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STATE OF DELAWARE

DELAWARE GEOLOGICAL SURVEY

REPORT OF INVESTIGATIONS NO. 7

AN INVERTEBRATE MACROFAUNA FROM THE UPPER CRETACEOUS OF DELAWARE

By
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and
Earl Shapiro

Newark, Delaware
July, 1963

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Abstract

Recent erosion along the Chesapeake and Delaware Canal has exposed an unusualy rich Upper Cretaceous fossiliferous outcrop at the Biggs Farm, near the eastern end of the Canal. Some III species of mollusks representing 72 genera have been identified. Coelenterata, Porifera, Annelida, Brachiopoda, Crustacea, and a few fragmentary vertebrate remains have also been found. Five species are being described as new, and there are 54 new records for the Cretaceous of Delaware.

The preservation of the material suggests that the animals lived on a sandy bottom in water between 50 and 100 feet in depth, possibly near the mouth of a bay.

Inasmuch as there is a mixing of some species characteristic of the Matawan Group and other species characteristic of the Monmouth Group, it is believed that the fauna at this locality lies near the Matawan-Monmouth boundary, perhaps in the lower part of the Monmouth Group.

Introduction

Recent erosion along the banks of the Chesapeake and Delaware Canal has revealed some new exposures of Upper Cretaceous sediments which have yielded a large macrofauna, including numerous species not hitherto reported from the Upper Cretaceous of Delaware. The site of present study was at the Biggs Farm locality, on the south bank of the canal about 1.5 miles east of St. Georges, Delaware.

The study of the fossils was carried out at the Academy of Natural Sciences of Philadelphia under the supervision of the senior author. The field and laboratory work of the junior author was made possible by grants from the Jessup Fund of the Academy of Natural Sciences.

ACKNOWLEDGMENTS

We are indebted to Dr. Johan J. Groot, State Geologist of Delaware. for suggestions and encouragement throughout the course of the project. Dr. Norman Sohl, of the U. S. Geological Survey in Washington, as well as Dr. G. Arthur Cooper and Mr. Henry B. Roberts, of the U. S. National Museum, rendered their most helpful assistance in the study of the mollusks, brachiopods, and crustacea, respectively. Dr. Donald Squires, now with the U. S. National Museum, allowed us to quote some remarks regarding the corals from the locality. Finally, we wish to express our thanks to the Jessup Fund Committee of the Academy of Natural Sciences which awarded the grant to the junior author.

PREVIOUS WORK

The history of previous work on the Cretaceous deposits of Delaware has recently been summarized by Groot, Organist, and Richards (1954), and will not be repeated here. Table 1 shows the interpretation of the upper part of the Upper Cretaceous section as proposed in three of the most recent surveys of the exposures along the canal banks (Carter, 1937; Spangler and Peterson, 1950; and Groot, Organist, and Richards, 1954). The latter is the correlation now accepted by the Delaware Geological Survey.

Much more intensive work has been done on the fauna and correlation of the Upper Cretaceous of New Jersey, and detailed descriptions have been published by Weller (1907) and Richards et al. (1958, 1962). Table 2 shows the correlation of the Upper Cretaceous deposits of New Jersey, Delaware, Maryland, the Carolinas, and Texas adapted from the works of Weller (1907), Richards et al. (1958), Groot, Organist, and Richards (1954), Clark et al. (1916), Stephenson (1923), Brett and Wheeler (1961), Stephenson (1941), and Sohl (1960).

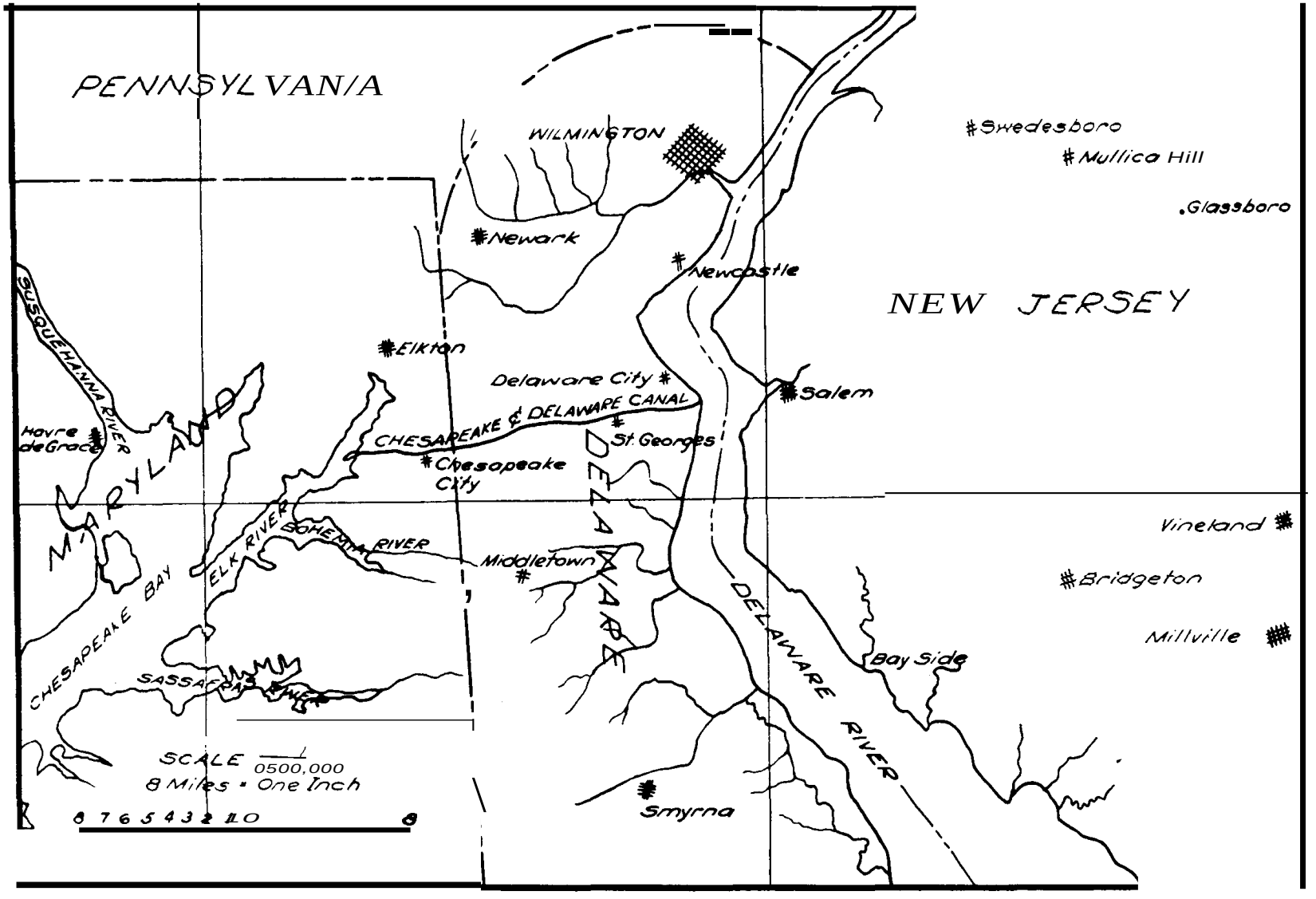

Figure 1 - Map showing location of Chesapeake and Delaware Canal.

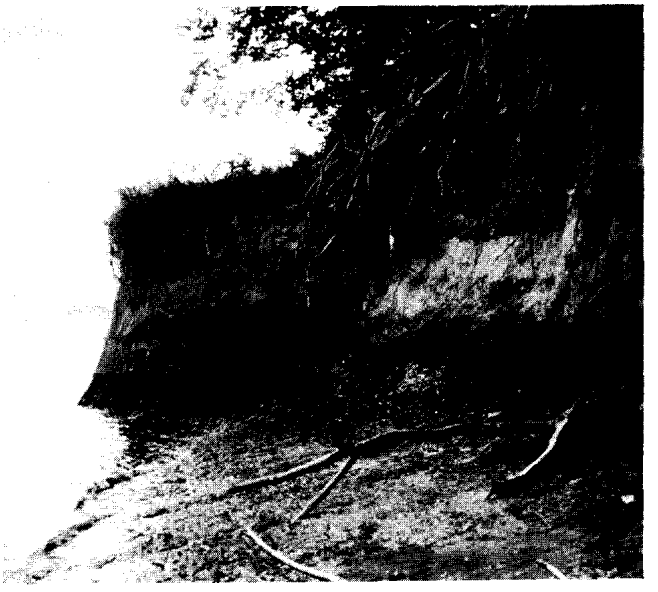

Figure 2 - Exposure of Cretaceous sediments at the Biggs Farm, Chesapeake and Delaware Canal.

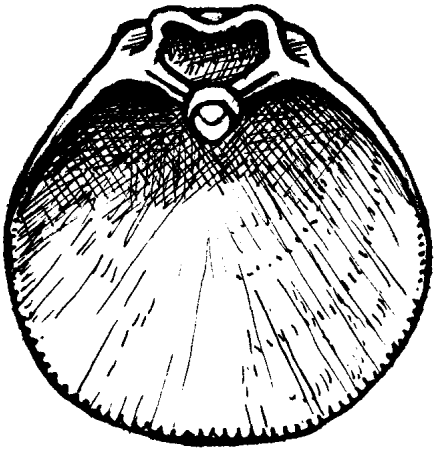

Figure 3 - TEREBRATULINA COOPERI Richards & Shapiro - A generalization of the internal structure of the brachial valve. While this is a composite drawn from several specimens, it is based largely on the paratype ANSP 30845 a, which is shown in Pl. I, fig. 3. We are indebted for this drawing to David Watkinson of Medford Lakes, N. J.

DESCRIPTION OF LOCALITY

The Biggs Farm locality (Station 6 of Groot, Organist and Richards, 1954) is situated on the south bank of the Chesapeake and Delaware Canal about 1.5 miles cast of where U. S. Highway 13 crosses the canal at St. Georges, Delaware (See Figs. 1 and 2).

The lowermost formation at the locality, according to Groot, Organist, and Richards (1954), is the Mount Laurel-Navesink; however, as is pointed out below, the faunal evidence suggests a much closer correlation with the age of the Mount Laurel than with that of the Navesink of Ncw Jersey. The formation has been described at this locality as follows (Groot, Organist, and Richards, 1954, p. 37):

> Rust brown with green and red spots, medium, well sorted, subrounded, quartz sand; most grains stained with iron hydroxide; some glauconite; few black minerals; some brick red and gray clay balls. A highly fossiliferous zone is found at sea level.

Above this unit is about 6 feet. of a reddish sand that has been assigned to the Red Bank Formation by Groot, Organist, and Richards (1954). Although a few fossils are present in this sand, they are poorly preservcd and were not considered in the present investigation.

Erosion of the lower part of this section has revealed a highly fossiliferous zone. This prompted the undertaking of thc present investigation.

PRESERVATION OF THE FOSSILS

Threc different types of preservation were noted in the matcrial collected. The most common form of prescrvation is that of an internal cast, the original shell material having been weathered away. The next most common form of preservation is that of a replacement of the original shell with a dark phosphatic mineral. Least common is the preservation of the original shell. Almost all the specimcns of *Ostrea, Anomia, Exogyra* and *Belemnitella* arc prcscrved as original shell material.

Evcn though much of thc material found at this locality is in bettcr condition than matcrial from the Cretaceous of New Jersey, the preservation was generany poorcr than that of similar material from North Carolina, Tennessec, Mississippi, and Texas.

Annotated List of Invertebrate Macrofossils from The Biggs Farm Locality

The following list is a record of all fossils found at the Biggs Farm locality during the present investigation (1960-61). Species found at this locality in previous years, but not during the present investigation, are listed at the end of this section.

References to the original descriptions are given, as well as a few notes on the abundance and distribution of the species. For further details of the distribution and correlation, the reader is referred to table 3. For full descriptions of the various species, see Weller (1907), Richards et al. (1958, 1962), Gardner (1916), Stephenson (1923, 1941), and Wade (1926).

A collection representing all species herein recorded, including types, is in the Department of Geology and Paleontology of the Academy of Natural Sciences of Philadelphia. Additional material may be found in the collection of the Delaware Geological Survey at Newark, Delaware.

Asterisks preceding the species name signify the following:

*=First record from the Cretaceous of Delaware.

**=Not hitherto known from the Cretaceous of New Jersey, Delaware, or Maryland.

Phylum PORIFERA
Class SILICISPONGIA
Family CLIONIDAE

CLIONA CRETACICA Fenton and Fenton

Cliona eretaciea Fenton and Fenton, 1932, Amer. MidI. Natur., vol. 13, p. 55, pI. 7, figs. 8, 9.

Commonly found on shells of *Exogyra* and occasionally on the guards of *Belemnitella.*

Phylum COELENTERATA
Class ANTHOZOA

**MICRABACIA HILGARDI Stephenson

Mierabacia hilgardi Stephenson, 1916, U. S. Geol. Surv. Prof. Paper 98, p. 120, pI. 22, figs. I 6.

Dr. Donald F. Squires, who kindly examined the specimens, assigned them to this species. They were very common at the locality. Acocrding to Dr. Squires, this species is Maestrichtian in age.

*GRAPHULARIA sp.

Some fragments of pennatulids resemble those from the Vincentown Formation of New Jersey which Howell (1947, p. 1195) refers to the genus *Graphularia;* however, the Delaware specimens are smaller than those described from New Jersey.

Phylum ANNE(IDA
Class CHAETOPODA
Family SERPULIDAE

HAMULUS FALCATUS (Conrad)

Dentalium falcatum Conrad, 1869, Amer. Jour. Conch., vol. 5, p. 44, pI. 1, figs. 12, 16.

*HAMULUS SQUAMOSUS Gabb

Hamulus squamosus Gabb, 1859, Cat. of Invert. Fossils, in Proc. Acad. Nat. Sci. Phila., vol. 11, p. 3.

**HAMULUS ANGULATUS Wade

Hamulus angulatus Wade, 1921, U. S. Nat. Mus. Proc., vol. 59, p. 45, pI. 10, figs. 1, 2, 8, 9.

This is the first record of this species outside of Tennessee.

LONGITUBUS sp.

DlPLOCHONCHA CRETACEA Conrad

Diplachancha cretacea Conrad, 1875, Geol. Surv. North Carolina Rept., vol. 1 (in Kerr), App. A, p. 12, pI. 2, fig. 26.

SERPULA sp. sensu lato

PI. 1, fig. 2

Only one small tightly coiled specimen was found.

Phylum ECHINODERMATA
Class ECHINOIDEA
Family SPATANGIDAE

HEMIASTER sp.

PI. I, figs. la-b

Only one specimen too poorly preserved for specific identification was found.

Phylum BRACHIOPODA
Class ARTICULATA
Family TEREBRATULIDAE

TEREBRATULlNA COOPERI Richards and Shapiro n. sp.

See Section on Systematic Paleontology.

Phylum MOLLUSCA
Class PELECYPODA
Family NUCULANIDAE

NUCULANA LONGIFRONS (Conrad)

Leda longifrons Conrad, I860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 281, pI. 46, fig. 18.

**NUCULANA PITTENSIS (Stephenson)

PI. II, fig. I

Leda pitten.l'i.\· Stephenson, 1923, North Carolina Geol. and Econ. Surv., vol. 5, p. 8I, pI. II, figs. 8-10.

This is the first reported occurrence of this species as far north as Delaware.

*NUCULANA STEPHENSONI Richards

PI. II, fig. 2

I'erri.wna/a pro/ex/a Conrad, I869, Amer. Jour. Conch., vol. 5, p. 98, pI. 9, fig. 24.

This is not a very common species in the Atlantic Coastal Plain, but two internal molds were found at the locality.

NUCULANA sp.

YOLDlA GABBANA (Whitfield)

Nuculana gabbana Whitfield, 1886, New Jersey Geol. Surv. Paleontology, vol. 1, p. 106, pI. 11, figs. 11-13.

This is a fairly common species at the locality.

YOLDlA sp.

Family GRAMMATODONTIDAE

*NEMODON EUFAULENSIS (Gabb)

PI. II, fig. 3

Arca eufaulensis Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, pI. 68, fig. 39.

NEMODON GRANDlS SOHLI Richards and Shapiro n.subsp.

See section on Systematic Paleontology.

Family CUCULLAEIDAE

CUCULLAEA NEGLECTA Gabb

Cucullaea neglecta Gabb, 1861, Proc. Acad. Nat. Sci. Phila., p. 326.

Family ARCIDAE

*ARCA ROSTELLATA Morton

Arca ros/ellata Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 64, pI. 3, fig. 11.

*ARCA OBESA (Whitfield)

Cibota obesa Whitfield, 1886, U. S. Geol. Surv. Mon., vol. 9, p. 93, pI. 11, figs. 30-31.

In both New Jersey and Maryland this species has previously been found only in the Matawan Group.

Family GLYCYMERIDAE

**POSTLIGATA CRENATA Wade

PI. II, fig. 5

Postligata crenata Wade, 1926, U. S. Geol. Surv. Prof. Paper 137, p. 48, pI. 11, figs. 3-6.

This is the first record of this species outside of Tennessee. Although not very well preserved, it is fairly common at the locality.

GLYCYMERIS MORTONI (Conrad)

Axinea mar/ani Conrad, 1869, Amer. Jour. Conch., vol. 5, p. 44, pI. I, fig. 14.

The genus *Glycymeris* is fairly common at the locality. However, most of the individuals are so poorly preserved that it is impossible to identify them specifically. Only two specimens were well enough preserved to be definitely referred to this species.

GLYCYMERIS sp.

Family PINNIDAE

PINNA LAQUEATA Conrad

Pinna laqueata Conrad, 1858, Jour. Acad. Nat. Sci. Phi/a., 2nd ser., vol. 3, p. 328.

This species is represented by a single fragment.

Family PEDALIONIDAE

INOCERAMUS PROXIMUS Tourney

Inoceramus proximus Tourney, 1854, Proc. Acad. Nat. Sci. Phi/a., vol. 7, p. 171.

Family OSTREADAE

OSTREA FALCATA Morton

Ostrea falcata Morton, 1830, Jour. Acad. Nat. Sci. Phi/a., 1st ser., vol. 6, p. 50, pI. 1, fig. 2.

This species is very common at the locality.

OSTREA MESENTERICA Morton

Ostrea falcata var. B *(0. mesenterica)* Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 51, pI. 9, fig. 7.

This species is about one-third as abundant as O. *falcata* but is still relatively common.

OSTREA MONMOUTHENSIS Weller

O.l'trea monmouthensis Weller, 1907, New Jersey Geol. Surv. Paleont. Ser., vol. 4, p. 442, pI. 43, fig. 15.

OSTREA PANDA Morton

Ostrea panda Morton, 1833, Amer. Jour. ScL, 1st ser., vol. 23, p. 293.

This species is represented only by an internal cast.

OSTREA BIGGSI Richards and Shapiro n. sp.

See Section on Systematic Paleontology.

OSTREA sp.

GRYPHAEOSTREA VOMER (Morton)

Gryphaea vomer Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 54, pI. 9, fig. 5.

GRYPHAEA CONVEXA (Say)

Ostrea convexa Say, 1820, Amer. Jour. Sci., 1st ser., vol. 2, p. 42.

EXOGYRA CANCELLATA Stephenson

Exogyra costata var. *cancel/ata* Stephenson, 1914, U. S. Geol. Surv. Prof. Paper 81, p. 53, pI. 20, figs. 2-4, pI. 21, figs. 1-2.

This is a common species but not as abundant as at many other Cretaceous localities. Many of the individuals here are juvenile.

EXOGYRA sp.

Family TRIGONIIDAE

TRIGON1A MORTONI Whitfield

Trigonia mortoni Whitfield, 1886, U. S. Geol. Surv. Mon., vol. 9, p. 112, pI. 14, figs. 5,6.

TR1GONIA sp.

Family PECTENIDAE

PECTEN WHITFIELDI Weller

Pecten whitfieldi Weller, 1907, New Jersey Geol. Surv. Paleont. Ser., vol. 4, p. 468, pI. 50, fig. 14.

"'PECTEN VENUSTUS Morton

Pecten venustus Morton, 1833, Amer. Jour. Sci., 1st ser., vol. 23, p. 293, pI. 5, fig. 7.

This is the first definite record of this fossil occurring in Delaware. It is a common species at the locality.

PECTEN (NEITHEA) QUINQUECOSTATA Sowerby

Pecten quinquecostata Sowerby, 1814, Min. Conch., vol. 1, p. 122, pI. 56, figs. 4-8.

PECTEN sp.

This genus is represented by fragments of a single valve. Not enough characters are present for a specific identification, but the sculpture resembles that of *P. berryi* Stephenson.

Family LIMIDAE

LIMA RETICULATA Lyell & Forbes

Lima I'eticulata Lyell & Forbes, 1845, Quart. Jour. Geol. Soc. London, vol. 1, p. 62, two text figs.

*LIMA OBLIQUA Gardner

PI. II, fig. 6

Lima obliqua Gardner, 1916, Maryland Geol. Surv., Upper Cret., p. 603, pI. 34, fig. 11.

Only one specimen was found at the locality, and this is the first record of this species outside of Maryland.

Family ANOMIIDAE

ANOMIA ARGENTARIA Morton

Anomia argentaria Morton, 1833, Amer. Jour. Sei., 1st ser., vol. 23, p. 293, pI. 5, fig. 10.

This species is not as common as *A. tellinoides.*

ANOMIA TELLINOIDES Morton

Anomia tellinoides Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 61, pI. 5, fig. 11.

This species is very common at the locality.

PARANOMIA SCABRA Morton

Paranomia scabra Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 62.

Family ANATINIDAE

*CORIMYA TENUIS Whitfield

Corimya tenuis Whitfield, 1886, U. S. Geol. Surv. Mon., vol. 9, p. 170, pI. 23, figs. 9-11.

This is a common species at the locality. This is the first record of this species outside of New Jersey.

Family CLAVAGELLIDAE

CLAYAGELLA ARMATA Morton

Clavagella armata Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 69, pl. 9, fig. 11.

This is a common species at the locality.

Family PRORMYACIDAE

LlOPISTHA PROTEXTA (Conrad)

Cardium protexta Conrad, 1853, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 2, p. 275, pl. 24, fig. 12.

This is a common species at the locality.

Family PLEUROPHORIDAE

YENlELLA CONRADI Morton

Veniella conradi Morton, 1833, Amer. Jour. Sci., 1st ser., vol. 23, p. 294, pl. 8, figs. 1-2.

**YENIELLA (ETEA) CAROLlNENSIS (Conrad)

Etea carolinensis Conrad, 1875, Geol. Surv. North Carolina Rept., vol. 1, (by W. C. Kerr), App. A, p. 6, pI. 1, fig. 14.

Except for a questionable occurrence in the Matawan Group, this is the first record of this species occurring in Delaware.

Family ASTARTIDAE

*YETERICARDIA CRENALlRATA (Conrad)

Astarte crenalirata Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 282, pI. 46, fig. 25.

The shells of this species are generally poorly preserved.

*YETERICARDIA sp.

**CRASSATELLlTES sp. B (Stephenson)

Crassatella sp. B Stephenson, 1941, Univ. Texas Pub. 4101,p. 180,pl.29,fig. 12.

One specimen, which is referred to Stephenson's unnamed Texas species, was found at the locality. There seems to be a certain amount of individual variation in Stephenson's specimens. The limits of variation will have to be determined on more and better preserved material before the species can be properly named. The one difference between the Texas and Delaware material is that the Delaware specimen has a slightly finer ribbing.

CRASSATELLlTES sp.

Family LUCINIDAE

*LUCINA PARYA Stephenson

PI. II, Fig. 7

Lucina parva Stephenson, 1923, North Carolina Geol. and Econ. Surv., vol. 5, p. 281, pI. 69, figs. 7-10.

This species is represented by one well-preserved individual which retains both values.

*LUCINA sp.

This is a common genus at the locality. However, most of the specimens are too poorly preserved for specific indentification.

Family CARDIIDAE

*CARDIUM WENONAH Weller

Cardium wenonah Weller, 1907, New Jersey Geol. Surv. Paleont.Ser., vol. 4, p. 576, pl. 63, figs. 14-16.

This is the first report of this species outside of New Jersey.

*CARDIUM EUFAULENSIS Conrad

Cardium eufaulensis Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 282, pI. 46, fig. 12.

Gardner (1916) questionably recorded this species from Delaware.

*CARDIUM WHITFIELDI Weller

Cardium whitfieldi Weller, 1907, New Jersey Geol. Surv. Paleont. Ser., vol. 4, p. 580, pI. 64, fig. 8.

One specimen which is questionably assigned to this species was collected. This is the first record of this species outside of New Jersey.

CARDIUM KUMMELl Weller

Cardium kummeli Weller, 1907, New Jersey Geol. Surv. Paleont. Ser., vol. 4, p. 582, pl. 66, figs. 1-3.

CARDIUM DUMOSUM Conrad

Cardium (Criocardium) dumosum Conrad, 1870, Amer. Jour. Conch., vol. 6, p. 75.

CARDIUM TENUlSTRIATUM Whitfield

Fragum tenuistriatum Whitfield, 1886, New Jersey Geol. Surv. Paleont. Ser., vol. 1, p. 139, pl. 20, figs. 15, 16.

CARDIUM sp.

**PROTOCARDIA PARAHILLANA Wade

Pl. II, fig. 9

Protocardia parahillana Wade, 1926, U. S. Geol. Surv. Prof. Paper 137, p. 87, pI. 27, fig. 1.

This is the first record of this species outside of Tennessee.

Family ISOCARDIIDAE

**ISOCARDIA BULBOSA Stephenson

Pl. II, fig. 10

lsocardia bulbosa Stephenson, 1941, Univ. Tex. Publ. 4101, p. 206, pI. 37, figs. 4-5.

This species has previously only been recorded from Texas. The species is only represented by one broken internal cast.

Family VENERIDAE

*APHRODINA sp.

LEGUMEN sp. ?

This questionably assigned genus is represented by one fragmentary specimen.

*TELLINA GEORGIANA Gabb

PI. II, fig. 12a-b

Tellina georgiana Gabb, 1876, Proc. Acad. Nat. Sci. Phila., p. 307.

*TELLINA GABBI Gardner

Tellina (Acropagia) gabbi Gardner, 1916, Maryland Geol. Surv., Upper Cret., p. 694, pI. 42, fig. 2.

LINEARIA METASTRIATA Conrad

Linearia metastriata Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 279, pI. 46, fig. 7.

SOLYMA sp.

PI. II, fig. 11

This specimen appears to be distinct from S. *elliptica* and S. *lineolatus,* but it is not preserved well enough for adequate description.

Family MACTRIDAE

*CYMBOPHORA sp.

Family CORBULIDAE

CORBULA CRASSIPLICA Gabb

Corbula crassiplica Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 394, pI. 68, fig. 25.

Family TEREDIDAE

*TEREDO sp.

This form seems to be intermediate between *T. irregualaris* Gabb and *T. rectus* Wade and was first mentioned by Weller as a *Teredo* tube from the Navesink of New Jersey. It has never been described because the shells have not been found.

Class SCAPHOPODA
Family DENTALIIDAE

uDENTALIUM INTERCALATUM Wade

Dentalium intercalatum Wade, 1926, U. S. Geol. Surv. Prof. Paper 137, p. 100, pI. 33, figs. 18-19.

This species is represented at the locality by several poorly preserved fragments. This is the first record of this species outside of Tennessee.

Class GASTROPODA
Family WEEKSIIDAE

**WEEKSIA DEPLANATA (Johnson)

Straparolus deplanatus Johnson, 1905, Proc. Acad. Nat. Sci. Phila., vol. 57, p. 19.

This species is represented by one internal cast. This is the first record of the genus *Weeksia* in the northern part of the Atlantic Coastal Plain.

Family PATELLIDAE

*EMARGINULA LADOWAE Eichman

Emarginula ladowae Eichman, 1955, Nautilus, vol. 68, p. 113, pI. 4, figs. 7-8.

This is only the second specimen of this species ever recorded. Its presence at the locality represents a significant increase in its stratigraphic range inasmuch as the type specimen came from the Woodbury formation of New Jersey. The genus *Emarginula,* except for this one species, is known only from the Tertiary.

Family ANGARIIDAE

**CALLIOMPHALUS (CALLIOMPHALUS) AMERICANUS Wade

PI. III, figs. la-c

Calliomphalus americanus Wade, 1926, U. S. GeoI. Surv. Prof. Paper 137, p. 178, pI. 60, figs. 1-3.

A sufficient amount of shell is left on one internal mold to make a specific identification. Aside from one questionable record from Delaware, this is the first record of this genus from the northern part of the Coastal Plain. There are several casts from New Jersey that have been called *Margarites* but could probably be assigned to *Calliomphalus.*

uCALLIOMPHALUS (CALLIOMPHALUS) NUDUS Sohl

PI. III, figs. 2a-c

Calliomphalus (Calliomphalus) nudus Sohl, 1960, U. S. Geol. Surv. Prof. Paper 331-A, p. 54, pI. 5, figs. 32-33.

Three internal casts were found with enough shell for specific indentification.

:::*CALLIOMPHALUS (CALLIOMPHALUS) sp.

**CALLIOMPHALUS (PLANOLATERALIS) sp.

Family EPITONIIDAE

**BELLISCALA CRIDERI Stephenson

pI. III, figs. 3a-b

Belliscala crideri Stephenson, 1941, Univ. Tex. Publ. 4101, p. 269, pI. 49, figs. 15-18.

This is the first record of this species outside of Texas.

Family ARCHITECTONICIDAE

**ARCHITECTONICA cf. VORAGIFORMIS Stephenson

PI. III,figs. 5a-c

Architectonica voragiformis Stephenson, 1941, Univ. Tex. Pubi. 4101, p. 271, pI. 48, figs. 12-14.

Only casts of this species are present, but they compare favorably with Stephenson's Texas material. This is the first record of this species outside of Texas.

**PSEUDOMALAXIS sp.

This genus is represented at the locality by a cast of the umbilical filling. It is a relatively large specimen measurng about 8 mm. in diameter. This may represent *P. pilsbryi* Harbison.

MARGARITES ABYSSINA (Gabb)

PI. III, figs. 6a-c

Solarium abyssinus Gabb, 1860, Proc. Acad. Nat. Sci. Phila. (1860), p. 94, pI. 2, fig. 9.

"'MARGARITES DEPRESSA Gardner

Margarites depressa Gardner, 1916, Maryland Geoi. Surv. Upper Cret., p. 505, pI. 8, fig. 6.

This is the first record of this species outside of Maryland.

**MARGARITELLA PUMILA Stephenson

PI. Ill, figs. 4a-c

Margaritella pumila Stephenson, 1941, Univ. Tex. Pubi. 4101, p. 272, pI. 49, figs. 9-10.

This species is fairly common at the locality. Only about half of the specimens are well enough preserved for positive identification. The other half are questionably assigned to this species.

Family NATICIDAE

LUNATIA HALLI Gabb

Lunatia ha//i Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 391, pI. 68, fig. 11.

This is the most common gastropod at the locality.

GYRODES ABYSSINA (Morton)

Natica abyssina Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 49, pI. 13, fig. 13.

GYRODES SUPRAPLICATUS (Conrad)

Rapa supraplicatus Conrad, 1858, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 3, p. 332, pI. 35, fig. 20.

GYRODES PETROSUS (Morton)

Natica petrosa Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 48, pI. 19, fig. 6.

"'POLINICES ALTISPIRA (Gabb)

? *Lunatia altispira* Gabb, 1861, Proc. Acad. Nat. Sci. Phila. (1861), p. 320.

This is a fairly common fossil at the locality.

Family XENOPHORIDAE

XENOPHORA LEPROSA (Morton)

Trochu,l' leprosa Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 46, pI. 15, fig. 6.

Family VERMETIDAE

LAXlSPIRA LUMBRICALIS Gabb

Laxi.l'pira lumbricalis Gabb, 1877, Proc. Acad. Nat. Sci. Phila. (1876), p. 301, pI. 17, figs. 6-7.

This is the first time that this species has been recorded from the Mount Laurel Formation.

Family TURRITELLIDAE

*TURRITELLA VERTEBROIDES Morton

Turritella vertebroides Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 47, pI. 3, fig. 13.

TURRITELLA ENCRINOIDES Morton

Turritella encrinoides Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 47, pI. 3, fig. 7.

*TURRITELLA TRILIRA Conrad

Turritella tri/ira Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 285.

TURRITELLA sp.

Family CERITHIIDAE

**CERITHIUM WEEKSI Wade

PI. IV, figs. 1a-b

Cerithium weeksi Wade, 1926, U. S. Geoi. Surv. Prof. Paper 137, p. 154, pI. 54, figs. 1-2.

This species is represented by one specimen. This is the first record of this species as far north as Delaware.

CERITHIUM sp. ?

One specimen is questionably assigned to this genus.

Family APORRHAIDAE

ANCHURA ROSTRATA (Gabb)

Rostellaria rostrata Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 390, pI. 68, fig. 7.

ANCHURA PENNATA (Morton)

Rostellaria pennata Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S., p. 48, pI. 19, fig. 9.

ANCHURA ABRUPTA Conrad

Anchura abrupta Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 284, pI. 47, fig. 1.

Family CYPRAEIDAE

CYPRAEA GROOTI Richards and Shapiro n. sp.

See section on Systematic Paleontology.

Family PYROPSIDAE

*NAPULUS WHITFIELDI (Weller)

Pyropsis whitfieldi Weller, 1907, Geoi. Surv. New Jersey Paleont., vol. 4, p. 750, pI. 2, figs. 8-9.

This species is represented by two specimens, one of which has most of the shell preserved.

NAPULUS sp.

PYROPSIS RICHARDSONI (Tourney)?

Pyrula richardsoni Tourney, 1854, Proc. Acad. Nat. Sci. Phila., vol. 7, p. 169.

Two specimens are questionably referred to this species. One is a cast; the other is a juvenile form.

Family MOREIDAE

**MOREA CANCELLARIA CORSICANENSIS Stephenson

PI. IV, figs. 2a-b

Morea cancellaria corsicanensis Stephenson, 1941, Univ. Tex. PubI. 4101, p. 326, pI. 61, figs. 7-9.

This is the first record of this species outside of Texas. It is represented by one fairly well preserved specimen.

Family FUSIDAE

*BELLIFUSUS MEDIANS? (Whitfield)

Odontofusus medians Whitfield, 1892, New Jersey Geol. Surv. Paleont., vol. 2, p. 67, pI. 5, figs. 18-21.

This specimen is represented by a cast which is questionably assigned to this species. It may be a juvenile form.

Family FULGURIDAE

*PYRIFUSUS MARYLANDICUS Gardner

PI. IV, figs. 4a-b

Pyrifusus marylandicus Gardner, 1916, Maryland Geol. Surv. Upper Cret., p. 457, pI. 16, figs. 7-9.

This is the first record of this species outside of Maryland.

Family VOLUTIDAE

VOLUTOMORPHA CONRADI (Gabb)

Volutilithes conradi Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 300, pI. 48, fig. 10.

This species is represented by one juvenile form.

VOLUTOMORPHA sp.

Family TURRITJDAE

*TURRICULA sp.

Family ACTEONIDAE

*ACTEON CRETACEA Gabb

A('teon eretacea Gabb, 1861, Proc. Acad. Nat. Sci. Phila. (1861), p. 318.

This species is fairly common at the locality. It is the first record of this species outside of New Jersey.

**ACTEON ? THROCKMORTONI Stephenson

PI. IV, figs. 5 a-b

Acteon ? *throckmorton;* Stephenson, 1941, Univ. Tex. PubI. 410 I, p. 380, pI. 72, figs. 5, 6.

This is the first record of this species outside of Texas.

Family RINGICULIDAE

*CINULA NATICOIDES (Gabb)

Actaeonia naticoides Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd Ser., vol. 4, p. 299, pI. 48, fig. 2.

Family SCAPHANDRIDAE

*ELLIPSOSCAPHA MORTONI (Forbes)

Blilla mortoni Forbes, 1845, Quart. Jour. GeoI. Soc. London, vol. I, p. 63, text fig. a.

One small individual, which is probably juvenile, is llucstionably assigned to this species.

Family ACTEOCINIDAE

*CYLICHNA RECTA (Gabb)

Bulla recta Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 302, pI. 48, fig. 16.

*CYLICHNA sp.

**GONIOCYLICHNA sp.

PI. IV, figs. 6a-c

This genus is represented by one internal cast which may be G. *bisculpturata* Wade. However, it is impossible to make a specific determination.

Family SIPHONARIIDAE

**ANISOMYON HAYDENI Shumard?

A Ilisomyon haydeni Shumard, 1862, Boston Soc. Nat. Hist. Proc., vol. 8, p. 198.

This questionably assigned species is represented by one fragmentary specimen. This is the first record of this species along the Atlantic Coastal Plain.

ANISOMYON JESSUPI Richards and Shapiro n. sp.

See section on Systematic Paleontology.

Class CEPHALOPODA
Order AMMONOIDEA
Family BACULITIDAE

BACULITES OVATUS Say

Baculites ovata Say, 1820, Amer. Jour. Sci., 1st ser., vol. 2, p. 41.

Fragments of this species are common at the locality.

Family NOSTOCERATIDAE

*NOSTOCERAS sp.

This genus is represented by one specimen found at the locality. It was recently collected by Mr. C. Fray who kindly donated it to the Academy.

Family SCAPHITIDAE

SCAPHITES HIPPOCREPIS (DeKay)

Ammonites hippocrepis DeKay, 1827, New York Lyceum Ann., vol. 2, p. 273, pI. 5, fig. 5.

Family PERONICERATIDAE

MENABITES (DELAWARELLA) DELAWARENSIS (Morton)

Ammonites delawarensis Morton, 1830, Amer. Jour. Sci., 1st ser., vol. 18, p. 244, pI. 2, fig. 4.

One small fragment was collected by the authors. There is also an almost complete specimen, recently collected from the locality, in the collections of the Delaware Geological Survey.

Order BELEMNOIDEA
Family BELEMNITIDAE

BELEMNITELLA AMERICANA (Morton)

Belemnites americanus Morton, 1830, Amer. Jour. ScL, vol. 17, p. 281; vol. 18, pI. I, figs. 1-3.

This species is very common at the locality.

Phylum ARTHROPODA
Class CRUSTACEA
Order DECAPODA
Family NEPHROPSIDAE

HOPLOPARIA GABBI Pilsbry

Hoploparia gabbi Pilsbry, 1901, Proc. Acad. Nat. Sci. Phila., vol. 53, p. 115, pI. 1, figs. 11-14.

This species is represented by one fixed finger which was questionably assigned to this species by Mr. Henry B. Roberts of the U. S. National Museum who very kindly examined the specimen.

DECAPODA indet.

This genus is represented by one fragment of a finger, exhibiting only two teeth. The specimen is remarkable mainly for its large size.

Length of fragment 23.4 mm, greatest width 16.5 mm.

Other Fossils from the Locality

Also found at the locality were echinoderm plates and spines, a few pieces of encrusting bryozoa, some fossil wood, and vertebrate remains that include shark teeth, fish vertebrae, and one bone fragment. There was also a large amount of fossiliferous material too poorly preserved for identification.

SPECIES NOT FOUND
IN THE PRESENT COLLECTION

The following species have not been found in the present collection but have been previously collected from the locality.

Terebratulina atlantica Morton
Exogyra costata Say
Lima serrata Gardner
Crenella elegantula Meek & Hayden
Tenea parilis Conrad
Napulus octoliratus Conrad
Eutrephocera,\' dekayi Morton
Heteroceras conradi Morton

Systematic Paleontology
Phylum BRACHIOPODA
Class ARTICULATA

TEREBRATULINA COOPERI
Richards and Shapiro n. sp.
PI. I, figs. 3, 4a-c

Shell small, punctate, moderately thin, biconvex with brachial valve flatter than pedicle valve. Pedicle valve subtrigonal, slightly auriculate, anteriorly rounded, cardinal margins meeting at about 90 degrees. Brachial valve subcircular, auricles in young become proportionally reduced in adult, hinge line almost straight. Beak on pedicle valve pronounced; deltidal plates disjunct, do not approach each other near hinge line; foramen large, subelliptical to trigonal, extending down to hinge line. Umbos smooth, radial ribbing begins just beyond umbos; ribs rounded, moderately pronounced, wider than interspaces, slightly increasing in size anteriorly and increasing in number by branching; fine growth lines present, becoming strong enough posteriorly to produce a cancellated effect on the auricles; no sinus present. Cardinalia typical for genus. Crura very short; loop, thin short cylinder of nearly circular cross-section.

Dimensions of holotype: length 6.7 mm
width 5.6 mm

This species differs from *T. brewsterensis* Adkins found in the Taylor of Texas, in being proportionally longer, more nearly trigonal in shape, more coarsely sculptured, and lacking a median sinus. Compared with *T. noakensis* Stephenson, from the Navarro of Texas, this species is smaller, has a non-circular foramen that opens broadly on the hingle line, and has ribbing which is broader and increases in size anteriorly.

Holotype: ANSP 30843 [1]

Paratypes: ANSP 30844, 30845

Named in honor of Dr. G. Arthur Cooper, of the U. S. National Museum.

Phylum MOLLUSCA
Class PELECYPODA

NEMODON GRANDIS SOHLI
Richards and Shapiro n. subsp.
PI. II, fig. 4

Nemodon grandis was first described by Wade (1926) from Coon Creek, Tennessee. Stephenson (1941) described a subspecies, *Nemodon grandis navarroanus,* from Texas.

The Delaware subspecies is smaller, proportionally longer, and more strongly striated than the Texas subspecies, which, in turn, is about half as large, proportionally longer, and has stronger striations than the species originally described from Tennessee.

Only internal casts have been found, but these give an indication of the strength of the sculpture and also show the muscle scars which were not seen in either the Tennessee or Texas forms.

[1] In collection of Academy of Natural Sciences of Philadelphia.

Anterior muscle scar moderately impressed, forming along anterior dorsal edge and extending, wedge shaped, downward to about the medial line. Posterior muscle scar larger, not as well impressed, forming along the posterior dorsal and posterior lateral edges and extending up over the keel.

Dimensions of holotype: length 23.8 mm
height 10.6 mm
convexity 4.1 mm

This subspecies is fairly common at the locality.

Holotype: ANSP 30840

Paratype: ANSP 30841

Named in honor of Dr. Norman Sohl, of the U. S. Geological Survey.

OSTREA BIGGSI

Richards and Shapiro n. sp.

PI. II, figs. 8 a-b

Shell of moderate size, subquadrate, height greater ,than length. Right valve very moderately convex laterally; posterior margin straight, meets ventral margin at about a right angle, anterior margin curved slightly until it meets dorsal margin in smooth curve. Beak situated at extreme posterior edge of dorsal margin. Shell plicate only at edges, no plications extend onto surface of shell. Dorsal margin very slightly plicate, strength of plications increasing slightly along anterior margin, disappearing entirely along ventral margin; posterior margin very faintly plicate at extreme ventral end. Surface of shell smooth showing faint growth lines. Muscle scar of moderate size, distinct, located toward center of shell.

Dimensions of holotype: length 33.6 mm
height 17.8 mm

Because the genus *Ostrea* is in great need of revision, it is generally unwise to describe new species of the genus. However, this form is sufficiently distinct to warrant such a description. It is easily differentiated from other Cretaceous species of *Ostrea* by its almost rectangular shape and the presence of plications only at the extreme margins.

The species is known from only one right valve.

Holotype: ANSP 30839

Named in honor of Mr. F. B. Biggs, owner of the farm on which these fossils were found.

Class GASTROPODA

CYPRAEA GROOTI Richards and Shapiro n. sp.

P. IV, figs. 3a-c

Shell of medium size, ovate, about 1½ times higher than wide, body whorl attains greatest width about one-third down from the top of the whorl. Curvature gently convex, increasing at anterior and posterior extremities. Spire small, low, conical. Suture moderately impressed on cast. Outer lip infolded. Aperture long, narrow, extends entire length of shell, greatly expanded below last whorl, then contracting again to form short siphonal canal. Abapically the aperture is reflected in towards the axis suggesting the presence of an anal canal. Both inner and outer margins of aperture crenulated. Ornamentation of shell unknown.

Dimensions of holotype: height 17.6 mm
diameter 10.4 mm

This species can be distinguished from *Cypraea mortoni* in that the latter has a flat spire, no abapical expansion of the aperture, and a more rounded form. The Delaware species differs from *Cypraea nuciformis*, from Texas, in being less rounded and having a greater expansion of the aperture abapically.

The species is represented by only one specimen which is an internal cast.

Holotype: ANSP 30838

Named in honor of Dr. Johan J. Groot, State Geologist of Delaware.

ANISOMYON JESSUPI

Richards and Shapiro n. sp.

PI. IV, figs. 7a-c

Shell thin, of moderate size, patelliform, aperture suboval to subelliptical with posterior end slightly wider than anterior. Summit situated slightly behind the middle; immediate apex pointed, directed posteriorly. Anterior slope gently undulating. Posterior slope varies from almost straight in some individuals to gently undulating in others. Sides slightly concave. Muscle scar moderately impressed, horseshoe shaped, enlarged at either extremity; left side extending slightly beyond the apex, right side abruptly terminated after rounding the posterior curvature. Surface marked by concentric lines of growth.

Dimensions of holotype: length 15.3 mm
width 11.6 mm
height about 6.5 mm

This species bears certain similarities with *A. haydeni*, from Texas, which is an extremely variable form. However, the Delaware species seems to be distinct in that it is proportionally shorter in height and has a posterior slope less convex and much less humped.

This species is present in the form of internal casts, some of which retain fragments of the shell. It is not an uncommon species in the collections made at the locality.

Holotype: ANSP 30842 a

Paratypes: ANSP 30842 b, 30847

Named in honor of Augustus E. Jessup, founder of the Jessup fund of The Academy of Natural Sciences.

Table of Species

Table 3 shows the distribution of the fossils recorded in the previous section from New Jersey, Delaware, Maryland, North and South Carolina, Georgia, Alabama, Mississippi, Tennessee, and Texas. The information is based upon the literature plus an examination of material in the collections of the Academy of Natural Sciences. In many of the states mentioned, an attempt has been made to record the various formations from which the species have been recorded. In the case of Georgia, Mississippi, Alabama, and Tennessee, insufficient material was available at our disposal to render such a breakdown possible.

For the sake of completeness, those specimens identified only to genus are included in the table, but no attempt has been made to record their distribution.

Environment of Deposition

The fauna is characterized by:

1. Its variety and great number of species.
2. The medium or small size of the majority of the members of the fauna.
3. The large number of individuals of *Anomia* and *Ostrea* and the relatively small number of *Exogyra.*
4. The large numbers of *Lunatia* and other Naticidae.
5. The large number of *Belemnitella.*
6. The large number of solitary corals and worm tubes.

The fossils are clearly marine, and are more or less evenly distributed throughout the portion of the formation exposed at the locality, and are not concentrated in either pockets or shell beds. This would seem to argue against it being a post mortem assemblage; this opinion is substantiated by the excellent condition of *Belemnitella americana* at the locality. According to Dr. J. A. Jeletzky (personal communication) these were probably deposited at or near their normal habitat.

That some currents were present is indicated by the large numbers of corals, pelecypods, and other attached forms which depend upon water currents for their food supply. A few fossils were undoubtedly washed in by these currents, but their number is probably small.

The fauna seems to lie intermediate between what Scott (1940) described from the Cretaceous of Texas as the epineritic zone and the infraneritic zone.

Scott described the epineritic as ocurring from 7-8 to 20 fathoms in depth and containing large numbers of echinoids, large gastropods and pelecypods with thick shells, many oysters including *Exogyra* and *Gryphaea,* corals, and crustacean fragments. The ammonites are represented by tenuous forms such as *Engonoceras, Placenticeras,* and *Sphenodiscus.*

He described the infraneritic zone as occurring from 20 to 80-100 fathoms in depth. It carries a rich and varied fauna. Gastropods and pelecypods are numerous and varied, but do not include the large thick species, while members of the oyster family are relatively rare. Corals are absent. The ammonite fauna consists of the sculptured ammonites such as *Hypacanthroplites, Mortoniceras,* and *Douvilleiceras* and the uncoiled or abnormally coiled genera such as *Baculites, Crioceras, Scaphites, Hamites, Turrilites,* and *Nostoceras.*

The Delaware fauna matches Scott's epineritic zone in the presence of corals, crustacean fragments, oysters, and heavy shelled gastropods and pelecypods. However, there are not many echinoderms. Also, the thick shelled forms do not attain great size, and *Exogyra* and *Gryphaea,* while common, are not actualy abundant.

The fauna matches Scott's infraneritic zone in its rich and varied fauna and in its ammonite assemblage which consists entirely of the sculptured or of the uncoiled or abnormally coiled genera.

This apparent blending of fossils can perhaps be explained by the paleogeographic differences between Texas and Delaware. The Texas seas were only the shallow northern extensions of the Mexican geosynclines. The neritic zone of these seas covered very large areas, and it is possible to make relatively fine subdivisions. On the other hand, the Delaware deposits represent an oceanic coast where the neritic zone was relatively narrow. It would be almost impossible to make as fine a distinction between the epineritic and infraneritic zones in this area. The depth at which the fauna lived can best be gauged by using Scott's two zones as ecological end members, and then determining where the fauna would fit between them. By using this method, it is estimated that the fauna from the Biggs Farm locality in Delaware lived at about a depth of 15 fathoms (± 5 fathoms).

Recent work with microfossils has yielded some additional information about the environment of deposition. According to Dr. Joyce Mumby (1961 and personal communication) the foraminifera of the Mount Laurel Formation in Delaware (largely obtained from the Biggs Farm locality) seem to indicate that the formation was deposited in a large shallow bay, open to the sea and tidal action, and without a heavy inflow of fresh water to make it brackish or to bring in much silt. This interpretation agrees with the data obtained from the present study of the macrofossils.

Age of the Fauna

The fauna at the Biggs Farm locality is known to lie in the Mount Laurel-Navesink Formation (Groot, Organist, and Richards, 1954). Based on the macrofossil assemblage as well as the presence of the index fossils *Belemnitel/a americana, Micrabacia hildgardi,* and *Exogyra cancel/ata* the age of the formation at this locality is thought to be late Late Cretaceous, probably early Maestrichtian. The preponderance of species that are found restricted to the Mount Laurel-Navesink Formation at other localities suggest that the Mt. Laurel-Navesink Formation at the Biggs Farm locality is the same age as the Mt. Laurel-Navesink Formation found elsewhere. However, the Biggs Farm assemblage does contain a few species that are restricted to the Matawan Formation elsewhere, further suggesting that the formation at this locality might lie near the Matawan-Monmouth boundary perhaps in the lower part of the Monmouth Group.

On the basis of a foraminiferal study, Miss Mumby (1961 and personal communication) believes that the Mount Laurel-Navesink Formation in Delaware is slightly older than the Mount Laurel Formation of New Jersey. Furthermore, the Marshalltown Formation at Fellowship, New Jersey contains a foraminiferal assemblage which is similar to but not identical with the foraminiferal assemblage found in the Mount Laurel-Navesink of Delaware. Therefore, on the basis of Miss Mumby's study, it is suggested that the age of the Mount Laurel-Navesink Formation at the Biggs Farm locality in Delaware is older than the Mount Laurel of New Jersey and slightly younger than the Marshalltown Formation of New Jersey.

Although the study of the macrofossils is not as conclusive as that of the Foraminifera by Miss Mumby, a more or less similar conclusion is reached.

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Table 1

	Carter, 1937		Spangler and Peterson, 1950			Groot, Organist, and Richards, 1954		
UPPER CRETACEOUS	MONMOUTH	-Unconforrnity-	EOCENE	AQUIA	-Unconforrnity-	UPPER CRETACEOUS	MONMOUTH	Red Bank
		Mount Laurel			Vincentown			
		-Unconforrnity-	UPPER CRETACEOUS	MONMOUTH	-Unconforrnity-			Navesink- Mount Laurel
		Marshalltown			Navesink			
	MATAWAN	-Unconformity-		MATAWAN	Mount Laurel		MATAWAN	Wenonah
		Englishtown			Wenonah			
		Crosswicks			Marshalltown Woodbury Merchantville Undifferentiated			Merchantville

TABLE I. CORRELATION OF UPPER CRETACEOUS FORMATIONS OF CHESAPEAKE AND DELAWARE CANAL AFTER CARTER. SPANGLER. AND PETERSON AND GROOT. ORGANIST. AND RICHARDS.

Table 2

NEW JERSEY Weller, 1907; Richards et al., 1958, 1962		DELAWARE Groot, Organist, and Richards, 1954	MARYLAND Clark et al., 1916	NORTH AND SOUTH CAROLINA Stephenson, 1923	TEXAS Stephenson, 1941
Monmouth Group	Tinton	-			
	Red Bank	Red Bank	Monmouth	Pee Dee	Navarro
	Navesink				
	Mt. Laurel	Navesink-Mt. Laurel		(including Snow Hill) *	
Matawan Group	Wenonah	Wenonah			
	Marshalltown	-	Matawan	Black Creek	Taylor
	Englishtown	-			
	Woodbury	-			
	Merchantville	Merchantville			

TABLE 2. SUGGESTED CORRELATION OF THE UPPER PART OF THE UPPER CRETACEOUS SECTION OF NEW JERSEY, DELAWARE, MARYLAND, NORTH AND SOUTH CAROLINA, AND TEXAS•

• ACCORDING TO BRETT AND WHEELER, 10111

Table 3, Range of species recorded from the Biggs Farm locality,

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt. Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
PORIFERA																					
Cliona cretacica Fenton and Fenton			X				X		X												
ANTHOZOA																					
Mierabacia hilgardi Stephenson									X							X	X	X	X		
Graphularia sp,																					
ANNELIDA																					
Hamulus fa/catus (Conrad)			X			X	X		X		X										
Hamulus squamosus Gabb							X		X							X	X	X	X	X	X
Hamulus angulatus Wade									X										X		
Longitubis sp.																					
Diplochoncha cretacea Conrad			?				X		X	X		X		X		X	X	X		X	
Serpula sp,																					

ECHINOIDEA		
Hemiaster sp.		
BRACHIOPODA		
Terebratulina cooperi n. sp.		
PELECYPODA		
Nuculana longifrons (Conrad)		
Nuculana pittensis (Stephenson)		
Nuculana stephensoni Richards		
Nuculana sp.		
Yoldia gabbana (Whitfield)		
Yoldia sp.		
Nemodon eufaulensis (Gabb)		
Nemodon grandis sohli n. subsp.		
	Pale=cene-Eocene	New Jersey
×	Red Bank-Tin=n	
×	^aves nk-Mt Laurel	
	Wen=nah	
×	Marshalltown	
	W=odbury	
×	Merchantville	
	Red Bank	Delaware
× × × × × × ×	^avesink-Mt. Laurel	
	Wen=nah	
	Me: chantville	
× × ×	M=nm=uth	Maryland
×	Matawan	
×	Peedee	North Ca=lina
	Black ⊂reek	
× × × ×		Ge=rgia
× × ×		Alabama
× × ×		Miss ssippi
× × ×		Tennessee
×	^avarro	Texas
	Tayl=:	

Table 3 cont.

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt. Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt. Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
Cucullaea neglecta Gabb			X			X	X		X		X										
Arca rostellata Morton			X						X								X				
Arca obesa (Whitfield)							X		X				X								
Postligata crenata Wade									X									X	X		
Glycymeris mortoni (Conrad)		X	X				X		X		X	X	X		?	X	X	X			
Glycymeris sp"																					
Pinna laqueata Conrad			X			X	X		X		X							X			
Inoceramus proximus Tourney					X	X	X		X	X					?		X	X	X	X	
Ostrea /alcata Morton			X		X				X			X		X		X	X	X	X	X	X
Ostrea mesenterica Morton		X	X						X								X	X		X	X
Ostrea monmouthensis Weller			X						X			X							X		
Ostrea panda Morton					X				X								X	X	X	X	X

Table 3 coot.

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt. Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt. Laurel	Wenonah	Merchantville	Monmouth	Manawan	Peedee	Black Creek					Navarro	Taylor
Ostrea biggsi n. sp.									X												
Ostrea sp.																					
Gryphaeostrea vomer (Morton)	X	X	X		X				X			X					X	X	X		
Gryphaea convexa (Say)			X		X				X			X	X	X		X	X	X	X		
Exogyra cancellata Stephenson			X						X			X		X		X	X	X	X	X	
Exogyra sp.																					
Trigonia mortoni Whitfield			X	X	X	X			X												
Trigonia sp.																					
Pecten whitfieldi Weller			X						X			X									
Pecten venustus Morton		X	X		X				X				X	X			X	X		X	
Pecten quinquecostata Sowerby			X		X		X		X		?	X				X	X	X	X		
Pecten sp.																					

Table 3 coot.

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
Lima reticulata Lyell and Forbes		X	X	X	X		X		X		X	X		X		X	X	X	X		
Lima obliqua Gardner									X			X									
Anomia argentaria Morton		X	X	X	X	X	X		X		X	X	X	X		X	X	X	X	X	X
Anomia tellinoides Morton			X			X		X	X					X		X	X	X	X	X	
Paranomia scabra Morton			X		X		X		X		X	X	X	X		X	X	X	X		X
Corimya tenuis Whitfield			X		X				X												
Clavagella armata Morton			X		X				X												
Liopistha protexta (Conrad)		X	X	X			X		X			X		X		X	X	X	X	X	
Veniella conradi Morton		X	X	X		X	X		X		X	X	X	X		X	X	X	X	X	X
Veniella carolinensis (Conrad)									X		?			X		X	X				
Vetericardia crenalirata (Conrad)						X	X		X								X	X	X		
Vetericardia sp_																					

Table 3 cont.

	New Jersey						Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt. Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt. Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
Crassatellites sp" B" (Stephenson)									X											X	
Crassatellites sp"																					
Lucina parva Stephenson						X			X					X							
Lucina sp.																					
Cardium wenonah Weller		X		X					X												
Cardium eufaulensis Conrad			X			X			X		?	X	X		?	X	X	X			
Cardium whitfieldi Weller?						X			X												
Cardium kummeli Weller		X	X						X			X				X	X	X	X		
Cardium dumosum Conrad		X		X		X	X		X		X	X		X		X	X	X	X		
Cardium tenuistriatum Whitfield			X	X	X		X		X		X	X	X					X	X		
Cardium sp"																					
Protocardia parahillana Wade									X										X		

Table 3 cant.

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt. Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
Isocardia bulbosa Stephenson									X											X	
Aphrodina sp.																					
Legumen sp. ?																					
Tellina georgiana Gabb				X					X				X			X					
Tellina gabbi Gardner		X		X		X			X			X				X					
Linearia metastriata Conrad		X		X	X	X	X		X		X	X		X		X	X	X	X		
Solyma sp.																					
Cymbophora sp.																					
Corbula crassiplica Gabb		X	X	X		X	X		X		X	X				X	X	X	X	X	X
Teredo sp.																					
SCAPHOPODA																					
Dentalium intercalatum Wade									X										X		

Table 3 cont.

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt. Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt. Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
GASTROPODA																					
Weeksia deplanata (Johnson)									X								X	X			
Emarginula ladowae Eichman						X			X												
Calliomphalus americanus Wade									X							X	X	X	X	X	
Calliomphalus nudus Sohl									X									X			
Calliomphalus (*Calliomphalus*) sp.																					
Calliomphalus (*Planolateralis*) sp.																					
Belliscala crideri Stephenson									X											X	
Architectonica voragiformis Stephenson									X											X	
Pseudomalaxis sp.																					

Table 3 cont

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
Margarites abyssina (Gabb)		X	X			X	X		X				X								
Margarites depressa Gardner									X			X									
Margaritella pumila Stephenson									X									X		X	
Lunatia halli Gabb			X	X		X	X		X			X									
Gyrodes abyssina (Morton)			X						X			X					X	X			
Gyrodes supraplicatus (Conrad)				X		X	X		X		X			X		X	X	X		X	
Gyrodes petrosus (Morton)		X	X	X			X		X			X	X				X	X		X	
Polinices altispira (Gabb)						X	X		X			?	X								
Xenophora leprosa (Morton)			X						X		X						X	X	X	X	X
Laxispira lumbricalis Gabb						X	X		X		X					X	X	X	X		
Turritella vertebroides Morton			X						X					X		X	X	X	X	X	
Turritella encrinoides Morton			X			X	X		X	X	X	X						X	X		
Turritella trilira Conrad				X					X			X	X	X		X	X	X	X	X	X

Table 3 coot.

	New Jersey						Delaware			Maryland		North Carolina	Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek				Navarro	Taylor
Turritella sp.																				
Cerithitml weeksi Wade									X							X	X	X	X	
Cerirhium sp. ?																				
Anchura rastrata (Gabb)				X		X	X		X		X							X		
Anchura pennata (Morton)			X			X			X			X					X			
Anchllra abrupta Conrad			X			X	X		X								X	X		
Cypraea groati n. sp.									X											
Napulus whitfieldi (Weller)			X						X			X								
Napulus sp.																				
Pyropsis richardsoni (Tourney) ?			X				X		X				?							
Morea cancellaria corsicanensis Stephenson									X										X	

Table 3 cone.

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
Bellifusus medians (Whitfieldi) ?			X		X		X		X			X						?			
Pyrifusus marylandicus Gardner									X			X									
Volutomorpha conradi (Gabb)	X		X			X	X		X		X	X									
Volutomorpha sp.																					
Turricula sp.																					
Acteon cretacea Gabb			X	X		X	X		X												
Acteon ? *throckmortoni* Stephenson									X											X	
Cinula naticoides (Gabb)			X						X			X									
Ellipsoscapha mortoni (Forbes) ?			X						X				X				X	X			
Cylichna recta (Gabb)			X									X					X	X	X		
Cylichna sp.																					

Table 3 coot.

	New Jersey							Delaware				Maryland		North Carolina		Georgia	Alabama	Mississippi	Tennessee	Texas	
	Paleocene-Eocene	Red Bank-Tinton	Navesink-Mt. Laurel	Wenonah	Marshalltown	Woodbury	Merchantville	Red Bank	Navesink-Mt. Laurel	Wenonah	Merchantville	Monmouth	Matawan	Peedee	Black Creek					Navarro	Taylor
Goniocylichna sp_																					
Anisomyon ;essupi n_ sp_									X												
Anisomyon haydeni Shumard									X											X	
CEPHALOPODA																					
Baculites ovatus Say			X			?	?		X		X										
Nostoceras sp_																					
Scaphite.1 hippocrepis (DeKay)							X		X		X		X								
Menabites delawarensis (Morton)							X		X		X										
Belemnitella americana (Morton)			X					X	X			X									
CRUSTACEA																					
Hoploparia gabbi Pilsbry ?							X		X		X										
*Decapoda indet_*																					

Table 3 cont.

PLATE I

Figure

I. *Hemiaster sp.*, x 1.2, ANSP 30815
   a. Right side
   b. Top view

2. *SerfJula sp.*, x 4, ANSP 30832

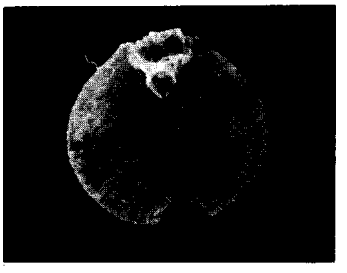
3. *Terebralulina cooperi* Richards & Shapiro, n. sp., PARATYPE, internal structure of brachial valve showing loop and crura, x 4, ANSP 30845 a

4. *Terebratulina cooperi* Richards & Shapiro, n. sp., growth series,
   a-b. PARATYPE, ANSP 30844 a
   c-d. PARATYPE, ANSP 30844 b
   e-f. PARATYPE, ANSP 30844 c
   g-h. PARATYPE, ANSP 30844 d
   i-j. PARATYPE, ANSP 30844 e
   k-1. HOLOTYPE, ANSP 30843

1 a

1 b

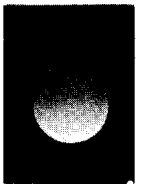
2



3

4 a

4 c



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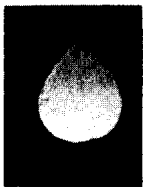

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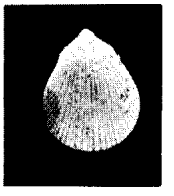

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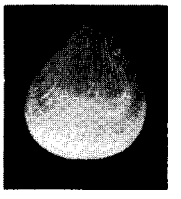
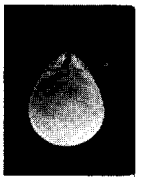


4 k

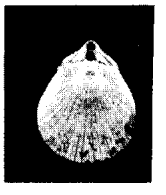
4 b

4 d



4 f

4 h



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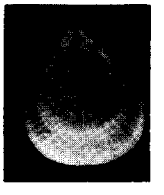


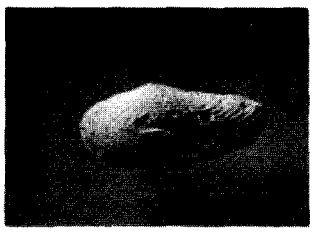
4 l

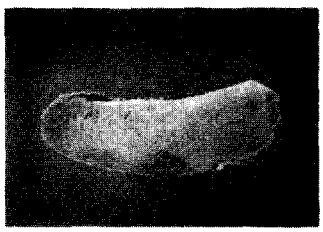
PLATE I

PLATE II

Figure

1. *Nuculana pittensis* (Stephenson), x 3, ANSP 30837
2. *Nuculana stephensoni* Richards, x 2, ANSP 30836
3. *Nemodon eufaulensis* (Gabb), x 2, ANSP 30823
4. *Nemodon grandis sohli* Richards & Shapiro, n. subsp., HOLOTYPE, x 2, ANSP 30840
5. *Postligata crenata* Wade, x 2.2, ANSP 30835
6. *Lima obliqua* Gardner, x 2, ANSP 30828
7. *Lucina parva* Stephenson, x 3, ANSP 30827
8. *Ostrea biggsi* Richards & Shapiro, n. sp., HOLOTYPE, x1, ANSP 30839
   a. View of exterior of right valve
   b. View of interior of right valve
9. *Protocardia parahillana* Wade, x 3, ANSP 30834
10. *Isocardia bulbosa* Stephenson, x 3, ANSP 30829
11. *Solyma sp.*, x 2, ANSP 30831
12. *Tellina georgiana* Gabb, x 2, ANSP 30830
    a. Internal cast, left side
    b. Internal cast, right side





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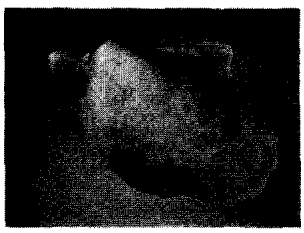

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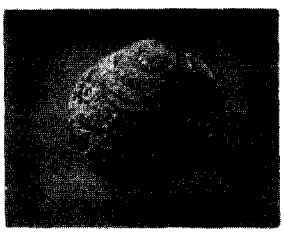

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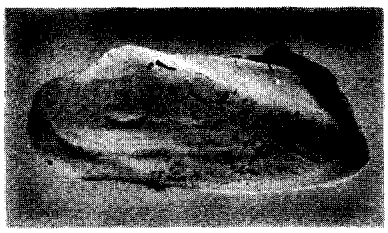

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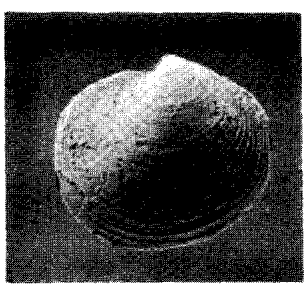

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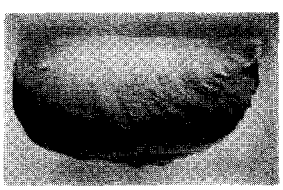

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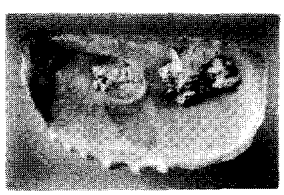

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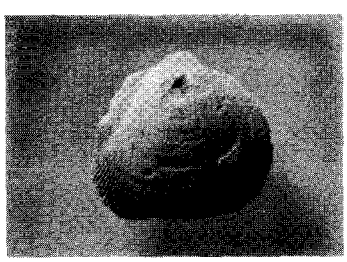

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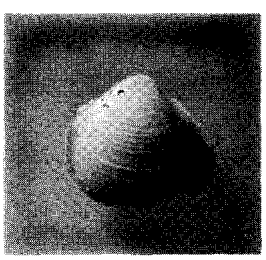

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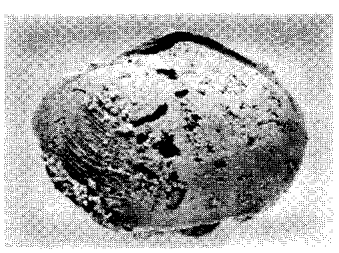

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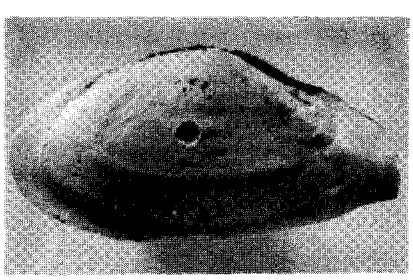

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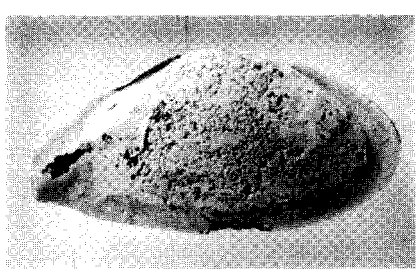


12 b

PLATE II

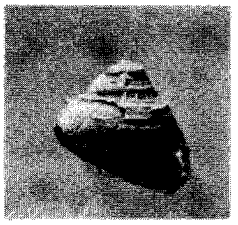
PLATE III

In all but figure 3, "a" is the front view, "b" is the apical view, and "c" the basal view.

Figure

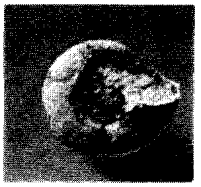
Ia-c *Calliomphalus americanus* Wade, x 3, ANSP 30819
2a-c *Calliomphalus nudus* Sohl, x 3, ANSP 30818
3 *Belliscala crideri* Stephenson, x 2, ANSP 30820
  a. Front view
  b. Back view
4a-c *Margaritella pumila* Stephenson, x 3, ANSP 30826
5a-c *Architectonica ct. voragijormis* Stephenson, x 2, ANSP 30821
6a-c *Margarites abyssina* (Gabb), x 3, ANSP 30825

1 a



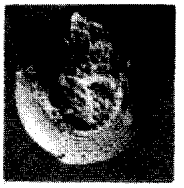
2 a

1 b

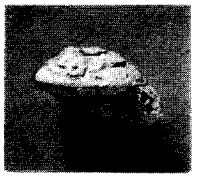


1 c

2 b



2 c



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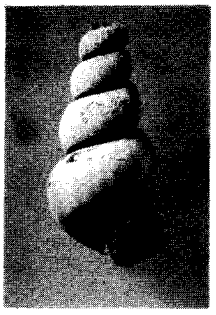

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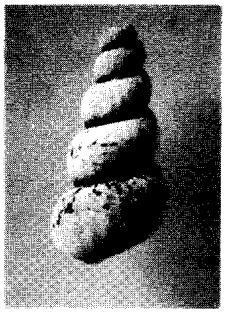

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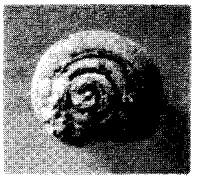

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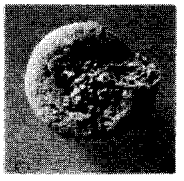

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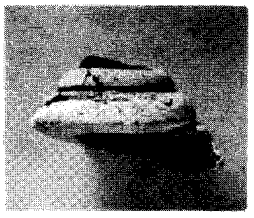

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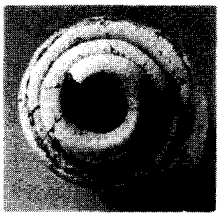

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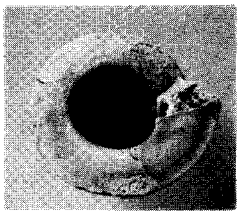

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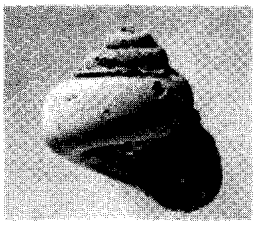

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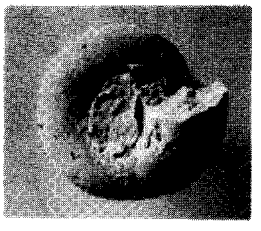
6 b



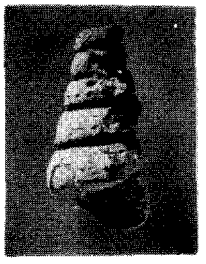
6 c

PLATE III

PLATE IV

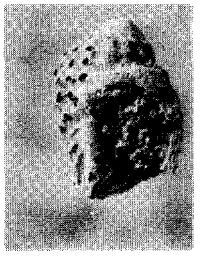
Figure

1. *Cerithium weeksi* Wade, x 3, ANSP 30817
   a. Front view
   b. Back view
2. *Morea cancellaria corsicanensis* Stephenson, x 2, ANSP 30824
   a. Front view
   b. Back view
3. *Cypraea grooti* Richards & Shapiro, n. sp., HOLOTYPE, x 2, ANSP 30838
   a. Front view
   b. Apical view
   c. Back view
4. *Pyrifusus marylandicus* Gardner, x 2, ANSP 30833
   a. Front view
   b. Back view
5. *Acteon? throckmortoni* Stephenson, x 2, ANSP 30822
   a. Front view
   b. Back view
6. *Goniocylichna sp.,* x 4.5, ANSP 30816
   a. Front view
   b. Apical view
   c. Back view
7. *Anisomyon ;essupi* Richards & Shapiro, n. sp., x 2
   a. Top view of HOLOTYPE, ANSP 30842 a
   b. Side view of HOLOTYPE, ANSP 30842 a
   c. Top view of PARATYPE showing muscle scars, ANSP 30842 b



1 a

1 b



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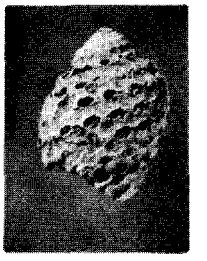

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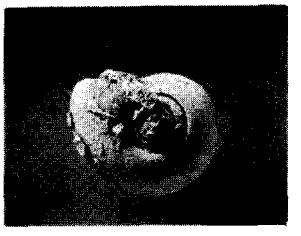
3 a



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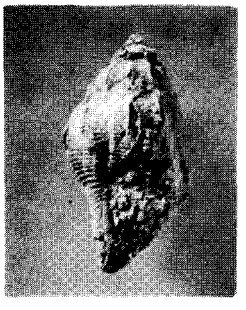
3 c



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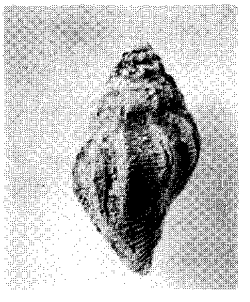
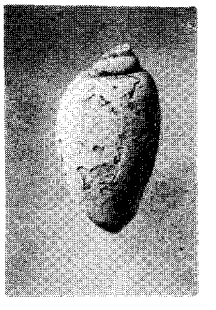


4 b

5 a



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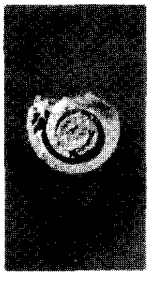
6 a



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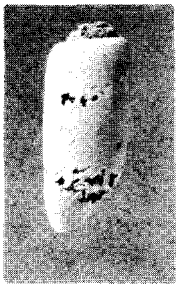

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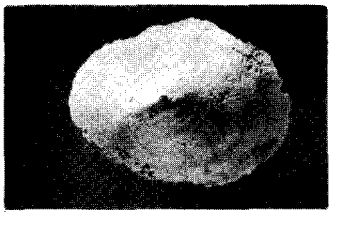
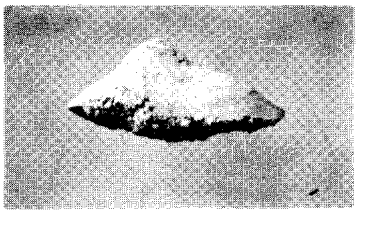


7 a



7 b

7 c

PLATE IV