of detail of the shell itself. These molds are from a pit of the Sayre and Fisher Brick Co. (USGS 19013). *Anchura raritanensis* Richards from Sayreville may belong to this species but the holotype, as figured, appears to be too incompletely preserved for certain identification.

A comparison of the two plesiotypes shown in plate 8, figures 20 and 21, shows that allowance must be made for individual variation in the strength and spacing of the axial ribbing of this species.

The species, *Anchura horreana* Stephenson from the Templeton member of the Woodbine formation of Texas is a closely related species, but it differs in the

coarser development and wider spacing of the axials on the body and penultimate whorls (Stephenson, 1952, p. 176, pl. 40, figs. 22, 23).

The plesiotype shown in plate 8, figure 21, measures: Height 38+ mm, diameter exclusive of expanded wing about 18 mm.

Types.—Holotype, YPM (Yale Peabody Museum) 14853; 4 paratypes, YPM 14854; 2 plesiotypes, USNM 108671; 1 unfigured example, USNM 108672.

Family BUCCINIDAE

Genus STREPSIDURA Swainson, 1840

Strepsidura? sp. A

Plate 8, figure 22

One incomplete external and one incomplete internal mold of a small smooth species of gastropod, from the southern pit of the New Jersey Clay Products Co. (USGS 19014), are referred questionably to *Strepsidura* Swainson. The species has a low spire with spiral angle about 65°, a deep sutural depression, expands rapidly, and has a large body whorl with a moderately long, twisted siphonal canal. The body whorl is plump, and broadly rounded in profile from suture above to base below. The flanks of the whorls are evenly convex. There is a faint indication of the end of a columellar fold about midway of the inner lip. The inner lip appears to form a thin wash of callus on the parietal wall. Dimensions: Height 10 mm, diameter 5 mm. One figured example, USNM 108673; one unfigured example, USNM 108674.

Strepsidura? sp. B

Plate 8, figure 23

An incomplete external mold of a small gastropod from the same source as *Strepsidura*? sp. A is also questionably referred to Swainson's genus. It has a low spire with spiral angle of about 80°, a rather deep sutural depression, expands rapidly, and has a large body whorl with broadly rounded profile. Although similar in form to *Strepsidura*? sp. A, it is less bulbose, and is ornamented with small, nonprominent, closely spaced spiral ribs; these can be seen on the upper part of the body whorl and on the penultimate whorl. The rather long twisted columella bears one fold of medium strength a little below the lower edge of the parietal wall. Dimensions: Height about 10 mm, diameter about 4.5 mm. USNM 108675.

Family FUSINIDAE

Genus ALIOFUSUS Stephenson, 1941

Aliofusus? sayrei Richards

1943. *Aliofusus*? *sayrei* Richards, Acad. Nat. Sci. Phila. Proc., v. 95, p. 28, pl. 5, fig. 17.

One poorly preserved, incomplete internal mold from a clay pit of the Sayre and Fisher Brick Co. (USGS 19013) appears to belong to the species *Aliofusus*? *sayrei* Richards. This is indicated by the form and by the narrow, short, widely spaced axial ribs which appear to be like those shown in Richards' illustration.

Types.—Holotype, New Jersey State Museum 10439. The example here recorded, a topotype if correctly identified, USNM 108676.

Family CANCELLARIDAE

Genus PALADMETE Gardner, 1916

Paladmete pristina Stephenson, n. sp.

Plate 8, figures 24–26

One external mold and four internal molds of a small gastropod, from the southern pit of the New Jersey Clay Products Co. (USGS 19014), are here described as representing a new species of *Paladmete* Gardner. Shell small with spire about half the total height; spiral angle about 40°. Protoconch not preserved. Whorls 3 or 4, moderately inflated, closely appressed, suture deeply impressed. Shoulder on whorls narrow, steeply sloping, obtusely subangular in cross section; flanks very gently convex. Periphery of body whorl broadly rounded, base gently convex above becoming steep below. The body whorl from the shoulder down bears at least 13 well developed, rather thick, squarish-topped spiral ribs, separated by interspaces of equal or slightly greater width; these ribs decrease slightly in width and strength from the shoulder downward. The shoulder bears three small spirals, the upper one of which is much stronger than the two tiny ones below it. Four of the larger spirals are exposed on each of the earlier whorls between the suture below and the shoulder above. Axial ribs are present, extending well down across the base, and are estimated to number 15 or 16 on the body whorl. With the exception of an occasional swollen varix-like rib the axials are rather weak; they produce dull, subrectangular nodes at the intersections with the spiral ribs; where the axials cross the shoulder above they bend forward and are quite weak. The features of the aperture and columella cannot be accurately determined in detail but they appear to be normal for the genus; however, the aperture is lanceolate, the outer lip is broadly convex, and the impression of a row of short crenulations is present on the inner margin of the outer lip of each of two internal molds.

Approximate dimensions of the holotype: Height 12 mm, diameter 6.5 mm. The paratypes are about the same size or smaller.

One described species of *Paladmete*, *P. turbiformis* Stephenson, from the Lewisville member of the Woodbine formation of Texas, is much smaller than this species, is less slender, and possesses more numerous

and finer spiral ribs. One specimen from the same source, identified as *Paladmete* sp., is plumper and has weaker spiral ribs. Several species of *Paladmete* have been recorded from Upper Cretaceous formations younger than the Raritan formation in the Atlantic and Gulf Coastal Plain, but they are all plumper in profile than *P. pristina*, and they all possess narrower spiral ribs which may be fewer or more numerous than those of the present species.

Types.—Holotype, USNM 108677; 2 figured paratypes, USNM 108678; 2 unfigured paratypes, USNM 108679.

Family ACTEONIDAE

Genus PIRSILA Stephenson, 1953

Pirsila? sp.

Plate 8, figure 27

This gastropod is represented by two smooth molds that do not show the aperture. The figured specimen is from a clay pit of the Sayre and Fisher Brick Co. (USGS 19013), and the unfigured specimen is from the southern pit of the New Jersey Clay Products Co. (USGS coll. 19014). In form and outline the shell resembles the genus *Pirsila* Stephenson, but does not closely match any of the four species recorded from the Woodbine formation of Texas. In its spiral and apical angles it appears to be intermediate between *Pirsila decora* Stephenson and *P. obtusa* Stephenson. It appears to be a smooth shell with slightly impressed sutures; the apical angle is about 55°, decreasing to about 40° on the lower, larger whorls of the spire. Dimensions of the figured specimen: Height 15.2 mm, diameter 7.5 mm. USNM 108680 and USNM 108681.

MISCELLANEOUS SPECIMENS

In addition to the identified specimens formally described on preceding pages the two collections from Sayreville contain a few poorly preserved specimens, mostly unidentifiable.

One piece of ferruginous sandstone (USGS 19013) exhibits a mixture of poorly preserved internal molds of pelecypods and gastropods on about 8 square inches of weathered surface, among which are the following recognizable forms: *Plicatula howelli* Richards?, *"Corbula"* sp., *Turritella bakeri* Richards?, and *Lispodesthes*? sp. The last named genus is represented by two species in the Woodbine formation of Texas. USNM 108636.

The same collection (19013) contains 3 unidentifiable pelecypod molds (USNM 108682) and 2 very poorly preserved gastropod molds (USNM 108683).

A piece of ferruginous sandstone in the same collection (19013) is studded with rectangular forms of nearly uniform size, averaging about 2 by 4 mm in plan, with vertical relief of about 1 mm. Some of the forms bear 1 or 2 horizontal lines running parallel to the long side of the rectangle; these lines may be either narrow ridges or narrow grooves. (Pl. 8, fig. 28.) The nature of these forms is problematical, but they may be the fossil fecal pellets of an undetermined organism. USNM 108684.

A fragment of the apical portion of the internal mold of a small conical gastropod (USGS 19014), with both axial and spiral ribs weakly impressed upon it, pertains to a *Capulus*-like form. USNM 108685.

In the same collection (19014) are three undetermined gastropod molds, USNM 108686.

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INDEX

[Italic numbers indicate descriptions]

PLATES 6–8

PLATE 6

[Figures natural size except as indicated]

FIGURE 1. *Cliona retiformis* Stephenson (p. 27).
View (× 3) of ferruginous casts of borings, in molluscan shell fragment (shell substance removed in solution). USGS 19014, USNM 108611.

2–5. *Barbatia? cuniculana* Stephenson, n. sp. (p. 27).
2. View (× 2) of rubber cast from external mold of holotype. USGS 19014, USNM 108613.
3. View (× 2) of rubber cast from external mold of a paratype. Same source, USNM 108614.
4. Dorsal view of internal mold of a paratype, from same source. USNM 108614.
5. View (× 2) of internal mold of a right valve of a paratype, from same source. USNM 108614.

6, 7. *Breviarca?* sp. A (p. 28).
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10–15. *Nemodon obesus* Stephenson, n. sp. (p. 28).
10. View (× 1½) of internal mold of a cotype, a right valve. USGS 19014, USNM 108620.
11. View (× 4) of rubber cast from external mold of umbonal and posterior portions of the preceding cotype.
12, 13. Views of internal molds of left valve (× 2) and of right valve (× 1½), of cotypes. USGS 19014, USNM 108620.
14. View (× 2) of rubber cast from external mold of a left valve of a cotype, from same source. USNM 108620.
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View (× 1½) of rubber cast showing the imprint of a portion of hinge and ligamental pits of a *Pedalion*-like bivalve. USGS 19014, USNM 108623.

18, 19. *Phelopteria dalli* (Stephenson)? (p. 29).
18. Incomplete internal mold of right valve. USGS 19014, USNM 108624.
19. View of incomplete internal mold of a small left valve, from the same source. USNM 108624.

20. *Ostrea (Alectryonia) jerseiana* Stephenson, n. sp. (p. 29).
Rubber cast from external mold of the holotype, a left(?) valve. USGS 19014, USNM 108626.

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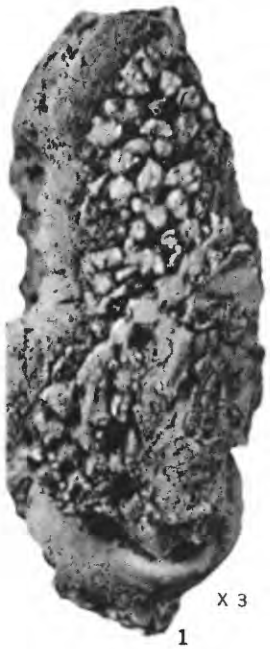
21. Rubber cast from external mold of a small right valve. USGS 19013, USNM 108627.
22. Internal mold of a medium-size left valve, showing *Exogyra*-like twist of the beak. USGS 19014, USNM 108629.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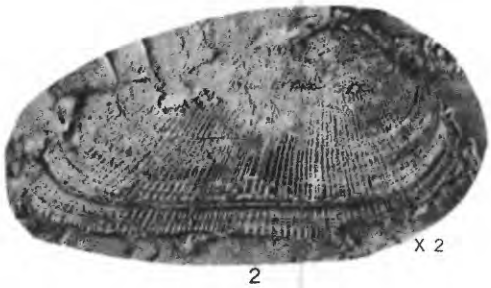
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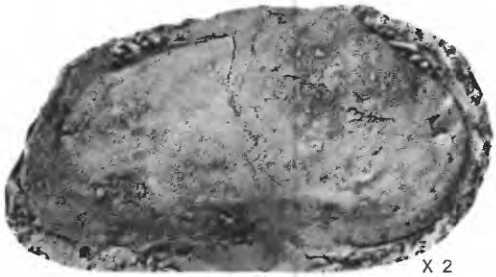
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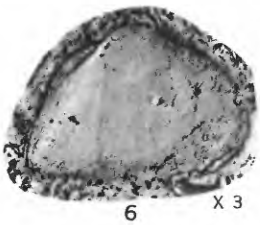
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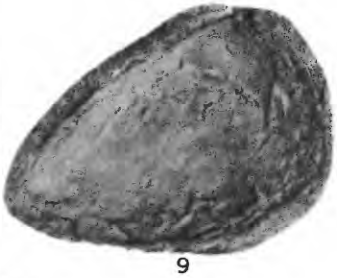
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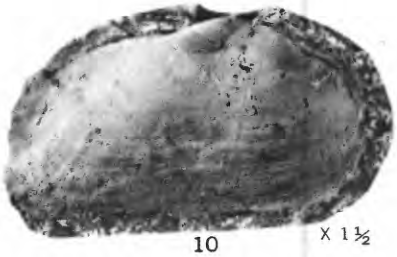
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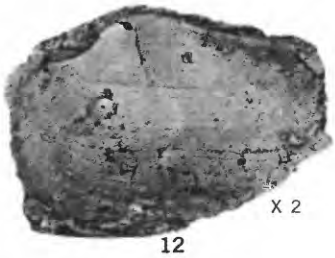
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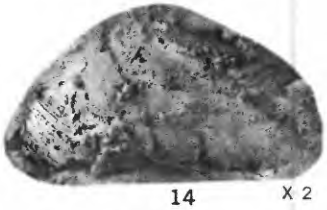
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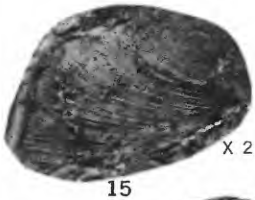
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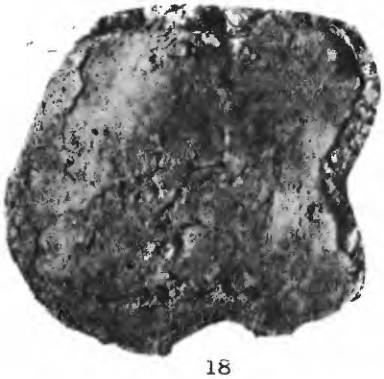
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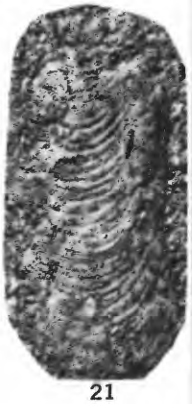
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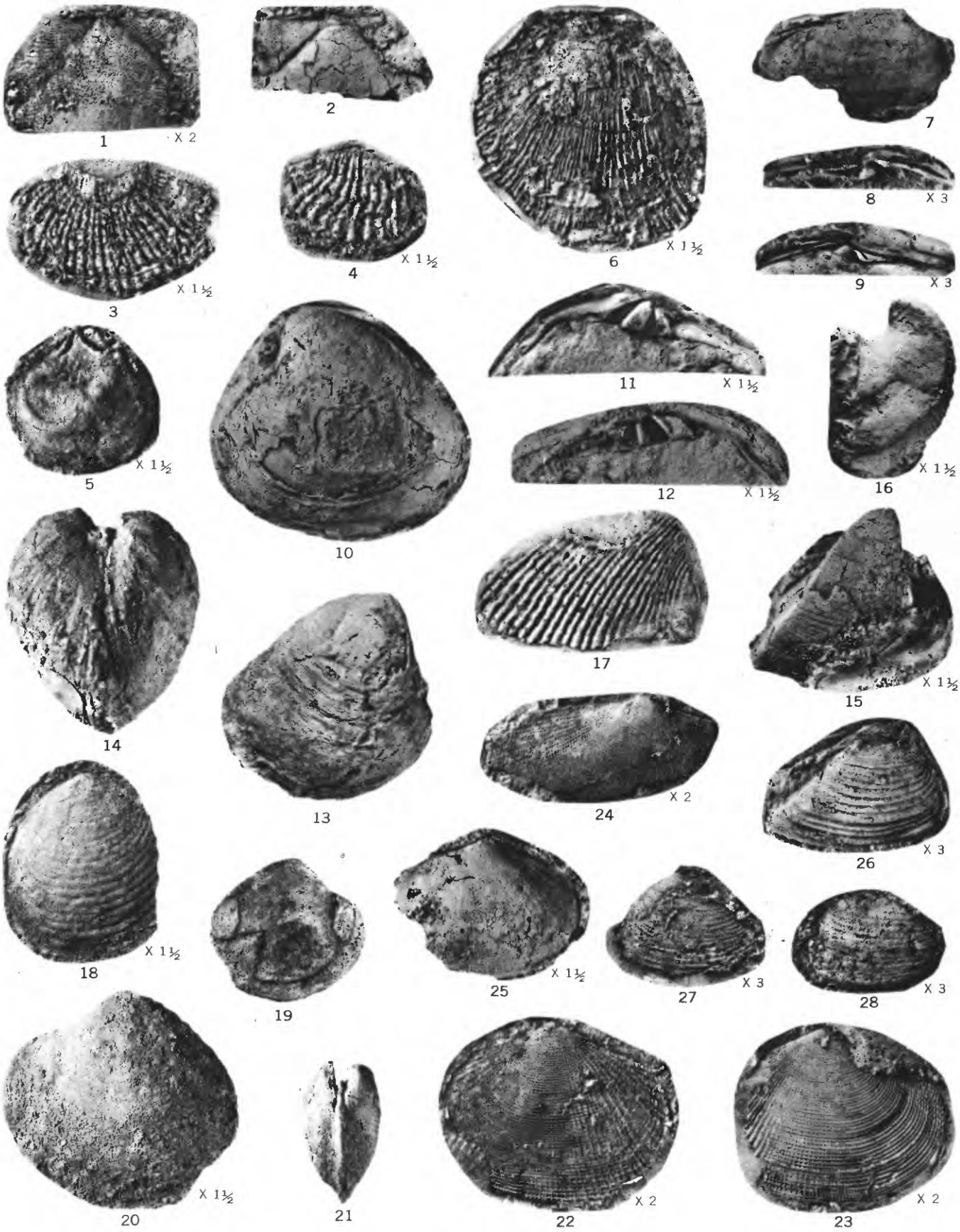
SPONGIAE AND PELECYPODA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3
X 1½
4
X 1½
5
X 1½
6
X 1½
7
8
X 3
9
X 3
10
11
X 1½
12
X 1½
16
X 1½
13
14
15
X 1½
17
18
X 1½
19
20
X 1½
21
22
X 2
23
X 2
24
X 2
25
X 1½
26
X 3
27
X 3
28
X 3

PELECYPODA

PLATE 7

[Figures natural size except as indicated]

FIGURES 1, 2. *Pecten* (*Camptonectes*) sp. (p. 30).
1. View (× 2) of rubber cast from portion of external mold of left valve. USGS 19014, USNM 108632.
2. Internal mold of portion of left valve, from same source. USNM 108632.

3–5. *Plicatula howelli* Richards (p. 30).
3. View (× 1½) of rubber cast from exterior mold of left valve of a plesiotype (=topotype). USGS 19014, USNM 108633.
4. View (× 1½) of rubber cast from exterior mold of right valve of a plesiotype (=topotype), from the same source. USNM 108633.
5. View (× 1½) of internal mold of a plesiotype (=topotype), from the same source. USNM 108633.

6. *Plicatula ferrata* Stephenson, n. sp. (p. 31).
View (× 1½) of rubber cast from the holotype, an external mold. USGS 19013, USNM 108637.

7–9. *Naritra polliciformis* Stephenson, n. gen. and sp. (p. 32).
7. The holotype, an internal mold of a right valve. USGS 19014, USNM 108638.
8. View (× 3) of the imprint of the hinge of the left valve of a paratype. USGS 19014, USNM 108639.
9. View (× 3) of rubber cast from imprint of hinge of the same paratype.

10–14. *Geloina? tenuidens* (Whitfield) (p. 32).
10. A plesiotype, an internal mold of a left valve. USGS 19013, USNM 108641.
11. View (× 1½) of imprint of the hinge of the left valve of the preceding plesiotype.
12. View (× 1½) of rubber cast from imprint of hinge of the same plesiotype.
13. Right valve of a plesiotype, an internal mold of both valves. USGS 19013, USNM 108641.
14. Rear view of the preceding plesiotype.

15, 16. *Opis? elevata biangulata* Stephenson, n. var. (p. 32).
15. View (× 1½) of internal mold of the holotype, a right valve. USGS 19014, USNM 108642.
16. Rear view (× 1½) of the preceding holotype.

17. *Cardium* sp. A (p. 33).
Rubber cast from exterior mold of part of anterior slope and side of a right valve. USGS 19014, USNM 108645.

18–21. *Callistina? johnsoni* (Richards) (p. 34).
18. View (× 1½) of internal mold of a right valve, a plesiotype (=topotype). USGS 19013, USNM 108649.
19. Right valve of an internal mold, a plesiotype (=topotype), showing an obscure impression of the pallial line and sinus (outlined). USGS 19013, USNM 108649.
20. View (× 1½) of the left valve of the internal mold shown in figure 19. USNM 108649.
21. Front view of the same internal mold.

22–25. *Linearia lirulifera* Stephenson, n. sp. (p. 34).
22. View (× 2) of rubber cast of external mold of the holotype, a left valve. USGS 19014, USNM 108650.
23. View (× 2) of rubber cast of the external mold of a paratype, a right valve, from the same source. USNM 108651.
24. View (× 2) of rubber cast of the external mold of a paratype, a left valve, from the same source. USNM 108651.
25. View (× 1½) of internal mold of the holotype. USNM 108651.

26. *Caryocorbula? ovisana* Stephenson (p. 34).
View (× 3) of rubber cast of external mold of a plesiotype, a right valve. USGS 19014, USNM 108653.

27, 28. "*Corbula*" sp. (p. 35).
Views (× 3) of rubber casts of two external molds of left valves. USGS 19014, USNM 108654.

PLATE 8

[Figures natural size except as indicated]

FIGURES 1, 2. *Petropoma? raritanum* (Richards) (p. 35).
1. Top view (× 1½) of a rubber cast from an external mold of a plesiotype (= topotype). USGS 19014, USNM 108657.
2. Side view (× 1½) of the same rubber cast.

3, 4. *Helicacanthus?* sp. A. (p. 36).
3. Side view (× 2) of a rubber cast from an external mold. USGS 19014, USNM 108659.
4. Top view (× 2) of the same rubber cast.

5. *Helicacanthus?* sp. B (p. 36).
Side view (× 3) of a rubber cast from an external mold. USGS 19014, USNM 108661.

6–13. *Lirpsa? lepida* Stephenson, n. sp. (p. 36).
6. Back view (× 2) of rubber cast from the external mold of the holotype. USGS 19014, USNM 108663.
7–11. Back views (× 2) of rubber casts of external molds of five paratypes showing variations in details of sculpture. USGS 19014, USNM 108664.
12, 13. Front and back views of the internal mold associated with the paratype illustrated in figure 8.

14–17. *Turritella bakeri* Richards (p. 37).
14. View (× 1½) of an internal mold, with spiral sculpture impressed upon it, of a plesiotype (= topotype). USGS 19013, USNM 108666.
15. View (× 1½) of another internal mold of a plesiotype (= topotype), from the same source. USNM 108666.
16, 17. Views (× 2) of rubber casts from external molds of two plesiotypes (= topotypes). USGS 19014, USNM 108667.

18. *"Pyrgulifera"* sp. (p. 38).
Front view (× 2) of an internal mold with sculpture impressed upon it. USGS 19013, USNM 108669.

19. *Voysa? cuniculana* Stephenson, n. sp. (p. 38).
Back view (× 3) of rubber cast from an external mold of the holotype. USGS 19014, USNM 108670.

20, 21. *Anchura pontana* Stephenson (p. 38).
Back views of internal molds of two plesiotypes with sculpture impressed upon them. USGS 19013, USNM 108671.

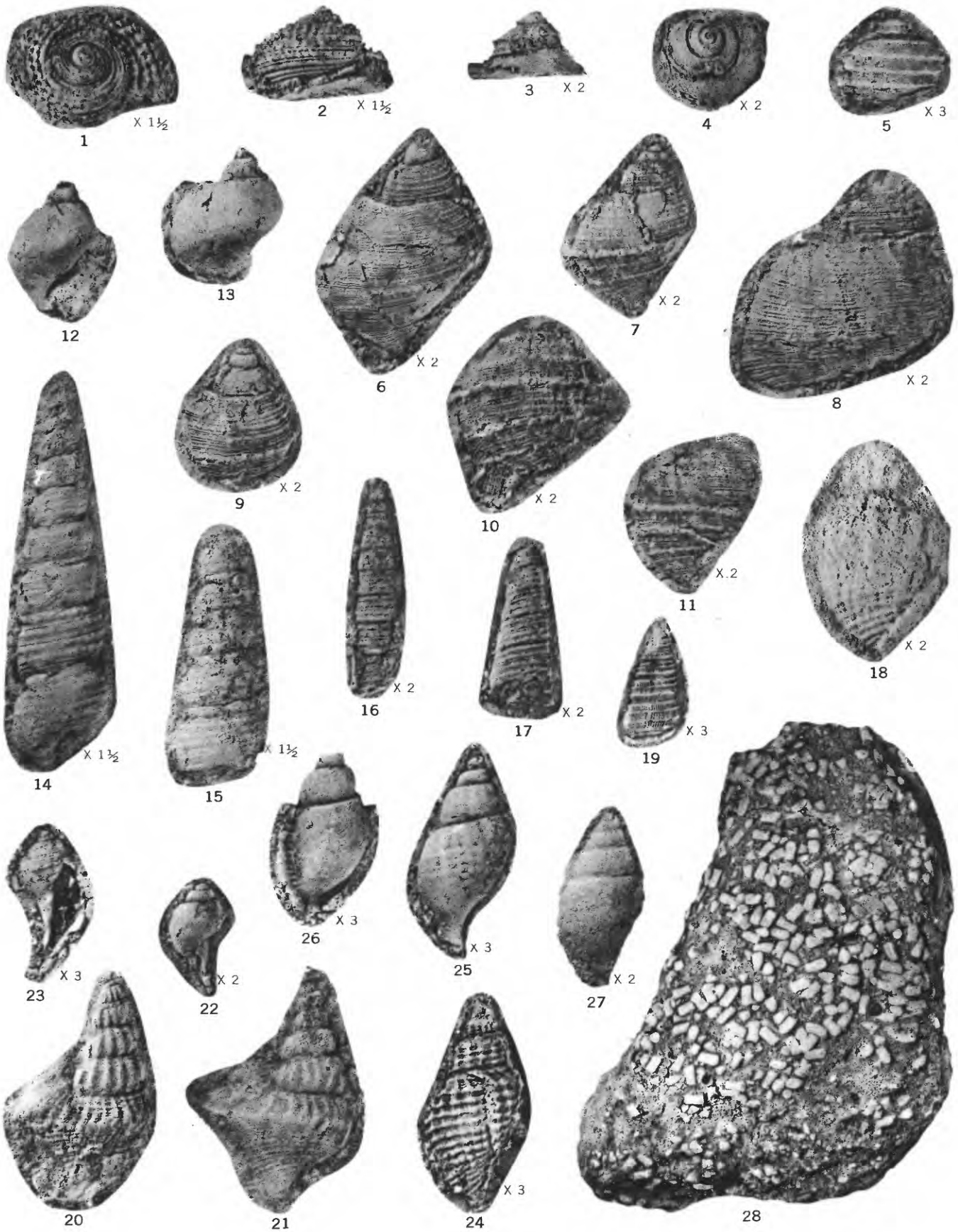
22. *Strepsidura?* sp. A (p. 39).
Front view (× 2) of rubber cast from an external mold. USGS 19014, USNM 108673.

23. *Strepsidura?* sp. B (p. 39).
Front view (× 3) of rubber cast from an external mold. USGS 19014, USNM 108675.

24–26. *Paladmete pristina* Stephenson, n. sp. (p. 39).
24. Back view (× 3) of rubber cast from the external mold of the holotype. USGS 19014, USNM 108677.
25. Back view (× 3) of an internal mold of a paratype, from the same source. USNM 108678.
26. Back view (× 3) of an internal mold of a paratype showing row of internal crenulations just back of outer lip, from the same source. USNM 108678.

27. *Pirsila?* sp. (p. 40).
Back view (× 2) of an internal mold. USGS 19013, USNM 108680.

28. Molds of fecal? pellets on ferruginous sandstone (p. 40). USGS 19013, USNM 108684.



GASTROPODA AND FECAL? PELLETS