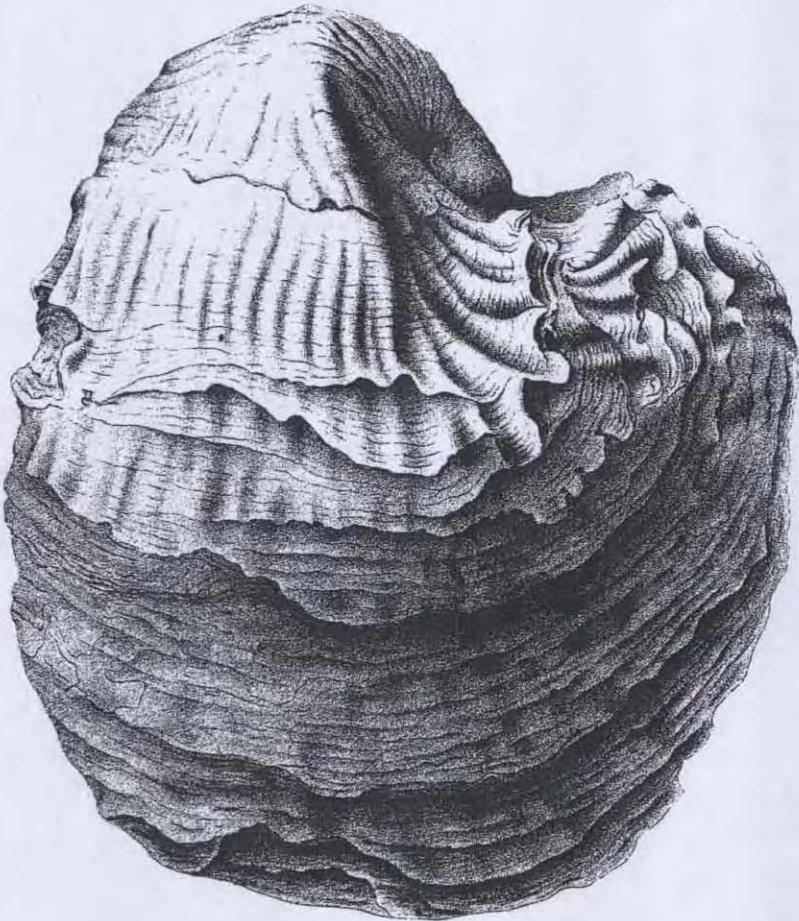


THE CRETACEOUS FOSSILS OF NEW JERSEY

Part 1



STATE OF NEW JERSEY

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Cover illustration: *Exogyra costata*. Illustration reproduced from "Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey," by Robert J. Whitfield (New Jersey Geological Survey Report on Paleontology, volume 1, 1886).

PALEONTOLOGY SERIES
Bureau of Geology and Topography
Meredith E. Johnson, State Geologist

THE CRETACEOUS FOSSILS OF NEW JERSEY

by

HORACE G. RICHARDS, *et al.*

A revision of the report on the *Cretaceous Paleontology of New Jersey* by Stuart Weller and published by the Geological Survey of New Jersey in 1907 as Volume IV of the Paleontology Series.

PART I

PORIFERA, COELENTERATA, ANNELIDA, ECHINOIDEA,
BRACHIOPODA and PELECYPODA
STATE OF NEW JERSEY

DEPARTMENT OF CONSERVATION
and ECONOMIC DEVELOPMENT

JOSEPH E. McLEAN, Commissioner

Division of Planning and Development

THEODORE J. LANGAN, Director

Trenton, N. J.

1958

Reprinted 1991

FOREWORD

"The Cretaceous Fossils of New Jersey," a standard work for both amateur and professional paleontologists, has been out-of-print for some time. Volume 1 was published in 1958 and volume 2 in 1962. Despite their age and their being long out of stock, a slow but steady demand continues for these books. For several years it has been necessary for the New Jersey Geological Survey to refer investigators to libraries and used book dealers.

This new printing is intended to eliminate this inconvenience. It is designed to satisfy the present-day demands and those in the near future. Accordingly, the re-issue is a new printing and not a new edition. Lack of funds for revision means that coverage is incomplete and nomenclature has not been updated. It is hoped that the second printing will nevertheless serve contemporary needs and that future funding may make possible a major revision and updating work on the Cretaceous fossils of the Garden State.

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Sir:

I am transmitting with this letter a much-needed report describing the fossils which occur in strata of Cretaceous age underlying the coastal plain of New Jersey. Those who seek water—or perhaps oil or natural gas—from deep wells, know that these fossils provide the key by which these strata can be recognized even though hundreds of feet beneath the surface and many miles down-dip from the point where the same strata are exposed at the surface.

Someone may ask, why mention oil and gas since neither of these fuels have been found in New Jersey. To that I should like to answer that large quantities of both oil and gas are now being obtained from wells 30 miles and more off the coast of Louisiana and Texas and to the writer this is the logical place to prospect for the same fuels off New Jersey. The increasing demands for water in our shore communities also require the drilling of deep wells and the fossils obtained from these are highly important in determining how deep the driller must go to reach an aquifer.

All authors were requested to follow a specified concise style in writing their descriptions of fossils. Nevertheless, it will be noted that there is considerable variation in style and no attempt has been made in editing manuscript to eliminate this; first, because it was felt that each expert was best acquainted with the descriptive style generally used by his colleagues in the same field; and secondly, because it was felt that any request for drastic revision by the authors would be an unwarranted additional burden upon these men who had already contributed so generously of their time and expert knowledge.

A Geological Survey is known by the work it does. Although local recognition may be won because of aid on specific problems, broader recognition comes only from its published works—particularly those of this type which provide the fundamental information upon which many investigations of the state's natural resources must depend. I am therefore happy in the knowledge that publication of this report will be a credit to all concerned as well as contributing to the economic well-being of the state.

Respectfully submitted,

MEREDITH E. JOHNSON
State Geologist

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It was originally planned to publish this report in a single volume. However, for practical reasons it has been necessary to issue the work in two parts. This has created certain difficulties in regard to the plates. A few of the illustrations of species described in Part I appear in Part II. Furthermore, certain of the plates which include both Gastropods and Pelecypods will be repeated in both parts (Plates 43 to 46). The table of species and a bibliography will appear at the end of Part II.

INTRODUCTION

by Horace G. Richards

Weller's Cretaceous Paleontology of New Jersey has been out of print for a number of years and is frequently difficult to obtain through second-hand book dealers. Since this book has a wide use among paleontologists, both amateur and professional in New Jersey and elsewhere, it seemed very desirable that the book should be reprinted. In the interval since 1907 a great deal of work has been done on Cretaceous paleontology and therefore certain revisions in nomenclature, stratigraphy and correlation are necessary. Furthermore, many of the notes on the relative abundance of certain species are based on localities no longer available. For these reasons, a simple reprinting would be unsatisfactory and misleading.

The present revision is an outgrowth of a cooperative program arranged between the New Jersey Geological Survey and the Academy of Natural Sciences of Philadelphia. It has been necessary to define certain limits to the project. Many chapters have been completely rewritten by experts in the particular fields, while others consist largely of Weller's original description with the synonymies, remarks and distribution data brought up to date. Further details about the scope of the respective chapters will be found elsewhere. (Page 27.)

Acknowledgments: Although most of the Cretaceous species of New Jersey are represented by specimens (types or otherwise) at the Academy of Natural Sciences of Philadelphia or the New Jersey State Museum in Trenton, N. J., material has also been consulted at the United States National Museum, Washington, D. C., Rutgers University, New Brunswick, N. J., Princeton University, Princeton, N. J., American Museum of Natural History, New York, N. Y., Wagner Free Institute of Science, Philadelphia, Pa., Johns Hopkins University, Baltimore, Md., Delaware Geological Survey, Newark, Del., the University of Chicago, Chicago, Ill., and the Peabody Museum of Yale University, New Haven, Conn. To all these institutions our thanks are tendered.

Next, the editor wishes to express his sincere thanks to Meredith E. Johnson, State Geologist of New Jersey, whose interest and understanding of the difficult task of editing such a lengthy volume, written by some eleven authors, has been of great help and encouragement throughout the course of the work. Next, he wishes to express his gratitude to the various contributors, listed on page ii, who have generously given of their time to help make this revision a success.

Financial aid for the project has been received from the New Jersey Geological Survey, the American Philosophical Society,¹ the Academy of Natural Sciences (Coastal Plain Fund) and the University of Pennsylvania².

¹ Johnson Fund Grant.

² Faculty Research Grant

It is impossible to acknowledge all the collectors—students, professionals and amateurs—who have supplied specimens for use in connection with this revision. In many cases, important material has thus been added to the collections of the Academy of Natural Sciences. Among those who must be mentioned in this connection are Louis R. Beck, Jr., Larry Buehler, Paul Cresthull, Charles Dilks, Robert Doyle, Albert Greenberg, Stephen Goldberg, Theodore Hesser, Jr., Leonard Johnson, Virginia Lippincott, Frank Markewicz, Halsey W. Miller, Jr., James L. Ruhle, and Stephen Wien.

The photographs of the corals, echinoids, nautiloids, ammonites, and belemnites have been prepared by the authors of the respective chapters. The remaining photographs were taken at the Academy of Natural Sciences by Louis R. Beck, A. Delwin Warden and Stephen F. Percival. A few of the pictures were retouched by Arthur Bink.

Assistance in preparing the manuscript for publication has been given by James L. Ruhle, Juliet Reed and Joseph Camperson.

Since it was necessary to have the photographs taken at different times by different photographers, it has unfortunately been impossible to have the illustrations of uniform magnification, and frequently it has been necessary to have pictures of related species on different plates. This is regretted, but was made necessary by financial limitations of the project.

HISTORICAL REVIEW OF PREVIOUS WORK ON THE CRETACEOUS OF NEW JERSEY¹

by Robert C. Ramsdell

This chapter is not intended to be a complete summary of previous work on the New Jersey Cretaceous. Only the more important references are cited.² Except for a few pertinent works, articles of a strictly paleontological nature are not discussed, although many such papers are listed in the Bibliography.

The sediments and fossils of the New Jersey Coastal Plain were among the first to attract the attention of early students of American geology. Many considered the deposits to be of alluvial origin, but others recognized their marine origin. By 1820 interest in these formations and their contained fossils was widespread. Among the early workers were William Maclure, Charles Lyell, Samuel G. Morton, Timothy A. Conrad, William Gabb and others. Their writings appeared chiefly in the publications of the American Philosophical Society, the Academy of Natural Sciences of Philadelphia and in the *American Journal of Science*. The collections of many of these writers are preserved in the Academy of Natural Sciences of Philadelphia. Unfortunately the exact locality and horizon from which many of these specimens were collected were not recorded and their labels read merely "Cretaceous, New Jersey."

Many early attempts were made to correlate the deposits of the New Jersey Coastal Plain with those in other regions. Finch (1824) attempted to show that the sediments were "contemporaneous with the newer secondary and tertiary formations" of certain European areas. Vanuxem (1828) considered the New Jersey deposits to be Upper Cretaceous. Morton (1830) correlated them with Lower Cretaceous sediments; however, he later (1832) recognized the presence of Upper Cretaceous fossils. Lyell (1845) correlated the New Jersey Cretaceous formations with the divisions between the Gault and Maestrichtian of Europe. He also considered Morton's uppermost division of the New Jersey Cretaceous to be Eocene. Conrad (1848) similarly suggested that the upper portions of the greensands³ possibly were of Tertiary age.

Morton's *Synopsis of the Organic Remains of the Cretaceous Group of The United States* was published in 1834. The Tertiary forms were described by the same author in 1835. A large number of the fossils described in these articles were collected in New Jersey. These publications were the most important contributions to New Jersey paleontology until Whitfield's monographs appeared in 1885 and 1892.

¹ This chapter is adapted partly from Johnson and Richards (1952), and Groot, Organist and Richards (1954).

² An excellent historical account of the early studies on the Coastal Plain of New Jersey is contained in Clark, Bagg and Shattuck (1898).

³ The green color of these sediments is derived chiefly from the presence of large amounts of the mineral glauconite.

Rogers was commissioned to study the geology of New Jersey in 1834. His first report (1836) and his "Final Report" (1840) contained a general classification of the Cretaceous and Tertiary strata of the state. Except that he considered the clays to lie on the marls, his reports generally were accurate. Although his classification did not contain the details now recognized, it did include the more evident main divisions. He included within the Cretaceous: "the blue plastic, sandy and micaceous clays, with plant remains; greensand or marl; yellow granular limestone, sometimes siliceous; yellow ferruginous sandstone and conglomerate" (Greacen, 1941, after Rogers, 1836). He called this entire sequence the "Greensand Series." His Tertiary series contained "a bluish or lead-colored clay with sand and some calcareous marl."

The greensand or marl belt of New Jersey was recognized early as being exceptionally fertile. Rogers was very interested in both the greensand and limestone (or limesand) as fertilizers. He included many details in both his "Preliminary Report" and "Final Report" on how best to use these materials. The marl deposits were mined extensively and the industry expanded rapidly, reaching its climax in the latter part of the nineteenth century. Most of these pits now are filled or so overgrown that many of the previous exposures no longer are available. Some of these greensands currently are used in the manufacture of water softener.

In 1854 Cook undertook a detailed study of the Cretaceous and Tertiary sediments of the state. He included these formations in three major divisions to which he applied the names: "Plastic Clay" (oldest), "Clay Marls" and "Marls" (youngest). Because of the large number of pits in the "Marl" series associated with the flourishing marl industry, Cook probably had an unexcelled opportunity to study these formations.¹ The resultant subdivision of this series was more detailed than that of the other divisions. His classification, based on the lithologic and economic characters of the strata, is shown in Table 1.

Cook's *Geology of New Jersey*, published in 1868, was a very comprehensive work and contained an excellent and generally accurate account of the Cretaceous and Tertiary formations of the state. This volume also contained a faunal list of the New Jersey invertebrates compiled by Conrad.

From the study of well-drilling records Cook (1883) concluded that the upper part of the Upper Marl was Eocene; however, he was uncertain as to the age of the lower and middle portions of the Upper Marl. He considered the Lower and Middle Marls to be Cretaceous. In the Annual Report for 1886 Cook included all except the upper part of the Upper Marl in the Upper Cretaceous.

Under Cook's direction a study of the fossils of the Cretaceous and Tertiary strata of the state was undertaken by Whitfield. The results of this study were published in two volumes, the first in 1885, and the

¹ Detailed records of the marl pits and chemical analyses of the various marls and of the limesand were included in the *Annual Reports of State Geologist* until 1897.

second in 1892. No new collections were made by Whitfield and he was dependent mainly upon the collections of the State Survey and those of "Rutgers College" and of the Academy of Natural Sciences of Philadelphia. Because no differentiation of the strata comprising the "Clay Marls" had been made in these early collections, the true stratigraphic position of many of the specimens was uncertain. The specimens with which Whitfield had to work often were poorly preserved and were generally few in number, the type specimen often being the only representative of a particular species.

Clark began his investigations of the New Jersey Coastal Plain in 1891. He used similar stratigraphic divisions as Cook, but he substituted geographic names derived from their type localities instead of the previously used lithologic equivalents. His classification (Clark, Bagg and Shattuck, 1897) of the Cretaceous, modified from earlier studies, is also given in Table 1.

Beginning in 1894 Knapp spent several years doing detailed mapping of the Cretaceous and Tertiary formations and in revising earlier maps and correlations. His work served as the basis of the present mapping of these formations as they appear on the present State Geological Map. Knapp first applied most of the currently used formational names of the Matawan group. In 1904 Kummel and Knapp presented a report on the New Jersey clays in which they interpreted the Cretaceous and Tertiary formations as shown in Table 1.

On the basis of floral evidence Clark (1904) considered the Raritan to be Albian in age and the Cliffwood (i.e., Magothy) to be Cenomanian.

Weller's extensive report on the Cretaceous paleontology of the state appeared in 1907. His stratigraphic interpretations, given in Tables 1 and 2 are held valid today except that a Tertiary age has been established for the Hornerstown, Vincentown and Manasquan formations. Weller noted that the Wenonah sand was readily distinguished lithologically from the overlying Mount Laurel in Monmouth County, but that further south the two formations were almost indistinguishable. He also thought it impossible to make a faunal distinction between the Mount Laurel and the overlying Navesink. These observations are considered valid today.

The report contained a detailed discussion of the New Jersey Cretaceous invertebrates. Weller was the first to critically analyze this fauna. This analysis led him to the conclusion that two major faunal divisions could be recognized; these were designated the "Ripleyian" (lower) and "Jerseyian" (upper) faunas. The latter now is considered to be of Tertiary age. Weller's studies indicated that the Ripleyian fauna in New Jersey was a

"complex assemblage of organisms with two or more distinct facies which were doubtless associated with different environmental conditions" (Weller, 1907, p. 180).

In considering the ages of the formations Weller suggested that the evidence supplied by the fauna of the Raritan was

“too meager to be of practical use in correlation, and the correlation of that formation must rest upon the evidence of the fossil plants” (Weller, 1907, pp. 183-184).

On the basis of the invertebrates he correlated the Magothy through the Tinton inclusive with the Senonian of Europe; the Hornerstown, Vincentown and Manasquan were correlated with the lower Danian (Maestrichtian).

“The Geology of New Jersey,” a general summary of the geology of the state, was written by Lewis and Kummel in 1915 mainly to explain the State Geological Map (1910-1912). This report as revised and rewritten by Kummel in 1940, contained a general description of the lithology, fauna and geologic history of the Coastal Plain sediments. Several editions of the map have been published with minor changes, the latest in 1950.

Mansfield's work on the New Jersey greensands was stimulated by the need for additional sources of potash during World War I. This study of the marl pits and well records was made by the United States Geological Survey in cooperation with the Geological Survey of New Jersey. The maps accompanying the report (Mansfield 1922) showed the areal distribution of the greensands superimposed on the topography. These maps were compiled by Knapp.

Until 1928 the Hornerstown, Vincentown and Manasquan generally had been considered as late Upper Cretaceous in age. In that year, however, Cooke and Stephenson on the basis of faunal and lithologic evidence, established the Eocene age of these formations. Although some writers assert a Paleocene age for the Hornerstown and Vincentown, most American workers agree at least with the Tertiary age.¹

After studying the bryozoans of the Vincentown, Canu and Bassler (1933) maintained an Upper Cretaceous age for the Hornerstown and Vincentown. Greacen (1941), concluded that the evidence for an early Eocene age of the Vincentown as indicated by most of its fauna, outweighed the evidence for a Cretaceous age as indicated by the bryozoans alone.

Stephenson *et al.* (1942) correlated the outcropping Cretaceous formations of the Atlantic and Gulf Coastal Plain and Trans-Pecos Texas. The Raritan was correlated with the Cenomanian of Europe; the Magothy with the lower Senonian (Coniacian); the Merchantville with the middle Senonian (Santonian); the Woodbury, Englishtown, Marshalltown and Wenonah with the upper Senonian (Campanian); and the Mount Laurel, Navesink and Red Bank (including the Tinton) with the lower Maestrichtian.

In discussing the aquifers of Middlesex County, Barksdale *et al.*

¹Several recent papers concerning the exact Tertiary age of these formations have been written. Since the present report is concerned with the Cretaceous, these articles are not discussed here.

(1943) first applied names to the sand members of the Raritan. In the same year Richards described several new species of invertebrates from the Raritan (Richards, 1943). He also discussed the subsurface geology of the Atlantic Coastal Plain and he first recorded the presence of Lower Cretaceous nonmarine sediments (Potomac group) in New Jersey in well samples from Salem, New Jersey.¹ Shell fragments and foraminifera from the Englishtown also were reported. This was the first record of fossils from this formation.

Spangler and Peterson (1950) discussed the geology of the Coastal Plain of New Jersey and adjacent states southward through Virginia. A large part of the article concerned New Jersey. These authors reached three main conclusions regarding the Cretaceous of New Jersey: (1) that the Matawan and Monmouth groups should be reduced to the rank of formations and the various formations within these groups should be reduced to members; (2) that the Mount Laurel should be included in the Matawan rather than in the Monmouth; and (3) that the Raritan is both upper Lower Cretaceous (Albian) and basal Upper Cretaceous (Cenomanian). (See Table 2.)

Johnson and Richards (1952) critically reviewed the New Jersey section of the above paper. These writers maintained the validity of the Matawan and Monmouth as groups and the Merchantville, Woodbury, etc. as formations; believed that the Mount Laurel is the basal portion of the Monmouth group; and reaffirmed the Late Cretaceous age of the entire Raritan. New information gained through the study of excavations and core borings connected with the New Jersey Turnpike also was included.

On the basis of a reexamination of the faunal and floral evidence, Dorf (1952) maintained that the Raritan is early Late Cretaceous in age. He also suggested that the Raritan may range from the Cenomanian into the early Turonian, and that the Magothy may extend from late Turonian into the Senonian.

Stephenson's recent paper (1954) is of particular interest because it contains descriptions of a large number of new Raritan fossils.

Groot, Organist and Richards have recently (1954) described the stratigraphy and paleontology of the Chesapeake and Delaware Canal. This article should be mentioned in the present summary because of the large number of geologic comparisons made between Delaware and New Jersey and because of references made to New Jersey geology.

¹Statement based upon unpublished work of Dr. Lincoln Dryden of Bryn Mawr College.

UPPER CRETACEOUS		COOK 1868	CLARK et al. 1897	KUMMEL and KNAPP 1904	WELLER 1907
Series	Upper Marl (part)	Ash Marl Green Marl	Manasquan	Upper Marl (part)	Manasquan
	Middle Marl	Yellow Sand	Vincentown Lsd.	Limesand	Vincentown
Red Sand		Yellow Ls & Lsd Shell Layers Green Marl Chocolate Marl	Sewell Marls	Middle Marl	Hornerstown
		Lower Marl	Indurated Green Earth Red Sand Dark Micaeous Clay Marl and Clay Blue Shell Marl Sand-Marl	Red Bank Sands Navesink Marls Mount Laurel Sands		Red Sand Lower Marl	Tinton Red Bank Navesink Mount Laurel
Clay Marl Ser.	Laminated Sands		Hazlet Sands	Wenonah	Wenonah
	Plastic Clay Ser.	Clayey Green Sand	Crosswicks Clays	Marshalltown Columbus Woodbury	Marshalltown Englishtown Woodbury
		Lignite		Merchantville Lignitic Sands and Clays Laminated Sands, No. 4	Merchantville
	Potters Clay Fire Clay	Raritan		Amboy Stoneware Clay Sand Bed No. 3 South Amboy Fire Clay "Feldspar", "Kaolin" Sand Bed Woodbridge Clay Fire Sand, No. 1 Raritan Fire and Terracotta (Potter's) Clay	Raritan

TABLE 1. Changes in nomenclature and interpretation of "Cretaceous" units in New Jersey from Cook (1868) to Weller (1907).
In part after Spangler and Peterson (1960)

PREVIOUS WORK ON CRETACEOUS INVERTEBRATE FOS-
SILS FROM THE ATLANTIC AND GULF COASTAL PLAIN
OTHER THAN NEW JERSEY

by Horace G. Richards

No attempt will be made to give a detailed review of the Cretaceous paleontology and stratigraphy of the Atlantic and Gulf Coastal Plain. This section will merely list a few references for the various areas between Georges Bank and Texas so that the interested reader can find further information on the presence and correlation of Cretaceous invertebrate fossils.

Georges Bank. Stephenson (1936) has discussed the mollusks from several dredgings on Georges Bank and the Banquereau (off Nova Scotia). Correlations are suggested with formations of New Jersey.

New England. Very few Cretaceous fossils have been found in New England. A few from Marthas Vineyard are listed by Stephenson (Woodworth and Wigglesworth, 1934) and are correlated with some part of the Matawan group of New Jersey.

Long Island. There are few Cretaceous outcrops on Long Island, although numerous occurrences have been reported from the subsurface. At present it is only possible to subdivide the Cretaceous into the Raritan and the post-Raritan. A few fossils—plant and mollusk—are listed by Fuller (1914, p. 78).

Delaware. Exposures of the Upper Cretaceous deposits of Delaware are largely limited to those along the Chesapeake and Delaware Canal; the Lower Cretaceous deposits contain only a few plant remains. Many of the invertebrates common in the Cretaceous of New Jersey also occur along the canal and not a few were originally described from Delaware. Gardner (1916) in her report on the Cretaceous mollusks of Maryland, discussed many records from the canal, while Stephenson *et al* (1932) in the Guidebook for the 16th International Geological Congress gave several geological sections and lists of fossils. Carter (1937) discussed the stratigraphy of the canal banks in some detail and listed many species. The marine Upper Cretaceous of Delaware was recently reviewed by Groot, Organist and Richards (1954) and an attempt was made to redefine the stratigraphy. A history of previous work in the state is included in the latter report.

Maryland. The most complete report on the Upper Cretaceous of Maryland is the well illustrated two-volume report issued by the Maryland Geological Survey (Clark *et al*, 1916). This volume includes a lengthy report on the Upper Cretaceous floras of the world by Berry as well as systematic sections on the different groups of animals and plants by various authors.

Lists and descriptions of the Cretaceous mollusks from wells near

Salisbury, Berlin and Ocean City, Maryland, were given by Stephenson and Vokes in a volume edited by Anderson (1948).

Virginia. No marine fossiliferous Cretaceous deposits are known to crop out in Virginia. However, the Raritan formation is known from the subsurface in the vicinity of Norfolk, from which the index fossil *Exogyra woolmani* was described (Richards, 1947).

North Carolina. Numerous Cretaceous localities as well as lists of species were given by Stephenson (1912) as part of a general survey of the Coastal Plain of North Carolina. The fossils were described and fully illustrated in a later volume (Stephenson, 1923), with a few additional species described still later (Stephenson, 1927). A brief summary of the Cretaceous of the state was included in a volume by Richards (1950).

South Carolina. Many species from the Cretaceous of South Carolina are included in the above mentioned North Carolina reports (Stephenson, 1923, 1927). A discussion of some localities with lists of fossils was given by Cooke (1936).

Georgia. Although many species were described by early workers from Pataula Creek and other localities in Georgia, no complete report on the Cretaceous fossils of that state has ever been published. Lists of localities and species have been given by Veatch and Stephenson (1911) and Cooke (1943). The fauna of the Eutaw formation of Georgia and Alabama has recently been described by Stephenson (1957).

Alabama. Although the locality at Eufaula, Alabama, on the Chattahoochee River has yielded many species described by Conrad and others, there has never been a complete report on the Cretaceous fauna of Alabama. The most complete summary is that of Stephenson (1926) which contains a few plates of typical fossils.

Mississippi. The most complete summary of the Cretaceous of Mississippi is the report of Stephenson and Monroe (1940). A few additional species from the vicinity of Dumas in Tippah County were described by Harbison (1945).

Tennessee. The fauna of the classic locality at Coon Creek, McNairy County, Tennessee, has been fully described and illustrated by Wade (1926).

Texas. Summaries of the Cretaceous of the state have been prepared by Adkins (1928, 1932), while detailed reports on the faunas of the Navarro and Woodbine formations have been published by Stephenson (1941, 1953).

General. For a general discussion of the Cretaceous of the Atlantic and Gulf Coasts, the reader is referred to the the writings of Stephenson (1939) and Richards (1953) as well as to the chart by Stephenson *et al* (1942) upon which Table 3—(page 13) is in part based. Works dealing with special groups of fossils found in the Cretaceous of the Coastal Plain include reports on the echinoids (Cooke, 1953), the *Exogyras* (Stephenson, 1914) and the corals (Wells, 1953).

	<i>Exogyra</i> zone	LONG ISLAND	NEW JERSEY	DELAWARE	MARYLAND	VIRGINIA	NORTH CAROLINA	SOUTH CAROLINA	GEORGIA	GULF COAST
UPPER	{ <i>E. costata</i> { <i>E. cancelata</i>	?	Tinton Red Bank Navesink Mount Laurel Monmouth Group	..... Red Bank? Navesink Mt. Laurel	Monmouth	....	Peedee	Peedee	Providence Ripley	Navarro
				Wenonah Marshalltown Englishtown Woodbury Merchantville Matawan Group	Wenonah *? Merchantville	Matawan	Black Creek	Black Creek	Cusseta Blufftown	Taylor
	<i>E. ponderosa</i>	Post Raritan								
	<i>E. upatoiensis</i>		Magothy	Magothy	Magothy	....	Black Creek (part)	*?	Eutaw	Eutaw Austin
	<i>E. woolmani</i>	Raritan	Raritan	Raritan	Raritan	*	Tuscaloosa	Tuscaloosa	Tuscaloosa	Tuscaloosa Woodbine
LOWER?			Potomac group*	Patapsco Arundel* Patuxent	Patapsco Arundel Patuxent	.... .... Patuxent	*	*?	*	Comanche

* Subsurface

NEW JERSEY GEOLOGICAL SURVEY
TABLE 3. Correlation of Cretaceous Formations of Atlantic Coastal Plain.

CRETACEOUS FORMATIONS OF NEW JERSEY¹

by Horace G. Richards

Lower Cretaceous. No deposits of Early Cretaceous age are known to crop out in New Jersey. The three formations of the Potomac group, the Patuxent (predominately a sand), the Arundel (clay) and the Patapsco (predominately a sand) are widely distributed in the area immediately to the south, but have not been reported from the surface in New Jersey. There is a difference of opinion regarding the age of the Potomac group. It has generally been placed in the Lower Cretaceous on the basis of fossil plants. More recently, Anderson (1948) and Spangler and Peterson (1950) placed the Patuxent in the Lower Cretaceous and the Arundel and Patapsco in the Upper Cretaceous. On a reexamination of the fossil plants, Dorf (1952) rejects the Upper Cretaceous dating and places the entire group in the Lower Cretaceous. Dryden, (quoted by Johnson and Richards, 1952 p. 2153) on the basis of heavy mineral studies, states that the lower section of the deep well at Salem, N. J. penetrated into the Lower Cretaceous. This is the only record of the Lower Cretaceous in New Jersey.

Raritan formation. The Raritan formation was first named by Conrad (1869, p. 360), but was redefined and restricted by Clark (1904) to exclude those beds now assigned to the Magothy. The Raritan formation consists chiefly of alternating layers of sand and clay. The clays are of various colors from nearly white to steel-blue, red and black; some beds are sandy and at times considerable quantities of pyrite and lignite are included. Some of the sands are nearly pure quartz, while others are micaceous, lignitic or arkosic.

In Middlesex County, the Raritan formation has been divided into seven beds but it is probable that they are rather local in distribution. The older and newer terminologies are given below:

Kummel and Knapp, 1904	Barksdale, <i>et al</i> , 1943
7. Amboy Stoneware Clay	Amboy stoneware clay (top)
6. Sand Bed No. 3	Old Bridge sand member
5. South Amboy Fire Clay	South Amboy fire clay
4. Feldspar-Kaolin Sand Bed	Sayreville sand member
3. Woodbridge clay	Woodbridge clay
2. Fire Sand No. 1	Farrington sand member
1. Raritan Fire and Terracotta (Potter's) Clay	Raritan fire clay (bottom)

In the vicinity of Raritan Bay, the Raritan formation can easily be distinguished from the overlying Magothy, but this separation is much more difficult farther to the southwest. Consequently many geological maps combine the two formations.

¹ This chapter is partly adapted from Weller (1907), Lewis and Kummel (1940), Spangler and Peterson (1950) and Johnson and Richards (1952).

Fossil plants are known from most members (Berry, 1911), while brackish and marine invertebrates are known only from the Woodbridge member where they occur in an impure siderite. It is probable that the Raritan formation is predominantly non-marine in origin with only a few thin lenses indicating marine conditions, as exemplified by the fossils in the Woodbridge member at Sayreville and a few shell fragments in wells at Fort Dix and Clementon.

Both the plants and animals suggest a basal Upper Cretaceous age correlated with the Tuscaloosa and Woodbine of the southern coastal plain and the Cenomanian of Europe.

Spangler and Peterson suggested that the Raritan of New Jersey was equivalent to the basal Upper Cretaceous (Cenomanian) plus the upper Lower Cretaceous (*Albion*), but this argument was refuted by Johnson and Richards (1952) and Dorf (1952).

Magothy formation. In early reports the Magothy of New Jersey was included with the Raritan. The name was first used by Darton (1893) for exposures along the Magothy River in Maryland. It supplanted the local name "Cliffwood clays" used for the fossiliferous material exposed along Raritan Bay at Cliffwood, New Jersey. The Magothy formation extends across New Jersey from Raritan Bay to the Delaware River below Camden; it is, however, difficult to distinguish it from the Raritan south of Trenton.

The Magothy consists of beds of sand and clay, many of them highly lignitic, with some glauconitic beds near the top. An extensive marine fauna has been described near Cliffwood, N. J., but elsewhere the formation is largely non-marine and frequently carries plant fossils. The fauna suggests a correlation with the Eutah beds of the Gulf Coast.

MATAWAN GROUP. The term Matawan was first suggested as a name for the glauconitic sands and clays exposed along Matawan Creek, New Jersey by Clark (1894). This unit had previously been known as the "clay marl series." At first it was regarded as a formation, but it was later raised to the rank of a group with the individual members being called formations. In Maryland, where the individual units are not readily recognizable, the Matawan is regarded as a formation.

Spangler and Peterson (1950) prefer the formational rank of the Matawan, but Johnson and Richards (1952) argue that since the various units are mappable for reasonably long distances, these units are truly formations. This would make the Matawan a group.

The Matawan group is roughly equivalent to the Black Creek formation of the Carolinas, the Taylor group of the Gulf region and the Campanian of Europe. For other correlations see table on page 13.

Merchantville formation. The clays overlying the Magothy were defined as the Crosswicks formation by Conrad (1869). Although this term is still sometimes used in Delaware and Maryland, in New Jersey it has been broken down into two distinct units. The lower unit, the Merchantville, was named by Knapp (Salisbury, 1899) and consists of black, glauconitic, micaceous, and occasionally sandy clay. It is gen-

erally greasy in appearance, massive in structure, and weathers to a brown earth. Its maximum thickness in outcrop is 60 feet, but it probably thickens down dip. The Merchantville contains an extensive fauna, especially from Maple Shade (Lenola).

Woodbury formation. The upper part of the Crosswicks formation was described as a separate formation, the Woodbury, by Knapp (Salisbury, 1899, p. 35). It is a black, non-glaucconitic, jointed clay which weathers to a light chocolate color and when dry breaks into innumerable blocks. It is conformable with the underlying Merchantville and the overlying Englishtown sand. It can be distinguished from the Merchantville by its color difference, the absence of glauconite, and by differences in faunal content.

Englishtown formation. The Englishtown is a white or yellow quartz sand, slightly micaceous and sparingly glauconitic. Locally parts of the formation have been cemented into rather massive beds of sandstone. The sand is frequently cross-bedded and occasionally there are beds of clay. It represents the lower part of the "Hazlet sand" of Clark and part of Cook's "clay marl series." It was formerly called the "Columbus sand." The term Englishtown was first used by Kummel (in Weller, 1907, p. 17).

The Englishtown sand is best exposed in the northeastern part of its distribution, near Englishtown, Browntown and Atlantic Highlands. It can be traced southwest across the state through Moorestown and Swedesboro to, or almost to, the Delaware River. It is not recognized in Delaware (Groot, Organist and Richards, 1954).

The Englishtown sand is probably largely non-marine or estuarine although a few marine fossils have been found in wells and bore holes (see page 23).

Marshalltown formation. This unit was named by Knapp (in Salisbury, 1899, pp. 35-6) and consists of material ranging from a black sandy clay to an argillaceous glauconitic marl. It extends in a narrow belt from Monmouth to Salem Counties but is known in relatively few outcrops. Credner (1870) reported abundant fossils from a railroad cut near Woodbury and Weller obtained excellent material near Swedesboro, but neither of these localities is accessible today.

Wenonah sand. Above the Marshalltown formation there is a considerable thickness of sand. This has been separated into two formations largely on the basis of the fossils, although the lower part (Wenonah) is generally a fine micaceous sand and the upper part (Mount Laurel) is coarser and contains considerable glauconite. Because of the differences in faunas, it is now believed that the Wenonah-Mount Laurel boundary is also the boundary between the Matawan group and the overlying Monmouth group. Spangler and Paterson raised an objection to this correlation and would prefer to move the Matawan-Monmouth boundary to the shell bed in the Navesink formation. The geological map of New Jersey combines these sands as the Mount Laurel-Wenonah, but in Delaware the boundary is very distinct.

The Wenonah fauna is largely recurrent from the Woodbury and contains few species in common with the Marshalltown or the overlying Mount Laurel. The problematical fossil tube (?) *Halyminites major* is characteristic of the Wenonah formation at a number of localities in New Jersey and Delaware. A thin deposit of bentonite is known in the Wenonah near Runnemede, N. J. The term Wenonah was first used by Knapp (Salisbury, 1899, p. 35).

MONMOUTH GROUP. The Monmouth formation was named by Clark (1897) from Monmouth County, New Jersey, but later the members were raised to the rank of formations. In Maryland, the Monmouth was originally divided into the Navesink and the Redbank, but at present it is regarded as a single formation. As in the case of the Matawan, Spangler and Peterson (1950) suggested reducing the Monmouth to the rank of a formation with the subdivisions being classed as members, but again Johnson and Richards point out the desirability of retaining the formational rank of the different units.

The Monmouth group is roughly equivalent to the Peedee formation of the Carolinas, the Navarro of Texas and part of the Maestrichtian of Europe (see page 13).

Mount Laurel sand. The Mount Laurel sand, named by Clark (1897), is generally slightly coarser and more glauconitic than the Wenonah, although they frequently cannot be separated. Faunally, however, the Mount Laurel is very distinct and is characterized by *Belemnitella americana*, *Choristothyris plicata*, *Exogyra costata* and *E. cancellata*. Faunally the Mount Laurel is almost identical with the overlying Navesink. In New Jersey the Mount Laurel and Navesink are very different lithologically, although in Delaware they are combined into a single unit (Groot, Organist and Richards, 1954).

Navesink marl. The Navesink formation (Clark, 1894, p. 336) consists of glauconitic marl mixed with varying amounts of quartz sand. The upper part of the formation is less glauconitic and more clayey. The glauconite is used in water-softening equipment and is dug at Sewell where it underlies a somewhat similar glauconitic marl of the Hornerstown formation. The Navesink corresponds in general with Cook's "Lower Marl." It is highly fossiliferous in places and contains such species as *B. americana*, *E. costata*, *Gryphea convexa* and *Choristothyris plicata*.

Red Bank sand. This formation, named by Clark (1893, p. 337) from Red Bank, N. J., is for the most part a fairly coarse yellow and reddish brown quartz sand, locally indurated to limonitic sandstone. The lower beds, which contain the better fossils, are somewhat clayey. It is best developed in northern Monmouth County where it attains a thickness of 140 feet, but it thins out toward the southwest and pinches out completely near Sykesville, Burlington County. It is not known from there to the Delaware River. A sand closely resembling the Red Bank sand of New Jersey occurs along the Chesapeake and Delaware Canal but because it contains certain elements of the Navesink fauna

it is possible that it is slightly older than the typical Red Bank (Groot, Organist and Richards, 1954 p. 29). The Red Bank formation is, in part, the "red sand" of earlier writers.

Tinton bed. Beds of green clayey and sandy glauconitic marl from 10 to 20 feet in total thickness overlie the Red Bank in Monmouth County. These beds are frequently well indurated. They were named by Weller (1904, p. 159) from Tinton Falls, N. J. The United States Geological Survey regards the Tinton as a member of the Red Bank, but in view of faunal and lithological differences, the State Survey gives the Tinton formational rank.

EOCENE. At the time that Weller prepared his report on the Cretaceous fossils of New Jersey the three next youngest formations—the Hornerstown, Vincentown and Manasquan—were regarded as of Cretaceous age and their faunas were discussed and illustrated in the 1907 volume. Later, however, Cooke and Stephenson (1928) pointed out that the faunas of these three formations suggested an Eocene age. While there has been some difference of opinion regarding the exact correlation, most American writers have followed Cooke and Stephenson in placing the Hornerstown, Vincentown and Manasquan formations in the Tertiary.

The Hornerstown, and to a lesser extent the Vincentown, contain species related to those of the Danian of Europe. Since the Danian is regarded by some as basal Paleocene and by others as uppermost Cretaceous, no convincing evidence for the age of these three formations can be reached by correlation with Europe.

McLean (1952, 1953) believes that the foraminifera from the Vincentown formation suggest a Paleocene age, but other workers have favored a Wilcox age. The problem of the age of these three New Jersey formations is being studied by various workers and it is hoped that a more positive correlation can be worked out soon. Table 4 gives the correlation favored by the author.

TABLE 4. Correlation of Eocene formations of New Jersey with those of the Gulf Coast.

NEW JERSEY	GULF COAST
Shark River	Claiborne
Manasquan	Wilcox (?)
Vincentown	} Midway (Paleocene)
Hornerstown	

Whatever be the age of the Hornerstown, it is apparent that it rests unconformably on the Tinton, Red Bank and Navesink formations progressively from northeast to southwest.

Alternation of faunas. "The strata from the Magothy to the Tinton, inclusive, contain a complex assemblage of organisms with two distinct facies. One of these, a *Cucullaea fauna*, characterizes the more glauconitic formations—the Merchantville, the Marshalltown, the Navesink, and the

Tinton—and may be regarded as a deeper-water fauna. The second faunal facies, characterized by *Lucina cretacea* [*Lucina glebula*] or its associates, occurs in the clay and clayey sand of the Magothy, the Woodbury, the Wenonah and the Red Bank formations and was a shallower water fauna.

“Both of these facies probably lived side by side in their respective zones off the shore and migrated back and forth across the Coastal Plain region with the gradual advance and retreat of the sea. During the periods of depression the deeper water with the accompanying glauconitic sediments and the *Cucullaea* fauna gradually entered this region from the southeast and occupied a belt that had formerly been occupied by the shallower water fauna and in which chiefly land-derived sediments had been deposited. With a later period of emergence both faunas shifted to the southeast and the shallower water facies again occupied the region.” (Lewis and Kummel, 1940 pp. 121-22)

It need not be assumed that the difference between the shallow water and the deeper water was very great. It was formerly believed that glauconite formed only under conditions of moderately deep water (at least 600 feet), but this has now been shown to be erroneous and that it can form even in very shallow water. This fact plus the fact that fossil wood has been found in most of the Cretaceous formations in New Jersey suggests that the water was never very deep and that the shoreline was never very far west of the Delaware River.

Exogyra zones. Paleontologists have found it convenient to recognize certain zones within the Upper Cretaceous which are characterized by certain assemblages of fossils. Among the fossils most useful for this zoning are certain species of the palecy pod *Exogyra*. These species with their associated fossils are very useful in long range correlation of the Cretaceous deposits of the Atlantic and Gulf Coastal Plain. The following zones have been recognized.

Exogyra woolmani zone. This species has been found in the Raritan and Tuscaloosa formations from New Jersey to South Carolina. It is closely related to *E. columbella* from the Eagle Ford formation of Texas which is approximately the same age as the Raritan and Tuscaloosa.

Exogyra upatoiensis zone. This zone was first recognized by Stephenson from a well at Charleston, South Carolina. It is probably equivalent to the older, continental phase of the Black Creek formation of the Carolinas, the Eutaw of Georgia and the Magothy of New Jersey, although the species has not actually been found in the latter state.

Exogyra ponderosa zone. This zone comprises the Marshalltown formation of New Jersey, part of the Matawan of Maryland, the Black Creek of the Carolinas, and the Taylor of Texas.

Exogyra costata zone. This group comprises the formations of the Monmouth group of New Jersey, the Peedee of the Carolinas, and part of the Navarro of Texas.¹

¹ *Exogyra costata* has recently been found in the Woodbury formation. See page 118.

Exogyra cancellata zone. This is a more restricted zone forming the base of the *Exogyra costata* zone. It has been traced a distance of 2500 miles from Atlantic Highlands, N. J. to Cardenas in the State of San Luis Potosi in Mexico. (Stephenson, 1933.) In New Jersey the zone is almost identical with the Mount Laurel formation although a few specimens of *E. cancellata* have recently been reported from the Navesink. In Delaware, where the Mount Laurel and Navesink formations are combined, *E. cancellata* is found throughout the combined formation (Groot, Organist and Richards, 1954). Some of the other species generally associated with the *Exogyra cancellata* zone are: *Ostrea falcata*, *O. panda*, *O. plumosa*, *O. tecticostata*, *Gryphaea convexa*, *E. costata*, *Pecten simplicius*, *Anomia argentaria*, *A. tellinoides*, *Paranomia scabra*, and *Belemnitella americana*. The only one of the above mentioned species limited to the Mount Laurel sand is *Anomia tellinoides*.

TABLE 5. Average thickness (at outcrop) and dip of Cretaceous formations of New Jersey

	Average thickness at outcrop in feet	Average southeastward dip in feet per mile
TINTON	10-20 in Monmouth Co. only	30
RED BANK	140 in Monmouth Co. Not present south of Sykesville.	30-33
NAVESINK	3-40	33
MOUNT LAUREL	5-60	35
WENONAH	20-35	36
MARSHALLTOWN	40-50	37
ENGLISHTOWN	140 in Monmouth Co. to about 35 feet in Salem Co.	39
WOODBURY	50	41
MERCHANTVILLE	45-60	42
MAGOTHY	175 on Raritan Bay and diminishing to less than 20 feet along Delaware River.	40-45
RARITAN	150-300	top about 45; base 65-100.

LIST OF CRETACEOUS FOSSIL LOCALITIES IN NEW JERSEY

by Horace G. Richards

No attempt is made to record all localities within the state from which fossils have been collected. The following list covers most of the important localities of early collectors as well as those available today. The list is partly adapted from Weller (1907) but has been brought up to date by the inclusion of numerous localities discovered during recent years. The information is not as detailed as given in Weller's original volume, but it is believed to be sufficient. In many cases, labels or published records of collected fossils merely list the nearest town such as Haddonfield or Cliffwood. In this case, the general region is given a number while the exact locality, when known, is given a subheading such as 1a, 1b, etc. Thus a specimen recorded from locality 5 came from Cliffwood, exact spot not known, while specimens recorded from 5d came from Oschwald's pits at Cliffwood.

Those localities from which fossils have been collected within the last five years and which presumably are still accessible to the fossil hunter are designated by the symbol *.

For more detailed information on some of the localities mentioned, the reader is referred to Weller (1907), Spangler and Peterson (1950), and Johnson and Richards (1952).

RARITAN FORMATION

1. Sayreville, Middlesex County, N. J.
 - *1a. Sayre and Fisher pit (Woodbridge member)
 - *1b. New Jersey Clay Products Company pit (Woodbridge member)
 - 1c. Furman's pits (Weller)
2. Woodbridge, Middlesex County, N. J. Valentine pits (Whitfield)
3. East Brunswick Township, Middlesex County, N. J. (Whitfield)
4. South River, Middlesex County, N. J. "Washington" of old labels of Conrad.

In addition, unidentifiable Raritan fossils have been found in wells at Fort Dix and Clementon, N. J.

MAGOTHY FORMATION

5. Cliffwood, Monmouth County, N. J.
 - *5a. Bluff along Raritan Bay
 - *5b. Material loose on beach near bluff
 - 5c. Old pits near Cliffwood (Weller)
 - *5d. Oschwald's pits (near Whale Creek)
6. Matawan, Monmouth County, N. J.

MERCHANTVILLE FORMATION

- *7. Cliffwood, Monmouth County, N. J. (Oschwald's pits. Overlies the Magothy formation).

8. Matawan, Monmouth County, N. J.
 - 8a. Along west bank of Matawan Creek, north of town of Matawan (Weller)
 - 8b. Small ravine tributary to Cheesequake Creek, two miles northwest of Matawan (Weller).
9. Lorillard, pits east of Keyport, Monmouth County, N. J. Lower part of pit (Weller).
10. Jamesburg, Middlesex County, N. J.
 - 10a. 3.5 miles a little north of east of Jamesburg on Matchaponix Brook (Weller)
 - 10b. 3 miles east of Jamesburg on side of road (Weller)
 - 10c. First railroad cut 1 mile south of Lower Jamesburg station (Weller)
11. Yardville, Mercer County, N.J. Exposures in bed of small tributary of Doctors Creek.
12. Bordentown, Burlington County, N. J. (Exact locality not recorded).
 - 12a. Church pit, two miles southwest of town. This pit is now abandoned.
13. Burlington, Burlington County, N. J. (Exact locality not given).
14. "Burlington County"
15. Lenola, Burlington County, N. J. Reeves clay pit on north bank of Pensauken Creek. Weller reported a very extensive fauna from this locality. It is very close to the present Graham brickyard at Maple Shade (locality 16).
- *16. Maple Shade, Burlington County, N. J. Graham brickyard, near junction of Main Street and Route 73. During recent years an excellent Merchantville fauna has been obtained from this pit.
17. Merchantville, Camden County, N. J. Railroad cut just east of Merchantville (Weller).

WOODBURY FORMATION

- *18. Lorillard, east of Keyport, Monmouth County, N. J. Many fossils were obtained here by Weller and other early collectors. At the present time only poorly preserved impressions can be found near the south end of the pit.
19. Matawan, Monmouth County, N. J. Farry brickyard, east of Matawan (Weller).
20. Crosswicks, Burlington County, N. J.
 - *20a. J. Braislin and Son's clay pits on Crosswicks Creek half a mile west of Crosswicks (Weller). Later operated by Franklin Brick Company. (A few fossils found during recent years).
- *21. Bordentown, Burlington County, N. J. Church Brick Company pits, one mile south of town.
22. Mount Laurel, Burlington County. A fauna of well preserved

unaltered shells was obtained between the depths of 150' and 160' in an artesian well near the town of Mount Laurel (Johnson, 1899).

23. Fellowship, Burlington County, N. J. Unaltered fossils, somewhat similar to those from the Mount Laurel well, were obtained from a well on the Rhule property at the corner of Church Road and the New Jersey Turnpike between the depths of 130' and 175' (Richards, 1954).

24. Haddonfield, Camden County, N. J.

*24a. Small stream tributary to Cooper Creek (near the corner of Maple Avenue and Grove Street). It was near this locality that the duck bill dinosaur *Hadrosaurus foulkii* was found in 1858. Many invertebrate fossils were reported from this locality by Weller, and it is still possible to obtain material from the clay in the stream bed.

24b. Dobbs clay pits, 1.5 miles northwest of Haddonfield and about 1 mile southeast of Collingswood station. (Weller).

24c. At crossroads $\frac{1}{4}$ mile southwest of Dobbs clay pits (Weller).

25. Collingswood, Camden County, N. J. Sewer excavations at Cooper Creek and Harvard Avenue. (Several specimens of *Placentiaceras placenta* found in 1937).

ENGLISHTOWN FORMATION

The only recognizable macrofossils from the Englishtown formation are some specimens of *Turritella* sp., *Cardium tenuistriata* and *Lunatia halli* from a well at Lavalette. Unidentifiable fragments from wells at Fort Dix, Holmdel and Mantoloking and from test borings for the New Jersey Turnpike between Runnemedede and Woodbury Heights have been recorded. (Johnson and Richards, 1952, pp. 2155-6).

26. Lavalette, borough well No. 2.

MARSHALLTOWN FORMATION

27. Marshalltown Salem County, N. J. Marl pits (Weller).

28. Swedesboro, Gloucester County, N. J.

*28a. One mile a little south of west from Swedesboro. According to Weller (p. 82) the clay is well exposed in the banks of the brook in the woods at this locality and he reported an extensive fauna of well preserved mollusks from it. However, careful investigation during recent years has failed to rediscover it and the only fossils found in that locality were a few specimens of *Exogyra ponderosa* and *Gryphaea*.

28b. 2.5 miles southwest of Swedesboro and 2.5 miles northwest from Harrisonville. (Weller).

29. Harrisonville, Gloucester County, N. J. Old mill pond 1.5 miles northwest of Harrisonville station. (Weller).

30. Woodbury, Gloucester County, N. J. (Exact locality not given).

*31. Penns Grove, Gloucester County, N. J. Abandoned marl pits along Route U.S. 40 between Penns Grove and Woodstown.

*32. Fellowship, Burlington County, N. J. Excavations for the New Jersey Turnpike at crossing of Pennsauken Creek.

WENONAH FORMATION

33. Matawan, Monmouth County, N. J.

*33a. Road cut 1.5 miles south of Matawan on east side of Route

34. Numerous tubes of *Halyminites major* and a few obscure mollusks.

*33b. Same locality, but new exposure in borrow pit 200 yards east of highway.

34. Crawfords Corner, Monmouth County, N. J. Longstreet's marl pit, a little less than a mile southeast of Crawfords Corner. (Weller, p. 91).

35. Marlboro, Monmouth County, N. J. A little over a mile east of Marlboro, in the south bank of Hop Brook. Many fossils reported by Weller. Not observed during recent field work.

*36. Runnemede, Camden County, N. J. Numerous tubes of *Halyminites major* can be seen along the New Jersey Turnpike north of Interchange 3 and along the Kings Highway south of the Turnpike.

MOUNT LAUREL AND NAVESINK FORMATIONS

Weller (1907 p. 103) stated "the faunas of the Mount Laurel and the Navesink marl constitute a single unit, and in any discussion of them they must be considered together." The accompanying list of localities, since it is partly based upon Weller's text, will also group the two formations, although when possible the different units will be indicated.

*37. Atlantic Highlands, Monmouth County, N. J. Bluff along Raritan Bay east of the railroad station. (Mount Laurel and Navesink).

38. Red Bank, Monmouth County, N. J. Ravine on east side of railroad, 1¼ miles northwest of Red Bank station. (Navesink) (Weller).

39. Middletown, Monmouth County, N. J.

*39a. Along Poricy Brook on both sides of bridge 2.5 miles south of Middletown on road to Lincroft. (Navesink).

39b. Marl pit about ½ mile west of railroad station. (Mount Laurel and Navesink) (Weller).

40. Crawfords Corner, Monmouth County, N. J. The Navesink was formerly exposed in the Longstreet marl pit. (Weller).

41. Holmdel, Monmouth County, N. J.

41a. Holmes' marl pit, 1 mile northwest of Holmdel. (Weller).

41b. Edgar Schenck's marl pit, 1.5 miles northwest Holmdel. (Weller).

41c. Henry Conover's marl pit over 1.5 miles a little west of north from Holmdel. (Weller).

41d. 0.5 mile east of Holmdel in creek bank. (Navesink)

41e. 1.5 miles east of Holmdel in ditch south of highway. (Navesink).

42. Marlboro, Monmouth County, N. J. Obadiah Herbert's marl pit just east of Marlboro (Weller) and along Hop Brook. (Navesink and Mt. Laurel).

43. Freehold, Monmouth County, N. J. Old marl pit three miles west of Freehold and one mile a little east of south from Tennents Station at headwaters of small tributary of Wemrock Brook. (Navesink) (Weller).

44. Upper Freehold, Monmouth County, N. J. From old labels.

*45. Cream Ridge, Monmouth County, N. J. Marl pits on "Schank farm" and along small tributary on east side of Crosswicks Creek, about $\frac{1}{2}$ mile southwest of Cream Ridge. (Navesink).

*46. Near Walnford, Monmouth County, N. J. Various tributaries on the west side of Crosswicks Creek. These tributaries are on the east side of the road leading south from Walnford and occur from Walnford to a point about three miles south of that town. *Belemnitella americana*, *Exogyra costata* and *Gryphaea* are abundant in some of these tributaries. (Navesink).

*47. Crosswicks Creek, Ocean County, N. J. Various exposures along west bank of Creek, especially on the Nutt Farm two miles south of Walnford. (Mount Laurel and Navesink).

48. Near New Egypt, Ocean County, N. J. The Navesink formation extends south along Crosswicks Creek to a point $2\frac{1}{2}$ miles north of New Egypt. Whitfield obtained some of his Navesink fossils from Bruere's marl pit, northwest of New Egypt.

49. Near Jacobstown, Burlington County, N. J. $1\frac{1}{2}$ miles northwest of Jacobstown and about $1\frac{1}{2}$ miles southwest of Arneytown. (Navesink) (Weller).

50. Mount Laurel, Burlington County, N. J. Roadside exposure 1 mile southwest of Mount Laurel. (Mount Laurel) (Weller).

51. Birmingham, Burlington County, N. J. Some Cretaceous reptiles have been reported from the vicinity of Birmingham. While the present excavations of the Permutit Company extend only into the Hornerstown formation, it is possible that earlier excavations penetrated into the underlying Navesink.

*52. Runnemede, Camden County, N. J. A number of Navesink fossils were obtained from excavations for the New Jersey Turnpike about $\frac{1}{2}$ mile north of Interchange 3.

*53. Mullica Hill, Gloucester County, N. J. This is the classic locality where so many Cretaceous fossils have been found ever since the days of Gabb and Whitfield. It is located on the south side of Route 322 at its junction with State Route 45. The locality is immediately south of Raccoon Creek. Although many species have been obtained in the past, collecting today is not likely to be very profitable.

*54. Hurffville, Gloucester County, N. J.

55. Barnsboro, Gloucester County, N. J.

*55a. Chestnut Branch Creek and roadcut 0.8 miles southeast of Five Corners in Barnsboro. (Navesink).

*55b. Ravine of Edwards Run 1.7 miles west of Five Corners. (Mount Laurel and Navesink).

56. Sewell, Gloucester County, N. J. The lower part of the pits of the Inversand Company, $\frac{1}{2}$ mile southeast of Sewell, have yielded Navesink fossils including the dinosaur *Hadrosaurus minor*. (Colbert, 1948).

57. "Burlington County."

58. "Monmouth County."

RED BANK FORMATION

59. Red Bank, Monmouth County, N. J. On both shores of Shrewsbury River in the vicinity of Red Bank. (Weller) Poorly preserved fossils were also found on the south side of Tower Hill in the eastern part of Red Bank. (Weller).

*60. Near Middletown, Monmouth County, N. J. The Red Bank formation overlies the Navesink along Poricy Brook, 2.5 miles south of Middletown. (See locality 39a).

*61. Beers Hill, Monmouth County, N. J. Road cut on road between Hazlet and Holmdel just south of Garden State Parkway and $\frac{3}{4}$ mile north of Crawfords Corner. Here the Red Bank underlies the Tinton.

TINTON FORMATION

*62. Beers Hill, Monmouth County, N. J. (See locality 61).

*63. Tinton Falls, Monmouth County, N. J. "Just below the mill."

64. Colts Neck, Monmouth County, N. J. In bank of small run 1.5 miles southwest of Colts Neck and 4.5 miles east of Freehold. (Weller).

65. Red Valley, Monmouth County, N. J. In bank of Ivanhoe Brook, about 1 mile east of Red Valley. Also, along road just east of Red Valley. (Weller).

INTRODUCTION TO SYSTEMATIC SECTIONS

By Horace G. Richards

In general, the present work has attempted to follow the outline and style of Weller's 1907 volume. However, with contributions from eleven authors, some variation has been necessary. In the case of chapters which have been largely rewritten, new descriptions have generally been prepared. In other chapters, many of Weller's original descriptions have been copied intact. In cases where the original text is quoted directly (or with very minor changes) the name of the author is given in parenthesis.

In all cases, attempts have been made to bring the nomenclature up to date. In some chapters fairly extensive revisions have been made, while in others little or no attempt has been made to discuss groups higher than those of generic rank.

The Gastropods and Pelecypods comprise the great bulk of the fauna, about 400 out of a total of 475 species. Many of these species are based upon very poorly preserved material making it extremely difficult to determine the correct generic or family relationship. Many of the species discussed by Whitfield and Weller were compared to species originally described from localities in the Cretaceous of the Southern Atlantic or Gulf Coastal Plain. Frequently, a cast or mold from New Jersey was compared with a perfect shell from North Carolina or Alabama. Stephenson has pointed out that many of these identifications are incorrect. There is need for a more detailed comparison of the New Jersey fauna with material from other localities, but this is not the purpose of the present volume. Generic and family classification in general follows Stephenson and Wenz.

In most cases abbreviated synonymies only are given. It has been thought sufficient to include references to the original description of species and synonyms as well as all important post-1907 references. In the case of those references most frequently cited, such as Whitfield, Weller, Stephenson, Gardner, Wade, etc., merely the year, page and plate numbers are given, the full reference being found in the bibliography at the end of Part II. Students wishing more complete bibliographies should consult Weller's original edition or the various works of Stephenson cited in the bibliography. (In a few chapters, the authors have preferred a more complete synonymy.)

For purposes of economy in most of the chapters all localities have been numbered according to the list given on pages 21-26. Because of the similarity of the fauna of the Chesapeake and Delaware Canal with that of New Jersey, many species from the canal banks are included in this report.

Two of the chapters—those on the nautiloids and belemnites—differ from the rest of the book in being much more detailed. Since both of these groups were in need of revision, it seemed appropriate that Dr.

Miller and Dr. Jeletzky expand their contributions into a more monographic treatment.

The following abbreviations indicate where the type (or other specimens) may be found:

AMNH American Museum of Natural History, New York, N.Y.

ANSP Academy of Natural Sciences, Philadelphia, Pa.

NJSM New Jersey State Museum, Trenton, N.J.

PU Princeton University, Princeton, N.J.

USNM United States National Museum, Washington, D.C.

WFIS Wagner Free Institute of Science, Philadelphia, Pa.

YPM Peabody Museum, Yale University, New Haven, Conn.

CRETACEOUS PORIFERA OF NEW JERSEY

by B. F. Howell

Family Clionidae

Cliona cretacea Fenton & Fenton 1932

Plate 1, Figures 1-5.

Cliona cretacea, Fenton & Fenton, 1932, Amer. Midl. Natur., vol. 13, p. 55, pl. 7, figs. 8, 9.

Description.—Boring sponges, represented in fossil form by their branching tubular excavations in shells (usually shells of pelecypods of the genera *Gryphaea* and *Exogyra*). These tubular excavations open on the outer and inner surfaces of the shells and extend more or less parallel to these surfaces inside the shells, so that the shells are often riddled with them and have their surfaces pitted by dozens of the open ends of the tubules. Usually the tubules are largely filled with a dark material which often weathers away less rapidly than the calcareous material of the shells, themselves, so that shells that are partly weathered away show the fillings of the tubules as ridges on the remaining portion of the shell. Rarely a shell is completely removed by solution, while the fillings of the tubules by which it was originally riddled remain as a network of imbricating, fused cylindrical rods.

Range in New Jersey—

MERCHANTVILLE: 16

MOUNT LAUREL—NAVESINK: 53

Range outside New Jersey—

Delaware

Type.—Mullica Hill, N. J. NJSM 8184 (lost) ; paratype NJSM 8185 (figured)

Cliona microtuberum Stephenson 1941

Plate 2, Figure 6.

Cliona microtuberum, Stephenson, 1941, p. 54, pl. 3, figs. 1-5 ; pl. 5, figs. 1, 2.

Description.—Boring sponges, represented as fossils by branching excavations in the shells of such mollusks as *Gryphaea*. These excavations are irregular in form, they being wider in some of their parts than in others. Some parts of them are tubular, but others are irregularly ovate or subspherical, these parts being connected with each other by the tubular excavations. Like the excavations of *Cliona cretacea*, those of *C. microtuberum* are filled with a dark material (often mixed with grains of sand) that is probably phosphatic in composition. The surfaces of these fillings are covered with tiny tubercles. The record of the occurrence of this species, which was originally described from Texas, is based on a single specimen in the New Jersey State Museum, which

differs from *C. cretacea*, the common species in New Jersey, in having the tubercles on the surface of the fillings of the excavations. These do not occur on the surfaces of the fillings of *C. cretacea*.

Range in New Jersey—

NAVESINK: 53

Type.—Navarro formation, Texas; USNM 76266

Cliona retiformis Stephenson 1953

Plate 45, Figure 1.

Cliona retiformis, Stephenson, 1953, U. S. Geol. Surv. Prof. Paper 242, p. 50, pl. 8, figs. 1-3.

Cliona retiformis, Stephenson, 1954, U. S. Geol. Surv. Prof. Paper 264-B, p. 27, pl. 6, fig. 1.

Ferruginous internal molds of the burrows of a sponge that is probably referable to this species, which was originally described from the Woodbine formation of Texas, have been found on the internal mold of a shell of *Ostrea soleniscus* Meek, and on the imprint of a fragment of a thick unidentified shell, from the Raritan Formation.

Young individuals of this burrowing sponge entered the shells of mollusks through circular openings of their own making that ranged in diameter from 0.1 mm. or less to about 0.5 mm. Once inside the shell, the sponge bored laterally, often meeting and joining its borrows with those of other sponges of the same species to form a network of borrows. These burrows are extremely irregular in form and directions, ranging from small to relatively large in size, and being expanded at intervals into irregular ovate or jug-shaped cavities. This network of burrows may form an open lacework of labyrinthine passages or a dense mesh of burrows and turnip-shaped intercommunicating cavities. The fossils of this species are usually composed of the fillings of the burrows, the outer surfaces of the fillings being molds of the walls of the burrows. The outer surfaces of these molds are finely stippled.

Range in New Jersey—

RARITAN: (Woodbridge member): 1

Range outside New Jersey—

Texas (Woodbine formation)

Type.—Near Eules, Tarrant County, Texas. USNM. 105068;

Plesiotype—Sayreville, N. J.; USNM 108611, 108612.

Family Coeloptychiidae

Coeloptychium ? jerseyensis Shimer & Powers 1914

Plate 2, Figures 4, 5.

Coeloptychium ? jerseyensis, Shimer & Powers, 1914, Proc. U. S. Nat. Museum, vol. 46, p. 155-156, pl. 7.

Description.—Mushroomlike, contracting from a broad and depressed upper surface into a short stalk. Edge of disk rounded. Entire

surface covered with low radiating folds, which increase in number toward the margin of the disk, where about 35 are present. Disk sub-circular, about 33 mm. in diameter. Entire height of sponge 20 mm. No ostia can be seen on the single specimen of the species that has been found.

Range in New Jersey—

MOUNT LAUREL: 37

Type.—Atlantic Highlands, N. J. USNM 31176

Family Delapiidae

***Corynella jerseyensis* Howell new species**

Plate 2, Figures 1-3.

Description—A compound sponge with a cylindrical base above which there are six lateral cylindrical branches, arranged in a circle, each branch tapering toward its lower end, and a central branch which rises within the circle of lateral branches, the whole sponge having, in general, a hemispherical form with a stem projecting downward from the base of the hemisphere. The basal stem is deflected to one side in our specimen, but was presumably vertical when the sponge was alive. The oscula of the branches are wide and are circular in form. No spicules have been found in the single known specimen, which is composed of greensand marl, and it is probable that the skeleton was originally calcareous and has since been dissolved away.

Discussion—Our specimen resembles in some degree the specimen of *Corynella socialis* Hinde figured by Hinde* in 1883. *Corynella socialis* occurs in the Albian, Upper Cretaceous, Upper Greensand of England. It has "three or more" branches "growing from a common cylindrical stem," and the summits of the branches are, as they are in our specimen "wide, and obliquely truncate." Because of this similarity in form, and because both *Corynella socialis* and our specimen are of Late Cretaceous age, it seems probable that, even though no spicules can be found in our specimen, our fossil is a representative of a species of *Corynella*.

It is to be hoped that additional specimens of the New Jersey species will be discovered in the future which will contain spicules, so that the systematic position of this interesting fossil can be definitely determined.

Occurrence.—In greensand marl of the Navesink formation from somewhere in New Jersey, exact locality not known.

Type.—New Jersey; Princeton University 76407

NOTE: Two additional species were described as sponges from Mullica Hill, N. J. One of these, *Desmatocium trilobitum* Gabb is almost certainly a concretion. (See Johnson, 1905). The other, *Eudea dichotoma* Gabb is probably from the Hornerstown formation of Eocene or Paleocene age and was recently redescribed by Howell and Richards (1955) and referred to the genus *Peronidella* [H.G.R.]

* Hinde, G. J.: Catalogue of the Fossil Sponges of the British Museum (Natural History), London, 1883, p. 183, pl. 34, fig. 11.

CRETACEOUS COELENTERATA OF NEW JERSEY

by

JOHN W. WELLS

CLASS ANTHOZOA

Family Rhizangiidae

Astrangia (Coenangia) cretacea (Bölsche) 1870

Plate 3, Figure 3

Astraea cretacea, Bölsche, 1870, Zeitschr. deutsch. geol. Ges. Vol. 22, p. 216.

Siderastrea cretacea, Wells, 1933, Bull. Amer. Paleont. vol. 18, p. 226, pl. 25, fig. 13; pl. 28, fig. 26.

Description.—Small, hemispherical, encrusting colonies of cerioid corallites. Calices polygonal, 3 - 6 mm. in diameter, directly united by thin walls. Septa in three complete cycles (24), those of the first two cycles extending to the columella; third cycle uniting to the second. Septa thin, laterally with scattered, acute granulations, and irregularly dentate marginally. Columella spongy.

Range in New Jersey—

MERCHANTVILLE: Maple Shade (ANSP 19644)

WOODBURY: Haddonfield (ANSP)

MARSHALLTOWN (plastic clay): Woodbury, Haddonfield (Bölsche)

Range outside New Jersey—

Texas (Navarro formation) (Wells)

Family Micrabaciidae

Micrabacia cribraria Stephenson 1916

Plate 3, Figures 1,2

Micrabacia cribraria, Stephenson, 1916, U. S. Geol. Surv. Prof. Paper 98-J, p. 117, pl. 20, figs. 1-3.

Micrabacia americana, Weller, 1907, p. 271, pl. 5, figs. 14-17 (*non M. americana* Meek 1864).

? *Micrabacia cribraria*, Wade, 1926, p. 27, pl. 1, figs. 9-10.

Micrabacia cribraria, Wells, 1933, Bull. Amer. Paleont., vol. 18, p. 244.

Description.—Corallum solitary, cupoloid, free, with flat or slightly concave base; diameter of base about 7 mm.; height 2-2.25 mm.; ratio of height to diameter about 30:100. Costae relatively narrow, slightly wider or slightly narrower than interspaces, with small, transversely acute granulations at each synapticular junction. Centrally costae and synapticulae form a meshwork. Costae in five complete cycles (96), unequal in length, those of the last or fifth cycle having a length-basal

diameter ratio of 14:100 to 21:100. Septa in five complete cycles, alternating in position with the costae.

Remarks.—All specimens seen are preserved as external molds that show the costal characters well, but the septa are very badly preserved. "The species is most abundant in the Woodbury Clay, it being a rather common species at Lorillard; from the other horizons it has been rarely met with, usually a single example having been observed." (Weller).

M. cribraria was originally described from the upper part of the *Exogyra ponderosa* zone in North Carolina, and occurs in the same part of the zone in Alabama and Mississippi. *M. arkansasensis* Wells from the same horizon in Arkansas is very close to, if not the same as this species, having the same low corallum (h:d, 30:100) as the New Jersey specimens, whereas typical *M. cribraria* is proportionately higher (40:100).

Range in New Jersey—

MERCHANTVILLE: near Matawan

WOODBURY: Lorillard, Matawan, Haddonfield

WENONAH: Crawfords Corner

Range outside New Jersey—

Upper part of *Exogyra ponderosa* zone: North Carolina, Georgia, Coahuila, Mexico.

Type.—Whiteley Creek Landing, Neuse River, N. C. (Snow Hill member, Black Creek formation); USNM 31996.

Family Caryophylliidae

***Trochocyathus woolmani* Vaughan 1900**

Plate 3, Figures 4-6

Trochocyathus woolmani, Vaughan, 1900, Phila. Acad. Nat. Sci., Proc., p. 436, figs. 1-3.

Trochocyathus woolmani, Weller, 1907, p. 268, pl. 5, figs. 5-7.

Trochocyathus woolmani, Wells, 1933, Bull. Amer. Paleont., vol. 18, p. 213, pl. 27, figs. 4-7.

? *Parasmilia balanophylloides*, Bölsche, 1870, Zeitschr. deutsch. geol. Ges., vol. 22, p. 215.

? *Parasmilia* ? *balanophylloides*, Wells, 1933, Bull. Amer. Paleont., vol. 18, p. 222.

Description.—Corallum short, attached, inversely conical, transverse outline circular. Wall rather thick, naked, ornamented externally by 24 costae, corresponding to all cycles of septa, and showing a fairly regular alternation of larger and smaller—*i. e.*, there are 12 larger costae of the same size corresponding to the septa of the first and second cycles, and 12 smaller corresponding to the septa of the third cycle; near the calice they are prominent, with acute edges and broad bases, as the base of the corallum is approached they decrease in prominence; they

possess granulations along their edges, and some scattered granulations on the sides. Septa arranged in three cycles, divided into six systems; the septa of the first cycle are appreciably larger than the others, and pass directly from the corallum wall to the columellar space without forming any part of any septal group; the septa of the third cycle bend towards the members of the second, and fuse to the sides of the latter below the level of the calice; the septal margins project very slightly above the upper edge of the corallum wall; the septal faces are ornamented with distant subconical granulations. The inner end of each of the primary septa is thickened, the thickening apparently representing a palus, and before each group of the members of the second and third cycle is what appears to be a slender palus, therefore, there apparently are slender pali before the septa of the first and second cycles. The columella is fasciculate, not large, with a papillary upper termination. The calicular fossa shallow.

The dimensions of the type specimen are: diameter of the calice, 3-5 mm.; height of corallum, 4 mm.; diameter of the area of attachment 1 mm. (Adapted from Vaughan.)

Remarks.—Bölsche's *Parasmilia balanophylloides*, based upon small corallites 5 mm. in height and diameter, attached to mollusc shells, is included here with considerable doubt. The species has never been figured, and according to its author there are four complete cycles of septa (48), regularly arranged with the third and fourth cycles uniting in the usual manner of carophylliids, but no mention is made of pali. *T. woolmani* is the only other species with which there are similarities. It is curious that no further specimens of Bölsche's little coral have turned up, for he states that it is common at Woodbury.

Range in New Jersey—

WOODBURY: Mt. Laurel well

MARSHALLTOWN: Woodbury

Range outside New Jersey—

Georgia (Ripley formation); Texas (Navarro formation).

Type.—well at Mount Laurel, N. J. (cotypes); ANSP 685.

***Paracyathus ? vaughani* Weller 1907**

Paracyathus vaughani, Weller, 1907, p. 270, pl. 5, figs. 11-13, 23.

Paracyathus ? vaughani, Wells, 1933, Bull. Amer. Paleont., vol. 18, p. 218.

Description.—Corallum subcylindrical in form, with a broad spreading base so that the diameter of the basal disk by which it is attached is as great or greater than the thickest portion of the corallum above; immediately above the base the outer wall contracts somewhat abruptly for a short distance, and then increases gradually in diameter to the summit. The calice is very deep, reaching almost to the base of the corallum. The outer surface of the theca is marked by about 40 longitudinal, finely

denticulate costae, which continue across the expanded basal portion. The characters of the septa are not clearly shown in the type specimen, but they are apparently of the same number as the external costae.

The dimensions of the type specimen are: diameter of corallum at base, 10 mm.; minimum diameter of corallum, 5.5 mm.; diameter of corallum at summit, 8 mm.; height of corallum, 14.5 mm.

Remarks.—This species is very poorly known and it is impossible to figure the specimens suitably. The holotype shows little more than the general form, basal attachment, deep calice, and presence of about 48 septa, of which the last cycle of 24 is very short.

Two additional specimens from Mullica Hill seem to belong here, but add little to our knowledge of the species. Both are unattached, a condition not of much taxonomic value in caryophylliid corals, slightly curved and compressed, cornute coralla, 12 to 19 mm. in height, 10 x 11 and 9.5 x 11 mm. in calicular diameters, each with four more or less complete septal cycles (48 septa). One is the specimen figured without identification by Weller (1907, pl. 5, fig. 23), the other is a recently-collected worn corallum with exterior decorticated, but fairly well-preserved internally: the calice is deep and the elongate, trabecular columella rises less than half way from base to summit; from the level of the columella downward the higher-cycle septa unite regularly with lower cycles, but all are free internally from the columella upward. This specimen does not definitely show the presence of pali, and the reference of these specimens to *Paracyathus* remains unproven.

Range in New Jersey—

NAVESINK: Mullica Hill

Type.—Mullica Hill, N. J.: NJSM 7544; other specimens ANSP 19641.

CRETACEOUS ANNELIDA OF NEW JERSEY

by

B. F. HOWELL

CLASS CHAETOPODA

Family Serpulidae

Serpula circularis Weller 1907

Plate 4, Figure 1

Serpula circularis, Weller, 1907, p. 307, pl. 19, figs. 5-6.

Description.—Tube rather large, moderately thick, increasing gradually in size, the increase being more rapid as it approaches the aperture, not closely coiled, the first volution of the type specimen forming a rather large irregular circle, after which the shell is in contact for about one-fourth volution nearly to the aperture. Another specimen is perhaps not in contact at all. Aperture more or less subcircular or subelliptical in outline. The surface of the shell is marked by more or less irregular, annular lines of growth.

The dimensions of the type species are: greatest diameter of aperture, 8 mm.; length of tube, 72 mm.; greatest diameter of space within first volution, 13 mm.

Remarks.—The type specimen is the only individual observed which is anywhere near complete, though other fragments indicate that the large open coiling of the tube was a common habit of growth. The type specimen was apparently attached to some large shell, probably a *Gryphaea*, during life, by the flatter side. The species is rare, being known only from the specimens described by Weller in 1907.

Range in New Jersey—

MARSHALLTOWN: 28

Type.—Swedesboro; NJSM; 7712.

Hamulus falcatus (Conrad) 1869

Plate 4, Figures 3, 4, 6, 7, 9-11

Dentalium falcatum, Conrad, 1869, Am. Jour. Conch., vol. 5, p. 44, pl. 1, figs. 12 and 16.

Dentalium falcatum, Whitfield, 1892, p. 169, pl. 20, figs. 12-17 (not fig. 18).

Hamulus falcatus, Weller, 1907, p. 309, pl. 22, figs. 11-12.

Hamulus falcatus, Howell, 1943, p. 152, pl. 19, figs. 14-28.

Description.—Tube curved in a half circle arc in its earlier stages of growth, but becoming gradually less bowed in later stages and almost straight in the latest stage. The curvature of the tube is all in one

plane: there is no torsion. The tube expands very gradually and evenly from the pointed initial end to the aperture. It consists of the two layers of calcium carbonate which are characteristic of *Hamulus*, an inner layer, whose inner and outer surfaces are smooth, and an outer layer, whose inner surface is smooth, but whose outer surface bears 6 irregular longitudinal ridges that increase in size and coarseness from the apex to the aperture and vary in the amount of their development in different individuals. The ridges are unevenly developed in all cases, but have relatively sharp crests, without distinct knobs, in the younger, smaller, stages of growth, and become somewhat knobby and sinuous in the older, larger, stages. They are, in general, equally spaced from each other and are roughly parallel to the long axis of the tube. They vary in height in different individuals and are bluntly, not sharply, peaked in cross section. The largest specimens seen, which are incomplete examples of the fillings of tubes, have a diameter of a little more than $\frac{1}{4}$ of an inch at the aperture and must have measured as much as 2 inches or more along the outside curve of the tube. The tubes differ from each other in the amount of their curvature, but all approach or reach a circular curve in their earlier stages of growth, even though they may become almost straight in their later stages.

Remarks.—In spite of the variations in size and curvature and in the form of the ridges on the tube exhibited by the fossils of this kind found in the Merchantville and Woodbury formations, they are all believed to belong to the one species, *Hamulus falcatus*. No example of the operculum, itself, of this species has yet been discovered; but three tube fillings from New Jersey—one from the Merchantville formation at Maple Shade, the others from the Woodbury formation at Crosswicks—in the collections of the Academy of Natural Sciences of Philadelphia (nos. 15267 and 14894 h) and of Princeton University (no. 55800) carry impressions of the under side of the operculum. Although the fillings of the tubes of this species are not uncommon, only five examples showing any part of the tube, itself, have been found.

Range in New Jersey—

MERCHANTVILLE: 15, 16

WOODBURY: 20, 22, 23

Range outside New Jersey—

Delaware, Mississippi.

Type.—Crosswicks, N. J.; ANSP 14891 cotypes.

Hamulus wenonahanus Howell 1943

Plate 4, Figures 2, 8

Hamulus wenonahanus, Howell, 1943, pp. 157-158, pl. 20, figs. 1-3.

Description.—Tube gently tapering; posterior gently curved, the curvature less than in the corresponding portion of the tube of *Hamulus falcatus*, outer surface bearing 6 longitudinal ridges which are

larger and more prominent than the ridges found on the outer surface of the tube of *H. falcatus*. (Usually only the filling of the tube is preserved.)

Range in New Jersey—

MARSHALLTOWN: 28

WENONAH: 34, 35

NAVESINK: Between Mount Holly and Pemberton (Princeton U.)

Type.—Marlboro, N. J.; NJSM 9680.

***Hamulus squamosus* Gabb 1859**

Plate 5, Figures 1, 2

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

Hamulus squamosus, Wade, 1926, p. 45, pl. 10, figs. 6-7.

Hamulus squamosus, Stephenson, 1923, p. 250, pl. 92, fig. 1.

Hamulus squamosus, Stephenson, 1941, pp. 60-61, pl. 4, fig. 10.

Hamulus squamosus, Howell, 1948, p.2, figs. 3-5.

Description.—Tube small, regularly tapering, posterior portion more or less strongly curved, anterior portion becoming straight, the curvature almost or entirely in one plane. The tube has on its outer surface 6 longitudinal ridges, two of which, on opposite sides of the tube, are extended laterally into flanges with irregularly serrated outer edges (presumably to prevent the tube from sinking into the mud). There is some variation in the size, form, sculpture, and degree of curvature of the tube in different individuals.

Range in New Jersey—

MERCHANTVILLE: 16

Range outside New Jersey—

Georgia, Alabama, Mississippi.

Type.—Prairie Bluff, Ala. ANSP 16530 (cotypes).

***Hamulus walkerensis* Stephenson 1923**

Plate 5, Figure 6, 9

Dentalium falcatum, Whitfield, 1892, Pal. N. J., vol. 2, p. 169, pl. 20, fig. 18 (not figs. 12-17). not of Conrad.

Hamulus walkerensis, Stephenson, 1923, pp. 74-75, pl. 10, figs. 9-10.

Hamulus walkerensis, Howell, 1943, p. 159, pl. 20, fig. 4.

Description.—The anterior portion of the tube is straight and gently tapering: the posterior portion is unknown. There are numerous low, broad transverse ridges extending lengthwise of the tube. The species is rare in New Jersey.

Range in New Jersey—

WOODBURY: 20

Type.—North Carolina; USNM 31468.

***Hamulus walkerensis praecursor* Howell 1948**

Plate 5, Figure 10

Hamulus walkerensis praecursor, Howell, 1948, Acad. Nat. Sci. Phil. Not. Nat., no. 202, p. 2, figs. 1-2.

Description.—Only anterior portion of the tube is known, and this is known only from the filling of the tube. The subspecies appears to be similar to *Hamulus walkerensis* except that it is smaller than that species. It is known only from the Merchantville formation, whereas *H. walkerensis* is found in New Jersey only in the overlying Woodbury formation. Like *H. walkerensis*, *H. walkerensis praecursor* is rare.

Range in New Jersey—

MERCHANTVILLE: 16

Type.—Maple Shade, N. J. ANSP 16618.

***Hamulus major* Gabb 1860**

Plate 5, Figure 3

Hamulus major, Gabb, 1860, Jour. Acad. Nat. Sci. Phila. 2nd ser. vol. 4 p. 399, pl. 68, fig. 46.

Hamulus major, Stephenson, 1923, p. 72, pl. 10, fig. 3-7.

This species has not been found in New Jersey but has been reported by Carter (1937, p. 253) from the Crosswicks formation (Merchantville) of the Chesapeake and Delaware Canal.

Range—

Delaware, North Carolina, Alabama, Mississippi, Arkansas.

Type.—ANSP 14831.

***Longitubus lineatus* (Weller) 1907**

Plate 4, Figure 5, Plate 6, Figure 5

Hamulus lineatus, Weller, 1907, p. 310, pl. 19, fig. 7.

Serpula lineata, Stephenson, 1923, p. 70, pl. 9, figs. 13-14.

Longitubus lineatus, Howell, 1943, p. 161, pl. 20, figs. 9-21.

Serpula ? lineatus, Stephenson, 1941, p. 57, pl. 4, figs. 4-6.

Description.—Tubes straight, or almost straight, tapering only a little, up to 82 mm. in length, with a smooth interior wall and closely spaced, fine, encircling ridges on the outer surface. Usually only the filling of the tube is preserved.

Range in New Jersey—

MERCHANTVILLE: 10, 15, 16

WOODBURY: 20

NEVESINK: 37, 40, 51

Range outside New Jersey—

Delaware, North Carolina, Georgia, Mississippi, Texas (?).

Type.—Lenola, N. J.; NJSM 7754**Diploconcha cretacea** Conrad 1875

Plate 5, Figures 7,8

Diploconcha cretacea, Conrad, 1875, Geol. Surv. N. C. Rept. vol. 1 (in Kerr), App. A, p. 12, pl. 2, fig. 26.*Diploconcha (Serpula?) cretacea?*, Whitfield, 1892, pp. 170, 171, pl. 20, fig. 25.*Dentalium (Falcula) falcatum*, Whitfield, 1892, p. 169, pl. 20, figs. 15-17 (not figs. 12-14, 18).*Serpula whitfieldi*, Weller, 1907, p. 308, pl. 19, fig. 2.*Serpula whitfieldi*, Gardner, 1916, p. 746.*Surpula cretacea*, Stephenson, 1923, p. 67 (part), pl. 9, figs. 1-12. (Not figs. 8, 9.)*Surpula cretacea*, Stephenson, 1941, p. 56, pl. 4, figs. 1-3.*Diploconcha cretacea*, Howell, 1948, p. 4, figs. 6-10.*Description.*—Curved, sometimes somewhat sinuous, gently tapering tubes composed of many thin concentric layers arranged as a series of truncated cones, one within the other. Outer surface of tubes marked by fine concentric lines of growth and, in the anterior portion, by coarser concentric ridges. Tubes 100 mm. or more in length. New Jersey specimens usually consist only of the fillings of tubes.*Range in New Jersey—*

MERCHANTVILLE: 16

NAVESINK: ?

Range outside New Jersey—

Maryland, North Carolina, Georgia, Alabama, Mississippi, Arkansas, Texas.

Type.—Snow Hill, N. C.; Cotypes ANSP 15866 a and b.**Diploconcha harbisonae** Howell 1943

Plate 5, Figures 11, 12

Hamulus ? ? sp., Weller, 1907, p. 311, pl. 19, figs. 3-4.*Serpula cretacea*, ?, Stephenson, 1923, (part) p. 67, pl. 9, figs. 8-9. (not figs. 1-7, 10-12.)*Diploconcha harbisonae*, Howell, 1943, p. 159, pl. 20, figs. 6-8.

Description.—Only the anterior portion of the tube is known. It is larger than the tube of *Diploconcha cretacea* Conrad. The inner surface of the tube is smooth. The outer surface bears a series of coarse, parallel, concentric ridges. The part of the tube that is known is straight and tapers a little. The species is known in New Jersey only from fillings of the tubes and from molds of the exterior of the tube. It is rare in this state.

Range in New Jersey—

WOODBURY: 20 (?)

WENONAH: 34

Range outside New Jersey—

North Carolina

Type.—Crawfords Corner, N. J.; NJSM 7677

***Filigranula jerseyensis* Howell new species**

Plate 5, Figure 4

Dr. Eugene S. Richardson, Jr., collected from the Merchantville formation of New Jersey part of the filling of the shell of an unidentified snail that consists in part of a mass of the fillings of the curved tubes of a small species of tubicolous worms, the tubes, themselves, having been dissolved away. These little fossils represent a species of worms not previously known.

The tubes of this species were somewhat curved, 5 mm. or more in length, and about one-fourth of a millimeter in diameter. Their inner surfaces were smooth. Our specimens are packed together, and partly intertwined, in what was originally the cavity in the empty shell of the snail, so that the worm tubes must have filled the cavity completely when the worms were living.

Location of types.—The cotypes and only known specimens are no. 77354 in the paleontological collection of Princeton University.

Occurrence.—Merchantville formation, Upper Cretaceous, in the clay pit of the Graham Brick Company at Maple Shade, New Jersey.

Discussion.—Although *Filigranula* has been reported from Cretaceous beds elsewhere, this is the first record of the genus from New Jersey. This species is considerably smaller than *Filigranula socialis* (Goldfuss) reported by Richards from the Upper Cretaceous in a well in Pamlico Sound, North Carolina.

INSERTÆ SEDIS

***Halyminites major* Lesquereux¹**

Plate 9, Figures 9, 10

Halyminites major, Lesquereux, 1873, U. S. Geol. Surv. of the Territories, 6th Ann. Rept. p. 373.

¹ by Horace G. Richards.

Halyminites major, Groot, Organist and Richards, 1954, Delaware Geol. Surv. Bull. 3 p. 54, Pl. 7, fig. 7.

These tubes have been variously identified as worm tubes, mollusk borings and remains of plant origin. They are widespread in Cretaceous and Tertiary formations. Tubes, apparently this species, have been found in the Wenonah formation near Runnemede and Matawan, New Jersey, and in the same formation in the banks of the Chesapeake and Delaware Canal in Delaware.

Thinner and more fragile tubes, possible referable to *H. major* have been found in the Red Bank formation in Delaware (Groot, *et al*, 1954 p. 54).

Tube or Burrow¹

Plate 9, Figures 11, 12

—————, Weller, 1907, p. 311, pl. 19, fig. 1.

—————, Groot, Organist and Richards, 1954, p. 54, pl. 7, fig. 8.

Tubes, somewhat less corrugated than those of *H. major* have been found in the Red Bank formation in the Chesapeake and Delaware Canal in Delaware and in the Red Bank and Tinton formations at Beers Hill (63). Weller believed that these were "probably the casts of the burrows of some organism, probably one of the segmented worms."

Xenohelix? jerseyensis Ramsdell n. sp.¹

Plate 90, figures 1, 2*

Description.—Specimen incomplete, the whorls at both ends having been broken away. Specimen consists of two whorls forming a loosely coiled, slightly tapering spiral; whorls symmetrically and regularly coiled and equally spaced, whorl outline elliptical in cross section. Umbilicus-like depression at base of axis of coiling. A tubelike structure, here designated the peripheral tube, circular in cross section, extends around the outer margin of the spiral.

Dimensions and measurements.—length, 154 mm.; maximum width, 98 mm.; pitch of coiling, about 35°; distance between coils, 50 mm.

Remarks.—Type specimen unique. This species differs from other described species of this genus in the presence of the peripheral tube, in the looseness of coiling, and in its greater size. This specimen varies from those of *Xenohelix marylandica* Mansfield and *X. ? utahensis* Gilliland and LaRocque in lacking in cross section, the two distinct parts—the peripheral wall and the central core—present in these latter species. An impressed area remains where the peripheral tube has been broken away from a portion of the upper whorl.

¹ by Robert C. Ramsdell.

* In Part II

The specimen was found in an upright position (so inferred) in association with several objects of questionable organic origin.

Range in New Jersey—

MAGOTHY: 5

Type.—Cliffwood Beach, N. J.; Prin. Univ.

CRETACEOUS ECHINOIDEA OF NEW JERSEY AND ADJACENT REGIONS.¹

by

C. WYTHE COOKE

On the following pages are described all the echinoids known from the Upper Cretaceous deposits of the Atlantic Coastal Plain north of Virginia. The types of most of the species described were collected in New Jersey, but a few came from nearby Delaware and one from Maryland. Though these latter mentioned species have not yet been found in New Jersey, they doubtless inhabited that region, and their remains may be discovered there at any time. One additional new species (*Cardiaster hilli* Cooke, n. sp.) from Texas is included because it closely resembles a form from New Jersey whose type is too poorly preserved to admit of sure identification. No other species is described as new.

Most of the material studied is in the form of natural molds of the interior, all more or less broken and distorted. The type specimens of these species lack many of the features essential for accurate identification and would better have been left unnamed.

Three of the species were named by Samuel G. Morton in 1833 and were included in his "Synopsis of the organic remains of the Cretaceous group of the United States" (1834). Other echinoids included in that work and then supposed to be Cretaceous in age are now regarded as Paleocene. The other Cretaceous species were described by William Bullock Clark between 1891 and 1916. His principal reports are "The Mesozoic Echinodermata of the United States" (U. S. Geological Survey Bull. 97, 1893) and Part I of "The Mesozoic and Cenozoic Echinodermata of the United States" (U. S. Geological Survey Monograph 54, 1915). The descriptions and figures from Clark's Bulletin 97 were used in 1907 by Stuart Weller in his "Cretaceous Paleontology of New Jersey," which included also descriptions of four new species by Clark.

The descriptions and figures of all but the one new species in the present report are adapted, with little modification, from my paper on "American Upper Cretaceous Echinoidea," which was published in 1953 as U. S. Geological Survey Professional Paper 254-A.

Faujasia geometrica (Morton)

Plate 6, Figures 1-7

Clypeaster geometricus Morton, 1833, Am. Jour. Sci., ser. 1, vol. 24, p. 131, pl. 10, fig. 9.

Clypeaster geometricus Morton. Morton, 1834, Synopsis of the organic remains of the Cretaceous group, p. 76, pl. 10, fig. 9.

¹ Publication authorized by the director, U.S. Geological Survey.

- Pygurus geometricus* (Morton). Agassiz and Desor, 1847, Catalogue raisonné des échinodermes, p. 141.
- Pygurus geometricus* (Morton). D'Orbigny, 1856, Paléontologie française, Terrain crétacé, ser. 1, tome 6, p. 313, pl. 920, fig. 4 (after Morton).
- Pygurus geometricus* (Morton). Desor, 1858, Synopsis des échinides fossiles, p. 313.
- Pygurus geometricus* (Morton). Clark, 1915, U. S. Geol. Survey Mon. 54, p. 72.
- Cassidulidae, new genus (?) new species. Carter, 1937, Maryland Geol. Survey, vol. 13, p. 273.
- Pygurostoma geometricum* (Morton). Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 14, pl. 4, figs. 15-20.
- Faujasia geometrica* (Morton). Cooke, 1955, U. S. Geol. Survey Prof. Paper 264-E, p. 96.
- Faujasia geometrica* (Morton). Groot, Organist and Richards, 1954, p. 40, pl. 3, fig. 2.

Test large; upper surface inflated; lower surface somewhat concave; margin acutely rounded; somewhat produced behind. Apical system in front of the center, probably monobasal, with four genital pores. Petals lanceolate, equal, extending more than halfway to the margin; poriferous zones nearly closed at each end, pores strongly conjugate, outer pores elongated, inner pores round. Peristome central; bourrelets rounded at the base, hollow, probably rounded at the tips; phyllodes short and broad. Periproct small, apparently transversely oval, inframarginal, nearly terminal but not visible from above, slanting upward toward the rear.

Length of type 56.4 mm.; width 54 mm.; height 25 mm. Length of figured specimen 55.5 mm.; width 49 mm.; height 25 mm.

Occurrence.—Delaware: Chesapeake and Delaware Canal (type); north side of Chesapeake and Delaware Canal 2,000 feet east of the railroad bridge (USGS 17753, Charles W. Carter, collector).

Geologic horizon.—Marshalltown formation (?).

Type.—C. and D. Canal. Del. ANSP 1946. Figured specimen, USNM 108378.

Remarks.—Carter's field label states that he found the specimen here figured (USNM 108378) in place in the Crosswicks clay, presently the basal formation of the Matawan group, but his published report places it in the Marshalltown formation, the upper formation of that group. This discrepancy doubtless records a change in correlation as the result of later studies,¹

Although this species has not yet been reported from New Jersey,

¹ Several individuals of this species have recently been found in the Wenonah formation along the Chesapeake and Delaware Canal, and it is possible that Carter's specimens were also from this formation. H. G. R.

it is recorded here because it is a member of the Marshalltown fauna and presumably lived there.

Catopygus pusillus Clark

Plate 8, Figures 15, 16

Catopygus pusillus Clark, 1891, Johns Hopkins Univ. Circ., vol. 10, no. 87, p. 67.

Catopygus pusillus Clark. Clark, 1893, Johns Hopkins Univ. Circ., vol. 12, no. 103, p. 52.

Catopygus pusillus Clark. Clark, 1893, U. S. Geol. Survey Bull. 97, p. 65, pl. 27, figs. 3a-d.

Catopygus pusillus Clark. Weller, 1907, New Jersey Geol. Survey, Paleontology ser., vol. 4, p. 292, pl. 11, figs. 16-19 (after Clark).

Catopygus pusillus Clark. Clark, 1915, U. S. Geol. Survey Mon. 54, p. 73, pl. 29, figs. 3a-d.

Phyllobrissus pusillus (Clark). Lambert and Thiéry, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 351.

Catopygus pusillus Clark. Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 15, pl. 5, figs. 1, 2.

Outline nearly circular; upper surface moderately inflated, rostrate behind; lower surface nearly flat; margin evenly rounded. Apical system nearly central. Petals straight, extending about halfway to the margin, open distally. Peristome not preserved. Periproct circular (?), terminal, well up on the posterior end, vertical.

Length of larger cotype 14 mm.; width 13.3 mm.; height 8.1 mm.

Range in New Jersey.—MERCHANTVILLE.

Type.—Wordills, Monmouth County, N. J. USNM 2210.

Comparisons.—This species, represented by two cotypes and one other, all molds of the interior, is proportionately shorter than *Catopygus carinatus* (Goldfuss).

Catopygus (Oolopygus) williamsi Clark

Plate 8, Figures 17-20

Catopygus williamsi Clark in Weller, 1907, New Jersey Geol. Survey, Paleontology ser. vol. 4, p. 292, pl. 12, figs. 1-4.

Catopygus williamsi Clark. Clark, 1915, U. S. Geol. Survey Mon. 54, p. 73, pl. 29, figs. 4a-d.

Oolopygus williamsi (Clark). Lambert and Thiéry, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 354.

Catopygus (Oolopygus) williamsi Clark. Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 16, pl. 5, figs. 7-10.

Outline rounded in front, produced and laterally truncate behind;

upper surface low-convex, highest behind the center; lower surface nearly flat; margin evenly rounded. Apical system nearly central; petals narrow, extending more than halfway to the margin; poriferous zones straight, open distally, about as wide as interporiferous zones. Peristome in front of the center. Bourrelets probably high, narrow, hollow. Periproct terminal, rostrate, longitudinally elongated, visible from below.

Length 16.2 mm.; width 21 mm.; height 14 mm.

Range in New Jersey.—NAVESINK: Bluff east of Atlantic Highlands (37).

Type.—Atlantic Highlands, N. J.; USNM 103698.

Geologic horizon.—Navesink marl.

Type.—USNM 103698 (deposited by Johns Hopkins University, T 3010).

Comparison.—*Catopygus williamsi*, represented only by the type, a mold of the interior, appears to be very similar to the species figured by d'Orbigny in 1860 under the name *Oolopygus pyriformis*.

Hardouinia florealis (Morton)

Plate 7, Figures 15-18

Clypeaster florealis Morton, 1833, Am. Jour. Sci., ser. 1, vol. 23, p. 294.

Clypeaster florealis Morton. Morton, 1834, Synopsis of the organic remains of the Cretaceous group, p. 76, pl. 3, fig. 12; pl. 10, fig. 12.

Pygurus florealis (Morton). Agassiz and Desor, 1847, Catalogue raisonné des échinodermes, p. 141.

Faujasia florealis (Morton). D'Orbigny, 1856, Paléontologie française, Terrain crétacé, ser. 1, tome 6, p. 319, pl. 920, figs 5, 6 (after Morton).

Faujasia florealis (Morton). Desor, 1858, Synopsis des échinides fossiles, p. 318.

Cassidulus florealis (Morton). Meek, 1864, Smithsonian Misc. Coll., vol. 7, (177), p. 2.

Cassidulus florealis (Morton). Clark, 1891, Johns Hopkins Univ. Circ., vol. 10, no. 87, p. 76.

Cassidulus florealis (Morton). Clark, 1893, Johns Hopkins Univ. Circ., vol. 12, no. 103, p. 52.

Cassidulus florealis (Morton). Clark, 1893, U. S. Geol. Survey Bull. 97, p. 66, pl. 28, figs. 1a-1.

Cassidulus florealis (Morton). Clark, 1915, U. S. Geol. Survey Mon. 54, p. 74, pl. 30, figs. 1a-1.

Procassidulus florealis (Morton). Lambert and Thiéry, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 361.

Faujasia florealis (Morton). Lambert and Thiéry, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 374.

Hardouinia florealis (Morton). Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 23, pl. 8, figs 11-14.

Horizontal outline subcircular; upper surface strongly inflated; highest point behind the apical system; lower surface flat or slightly concave; margin acute. Petals extending more than halfway to the margin; poriferous zones about as wide as the interporiferous. Peristome central; surrounded by five strong, pointed, hollow bourrelets; phyllodes longer than wide. Periproct oval, twice as high as wide, sunken, well up above the margin, opening into a shallow depression, which extends to the margin.

Length 38.1 mm.; width 34.1 mm.; height 21.2 mm.

Occurrence.—Delaware: Chesapeake and Delaware Canal.

Geologic horizon.—Exact horizon unknown; probably from the Marshalltown formation.

Type.—Delaware and Chesapeake Canal, Del. ANSP 1495.

Comparisons.—*Hardouinia florealis*, known only from internal molds, differs from *Hardouinia mortonis* (Michelin), type of the genus, in the shape of its periproct, which is longitudinally elongated, not circular, and in the narrowness of its interporiferous zones. Its recognizable features closely resemble a tall variety of *Hardouinia aequoria* (Morton), though the type of that species is much lower, its phyllodes are shorter, and its petals are somewhat shorter. The shape of its periproct allies *Hardouinia florealis* with *H. micrococcus* (Gabb), but that species is very much flatter, and its floscelle is smaller.

***Hardouinia mortonis emmonsii* (Stephenson)**

Plate 46, Figure 4

?*Cassidulus berryi* Twitchell, 1915, U. S. Geol. Survey Mon. 54, p. 220, pl. 101, figs. 3a-d.

?*Hardouinia berryi*, (Twitchell). Lambert and Thiéry, 1921, Nomenclature raisonnée des échinides, fasc. 5, p. 363.

Cassidulus emmonsii Stephenson, 1927, U. S. Natl. Mus. Proc., vol. 72, art. 10 (no. 2706), p. 7, pl. 3, figs. 3-8; pl. 4, figs. 1-5.

Hardouinia? *stetsoni* Stephenson, 1936, Geol. Soc. American Bull., vol. 47, no. 3, p. 371, pl. 1, figs. 2-4.

Hardouinia mortonis emmonsii (Stephenson). Cooke, 1953, U. S. Geol. Survey Prof. Paper 254-A, p. 20, pl. 5, figs. 22-24.

Test medium-sized, upper surface tending to be slightly conical, rather low. Horizontal outline rounded in front, slightly produced behind. Margin angular. Lower surface somewhat concave near the peristome. Apical system central; four genital pores. Petals narrowly

lanceolate, extending little more than halfway to the margin. Peristome central, pentagonal, surrounded by strong pointed bourrelets and short, broad, depressed phyllodes. Periproct circular, sunken, opening into a conspicuous sulcus, which extends to the margin. Differing from typical *Hardouinia mortonis* in its smaller size and lower, more conical form.

Occurrence.—New Jersey: Matawan. Occurs also from Georges Bank (*H. stetsoni*) to Texas.

Geological horizon.—Wenonah formation.

Type.—U. S. Nat. Mus. 73423, from North Carolina.

Remarks.—Seven fairly well preserved individuals of this subspecies were collected by Frank Markewicz from Matawan (33b) in 1955. They closely resemble the typical form. The best specimen measures 33 by 30.5 by 12.3 mm.

Cardiaster smocki Clark

Plate 7, Figures 6-8

Cardiaster smocki Clark in Weller, 1907, New Jersey Geol. Survey, Paleontology ser., vol. 4, p. 298, pl. 13, figs. 9-11.

Cardiaster smocki Clark. Clark, 1915, U. S. Geol. Survey Mon. 54, p. 84, pl. 36, figs. 3a-c.

Cardiaster smocki Clark. Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 28, pl. 11, figs. 8-10.

This species, described from an imperfect mold of the interior, is unrecognizable without better preserved topotypes. Its shape resembles that of *Cardiaster hilli* Cooke, from the Anacacho limestone of Texas, which may eventually prove to be the same species.

Range in New Jersey.—MERCHANTVILLE: 8.

Type.—2.5 miles northwest of Matawan, N. J. NJSM.

Cardiaster hilli Cooke, n. sp.

Plate 7, Figures 9-14

Cardiaster hilli Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 28 (*nomen nudum*).

Test cordate, weakly emarginate in front, broadly truncated behind, with rounded margins. Upper surface inflated; highest point in front of the apex, thence sloping steeply forward and gently backward to the posterior truncation. Lower surface nearly flat. Peristome at the anterior third. Periproct longitudinally elongated, rather large, erect.

Length 29.7 mm.; width 28.7 mm.; height 15 mm.

Occurrence.—Texas: Cline Mountain, Uvalde County, 2 miles south of Cline station (types, USGS 357, R. T. Hill collector; USGS

1774, T. W. Vaughan, collector). Summit of hill north of Anacacho Mountain 3 or 4 miles north of Cline station (USGS 1613b, R. T. Hill and T. W. Stanton, collectors). Quarry on Elm Creek, Kinney County (USGS 16760, J. A. Udden, collector). Kings Water Hole, 3 miles north of Hondo, Medina County (USGS 12902, L. W. Stephenson, collector).

Geologic horizon.—Upper Cretaceous, Anacacho limestone.

Types.—USNM 108792 (holotype and three paratypes).

Comparisons.—This species has the shape of *Cardiaster smocki* Clark, but the type of *C. smocki* is too poorly preserved for detailed comparison. *Cardiaster deciper* Cooke has a much longer, deeper, and sharper sulcus, and its posterior truncation is narrower.

Remarks.—The holotype of *Cardiaster hilli* is too much corroded to show the apical system and the ambulacra plainly, and a marginal fasciole is not discernible on it. The specimens listed from USGS 16760 and 12902, whose identification is somewhat doubtful, show traces of a marginal fasciole.

A description of this species was inadvertently omitted from Professional Paper 254, though the name was mentioned in the discussion of *Cardiaster smocki*. It is inserted here because the species may prove to be *Cardiaster smocki*.

***Cardiaster marylandicus* Clark**

Plate 7, Figures 1-5

Cardiaster marylandicus Clark, 1916, Maryland Geol. Survey, Upper Cretaceous, p. 750, pl. 47, figs. 6-10.

Cardiaster marylandicus Clark. Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 28, pl. 14, figs. 1-5.

Clark describes this species as follows: "Test small, cordate, with pronounced anterior grooves; upper face slightly convex, lower surface flat. Ambulacra wide. Apical system moderately elongated. Peristome very near anterior margin. Periproct oval and situated rather high on truncated posterior margin."

"Length 18 mm.; width 18 mm.; height 11.5 mm."

Occurrence.—Maryland: Brightseat, Prince Georges County.

Geologic horizon.—Monmouth formation.

Type.—Maryland Geological Survey (apparently lost).

Comparison.—Clark compares this species with *Cardiaster smocki*, but finds it to be more sharply contracted posteriorly and to have "a more pronounced anterior surface".

Remarks.—Although *Cardiaster marylandicus* has not yet been found in New Jersey, it should be looked for in the Tinton sand member of Red Bank sand, which is supposed to be of the same age as the Monmouth formation at Brightseat.

Hemiaster unguia (Morton)

Plate 8, Figures 8-12

- Spatangus unguia* Morton, 1833, Am. Jour. Sci., ser. 1, vol. 24, p. 131, pl. 10, fig. 6.
- Spatangus unguia* Morton. Morton, 1834, Synopsis of the organic remains of the Cretaceous group, p. 78, pl. 10, fig. 6.
- Micraster unguia* (Morton). Agassiz in Agassiz and Desor, 1847, Catalogue raisonné des échinodermes (reprint), p. 141.
- Holaster unguia* (Morton). Gabb, 1859, Cat. invert. foss. Cretaceous, p. 19.
- Not *Hemiaster unguia* (Morton). Clark, 1891, Johns Hopkins Univ. Circ., vol. 10, no. 87, p. 77.
- Not *Hemiaster unguia* (Morton). Clark, 1893, Geol. Survey Bull. 97, p. 88, pl. 46, figs. 2a-g.
- Not *Hemiaster unguia* (Morton). Weller, 1907, New Jersey Geol. Survey Paleontology series, vol. 4, p. 301, pl. 16, figs. 5-11. After Clark, 1893.
- Not *Hemiaster unguia* (Morton). Clark, 1915, U. S. Geol. Survey Mon. 54, p. 93, pl. 48, figs. 3a-g.
- Not *Hemiaster* (*Gregoryaster*) *unguia* (Morton). Lambert and Thiéry, 1924, Nomenclature raisonnée des échinides, fasc. 7, p. 503.
- Hemiaster unguia* (Morton). Cooke, 1953, U. S. Geol. Survey Prof. Paper, 254, p. 34, pl. 14, figs. 10-14.

Horizontal outline cordate, with a weak frontal furrow, vertically truncated behind. Petals sunken. Anterior paired petals extending more than halfway to the margin, diverging at an angle of nearly 90°. Posterior petals shorter, less diverging. Peristome transversely oval, apparently strongly lipped. Periproct oval, well up on the posterior truncation.

Occurrence.—Delaware: Chesapeake and Delaware Canal.

Geologic horizon.—Upper Cretaceous, formation unknown.

Type.—C. and D. Canal, Del. ANSP 1503.

Remarks.—This species is based on a mold of the interior, which is somewhat crushed and partly broken. Clark's drawings, which were copied by Weller, ostensibly represent the type, but they were probably made from specimens of a Paleocene species from Vincentown, New Jersey, in the Philadelphia Academy (no. 1502).

"Hemiaster" kümmeli Clark

Plate 8, Figures 13, 14

- Hemiaster kümmeli* Clark in Weller, 1907, New Jersey Geol. Survey, Paleontology ser., vol. 4, p. 303, pl. 17, figs. 1-3.

Hemiaster kummeli Clark. Clark, 1915, U. S. Geol. Survey Mon. 54, p. 97, pl. 52, figs. 1-3.

Hemiaster kummeli Clark. Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 35, pl. 13, figs. 5, 6.

This species is based on a badly crushed mold of the interior having rather long posterior petals much like those of *Hemiaster texanus* Roemer. It is unrecognizable without better-preserved topotypes.

Range in New Jersey.—WOODBURY: Lorillard (18).

Type.—Lorillard, N. J. NJSM.

***Hemiaster delawarensis* Clark**

Plate 8, Figures 1-4

Hemiaster delawarensis Clark, 1916, Maryland Geol. Survey, Upper Cretaceous, p. 751, pl. 47, figs. 11-14.

Hemiaster delawarensis Clark. Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 35, pl. 14, figs. 6-9 (after Clark).

This species, known only from the type, which appears to have been mislaid or lost, is described by Clark as follows:

"Test small, nearly circular, slightly cordiform, truncated posteriorly; upper surface slightly convex, elevated posteriorly; lower surface nearly flat; sides inflated; apex nearly central, slightly posterior of the center; ambulacra slightly depressed, posterior pair short, anterior surface broad. Peristome slightly depressed. Periproct small, high above posterior margin. Peripetalous fasciole narrow, distinct."

"Length 22 mm.; width 22 mm.; height 17 mm."

Occurrence.—Delaware: Marl pit south side of Chesapeake and Delaware Canal, 1 mile east of St. Georges.

Geologic horizon.—Probably from the Mount Laurel sand (Clark says Matawan formation).

Type.—Johns Hopkins University (*vide* Clark).

Comparison.—The figures of the type, which I have not seen, resemble *Hemiaster wetherbyi* de Loriol, a very common species in the Prairie Bluff chalk and equivalent formations of the Southern States, but the posterior petals of *H. delawarensis* seem to be proportionately shorter and its fasciole less indented.

***Hemiaster welleri* Clark**

Plate 8, Figures 5-7

Hemiaster welleri Clark in Weller, 1907, New Jersey Geol. Survey, Paleontology ser., vol. 4, p. 302, pl. 17, figs. 4-6.

Hemiaster welleri Clark. Clark, 1915, U. S. Geol. Survey Mon. 54, p. 98, pl. 52, figs. 2a-c.

Hemiaster (Integraster) welleri Clark. Lambert and Thiéry, 1924, Nomenclature raisonnée des échinides, fasc. 6, p. 504.

Hemiaster welleri Clark. Cooke, 1953, U. S. Geol. Survey Prof. Paper 254, p. 35, pl. 14, figs. 15-17.

This species is based on a broken mold of the interior, which lacks the apical system and the posterior petals. It is unrecognizable without better-preserved topotypes. In general appearance it resembles *Hemiaster wetherbyi* de Loriol and *H. arcolensis* Cooke, both of which occupy higher horizons in Alabama.

Range in New Jersey.—MERCHANTVILLE: 10c

Type.—1 mile south of Lower Jamesburg, N. J. NJSM

CRETACEOUS BRACHIOPODA OF NEW JERSEY

by

Horace G. Richards

ORDER ATREMATA

Family Lingulidae

Lingula subspatulata Hall and Meek 1856

Plate 9, Figures 14, 15

Lingula subspatulata Hall and Meek, 1856, Mem. Amer. Acad. Arts and Sci. n. ser. vol. 5, p. 380, pl. 1, fig. 2 a-b.

Lingula subspatulata, Weller, 1907, p. 356, pl. 27, fig. 20-21.

? *Lingula subspatulata*, Stephenson, 1953, U. S. Geol. Surv. Prof. Paper 242 p. 54, pl. 10, figs. 1-3.

Description.—Shell subelliptical in outline, pointed posteriorly and more or less subtruncate anteriorly, the lateral margins subparallel, the antero-lateral angles rounded. Surface marked by fine, concentric lines of growth, some of which are more conspicuous than others. The dimensions of one of the largest individuals observed are: length 19 mm., width 10 mm. (Weller)

Remarks.—Formerly common at Lorillard, but not found during recent years. According to Weller, one specimen is more slender, more pointed posteriorly, and more rounded anteriorly, resembling *L. nitida* Meek and Hayden from the Fox Hills formation of the Western Interior. However, it is regarded as a distorted form of *L. spatulata*.

Range in New Jersey—

WOODBURY: 18, 20, 24

Type—Near Red Cedar Island, 35 miles below Ft. Pierre, S. D., AMNH 9340/1 (cotypes).

Range outside New Jersey—Texas, Nebraska, New Mexico.

ORDER TELOTREMATA

Family Terebratulidae

Terebratulina atlantica (Morton) 1842

Plate 9, Figures 3, 4

Terebratula atlantica Morton, 1842, Jour. Acad. Nat. Sci. Phila. 1st ser. vol. 8, p. 214.

Terebratulina halliana Gabb, 1861, Prod. Acad. Nat. Sci. Phila. Vol. ? p. 19.

Terebratulina atlantica, Whitfield, 1886, p. 9-11 (part) pl. 1 fig. 11, 12 (not fig. 10, 13 = *T. manasquani* Stenzel)

Terebratulina atlantica, Hollick, 1892, Trans N. Y. Acad. Sci. Vol. 11 p. 98, fig. 8.

Terebratulina atlantica, Weller, 1907, p. 360 (part) not pl. 28, figs. 9-12 = *T. manasquani*.

Not *Terebratula glossa* Conrad in Cook. Geol. N. J. p. 377, fig. 3, p. 723.

Not *T. glossa* Conrad, 1869, Amer. Jour. Conch. vol. 5, p. 42, pl. 1, fig. 22.

Description.—Shell ovate, valves equally convex with numerous, distinct, and bifurcating striae, most prominent in the umbo; foramen large; beaks not incurved. Length of the largest specimen five-eighths of an inch; width half an inch.

Remarks.—This species has been greatly confused in the literature and was recently straightened out by Stenzel (1942). *Terebratula atlantica* was originally described by Morton from the Woodward farm near Walnford, N. J. and was collected together with *Exogyra costata*, *Gryphaea*, *Belemnitella* and *Choristothyris plicata*, all characteristic Cretaceous species.

Stenzel analyzes the evidence and points out the probability that Gabb in 1861 redescribed the type specimen of *T. atlantica* and called it *T. halliana*. He also calls attention to the fact that two Tertiary species of terebratulids have been confused with *Terebratulina atlantica*. *Terebratula glossa* Conrad, described from the "green marl of the Upper Bed" (= Manasquan) and placed in the synonymy of *Terebratulina atlantica* by Whitfield and Weller is probably not a *Terebratulina* and should be removed from the synonymy. Other specimens of *Terebratulina* described by Whitfield and Weller from marl pits one mile south of Farmingdale, N. J. (Manasquan formation) and placed in the synonymy of *T. atlantica* were placed in the new species *Terebratulina manasquani* by Stenzel (p. 728).

Range in New Jersey—

NAVESINK: 46

Type.—Woodward Farm near Walnford, N. J. ; ANSP 19607 (type of *T. halliana* Gabb and probably also type of *T. atlantica* Morton).

Family Terebratellidae

Choristothyris plicata (Say) 1820

Plate 9, Figures 5-8, 13

Terebratula plicata Say, 1820, Amer. Jour. Sci. 1st ser. vol. 2, p. 43.

T. Sayi Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S. p. 71, pl. 3, figs. 3-4.

T. plicata, Whitfield, 1886, p. 12, pl. 1, figs. 5-9.

T. plicata, Weller, 1907, p. 364, pl. 27, figs. 1-11.

C. plicata, Cooper, 1942, Jour. Wash. Acad. Sci. Vol. 32, p. 233.

Description.—Shell subcircular or subovate in outline, pointed posteriorly and rounded in front, strongly plicated, each valve marked by from 8 to 12 or more sharply angular plications which extend to the beak; usually a little wider than long but sometimes longer than wide; the dimensions of four specimens are: length, 14.5 mm., 15.5 mm., 19 mm., 17.5 mm.; width, 16 mm., 15 mm., 20 mm., 16.3 mm.; thickness 8 mm., 9 mm., 10 mm., 9.5 mm. Pedicle valve strongly convex, with a small, nearly erect beak; cardinal area of moderate size, sharply defined, slightly concave, with a broad delthyrium partially closed by a pair of deltidial plates leaving a large circular foramen; interiorly the diductor muscular impressions are rather strong and flabellate, occupying the upper third of the valve which is considerably thickened. Brachial valve flattened or but moderately convex, often with a broad, ill-defined mesial sinus usually occupied by a single strong plication, but sometimes by from three to five smaller ones; internally the valve is much thickened in the cardinal region, the cardinal process is prominent, being bilobed or trilobed, with the hinge-plates well developed on either side, the crura originate in front of and between the bases of the hinge-plates at a moderate distance apart, they are directed forward and outward, each one giving origin to a crural process a short distance from the hinge-plate, which points inward and forward, the brachidium is formed by rather broad primary lamellæ which curve outward from the crural extremities and describe an incomplete subcircle of nearly one-half the diameter of the valve; anteriorly they are sharply recurved and returned at a short distance above the main portions, being united by a transverse band just in front of the crural processes; the main portions of the loop are united to the median septum which originates in front of the cardinal process, by a transverse plate near the end of the septum and just in front of the middle of the loop. Surface of the shell marked by numerous strong concentric lines of growth crossing the plications. Shell structure strongly and minutely punctate, the punctæ arranged in quincunx. (Weller)

Remarks.—Specimens in which the brachidium of this species can be observed are not common, but those which have been observed show that this structure varies considerably in the proportions of its different parts. The species is especially characteristic of the Navesink marl where it sometimes occurs in great numbers, and has not been observed in any other formation. It is not closely related to any other American form except *T. vanuxemi* from which it can be easily distinguished by its strongly angular plications.

Cooper (1942, p. 233) set up the new genus *Choristothyris* with *Terebratula plicata* Say as the genotype. The reference specimens were USMN 2395 and 103556.

Stephenson (1948, p. 120) has recently reported this species from the Hammond well near Salisbury, Maryland at 1362 feet. The section is referred to the Navesink.

Range in New Jersey—

NAVESINK: 37, 39, 40, 41, 42, 45, 46, 48, 49, 50, 53

Type.—"New Jersey"

Type of *T. sayi*: Burlington County, N. J. ANSP 19477.

Choristothyris vanuxemi (Lyell and Forbes) 1844

Plate 9, Figures 1, 2

Terebratula vanuxemi Lyell and Forbes, 1844, Proc. Geol. Soc. London. Vol. 4, p. 308 and figs.

Terebratella vanuxemi, Whitfield, 1886, p. 14, pl. 1, figs. 1-4

Terebratella vanuxemi, Weller, 1907, p. 344, pl. 27, figs. 12-13

Description.—Shell subovate in outline, pointed posteriorly and rounded anteriorly, each valve marked by from 15 to 23 rather faint, rounded plications, some of which divide in passing from the beak to the front margin; longer than wide, the dimensions of two individuals being: length, 16 mm., 11.5 mm.; width, 14 mm., 11 mm.; thickness, 8.5 mm., 5.2 mm. Pedicle valve rather strongly convex, usually somewhat flattened along the median line, with a small, nearly erect beak, the cardinal area of moderate size, sharply defined, slightly concave, with a broad delthyrium partially closed by a pair of deltidial plates, leaving a large foramen. Brachial valve depressed convex in younger individuals, becoming more convex with age, so that in some old examples the convexity is almost as great as that of the pedicle valve, usually with a more or less ill-defined mesial flattening or shallow sinus occupied by from two to four plications. Surface of the shell marked at intervals by rather strong, concentric lines of growth. Minute structure of the shell strongly punctate.

Remarks.—This species has its closest relations with the associated *C. plicata*, but it may be easily distinguished from that species by its smaller size, its more elongate form, its more numerous and fainter plications, and usually in the larger individuals by the more strongly convex brachial valve. Both these species occur in the Navesink marl, and neither has been found in any other horizon. *C. vanuxemi* is much the rarer form, and in its typical form has not been observed to occur actually in association with *C. plicata*, but in a bed several feet beneath the horizon of that species. (Weller)

Range in New Jersey—

NAVESINK: 41

Type.—"New Jersey"

CRETACEOUS PELECYPODA OF NEW JERSEY

by Horace G. Richards

Family Nuculidae

Nucula percrassa Conrad 1858

Plate 10, Figures 1, 2, 4

Nucula percrassa Conrad, 1858, Jour. Acad. Nat. Sci. Phila. 2nd ser. vol. 3, p. 327, pl. 35, fig. 4

Donax fordii Conrad, 1869, Am. Jour. Conch. vol. 5, p. 102, pl. 9, fig. 25.

Nucula percrassa, Whitfield, 1886, p. 102, pl. 11, figs. 4-6.

Nucula percrassa, Weller, 1907, p. 369, pl. 29, figs. 1-5.

Nucula percrassa, Wade, 1926, p. 39, pl. 8, figs. 1-4.

Description.—Shell moderately convex, attaining a large size for the genus, the largest New Jersey specimen observed being: length, 32 mm., and height about two-thirds the length. Shell subelliptical in outline, the beaks situated at about the anterior third of the shell, the greatest length of the shell at about the mid-height. Anterior margin obliquely subtruncate above, the anterior extremity of the shell subangular; basal margin between the two extremities of the shell usually regularly rounded, sometimes more or less obscurely obliquely subtruncate in front and sometimes somewhat straightened ventrally; posterior margin more or less sharply rounded; the postero-dorsal margin gently convex or nearly straight. Valves regularly convex, antero-dorsal slope rather abrupt, passing into the rather large lunular depression. Surface of the shell marked by more or less irregular concentric lines of growth, and by fine, regular, radiating costæ, narrower than the interspaces, which are more strongly developed on the anterior portion of the shell. The shell substance thick. Teeth strong, about 20 posterior and 8 or 10 anterior to the beak, both series diminishing in size as they approach the beak. Well preserved internal casts preserve strongly defined muscular impressions and pallial line, and are strongly crenate about the free margin. (Weller)

Remarks.—Whitfield considered *N. percrassa* and *N. slackiana* as distinct, but a careful study of the material convinced Weller that they were conspecific. Gabb had also expressed this view in 1876. Weller also regarded *Donax fordii* as an imperfect and somewhat distorted example of *N. percrassa*. In the Marshalltown formation near Swedesboro, the shell substance is perfectly preserved, but in other localities the specimens are usually in the form of casts.

Gardner (1916, p. 513) discusses the differences between *N. percrassa* and *N. slackiana*: "*Nucula slackiana* runs higher and heavier

than the *Nucula percrassa* of Conrad. A typical example from Maryland (*N. slackiana*) measures 33.8 mm. in length and 23 mm. in altitude, while one from Ripley (*N. percrassa*) measures 25.3 mm. in length and 19.5 mm. in altitude. The umbones are less prominent in the northern species, less convex and feebly opisthogyrate, the lunule and escutcheon less sharply differentiated and the ventral margin less flattened. . . . ”

Wade reports *N. percrassa* common at Coon Creek, Tennessee.

A further study of all specimens of both *N. percrassa* and *N. slackiana* should be made to determine the exact distribution of these two species in New Jersey and elsewhere. It is possible that some of the casts reported from New Jersey as *N. percrassa* should more correctly be referred to *N. slackiana*.

Range in New Jersey—

MAGOTHY: 5

MERCHANTVILLE: 10, 15, 17

WOODBURY: 18, 24

MARSHALLTOWN: 28

WENONAH: 35

*Range outside New Jersey.—*Georgia, Alabama, Mississippi, Tennessee.

*Type.—*Owl Creek, Mississippi. ANSP 16710; type of *Donax fordii* Haddonfield, N. J. ANSP 19700.

***Nucula slackiana* (Gabb) 1860**

Plate 10, Figures 3, 5, 6

Leda slackiana Gabb 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 397, pl. 69, fig. 36.

Nucula slackiana, Whitfield, 1886, p. 103, pl. 11, figs. 2-3.

Nucula percrassa, Weller, 1907, (part) pp. 369-71

Nucula slackiana, Gardner, 1916, p. 511, pl. 19, figs. 1-4

*Description.—*Inequilateral (casts); muscular scars large and deep; margin crenate; cardinal line apparently curved, basal irregularly rounded; hinge teeth apparently large, cup very distinct, pallial line very distinct.

*Remarks.—*For comparison with *N. percrassa* see under that species.

Range in New Jersey—

WOODBURY: 20, 24

Range outside New Jersey: Delaware.

*Type.—*Crosswicks, N. J. ANSP 19876.

***Nucula whitfieldi* Weller 1907**

Plate 17, Figures 1, 2

Nucula whitfieldi Weller, 1907, p. 371, pl. 29, figs. 6-12.

Description.—Shell triangularly subovate in outline, with moderately convex valves; the beaks pointed, situated from one-fifth to one-fourth the length of the shell from the anterior extremity; postero-dorsal margin moderately convex from the beak to the somewhat sharply rounded posterior extremity of the shell which is below the mid-height; ventral margin convex throughout, curving upward more rapidly in front than behind; anterior margin rounded; antero-dorsal margin sloping somewhat abruptly from the beak. Hinge-line with 20 to 25 teeth posterior to the beak and 10 or 12 in front, with a few small ones directly beneath the beak. Surface of the shell marked by somewhat regular concentric lines. Surface of the casts usually smooth and without marginal crenulations.

The dimensions of a rather large individual from the Wenonah sand are: length, 21 mm; height, 15.5 mm. (Weller)

Remarks.—The species differs from *N. percrassa* in the absence of radiating costae upon the external surface of the shell, and in the absence of marginal crenulations.

Range in New Jersey—

MAGOTHY: 5

MERCHANTVILLE: 8, 9, 10, 15

WOODBURY: 19, 20, 24

WENONAH: 34, 35

RED BANK: 59, 60

Type.—Marlboro, N. J. NJSM (cotype), Lorillard, N. J. NJSM 7732 (cotype), Crawford's Corner 7685, Chicago 18661

Family Nuculanidae

***Nuculana compressifrons* Whitfield 1886**

Plate 10, Figure 7

Nuculana compressifrons Whitfield, 1886, p. 109, pl. 11, fig. 9.*Leda compressifrons* Weller, 1907, p. 372, pl. 29, figs. 13-17.

Description.—Shell small, the dimensions of an average specimen from Lorillard being: length, 8.5 mm., height 4 mm. Beaks rather prominent, situated near the anterior third of the shell. Posterior portion of the shell, from the beaks back, subcuneate in outline, the posterior extremity sharply rounded, and just below the extremity the margin is very obliquely subtruncate for a short distance; anterior portion of the shell in front of the beaks subsemielliptical in outline. Hinge-line elongate, the anterior and posterior portions widely divergent, meeting under the beak at an angle of about 140°, the posterior

row of teeth, 20 or more in number, the anterior row with about 12 or more teeth. External surface of the shell, as indicated by impressions, perfectly smooth. (Weller)

Remarks.—This name was first legitimately used by Whitfield, although that author credits it to Conrad. Conrad, however, only applied it as a manuscript name upon a label in the collection of the Academy of Natural Sciences. Whitfield's original illustration is inaccurate in representing the posterior extremity of the shell too squarely truncate.

Range in New Jersey—

MERCHANTVILLE: 10

WOODBURY: 18, 20, 24

Type.—Haddonfield, N. J. ANSP 18730

***Nuculana pinnaformis* (Gabb) 1860**

Plate 10, Figure 8

Leda pinnaforma Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 303, pl. 48, fig. 22.

Nuculana pinnaformis, Whitfield, 1886, p. 108, pl. 11, fig. 7.

(Not 8 = type of *Leda whitfieldi* fide Gardner.)

Leda pinnaformis, Weller, 1907, p. 373, pl. 29, fig. 27.

Description.—Shell small, the dimensions of the type specimen being: length, 6.5 mm.; height, 4.7 mm.; cuneate-subovate in outline, the anterior margin rather broadly rounded, the ventral margin rather strongly convex in the middle, the posterior extremity pointed; valves strongly ventricose in the middle, becoming compressed posteriorly. Beaks large and rather prominent, situated about two-fifths of the length of the shell from the anterior extremity; along the postero-cardinal margin the edge of the shell is inflected to form a narrow, nearly linear area extending from the beak to the posterior extremity. Surface of the shell marked by conspicuous, regularly concentric lines which become obsolete at the margin of the linear area along the post-cardinal margin. Characters of the hinge-line not observed. (Weller)

Remarks.—Known only from Gabb's original type specimen. The species may be recognized by its short, ventricose form, and its strong concentric markings.

Range in New Jersey—

WOODBURY: 24

Type.—Burlington County, N. J. ANSP 19519.

***Nuculana marlboroensis* (Weller) 1907**

Plate 10, Figures 9, 10

Leda marlboroensis Weller, 1907, p. 374, pl. 29, figs. 18-23.

Description.—Small shell, the dimensions of a small internal cast being: length, 6 mm.; height, 3-5 mm.; convexity, 1.5 mm. The dimensions of a larger individual are: length, 13.5 mm.; height, 7.5 mm.; convexity, 2 mm. Beaks rather prominent, directed backward, situated about two-fifths the length of the shell from the anterior end. Anterior portion of the shell in front of the beaks, subsemielliptical in outline, somewhat inflated; posterior portion compressed, rostrate, the postero-dorsal margin concave, the posterior extremity sharply and narrowly rounded, the postero-ventral margin gently convex. Hinge-line elongate, the anterior row of teeth straight, about 12 in number; posterior row slightly concave, with 16 or 18 teeth. Surface of the shell as shown in impressions of the exterior, marked by fine, regular, concentric costæ. (Weller)

Remarks.—This species has been confused with *N. pinnaformis*, but *N. marlboroensis* has a decidedly more elongated form. It may be distinguished from other species in the New Jersey fauna by its conspicuously inflated anterior portions and its compressed posterior regions. Stephenson (1923, p. 84) says that Weller's specimens should probably be referred to several species.

Range in New Jersey—

WENONAH: 34, 35.

Type.—Crawfords Corner, N. J. (cotypes) NJSM 9686; Marlboro, N. J. (cotypes) NJSM 9687; Univ. Chicago 18660.

Nuculana tintonensis (Weller) 1907

Plate 10, Figure 13

Leda tintonensis Weller, 1907, p. 379, pl. 29, figs. 31-34.

Description.—Shell small, the dimensions of an internal cast being: length 10 mm., height 5 mm., convexity 1.5 mm. Beaks rather prominent, nearly erect or pointed slightly backward, situated a little over two-fifths of the length of the shell from the anterior extremity. Anterior portion of the shell semielliptical in outline; posterior portion subcuneate behind; the posterodorsal margin nearly straight or slightly concave; the posterior margin curving downward and forward into the basal margin so that the whole ventral margin from the posterior extremity of the hinge-line to the middle of the anterior margin, describes nearly the arc of a circle. Anterior series of teeth straight or slightly convex, about 10 or 12 in number; posterior series nearly straight or slightly concave, about 15 or 16 in number. Surface of casts smooth, external surface of shell unknown. (Weller)

Remarks.—Differs from *N. gabbana* in having much coarser teeth, there being 25 posterior and 20 anterior in *N. gabbana*, which is nearly twice as many as in the shell under discussion.

Range in New Jersey—

TINTON: 62

Type.—Beers Hill, N. J. NJSM 7499; Univ. Chicago 18695 (cotypes).

***Nuculana protexta* (Gabb) 1860**

Plate 10, Figure 15

Leda protexta Gabb, 1860, Jour. Acad. Nat. Sci. Phil., ser. 2nd, vol. 4, p. 303, pl. 48, fig. 23 (Not *Leda protexta* Gabb, Jour. ANSP 2nd ser., vol. 4, p. 397, pl. 68, fig. 35).

Nuculana protexta, Whitfield, 1886, p. 105, pl. 11, fig. 10.

Leda protexta, Weller, 1907, p. 375, pl. 29, fig. 26.

Nuculana protexta, Groot, Organist and Richards, 1954, p. 40.

Description.—"Shell very elongate and narrow, the narrow end about once and a half as long as the wider, and strongly recurved. Valves moderately ventricose and the beaks only moderately elevated; anterior end narrowly rounded and the posterior extremity extended and narrow; basal line gibbous in the middle. On the cast the hinge is seen to be marked by a very large number of small teeth, but the number cannot be made out on any of the several specimens examined. The cartilage pit beneath the beak has been of moderate size. Surface features of the shell unknown." (Whitfield.)

Remarks.—This species is only known from somewhat imperfect internal casts which do not show the external features of the shell. The species differs from any other member of the genus in the New Jersey faunas with a similar outline in having much more strongly ventricose valves. The species has not been found in recent collections of the Survey.

Range in New Jersey—

MT. LAUREL—NAVESINK: 47, 53

Range outside New Jersey: Delaware.

Type.—Gloucester County, N. J. ANSP 18729.

***Nuculana cliffwoodensis* (Weller) 1907**

Plate 10, Figure 11

Leda cliffwoodensis Weller, 1907, p. 377, pl. 29, figs. 24-25.

Description.—Shell elongate, the dimensions of a nearly perfect internal cast being: length, 21.5 mm.; height, 9 mm.; thickness, 3.5 mm. The beaks moderately pointed and directed backward, situated about four-tenths of the length of the shell from the anterior extremity. Anterior portion of the shell in front of the beaks, subsemielliptical in outline, postero-dorsal margin concave, posterior extremity subtruncate, rounding rather abruptly below into the gently convex postero-ventral margin. Hinge very long, the anterior portion nearly straight,

with about 20 teeth, the posterior portion concave, with 30 or more teeth, the teeth of each series diminishing in size regularly as they approach the beaks, the two series meeting beneath the beaks in a very broadly obtuse angle. Surface of the shell, as indicated by external impressions, smooth. (Weller)

Remarks.—This species is a common one in the Cliffwood clays. It is an elongate form of rather large size, somewhat similar in general outline to *L. protexta*, but it may always be distinguished from that species by its much more compressed form. The species most closely resembles *Perrisonota protexta*, but it differs from that form in the much more posterior position of the beaks.

Range in New Jersey—

MAGOTHY: 6

Type.—Cliffwood, N. J. NJSM 7781.

***Nuculana longifrons* (Conrad) 1860**

Plate 10, Figure 14; Plate 11, Figure 3

Leda longifrons Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 281, pl. 46, fig. 18.

Nuculana longifrons, Whitfield, 1886, p. 107, pl. 11, figs. 16-17.

Yoldia longifrons, Weller, 1907, p. 381, pl. 30, fig. 5.

Yoldia longifrons, Gardner, 1916, p. 518, pl. 19, fig. 13.

Yoldia longifrons, Wade, 1926, p. 41, pl. 8, figs. 13-14.

Nuculana longifrons, Stephenson, 1941, p. 78, pl. 8, fig. 25.

Nuculana longifrons, Groot, Organist and Richards, 1954, p. 41.

Description.—The dimensions of an average specimen are: length, 36 mm., height, 14.5 mm.; convexity, 4.5 mm. Shell longitudinally sub-elliptical in outline, a little narrower behind than in front. Beaks scarcely elevated above the hinge-line, situated about two-fifths the length of the shell from the anterior extremity. Anterior and posterior cardinal margins sloping away from the beak on either side, meeting in an angle of 150° to 155°; anterior margin broadly rounded, its most anterior extension above the mid-height of the shell; posterior margin more narrowly rounded, its greatest extension above the middle; ventral margin gently convex in the middle, curving upward more sharply at either end. Impression of the hinge-line in the internal cast bearing about 35 or more <—shaped teeth posteriorly in nearly a straight line, and about 25>—shaped teeth anteriorly, also in a straight line. External surface of the shell polished, marked only by fine, more or less conspicuous concentric lines of growth. (Weller)

Remarks.—Formerly abundant at Lorillard. In some of the internal casts a deep pallial sinus is faintly seen, which gives to the shells the characteristic features of the genus *Yoldia*. The species is a close ally of *Yoldia evansi* M. & H. of the Cretaceous faunas of the interior.

Range in New Jersey—

WOODBURY: 18, 19, 20, 24

Range outside New Jersey: Delaware, Maryland, Georgia, Alabama, Arkansas, Texas, Mississippi.

Type.—Haddonfield, N. J. ANSP 18726.

***Nuculana whitfieldi* Gardner 1916**

Plate 18, Figure 7-9

Nuculana pinnaformis, Whitfield, 1885, (part) p. 108, pl. 11, fig. 8 (not fig. 7=*N. pinnaformis*, Gabb).

Leda whitfieldi, Gardner, 1916, p. 516, pl. 19, figs. 10-12.

Leda whitfieldi, Wade, 1926, p. 41, pl. 19, figs. 10-12.

Leda pinnaformis, Weller, 1907, (part) p. 373, (not fig. 27=*N. pinnaformis* Gabb).

Description.—Shell small, convex, cuneate dorsally, arcuate ventrally, forming roughly a sector of 120°; posterior end more produced than the anterior and sharply rostrate; anterior end evenly rounded; umbones inflated, flattened upon their summits; incurved, proximate; external adult sculpture of twenty to thirty concentric rugae, strongest and most crowded toward the ventral margin, altogether absent upon the umbones and evanescent in the slightly depressed area directly in front of the rostrum; teeth fine but sharp becoming increasingly finer and convergent beneath the umbones; both anterior and posterior series numbering from thirteen to seventeen; ligament pit trigonal, minute, subumbonal; muscle scars small, placed at the distal ends of the hinge; pallial line running close to the ventral margin; pallial sinus short, steeply ascending, squarely truncate.

Remarks.—"Forms referable to *L. whitfieldi* were included by Whitfield under *L. pinnaformis*, an error perpetuated by Weller and others. The differences are sufficiently obvious in Whitfield's two figures. Gabb's species is much higher relatively, with higher, more prominent umbones, a broader posterior keel, and a finer concentric sculpture." (Gardner).

Range in New Jersey—

WOODBURY: 24

Range outside New Jersey: Maryland, Tennessee.

Type.—Haddonfield, N. J. ANSP missing.

***Nuculana stephensoni* Richards new name**

Plate 11, Figures 1, 2

Perrisonta protexta, Conrad, 1869, Amer. Jour. Conch. vol. 5, p. 98, pl. 9, fig. 24.

Perrisonta protexta, Whitfield, 1886, p. 110, pl. 11, figs. 14-15.

Perrisonta protexta, Weller, 1907, p. 379, pl. 30, figs. 1, 2.

Perrisonta protexta, Gardner, 1916, p. 522.

Description.—"Shell small, ensiform, extremely elongated posteriorly, and gradually narrowed from the beaks. Valves depressed convex with very small inconspicuous beaks, which are curved backward, and with an obsolete carination extending from them backward to the postero-basal angle. Anterior end broadest, sharply rounded; posterior end narrowly rounded, longest above the middle. Hinge-line arched upward in front of the beaks, and gently concave posteriorly throughout the entire length of the shell. Basal line moderately curved, more prominent just in advance of the beaks. Surface of the shell polished or marked by very fine concentric lines of growth, except on the posterior cardinal slope, where they unite and form a few inconspicuous folds." (Whitfield.) The impression of the hinge-plate in internal casts shows the presence of 60 or more fine, straight teeth posterior to the beaks, and about 12 much larger and decidedly >—shaped teeth in front.

The dimensions of a large internal cast are: length 26 mm., height 8 mm.

Remarks.—Conrad (1869) proposed the new generic name *Perrisonta* for greatly elongated forms closely related to *Leda* (= *Nuculana*). The type species was *P. protexta*. Gabb (1860) had already described another elongated form under the name *Leda protexta* which, by definition, would fall in the genus *Perrisonta*. It is doubtful whether the characteristics mentioned by Conrad should be given generic rank. However, whether *Perrisonta* be recognized or not, it is apparent, as pointed out by Stephenson (1941, p. 79), that a new name must be found for Conrad's species. Accordingly the new name *Nuculana stephensoni* is proposed in honor of Dr. L. W. Stephenson.

In all localities, except Haddonfield, this species has been observed only in the form of internal casts, and these do not possess the obscure carination or umbonal ridge passing from the beak to the postero-basal margin.

Range in New Jersey—

MERCHANTVILLE: 10, 15

WOODBURY: 24

WENONAH: 35

MT LAUREL—NAVESINK: 53

RED BANK: 59, 60

TINTON: 62

Range outside New Jersey.—Maryland, Georgia, Mississippi.

Type.—Haddonfield, N. J. ANSP 18728.

Yoldia gabbana (Whitfield) 1886

Plate 10, Figure 12; Plate 11, Figures 7, 8

Leda protexta Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. 4, p. 397, pl. 68, fig. 35 (Not *Leda protexta* idem. p. 303, 1860 pl. 48, fig. 23.)

Nuculana gabbana, Whitfield, 1886, p. 106, pl. 11, figs. 11-13.

Leda gabbana Weller, 1907, p. 378, pl. 29, figs. 28-30.

Yoldia gabbana Gardner, 1916, p. 520, pl. 29, figs. 28-30.

Description.—"Shell of moderate size, extremely elongated, the length being nearly twice and a half the extreme height. Valves convex, regularly and evenly rounded. Beaks small, appressed and incurved, and distinctly inclined toward the narrower end of the shell, scarcely rising above the hinge-line on the wider part, and situated about two-fifths of the length from the larger end. Cardinal margin on the wider end gently arcuate and a little more strongly concave on the narrower side of the beak; large extremity of the shell sharply rounded; basal margin gently rounded throughout and the posterior end narrow and rounded. As the specimen is an internal cast, it preserves no evidences of the surface characters. The muscular scars are extremely faint and the pallial line indistinguishable, although the cast is in an excellent state of preservation and somewhat polished on the surface from the perfect condition. The hinge-line has been marked by a large number of very fine teeth, gradually increasing in size from the center outward. On the wider end of the shell there are about 25 visible under a glass and about 20 somewhat stronger ones on the narrower side of the beak. The ligamental pit has been of moderate size, but well marked and deep." (Whitfield.)

Remarks.—Rare, and not known from recent collections.

Range in New Jersey—

MT. LAUREL—NAVESINK: 43

Range outside New Jersey—Maryland, Tennessee.

Type.—Freehold, N. J. (?) ANSP 18727.

Yoldia papyria (Conrad) 1869

Plate 11, Figures 4, 5

Nucularia papyria Conrad, 1869, Am. Jour. Conch, vol. 5, p. 44, pl. 1, fig. 7.

Nucularia papyria Whitfield, 1886, p. 111, pl. 11, figs. 18-20.

Yoldia papyria Weller, 1907, p. 382, pl. 30, fig. 6.

Description.—The dimensions of a large right valve are: length, 15.5 mm.; height, 9.5 mm.; convexity, 3 mm. Shell subelliptical in outline, strongly convex in the anterior half, becoming rapidly depressed posteriorly. Beak scarcely elevated above the hinge-line, situated

a little over one-fifth of the length of the shell from the anterior extremity. Posterior portion of the hinge-line nearly straight, the hinge-plate bearing about 18 >-shaped teeth; the anterior hinge-line much shorter than the posterior, rapidly declining, forming an angle of about 125° with the posterior portion, the hinge-plate bearing about 12 <-shaped teeth. Anterior margin of the shell rounded from just below the beak to a point on the ventral margin directly beneath, the curve being subsemielliptical with the most anterior point at about the mid-height of the shell; basal margin gently convex, subparallel with the posterior part of the hinge-line; posterior margin rounding from the posterior extremity of the hinge-line, the greatest posterior extension of the shell being above the middle, obliquely convex, subtruncate below and rounding into the basal margin. Surface of the shell nearly smooth, marked only by faint concentric lines of growth.

Remarks.—The types of this species from Haddonfield are scarcely more than one-half the size of the specimens whose dimensions are given above. This fact, however, is in accord with the individuals of many of the Haddonfield species, which grow to a much larger size in the more northern localities. The hinge characters of the Haddonfield specimens have never been properly made out; the fragmentary shells, preserving imperfectly the hinge-teeth assigned to this species, and made typical of the genus *Nucularia*, belong without doubt to some other species as has been suggested by Whitfield. An internal cast from near Matawan agrees in all the general characters of the shell, except size, with the typical Haddonfield specimens, and there can be no doubt as to their specific identity, but the Matawan specimen preserves very perfectly an impression of the hinge-plate, which shows the dentition to be not fundamentally different from that of the associated *Yoldia longifrons*. The presence or absence of the deep pallial sinus has not been detected in any of the specimens observed, so that it has not been absolutely demonstrated that the species is a member of the genus *Yoldia*, but when the strong general similarity with *Y. longifrons* is taken into account, there is little or no doubt as to its proper generic position. (Weller)

Range in New Jersey—

WOODBURY: 19, 24

Type.—Haddonfield, N. J. ANSP 18752.

***Yoldia cliffwoodensis* Weller 1907**

Plate 11, Figure 6

Yoldia cf. evansi Meek and Hayden, Weller, 1905, Jour. Geol., vol. 13, pp. 239, 331; also Ann. Rep. State Geol. N. J. for 1904, pp. 137, 138. (Not *Y. evansi* Meek and Hayden)

Yoldia cliffwoodensis Weller, 1907, p. 383, pl. 30, figs. 3-4.

Description.—The dimensions of one of the type specimens are: length, 15.5 mm.; height, 9 mm.; convexity, 2 mm. Shell subelliptical in outline, the valves depressed convex, somewhat compressed in front and behind. Beaks scarcely elevated above the hinge-line, situated about two-fifths the length of the shell from the anterior extremity. Both the anterior and posterior portions of the hinge-line straight or nearly straight, the posterior portion with 20 or more teeth, the anterior portion declining from the beak at an angle of about 46° with the posterior portion, with about 15 teeth. Anterior margin of the shell rounding from the anterior extremity of the hinge-line, the greatest extension at about the mid-height of the shell; posterior margin rounding from the posterior extremity of the hinge-line, the greatest extension above the middle; ventral margin, between the most anterior and posterior points of the shell, approaching a longitudinal semi-ellipse, but with the posterior portion more or less obscurely obliquely subtruncate. Surface of the shell smooth, as indicated by impressions of the exterior. (Weller)

Remarks.—This species resembles *Y. longifrons*, but is proportionately shorter with the basal margin more strongly curved and the anterior and posterior portions of the hinge-line forming less nearly a straight line; it has not been observed to grow as large as the larger individuals of *Y. longifrons* from Lorillard.

Range in New Jersey—

MAGOTHY: 5, 6

Type.—Near Matawan, N. J. NJSM 8868.

Family Grammatodontidae

Nemodon eufaulensis (Gabb) 1860

Plate 11, Figure 9

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

Nemodon eufaulensis, Whitfield, 1886, p. 83, (part) pl. 12, figs. 3-4 (not 5).

Nemodon eufaulensis, Weller, 1907, p. 385, pl. 30, figs. 8-11.

Nemodon eufaulensis, Gardner, 1916, p. 525, pl. 20, figs. 3-4.

Nemodon eufaulensis, Wade, 1926, p. 42, pl. 8, figs. 17-18.

Description.—“Shell, small, seldom reaching a length of one inch in the extreme. Form trapezoidal, the cardinal and basal margins subparallel, and the length about twice and a half as great as the height. Anterior end obliquely and rapidly receding from the extremity of the hinge and most rapidly on the lower half; posterior end obliquely truncate, prolonged backward below to the umbonal angle. Valves moderately ventricose, with a decidedly angular umbonal ridge behind,

and a shallow mesial depression extending from the beaks to the basal border, slightly affecting the basal near the middle of its length. Beaks large and rather prominent, situated at about the anterior third of the length. Area moderate. Surface marked by numerous fine radiating striae showing upon the cast, which are a little coarser near the posterior angle and on the cardinal slope, possibly somewhat alternating in size on the anterior end, but indistinctly showing this feature on the internal cast. Hinge-line marked by two distinct linear teeth on the anterior end parallel to the hinge. Those of the rest of the hinges have not been observed." (Whitfield).

Remarks.—Some of the specimens referred to this species by Whitfield have been placed in the species *N. conradi* by Johnson. *N. eufaulensis* seems to differ from *N. conradi* in the greater extension of the hinge-line anterior to the beak, in the more angular umbonal ridge, and in the stronger sinus extending from the beak to the ventral margin. The species as here recognized in the New Jersey faunas is represented by a specimen from the Navesink formation described and illustrated by Whitfield. The same form occurs abundantly in the Red Bank sand, and rarely in the Merchantville clay-marl. The Red Bank examples vary considerably in size, at some localities small individuals 10mm. to 12mm. in length being the only ones recognized, while in other localities they are larger, reaching a length of 20mm. more or less. In Whitfield's description it is stated that the posterior hinge-teeth have not been observed, but recently collected specimens show them to be two or three in number, parallel with the hinge-line and similar to the anterior teeth but more elongate.

This species has been confused with a form described by Conrad (1869) as *Nemodon eufaulensis*. *N. conradi* is separated from *N. eufaulensis* by the less elongate outline, the more nearly central umbone and by the presence of a fine radial sculpture over the entire external surface.

The New Jersey specimens are merely casts and are questionably referred to *N. eufaulensis*.

Range in New Jersey—

MERCHANTVILLE: 10, 15

MARSHALLTOWN: 28

MT. LAUREL—NAVESINK: 41, 46, 49

RED BANK: 59, 60

TINTON: 62

Range outside New Jersey: Maryland, Tennessee, Alabama, Georgia, Mississippi, Arkansas.

Type.—Eufaula, Alabama ANSP 18799.

Nemodon conradi Johnson 1905

Plate 17, Figure 3

Trigonarca eufaulensis Conrad 1867 Am. Jour. Conch, vol. 3, p. 9 (not of Gabb).

Nemodon eufaulensis Whitfield, 1886, p. 83, pl. 12, fig. 5 (Not figs. 3-4.)

Nemodon conradi Johnson, 1905, Proc. Acad. Nat. Sci. Phila. p. 9.

Nemodon conradi Weller, 1907, p. 387, pl. 30, fig. 7.

Description.—Shell subrhomboidal in outline, the dimensions of a nearly complete right valve being: length, 16.8 mm.; height, 9 mm.; length of hinge-line, 12 mm. The valves moderately convex, with the beaks somewhat incurved and situated at about the anterior third of the total length of the shell, the umbo produced a little beyond the hinge-line. Hinge-line straight; the anterior margin making an obtuse angle with the hinge-line, broadly rounding into the slightly convex ventral margin, the ventral margin curving rather sharply posteriorly into the obliquely subtruncate posterior margin. Umbonal ridge rounded, the posterior slope rather narrow. Surface of the internal cast marked by concentric and radiating lines of nearly equal strength, giving it a cancellated appearance. Anterior and posterior hinge-teeth both three in number, straight and nearly parallel with the hinge-margin, the posterior ones being slightly longer than the anterior. (Weller)

Remarks.—It somewhat resembles *N. eufaulensis*, but the beaks are more prominent and the anterior margin is very different, the most anterior extension of the shell being near the hinge-line in *N. eufaulensis*, while in *N. angulatum* it is near the base. The radiating markings of the shell may be distinguished upon the casts of *N. eufaulensis*, which is not the case with this species.

Range in New Jersey—

WOODBURY: 18, 24

Type.—Haddonfield, N. J.; ANSP 18798.

Nemodon angulatum (Gabb) 1860

Plate 11, Figure 10

Leda angulata, Gabb, 1860, Proc. Acad. Nat. Sci. Phil. (1860), p. 95, pl. 2, fig. 12.

Nemodon angulatum, Whitfield, 1886, p. 84, pl. 12, figs. 6-7.

Nemodon angulatum, Weller, 1907, p. 388, pl. 30, fig. 15.

Description.—Shell small, the dimensions of the type specimen being: length, 15.7 mm.; height, 8 mm.; thickness, 5 mm. Beaks rather prominent, situated at about the anterior third of the shell. Anterior margin broadly curved from beneath the beak to the antero-

basal region, where it curves more abruptly into the nearly straight ventral margin, postero-basal margin produced and subangular, posterior margin truncate, meeting the posterior extremity of the hinge-line in an obtuse angle, dorsal margin nearly straight, sloping gently backward from the beak to the posterior hinge extremity. From the beak a subangular umbonal ridge passes obliquely backward to the postero-basal angle, and a broadly-flattened or slightly sinuate area passes downward from the beak to about the middle of the ventral margin. The surface markings and hinge characters not preserved on the type specimen, which is an internal cast. (Weller)

Remarks.—Known only from the type specimen. Somewhat resembles *N. eufaulensis*, but the beaks are more prominent, and the anterior margin is very different, the most anterior extension of the shell being near the hinge-line in *N. eufaulensis*, while in *N. angulatum* it is near the base. The radiating markings of the shell can usually be distinguished upon the casts of *N. eufaulensis* which is not the case with this species.

Range in New Jersey—

NAVESINK: 57

Type.—Burlington County, N. J. ANSP 18723.

Nemodon brevifrons Conrad 1875 (†)

Plate 11, Figures 11, 12

Nemodon brevifrons Conrad, 1875, Kerr's Geol. N. Car., App. A., p. 4, pl. 1, fig. 15.

Nemodon brevifrons, Whitfield, 1886, p. 85, pl. 12, figs. 1-2.

Nemodon brevifrons, Weller, 1907, p. 389, pl. 30, figs. 12-14.

Nemodon brevifrons, Stephenson, 1923, p. 91, pl. 14, figs. 1-4.

Description.—Shell of moderate size, the dimensions of a very perfect right valve being: length, 23 mm.; height, 13 mm.; length of hinge-line, 15 mm.; convexity, 6 mm. Shell subrhomboidal in outline, rather strongly convex. Beaks incurved, the umbo rather broad and prominent, and produced above the hinge-line. Hinge-line straight. Anterior margin meeting the hinge-line in an obtuse angle, broadly and evenly rounded, passing with a regular curvature into the gently convex ventral margin, postero-ventral margin rather broadly rounded and passing into the obliquely subtruncate posterior margin above, which meets the hinge-line in an obtuse angle. The umbonal ridge prominent, broadly rounded or somewhat inflated, the posterior slope being narrow and somewhat abrupt. Surface of the shell marked by concentric lines of growth, and in some specimens by faint radiating lines, which are more conspicuous upon the anterior portion of the shell. The anterior hinge-teeth are three in number, rather short and slightly curved, but nearly parallel with the hinge-line, the posterior teeth are also three in number,

perhaps a little longer than the anterior ones, straight and subparallel with the hinge-line. (Weller)

Remarks.—Whitfield's figured specimens from Haddonfield in the Woodbury formation probably actually came from Snow Hill, North Carolina, the type locality of the species (Johnson, 1905, p. 9). In specimens obtained from the Cliffwood clay the radiating markings of the shell, as shown in an impression of the exterior, are apparently obsolete, the markings being essentially as shown in Conrad's original illustrations of the species. One of the specimens from the Wenonah sand, on the other hand, with no essential differences in the contour of the shell, exhibits some faint radiating markings, which are more strongly developed on the anterior portion of the shell, agreeing essentially with Whitfield's description.

Stephenson (1923, p. 92) questions the correctness of Weller's reference of the New Jersey specimens to *N. brevifrons*; he points out that they are all casts and with the possible exception of Figure 13, appear to lack the obliquity that characterizes the North Carolina specimens; also the beaks appear to be a little farther from the anterior end.

Range in New Jersey—

MAGOTHY: 5

WENONAH 34, 35

Range outside of New Jersey: North Carolina, Alabama.

Type.—Snow Hill, N. C. ANSP 2301.

Nemodon obesus Stephenson 1954

Plate 42, Figures 3, 4

Nemodon obesus Stephenson, 1954, U. S. Geol. Surv. Prof. Paper 264-B, p. 29, pl. 6, figs. 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 postero-

dorsal 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." (Stephenson)

Range in New Jersey—

RARITAN: 1b

Type.—Sayreville, N. J. USNM 108620, 108621 (cotypes).

Family Cucullaeidae

Cucullaea vulgaris Morton

Plate 12, Figures 6, 7; Plate 13, Figures 3, 5

Cucullaea vulgaris Morton, 1830, Amer. Jour. Sci. 1st ser. vol. 17, p. 285, pl. 3, fig. 21.

Idonearca vulgaris, Whitfield, 1886, p. 98, pl. 13, figs. 1-5.

Idonearca tippiana, Whitfield, 1886, p. 95, pl. 12, figs. 19-21.

(Not *Cucullaea tippiana*, Conrad, 1858.)

Idonearca medians, Whitfield, 1886, p. 199, pl. 26, figs. 5, 6.

Cucullaea tippiana, Weller, 1907, p. 394, pl. 31, figs. 5-10.

(Not *Cucullaea tippiana*, Conrad, 1858.)

Cucullaea vulgaris, Weller, 1907, p. 397, pl. 32, figs. 5, 6.

Cucullaea vulgaris, Gardner, 1916, p. 529, pl. 20, figs. 8, 9; pl. 21, figs. 1, 2.

Cucullaea vulgaris, Wade, 1926, p. 43, pl. 9, figs. 3, 4, 6, 7.

Description.—Internal casts subtriangular in outline, subcuneate behind; the dimensions of a large, nearly perfect specimen, are: length, 40 mm.; height, 32 mm.; thickness, 32 mm. Shell very oblique, the beaks of the internal cast large, widely separated and greatly elevated above the hinge-line. Anterior margin curving backward and downward from the anterior extremity of the hinge-line into the gently convex basal

margin; postero-basal extremity prominent, sharply rounded or sub-angular; posterior margin obliquely truncate. Valves with a strong, angular umbonal ridge, becoming especially prominent towards the postero-basal extremity; the postero-dorsal slope abrupt, indented by the deep and strong, crescentiform cavity left by the posterior muscular ridge. Anterior muscular impression of moderate strength. Pallial line usually strongly defined, especially posteriorly, represented in the casts by an elevated ridge crossed by sharply defined elevated ridges which are short and close anteriorly, becoming longer, stronger and more distant posteriorly, especially where the pallial line crosses the umbonal ridge. (Weller)

Remarks.—The original examples of this species are sixteen individuals in the Academy of National Sciences labelled "New Jersey; Crosswicks ?" One of these was undoubtedly Morton's figured specimen but it is impossible to identify it. The specimens are internal molds and are therefore difficult to compare with perfect specimens from southern localities. Specimens similar to the type lot of *C. vulgaris* are common in the Navesink and Hornerstown formations. The specimens from the Marshalltown, Navesink and Tinton formations referred to *C. tippiana* Conrad by Weller are probably also this species. The true *C. tippiana* is not known from New Jersey and is probably a young stage of *C. capax* Conrad (Stephenson, 1941, p. 89).

There seems to be some confusion about the generic names *Cucullaea* and *Idonearca*, the latter formerly being regarded as a subgenus. The present author prefers to use the broader term *Cucullaea*.

Pilsbry (1929) pointed out that the generic name *Cyphoxis* proposed by Rafinesque in 1819 was probably based on some casts of *Idonearca* (probably *I. vulgaris*) probably from the Cretaceous marls of New Jersey. But since no locality was given by Rafinesque and since there is a doubt that Rafinesque's specimens were actually *C. vulgaris*, the present author agrees with Stephenson (1941, pp. 89-90) that the name *Cyphoxis* should not be used for the New Jersey specimens.

Range in New Jersey—

MARSHALLTOWN: ("C. tippiana") 27, 28, 31

MT LAUREL-NAVESINK: 37, 57

RED BANK: ("C. tippiana") Shrewsbury River.

TINTON: ("C. tippiana") 62

HORNERSTOWN: New Egypt, Sewell, Birmingham

Range outside New Jersey: Delaware; other records not verified because of confusion with *C. tippiana*, etc.

Type.—Label says "New Jersey, Crosswicks ?" probably equals Crosswicks Creek; ANSP 19568.

Cucullaea antrosa Morton 1834

Plate 11, Figures 13, 14; Plate 12, Figure 1

Cucullaea antrosa Morton, 1834, Synop. Org. Rem. Cret. Gr. U. S. p. 65, pl. 13, fig. 6.

Idonearca antrosa, Whitefield, 1886, p. 96, pl. 13, figs. 6-11.

Cucullaea antrosa, Weller, 1907, p. 391, pl. 32, figs. 7-9.

Cucullaea antrosa, Gardner, 1916, p. 534.

Cucullaea antrosa, Stephenson, 1923, p. 87, pl. 12, figs. 5-6.

Description.—“Shell subcircular in outline, or very slightly ovate from being a little prolonged at the postero-basal angle, very slightly oblique with a straight hinge-line, which is about half as long as the greatest length of the shell. Beaks large, erect, and slightly incurved, but not projecting beyond the edge of the proportionally small ligamental area which is marked by oblique grooves, as in all species of the group. Surface of the shell slightly angulated along the postero-umbonal slope and very convex; marked by numerous strong concentric lines of growth at irregular distances; no radiating striæ. Hinge-plate narrow in small and medium sized specimens and the teeth small, but barely bent down at their inner extremity and few in number; the denticulations along the middle of the hinge vertical and small. On large individuals the outer teeth are strong, from four to five in number on each side, according to the size of the individual; slightly declining outwardly, and the bent portion usually nearly half as long as the horizontal portion, the bending being at an angle within ninety degrees, the denticles on the middle part of the hinge being small and numerous. Muscular scars, as seen on the casts, strongly marked; the impression of the ridge deep, strongly arched, and situated pretty well up on the posterior slope; surface of the cast marked by rather strong vascular lines. The outer margin of the cast is bordered by a strong keel, indicating the great thickening of the valves along the pallial line, which extends around three sides, being broadest on the anterior.” (Whitefield.)

The dimensions of a large left valve are: length, 75 mm.; height, 70 mm.; convexity, 26 mm.

Remarks.—Morton's type is a distorted internal mold from an unknown locality in New Jersey. For this reason it is difficult to compare it with perfect specimens from other localities. It can, however, usually be distinguished from *C. vulgaris* by its more rounded form. This species, or closely related species, is found along the Atlantic and Gulf Coastal Plain from Maryland to Texas; but in view of the poor condition of the type it seems best to restrict the name *C. antrosa* to New Jersey specimens.

Range in New Jersey—

MERCHANTVILLE: 7, 8, 9, 15

NAVESINK : 37, 43, 46, 47, 49, 50

TINTON : Freehold.

Range outside of New Jersey : ?

Type.—New Jersey : ANSP 2272.

***Cucullaea woodburyensis* Weller 1907**

Plate 12, Figure 8

Cucullaea woodburyensis Weller, 1907, p. 393, pl. 34, fig. 1.

Description.—Shell large, the dimensions of the type specimen, the internal cast of a left valve, being: length, 75 mm.; height, 69 mm.; convexity, 28 mm.; length of hinge-line, 53 mm. Anterior margin regularly rounding from the anterior extremity of the hinge-line to the middle of the ventral margin, ventral margin less curved in its posterior half, the postero-ventral margin obtusely rounding into the subtruncate posterior margin which is nearly vertical below and curves gently forward to the posterior extremity of the hinge-line above. Beaks of moderate size, those of the two valves approaching somewhat closely. Valves ventricose, without a sharp umbonal ridge, extending to the postero-ventral extremity. Indentation of the posterior muscular ridge rather narrow and of moderate strength. (Weller)

Remarks.—This species resembles *C. antrosa*, but is somewhat shorter and more nearly erect in aspect. It has, apparently, a thinner shell, so that the internal cast is not marked by the distinct marginal keel which is so characteristic of *C. antrosa*.

Range in New Jersey—

WOODBURY : 18

Type.—Lorillard, N. J.; NJSM 9526.

***Cucullaea neglecta* Gabb 1861**

Plate 13, Figures 1, 2, 4

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

Cucullaea neglecta Weller, 1907, p. 396, pl. 31, figs. 1-4.

Description.—Shell oblique, subrhomboidal in outline, the dimensions of a nearly perfect internal cast being: length, 39 mm.; height, 28.5 mm.; thickness, 22 mm.. Beaks of the internal cast of moderate size, moderately elevated above the hinge-line, and somewhat approximate for members of this genus. Anterior margin rounding regularly from the anterior extremity of the hinge-line into the gently convex basal margin; postero-basal extremity sharply rounded or subangular; posterior margin obliquely truncate; the free margins somewhat keeled. Valves with a narrowly rounded or subangular umbonal ridge, with the postero-dorsal slope rather steep, indented by the impression of the

posterior muscular ridge; anterior muscular impression of only moderate strength; pallial line not sharply defined. (Weller)

Remarks.—Known only from internal casts.

Range in New Jersey—

MERCHANTVILLE: 15

WOODBURY: 20

NAVESINK: 37, 41, 42, 48, 53

Range outside New Jersey: ?

Type.—Crosswicks, N. J. ANSP 18765.

***Cucullaea littlei* (Gabb) 1876**

Plate 12, Figure 2; Plate 13, Figures 6, 9

Idonearca littlei Gabb, 1876, Proc. Acad. Nat. Sci. Phil., p. 316.

Cucullaea littlei Weller, 1907, p. 400, pl. 33, figs. 1-2.

Cucullaea littlei Wade, 1926, p. 45, pl. 9, fig. 5.

Description.—Shell very large, the dimensions of a large internal cast being: length, 115 mm.; height, 89 mm.; thickness, 100 mm. Anterior margin regularly rounding from the anterior extremity of the hinge-line into the convex ventral margin; postero-basal margin rather bluntly rounded; posterior margin obliquely subtruncate, slightly convex; hinge-line arcuate. Beaks large and prominent, widely separated and much elevated above the hinge-line in the cast. Valves strongly ventricose, the umbonal ridge broadly rounded, the postero-dorsal slope abrupt, the posterior surfaces of the two valves meeting at the posterior margin in nearly a plane. Indentation of the posterior muscular ridge strong and very deep, 12 mm. in the type specimen. Hinge characters not observed. (Weller)

Remarks.—This is the largest species of the genus and is represented from New Jersey only by a single specimen from Tinton Falls.

Range in New Jersey—

TINTON: 63

Range outside New Jersey: Maryland ?, Georgia, Alabama, Tennessee.

Type.—Pataula Creek, Georgia; ANSP 18764.

***Cucullaea compressirostra* (Whitfield) 1886**

Plate 12, Figures 3, 4

Idonearca compressirostra Whitfield, 1886, p. 199, pl. 26, figs. 15-16.

Cucullaea compressirostra, Weller, 1907, p. 399; pl. 32, figs. 3, 4.

This species is recorded only from the Hornerstown formation but is figured because it is frequently associated with *C. vulgaris*.

***Idonearca blanpiedi* Stephenson ?**

Plate 42, Figure 8

Idonearca blanpiedi Stephenson, 1953, U. S. Geol. Surv. Prof. Paper 242, p. 63, pl. 11, figs. 1-4 (1952-1953).

Idonearca blanpiedi, Stephenson ? 1954, U.S. Geol. Surv. Prof. Paper 264-B p. 28, pl. 6, fig. 9.

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 postero-ventral direction, and a long, steep postero-dorsal 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. (Stephenson)

Range in New Jersey—

RARITAN: 1a

Range outside New Jersey: Texas.

Type.—Woodbine formation of Texas; USNM 105146.

Family Arcidae sensu lato

***Trigonarca cliffwoodensis* Weller 1907**

Plate 17, Figure 4

Trigonarca cliffwoodensis Weller, 1907, p. 401, pl. 30, fig. 17.

Trigonarca sp. Stephenson, 1923, p. 103.

Description.—Shell subtrapezoidal in outline, the dimensions of a large individual being: length, 31 mm.; height, 23 mm.; convexity of one valve, 7 mm. Anterior margin broadly rounded, the most anterior point at about the mid-height of the shell, passing below with regular curvature into the basal margin; basal margin convex throughout, but becoming straighter posteriorly; postero-basal margin broadly rounded; posterior margin subtruncate above. Valves moderately convex, the beaks at about the middle of the hinge-line and but slightly elevated above it; the umbonal ridge rounded, the post-umbonal slope gentle. Indentation of both an anterior and a posterior muscular ridge present in the casts, both of them slight but the posterior one somewhat the stronger. The larger casts marked by more or less indistinct radiating costæ above the pallial impression. Hinge teeth short, arranged in an arcuate line, diverging from either side of the beak, 20 or more in number. Surface of the valves as indicated by impressions of the exterior marked only by more or less indistinct lines of growth. (Weller)

Remarks.—This seems to be a very distinct species of *Trigonarca*

which is characterized by the slight elevation of the beaks above the hinge-line, and in the shell itself must have had very low cardinal areas. All the New Jersey specimens observed are in the form of internal casts.

Stephenson (1953) has suggested that this species more properly belongs in the genus *Breviarca*.

Range in New Jersey—

MAGOTHY: 5

Type.—Cliffwood, N. J. NJSM 7789.

***Trigonarca triquetra* Conrad 1875**

Plate 13, Figure 7; Plate 14, Figures 5, 6

Trigonarca triquetra, Conrad in Kerr, 1875, Rep. Geol. Surv. N. Car., App. A, p. 2, pl. 1, fig. 7.

Trigonarca triquetra, Weller, 1907, p. 402, pl. 30, fig. 16.

Trigonarca triquetra, Stephenson, 1923, p. 98, pl. 17, figs. 3-7.

Description.—Shell subtriangular in outline, the dimensions of a right valve being: length, 41 mm.; height, 32 mm.; convexity of one valve, 8.5 mm. Hinge-line strongly arcuate; anterior margin broadly rounded, passing regularly into the gently convex basal margin; postero-basal margin rather sharply rounded; posterior margin obliquely truncate. The valves moderately convex, the beaks situated near the middle of the hinge-line and but slightly elevated above it; umbonal ridge rounded, the postumbonal slope gentle below, becoming more abrupt towards the beak. Indentations of both anterior and posterior muscular ridges present in the casts, the anterior indentation very slight, posterior one much stronger, its lower end below the mid-height of the shell. Pallial impression distinct, above which the surface of the cast is marked by distinct radiating grooves and costæ. Hinge strongly arcuate, teeth short, diverging from either side of the beak, thirty or more in number. Surface of the valves, as indicated by impressions of the exterior, marked by fine, crowded concentric lines of growth, and by indistinct, rather broad and flat radiating costæ upon the central portion of the shell. (Weller)

Remarks.—Found associated with *T. cliffwoodensis* Weller but distinguished from it by its larger size, more nearly subtriangular outline, and especially by its more strongly arcuate hinge, the hinge plate bearing the teeth extending far down along the posterior margin, and also down the anterior margin but apparently not so far as on the posterior. This strongly arcuate hinge is apparently the most characteristic feature of the shell.

Range in New Jersey—

MAGOTHY: 5

Range outside New Jersey: North Carolina.

Type.—Snow Hill, N. C., lost; paratypes USNM 31910, 31911; ANSP 19572.

***Trigonarca cuneiformis* Conrad 1869**

Plate 13, Figure 8

Trigonarca cuneiformis Conrad, 1869, Am. Jour. Conch, vol. 5, p. 98, pl. 9, fig. 1.

Trigonarca cuneiformis, Whitfield, 1886, p. 88, pl. 12, figs. 17-18.

Trigonarca cuneiformis, Weller, 1907, p. 403, pl. 30, figs. 18-20.

Description.—"Shell quite small, not exceeding half an inch in extreme length in any of the examples yet observed. Trapezoidal in outline and quite ventricose. Hinge but little more than one-half the length of the shell, and the area very narrow. Beaks small, slightly incurved. Anterior end of the shell regularly rounded; posterior end elongate, produced below, the posterior margin very oblique, so as to make the postero-basal angle quite acute. Hinge-plate very narrow, marked by oblique transverse teeth, the anterior end having 10 or 12 directed inward below, and the posterior a somewhat larger number pointed in the opposite direction. Muscular impression large, the posterior one bordered by a slightly elevated lamella on the anterior margin. Surface of the shell marked by radiating lines, strongest on the anterior end and faintest on the middle of the valve; also by concentric lines which cross them and form slight pustules at the junctions." (Whitfield.)

The dimensions of an internal cast are: length, 6 mm.; height, 3.5 mm.

Remarks.—Rare and known only from Haddonfield and Matawan. Whitfield had suggested that the Haddonfield specimens might be the young of another species, but the occurrence of the species at Matawan with the same dimensions together with the lack of larger individuals, would seem to indicate that the specimens were adult.

Range in New Jersey—

WOQDBURY: 19, 24

Type.—Haddonfield, N. J.; ANSP 18718

***Breviarca haddonfieldensis* Stephenson 1935**

Plate 13, Figures 10, 11

Breviarca saffordi Whitfield, 1886, p. 87, pl. 12, figs. 11-12. Not of Gabb, 1860.

Breviarca saffordi, Weller, 1907, p. 404, pl. 30, figs. 21-24.

Breviarca haddonfieldensis Stephenson, 1935, Jour. Wash. Acad. Sci. v. 25, p. 362.

Description.—"Shell rather small, ovately trapezodial in outline, with strongly ventricose valves and large, tumid, subcentral beaks, which stand prominently above the hinge line, are incurved and approximate. Hinge line about two-thirds as long as the entire length of the valves, with a moderately high, vertically striated area, the striated portion being bounded by a plain border over which the striations do not extend. Anterior end sharply rounded and the basal line round and full. Posterior extremity oblique, extended somewhat below and rounding into the basal line. Posterior umbonal ridge rounded but quite distinct. Surface covered entirely with fine, slightly raised thread-like striæ, which are somewhat alternating in size on the postero-cardinal slope. Hinge plate moderately wide and distinctly arched on the inner margin, the line of teeth more distinctly arcuate. Teeth numerous, narrow, and diverging outward from beneath the beak, and gradually increasing in length to near the outer ones. Muscular impressions proportionally large and distinct, the posterior one having a slightly raised line on its anterior margin, but only seen in the larger specimens." (Whitfield.)

Remarks.—Stephenson calls attention to the fact that most of the New Jersey specimens referred to *B. saffordi* by Whitfield are actually distinct and he therefore proposed the new name *B. haddonfieldensis*. One right valve referred to *B. saffordi* by Whitfield is actually *B. umbonata* according to Stephenson.

Range in New Jersey—

WOODBURY: 18, 19, 23, 24

Range outside New Jersey: Delaware.

Type.—Haddonfield, N. J. ANSP 13141.

Breviarca umbonata (Conrad) 1875

Plate 13, Figures 12, 13

Trigonarca (Breviarca) umbonata Conrad, 1875, in Kerr's Rept. Geol. N.C. Vol. 1, p. 3, pl. 1, fig. 8.

Breviarca saffordi, Whitfield, 1886, p. 87 (part). Not pl. 12, figs. 11-12 (= *B. haddonfieldensis* Stephenson) Not *B. saffordi* Gabb.

Striarca umbonata, Stephenson, 1923, p. 11, pl. 20, figs. 14-20.

Breviarca umbonata, Stephenson, 1935, Jour. Wash. Acad. Sci. Vol. 25, p. 363.

Description.—"Shell subtrigonal, relatively short, strongly convex. Beaks protruding prominently above the hinge line, distant, incurved, directed neither forward nor backward and situated centrally with respect to the area and a little in advance of the middle of the shell. Umbonal ridge prominent, angular; umbonal slope nearly at right angles to the plane separating the valves.

Hinge plate relatively broad, arched on lower margin and truncated above by the straight lower margin of the area. The teeth are numerous and crowded; 8 or 10 of the centrally located teeth are short and transverse; away from the central teeth on the broader parts of the plate the teeth become longer and successively more oblique, those at the extremities being nearly horizontal.

Cardinal area amphidetic and rather broad; ligament amphidetic but not attached over the entire cardinal area as shown by the much smaller lozenge-shaped surface minutely striated at right angles to the hinge line; in other words, a smooth margin exists between the striated portion and the outer margin of the area.

The interior of the shell is marked by faint radiating lines; the posterior adductor scar is bounded on the lower or inner margin by a thin, low carina that extends apically away from the scar, and though becoming fainter, is traceable nearly to the beak. A similar but much fainter carina appears on the lower inner margin of the anterior adductor scar.

Anterior margin broadly and regularly rounded; ventral margin slightly convex, becoming nearly straight posteriorly; posterior margin sharply rounded to subangular below at the extremity, becoming nearly straight and inclined forward above, meeting the hinge line at an angle of 125 to 130 degrees.

Surface marked by fine concentric lines of growth and by a few coarse growth undulations." (Stephenson).

Remarks.—According to Stephenson (1923, p. 163) one right valve referred to *B. saffordi* by Whitfield is probably *B. umbonata*. The other specimens referred to *B. saffordi* by Whitfield are assigned to *B. hadonfieldensis* by Stephenson (see page 82).

Range in New Jersey—

WOODBURY: 24

Type.—Snow Hill, N. C. probably lost; paratypes USNM 31918; ANSP 2275.

Breviarca cuneata (Gabb) 1876

Plate 13, Figures 14, 15

Trigonarca cuneata Gabb, 1876, Proc. Acad. Nat. Sci. Phil., 1876, p. 316.

Breviarca cuneata, Weller, 1907, p. 406, pl. 30, fig. 17.

Description.—Shell oblique, subtriangular in outline, the dimensions of a nearly complete internal cast of a left valve being: length 23 mm., height 18.5 mm., convexity 7.5 mm. Anterior margin rounding from the anterior extremity of the hinge-line into the basal margin, which is gently convex in the central portion, curving upward more abruptly in front and behind; postero-basal extremity rather sharply rounded; posterior margin obliquely truncate. Valves strongly convex

or somewhat ventricose; the beaks, in the casts, rather large and somewhat incurved, elevated above the hinge-line, situated in front of the middle of the shell at about the middle of the hinge-line; umbonal ridge rather sharply rounded, the postero-dorsal slope abrupt; in front of the umbonal ridge the surface is nearly flat or gently convex for some distance, and then curves rather abruptly to the anterior margin. Hinge-plate with about 12 or 15 teeth on either side of the beak. Surface marked by rather strong concentric lines of growth and by fainter radiating striae. (Weller)

Remarks.—Occurs usually in the form of internal casts; can be distinguished from *B. umbonata* and *B. haddonfieldensis* with which it is associated, by its larger size and more conspicuous markings on the shell shown in impressions of the exterior.

Range in New Jersey —

MERCHANTVILLE: 8, 10

WOODBURY: 18, 22

Range outside New Jersey: Georgia.

Type.—Pataula Creek, Georgia ANSP 18800.

***Arca uniopsis* Conrad 1853**

Plate 14, Figure 1

Arca uniopsis Conrad, 1853, Acad. Nat. Sci. Phil., 2nd ser. vol. 2, p. 275, pl. 24, fig. 17.

Cibota uniopsis Whitfield, 1886, p. 92, pl. 11, figs. 32-33.

Arca uniopsis Weller, 1907, p. 407, pl. 34, figs. 6-8.

Description.—"Shell rather above a medium size, transversely elongate, and trapezoidal or subrhomboidal in outline, with moderately convex valves, which are broadly sulcated in the middle, particularly on the right valve, and only moderately elevated beaks, situated at about the anterior third of the length, and which in the casts appear to have been scarcely enrolled and moderately distant from each other. Hinge-line not quite as long as the body of the shell, in the cast showing characters of a rather low area; anterior end obliquely rounded, receding below; basal line broadly sinuate and the posterior end obliquely truncate, longest below the center." (Whitfield).

The surface marked by radiating costae which are not present upon the internal casts. Muscular scars faintly impressed.

The dimensions of an internal cast illustrated by Whitfield are: length 50 mm., height 24 mm., thickness 17 mm.

Remarks.—Resembles *A. rostellata* and like that species is rare and usually occurs as internal casts. This species may be distinguished by its proportionately greater height, the more central position of the beaks, and the more conspicuous sinus, especially in the right valve, extending

from the beaks obliquely to the ventral margin. Radiating costae are rarely visible on the casts, while in *A. rostellata* the impressions of the plications are clearly seen.

Range in New Jersey —

MERCHANTVILLE: 14

MT. LAUREL—NAVESINK: 37, 45, 47, 57

Type.—Burlington Co., N. J. ANSP 16876.

***Arca rostellata* Morton 1834**

Plate 17, Figure 5

Arca rostellata Morton, 1834, Synop. Org. Rem. Cret. Gr. U.S., p. 64, pl. 3, fig. 11.

Cibota rostellata Whitfield, 1886, p. 91, pl. 11, figs. 34-36.

Arca rostellata Weller, 1907, p. 408, pl. 34, figs. 4-5.

Description.—"Shell trapezoidal and very oblique, the length being about twice and a half the height, with subparallel cardinal and basal margins, posterior end very obliquely prolonged below, and the anterior end rather rapidly rounding backward from near the hinge-line to its junction with the base. Basal margin very perceptibly sinuate nearly opposite the beaks and apparently very slightly gaping. Valves moderately inflated, most ventricose on the umbones just anterior to the sulcus, which crosses them from the beak to the sinus of the base, and then rapidly declining to the anterior extremity, but sloping quite gradually on the posterior side. Beaks moderately large, somewhat projecting above the hinge and slightly incurved; situated at about the anterior third of the entire length of the valves. Cardinal area moderate in size and extending about two-thirds of the length. Teeth unknown. Surface as indicated on internal casts marked by radiating ribs, pretty fine and numerous on the anterior end and in the mesial sulcus, becoming much coarser posteriorly, and showing a slight tendency to alternation in size between the sulcus and posterior umbonal angle, and on the cardinal slope a tendency to bifurcation in some cases." (Whitfield).

The dimensions of a perfect internal cast are: length, 38 mm.; height, 18.5 mm.; thickness, 13 mm.

Remarks.—Rare, the only recent record is a specimen collected at Cream Ridge by Halsey W. Miller, Jr. The New Jersey specimens have the general outline of Morton's type from Alabama, but are not so conspicuously marked by radiating costae and do not have as broad a byssal gap in their ventral margin.

Range in New Jersey —

MT. LAUREL—NAVESINK: 41, 45

Range outside New Jersey: Alabama.

Type.—Alabama; ANSP 19596.

***Arca obesa* (Whitfield) 1886**

Plate 14, Figure 2, 3

Cibota obesa Whitfield, 1886, p. 93, pl. 11, figs. 30-31.*Arca obesa* Weller, 1907, p. 409, pl. 34, fig. 9.*Arca obesa* Gardner, 1916, p. 536.

Description.—"Shell small, with full and very ventricose valves, large tumid beaks situated opposite the anterior third of the length, slightly enrolled, and distant from each other as shown on the internal cast. Form of the outline trapezoidal, the length of the cast nearly twice the height, exclusive of the projection of the beaks; anterior end vertically rounded; posterior obliquely truncate; extremity obtusely pointed; basal line full, but constricted just anterior to the middle by the very marked but short and broad byssal opening; area two-thirds the length of the valve and moderately wide. On the casts the muscular imprints are very distinctly marked and of fair size, no muscular ridge; the outer margin indicating a strong and abrupt thickening of the valves with a crenulated border; radiating lines indicating moderately fine striae show on nearly all parts of the cast, but strongest on the postero-basal section." (Whitfield.)

The dimensions of Whitfield's type of this species are: length, 25.5 mm.; height, 15.5 mm.; thickness, 13.5 mm.

Remarks.—Occasionally found in the Merchantville formation, but usually poorly preserved. The three species *A. rostellata*, *A. uniopsis* and *A. obesa* (referred to the genus *Cibota* by Whitfield), are very similar and because of their poor preservation may represent varieties of a single species.

Range in New Jersey —

MERCHANTVILLE: 14, 15, 16

Range outside New Jersey.—Maryland.

Type.—Burlington Co., N. J. ANSP 19518.

***Nemoarca cretacea* Conrad 1869**

Plate 14, Figure 4

Nemoarca cretacea Conrad, 1869, Am. Jour. Conch, vol. 5, p. 97, pl. 9, fig. 21.*Nemoarca cretacea*, Whitfield, 1886, p. 86, pl. 12, figs. 8-10.*Nemoarca cretacea*, Weller, 1907, p. 413, pl. 30, figs. 25-26.

Description.—"Shell small, seldom attaining more than half an inch in extreme length, trapezoidal in form, the transverse diameter being nearly once and a half the height. Valves very ventricose, with large, strongly inflated, prominent beaks, situated nearly opposite the middle of the length. Hinge-line straight and low; area narrow, the length

a little less than the greatest length of the body of the shell. Hinge-plate narrow, marked by about 12 short, oblique teeth which diverge from the center on each side, and two or three transverse teeth nearly parallel to the hinge-line at the posterior end. Muscular imprints too faint to be observed on well-preserved casts of the interior. No internal rib bordering the posterior scar. Surface marked by from four to six fine radiating ribs on the posterior slope, and 24 to 26 on the body of the shell and anterior end. Strongest on the posterior part of the body of the shell and gradually decreasing in size anteriorly. On some individuals one or more of the ribs on the posterior slope appear to be divided, while all are strongly elevated and rather sharp with narrow interspaces. On the matrix there are remains of distinct elevated concentric lines at regular distances crossing the radiating ribs." (Whitfield.)

The dimensions of a large internal cast of a right valve are: length, 11.5 mm.; height, 9.5 mm.; length of hinge-line, 8.5 mm.; convexity, 4.5 mm.

Remarks.—This species generally occurs in the form of internal casts, in which condition the umbo appears to be more prominent than when the shell itself is preserved. The impressions of the exterior show that the surface of the shell was covered with strong, close, concentric lines in addition to the radiating markings, and in one of the largest individuals observed the number of radiating costae is seen to be about 40.

Range in New Jersey —

MERCHANTVILLE: -?

WOODBURY: 20, 24

WENONAH: 53, 55

Eocene:

Type.—Haddonfield, N. J. ANSP 18724.

***Barbatia ? cuniculana* Stephenson 1954**

Plate 42, Figures 1, 2

Barbatia ? cuniculana Stephenson, 1954, U.S.G.S. Prof. Paper 264-B p. 27, pl. 6, figs. 2-5.

Description.—"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." (Stephenson)

Range in New Jersey—

RARITAN: 1b

Type.—Sayreville, N. J. USNM 108613

***Striarca congesta* (Conrad) 1875**

Plate 12, Figure 5

Trigonarca congesta Conrad, 1875, in Kerr's, Geol. N. Car. App. A p. 3, pl. 1, fig. 2.

Axinea congesta Weller, 1907, p. 418, pl. 35, figs. 12-19.

Striarca congesta Stephenson, 1923, p. 112, pl. 20, figs. 9-13.

Description.—"Shell subcircular, slightly oblique, moderately convex, with a slight suggestion of an umbonal ridge. Beaks protruding a little above the hinge line, incurved, rather distant, directed neither forward or backward, located centrally with respect to the area and slightly in advance of the midlength of the shell. The dimensions of an average-sized specimen, a right valve are: length 10.5 mm., height 9.5 mm., convexity 3.5 mm., length of area about 6.5 mm.

Hinge plate regularly arched on the lower margin, moderately broad at the extremities and narrow in the middle where the upper part of the plate is truncated by the cardinal area, the lower margin of which is straight. Several of the centrally located teeth are short and transverse to the hinge line; on the broader portions of the plate the teeth are longer and away from the center become progressively more oblique until at the extremities they are horizontal; in well preserved specimens the teeth are seen to be finely striated at right angles to the plane of the hinge plate.

Area amphidetic subtriangular, straight on the inner margin,

bounded on the outer margin by a narrow, low carina overhanging inwardly; surface minutely striated at right angles to the hinge line.

Inner surface of the shell smooth, except for low, narrow, down-lapping carinas bounding the lower or inner margins of the anterior and posterior adductor scars.

Anterior and ventral margins broadly and regularly rounded; posterior margin subtruncated and slightly inclined forward.

Surface of shell marked by fine concentric lines of growth and by coarser, irregular growth undulations; also by fine, faint, radiating lines which are scarcely visible macroscopically, and which vary in strength of development, being almost absent on some shells and on parts of others." (Stephenson.)

Remarks.—Stephenson placed this form in the genus *Striarca*.

Range in New Jersey —

MAGOTHY: -?

MERCHANTVILLE: 7, 8, 9, 10, 15

WOODBURY: 18, 19, 20, 24

WENONAH: 35

RED BANK: 60

Range outside New Jersey.—North Carolina.

Type.—Snow Hill, N. C. "probably lost"; paratypes in USMN and ANSP.

Family Glycymeridae

Glycymeris mortoni (Conrad) 1869

Plate 14, Figure 7, 8, 9

Axinea mortoni Conrad, 1869, Am. Jour. Conch., vol. 5, p. 44, pl. 1, fig. 14.

Axinea mortoni, Whitfield, 1886, p. 99, pl. 11, figs. 23-25.

Axinea alta, Whitfield, 1886, p. 101, pl. 11, figs. 26-29.

Axinea subaustralis, Weller, 1907, p. 414, pl. 35, figs. 1-8.

Glycymeris mortoni, Gardner, 1916, p. 540.

?*Glycymeris whitleyensis*, Stephenson, 1923, p. 106, pl. 18, figs. 11-13.

Glycymeris mortoni, Groot, Organist and Richards, 1954, p. 41, pl. 33, fig. 7.

Description.—Shell subcircular in outline, varying in size from 15 mm. to 40 mm. in diameter, the convexity of each valve being from one-fourth to three-tenths the diameter; very slightly oblique, the beaks central in position. The internal casts compressed about the free margin especially in adult shells, the margin strongly crenulate when well preserved. The beaks strongly elevated and pointed, their lateral slopes meeting in an angle varying several degrees either way from 90°; the impression of the hinge-plate broad and arcuate, with 9 or 10 strong

teeth on each side of the beak, directed at nearly right angles to the inner margin of the hinge-plate, and with several smaller teeth in the middle beneath the beak. Anterior and posterior muscular impressions well defined, especially in the larger specimens. The shell substance thick, marked externally with more or less irregular, concentric lines of growth, and by regular radiating costae which are more or less interrupted by the concentric lines upon partially exfoliated individuals. The beaks approximate and the cardinal areas small with divergent furrows. (Weller)

Remarks.—This is the common species of *Glycymeris* from the New Jersey Cretaceous.

The New Jersey specimens are poorly preserved and according to Stephenson (1923) may be the same as his *G. whitleyensis* which he described from the Black Creek formation of North Carolina.

Range in New Jersey —

MERCHANTVILLE: 8, 11, 15, 16, 17

MT. LAUREL—NAVESINK: 40, 46, 48, 49, 50

TINTON: 62, 63

Range outside New Jersey.—Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi.

Type.—Prairie Bluff, Alabama.

***Glycymeris microdentus* (Weller) 1907**

Plate 14, Figure 10

Axinea microdentus Weller, 1907, p. 416, pl. 35, figs. 10-11.

Description.—Shell subcircular, attaining a length and breadth of 21.5 mm. each in the largest specimen observed, the convexity of each valve from one-fourth to three-tenths the diameter. The internal casts somewhat compressed about the free margins, the margin very faintly or not at all crenate. Beaks moderately elevated, pointed, and slightly oblique, their lateral slopes meeting at an angle of about 90°; the impression of the hinge-plate of moderate width, with 11 or 12 teeth on each side of the beak, with several less distinct ones in the middle beneath the beak, the individual teeth on each side are slightly oblique to the inner margin of the hinge-plate, the anterior and posterior rows are nearly straight or slightly convex, meeting beneath the beak in a rounded angle. Both muscular impressions moderately developed. The external surface of the shell, as indicated by impressions, is marked by fine, regular, radiating costæ, and by more or less irregular concentric lines of growth. The beaks are approximate and the cardinal areas small. (Weller)

Remarks.—This species is very similar to *A. subaustralis*, but may be distinguished from it by its much smaller teeth which are arranged in a broadly \wedge -shaped hinge with the angle under the beak rounded,

instead of in a broadly arcuate line. Another distinction is found in the almost or wholly obsolete crenulations upon the interior of the free margins of the valves.

Stephenson (1936, p. 373) suggests that this species might be close to or identical with *G. subcrenata* Wade, but since the New Jersey specimens are merely molds, it is impossible to make them conspecific.

Range in New Jersey—

WENONAH: 34

Type.—Crawfords Corner, N. J. NJSM 7672.

***Glycymeris compressa* (Weller) 1907**

Plate 14, Figure 11

Axinea compressa Weller, 1907, p. 417, pl. 35, fig. 9.

Description.—Shell subcircular, the valves compressed, oblique, the height of the type specimen 23 mm., its length about 25 mm., its convexity 4 mm. The anterior margin from the beak to the middle of the basal margin forms nearly a semicircle, the posterior margin is obliquely subtruncate above from the beak nearly to the middle of the shell, below which point it rounds into the basal margin. In the internal casts the free margin is strongly crenate; the beaks pointed, the lateral slopes meeting in an angle of about 90°; impression of the hinge-plate rather broad, with 10 or more rather strong teeth visible on each side of the beak, the teeth are placed a little obliquely to the inner margin of the hinge-plate, the anterior row is slightly arcuate, the posterior row nearly straight. The posterior muscular impression is slightly defined, the anterior one scarcely recognizable. The external surface of the shell, as indicated by an impression, is marked only with concentric lines of growth.

Remarks.—This species somewhat resembles *A. subaustralis*, but besides being more oblique, it is a much more compressed shell. The type consists of the nearly perfect cast of the interior of a right valve with the accompanying impression of the exterior. This specimen shows no sign of radiating costae upon the exterior, but associated with it is a very imperfect and much crushed impression of another individual, possibly belonging to the same species, which preserves the impressions of fine radiating costae upon at least a portion of the shell surface. These costae are much finer than in *G. mortoni*. (Weller)

Range in New Jersey—

RED BANK: 60

Type.—Middletown, N. J. NJSM 7510.

Family Pinnidae

Pinna laqueata Conrad 1858

Plate 15, Figures 1, 2

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

Pinna laqueata, Whitfield, 1886, p. 81, pl. 16, figs. 1-2.

Pinna laqueata, Weller, 1907, p. 419, pl. 36, fig. 1, pl. 37, fig. 1.

Pinna laqueata, Gardner, 1916, p. 545, pl. 21, fig. 12.

Pinna laqueata, Groot, Organist and Richards, 1954, p. 41.

Description.—"Shell of moderate size, very rapidly expanding from the apex and ventricose, giving a subquadrangular section. Surface marked by from 9 to 11 strong, simple, radiating ribs on the dorsal portion, which are broad and rounded on the top and separated by very broad concave interspaces. The lower or basal portion is marked by very strong concentric striæ parallel to the margin, so very irregular as to often form strong undulations of the surface. Line of division between the upper and lower sections of the valves very strongly marked on the cast, often presenting the appearance of a distinct suture. Posterior margin of the shell apparently double, being deeply emarginate or lobed at the line of division between the upper and lower portions of the valve. The margin of the upper division is obliquely truncate, receding from below to the hinge-line, and strongly curved inward at the central emargination. Lower section also strongly lobed and somewhat rounded." (Whitfield.)

Remarks.—The specimens of this shell have only been observed in a fragmentary condition so that the full dimensions of the species cannot be determined from actual observation. The largest specimen illustrated by Whitfield is 80 mm. in maximum height, and its length when complete must have been 250 mm. or more. The species is most characteristic of the Merchantville clay, but a few fragmentary individuals, which seem to belong to the same species, have been recognized from the Navesink marl. It is fairly common at Maple Shade.

Range in New Jersey—

MERCHANTVILLE: 10, 13, 15, 16

WOODBURY: 20, 24

MT. LAUREL-NAVESINK: 40, 46, 49, 57

Range outside New Jersey: Delaware, Mississippi.

Type.—Owl Creek, Mississippi.

Family Pedalionidae

Gervillioipsis ensiformis (Conrad) 1858

Plate 15, Figure 4

Plate 17, Figure 8

Gervillia ensiformis, Conrad, 1858, Jour. Acad. Nat. Sci. Phil., 2nd ser. vol. 3, p. 328, pl. 34, fig. 10.

Gervillioipsis ensiformis, Whitfield, 1886, p. 73, pl. 15, figs. 8-11; pl. 16, fig. 5.

Gervillioipsis ensiformis, Weller, 1907, p. 421, pl. 37, figs. 4-5; pl. 38, figs. 1-3.

Gervillioipsis ensiformis, Wade, 1926, p. 51, pl. 13, figs. 1-3.

Gervillioipsis ensiformis, Groot, Organist and Richards, 1954, p. 42, pl. 3, fig. 3.

Description.—"Shell of moderately large size and thickened, falci-form, very oblique; the body of the shell finally becoming parallel to the hinge or even slightly recurved, narrowing posteriorly and flattened on the surface. Hinge-line straight, short, not more than one-fourth the length of the shell in grown individuals; posterior wing only moderately elevated, and the posterior margin rapidly sloping backward from its extremity to the body of the shell, anterior wing very slight, the anterior end of the shell being squarely truncate at right angles to the hinge. Beak of the shell small and terminal, elevated above the wing and continuing in a ridge to the surface of the valve. Greatest width of the shell opposite the posterior extremity of the hinge. Surface of the shell lamellose, and marked by numerous concentric varices of growth, and on the basal portion of the right valve indications of fine radiating lines occur. Hinge area moderately wide, marked by several transverse ligamental pits, arranged at a little more than one-fourth of an inch apart, and also by numerous oblique corrugations. Muscular imprints large and obliquely situated. Substance of the shell highly nacreous throughout and iridescent." (Whitfield.)

The dimensions of a large, nearly perfect individual illustrated by Whitfield, are: extreme length, 190 mm.; length of hinge-line, 48 mm.; height at posterior extremity of hinge-line, 44 mm.; greatest width of body of shell, 35 mm.

Remarks.—Some excellent specimens, with shell preserved, were found many years ago in the Woodbury and Marshalltown formations. Casts referred to this species occur in the Merchantville, Wenonah, Navesink, and Red Bank.

Range in New Jersey—

MERCHANTVILLE: 15, 16

WOODBURY: 20, 24

MARSHALLTOWN: 30

WENONAH: 35

MT. LAUREL-NAVESINK: 37, 43, 53

RED BANK: 59

Range outside New Jersey: Delaware, Maryland, Alabama, Tennessee, Mississippi.

Type.—Tippah County, Mississippi.

Gervilliopsis minima Whitfield 1886

Plate 17, Figure 11

Gervilliopsis minima Whitfield, 1886, p. 74, pl. 15, fig. 7.

Gervilliopsis minima, Weller, 1907, p. 423.

Description.—"Shell small, the only specimen observed, a cast, measuring only a trifle over one inch in length, and less than three-eighths of an inch in its greatest width. Shell elongate-elliptical, extremely oblique, slightly curved, and the valves very ventricose. The beaks, as shown on the cast, have been pointed, the area wide, and the anterior hiatus has been proportionally large and distinct. The muscular scars are very distinct and well marked." (Whitfield).

Remarks.—This species was described as "a miniature of *G. ensiformis*, except in its greater ventricosity."

Range in New Jersey—

NAVESINK: 43

Range outside New Jersey: Mississippi

Type.—Freehold, N. J. Lost.

Inoceramus proximus Tuomey 1854

Plate 15, Figures 6, 7; Plate 42, Figure 1

Inoceramus proximus Tuomey, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 171.

Inoceramus sagensis, Whitfield, 1886, p. 76, pl. 14, fig. 15; pl. 15, figs. 1-2. (Not of Owen, 1854.)

Inoceramus proximus, Weller, 1907, p. 424, pl. 40, figs. 1-6; pl. 41, fig. 1.

Inoceramus proximus, Wade, 1926, p. 49, pl. 12, fig. 2.

Inoceramus proximus, Groot, Organist and Richards, 1954, p. 42, pl. 3, fig. 8.

Description.—Shell in large examples attaining a height of 100 mm. or more, and a length of 120 mm. or more. The valves subovate in outline, moderately convex, the hinge-line about two-thirds the length of the shell, the beak but little elevated above the hinge-line. The anterior margin sloping forward from the beak and rounding gradually into the broadly rounded basal margin, posterior margin broadly rounded and meeting the hinge-line in an obtuse angle. Surface of the shell marked

by more or less rounded or subangular, concentric undulations, which are often somewhat irregular in the strength of their development and in their distances apart. In addition to the undulations the surface of the shell is marked by fine concentric striæ separated by intervals of 1 mm. or less.

Remarks.—This species is the common member of the genus in the Merchantville clay-marl, and includes the two specimens illustrated by Whitfield as *I. sagensis*. In Owen's original description of *I. sagensis*, which occurs typically in the western faunas, it is distinctly stated that the shell is not marked by concentric striations, while the New Jersey examples always have these lines when the surface markings can be seen; furthermore the valves of the eastern form are usually less strongly convex than those of the western specimens. The concentric striæ are usually not recognizable upon the internal casts, although they may sometimes be detected, but they can almost always be seen upon the impressions of the outside of the shells. These striæ in most cases seem to be slightly raised lines, but in one specimen from the Cliffwood clay they are apparently impressed. One large example from Lenola with a length of 135 mm., has a broad, smooth area without undulations around the free margins of the shell, a character which is sometimes seen in other species of the genus and which doubtless represents a senile stage of growth. Among the various specimens examined, there is considerable variation in the width of the spaces between the concentric undulations of the shell, and in some specimens these undulations bifurcate anteriorly and more rarely posteriorly. (Weller)

Range in New Jersey—

RARITAN: 1

MAGOTHY: 5, 6

MERCHANTVILLE: 8, 10, 15, 16

WOODBURY: 23, 25

MARSHALLTOWN: 28

Range outside New Jersey:—Delaware, Tennessee, Mississippi, Alabama, Texas, North Carolina (?).

Type.—Columbus, Miss.

***Inoceramus quadrans* Whitfield 1886**

Plate 15, Figure 5

Inoceramus sagensis, var. *quadrans* Whitfield, 1886, Pal. N. J., p. 79, pl. 14, fig. 16.

Inoceramus quadrans Weller, 1907, p. 426, pl. 39, fig. 1.

Description.—Shell moderately convex, subquadrangular, broadly subovate, the dorsal and ventral margins subparallel or slightly diverging posteriorly. The beak large and prominent, produced beyond the hinge-line. Anterior margin truncate to a point below the middle, and

forming with the hinge-line nearly a right angle; below the middle it rounds into the nearly straight basal margin, which in turn posteriorly passes with a regular curve into the posterior margin which is rounded below and obliquely subtruncate above, meeting the posterior extremity of the hinge-line in an oblique angle. The surface is marked by somewhat irregular subangular undulations which are more crowded and less distinct towards the umbonal region, those on the outer portion of the shell being rather widely separated. "The middle of the cast for about two-thirds the width is marked by strong, rather deep pits, connected by shallow furrows, showing that the interior of the shell was covered with strong pearl-like protuberances." (Whitfield).

The dimensions of the type specimen are: length, 102 mm.; height from hinge-line to basal margin, 78 mm.

Remarks.—Whitfield described this as a variety of *I. sagensis*, but it is definitely distinct. Furthermore, the specimen regarded by Whitfield as *I. sagensis* is actually *I. proximus* (see p. 95) *I. quadrans* is characterized by its truncate anterior margin and subquadangular form. It is known only from the type specimen.

Range in New Jersey—

MERCHANTVILLE: 13

Type.—Near Burlington, N. J.; ANSP 18710.

***Inoceramus confertim-annulatus* Roemer 1849**

Plate 15, Figure 8; Plate 18, Figure 10

Inoceramus confertim-annulatus Roemer, 1849, Texas, p. 402.

Inoceramus barabini Whitfield, 1886, p. 75, pl. 15, figs. 3-5. (Not *I. barabini* Morton)

Inoceramus confertim-annulatus, Weller, 1907, p. 427, pl. 39, figs. 2-5.

Inoceramus confertim-annulatus, ? Gardner, 1916, p. 547.

Description.—"Shell of only moderate size, transversely ovate or elliptical, with moderately to prominently convex valves. Beaks large, only slightly projecting beyond the line of the hinge, and situated near the anterior end. Hinge-line two thirds as long as the shell, and rapidly rounding at the posterior extremity into the posterior margin, which is more broadly rounded than the anterior extremity. Basal line gently and somewhat gradually arcuate, but more rapidly curving upward near the anterior part. Surface of the shell marked by regular concentric, rounded undulations parallel to the margin of the valve, and separated by concave interspaces. Near the outer limits of the valve the undulations become more irregular, as if taking on old-age characters." (Whitfield.)

The dimensions of the two specimens illustrated by Whitfield are: length, 54 mm. and 50 mm.; height from hinge-line to ventral margin, 39 mm. and 36 mm.; convexity of the larger specimen, 14.5 mm. .

Remarks.—The specimens seem to agree most closely with *I. confertim-annulatus* Roem., described from the Eagle Ford shales of Texas, and have therefore been so identified,; they resemble *I. proximus* and *I. confertim-annulatus* much more closely than they do *I. barabini*. The species is apparently somewhat rare as it has been met with only rarely in the recent collections.

Range in New Jersey—

MT. LAUREL-NAVESINK 41, 43, 47, 53

Range outside New Jersey.—Maryland, Texas, Delaware.

Type locality.—New Braunfels, Texas; University of Bonn (Germany), 114.

Inoceramus pro-obliqua Whitfield 1886

Plate 15, Figure 9

Inoceramus pro-obliqua Whitfield, 1886, p. 80, pl. 14, fig. 17.

Inoceramus proobliqua, Weller, 1907, p. 428, pl. 38, fig. 4.

Description.—“Shell somewhat below the medium size for the genus; subovate in outline, the axis of the shell being directed forward of a right angle to the hinge-line, instead of backward as is usual with nearly all shells. Hinge-line shorter than the width of the body of the shell and forming an angle of about 110° to the axis of the valve. Left valve, the only one known, extremely ventricose, with a rather small beak, which is but little elevated above the line of the hinge, and situated in advance of the anterior margin of the valve. Height of the valve a little greater than its extreme width or length. Surface of the cast marked by numerous, regularly increasing concentric undulations, which are moderately sharp on the crests and the interspaces broadly concave. There are also indications of radiating lines along the middle of the valve, as in many species of the genus.” (Whitfield.)

The dimensions of the type specimen are: length, 42 mm.; height, 45 mm.

Remarks.—This species of *Inoceramus* is remarkable in that the line of obliquity is directed forward in passing from the beak to the basal margin instead of backward as is usually the case. The species was established upon a single individual, and it has not been met with in any of the recent collections.

Known only from the single specimen.

Range in New Jersey—

NAVESINK: 41

Type locality.—Holmdel, N. J. NJSM 9677.

Inoceramus ? perovalis Conrad 1852

Plate 15, Figure 3

Inoceramus perovalis Conrad, 1852, Jour. Acad. Nat. Sci. Phil. ser. 2, vol. 2, p. 299, pl. 27, fig. 7.

Inoceramus perovalis, Whitfield, 1886, p. 80.

Inoceramus ? perovalis, Weller, 1907, pl. 38, fig. 5.

Inoceramus perovalis, Groot, Organist and Richards, 1954, p. 42, pl. 3, fig. 9.

Description.—Shell small, almost regularly oval, the width and height being nearly as six and seven. Valves nearly equally convex, the right side perhaps a very trifle more convex than the left. Hinge-line comparatively long when the oval form is considered, being about three-fifths as long as the greatest width of the shell and oblique to the axis of the valve. Beak of the right valve sharp, projecting much beyond the line of the hinge, giving a proportionally broad or high hinge area, and on the cast, which is the condition of the type specimen, shows the single strong ligamental depression opposite the apex. Surface of the shell, as indicated on the cast, marked by proportionally distinct concentric lines parallel to the margin of the valves.

In form this species is very distinct from any other described, and cannot well be confounded with them; the obliquely oval form, only a little deflected from an erect position, is also quite distinctive. The only individual known is the type specimen figured by Mr. Conrad, as above cited, and is entirely a cast with the left valve imperfect. In size, it is less than one and three-eighth inches in height, measuring along the axis of the valve, by a little more than one and one-eighth inches in width. The remarkable height of the hinge area and the impression of a single ligamental pit is somewhat peculiar and gives one some doubt as to its true affinities with the ordinary forms of *Inoceramus*.

Range in New Jersey—

“NEW JERSEY”

Type.—(Labels say both “New Jersey” and “Chesapeake & Delaware Canal”) ANSP 18803.

Inoceramus sp.

Plate 16, Figure 1

An impression of a specimen of *Inoceramus*, too poorly preserved for specific identification, is in the collection of the Wagner Free Institute of Science from the Merchantville formation at Lenola, N. J.

Family Pteriidae

Pteria petrosa (Conrad) 1853

Plate 16, Figure 2

Avicula petrosa Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 274, pl. 24, fig. 15.

? *Avicula linguaeformis*, Evans & Shumard, 1854, proc. Acad. Nat. Sci. Phil., p. 163.

Pteria petrosa, Whitfield, 1886, p. 68, pl. 14, fig. 10.

Pteria petrosa, Weller, 1907, p. 429, pl. 42, figs. 1-2.

Pteria petrosa, Gardner, 1916, p. 548, pl. 21, fig. 10.

Pteria petrosa, Stephenson, 1923, p. 131, pl. 27, figs. 5-6.

Pteria petrosa, Wade, 1926, p. 51, pl. 13, fig. 7.

Description.—Shell oblique, winged in front and behind, the hinge-line straight with the beaks in front of the middle. Both valves rather strongly convex, but the left a little more so than the right. Posterior wing compressed, of moderate length, pointed behind, its posterior margin concave; anterior wing narrower, pointed in front, less compressed than the other, its free margin nearly straight or slightly concave; in the right valve it is separated from the body of the shell by a narrow and shallow sulcus which extends from the anterior side of the beak downward and usually a little obliquely backward to the antero-ventral margin; just in front of the marginal extremity of this sulcus the surface is slightly bulged so as to leave a byssal opening between the valves. The antero-ventral margin slopes obliquely backward from the anterior extremity of the hinge-line; it is slightly concave to the base of the anterior wing beyond which point it becomes slightly convex, curving more and more below into the rounded postero-basal margin; the posterior margin oblique below and sinuate above. Surface of the shell marked only by concentric lines of growth which are inconspicuous on the internal casts.

The dimensions of a large specimen are: length from the anterior extremity of the hinge-line to the postero-basal margin, 51 mm.; length of hinge-line, 37 mm.; distance of beak from the anterior extremity of hinge-line, 12 mm.; convexity of right valve, 10 mm.

(Weller)

Remarks.—This species occurs in nodules in the Cliffwood locality and less commonly at the top of the Wenonah sand. The species shows variation in the obliquity of the shell and also in the extension of the posterior wing, although the variation in this latter character may be more apparent than real on account of imperfections on the specimens.

These New Jersey specimens do not seem to possess any characteristics to distinguish them from the western shell described as *Avicula linguaeformis*, and that name must undoubtedly be considered as a

synonym of Conrad's species. Some of the New Jersey specimens are a little more oblique than the western shell as illustrated by Meek, but others possess essentially the same form.

Range in New Jersey—

MAGOTHY: 5, 6

WENONAH: 34, 35

Range outside New Jersey.—Delaware, Maryland, Tennessee, North Carolina, South Carolina, Mississippi (Western Interior ?).

Type.—Chesapeake and Delaware Canal, Del. Lost.

***Pteria laripes* (Morton) 1834**

Plate 18, Figure 1

Avicula laripes Morton, 1834, Synop. Org. Rem. Cret. Gr. U.S. p. 63, pl. 17, fig. 5.

Pteria laripes, Whitfield, 1886, pl. 14, fig. 9.

Pteria laripes, Weller, 1907, p. 431, pl. 42, fig. 3.

Pteria laripes, Groot, Organist and Richards, 1954, p. 42, pl. 3, fig. 10.

Description.—"Shell of but moderate size, oblique ovate and moderately convex, with rather prominent beaks. Hinge less than half the length of the body of the shell, forming on the posterior side a proportionally large wing, which is obtusely pointed at the extremity and only shallowly sinuate on the outer margin between the hinge line and body of the shell. Anterior wing unknown. Surface of the shell, on the left valve, strongly marked by distant elevated radii, which seem to have been alternately coarse and fine on the posterior half of the valve, judging from the only cast examined, and equal in strength and moderately curved forward on the anterior half; while the margin of the valve seems to have been marked by strongly projecting points corresponding to the ribs." (Whitfield.)

Remarks.—There is some question as to the occurrence of this species in New Jersey. The specimen used by Whitfield is probably the type of the species which was said to have come from Delaware by Morton in connection with his original description; however, the label in The Academy of National Sciences says both New Jersey and Delaware.

Range in New Jersey—

"New Jersey"

Range outside New Jersey.—Delaware.

Type.—"New Jersey and Delaware" ANSP 18714.

***Pteria navicula* Whitfield 1886**

Plate 16, Figure 4; Plate 18, Figure 2

Pteria navicula, Whitfield, 1886, p. 70, pl. 14, fig. 8.

Pteria navicula, Weller, 1907, p. 432, pl. 42, fig. 4.

Description.—"Shell of small size, the greatest length being less than half an inch; very oblique and angularly ventricose, the height scarcely more than half the length. Hinge line nearly as long as the body of the shell, mucronate and slightly prolonged at the posterior extremity, which is separated from the body of the shell by a slight sinuosity. Anterior wing, if any, not preserved on the specimen; but the shell, although somewhat imperfect, does not appear to have been winged on the anterior side. Posterior extremity of the body of the (left) valve obtusely pointed, and the anterior end narrowly rounded from the extremity of the cardinal line. Basal line broadly curved gradually descending from the anterior end to about the posterior third of the length, where it again rises to the extremity. Beaks small, rising a little above the hinge line, and prominently ventricose. Surface of the shell marked only by concentric striæ, so far as can be determined from the partially exfoliated individual. Right valve unknown." (Whitfield.)

Remarks.—Described from a single left valve from Haddonfield. A single specimen from Middletown has also been reported.

Range in New Jersey—

WOODBURY: 24

RED BANK: 60

Type.—Haddonfield, N. J. ANSP 18753.

***Pteria* sp.**

Plate 16, Figure 3

One smooth cast of a pelecypod from the Chesapeake and Delaware Canal in the collections of the Academy is referred to the genus *Pteria* without any attempt at specific identification.

Figured specimen.—Chesapeake and Delaware Canal, Del; ANSP 19353.

***Phelopteria dalli* (Stephenson) 1936 ?**

Plate 42, Figures 5, 7

Pteria ? *dalli* Stephenson, 1936, Bull. Geol. Soc. Amer. Vol. 47, p. 389, pl. 3, figs. 19-20.

Phelopteria dalli Stephenson, 1953, U. S. Geol. Surv. Prof. Paper 242, p. 68, pl. 14, figs. 4-14, 1952=1953.

? *Phelopteria dalli* Stephenson, 1954, p. 29, pl. 6, figs. 18, 19.

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 indetical 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. (Stephenson.)

Range in New Jersey—

RARITAN: 1 b

*Range outside New Jersey.—*Banquereau, Texas.

*Type.—*Banquereau, off Nova Scotia; Yale Peabody Museum 14811.

***Meleagrinella abrupta* (Conrad) 1853**

Plate 17, Figures 6, 7

Avicula abrupta, Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 274, pl. 24, figs. 5-6.

Meleagrinella abrupta, Whitfield, 1886, p. 72, pl. 14, figs. 11-14.

Meleagrinella abrupta, Weller, 1907, p. 433, pl. 42, figs. 5-9.

Description.—“Shell small, inequivalve, rhombo-quadrangle in outline, the hinge-line long and straight, reaching nearly the entire length of the shell, beaks small, situated at about the anterior third or fourth of the length of the hinge; that of the left valve rising a little above the cardinal line, and that of the right just to its margin. Right valve with a deep notch-like slit on the anterior side just below the hinge, with a narrow, deep groove running from it to the apex of the valve on the exterior surface. Left valve provided with an internal fold, quite indistinct except under a glass, on the anterior side of the beak, which corresponds to the byssal notch of the right valve. Anterior margin of the valve somewhat regularly rounded; basal margin broadly rounded, and the posterior obliquely truncate, passing backward slightly from the hinge extremity to the postero-basal line. Surface of the valves smooth or very finely lamellose, and marked with concentric undulae. When not at all worn or macerated the surface of the left valve shows indistinct thread-like interrupted, radiating lines which remind one very strongly of those seen on species of *Placunomya*.” (Whitfield).

The dimensions of the right valve illustrated by Whitfield are: length, 14.5 mm.; height, 12 mm.

Remarks.—Very rare and not found recently.

Range in New Jersey—

MT. LAUREL-NAVESINK: 41, 43

Type.—Nimrod Woodward's farm near Holmdel, N.J. ANSP 19670.

Family Pulvinitidae

Pulvinites argenteus Conrad 1858 †

Plate 18, Figure 11

Pulvinites argenteus, Conrad, 1858, Jour. Acad. Nat. Sci. Phila. 2nd Ser. vol. 3, p. 330, pl. 34, fig. 5.

Pulvinites sp., Carter, 1937, Maryland Geol. Surv. Vol. 13, p. 255.

Pulvinites argenteus, † Groot, Organist and Richards, 1954, p. 41, pl. 3 fig. 11.

Carter reported *Pulvinites* sp. from the Crosswicks formation in the spoil bank east of Summit Bridge along the Chesapeake and Delaware Canal. A comparison of Carter's specimen with specimens of *P. argenteus* from Tippah County, Mississippi (ANSP 19998) suggests that the Delaware specimen be tentatively referred to this species.

P. argenteus has been reported previously from the Ripley formation at Coon Creek, Tennessee, and the Chattahoochee River, Georgia and Alabama, the Providence sand of the Chattahoochee River, the Owl Creek formation of Mississippi, the Nacatoh sand of Arkansas and the Corsicana marl (Navarro) of Texas. If the Delaware specimen be cospecific with the southern forms, it is stratigraphically lower than previously reported. No other specimens of *Pulvinites* have been reported from the Atlantic Coastal Plain.

Type.—Owl Creek, Mississippi; lost.

Family Ostreidae

Ostrea cretacea Morton 1834 (†)

Plate 16, Figure 7

Ostrea cretacea, Morton, 1834, Synop. Org. Rem. Cret. Gr. U.S., p. 52, pl. 19, fig. 3.

† *Ostrea cretacea*, Weller, 1907, p. 434, pl. 42, fig. 11.

Ostrea cretacea, Stephenson, 1923, p. 135, pl. 28, figs. 8-17.

Description.—"Shell suboval to subtriangular in outline, the height greater than the length, compressed to moderately ventricose; left valve more ventricose than the right valve. Shell wall moderately thick. Beaks situated centrally; on the left valve the beak varies from dull and non prominent to pointed and rather prominent; on the right valve the beak is small and nonprominent. Dimensions of the type specimen, a left valve: Length 24 mm., convexity 6 mm. Hinge on left valve triangular, subequilateral, crossed by concentric growth lines. Ligament pit triangular, deeply impressed, broad at the inner margin. Hinge on right valve triangular, smaller than on left valve, with the base longer than the sides. Ligamental pit shallow. Adductor scar below the midheight and toward the posterior margin. Anterior and posterior margins

straight or curved and diverging from the hinge extremities; ventro margins typically rather sharply rounded. The margin of the left valve overlaps the margin of the right valve, but the two valves meet approximately in a plane." (Stephenson)

Remarks.—Stephenson believes that the New Jersey specimens are too poorly preserved for positive identification with this species.

Range in New Jersey—

MAGOTHY: 5

Range outside New Jersey—

North Carolina, South Carolina, Georgia, Alabama, Arkansas.

Type.—Erie Bluff, Alabama; ANSP 2270.

***Ostrea congesta* Conrad 1843**

Plate 16, Figures 8, 9

Ostrea congesta, Conrad, 1843, Nicollet's Rep. Expl. N.W. p. 167.

? *Ostrea congesta*, Weller, 1907, p. 435, pl. 43, fig. 16.

Ostrea congesta, Stephenson, 1941, p. 105, pl. 13, figs. 6-13.

Description.—Shell small, the individuals often crowded closely together in considerable numbers, so as to assume quite irregular forms. Surface of attachment of the lower valve large, beyond which the margin of the shell is abruptly deflected upward at right angles to the attached portion; upper valve flat or a little concave, having the form of the attached portion of the lower valve.

The dimensions of a specimen referred to the species are: length, 12.5 mm.; width, 15 mm.

Remarks.—Weller questionably identified this species from New Jersey. "The species may be recognized by the proportionately large area of attachment with the abruptly deflected margins of the lower valve."

Range in New Jersey—

MAGOTHY: 5

Range outside New Jersey: Gulf Coast, "Western Interior."

Type.—"Cretaceous marls on the Missouri"; lost

***Ostrea panda* Morton 1833**

Plate 16, Figures 5, 6

Ostrea panda, Morton, 1833, Am. Jour. Sci., 1st ser., vol. 23, p. 293.

Ostrea panda, Whitfield, 1886, p. 30.

Ostrea panda, Weller, 1907, p. 437, pl. 42, fig. 10.

Ostrea panda, Stephenson, 1941, p. 104, pl. 15, figs. 3-6.

Ostrea panda, Groot, Organist and Richards, 1954, p. 42.

Description.—Shell rugose, irregularly subovate in outline; the

dimensions of a nearly complete lower valve are: height, 21.5 mm.; width, 26 mm.; free margins of the valves corrugated by rather broad, rounded plications which do not extend to the beak, those towards the cardinal margins becoming smaller; shell also marked by more or less irregular concentric lines of growth which are sublamellose upon some portions of the valve; beak rather sharply pointed and separated from the hinge-line by a flat, triangular, cardinal area whose surface lies nearly at a right angle to the general plane of the valve. The upper valve not recognized in the New Jersey collections. (Weller)

Remarks.—This species was originally described from the Cretaceous of Delaware and later was found at various Eocene localities in South Carolina and Alabama.

Range in New Jersey—

MARSHALLTOWN: 28, 29

Range outside New Jersey—

Delaware (Mount Laurel-Navesink), Alabama, Tennessee, Texas, Arkansas; also Eocene of South Carolina and Alabama.

Type.—Saint Georges, Delaware; apparently lost.

***Ostrea subspatulata* Forbes 1845**

Plate 16, Figure 10

Ostrea subspatulata Forbes 1845, Quart. Jour. Geol. Soc. Lond., vol. 1, p. 61, text figs. pp. 61-62.

Ostrea subspatulata, Whitfield, 1886, p. 32, pl. 3, fig. 14.

Ostrea subspatulata, Weller, 1907, p. 440, pl. 42, fig. 15.

Ostrea subspatulata, Gardner, 1916, p. 561, pl. 23, fig. 3; pl. 24, fig. 1.

Ostrea subspatulata, Stephenson, 1923, p. 158, pl. 40-41.

Description.—Shell subovate in outline, higher than wide, usually widest below the middle, the dimensions of a nearly complete cast of the interior of a lower valve are: length, 45 mm.; width, 31 mm. Lower valve strongly arcuate longitudinally, the cast nearly smooth or with a few obscure concentric undulations, the muscular impression large, situated in the lower left-hand quarter of the cast. The impressions of the exterior of the shell show rather strong concentric undulations.

Remarks.—In New Jersey this species is only known in the form of casts, none of which have been observed to attain so large dimensions as some of the examples from the South. The most characteristic feature of the species is its strongly arcuate form longitudinally, a feature which is even more conspicuous in the shell itself than in the casts because of the great thickening of the shell in its central part. (Weller)

Range in New Jersey—

WENONAH: 34, 35

Range outside New Jersey—

Maryland, North Carolina, South Carolina, Alabama, Georgia, Mississippi, Arkansas.

Type.—South Washington, N. C. ; lost.

***Ostrea monmouthensis* Weller 1907**

Plate 16, Figures 11, 12, Plate 19, Figure 1

Ostrea monmouthensis Weller, 1907, p. 442, pl. 43, fig. 15.

Ostrea monmouthensis, Gardner, 1916, p. 558, pl. 23, figs. 4-5.

Ostrea monmouthensis, Wade, 1926, p. 54, pl. 14, figs. 6-8.

Ostrea monmouthensis, Groot, Organist and Richards, 1954, p. 43, pl. 3, fig. 12.

Description.—Shell slightly oblique, subovate in outline, the dimensions of the type specimen being: length, 28 mm.; width, 22 mm. Upper valve depressed convex, nearly smooth, marked only by inconspicuous concentric lines of growth. Along the ventral margin the edge is folded into sharply angular teeth which do not extend as plications into the body of the shell, these tooth-like crenulations becoming smaller and at last disappearing upon the lateral margins of the shell. Lower valve not known. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 40, Arneytown.

Range outside New Jersey—

Delaware, Maryland, Tennessee.

Type.—Crawfords Corner, N. J. ; NJSM 7619.

***Ostrea tecticosta* Gabb 1860**

Plate 16, Figure 13, 14

Ostrea tecticosta, Gabb, 1860, Jour. Acad. Nat. Sci. Phil. 2nd ser. vol. 4, p. 403, pl. 68, figs. 47-48.

Ostrea tecticosta, Whitfield, 1886, p. 33, pl. 3, figs. 1-2.

Ostrea tecticosta, Weller, 1907, p. 443, pl. 43, figs. 17 (?), 18, 19.

Ostrea tecticosta, Gardner, 1916, p. 560, pl. 24, figs. 2-4.

Ostrea tecticosta, Stephenson, 1923, p. 143, pl. 38, figs. 1-9.

Ostrea tecticosta, Wade, 1926, p. 54, pl. 14, figs. 4-5.

Ostrea tecticosta, Stephenson, 1941, p. 107.

Description.—“Shell small, elongate, oval, ovate or irregularly elliptical in outline, slightly curved, with a small, strongly-twisted beak and moderately-sized ligamental area on the lower valve. The lower valve usually shows a large cicatrized area of attachment and is strongly plicated, the plica being usually sharply rounded and very

rugose from concentric lamellose lining. The inner margins of the valves are also crenulated on the upper half or two-thirds of their length, and more minutely so on the inner border at the junction of the valves just below the ligamental area. Muscular scar large, but only moderately marked. Upper valves slightly convex and destitute of plications except near the border." (Whitfield.)

Remarks.—In general these Wenonah specimens somewhat resemble the *O. larva* type of oysters, but the lower valve was apparently attached uniformly by a much larger area than any of the New Jersey forms here referred to *O. falcata*, *O. mesenterica*, and *O. nasuta*.

Range in New Jersey—

WENONAH: 35

HORNERSTOWN: Harrisonville, N. J.

Range outside New Jersey—

Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas, Texas.

Type.—Cotype-N. J.; ANSP 18761. Cotype-Tennessee; ANSP 18808.

***Ostrea falcata* Morton 1830**

Plate 19, Figures 2, 3

Ostrea falcata, Morton, 1830, Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 50, pl. 1, fig. 2.

Ostrea larva, Lamarck, Cook, 1868, Geol. N. J., p. 375, text fig. Not of Lamarck.

Ostrea larva, Whitfield, 1886, (in part) p. 34, pl. 3, figs. 5-6 (not figs. 3-4).

Ostrea falcata, Weller, 1907, p. 444, pl. 43, figs. 3-6.

Ostrea larva var. *falcata*, Gardner, 1916, p. 552, pl. 22, fig. 4.

Ostrea falcata, Stephenson, 1923, p. 154, pl. 39, figs. 1-10.

Ostrea falcata, Wade, 1926, p. 155, pl. 14, figs. 9-13.

Ostrea falcata, Stephenson, 1941, p. 111, pl. 14, figs. 7-8.

Ostrea falcata, Groot, Organist and Richards, 1954, p. 42, pl. 3, fig. 13.

Description.—Shell of medium size, laterally arcuate. The dimensions of an average specimen are: length along the arcuate median line from beak to posterior extremity, 47 mm.; distance between beak and posterior extremity, 28 mm.; width of shell at middle, 16 mm.; length of hinge-line, 20 mm. Shell usually more or less strongly auriculate, the ears subequal or with one ear somewhat larger than the other. Hinge-line straight. Shell marked with from seven to ten deep plications which originate along the lower or convex margin and extend nearly to the beak, not leaving a conspicuous non-plicate central area, the plications towards the anterior hinge extremity decreasing re-

gularly in size; along the upper or concave margin the shell is marked by a series of short, marginal plications. Lower valve moderately convex, with a small scar of attachment; upper valve much flatter, its plications similar to those of the lower valve.

Remarks.—This species, as observed in New Jersey, is most abundantly represented in the Marshalltown marl, where it sometimes occurs in innumerable individuals. In its laterally arcuate form it resembles *O. mesenterica*, but it differs from that species in its larger size, and in its more strongly plicated shell, there being no central non-plicate area as in that species. The specimens vary greatly in the form and size of the auriculariations, and to some extent in the number of plications, but not so much in this latter respect as does *O. mesenterica*. Both of these species have usually been considered as members of a single species, *O. larva*, but they are clearly distinct, and are for the most part restricted to different geologic horizons, and in the New Jersey faunas, at least, do not have intermediate connecting forms. Their relationship to the true *O. larva* must be investigated. (Weller)

Range in New Jersey—

MARSHALLTOWN: 28, 32

MT. LAUREL-NAVESINK: 38, 47, 48

Range outside New Jersey—

Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas, Texas.

Type.—Label says "New Jersey", although Morton says St. Georges, Delaware; ANSP 19351.

Ostrea mesenterica Morton 1834

Plate 16, Figures 16, 17

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

Ostrea larva, Whitfield, 1886, (part) p. 34, pl. 3, fig. 7 (not figs. 3-6).

Ostrea mesenterica, Weller, 1907, p. 446, pl. 43, figs. 9-14.

Ostrea larva var. *mesenterica*, Gardner, 1916, p. 555, pl. 22, figs. 6-8; pl. 23, figs. 1-2.

Ostrea mesenterica, Stephenson, 1941, p. 113, pl. 16, figs. 7-9.

Ostrea mesenterica, Groot, Organist and Richards, 1954, p. 42, pl. 3, fig. 14.

Description.—Shell small, laterally arcuate. The dimensions of an average specimen are: length along the arcuate median line from the beak to the posterior extremity, 32 mm.; distance between beak and posterior extremity, 26 mm.; width of shell at middle, 9 mm. Shell usually auriculate, the ears variable in size and sometimes nearly obsolete, the posterior usually larger than the anterior. Shell strongly

plicate along its lower convex margin, the plications variable in number and size, not extending into the median portion of the shell, those near the hinge-line notably smaller than those in the middle of the shell; the plications of the upper concave margin much smaller than those of the convex margin. Central area of the shell marked only by the concentric lines of growth. Lower valve moderately convex, the scar of attachment variable, but usually small and restricted to the apical region; upper valve flat.

Remarks.—This little oyster is extremely abundant in the Navesink marl, and has not been observed in any of the beds below that horizon in New Jersey. It is one of several forms of the type of *O. larva* in the New Jersey faunas, and can always be distinguished by its small size and the nonplicate central area of the shell. The number of plications along the convex margin is exceedingly variable, a fact which can be best observed in the larger plications along the lower or convex margin of the shell, excluding the smaller ones near the extremity of the hinge-line, the number varying from four to as many as nine or ten. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 37, 38, 39, 40, 41, 42, 45, 47, 48, 49,
53, 54

RED BANK: 59

TINTON: 63

Range outside New Jersey—

Delaware, Maryland, Alabama, Mississippi, Arkansas, Texas.

Type.—Shrewsbury, N. J.; lost.

Ostrea nasuta Morton 1834

Plate 16, Figure 15

Ostrea falcata Var. *A* (*O. nasuta*) Morton, 1834, Synop. Org. Remains.
Cret. Group. U.S. p. 51, pl. 9, fig. 6.

Ostrea nasuta, Gabb, 1861,, Synop. Moll. Cret. Form. p. 209.

Ostrea larva var. *nasuta*, Whitfield, 1886, p. 35, pl. 3, figs. 3-4.

Ostrea nasuta, Weller, 1907, p. 447, pl. 43, figs. 7-8.

Ostrea larva var. *nasuta*, Gardner, 1916, p. 554, pl. 22, fig. 4.

Description.—Shell of medium size, laterally arcuate. The dimensions of a rather small individual are: length along the median line from beak to posterior extremity, 45 mm.; distance between beak and posterior extremity, 21 mm., width of shell at middle, 17 mm., length of hinge-line, 12 mm. Shell more or less strongly auriculate, the auriculations variable in size. Hinge-line straight. Shell surface marked by from four to seven profound and broad plications along the lower or convex margin, which rapidly die out, leaving the central area of the shell nonplicate; the upper or concave margin marked by much smaller,

short, marginal plications or denticulations. Lower valve moderately convex, with a small scar of attachment; upper valve flat. Entire surface of both valves marked by fine, more or less irregular, concentric lines of growth.

Remarks.—This species is a close ally of *O. mesenterica*. The two species agree in having the median portion of the shell nonplicate, but *O. nasuta* is a much larger and coarser shell, with broader and more profound plications. It should, perhaps, be considered only as a varietal form of *O. mesenterica*, but is for the most part characteristic in New Jersey, of higher beds than the Navesink marl, where that species is most abundant. The two forms usually do not occur in association, and it is at least convenient to have a special name for the designation of this form. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 38, 48

RED BANK: 60

TINTON: 62, 65

Range outside New Jersey: Delaware, Maryland

Type.—Saint Georges, Delaware; lost

***Ostrea plumosa* Morton 1833**

Plate 17, Figures 9, 10; Plate 18, Figure 3; Plate 19, Figures 4-6

Ostrea plumosa, Morton, 1833, Amer. Jour. Sci. ser. 1, vol. 23, p. 293.

Ostrea denticulifera, Conrad, 1858, Jour. Acad. Nat. Sci. Phila. vol. 3, p. 330, pl. 34, figs. 1, 8.

Ostrea plumosa, Whitfield, 1886, p. 30, pl. 3, figs. 12, 13.

Ostrea denticulifera, Whitfield, 1886, p. 29, pl. 3, figs. 8, 9.

Ostrea plumosa, Weller, 1907, p. 439, pl. 42, figs. 16-18.

Ostrea crenulimarginata, Weller, 1907, p. 441, pl. 42, figs. 12, 13
(not of Gabb).

Ostrea denticulifera, Weller, 1907, p. 436, pl. 43, figs. 1, 2.

Ostrea plumosa, Gardner, 1916, p. 556.

Ostrea plumosa, Stephenson, 1923, p. 147, pl. 38, figs. 14-17, pl. 39, figs. 11-15.

Ostrea plumosa, Wade, 1926, p. 53, pl. 14, figs. 1-3, 7.

Ostrea plumosa, Stephenson, 1941, p. 109, pl. 16, figs. 4-6.

Description.—Shell variable in shape and outline, being subtriangular, subovate, and subcircular in different individuals. Shell wall thin to moderately thick. Left valve compressed and generally attached over the greater part of its area to some object; right valve compressed to moderately ventricose. In typical specimens the midline of the shell is curved or even sinuous, but in this character the species is extremely variable.

Hinge variable in shape, but in general triangular and crossed by numerous concentric growth lines; ligamental pit on left valve more deeply impressed than on right valve. On typical specimens the inner anterior and posterior margins are crenulated to different distances from the hinge.

Inner surface of shell smooth; adductor scar large, and situated a little above the midheight and toward the posterior margin of the shell.

Surface marked by fine concentric growth lines and on typical specimens by radiating, fine, unequal, bifurcating costae, which are extremely variable in strength of development, being very obscure or even absent on some specimens.

Remarks.—This species and its various synonyms have been fully discussed by Stephenson (1941 pp. 108-111).

Distribution in New Jersey—

WOODBURY: 24

MARSHALLTOWN: 28

WENONAH: 34

MT. LAUREL-NAVESINK: 42

RED BANK: Shrewsbury River

Range outside New Jersey: Maryland, North Carolina, Georgia, Alabama, Mississippi, Tennessee, Texas.

Type.—Arneytown, N. J.; ANSP 108807.

***Ostrea (Alectryonia) jerseiana* Stephenson 1954**

Plate 42, Figure 11

Ostrea jerseiana, Stephenson, 1954, p. 29, pl. 6, fig. 20.

Description.—“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 sub-circular 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. (Stephenson)

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

Range in New Jersey—

RARITAN: 1 b

Type.—Sayreville, N. J.; USNM 108626.

Ostrea soleniscus Meek 1871

Plate 42, Figure 6

Ostrea soleniscus, Meek, 1871, Proc. Amer. Philos. Soc. Vol. 11, p. 430.

Ostrea soleniscus, Stephenson, 1953, U.S. Geol. Surv. Prof. Paper 242, p. 74, pl. 16, figs. 1-4; pl. 17, figs. 7-10, 1952=1953.

Ostrea soleniscus, Stephenson, 1954, p. 30, pl. 6, figs. 21, 22.

Description.—"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." (Stephenson)

Range in New Jersey—

RARITAN: 1

Range outside New Jersey: Texas (Woodbine formation; Western Interior).

Type.—Bear River City, Wyoming; USNM 7780 (cotypes).

Gryphaeostrea vomer (Morton) 1834

Plate 21, Figure 3

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

Gryphaeostrea vomer, Whitfield, 1886, p. 195, pl. 26, figs. 11-12.

Gryphaeostrea vomer, Weller, 1907, p. 455, pl. 44, figs. 6-11.

Gryphaeostrea vomer, Gardner, 1916, p. 579, pl. 25, figs. 1-4.

Gryphaeostrea vomer, Stephenson, 1936, Bull. Geol. Soc. Amer. vol. 47, p. 375, pl. 1, fig. 12.

Gryphaeostrea vomer, Stephenson, 1941, p. 118, pl. 18, fig. 5-9.

Description.—The dimensions of a rather large individual are: length, 55 mm.; greatest width, near the hinge-line, 33 mm. Shell narrowly elongate, subovate or subelliptical in outline, more or less strongly arcuate from beak to base, and often more or less twisted laterally. Lower or right valve more or less strongly convex, the beak small, pointing forward, a little coiled; in typically developed shells both the anterior and posterior cardinal regions are produced into compressed auricular extensions, one or both of which are frequently wanting; the surface of the valve nearly smooth or only slightly marked with concentric lamellose lines upon the body of the shell, the auricular ex-

tensions usually more strongly lamellose. The upper left valve usually concave longitudinally, flat or slightly concave transversely, the dorsal margin rounded, its cardinal regions not produced into auricular appendages, the beak curved anteriorly; surface marked by distinct and somewhat regular, elevated concentric ridges whose summits are produced as free lamellæ. Ligamental areas small or nearly obsolete. (Weller).

Remarks.—This form is widespread throughout the Upper Cretaceous and Eocene of the Atlantic Coastal Plain. In general, the Eocene specimens are smaller than those from the Cretaceous.

Range in New Jersey—

MARSHALLTOWN: 28

MT. LAUREL-NAVESINK: 38, 42, 47, 48, 49, 50, 53

RED BANK: 59

HORNERSTOWN: Hornerstown, Sewell

VINCENTOWN: Vincentown, Brownsville

MANASQUAN: Clementon

Range outside New Jersey: Delaware, Maryland, Alabama, Mississippi, Tennessee, Texas, Arkansas, Georges Bank.

Type.—New Egypt, N. J. ANSP 16167.

***Gryphaea convexa* (Say) 1820**

Plate 19, Figures 7, 8

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

It is impossible to give an adequate description or synonymy of this form until the various closely related species have been studied in detail. It is an extremely variable form, but is one of the commonest large pelecypods of the Marshalltown, Mount Laurel and Navesink formations. It is generally subcircular to elliptical in outline. The left valve is usually convex, while the right valve is concave. On many specimens a constriction extends from the beak obliquely backward and downward forming a wing-like extension of the shell. Beak on the left valve is incurved; hinge relatively small, triangular with the inner or basal margin longer than the sides. Surface of the left valve smooth with the exception of concentric growth lines and rather broad irregular growth undulations. Surface of right valve with concentric growth lines and radiating straight lines or shallow depressions.

It is very similar to *Gryphaea vesicularis* (Lamarck) from the Cretaceous of Europe and may be identical as has been suggested by several authors.

Gryphaea mutabilis Morton has been described from the Marshalltown formation and differs from typical *G. convexa* by its thinner shell, its more depressed lower convex valve and in the absence of the conspicuous posterior constriction and auriculation of the lower valve.

It is possible that this is within the range of variation of *G. convexa*.

G. dissimilaris Weller was described from the Hornerstown formation, but is probably merely the young or a small race of *G. convexa*.

For full descriptions and synonymy see Weller (1907), Gardner (1916), Wade (1926) and Stephenson (1923, 1941).

Range in New Jersey—

MARSHALLTOWN: 28, 32

MOUNT LAUREL-NAVESINK: 39, 40, 41, 42, 46, 47, 49, 53

HORNERSTOWN: Near Woodstown; New Egypt; near Mullica Hill

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Tennessee and Gulf Coastal Plain.

***Exogyra ponderosa* Roemer 1849 .**

Plate 19, Figure 9

Exogyra ponderosa, Roemer, 1849, Texas p. 395.

Exogyra costata, Whitfield, 1886, p. 39, (part) pl. 6, figs. 1-2.

Exogyra ponderosa, Weller, 1907, p. 458, pl. 47, fig. 2.

Exogyra ponderosa, Gardner, 1916, p. 569.

Exogyra ponderosa, Stephenson, 1923, p. 165, pl. 45, figs. 6-7; pl. 46.

Exogyra ponderosa, Groot, Organist and Richards, 1954, p. 43, pl. 4, fig. 1.

Description.—"Shell of adult, thick, subcircular to subovate in outline. Dimensions of the specimen shown in Plate 46: Length about 97 mm., estimated height 108 mm., convexity about 47 mm.

Left or lower valve much larger than right valve, convex attached in proximity to beak to an external object, this part of the shell being often very much deformed by the scar of attachment. Apical portion spirally coiled within the margin of the shell. A more or less clearly defined umbonal ridge extends from the beak backward in a curve conforming to the spiral twist of shell, to the lower posterior margin, usually, however, becoming rounder and less clearly recognizable towards the margin. Hinge narrow with ligamental groove deeply impressed, paralleled on the upper side by a rather faintly developed, narrow, shallow groove, both grooves curved to conform to the spiral twist of shell; posterior to the larger groove on the inner surface is a broad, shallow, pitted or striated depression which is not equally distinct on all specimens. Adductor scar broadly oval in outline, situated a little above the midheight and a little back of the midlength of the shell. Surface marked by thin, rather prominent, concentric, imbricating growth lamellae, with intermediate fine growth lines; radiating costae either entirely absent, or small regularly arranged costae are present in proximity to the beak, extending back from the

beak one-half to three-quarters of an inch; in addition to the preceding, faint, irregular costae may extend back to varying distances from the beak.

Upper or right valve flat or slightly concave, operculiform, sub-circular or subovate in outline, with a nearly flat, spiral twist, the beak being well within the margin; beak depressed; this valve enclosed within and slightly depressed below the projecting margin of the lower valve.

Hinge narrow with deeply impressed ligamental groove curved to conform to the spiral twist of shell, the upper margin of the groove finely crenulated; posterior to the groove a striated protuberance occupies a position in apposition to the similarly striated depression on the left valve. The surface is marked in proximity to the beak by numerous fine, concentric growth lines, and toward the margin by projecting, imbricating lamellae, separated by deep, narrow depressions." (Stephenson.)

Remarks.—*E. ponderosa* differs from *E. costata* in having lamellose extensions and in lacking the strongly costate sculpture characteristic of the latter species. It is limited to the Marshalltown formation.¹

Range in New Jersey—

MARSHALLTOWN: 28, 31, 32

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas, Texas.

Type.—New Braunfels, Texas; University of Bonn 131.

***Exogyra ponderosa* var. *erraticostata* Stephenson**

Plate 20, Figure 2

E. ponderosa var *erraticostata* Stephenson, 1914, U. S. Geol. Surv. Prof. Paper 81, p. 49-50 pl. 15, fig. 4; pl. 16, figs. 1, 2.

E. ponderosa var. *erraticostata*, Stephenson, 1923, p. 171, pl. 47, fig. 1.

E. ponderosa erraticostata, Stephenson, 1936, Bull. Geol. Soc. Amer. vol. 47, p. 375, pl. 1, fig. 10.

Description.—In all its characters except the surface ornamentation of the left or lower valve, this variety is essentially like the typical *Exogyra ponderosa* Roemer. The surface of the left valve is characterized by the presence of more or less well defined, sharp to round crested radiating costae or plications which differ from the costae on *Exogyra costata* Say in their generally weaker development, and in their striking irregularity as regards size, shape, and distribution. In proximity to the beak the shell is, as a rule, ornamented with small, regularly arranged radiating costae which extend backward over the

¹ For discussion of *Exogyra* zones see pages 19-20.

shell only one-half to three-quarters of an inch, such as are present on some specimens of *Exogyra ponderosa* Roemer, but these merge into the irregular costae which characterize the variety. The irregular costae extend backward 3 to 5 inches from the beak, becoming weaker in the direction of the margin; on a considerable part of the surface bordering the margin of large individuals the costae are either very faint or entirely absent. All gradations in surface ornamentation are found between the extremes of this variety and typical specimens of *Exogyra ponderosa* Roemer. (Stephenson)

Remarks.—Associated with *E. ponderosa* in the Marshalltown formation; also known from a single specimen in the Woodbury formation from Haddonfield.

Range in New Jersey—

WOODBURY: 24

MARSHALLTOWN: 28

Range outside New Jersey: North Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas, Texas, Georges Bank.

Type.—1 mile west Cotton Gin Port, Monroe County, Mississippi; U.S.N.M.

Exogyra costata Say 1820

Plate 20, Figure 1, 4

Exogyra costata, Say, 1820, Amer. Jour. Sci. 1st ser. vol. 2, p. 43.

Ostrea torosa, Morton, 1834, Amer. Jour. Sci. 1st ser. vol. 24, p. 130, Pl. 10, fig. 1.

Exogyra costata, Whitfield, 1886, (part) p. 39, pp. 39-41, pl. 6, figs. 1, 2.

Exogyra costata, Weller, 1907, p. 456, pl. 47, fig. 1.

Exogyra costata, Gardner, 1916, p. 564.

Exogyra costata, Stephenson, 1914, U.S. Geol. Surv. Prof. Paper 81, p. 50, pl. 16, figs. 3, 4; pl. 17, fig. 1, pl. 18, pl. 19, figs. 3, 4, pl. 20, fig. 1,

Exogyra costata, Stephenson, 1923, pp. 173-9, pl. 47, figs. 2-5; pl. 48.

Exogyra costata, Wade, 1926, p. 56, pl.

Exogyra costata, Groot, Organist and Richards, 1954, p. 43, pl. 4, fig. 3.

Description.—"Shell of the adult inequivalve, thick, and massive, occasional overgrown specimens becoming ponderous; subcircular to subovate in outline. Dimensions of a medium sized specimen: Length 90 + mm., height 90 + mm., convexity 55 + mm.

Left or lower valve much larger than right valve, strongly convex, attached in proximity to the beak to an external object; beak usually more or less deformed by the scar of attachment. Apical portion of shell spirally coiled within the margin. On most specimens there is a more or less distinctly marked umbonal ridge extending from the

beak around to the posterior margin in a curve corresponding to the spiral twist of the shell.

Hinge and other internal shell characters essentially the same as in *Exogyra ponderosa* Roemer.

Surface characterized by regularly arranged, prominent, often rugged, radiating, entire or bifurcated costae, which in typical normal specimens extend in curves conforming to the spiral twist of the shell from the beak to the margin; the costae are separated by depressions which are usually narrower than the costae themselves; in occasional non-typical specimens the costae are weakly developed and in large overgrown individuals they become faint or disappear entirely toward the margin; in cross-section the costae vary in shape from semi-circular to squarish; they vary in maximum width on different adult individuals from 2 to 6 mm.; in some specimens the summits of the costae are ornamented with slight nodular protuberances. Along the umbonal ridge the costae bifurcate frequently, those in front and below the ridge extending with a slight backward curve to the lower margin, and those above and to the rear of the ridge extending with a strong upward curve to the upper posterior margin.

Upper or right valve flatly spiral, roughly disc-shaped or operculiform, the outer surface varying from slightly convex to slightly concave, the valve inclosed within and depressed below the projecting margin of the lower valve. Hinge and other internal shell characters essentially the same as in *Exogyra ponderosa* Roemer. Beak strongly depressed. Surface of shell ornamented with numerous concentric sharp-edged lamellae, separated by narrow, deep depressions. Radiating costae absent or but faintly developed on most specimens, but on occasional specimens becoming fairly distinct on the upper posterior one-third of the shell." (Stephenson.)

Remarks.—Two adult specimens of *E. costata* are in the collections of the Academy from Haddonfield, and very recently a number of young individuals of this species were found at this locality. This marks the first record of the species from the Woodbury formation or from the Matawan group. While this record may seem to extend the time range of the *Exogyra costata* group, its rareness in the Woodbury formation will not appreciably affect the value of the species as an index of the Monmouth group as has been stated by Stephenson and many other authors.

Distribution in New Jersey—

WOODBURY: 24a

MT. LAUREL-NAVESINK: 37, 38, 39, 40, 41, 43, 49, 50, 53.

RED BANK: 59

TINTON: 62

Distribution outside New Jersey: Delaware, Maryland, North Caro-

lina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, Texas, Mexico.

Type.—Mullica Hill, N. J.; lost.

***Exogyra costata* var. *spinifera* Stephenson 1941**

Plate 20, Figure 3

Exogyra costata Stephenson, 1914, (in part) U.S. Geol. Surv. Prof. Paper 81, pl. 17, fig. 2, pl. 19, figs. 1-2.

Exogyra costata var. *spinosa*, Stephenson, 1923, p. 179, pl. 49, figs. 1-6, pl. 50, figs. 1, 2.

Exogyra costata spinifera, Stephenson, 1941, p. 125, pl. 21, fig. 1.

Description.—"The left valve of this variety differs from the more typical representatives of the species in the prominent development of concentric, imbricating growth lamellae which along the crests of the costae project outward in spine-like folds with the convex side of the folds upward. The folds vary in prominence, but reach maximum extensions of 6 or 8 mm. from the crests of the ridges; they are easily broken, so that even the best specimens are imperfect.

The right valves vary considerably in form and sculpture on different individuals; they range from flat or concave to rather strongly convex and massive; some lack costae and projecting folds, while others have them rather strongly developed on the postero-dorsal portion of the surface. On some specimens the concentric lamellae on the ventral and anterior portions of the surface are distinctly wavy or fluted.

The variety appears to be somewhat smaller on the average than typical adults of the species, but occasional specimens become moderately large." (Stephenson)

Remarks.—More characteristic of North Carolina than New Jersey. According to Stephenson, one specimen from Burlington County, New Jersey is a fairly good example of this variety. The variety has also been found at Cream Ridge, N. J.

Since the name *spinosa* originally proposed for this variety was preoccupied, Stephenson (1941) proposed the new name *spinifera*.

Distribution in New Jersey:

NAVESINK: 57

Distribution outside New Jersey: North Carolina, South Carolina, Mississippi, Texas.

Type.—Robinsons Landing, N. C. USNM 31231.

***Exogyra cancellata* Stephenson 1914**

Plate 21, Figures 1, 2

Exogyra costata var. *cancellata* Stephenson, 1914, p. 53, pl. 20, figs. 2-4; pl. 21, figs. 1-2, 1914.

Exogyra costata var. *cancellata*, Gardner, 1916, p. 566, pl. 27, fig. 3.

Exogyra cancellata, Stephenson, 1923, p. 182, pl. 50, figs. 5-6; pl. 51, figs. 1-2.

Exogyra cancellata, Wade, 1926, p. 58, pl. 16, figs. 1-3.

Exogyra cancellata, Groot, Organist and Richards, 1954, p. 43, pl. 4, fig. 2.

Description.—Shell of adult moderately thick, subcircular to subovate in outline. Approximate dimensions of an average specimen: Length 80 mm., height 83 mm., convexity 37 mm.; length of a rather large specimen 125 mm.

Left or lower valve much larger than right valve, attached in proximity of beak to an external object, the beak usually somewhat deformed by the scar of attachment; general form, hinge characters, and other internal shell characters essentially the same as in *Exogyra ponderosa* Roemer. On most specimens a more or less distinct shallow depressed area extends from the beak to the posterior margin in a curve corresponding to the spiral twist of the shell, broadening distally. Surface of left valve ornamented with more or less distinct, low, bifurcating, nodular costae, the nodes produced by concentric depressions regularly arranged in such a manner as to give to the surface of the shell a checkered or cancellated appearance; the nodes on the costae are in some cases more prominently connected concentrically than in the direction of the radiating costae, thus producing distinct concentric ridges. In non-typical specimens the costae are weakly developed and there is a corresponding strong development of concentric growth lamellae, but on such specimens the characteristic cancellated markings are generally fairly well developed in proximity to the beak. On adult specimens the costae, apparently in all cases, become faint and disappear distally, concentric imbricating lamellae being only ornamentation. On the portion of the shell corresponding to the umbonal ridge, the radiating costae bifurcate frequently, those in front extending downward in the direction of the lower margin of the shell and those behind extending in a rather sharp upward curve to the upper posterior margin of the shell.

Upper or right valve operculiform, roughly ovate in outline and overlapped by the projecting margin of the lower valve; usually this valve is distinctly concave. Hinge and other internal characters essentially as in *Exogyra ponderosa* Roemer. Beak depressed, with a nearly flat spiral twist or coil. Surface nearly smooth on the inner concave portion, becoming ornamented toward the outer margin with numerous concentrically arranged sharp-edged lamellae, separated by deep, narrow depressions. Costae either absent or but very faintly developed towards the margin." (Stephenson.)

Remarks.—This species has hitherto been reported from New Jersey only from the Mount Laurel formation. However, recently a specimen

(Plate 21, Figure 2) was obtained in the Navesink formation near Arneytown, N. J. Also, Spangler and Peterson (1950) report it from the Navesink. In Delaware the Mount Laurel and Navesink are regarded as a unit and *E. cancellata* is found throughout the formation.

Range in New Jersey—

MOUNT LAUREL: 45, 48

NAVESINK: Near Arneytown.

Range outside New Jersey: Delaware, Maryland, North Carolina, Georgia, Alabama, Mississippi, Texas, Mexico.

Type.—Mississippi and Tennessee (cotypes) USNM; lectotype, 1 mile east Cedar Bluff, Mississippi (USNM 31235).

***Exogyra woolmani* Richards 1947**

Plate 46, Figures 9, 10

Exogyra Woolman, 1899, Ann. Rept. New Jersey State Geol. for 1899, p. 98.

Exogyra woolmani, Richards, 1947, Jour. Paleont. Vol. 21, p. 14, pl. 35, figs. 7, 8.

This species was obtained by Lewis Woolman from a well at Norfolk, Virginia, but was not described until 1947 by Richards. It is closely related to *E. columbella* Meek from the Eagle Ford formation of Texas, but is smaller and does not show radiating striae.

E. woolmani is apparently restricted to the Raritan-Tuscaloosa formations and has been found in wells in Virginia, North and South Carolina and Florida (?).

A cast of a small *Exogyra*, possibly *E. woolmani*, was found at Sayreville, N. J. (Plate 41, Figure 13) and recently a number of well preserved specimens have been found in a core in the Raritan formation at the depth of 1648 feet near Harrisville, Burlington County, New Jersey.¹

Exogyra

A poorly preserved cast of an *Exogyra* was found at the Graham Brick Yard in Maple Shade, N. J. (locality 16). This is the first record of this genus from the Merchantville formation. The specimen measures 120 mm. by 123 mm.

Family Trigoniidae

***Trigonia mortoni* Whitfield 1886**

Plate 21, Figures 4, 8

Trigonia mortoni Whitfield, 1886, p. 112, pl. 14, figs. 5, 6.

¹ A full report on the fossils from this and other cores is in preparation.

Trigonia thoracica, Weller, 1907, p. 460, pl. 48, figs. 1-4. Not of Morton 1834.

Trigonia mortoni, Groot, Organist and Richards, 1954, p. 43.

Description.—Shell large, the dimensions of an average-sized individual being: length, 48 mm.; height, 42 mm.; convexity, 11 mm. Ovate subtrigonal in outline, the valves moderately convex in front, becoming compressed posteriorly; the beaks nearly anterior, slightly recurved. Anterior margin broadly rounded, passing into the ventral margin; ventral margin broadly rounded, often becoming a little straightened as it approaches the posterior extremity of the shell; posterior margin obliquely subtruncate above; dorsal margin gently concave from the beak to the posterior hinge extremity. Surface of the valve divided into two portions by an angular, curved furrow, passing backward from just behind the beak sub-parallel with the dorsal margin, to a point in the posterior margin of the shell a short distance below the posterior hinge extremity; the lower portion of the valve constitutes much the greater part and is marked by about fifteen ribs, about ten of which are very strong, subangular, more or less nodose, with broad concave interspaces, and occupying the greater portion of the shell, the more anterior of these ribs are shorter and curve strongly forward, the more posterior ones curve slightly downward; between these strong ribs and the curved divisional furrow is a subtriangular area occupied by much smaller somewhat nodose furrows, which usually have a more or less distinct upward curvature as they approach the posterior border. The upper portion of the valves is divided into two regions, being nearly in the plane of the valve below and abruptly inflected above to the hinge-line, to form a long and rather broad escutcheon, this region is marked with 12 or 14 subangular ribs which originate along the divisional furrow, curving backward and upward across the escutcheon to the hinge-line. The entire surface is also marked by more or less irregular concentric lines of growth. (Weller)

Remarks.—Whitfield described this species from internal casts from the Marshalltown formation. Weller figured somewhat better individuals and placed them all in *T. thoracica*. However, as pointed out by Stephenson (1941 p. 127), the New Jersey specimens are too closely ribbed to be so classified. Therefore it seems desirable to reintroduce Whitfield's name *T. mortoni*.

Range in New Jersey—

WOODBURY: 22

MARSHALLTOWN: 28

WENONAH: 34

MT. LAUREL-NAVESINK: 41, 43

Range outside New Jersey: Delaware

Type.—New Jersey (Morton) ANSP 19346

Trigonia eufaulensis Gabb 1860

Plate 21, Figure 7; Plate 22, Figure 1

Trigonia eufaulensis Gabb, 1860, Jour. Acad. Nat. Sci. Phila. 2nd ser. vol. 4, p. 396, pl. 68, fig. 32.

Trigonia eufaulensis, Whitfield, 1886, p. 113, pl. 14, figs. 1-4.

Trigonia eufaulensis, Weller, 1907, p. 462, pl. 48, figs. 5-10.

Trigonia eufaulensis, Gardner, 1916, p. 582, pl. 34, figs. 1-2.

Trigonia eufaulensis, Stephenson, 1923, p. 189, pl. 54, figs. 1-6.

Trigonia eufaulensis, Wade, 1926, p. 61, pl. 20, figs. 3-4.

Trigonia eufaulensis, Groot, Organist and Richards, 1954, p. 44.

Description.—Shell small, the dimensions of an average specimen being: length, 21 mm.; height 15 mm.; convexity, 4 mm. The largest specimen observed is under 30 mm. in length. Ovate subtrigonal in outline, somewhat alate posteriorly, moderately convex in front, compressed behind. Beaks almost anterior, slightly recurved. Anterior and antero-basal margin broadly rounded, postero-basal margin nearly straight, sloping upward towards the posterior hinge extremity, posterior extremity rounding sharply into the dorsal margin; dorsal margin nearly straight behind, becoming more strongly concave as it approaches the beak. Surface of the valves divided into two portions by a ridge passing with a concave curve from the posterior side of the beak to the posterior margin of the shell just below the posterior extremity of the hinge-line. The lower portion of the valve is marked by 12 or 14 strong, angular, non-nodose ridges, narrower than the interspaces, the more anterior ones of which curve strongly forward in passing from the bounding ridge to the shell margin, the more posterior ones becoming straighter, in some cases having a slightly sigmoidal curve. The upper portion of the shell is inflected above the bounding ridge for about one-half the distance to the hinge-margin, above which it is again deflected into nearly a plane with the valve, the ribs of the lower portion of the shell are continued across the upper portion, being abruptly bent backwards in crossing the bounding ridge, the more posterior ones being more strongly bent than those in front. Besides the ribs, the shell is marked by inconspicuous lines of growth.

Remarks.—This species usually occurs in the New Jersey formations in the form of more or less indefinite internal casts, but occasionally in certain hard nodules good impressions of the exterior are preserved, from which casts may be taken to show the external characters. It has been from such casts that the above description has been made. Whitfield's material from which he illustrated the species was much more incomplete than that now available, some of his figures are more or less restored, and none of them represent the characters of the species as ordinarily preserved in the New Jersey faunas. The internal casts do not preserve the characters of the upper portion of the shell which are

really the most essential specific features, but the presence of the keel-like extension of the shell along the hinge-line, rather than a sharply inflected border to form a broad escutcheon, can usually be recognized. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 15

WOODBURY: 19, 23, 24

WENONAH: 34, 35

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi.

Type.—Eufaula, Alabama; ANSP 19578.

Trigonia cerulia Whitfield 1886

Plate 21, Figure 5

Trigonia cerulia Whitfield, 1886, p. 114, pl. 14, fig. 7.

Trigonia cerulia, Weller, 1907, p. 464, pl. 48, fig. 13.

Trigonia cerulia, Gardner, 1916, p. 584.

Description.—Shell small, the dimensions of an average-sized left valve being: length, 30 mm.; height, 24.5 mm.; convexity, 9 mm. Subovate in outline, the beaks nearly anterior, obtuse, scarcely recurved. Anterior and ventral margins together forming nearly a semicircle, posterior margin rather sharply rounded above into the dorsal margin; dorsal margin gently concave from the beak to the posterior extremity of the hinge-line. Surface of the valve divided into two portions by an obscure ridge, subparallel with the dorsal margin, passing from the posterior side of the beak, with a gently concave curvature to the posterior margin a short distance below the posterior extremity of the hinge-line. The lower portion of the shell, which comprises the greater part of the surface, is covered with sharply angular and faintly crenulate ribs which curve strongly forward in front, the more posterior ones passing in a nearly straight line from the bounding ridge above to the basal margin, the interspaces between these ribs are broad in front becoming regularly narrower towards the posterior portion of the shell. The upper portion of the surface is divided longitudinally by a shallow groove along the lower side of which the ribs of the lower portion of the shell originate; they pass obliquely backward from their point of origin, bending more or less abruptly downward as they cross the bounding ridge; above the longitudinal furrow the surface is continuous for a short distance with the general surface of the valve and is then abruptly inflected to the hinge-line to form a rather broad escutcheon; from the upper margin of the longitudinal furrow a series of about 10 obscure ribs originates, which are directed obliquely backwards and continue in that direction to the margin of the inflected portion of the shell when they bend abruptly forward, becoming much

stronger and continuing to the hinge-line which they meet in nearly right angles. Besides the ribs the surface of the shell is covered with obscure concentric lines of growth.

Remarks.—Whitfield's illustration and description of this species are misleading. The type specimen is very imperfect and has the surface much injured, the illustration being greatly restored. According to the original description there is no differentiation of the upper portion of the shell, but a little further development of the type specimen has shown the surface features to be as has been described above. The species is a common one in its type locality at Beers Hill cut, south of Keyport, and the recent collections of the Survey contain many specimens which show the essential features of the shell far better than the type. (Weller)

Range in New Jersey—

TINTON: 62, Freehold

Range outside New Jersey: Maryland.

Type.—Beers Hill, N. J.; NJSM 7508.

***Trigonia kummeli* Weller 1907**

Plate 21, Figure 6

Trigonia kummeli Weller, 1907, p. 466, pl. 48, figs. 11-12.

Description.—Shell small, the dimensions of an average specimen being: length about 26 mm.; height, 20 mm.; convexity, 6 mm. Ovate-subtrigonal in outline, moderately convex in front, the greatest convexity being near the anterior margin, compressed posteriorly. Beaks rather sharp, nearly anterior, slightly recurved. Anterior and antero-basal margin describing nearly a semicircle; postero-basal margin straighter and sloping upward towards the posterior hinge extremity: dorsal margin gently concave. Surface of the valves divided into two regions by a ridge, or more properly by a row of nodes passing in a concave line from the posterior side of the beak to the posterior margin a little below the hinge extremity. The lower portion of the valve marked by 14 or 15 sharply angular, prominent, narrow, nodose ribs, the most anterior ones of which curve strongly forward in passing the dorsal extremity to the shell margin; the first two or three ribs on the beak are crowded close together, the interspaces gradually becoming broader to about the sixth rib, beyond which the interspaces are about equal in width, being much wider than the ribs themselves. The upper surface of the valve continues in the general slope of the valve from the row of bounding nodes to over half the distance to the hinge-line. The surface is then sharply inflected for a short distance and then again deflected, when it continues to the hinge margin in nearly the plane of the valve, this deflected portion of the two valves forming a keel-like projection of the shell along the hinge-line back of the beaks.

The ribs of the lower portion of the shell are bent abruptly forward as they cross the bounding line between the two portions of the valve; they continue in that direction to about the middle of the broad, inferior part of the upper portion, when they are bent abruptly backward to the lower margin of the inflected portion, where they are again bent forward to the hinge margin; towards the posterior extremity of the shell the ribs become more or less indistinct. In addition to the ribs the shell is marked by concentric lines of growth, which are indistinct except in front near the margin.

Remarks.—This species resembles *T. eufulensis* in general form and proportions, and in the keel-like extension of the shell along the hinge-line back of the beak. From the internal casts alone the two species can hardly be distinguished if at all, but the external characters of the shell are quite different. The ribs of the shell of *T. kummeli* are narrower, sharper and nodose, and the interspaces between the ribs continue to the posterior portion of the shell with about the same width, while in *T. eufulensis* the interspaces become regularly narrower posteriorly. The zig-zag direction of the ribs across the upper portion of the shell is also different from *T. eufulensis*, in which species they pass directly across this portion of the shell from the bounding ridge below to the hinge-line. (Weller)

Range in New Jersey—

RED BANK: 59, 60

Type.—Plastocotype—Chicago; 18688.

Family Pectinidae

Pecten tenuitestus Gabb 1861

Plate 23, Figure 8

Pecten tenuitesta, Gabb, 1861, Proc. Acad. Nat. Sci. p. 327.

Pecten planicostatus, Whitfield, 1886, p. 48, pl. 8, figs. 10-11.

Pecten tenuitestus, Weller, 1907, p. 467, pl. 50, fig. 9.

Pecten quinquaria, Wade, 1926, p. 65 (part).

Not *Pecten tenuitestus*, Whitfield, 1886, p. 47 = *P. whitfieldi* Weller

Description.—Left valve depressed convex or nearly flat, equilateral, and aside from the auriculations nearly subcircular in outline. The dimensions of an imperfect impression of a left valve are: height, about 40 mm.; width, 41.5 mm.; length of hinge-line, about 22 mm. Auriculations of moderate size, subequal, but slightly depressed below the general surface. Surface marked by about thirty, low, rounded ribs, which are much narrower than the flattened interspaces, the stronger ribs continue to the beak and never bifurcate, the smaller ones being added by intercalation, the auriculations are entirely free from radiating ribs; besides the radiating ribs the entire surface is marked by

exceedingly fine, regular, concentric striae. The shell substance is apparently very thin. (Weller)

Remarks.—Whitfield is in error in his identification of *Pecten tenuitestus* Gabb, as has been shown by a study of the type specimens in the collection of the Philadelphia Academy of Science, the species being described as a new form by him under the name *P. planicostatus*. The shells which Whitfield has referred to *P. tenuitestus* are quite a distinct form, and were described by Weller as *P. whitfieldi*. The true *P. tenuitestus* differs from *P. whitfieldi* in its more nearly subcircular outline, the less compressed auriculations, the non-nodose radiating ribs, and in the character of the fine concentric striae.

Wade placed *P. tenuitestus* in the synonymy of *P. quinquenarius* Conrad, regarding the former merely as the left valve of the latter. However, additional specimens will be needed before this can be shown with certainty.

Range in New Jersey—

MOUNT LAUREL-NAVESINK. 42, 43, 47

Type.—Burlington County, N. J.; ANSP 18759.

***Pecten whitfieldi* Weller 1907**

Plate 22, Figure 2

Pecten tenuitestus, Whitfield, 1886, p. 47, pl. 7, figs. 5-6. Not of Gabb 1861.

Pecten whitfieldi, Weller, 1907, p. 468, pl. 50, fig. 14.

Pecten whitfieldi, Gardner, 1916, p. 589.

Pecten whitfieldi, Groot, Organist and Richards, 1954, p. 44, pl. 4, fig. 5.

Description.—Shell, exclusive of the auriculations, broadly ovate in outline, higher than wide, the dimensions of a left valve being: height, 40 mm.; width, 35 mm.; convexity, 5 mm.; length of hinge-line about 16 mm. Left valve depressed convex, deepest above the middle, the beak pointed, auriculations of moderate size, the anterior one larger than the posterior. Surface marked by low, rounded, nodose, more or less unequal, radiating ribs, which increase by intercalation, 30 or more are present upon the body of the shell where they are narrower than the interspaces, the ribs upon the auriculations are narrower, closer together, and more nodose than upon the body of the shell, though in some examples, especially the larger ones, they are inconspicuous. The surface is also marked by more or less irregular, concentric lines of growth. (Weller)

Remarks.—This species was discussed under *P. tenuitestus* Gabb. It differs from *P. tenuitestus* by being proportionally higher, narrower, and more convex, with nodose and proportionally broader radiating

ribs. It has narrower interspaces and the concentric markings are coarser and less regular.

Range in New Jersey—

MT. LAUREL-NAVESINK: 41, 42, 47, 49

Range outside New Jersey: Delaware, Maryland.

Type.—Holmdel, N. J. NJSM 8034.

***Pecten cliffwoodensis* Weller 1907**

Plate 22, Figure 3

Pecten cliffwoodensis Weller, 1907, p. 469, pl. 50, figs. 7-8.

?*Pecten cliffwoodensis*, Gardner, 1916, p. 592.

Pecten cliffwoodensis, Stephenson, 1923, p. 196, pl. 55, figs. 1-5.

Description.—The dimensions of an average specimen, a left valve, are: height, 30 mm.; width, 27.5 mm.; convexity, 4 mm.; length of hinge-line, 14 mm. The body of the shell broadly subovate in outline, the beaks situated a little back of the middle of the hinge-line, the auriculations moderately large and sharply differentiated, the anterior ones somewhat larger than the posterior, the cardinal slopes diverging from the beak at an angle of 90° or a little more, nearly straight or slightly concave, terminating at the sides of the shell above the middle of its height. The valves subequally depressed convex, the right valve if anything slightly flatter than the left, with a moderately deep byssal sinus. Surface of both valves nearly smooth, marked only by fine concentric lines of growth which continue across the auriculations, and on the anterior ear of the right valve become stronger than elsewhere on the shell. (Weller)

Remarks.—One imperfect specimen which seems to be a member of this species, had a height when complete of about 50 mm., but the dimensions given above are those of a specimen of about average size. Some of the smaller individuals do not exceed 12 mm. in height. With the growth of the shell the proportionate width seems to increase. This species is unlike any of the other *Pecten*s in these New Jersey faunas, but in general form and size the shells most closely resemble some individuals of *Pecten bellisculptus* Con.; the two species can always be distinguished, however, by their surface markings. (Weller)

Stephenson noted that obscure radiating ribs were present on the dorsal slopes and on the ears of the type specimen as well as on some of the specimens subsequently collected from North Carolina.

Range in New Jersey—

MAGOTHY: 5

Range outside New Jersey: Maryland, North Carolina, Georgia, Alabama.

Type.—Cliffwood Point, N. J. NJSM 7785.

Pecten burlingtonensis Gabb 1860

Plate 23, Figures 3, 6

Pecten burlingtonensis, Gabb, 1860, Jour. Acad. Nat. Sci. Phil. 2nd ser. vol. 4, p. 304, pl. 48, fig. 25.

Camptonectes burlingtonensis, Whitfield, 1886, p. 53, (part) pl. 8, figs. 7-8 (not 3-6, 9 = *P. argillensis*, Conrad).

Pecten perlamellosus, Whitfield, 1886, p. 50, pl. 7, fig. 7.

Pecten burlingtonensis, Weller, 1907, p. 470, pl. 49, figs. 5-9.

Pecten burlingtonensis, Wade, 1926, p. 63, pl. 20, figs. 5, 6, 10, 11.

Description.—Shell, in large individuals, attaining a height of 57 mm., and a width of 62 mm.; the hinge-line straight, one-half or a little less than one-half the width of the shell, with a central triangular cartilage pit; the body of the shell broadly subovate in outline, the auriculations moderately large and nearly equal in size; the cardinal slopes a little concave, diverging from the beak at an angle of 90° or more, the shoulders of the valves prominent and above the middle of the height of the shell. Left valve depressed convex with the auriculations sharply differentiated. Right valve nearly flat, with a moderately deep byssal sinus. Surface of the valves marked by concentric bands which are continuous across the auriculations, and by exceedingly fine, impressed, radiating striae which are continuous upon the auriculations and the umbo, where they are about equal in width with the interspaces, but on the outer portion of the shell they become more or less discontinuous. The inner portion of the concentric bands often being nearly smooth, while on the outer portion they are completely striate, but with the interspaces between the striae broader than the striae themselves. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 10, 13, 14, 15

WOODBURY: 18, 24

WENONAH: 34

Range outside New Jersey: Tennessee.

Type.—Burlington County, N. J.; ANSP 18756

Haddonfield, N. J.; ANSP 18758 (TYPE of *perlamellosa*).

Pecten bellisculptus (Conrad) 1869

Plate 22, Figure 4; Plate 23, Figure 10

Camptonectes bellisculptus Conrad, 1869, Am. Jour. Conch., vol. 5, p. 99, pl. 9, fig. 11.

Camptonectes burlingtonensis, Whitfield, 1886, p. 53, pl. 8, figs. 3-6, 9 (not 7-8).

Pecten argillensis Weller, 1907, p. 472, pl. 49, figs. 1-4. Not of Conrad 1860.

Pecten argillensis Gardner, 1916, p. 588, pl. 34, figs. 3-5. Not of Conrad

Pecten bellisculptus Stephenson, 1923, p. 193, pl. 54, figs. 10-11.

Description.—Shell, in large individuals, attaining a height of 35 mm. to 40 mm., and a width of 30 mm. to 36 mm., the height usually considerably greater than the width, but the two dimensions nearly equal in some individuals; hinge-line straight, one-half or less than one-half the width of the shell, the beaks situated back of the middle point of the hinge; the body of the shell subovate in outline, the aurications sharply differentiated, unequal, the anterior ones being much broader than the posterior; cardinal slopes usually a little concave, diverging from the beaks at an angle of 90° or less. Right valve depressed convex with a rather deep byssal sinus in front; left valve more strongly convex. Surface of both valves marked by fine, even radiating ribs with much narrower interspaces; by reason of their frequent bifurcation the ribs maintain essentially the same size throughout and at the sides of the valves they curve strongly upward in the upper portion, crossing the cardinal slopes and continuing across the aurications. Besides the radiating ribs the shells are marked by rather close, concentric raised lines which project slightly as they cross the radiating ribs, and which towards the front of the shell sometimes form fine spines. (Weller)

Remarks.—Both Weller and Gardner regarded this as synonymous with *P. argillensis* Conrad. However, as pointed out by Stephenson, the radiating ribs of the New Jersey specimens are much finer and more closely spaced. Also the average size of *P. bellisculptus* is probably greater than that of *P. argillensis*.

Range in New Jersey—

MERCHANTVILLE: 8, 10, 15, 16

WOODBURY: 18, 24

MARSHALLTOWN: 28

WENONAH: 35

MT. LAUREL-NAVESINK: 43, 47

Range outside New Jersey: Delaware, Maryland, North Carolina, Georgia, Alabama, Mississippi.

Type.—Haddonfield, N. J.; ANSP 18755.

***Pecten conradi* (Whitfield) 1886**

Plate 23, Figures 7, 11

Amusium conradi Whitfield, 1886, p. 52, pl. 7, figs. 8-10.

Pecten conradi, Weller, 1907, p. 474, pl. 50, figs. 1-4.

Pecten conradi, Gardner, 1916, p. 593.

Description.—"Shell small, seldom exceeding half an inch in height; erect-ovate, becoming more elongate proportionally with increased growth. Valves slightly convex. Hinge short, from half to two-thirds as long as the width of the body of the shell, strongly and distinctly auriculated. Beaks of the valves small and pointed, and the cardina slopes long, straight or slightly concave, extending to near the point of greatest width of the body of the shell. Left valve smooth or but faintly marked by fine concentric lines, and a few (five or six) very faint radii. Ears smaller than in the opposite valve, both sloping toward the beak on the outer margin. Right valve marked with crowded concentric folds or elevated lines; also by five or six radiating lines; not always present. On most specimens there are distinctly rounded concentric folds or varices, but on some they are thin, sharp lines; always more crowded and usually finer toward the front, in adult specimens. Ears very distinct; that of the posterior side sloping toward the beak and the anterior one rounded at the extremity and deeply notched." (Whitfield.)

Remarks.—This species is not uncommon in both the Merchantville and Woodbury formations. It is especially abundant in the Woodbury at Lorillard, but, like so many of the species from that locality, it grows to a much larger size than elsewhere; the average size of the individuals from there is not far from 15 mm. in height, while the largest ones are 17 mm. or more. The types of the species illustrated by Whitfield are 9 and 10 mm. in height, and he states that it seldom exceeds "half an inch in height" (12.5 mm.); the specimens from other localities than Lorillard agree with this statement. As noted by Whitfield, the species is a close ally of *Pecten simplicum* Con., and the New Jersey specimens have frequently been identified with that species. It differs especially from that species, however, in the conspicuous concentric markings which are always present upon the left valve at least. The larger specimens of the species from Lorillard somewhat resemble the young of *Pecten burlingtonensis* Gabb, but the concentric bands are narrower and do not continue across the auriculations as in that species. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 10, 15, 17

WOODBURY: 18, 20, 24

NAVESINK: 40, 53

Range outside New Jersey: Maryland.

Type.—Haddonfield, N. J.; ANSP 18757.

***Pecten quinquenarius* Conrad 1853**

Plate 23, Figure 5

Pecten quinquenaria Conrad, 1853, Jour. Acad. Nat. Sci, Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 10.

Pecten quinquenarius, Whitfield, 1886, p. 47, pl. 7, figs. 13-16.

Pecten quinquenaria, Weller, 1907, p. 476, pl. 50, figs. 10-12 (not fig. 13 = *P. mississippiensis* Conrad).

Pecten quinquenarius, Groot, Organist and Richards, 1954, p. 44.

Description.—"Shell of medium size, slightly oval transversely; in outline a little wider than high. Valves plano-convex in profile when united. Hinge line much shorter than the width of the shell below. Ears large, slightly unequal; that of the flat valve (right) somewhat sinuate on the anterior side. Cardinal slope of the valves somewhat concave between the beaks and the lateral margins of the body of the shell. Surface of the valves marked by strong, wide, rounded, radiating ribs, about five on the flat valve and six on the convex valve. On the convex valve as shown upon the impression left in the fine blue marl, there have been fine, even, and closely arranged concentric lines crossing the folds and passing up over the aurications; in fact, covering the entire surface of the valve. The opposite flat valve has not been marked by concentric lines, as was the convex valve, the surface of the cast, both inside and outside impressions, being apparently smooth. No remains of radiating lines on the folds can be seen." (Whitfield.)

Remarks.—This species formerly occurred in abundance in the Wenonah sand just beneath the base of the Navesink marl at a locality near Marlboro. Whitfield reports the species from the base of the Navesink.

P. quinquenarius is based upon an internal mold, and, according to Stephenson (1941, p. 139) is specifically indeterminable, but related to *P. mississippiensis* Conrad.

Range in New Jersey—

WENONAH: 35

MT. LAUREL-NAVESINK: 38

Range outside New Jersey: Delaware.

Type.—Delaware & Chesapeake Canal; ANSP 18805.

***Pecten parvus* (Whitfield) 1886**

Plate 22, Figure 5

Camtonectes parvus, Whitfield, 1886, p. 55, pl. 8, figs. 1-2.

Pecten parvus, Weller, 1907, p. 477, pl. 50, figs. 5-6.

Description.—"Shell quite small, the only specimen observed measuring only about three-tenths of an inch in height. Outline subcircular and (the left valve) convex, moderately elevated on the umbo and somewhat regularly declining in convexity, toward the front; anterior auriculation proportionally large and vertically striated with lamellose striae parallel to the anterior margin. Surface of the shell polished and marked with numerous interrupted impressed striae, the spaces be-

tween the striae being flattened and crossed by very faint lines of growth." (Whitfield.)

Remarks.—Whitfield reports having seen but a single specimen of this small species, and no further examples have come to light in the more recent collections. The type is probably from some portion of the Navesink marl, although the horizon cannot be determined with any great degree of certainty.

Range in New Jersey—

NAVESINK: 43

Type.—Freehold, N. J. NJSM 7548.

***Pecten venustus* Morton 1833**

Plate 23, Figures 1, 2, 4, 13

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

Pecten venustus, Whitfield, 1886, p. 45, pl. 7, figs. 1-2.

Pecten venustus, Weller, 1907, p. 478, pl. 51, figs. 1-5.

Pecten venustus, Stephenson, 1923, p. 204, pl. 57, figs. 1-5.

Pecten venustus, Stephenson, 1941, p. 130, pl. 22, figs. 3-6.

Description.—"Shell quite small, seldom attaining a height of more than five-eighths of an inch, and not commonly of more than half an inch. Form nearly circular below the ears and a little straightened on the cardinal slopes. Valves convex, slightly inequivalve and erect, or not perceptibly inequilateral. Cardinal line about half as long as the greatest width of the valves which is a very trifle less than the height. Auriculations very unequal, distinctly separated from the body of the shell. The posterior one is quite small and unlike in each valve; anterior large, ribbed on each valve, and provided with a moderately distinct notch below in the right one. Right valve most convex, marked by 17 to 19 elevated radiating ribs, which are somewhat flattened on the top and are marked by fine transverse striae. Interspaces narrow and deep. Many of the ribs of this valve become duplicate below the middle of the valve. Left valve depressed, convex, with narrow, sharply-elevated ribs, which are separated by much wider interspaces, and are marked by comparatively distant elevated rugae. Many of the wider interspaces have a thinner and smaller rib along their middle below the center of the valve, corresponding to the duplicated ribs of the opposite valve.

On the interior of the valves the ribs are distinctly marked, but much more strongly so along the margin of the shell. Cardinal line marked by a single ridge on each side of the center nearly parallel to the hinge-line in the left valve, with corresponding grooves in the right. Ligamental pit well marked." (Whitfield.)

Remarks.—This is one of the smaller species of *Pecten* from the Cretaceous of New Jersey. Stephenson has questioned the identification of the Marshalltown specimens.

Range in New Jersey—

MARSHALLTOWN: 28

MT. LAUREL-NAVESINK: 40, 41, 42, 43, 46, 47, 53

RED BANK: 59

TINTON: 61, 63

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Alabama, Mississippi, Texas (?).

Type.—near Arnetown, N. J.; ANSP 16165.

***Pecten craticulus* Morton 1833**

Plate 24, Figure 1

Pecten craticula Morton, 1833, Am. Jour. Sci. 1st ser., vol. 23, p. 293,

Pecten craticulus Whitfield, 1886, p. 49, pl. 7, figs. 17-18.

Pecten craticulus Weller, 1907, p. 478, pl. 50, figs. 15-16.

Description.—“Shell suborbicular, unequal, with about ten large, elevated, convex, longitudinally sulcated ribs, and a much smaller one interposed between each pair.” (Morton).

Remarks.—This species was described by Morton from a fragment of a shell said to have been collected by Conrad at Arnetown, New Jersey. The type specimen was illustrated by Whitfield, but the species has not been met with in any recent collections. If the recorded locality of the species is correct it probably came from the Navesink marl.

Range in New Jersey—

NAVESINK: Near Arnetown

Type.—near Arnetown, N. J.; ANSP 18804.

***Pecten simplicius* Conrad 1860**

Plate 23, Figure 12

Pecten simplicius Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 283, pl. 46, fig. 44.

Amusium simplicum, Whitfield, 1886, p. 51, pl. 7, figs. 11-12.

Pecten simplicius, Weller, 1907, p. 480, pl. 51, fig. 6.

Pecten simplicius, Gardner, 1916, p. 595, pl. 34, figs. 8-9.

Pecten simplicius, Stephenson, 1923, p. 199, pl. 55, figs. 6-11.

Pecten simplicius, Wade, 1926, p. 62, pl. 20, fig. 7.

Pecten simplicius, Stephenson, 1941, p. 133, pl. 20, figs. 10-11.

Pecten simplicius, Groot, Organist and Richards, 1954, p. 44.

Description.—"Shell small, barely half an inch in extreme height, and of equal width; discoid or very depressed convex, nearly or quite equilateral; margins of the shell somewhat regularly rounded; hinge-line a little less than half the width of the shell, and slightly rising from the center toward the extremities. Auriculations moderately large, the anterior side largest, slightly rounded on the outer margin and forming a slight byssal notch at its junction with the body of the shell on the right valve. Cardinal slopes on the right valve straight to near the point of greatest width of the valve, and forming an angle of about fifty to fifty-five degrees with each other and very strongly impressed. Beak small and pointed. On the left valve the posterior ear is the smallest of the two, and the cardinal slopes less strongly marked, not so straight, and extend down the valve not so far as on the opposite valve. Surface of the valves smooth and shining to the naked eye, but under a lens is seen to be marked by fine concentric lines of growth, and on the left valve by faint, incipient, radiating lines." (Whitfield).

Remarks.—Whitfield's description quoted above, is drawn from Alabama specimens of this species, all the New Jersey material at his disposal being "too imperfect for illustration." The species is also extremely rare in the more recent collections of the Survey, nearly all the shells of this type being marked with conspicuous concentric lines, which have been made the chief characteristics of the species *Pecten conradi* Whitf. A few individuals of a small *Pecten* from the Tinton beds, however, the largest of which does not exceed 10 mm. in height, seem to be characterized in the impressions of the external surface, by their perfectly smooth shells, and have been identified with Conrad's species. (Weller)

Range in New Jersey—

WOODBURY ? :24

RED BANK: 60

TINTON: 62, 63

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Alabama, Georgia, Mississippi, Texas.

Type.—Eufaula, Alabama and Tippah County, Mississippi; probably lost.

***Pecten (Neithea) quinquecostata* Sowerby 1814**

Plate 23, Figure 9

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

Neithea quinquecostata, Whitfield, 1886, p. 56, pl. 8, figs. 12-14.

Neithea quinquecostata, Weller, 1907, p. 481, pl. 51, figs. 7-12.

Pecten quinquecostata, Gardner, 1916, p. 596, pl. 34, fig. 10.

Pecten quinquecostata, Wade, 1926, p. 64, pl. 21, figs. 1-5.

Neithea quinquecostata, Groot, Organist and Richards, 1954, p. 44.

Description.—"Shell broadly ovate exclusive of the aurications, and plano-convex to concavo-convex in profile, right valve strongly convex, with a sharp, arching, and incurved beak extending beyond and partially overarching the hinge-line; hinge-line straight or nearly so, slightly declining on the anterior side; nearly two-thirds as long as the entire width of the shell; aurications moderate in size, the anterior one the smallest and constricted below where it joins the body of the shell, forming a slight byssal notch; posterior side triangular, longest at the hinge-line and receding below. Sides of the valve where it joins the aurications strongly incurved laterally, so as to cause the sides to overhang. Valve marked by six strong, rounded, principal radiating costae, with from two to four smaller ones between. These are usually distributed in the following manner: three between the two anterior strong ones; three or four between the two antero-basal and median ones; three usually between the postero-basal pair, and usually two only between the posterior pair. There are also three or four anterior to the first strong ray, and from four to six on the area posterior to the last principal ray. The aurications are also rayed, unequally on the opposite sides, the posterior one most strongly. The characters of the flat or left valve have not been observed on the New Jersey specimens. The casts, the only condition in which I have seen them from within the State, show evidence of moderately strong concentric lines crossing the rays and intermediate portions of the shell." (Whitfield.)

Remarks.—The secondary ribs between the six larger ones show considerable variation in the different individuals of this species, but Whitfield was doubtless correct in his reference of all the specimens to a single species. In 1850 D'Orbigny proposed the specific name *mortoni* for this American form and was followed by several authors, but that species seems to have been founded upon insufficient characters, and in this place we follow Whitfield in considering the American specimens to be identical with the common European one.

Range in New Jersey—

MERCHANTVILLE: 8, 13, 15, 17

MARSHALLTOWN: 28

MT. LAUREL-NAVESINK: 37, 41, 43, 47, 53

Range outside New Jersey: Delaware, Maryland, District of Columbia, Georgia, Alabama, Mississippi, Tennessee, Mexico, England, South Africa.

Type.—Sussex Chalk, England.

Family Spondylidae

Plicatula urticosa (Morton) 1833

Plate 24, Figures 2-4

Ostrea urticosa Morton, 1833, Am. Jour. Sci. 1st ser., vol. 23, p. 293, vol. 24, pl. 10, fig. 2.

Plicatula urticosa, Whitfield, 1886, p. 61, pl. 9, figs. 1-2.

Plicatula urticosa, Weller, 1907, p. 484, pl. 52, figs. 1-2.

Description.—"Shell irregularly oval in outline and obliquely curved, biconvex or plano-convex, marked by strong, somewhat angular radiating and bifurcating plications, usually much stronger and less numerous on the lower than on the upper valve, and crossed by strong projecting concentric lamellae, which are elevated and often form thin, flat spines on the crest of the radiating plications of greater or less length, which give a very rough and spiny surface to the shell, resembling that of *Spondylus*. Muscular impression moderate; teeth not observed." (Whitfield.)

Remarks.—This species differs from *P. mullicaensis* in its more irregular form and in its much more rugose markings.

Range in New Jersey—

MERCHANTVILLE: 15, 17

MT. LAUREL-NAVESINK: 41, 43, 46

Type.—New Jersey; ANSP 18711.

Plicatula mullicaensis Weller 1907

Plate 18, Figures 5, 6

Plicatula mullicaensis Weller, 1907, p. 485, pl. 52, figs. 3-5.

Plicatula mullicaensis, Stephenson, 1941, p. 140, pl. 22, figs. 14-15.

Description.—Shell obliquely ovate. The upper valve depressed-convex, marked by radiating costae and concentric lines of growth, at the junction of which the radiating costae are produced into short spines.

The dimensions of an average specimen are: total length, 30 mm.; width, 22 mm.

Remarks.—This species is abundant at Mullica Hill and has usually been confused with *P. urticosa*. It differs from that species, however, in its much more regular outline and in its much finer surface markings. Only the upper valves of the species have been observed, but these seem to be more uniform in their characters than is usual for members of this genus. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 53

Range outside New Jersey: Mississippi, Alabama, Texas.

Type.—Mullica, Hill, N. J. NJSM 9996; Univ. Chicago 18630 (cotypes).

***Plicatula woodburyensis* Weller 1907**

Plate 24, Figures 5, 6

Plicatula woodburyensis Weller, 1907, p. 485, pl. 52, figs. 8-9.

Description.—Upper valve subovate in outline, only slightly oblique, moderately convex on the umbo, the remainder of the valve nearly flat. Marked by more or less alternating radiating costae which are nearly obsolete upon the umbonal portion, becoming regularly stronger towards the margin, those in front and behind the umbo curving strongly upward, the costae elevated at intervals into small, short spines directed at nearly right angles to the surface of the shell. Lower valve not known.

The dimensions of the type specimen are: height, 28.5 mm.; width, 26 mm. (Weller)

Remarks.—Not found in recent collections.

Range in New Jersey—

WOODBURY: 18

Type.—Lorillard, NJSM ?

***Plicatula howelli* Richards 1943**

Plate 40, Figure 6; Plate 44, Figure 10

Plicatula howelli Richards, 1943, p. 25, pl. 4, fig. 6.

Plicatula howelli, Stephenson, 1954, p. 30, pl. 7, figs. 3-5.

Description.—Shell irregular in outline; length greater than width; very slightly convex. Hinge indistinct. Surface ornamented with 12 prominent ribs evenly distributed and about 1.0 mm. apart. The crests of these ribs are covered with spine-like protuberances about 0.5 mm. apart. Between the major ribs can be seen irregular series of small nodules, particularly noticeable near the margin of the shell. Length 14.0 mm.; width 16.0 mm. (Richards.)

Remarks.—The species resembles *P. clarki* Stephenson, from the Black Creek formation of North Carolina, in the presence of the minor ribs between the major ribs, although they are less conspicuous in *P. howelli* than in *P. clarki*. The major spines of *P. howelli* are also less conspicuous than in *P. clarki* and there are no indications of the small tubes described on the ribs of the North Carolina species, although these latter structures may have been destroyed by weathering. The new species also differs from *P. clarki* in that its proportions are relatively much longer in relation to width.

It is apparently not very closely related to any of the three species of *Plicatula* described from the Cretaceous of New Jersey, although it resembles *P. urticosa* (Morton) in the arrangement of the major ribs. The new species is somewhat variable, but for the present all specimens are referred to a single species.

Stephenson (1954, p. 30) has added some further notes on this species.

Range in New Jersey—

RARITAN: 1a, 1b

Type.—Sayreville, N. J.; holotype NJSM 10475; paratype ANSP 15565.

***Plicatula ferrata* Stephenson 1954**

Plate 44, Figure 12

Plicatula ferrata, Stephenson, 1954, p. 31, pl. 7, fig. 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." (Stephenson)

Range in New Jersey—

RARITAN: 1a

Type.—Sayreville, N. J. USNM 108637.

***Spondylus gregalis* Morton 1833**

Plate 22, Figures 6, 7; Plate 24, Figures 10, 11

Plagiostoma gregalis Morton, 1833, Am. Jour. Sci. 1st ser., vol. 23, p. 292, pl. 5, fig. 6.

Spondylus gregalis, Whitfield, 1886, p. 57, pl. 9, figs. 11-12; pl. 10, figs. 1-2.

Spondylus gregalis, Weller, 1907, p. 486, pl. 53, figs. 1-3.

Description.—"Shell rather above medium size when fully grown, and generally ovate in form, with the lower or attached valve somewhat the deepest. Cardinal area large, but short, much extended and flattened on the surface; transversely striated and with a narrow linear groove through the middle; teeth strong. Surface of the lower valve strongly lamellose on the free portions; the attachment apparently being only small and near the apex; between the lamella, which are elevated, the surface shows indistinct radiations, which on the interior are quite distinctly marked and flexuose, and are comparatively fine. The upper valve not observed, except as shown on casts of the interior. In this condition it is shown to have been only very moderately convex at the apical portions, and to have been flattened or but very slightly convex toward the front, with the surface radiated as in the case of the lower valve, but whether the exterior has been lamellose or only simply radiated I have not been able to ascertain." (Whitfield.)

The dimensions of the large lower valve figured by Whitfield are: length, 95 mm.; width, about 55 mm.

Remarks.—This species seems to be of rather rare occurrence as only fragments have been found recently. All the specimens on record seem to have come from the Navesink marl.

Range in New Jersey—

MT. LAUREL-NAVESINK: 40, 44, 46, 47, 53, 57

Type.—Burlington County, N. J.; ANSP 18712.

***Dianchora echinata* (Morton) 1835**

Plate 24, Figures 7, 8

Plagiostoma echinatum Morton, 1835, Snop. Org. Rem. Cret. Gr. U.S., Add. Obs., 4.

Spondylus capax, Conrad, 1853, Jour. Acad. Nat. Sci. Phila. 2nd Ser. Vol. 2, p. 274, pl. 24, fig. 8.

Dianchora echinata, Whitfield, 1886, p. 59, pl. 10, figs. 3-9.

Dianchora echinata, Weller, 1907, p. 487, pl. 53, figs. 4-6; pl. 54, figs. 1-2.

Description.—"Shell below medium size, subcircular or very broad-ovate in general outline, and with a very highly convex or gibbous free valve. Lower valve fixed to foreign substances, and often by nearly its entire surface, and conforming in depth to the surface to which it is affixed, or nearly so. Or when more concave the space between the margin of the shell and the object to which it is attached is filled up with shelly matter formed in the same manner as the spines of the valves. The cardinal portion of the valve is open, forming a broad tri-

angular foramen the entire width of the valve at this point, the margins of the foramen being sharp, no hinge-teeth or cardinal area existing. The interior of the valve is strongly marked by moderately fine striae or ribs, which are flattened on their surfaces; muscular imprints not observable. Upper valve very ventricose and strongly arcuate, the beak thin and sharply incurved. Hinge open as in the lower valve, the cardinal angles spread outward in the form of auriculations to meet those of the opposite valve. The sides of the valve are sharply bent inward on a line from the beak to the point of greatest width, forming a hiatus on each side between the body of the valve and the auriculation, as in the genus *Janira*. Surface of the valve marked by strong, closely compact, radiating ribs; every fifth or sixth one of which is stronger than the others, and bears short, sharp, curved spines, some of which are nearly one-fourth of an inch long, while the others are only rugose from the concentric lamella which cross them. On the depressed spaces on the sides of the valve there are no radii, the concentric lines only being present. Substance of the shell thin in the cardinal portions and much thickened toward the front. Interior of the valve marked by the radii, and the thickened front margin strongly crenulate." (Whitfield.)

Remarks.—This species is a rare form restricted to the Navesink fauna, the lower valves usually being attached to the interior surface of the shells of *Gryhaea convexa*. At Mullica Hill the casts of this species have been observed more commonly than at any other locality. The upper free valve does not always have the larger, spine-bearing ribs so conspicuously developed as in the type of the species illustrated by Whitfield. In some specimens the ribs are of essentially uniform size throughout, and in others the larger ones are only moderately developed. The type specimen seems to be rather exceptional in its conspicuous development of the larger ribs. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 39, 41, 43, 53, 58

TINTON: 63

Type.—(*S. capax*) Woodward's Farm, Monmouth Co. ANSP 18713

Family Promyacidæ

Liroscapha squamosa Conrad 1869

Plate 24, Figure 9

Liroscapha squamosa Conrad, 1869, Amer. Jour. Conch. Vol. 5, p. 100, pl. 9, fig. 23.

Liroscapha squamosa, Weller, 1907, p. 489, pl. 52, figs. 6-7.

Description.—Shell subelliptical in outline, pointed at the beak, rounded at the opposite extremity, the sides nearly straight and

parallel. The upper valve rather strongly convex, marked by unequal, radiating, squamose or spinulose costae.

The dimensions of the type specimen are: length, 15 mm.; width, 7.5 mm.

Remarks.—In describing this species as the type of the new genus *Liroscapha*, Conrad expressed some doubt as to its true relations, expressing the possibility of its being a univalve. Recent collections have brought no additional specimens to light and nothing can be added at this time to our knowledge of the form. (Weller)

Range in New Jersey—

WOODBURY: 24

Type.—Haddonfield, N. J. ANSP 19412.

Family Limidae

Lima pelagica Morton 1833

Plate 24, Figure 12

Plagiostoma pelagica Morton, 1833, Am. Jour. Sci., 1st ser., vol. 23, p. 293, pl. 5, fig. 2.

Radula pelagica, Whitfield, 1886, p. 61, pl. 9, figs. 3, 5 (not 4).

Lima pelagica, Weller, 1907, p. 489, pl. 54, fig. 7.

Description.—Shell, in large examples, attaining a height of 33 mm., a width of 25.5 mm., and a thickness of about 21.5 mm.; oblique subovate in outline, the valves not gaping posteriorly. The hinge-line straight, its length about one-third of the greatest length of the shell, the hinge area of moderate height, with a large central cartilage pit, hinge edentulous; beaks at about the center of the hinge-line, auricularia small, nearly equal. The valves strongly convex and marked by about 25 strong, subangular or rounded plications, and usually with a minute, elevated rib in the bottom of each interspace; fine concentric lines of growth, with sometimes an occasional stronger one, also mark the entire surface of the shell.

Remarks.—This is a common member of the Navesink fauna, and, besides its large size, it is characterized by the presence of the minute secondary radiating ribs in the bottoms of the interspaces between the primary plications of the shell, and by the more or less subangular primary ribs. Whitfield included in this species the shells described in the present report as *Lima whitfieldi*, in which the secondary ribs are wanting and in which both the plications and interspaces are rounder. In general form the two shells are essentially identical, and in the internal casts, the condition in which the species usually occurs, they probably cannot be separated. The secondary ribs are more or less variable in the degree of their development in different individuals, and are always more conspicuous on the anterior portion of the shell,

sometimes being faintly developed or entirely absent from the central and posterior portion. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 18

Type.—New Jersey; ANSP 18754.

***Lima whitfieldi* Weller 1907**

Plate 24, Figure 13

Radula pelagica Whitfield, 1886, p. 61, pl. 9, fig. 4 (not 3, 5).

Lima whitfieldi Weller, 1907, p. 491, pl. 54, fig. 8.

Description.—The dimensions of the type specimen are: extreme length, 25 mm.; greatest width, 21.5 mm.; length of hinge-line, 8 mm.; convexity of one valve, 7 mm. In general form and proportions this shell is essentially identical with *R. pelagica*, but it has not been observed to attain so large a size as that species, and differs fundamentally in the character of the surface markings. In this species the plications and interspaces are always rounded and lack entirely the secondary ribs which are present in the bottom of the interspaces in *R. pelagica*. In addition to the ribs the shell is entirely covered with fine concentric markings.

Remarks.—The type of this species is one of the specimens which Whitfield illustrates as *R. pelagica*. The specimen has the shell well preserved, showing all the surface features, as well as the hinge; it is preserved in a rather coarse sand cemented with calcium carbonate, the so-called "limestone nodules" of Whitfield, said to come from the base of the "lower marl." The horizon of these calcareo-arenaceous masses as observed in recent field work, is near the very base of the Navesink, or in the uppermost beds of the Wenonah. A few other specimens from the Marshalltown clay-marl are referred to this species although they differ somewhat from the type in having narrower interspaces between the ribs and in having stronger concentric markings (Weller)

Range in New Jersey—

MARSHALLTOWN: 28

MT. LAUREL-NAVESINK: 41

Type.—Holmdel, N. J. NJSM 7601

***Lima lorillardensis* Weller 1907**

Plate 22, Figure 8

Lima lorillardensis Weller, 1907, p. 492, pl. 54, figs. 5-6.

Description.—The dimensions of the type specimen are: height, 27 mm.; width, 22 mm.; thickness, about 16.5 mm. Shell oblique, sub-

ovate in outline; valves rather strongly convex, marked by 30 to 35 strong ribs, those on the central portion of the shell being much stronger than those towards the lateral margins, these larger ribs are subcarinate on top, with a somewhat conspicuous shoulder about half-way down each slope, the interspaces rounded in the bottom and somewhat broader than the ribs, the lateral ribs are much narrower, lower and lack the lateral shoulders. Entire surface marked by fine, regular concentric lines.

Remarks.—The type and only specimen of this species seen is a somewhat crushed and distorted internal cast whose exact form and proportions cannot be determined, and a portion of the impression of the exterior which preserves the surface markings very perfectly. The shell apparently has much the same size and proportions as *L. whitfieldi*. but its distinguishing characters are to be found in the surface markings. The species somewhat resembles *L. squarrosa* Gabb, from Alabama, but that species has broader, higher and more square ribs, which are not carinate, and less strongly marked concentric lines. (Weller)

Range in New Jersey—

WOODBURY: 18

Type.—Lorillard, N. J. NJSM 7727.

***Lima reticulata* Lyell & Forbes 1845**

Plate 22, Figures 9, 10

Lima reticulata Lyell & Forbes, 1845, Quart. Jour. Geol. Soc., London, vol. 1, p. 62; two text figures.

Radula reticulata, Whitfield, 1886, p. 63, pl. 9, figs. 8-9.

Lima auctilineata, Whitfield, 1886, p. 62, not of Conrad.

Lima reticulata, Weller, 1907, p. 492, pl. 54, figs. 3-4.

Lima reticulata, Gardner, 1916, p. 600, pl. 34, figs. 12-13.

Lima reticulata, Stephenson, 1923, p. 212, pl. 58, figs. 10-15.

Lima reticulata, Wade, 1926, p. 66, pl. 20, fig. 12.

Lima reticulata, Groot, Organist and Richards, 1954, p. 44.

Description.—“Shell small, moderately oblique, strongly ovate and inflated. Hinge short; beaks proportionately strong and projecting beyond the cardinal line. Valves nearly equal; anterior margin straight and not at all gaping; auriculations small but distinct, rectangular or very slightly pointed at their outer angles. Surface radiately ribbed, those of the anterior and posterior slopes faintly marked or obsolete, ribs (about 30) distinct, with five or more indistinct on each side; subangular on the middle of the valves and rounded toward the sides, crenulate or subspinose on the larger specimens when well preserved, but often appearing nearly smooth. Entire surface marked by con-

centric lines which give a roughened surface when perfect, giving the reticulated character indicated by the specific name." (Whitfield.)

Remarks.—This species is frequently associated with *L. pelagica*, but it can always be distinguished from it by reason of its smaller size and its much finer plications. The specimens are usually preserved in the form of internal casts so that the delicate concentric surface markings cannot be detected, but upon some specimens from the Marshalltown marl near Swedesboro the shell is perfectly preserved. Whitfield has considered *Lima denticulicosta* Gabb as a synonym of *L. reticulata*. In this he is probably in error, since that species is described as having "about 28 ribs," while usually as many as 40 may be easily recognized upon specimens of *R. reticulata*, and furthermore the surface markings are very different in the two species. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 15

MARSHALLTOWN: 28

WENONAH: 34

MT. LAUREL-NAVESINK: 37, 38, 40, 46, 47, 53

RED BANK: 59

TINTON: 63

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi.

Type.—New Jersey. Lost.

Lima monmouthensis (Whitfield) 1886

Plate 22, Figure 11

Nucula monmouthensis Whitfield, 1886, p. 102, pl. 11, fig. 1.

Lima monmouthensis, Weller, 1907, p. 494, pl. 54, fig. 9.

Description.—Shell small, the dimensions of the type specimen being: height, 12 mm.; length, 11 mm.; convexity of one valve, 3 mm. Valves oblique, moderately convex, subovate in outline not gaping; hinge-line short, arcuate, edentulous; beaks near the center of the hinge-line, auriculations absent. Surface of valves marked only by faint, concentric lines of growth.

Remarks.—This little shell was described by Whitfield as a member of the genus *Nucula*. A further development of the type specimen has shown the entire absence of the nuculoid hinge, and the essential agreement of the shell in all its characters with members of the genus *Lima*. A second specimen in the collection of the Philadelphia Academy of Science, referred to, but not illustrated, by Whitfield is a true *Nucula*. The species differs from all other members of the genus *Lima* recognized in the Cretaceous faunas of New Jersey, in the absence of radiating plications, and in the obsolescence of the auriculations. (Weller)

Range in New Jersey—

MERCHANTVILLE: 15

WENONAH: 35

Type.—Marlboro, N. J. NJSM 9731.

***Plagiostoma erecta* (Whitfield) 1886**

Plate 22, Figure 12

Dosina ? erecta Whitfield, 1886, p. 162, pl. 18, fig. 17 (?18-20).

Plagiostoma erecta, Weller, 1907, p. 495, pl. 54, fig. 10.

Description.—Shell very thin, depressed convex, subcircular in outline, a little longer than high, in large examples attaining a length of 25 mm., a height of 22.5 mm. and convexity of 4.5 mm. Beaks nearly erect, situated back of the middle of the valves, antero-cardinal margin deeply inflected to form an excavated escutcheon, back of the beaks the shell is compressed and produced into a small triangular auriculation; the anterior extremity of the hinge-line meeting the anterior shell margin in a slightly obtuse angle. The posterior margin slightly sinuate above from the hinge extremity to below the base of the auriculation; beyond this point the margin describes a nearly circular curve to the posterior hinge extremity. The surface smooth and shining, marked by fine concentric lines of growth.

Remarks.—This species was established by Whitfield "entirely from the external appearances of a few shells destitute of the most of the cardinal portions, and one internal cast, on which the markings are so faint as not to be considered reliable," and was referred to the genus *Dosinia*. The internal cast mentioned by Whitfield may belong to the same species as the specimens preserving the shells, but it is not possible to affirm this with any certainty, and the specimens preserving the shells will be considered as the types of the species. These specimens are two in number from Marshalltown, N. J., and they undoubtedly came from the Marshalltown clay-marl. Several additional specimens of the same form are preserved in the more recent collections of the Survey from the same formation near Swedesboro, and these, with some others from the Navesink marl, present additional features of the shell not seen by Whitfield, which show the species to be a member of the genus *Plagiostoma*. (Weller)

Range in New Jersey—

MARSHALLTOWN: 27, 28

MT. LAUREL-NAVESINK: 40, 41, 47

Type.—Near Marshalltown, N. J. NJSM 9634.

Family Anomiidae

Anomia argentaria Morton 1833

Plate 22, Figure 15 ; Plate 41, Figure 12

Anomia argentaria Morton, 1833, Am. Jour. Sci., 1st ser., vol. 23, p. 293, pl. 5, fig. 10.

Anomia argentaria, Whitfield, 1886, p. 42, pl. 4, figs. 10-11.
(not fig. 9 = *Ostrea plumosa*).

Diploschiza cretacea, Whitfield, 1886, p. 43, pl. 4, figs. 4-8.
(Not Conrad.)

Anomia argentaria, Weller, 1907, p. 496, pl. 54, figs. 12-14 (not fig. 15).
= *A. tellinoides*.

Anomia argentaria, Gardner, 1916, p. 608, pl. 35, figs. 1-2.

Anomia argentaria, Wade 1926, p. 68, pl. 22, figs. 10-13.

Anomia tellinoides, Wade, 1926, p. 69, pl. 23, figs. 3-4 (not Morton).

Anomia argentaria, Stephenson, 1941, p. 148, pl. 24, figs. 1-4.

Anomia argentaria. Richards, 1943, Proc. Acad. Nat. Sci. Phil., vol. 95, p. 24, pl. 5, fig. 12.

Anomia argentaria. Groot, Organist and Richards, 1954, p. 45.

Description.—Shell subcircular, more or less irregular in outline. the larger individuals attaining a diameter of 25 mm. or more. Upper valve depressed convex, with the apex marginal, or nearly marginal. the surface marked by more or less irregular, sometimes sublamellose. lines of growth, and sometimes by more or less distinct radiating costae. Lower valve flat, concave or convex, often irregular in contour, the perforation rather large and situated near or at some distance from the margin. (Weller)

Remarks.—This shell has been confused with *A. tellinoides* Morton. See under that species for distinguishing features.

Range in New Jersey—

RARITAN: 1

MAGOTHY: 5, 6

MERCHANTVILLE: 8, 10, 15, 17

WOODBURY: 18, 20, 23

MARSHALLTOWN: 28

WENONAH: 35

MT. LAUREL-NAVESINK: 39, 40, 41, 43, 47

RED BANK: 60

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi, etc.

Type.—New Jersey; ANSP 15655.?

Anomia tellinoides Morton 1833

Plate 22, Figures 14, 16

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

Anomia tellinoides, Whitfield, 1886, p. 43, pl. 4, figs. 12-13.

Anomina argentaria, Weller, 1907, p. 496, pl. 54, fig. 15. (Not 11-14 = *A. argentaria*)

Anomia tellinoides, Gardner, 1916, p. 610, pl. 35, figs. 3-4.

Anomia tellinoides, Stephenson, 1923, p. 223, pl. 60, figs. 1-7.

Anomia tellinoides, Stephenson, 1941, p. 147, pl. 24, figs. 5-7.

Anomia tellinoides, Groot, Organist and Richards, 1954, p. 45, pl. 4, fig. 6.

Description.—"Shell inequilateral, thin but firm, partly transparent, somewhat irregular, but in general broadly subovate with a tendency to a roughly triangular outline; depressed convex to moderately convex in form, inflated most strongly anteriorly, becoming somewhat compressed posteriorly. Beak small, projecting slightly above the dorsal margin, directed backward, and situated about three-fifths the length of the shell from the anterior margin. Dimensions of the type (from "New Jersey"): Length 34 mm., height 30 mm., convexity 6 mm. In general the anterior margin is regularly rounded, the ventral margin broadly and regularly rounded, and the posterior margin rather sharply rounded at about midheight. Between the posterior extremity and the beak in typical specimens the margin is truncated or slightly concave.

Hinge edentulus and developed only in front of the beak; it is 10 to 15 mm. long, 1 to 2 mm. broad, and roughly striated with concentric growth lines. Resilifer submerged with the margin, deeply impressed, flaring, and marked with fine striae. A small muscle scar is situated just below the forward end of the resilifer, and centrally above the midheight is a large, somewhat irregular but roughly ovate muscle scar, which probably is in reality three smaller scars not sharply separated from each other.

Surface marked with fine concentric growth lines, and on some specimens irregularly spaced shallow growth undulations; very fine radiating lines can be fairly seen on some specimens." (Stephenson.)

Remarks.—This has been confused with *A. argentaria* Morton. Certain characters distinguish it sharply from that form. Fine radiating lines are faintly visible on some specimens when examined under a hand lens, but they are much weaker than on *A. argentaria*. The hinge is limited to part of the dorsal margin in front of the beak; the beak is marginal, projects a little, and is directed backward; and the postero-dorsal margin is more or less concave. *A. argentaria* is subcircular in outline, is marked by stronger though still very fine

radiating lines, and has a nonprominent beak situated 1 mm. or more away from the margin.

Range in New Jersey—

WOODBURY: 22

MOUNT LAUREL: 47

Range outside New Jersey: Delaware, North Carolina, Tennessee, Georgia, Alabama, Mississippi, Texas.

Type.—"New Jersey". ANSP

***Anomia radiata* Weller 1907**

Plate 25, Figure 2

Anomia radiata Weller, 1907, p. 499, pl. 54, figs. 16-17.

Description.—Shell irregularly subovate in outline, the dimensions of the type specimen being: height, 12.5 mm.; width, about 20 mm. Free valve depressed convex, the apex marginal. The attached valve flatter, the perforation near the margin. Both valves marked by rather coarse, irregular, nodose, radiating costae, the nodes being small squamose projections as shown by impressions of the exterior.

Remarks.—The example selected as the type of this species is the most complete of several individuals which are attached to the leaves of a marine plant, the plant having been fossilized with the shells attached. A few impressions and casts of other individuals have been found in the Merchantville and Woodbury formations, but no others have been seen attached. Some of these specimens are much larger than the type, the larger ones sometimes having a maximum diameter of nearly 30 mm. In the character of their surface markings the members of this species resemble *Paranomia scabra*, but the costae are always finer than in that species, and the shells do not grow to so large a size. In the perforated lower valve, however, these shells possess the essential feature of the genus *Anomia*.

In recent years a single specimen has been found at Maple Shade.

Range in New Jersey—

MERCHANTVILLE: 15, 16

WOODBURY: 28

Type.—Lorillard, N. J. NJSM 9599.

***Paranomia scabra* (Morton) 1834**

Plate 18, Figure 4; Plate 22, Figure 3; Plate 25, Figure 1

Placuna scabra Morton, 1834, Snop. Org. Rem. Cret. Gr. U. S., p. 62.

Placunanomia lineata, Whitfield, 1886, p. 44, pl. 10, fig. 10.

Paranomia scabra, Whitfield, 1886, p. 44, pl. 10, fig. 10.

Paranomia lineata, Whitfield, 1886, p. 45, pl. 9, fig. 10.

Paranomia scabra, Weller, 1907, p. 500, pl. 52, figs. 10-13.

Paranomia scabra, Gardner, 1916, p. 605.

Paranomia lineata, Gardner, 1916, p. 606, pl. 35, figs. 11-12.

Paranomia scabra, Stephenson, 1923, p. 234, pl. 61, figs. 1-4.

Paranomia scabra, Wade, 1926, p. 67, pl. 22, figs. 3-9.

Paranomia scabra, Groot, Organist and Richards, 1954, p. 45.

Description.—Shell thin and fragile, broadly and irregularly subovate in outline, the dimensions of the largest individual observed being: length from beak to opposite border, 55 mm.; width at right angles to the last dimension, 54 mm. The dimensions of an individual of more nearly average size are: length, 31 mm.; width, 34 mm. The upper valve depressed convex, the surface marked by distant, rounded, elevated radiating ribs, which are frequently more or less wavy in their direction and become stronger towards the front of the shell. At irregular intervals the ribs are produced into hollow spines directed away from the beak, which become larger and more distant as the ribs increase in strength towards the front of the shell; the spaces between the ribs are broad and flat, being three or four times as wide as the ribs, and on the best preserved shells are marked with rather delicate concentric lines. The lower valve is convex towards the beak, where it is apparently broadly perforate, becoming concave towards the front of the valve. The surface markings are similar to those of the upper valve, though in some cases the ribs and spines seem to be less strongly developed.

Remarks.—This species was formerly common in the Marshalltown formation near Swedesboro where a large number of individuals retaining the shell were collected. None of them are so large as the specimen illustrated by Whitfield under the name of *P. lineata*, but they all exhibit the same essential specific characters as that shell. Whitfield was in error, however, in considering the specimen he used for study as a perforate valve, the apparent perforation near the beak being only a fracture. In none of the Swedesboro specimens, which are perfectly preserved up to the beak, is any perforation shown in the convex valve, but in several of those which become concave towards the front there is apparently a broad perforation close to the beak, although there is some reason for doubting the presence of an actual perforation in this valve, as it seems to be absent from some specimens which are complete to the beak.

There seems to be no sufficient reason for recognizing the two species of *Paranomia* of Whitfield's monograph. The type of Morton's species, *P. scabra*, illustrated by Whitfield, is only a fragment of a shell belonging to the same species as the one illustrated as *P. lineata*, although it is somewhat more irregular and rougher than usual. Morton's name having priority is adopted for the species. *P. saffordi* Con., from Tennessee, must also be considered as a synonym. (Weller)

Range in New Jersey—

MERCHANTVILLE: 15

MARSHALLTOWN: 31

MT. LAUREL-NAVESINK: 47

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Mississippi, Alabama, Tennessee, Arkansas, Texas.

Type.—Blue Marl of N. J.; ANSP 3969.

Family Mytilidae

Mytilus smocki Weller 1907

Plate 25, Figure 3

Mytilus smocki Weller, 1907, p. 502, pl. 55, figs. 1-4.

Description.—Shell more or less arcuate, the larger type specimen with an extreme length of 37 mm.; a maximum width of 13 mm., and thickness of both valves 18 mm. The valves strongly convex, with a rounded ridge below the middle extending from the beak to the postero-basal margin, below the ridge the surface of the valves are rather abruptly inflected, meeting nearly in a plane along the ventral margin. The beaks pointed, the dorsal and ventral margins diverging at an angle of about 35°; the hinge arcuate, passing gradually into the postero-dorsal margin which is more or less carinate, posteriorly the dorsal and ventral margins of the shell are subparallel, the posterior margin rather narrowly rounded below, the antero-ventral margin more or less concave. Adductor muscular impressions rather large, situated near the posterior extremity of the shell. Surface of the shell marked by fine radiating costae, about three of which occupy the space of one millimeter, and also by concentric lines of growth.

Remarks.—This species is remarkable for the great convexity of the valves, the thickness of the entire shell being considerably greater than its width. Two complete specimens have been observed, both of which show the enormous thickness of the shell, although one is considerably more arcuate than the other. The surface markings have not been satisfactorily determined because the specimens are both for the most part internal casts, both of them, however, retain some indications of the fine radiating costae, and one of them retains a small fragment of the shell itself. In the casts several concentric lines of growth are of considerable strength. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 40, 46

Type.—Walnford, N. J. NJSM 7609; Univ. Chicago 18634 (cotypes).

Mytilus oblivius Whitfield 1886

Plate 25, Figure 4

Mytilus oblivius Whitfield, 1886, p. 64, pl. 17, fig. 1.*Mytilus oblivius*, Weller, 1907, p. 503, pl. 55, figs. 5-8.

Description.—"Shell small, erect, or but very slightly curved on the buccal margin; beaks terminal, projecting and acute. Hinge line sloping at an angle of about 60° to the buccal margin; posterior margin subparallel to the anterior, and the extremity rather sharply rounded. Anterior face abrupt, and the surface of the valve gradually sloping from the umbo angle to the posterior margin. Surface apparently marked by fine lines of growth as indicated on the east." (Whitfield.)

Remarks.—Whitfield described this species from a single specimen collected from the summit of the Wenonah sand near Marlboro. It has rarely been found in recent collections.

Range in New Jersey—

MAGOTHY: 5

WENONAH: 35

NAVESINK: 53

Type.—Marlboro, N. J. NJSM 9733.

Mytilus? planus Richards 1943

Plate 40, Figure 5

Mytilus ? planus Richards, 1943, p. 23, pl. 4, fig. 5.

Description.—Shell narrow, beak pointed, surface smooth. Has outward appearance of a *Mytilus*, but the exact relationship can not be determined because of the poor state of preservation. Length 23.0 mm.; greatest width 15.0 mm. (Richards.)

Range in New Jersey—

RARTAN: 1a

Type.—Sayreville, N. J. NJSM 10447.

Volsella monmouthensis (Weller) 1907

Plate 25, Figure 5

Modiola monmouthensis Weller, 1907, p. 504, pl. 55, figs. 9-10.

Description.—Shell small, the dimensions of an average specimen being: length, 8 mm.; width, 4.5 mm.; convexity of one valve 2.5 mm. Hinge-line about one-half the total length of the shell, beaks nearly anterior, incurved, umbo prominent; anterior margin short and rounded, ventral margin nearly straight, slightly sinuate back of the middle of the shell, posterior margin rather sharply rounded below, sloping from the posterior extremity of the hinge-line above with a slightly convex curve. Surface of the valves marked with fine radiating costæ,

which, judging from the internal casts alone, are much stronger upon the posterior portion of the shell; surface also marked with concentric lines of growth.

Remarks.—This species is the only member of the genus as yet recognized in the Cretaceous faunas of New Jersey, in which the shell is marked with radiating costæ. It is also the smallest species of the genus observed, none of the individuals varying materially from the dimensions given above. (Weller)

The validity of *Volsella* Scapoli versus *Modiolus* Lamarck has recently been established.¹

Range in New Jersey—

MERCHANTVILLE: 8

Type.—Near Matawan, N. J. NJSM 8964.

***Volsella burlingtonensis* (Whitfield) 1886**

Plate 25, Figure 6; Plate 26, Figure 1

Modiola burlingtonensis Whitfield, 1886, p. 65, pl. 17, figs. 8-9.

Modiola burlingtonensis, Weller, 1907, p. 505, pl. 55, figs. 18-19.

Modiola burlingtonensis, Gardner, 1916, p. 615.

Volsella burlingtonensis, Groot, Organist and Richards, 1954, p. 45.

Description.—"Shell of moderately large size, very ventricose, and with subparallel dorsal and ventral margins, large prominent umbones and incurved beaks situated near the anterior end but not terminal, the anterior margin perceptibly extending beyond them and rounded. Umbonal ridge prominent and subangular, especially near the beaks, and becoming broader and more rounded posteriorly; surface of the valves strongly constricted and sinuate in front of the ridge and the anterior surface again inflated; cardinal slope comparatively broad and slightly concave toward the postero-cardinal border. **Hinge-line** straight and three-fifths as long as the shell, and rather strongly impressed in the internal cast; postero-cardinal margin rounding rapidly forward from the more narrowly rounded posterior extremity. Surface of the cast, the only condition under which it is known, apparently smooth or marked only by irregular concentric lines of growth, some of which produce undulations of considerable strength on the casts. On one individual there appears on the posterior cardinal slope very faint indications of rather coarse radiating lines, but too faint to warrant the statement that such markings really exist on the shell." (Whitfield.)

Remarks.—The horizon of this species is not satisfactorily known, as it has not been met with in any of the recent collections of the Survey, and the recorded locality "Burlington County," is too indefinite to be of much assistance in forming an opinion. The lithologic character of the specimen, however, more closely resembles that of specimens from

¹ Stewart, Ralph, Acad. Nat. Sci. Phila. Special Pub. 3. pp. 98-99.

the Merchantville clay-marl than any others, and it is probable that it was collected from that formation. (Weller)

Range in New Jersey—

MERCHANTVILLE: (?) 14

Range outside New Jersey: Delaware.

Type.—Burlington County, N. J.; ANSP 18801.

***Voisella julia* (Lea) 1861**

Plate 25, Figure 7

Modiola juliae Lea, 1861, Proc. Acad. Nat. Sci. Phil., p. 149.

Modiola julia, Whitfield, 1886, p. 64, pl. 17, fig. 6 (not fig. 7)

Modiola julia, Weller, 1907, p. 506, pl. 55, figs. 12-13.

Description.—Shell subovate in outline, the dimensions of the largest specimen observed being: length, 27 mm.; greatest height, 13 mm.; convexity of one valve, 5.5 mm.; the hinge-line about .63 of the total length; the beaks incurved, situated about one-seventh of the total length of the shell from the anterior extremity. Anterior margin rounded, meeting the hinge-line in an obtusely rounded angle, ventral margin nearly straight or slightly sinuate near the middle; if projected anteriorly it would meet the projection of the dorsal margin in an angle of about 16°; posterior margin broadly rounded, its most posterior projection below the middle. From the beak a rounded umbonal ridge passes obliquely backward to the postero-basal margin, in front of which is a rather broad, shallow, ill-defined sulcus. The surface markings of the shell consist of concentric lines of growth which are stronger and more regular upon the posterior slope.

Remarks.—The type of this species, from the Woodbury clay near Haddonfield, is a badly crushed shell 13.5 mm. in length, which is just one-half the size of the larger individual figured in the present report from Lorillard. This fact is in agreement, however, with nearly all the species which are common to these two localities, the Lorillard individuals generally being much larger than those from Haddonfield. The Haddonfield specimen of this species is proportionally much shorter than those from Lorillard, but this difference is doubtless due to the distortion of the former, and it is believed that the Lorillard specimens much more nearly exhibits the normal form of the shell. The original of Whitfield's figure 7 is not a member of this species, and judging from its lithologic characters it must have come from a much higher horizon, certainly from one of the marl beds and possibly the Manasquan. (Weller)

Range in New Jersey—

MERCHANTVILLE: 10

WOODBURY: 18, 19, 24

Type.—Haddonfield, N. J.; ANSP 19579. (Badly crushed.)

***VolSELLA wenonah* (Weller) 1907**

Plate 25, Figure 8

Modiola wenonah Weller, 1907, p. 507, pl. 55, fig. 11.

Description.—Shell small, the dimensions of the type specimen being: length, 15 mm.; width, 8 mm.; convexity, 3.5 mm. The hinge-line a little more than one-half the length, the beaks nearly anterior, umbo rather prominent with a somewhat broadly rounded umbonal ridge extending to the postero-basal margin. Anterior margin rather broadly rounding into the nearly straight basal margin which is slightly sinuate back of the middle, postero-basal margin rather sharply rounding into the long, oblique, slightly convex upper portion of the posterior margin which meets the posterior extremity of the hinge-line at an angle of about 125° . Surface of the internal cast marked by indistinct concentric lines of growth.

Remarks.—This species is based upon a single individual from the top of the Wenonah sand near Marlboro. It differs from all other members of the genus in the New Jersey Cretaceous faunas, in the conspicuous postero-basal extension of the shell with the long oblique posterior slope above. (Weller)

Range in New Jersey—

WENONAH: 35

Type.—Marlboro, N. J. NJSM 7681.***Crenella serica* Conrad 1860**

Plate 25, Figure 9

Crenella serica Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 281, pl. 46, fig. 23.*Crenella serica*, Weller, 1907, p. 510, pl. 56, figs. 7-8.*Crenella serica*, Gardner, 1916, p. 624, pl. 36, figs. 16-18.*Crenella serica*, Stephenson, 1923, p. 241, pl. 62, figs. 1-2.*Crenella serica*, Stephenson, 1941, p. 153, pl. 25, figs. 13-15.

Description.—Shell small, the dimensions of an average individual being: greatest length, 4 mm.; greatest width, 3 mm. Oblique, sub-ovate in outline, strongly convex, the umbo prominent, the beaks incurved. The anterior slope from the umbo abrupt, inflected towards the anterior extremity of the hinge-line. Surface marked by fine regular, concentric lines which can be easily seen with the unaided eye, and by finer, regular, radiating striæ, which can usually be seen only with a magnifying glass. (Weller)

Range in New Jersey—

MARSHALLTOWN: 28

RED BANK: 59, 60

Range outside New Jersey: Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Texas.

Type.—Eufaula, Alabama; probably lost.

***Crenella elegantula* Meek & Hayden 1861**

Plate 25, Figure 10

Crenella elegantula Meek & Hayden, 1861, Proc. Acad. Nat. Sci. Phil., p. 441.

Crenella elegantula, Weller, 1907, p. 511, pl. 56, fig. 6.

Crenella elegantula, Gardner, 1916, p. 625, pl. 36, fig. 19.

Crenella elegantula, Wade, 1926, p. 71.

Crenella elegantula, Groot, Organist and Richards, 1954, p. 45.

Description.—Shell obliquely subovate in outline; the dimensions of a perfect cast of a left valve are: height, 10.5 mm.; width, 8.5 mm.; convexity, 5 mm. Valves ventricose, umbo prominent, beak nearly terminal, small and strongly incurved. Surface marked by exceedingly fine radiating costæ which can be seen upon the internal cast, indicating that the shell substance was very thin.

Remarks.—This species differs from *C. serica* in its much larger size, its proportionally broader form, and in the absence of the conspicuous concentric markings of the shell. The New Jersey examples are apparently identical with the western specimens from which the species was described, and the same form occurs in the southern Ripley beds. (Weller)

Range in New Jersey—

TINTON: 62

Range outside New Jersey: Delaware, Maryland, Tennessee, Mississippi, Western Interior, Rocky Mountains.

Type.—Deer Creek, Nebraska; USNM 1925.

***Lithophaga ripleyana* Gabb 1861**

Plate 25, Figure 11

Lithophagus ripleyanus Gabb, 1861, Proc. Acad. Nat. Sci. Phil., p. 326.

Lithodomus ripleyana, Whitfield, 1886, p. 67, pl. 17, figs. 4-5.

Lithophaga ripleyana, Weller, 1907, p. 512, pl. 56, figs. 9-12.

Lithophaga ripleyana, Gardner, 1916, p. 618, pl. 36, figs. 4-6.

Lithophaga ripleyana, Wade, 1926, p. 70, pl. 23, figs. 5-6.

Lithophaga ripleyana, Groot, Organist and Richards, 1954, p. 45, pl. 4, fig. 7.

Description.—Shell more or less subcylindrical, sometimes curved downward posteriorly, attaining a length of 15 mm. to 20 mm. in full

grown specimens, the width and thickness usually about one-half the length. Anterior extremity of the shell bluntly rounded, the beaks blunt, anterior or nearly terminal in position; posterior extremity of the shell compressed. Dorsal margin marked by an impressed line between the valves. Surface of the shell, which is rarely preserved, marked by lamellose, concentric lines of growth.

Remarks.—This species occurs most frequently in the Navesink marl, where it attains its maximum size, but one colony of shells has been detected in the recent Survey collections from the Wenonah sand, the individuals of which seem not to differ from those in the Navesink, except that none of them exceed 10 mm. in length. In connection with his original description, Gabb mentions having collected one specimen of the species from near the place now known as Westville, the horizon of which would be Merchantville clay-marl, but the species has not been detected in the recent collections of the Survey from this horizon. (Weller)

L. ripleyana Gabb is relatively more elongated transversely than *L. affinis* Gabb, a co-existent species over much of the area of its occurrence, and is much less inflated. (Gardner.)

This species may be identical with *L. carolinensis* (Conrad) (Stephenson, 1941, p. 155)

Range in New Jersey—

MERCHANTVILLE: 16 (?)

WENONAH: 34

MT. LAUREL-NAVESINK: 37, 42, 46, 47, 53

Range outside New Jersey: Delaware, Maryland, Tennessee, Mississippi.

Type.—Crosswicks, N. J.; ANSP 19580.

***Lithophaga affinis* Gabb 1861**

Plate 25, Figure 12

Lithophagus affinis Gabb, 1861, Proc. Acad. Nat. Sci. Phila., p. 327

Lithodomus affinis, Whitfield, 1886, p. 66, pl. 17, figs. 2, 3.

Lithophaga ripleyana, Weller, 1907, p. 512, pl. 56, figs. 9-12.

Description.—Tube robust, curved, short. Portion containing the shell broad, grooved at the anterior half of the back, rounded carinate the rest of the length. Opposite face more narrow and deeply grooved. Extremity distinctly trilobate. Shell unknown. From the shape of the tube, it appears related to [*Lithophaga ripleyana*] but the beaks are less prominent in advance; the shell is much more gibbous, the basal margins more emarginate, and the posterior margin more depressed. (Gabb.)

Length of tube (extending a little beyond the shell) .6 inches.

Width (in the direction of the length of the shell) .35 inches. Transverse width .4 inch.

Range in New Jersey—

MERCHANTVILLE: 16

Type.—New Jersey; ANSP 18802.

Family Pholadomyadae

Pholadomya occidentalis Morton 1833

Plate 26, Figures 3, 4

Pholadomya occidentalis, Morton, 1833, Am. Jour. Sci., 1st ser., vol. 23, p. 292, pl. 8, fig. 3.

Pholadomya occidentalis, Whitfield, 1886, p. 175, pl. 24, figs. 1-3.

Pholadomya occidentalis, Weller, 1907, p. 513, pl. 56, figs. 1-3
(syn. excl.)

Pholadomya occidentalis, Gardner, 1916, p. 630, pl. 37, figs. 1-3.

Pholadomya occidentalis, Wade, 1926, p. 72, pl. 23, figs. 13-15.

Pholadomya occidentalis, Groot, Organist and Richards, 1954, p. 45, pl. 5, fig. 1.

Description.—The dimensions of an average sized specimen are: length, about 70 mm.; height, 47 mm.; thickness, 45 mm. Shell subovate or subelliptical in lateral outline, and cordate from in front. Hinge-line straight, about two-thirds as long as the shell; anterior margin rounding from the cardinal extremity into the basal margin, or obliquely subtruncate; basal margin gently convex, becoming straighter posteriorly; posterior margin more narrowly rounded than the anterior. Beaks large and broad, situated from one-fifth to one-fourth the length of the shell from the anterior extremity, strongly incurved and nearly in contact, moderately elevated above the hinge-line. Valves most prominent at about their mid-height in front of the middle of the shell; from this point the surface curves rather abruptly to the ventral anterior and cardinal margins, and much more gently to the gaping posterior margin; the cardinal margins back of the beaks are slightly inflected to form a rather distinct, concave cardinal area of moderate width on each valve. Surface of each valve marked by 25 to 30 more or less irregular and wavy, rounded, radiating costæ of moderate strength, much narrower than the intervening depressions, and closer together in the middle of the shell than at either the anterior or posterior portions; in the middle of the shell every other costa on large individuals has usually been intercalated between two others at some distance below the beak; the shell is also marked by more or less irregular, concentric undulations. (Weller)

Remarks.—Especially common in the Merchantville formation.

Range in New Jersey—

MAGOTHY: 5, 6

MERCHANTVILLE: 10, 15, 16, 17

WOODBURY: 19

Range outside New Jersey: Delaware, Tennessee, Alabama, Mississippi, Arkansas.

Type.—Chesapeake and Delaware Canal, Del.

Pholadomya roemeri Whitfield 1886

Plate 26, Figure 5

Pholadomya roemeri Whitfield, 1886, p. 176, pl. 24, fig. 4.

Pholadomya roemeri, Weller, 1907, p. 515, pl. 56, figs. 4-5.

Description.—The approximate dimensions of a rather small specimen are: length, 38 mm.; height, 22 mm.; thickness, 18 mm. Shell very oblique and inequilateral, elongate subovate in outline, widest back of the middle. Beaks small, incurved and nearly in contact, situated far forward. Hinge-line straight, rather long; anterior margin rounding from the anterior cardinal extremity into the basal margin; basal margin gently convex, curving upward posteriorly; posterior margin rather sharply rounded above the mid-height of the shell. Valves strongly convex or ventricose, the surface curving rather abruptly from the prominent umbones to the dorsal, anterior and ventral margins, much more gently to the posterior margin. Surface of each valve marked by about 13 narrow, angular, radiating costæ, separated by broad, concave interspaces; the most anterior costæ curve slightly forward in passing from the beak to the margin of the shell. The surface is also marked by more or less irregular concentric lines of growth.

Remarks.—This species is a much smaller and more elongate form than *P. occidentalis*, and the two are never found associated in the same fauna. It also has a much smaller number of costæ which are relatively more distant than in the larger species. (Weller)

Range in New Jersey—

WENONAH: 35

Type.—Marlboro, N. J. NJSM 9735.

Family Anatiniidae

Anatina jerseyensis Weller 1907

Plate 25, Figures 13, 14

Anatina jerseyensis Weller, 1907, p. 516, pl. 57, figs. 1-4.

Description.—The dimensions of a nearly complete internal cast are: length, 44 mm.; height, 29 mm.; thickness, 11 mm. Shell subovate

in outline, a little gaping posteriorly, much broader in front than behind; beaks transversely fissured, situated back of the middle, pointing posteriorly. Antero-cardinal margin straight and nearly horizontal in front of the beak, curving gradually downward in front; anterior margin broadly rounded from the cardinal to the basal margins; basal margin nearly straight in the middle, curving upward at each end; posterior margin with its greatest extension above the middle of its height, curving into the basal margin below and the cardinal margin above; post-cardinal margin strongly concave. Valves depressed convex, most prominent in the umbonal region, abruptly compressed towards the postero-cardinal extremity, the anterior and ventral slopes gently convex. Shell marked by more or less irregular concentric lines of growth. (Weller)

Remarks.—This species resembles *Periplomya elliptica*, but is larger, less cuneate behind, and lacks the curved angular umbonal ridge of that species. It seems to be a true *Anatina*, although it is difficult to distinguish it from *Periplomya* when it occurs as internal casts.

Range in New Jersey—

MERCHANTVILLE: 10

WOODBURY: 18

WENONAH: 35

MT. LAUREL-NAVESINK: 53

Range outside New Jersey: Delaware.

Type.—Jamesburg, N. J. NJSM 7740 (cotype); Marlboro, N. J. NJSM 9737 (cotype).

***Anatina cliffwoodensis* Weller 1907**

Plate 27, Figure 1

Anatina cliffwoodensis Weller, 1907, p. 517, pl. 57, figs. 5-6.

Description.—Shell small, the dimensions of the type specimen being: length, about 18 mm.; height, 12 mm.; thickness, 6 mm. Shell subovate in outline, apparently a little gaping posteriorly, much broader in front than behind. Beaks compressed, directed backward, fissured transversely, situated about seven-ninths of the length of the shell from the anterior extremity, antero-cardinal margin straight and nearly horizontal in front of the beaks, curving downward in front into the broadly rounded anterior margin; basal margin gently convex curving upward more strongly at each end; posterior margin shorter and probably more sharply rounded than the anterior. Valves depressed-convex, more prominent in the umbonal region, abruptly compressed towards the postero-cardinal extremity, the anterior and ventral slopes greatly convex. Shell marked by rather fine concentric lines of growth.

Remarks.—This species resembles the one described in this report as *Anatina jerseyensis*, but may be distinguished by reason of its smaller

size more elongate form, and by the much more posterior position of the beaks. (Weller)

Range in New Jersey—

MAGOTHY: 5

Type.—Cliffwood, N. J. NJSM 9554.

***Anatina jamesburgensis* Weller 1907**

Plate 27, Figure 2

Anatina jamesburgensis Weller, 1907, p. 517, pl. 57, fig. 7.

Description.—The type specimen is only the dorsal portion of a shell preserved as a mould of the exterior, and the ventral outline can be determined only by restoration from the direction of the concentric markings of that portion of the shell which is preserved. The dimensions of the restored type are: length, 37 mm.; height, estimated, 20 mm.; thickness about 7.5 mm. Beaks incurved and nearly or quite in contact, situated back of the middle of the shell, pointing backward. Antero-cardinal margin straight and nearly horizontal in front of the beaks, curving downward in front; anterior margin rounding from the cardinal into the basal margin; basal margin slightly convex in the middle, curving upward in front and behind; posterior margin apparently rounded. Valves most prominent below the umbonal region. the surface curving rather abruptly to the cardinal margin, gently convex to the anterior and ventral margins; posteriorly the valves are rather abruptly depressed along a line running obliquely backward from the beaks, so that the postero-cardinal portion of the shell is conspicuously compressed. Surface of the shell marked by rather strong concentric undulations and by fine concentric lines of growth; the postero-cardinal compressed portion of the shell is apparently smooth, but the character of the markings of this portion of the shell is not clearly shown on the specimen. (Weller)

Remarks.—This species is much like *A. jerseyensis*, but it is proportionally more elongate and not so high. It is also marked by the conspicuous, somewhat regular, rounded, concentric undulations which are wanting in the other species.

Range in New Jersey—

MERCHANTVILLE: 10

Type.—Jamesburg, N. J. NJSM 8958.

***Cercomya peculiaris* (Conrad) 1869**

Plate 26, Figure 6

Inoceramus peculiaris Conrad, 1869, Am. Jour. Conch., vol. 5, p. 43, pl. 1, fig. 13.

Cercomya peculiaris, Whitfield, 1886, p. 178, pl. 23, figs. 24-25.

Cercomya peculiaris, Weller, 1907, p. 518, pl. 56, figs. 13-14.

Description.—The dimensions of the type specimen are: length, approximately 50 mm.; height, 29 mm. Shell subtrapezoidal in outline; beaks considerably in front of the middle of the shell. Anterior margin obliquely truncate above, sloping abruptly downward from the beak, sharply rounded below into the basal margin; basal margin gently convex; posterior margin probably broadly rounded; post-cardinal margin concave just back of the beak, probably becoming straighter posteriorly. Valves moderately convex. Surface marked by strong, concentric wrinkles of growth.

Remarks.—This species is known from the single type specimen which is a mere fragment showing only the anterior portion of a left valve, and probably represents less than one-half of the entire valve. The outline of the posterior portion of the valve can only be judged by the direction of the concentric lines of growth upon the umbonal portion of the type specimen. The specimen was originally described by Conrad as an *Inoceramus* as follows: "Subequilateral; ? convex, posterior margin rectilinear, very oblique, extremely angular; ribs prominent, concentric." The so-called posterior margin in this description is without doubt in reality the anterior margin, and is so considered in the description given above. (Weller)

Range in New Jersey—

WOODBURY: 20

Type.—Crosswicks, N. J. ANSP 18768.

***Anatimya anteradiata* Conrad 1860**

Plate 27, Figures 3, 5

Anatimya anteradiata Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 276, pl. 46, fig. 3.

Anatimya anteradiata, Weller, 1907, p. 519, pl. 57, fig. 12.

Description.—The dimensions of a right valve are: length, 56 mm.; height, 31 mm. Shell subelliptical in outline, the beaks small, sub-central in position, scarcely elevated above the hinge-line, pointing posteriorly, fissured. Antero-cardinal margin straight and horizontal in front of the beak, curving downward anteriorly; anterior margin broadly rounding from the cardinal to the basal margins; basal margin curving upward in front and behind, nearly straight in the middle, subparallel with the dorsal margin; posterior margin most produced near the cardinal line, curving broadly to the basal margin and more sharply to the cardinal extremity; post-cardinal margin concave just behind the beaks, becoming nearly straight posteriorly. Valves depressed convex, a little gaping behind. Surface of the shell in front of the beaks, marked by rather strong, more or less irregular concentric undulations, and by fine, more or less irregular lines of growth; posterior

half of the shell marked by more or less inconspicuous concentric markings, and by about 10 or 12 narrow, angular, radiating costæ, the most anterior of which extends nearly vertically downward from the beak to the ventral margin, being slightly bowed forward; back of this is a rather broad smooth space beyond which the costæ reappear, the intervals between them gradually becoming wider posteriorly, the most posterior one reaching the posterior margin of the shell near the middle, leaving a smooth area for some distance below the cardinal border.

Remarks.—This species was originally described from Tippah County, Mississippi. It occurs in both the Woodbury clay and the Wenonah sand. In the original description of the species the anterior and posterior extremities of the shell were reversed. There was also published at the same time with the definition of this species, the descriptions of two others, *A. postsulcata* and *A. papyria*, but the types of both of these have apparently been lost or destroyed. However, both are probably only variations of *A. anteradiata* and are not worthy of recognition as distinct species. The species is an abundant one at the original locality in the Ripley beds of Tippah County, Mississippi, and a comparison of the New Jersey specimens with many examples including the type of the species in the collection of the Philadelphia Academy of Science, has demonstrated the specific identity of the specimens from the two regions. (Weller)

Range in New Jersey—

WOODBURY: 18

WENONAH: 35

Range outside New Jersey: Alabama, Mississippi.

Type.—Tippah County, Miss.; ANSP ?

***Anatimya lata* (Whitfield) 1886**

Plate 27, Figure 4

Pholas ? lata Whitfield, 1886, p. 189, pl. 25, fig. 17.

Anatimya lata, Weller, 1907, p. 521, pl. 57, fig. 13.

Anatimya lata, Wade, 1926, p. 74.

Description.—“Shell large and proportionally very broad between dorsal and basal margins, the relative height and length being about as two to three respectively. The general outline is slightly ovate, widest at the anterior end and gradually narrowing posteriorly, the beak being a little in advance of the middle and showing somewhat above the cardinal line in the slightly compressed and somewhat crushed specimen of an internal cast of a left valve, the only one yet seen. Anterior and posterior ends rounded, the latter one most narrowly so; basal line slightly emarginate just behind the middle of its length; cardinal line apparently arcuate throughout. Surface of the shell, as shown on the cast, convex, with a broad sulcus passing across the

valve from beak to base, reaching the latter behind the middle. Anterior to the sulcus the surface is radiately ribbed, the rays being somewhat alternate in size over a portion of the space. At the bottom of the broad sulcus there is a single larger and stronger rib, which passes from the beak directly to the base of the shell, which it reaches at the point of greatest emargination. Posterior to this larger rib the surface is destitute of radiating lines, the surface being marked only with broad, irregular, concentric sulci, which extend over the entire surface parallel to the margin of the shell." (Whitfield.)

Remarks.—The type specimen of this species, which is the only one which has been observed, is poorly preserved, but it is clearly a member of the genus *Anatimya* rather than *Pholas*, and is possibly identical with *A. postsulcata* Con. The type of Conrad's species is only a fragment exhibiting the inside of the shell, but both the concentric and radiating markings are finer than in Whitfield's species. In Whitfield's description of the species, quoted above, the anterior and posterior extremities of the shell are evidently reversed.

The horizon of the species is stated by Whitfield to be "Lower Green Marls" and the locality "Marlborough, N. J." The specimen itself is an internal cast of rather dark sand with some larger, lighter colored quartz grains, and is very similar in its lithologic characters to some portions of the Wenonah sand, from which formation it is quite probable that the specimen was collected. (Weller)

Range in New Jersey—

WENONAH: 35

Range outside New Jersey: Tennessee.

Type.—Marlboro, N. J. NJSM 7670.

Periplomya elliptica (Gabb) 1861

Plate 26, Figure 7

Anatina elliptica Gabb, 1861, Proc. Acad. Nat. Sci. Phila. Vol. for 1861, p. 324.

Periplomya elliptica Whitfield, 1886, p. 177, pl. 23, figs. 14, 15.

Periplomya truncata Whitfield, 1886, p. 220, pl. 28, figs. 20, 21.

Veleda nasuta Whitfield, 1886, p. 217, pl. 28, fig. 23.

Periplomya elliptica, Weller, 1907, p. 522, pl. 57, figs. 8-11.

Periplomya elliptica, Gardner, 1916, p. 633.

Periplomya elliptica, Wade, 1926, p. 74, pl. 24, fig. 2.

Description.—"Shell small, inequivalve, and very inequilateral, subovate in outline, largest across the anterior side of the beaks, and strongly constricted just behind them, the posterior end being narrowed on the hinge-line and excavated at this point. Valves somewhat ventricose, the right one less convex than the left, and very decidedly de-

pressed in the central region and toward the basal line, showing a decided twist or arcuation of the valves as seen in a basal view. Anterior end broadly rounded, and the posterior pointedly rounded. Beaks small, appressed, incurved, and apparently directed backward, as is usual in this group of shells, from the expansion or inflation of the anterior side of the hinge line. Cardinal margin, as seen on the cast, inflected both in front and behind the beaks, forming an apparent lumule and escutcheon on the cast, probably produced mainly from a thickening of the hinge-plate within. Muscular imprints and palial line and hinge not observed." (Whitfield.)

The dimensions of the specimen illustrated by Whitfield are: length, 31 mm.; height, 27.5 mm.; thickness, 10 mm.

Remarks.—Whitfield figured this species from the "Lower Green marls at Mullica Hill and Holmdel," which would indicate a Cretaceous age. However, Weller believed that this, together with the two synonyms, (*P. truncata* and *V. nasuta*) of Whitfield are from the Manasquan formation of Eocene age. The fact that the species is known from the Cretaceous of Maryland and Tennessee, suggests that a Cretaceous dating is preferable.

Range in New Jersey—

MT. LAUREL-NAVESINK: 41, 53

MANASQUAN: New Egypt

Range outside New Jersey: Maryland, Tennessee.

Type.—Mullica Hill, N. J. ANSP 18767.

***Corimya tenuis* Whitfield 1886**

Plate 26, Figure 8

Corimya tenuis Whitfield, 1886, p. 170, pl. 23, figs. 9-11.

Corimya tenuis, Weller, 1907, p. 524, pl. 57, figs. 16-18.

Description.—The dimensions of a nearly perfect internal cast are: length, 32.5 mm.; height, 22 mm.; thickness, 10 mm.; the length of the largest specimen observed is 37 mm. Shell subelliptical to broadly triangularly ovate in outline; the valves unequally depressed convex, the right valve flatter than the left. Beaks small, little elevated above the hinge-line, nearly central in position. Anterior and posterior cardinal margins sloping away from the beak in a broadly obtuse angle; anterior and posterior margins rounded, the anterior higher than the posterior; basal margin broadly convex. Surface of the casts marked by more or less indistinct and irregular concentric undulations, and in some specimens by faint radiating ribs on the anterior slope of the shell. In the central portion of the casts, beneath the beak and extending further posteriorly than anteriorly, wavy vascular impressions can often be seen extending about half way to the ventral margin of the shell. Muscular impressions of moderate size, the posterior ones

more conspicuous than the anterior, and bordered in front by a rather deep groove in the casts extending obliquely backward from behind the beak towards the posterior margin.

Remarks.—This species can be easily recognized by the unequal convexity of the valves which give to the specimens a slightly bent form, and by the conspicuous oblique furrow in front of the posterior muscular scars in the casts, which in the interior of the shells themselves was a ridge-like thickening of the valve. The species has only been observed in the form of internal casts and the external surface markings are not known. (Weller)

Range in New Jersey—

MARSHALLTOWN: 27

MT. LAUREL-NAVESINK: 37, 40, 44, 47, 53

Type.—Upper Freehold, N. J. ANSP

Family Clavagellidae

Clavagella armata Morton 1834

Plate 27, Figure 6

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

Clavagella armata, Whitfield, 1886, p. 192, pl. 25, fig. 24.

Clavagella armata, Weller, 1907, p. 525, pl. 58, figs. 1-2.

Clavagella armata, Wade, 1926, p. 75, pl. 24, figs. 4-5.

Clavagella armata, Groot, Organist and Richards, 1954, p. 46

Description.—The dimensions of a complete internal cast of the shell, exclusive of the tube, are: length, 14 mm.; height, 8.5 mm.; thickness, 7.5 mm. Shell subovate in outline; the beaks small, situated a little in front of the middle, slightly recurved. Anterior and posterior margins rather sharply rounded; ventral margin convex throughout. The anterior margin with several tubular spines. Valves rather strongly convex, the right one free, the left one attached to the tube. Surface of the cast smooth, the muscular impressions more or less strongly marked, sometimes scarcely distinguishable. (Weller)

Remarks.—Specimens of this peculiar species are rare in the New Jersey collections. The peculiar tubular spines which arm the anterior margin of the shell have sometimes been broken from the fossil specimens. Some specimens have been observed, however, upon which they are as clearly shown as upon the type specimen illustrated by Morton. The tube, except its very basal portion, is rarely preserved.

Range in New Jersey—

MERCHANTVILLE: 16

MT. LAUREL-NAVESINK: 37, 40, 45, 46

Range outside New Jersey: Delaware, Alabama, Tennessee.

Type.—?

Family Poromyacidae

Liopistha protexta (Conrad) 1853

Plate 27, Figures 7, 8

Cardium protextum, Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 275, pl. 24, fig. 12.

Liopistha protexta, Whitfield, 1886, p. 140, pl. 20, figs. 1-3.

Liopistha inflata, Whitfield, 1886, p. 142, pl. 20, figs. 6-7.

Liopistha protexta, Weller, 1907, p. 526, pl. 58, figs. 4-6.

Liopistha protexta, Gardner, 1916, p. 636, pl. 36, fig. 15.

Liopistha protexta, Stephenson, 1923, p. 250, pl. 65, fig. 3.

Liopistha protexta, Wade, 1926, p. 75 (part), pl. 24, fig. 6.

Liopistha protexta, Stephenson, 1941, p. 162, pl. 26, figs. 27-30.

Liopistha protexta, Groot, Organist and Richards, 1954, p. 46, pl. 5, fig. 2.

Description.—The dimensions of a large individual are: length, 30.5 mm.; height, 22 mm.; thickness, 16.5 mm. Shell, exclusive of the projecting beaks, subelliptical in outline. Beaks prominent, situated a little in advance of the middle of the shell, their apices pointed, incurved and nearly in contact. Antero-cardinal slope slightly concave; anterior margin sharply rounded; basal margin regularly convex throughout; posterior margin rather short, obliquely subtruncate, straight or slightly convex; posterior cardinal slope more concave than the anterior. Valves ventricose in the umbonal region, the surface curving regularly to the margin all around, being more abrupt to the cardinal margin, and often somewhat compressed towards the postero-cardinal extremity; slightly gaping behind. Surface marked by 25 to 30, and in very large individuals as many as 35, angular, radiating costæ with concave interspaces, a small area at the posterior extremity being nearly or wholly destitute of ribs. External impressions of the shell show these ribs to be crossed by fine concentric lines of growth, and to be surmounted along the summit by a row of small tubercles appearing almost like spine bases, whose distance apart is less than the distance between adjacent costæ; the radiating rows of tubercles also continue across the posterior noncostate portion of the shell.

Remarks.—This is the commonest member of the genus in New Jersey and occurs, so far as known, only in the form of internal casts with their external impressions. The delicate surface markings of the shell can only be seen in impressions of the external surface, and only occasionally in these because of the imperfection of their preservation. Whitfield's *L. inflata* is certainly a synonym of this species; it is said to be shorter, with more inflated beaks, and less sharply defined costæ, but these differences are nothing more than individual variations.

(Weller)

More perfect individuals are known from the Cretaceous south of New Jersey.

Range in New Jersey—

MERCHANTVILLE: 15

WENONAH: 35

MT. LAUREL-NAVESINK: 37, 40, 46, 47, 57

RED BANK: 59

TINTON: 60, 61

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Alabama, Mississippi, Tennessee, Arkansas, Georgia.

Type.—Burlington County, N.J.; ANSP; 16871.

***Liopistha alternata* Weller 1907**

Plate 27, Figure 10

Liopistha alternata, Weller, 1907, p. 527, pl. 58, figs. 7-9.

Liopistha alternata, Gardner, 1916, p. 637.

Liopistha alternata, Groot, Organist and Richards, 1954, p. 46.

Description.—The dimensions of an average left valve are: length, 22 mm.; height, 15.5 mm.; convexity, 7 mm. The shell, exclusive of the projecting beaks is subelliptical in outline. The beaks are central, or in some specimens apparently a little back of the center, their apices pointed, elevated above the hinge-line, strongly incurved and nearly or quite in contact. Antero-cardinal slope slightly concave or nearly straight; anterior margin rather sharply rounded, basal margin broadly and regularly convex; posterior margin rather sharply rounded above to the posterior extremity of the hinge-line; post-cardinal slope more concave than the anterior. Valves ventricose or inflated in the umbonal region, the surface curving abruptly to the cardinal margin, convex to the anterior and ventral margins, more or less compressed to the postero-cardinal extremity; slightly gaping posteriorly. Surface marked with 40 or more angular, radiating costæ in adult shells, the alternate ones being conspicuously larger. The smaller costæ are intercalated between the larger ones and do not reach the beak, so that in very young shells the alternation of costæ does not exist; upon the posterior, more or less compressed portion of the valves the costæ are nearly or quite obsolete. Distinct impressions of the external surface of the shells, show them to be marked by fine, indistinct lines of growth; they also show each costæ, both the larger ones and the smaller ones, to be surmounted by a row of fine tubercles or short spines, whose distance apart is less than the spaces between the costæ, the radiating lines of tubercles are also present upon the posterior non-costate portion of the shell.

Remarks.—This species can be easily distinguished from *L. protexta* by the alternating costæ and the more central position of the beaks.

These two species have never been observed associated in the same fauna, *L. alternata* being characteristic of the Merchantville, while *L. protexta* is especially characteristic of the Navesink. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 10

Range outside New Jersey: Delaware, Maryland.

Type.—Matawan, N. J. NJSM 7759; near Jamesburg, N. J. NJSM 8953 (cotypes).

***Liopistha kummeli* Weller 1907**

Plate 27, Figure 11

Liopistha kummeli Weller, 1907, p. 529, pl. 58, fig. 3.

Description.—The dimensions of a large right valve are: length, 21 mm.; height, 15 mm.; convexity, 4.5 mm. Shell subovate in outline, beaks central or a little in advance of the center, strongly incurved; antero-cardinal margin curving gently downward anteriorly from beneath the beak and passing regularly into the broadly rounded anterior margin; basal margin broadly rounded, becoming straighter posteriorly and sloping upward to the most posterior extremity of the shell which is above the mid-height; posterior extremity rather sharply rounded into the post-cardinal margin which is straight and horizontal. Surface marked by about 20, simple, subangular, radiating costæ, subequal in size, but becoming somewhat smaller anteriorly; upon the cardinal slopes the costæ become much fainter or even obsolete, the smooth area being broader behind than in front; upon the umbo and towards the beak, more or less faint concentric undulations cross the radiating ribs, but these become obsolete before reaching the middle of the shell in adult examples; impressions of the exterior show in addition to the radial and concentric markings already described, fine concentric lines of growth.

Remarks.—This species differs from *L. alternata* which occurs in the same horizon, in the absence of the alternating costæ, and in the presence of the concentric undulations towards the beak. It agrees more nearly with *L. protexta* from the Navesink marl, but the radiating costæ are coarser and less numerous, and that species also lacks the concentric undulations. In the presence of these concentric undulations, the species approaches the members of the genus *Cymella* in which the concentric markings are more conspicuous than the radial, but the much stronger radial markings suggests a closer relationship to the members of the genus *Liopistha*. (Weller)

Range in New Jersey—

MERCHANTVILLE: 10, 15

Range outside New Jersey: Delaware.

Type.—Lenola, N. J. NJSM 7757.

***Cymella bella texana* Stephenson 1941**

Plate 26, Figures 9, 10

Cymella meeki, Whitfield, 1886, (part) p. 142, pl. 20, figs. 6, 7.*Cymella bella*, Weller, 1907, p. 530, pl. 58, figs. 10-12.*Liopistha (Cymella) bella*, Stephenson, 1923, p. 253, pl. 65, figs. 4-8.*Cymella bella texana* Stephenson, 1941, p. 165, pl. 26, figs. 21-23.*Cymella bella* var., Groot, Organist and Richards, 1954, p. 46, pl. 5, fig. 3.

Description.—"Shell of moderate size, transversely oval or ovate, about once and a half as long as high. Valves strongly convex, with large, somewhat prominent beaks, situated much nearer the anterior end. Shell nearly erect, and a little wider at the anterior end than behind. Extremities of the valves nearly equally rounded and the base regularly curved. Cardinal line long behind the beaks, and the margin inflected forming a narrow, linear, escutcheon-like area. Surface of the shell marked by strong and regularly rounded and regularly increasing undulations parallel to the border of the valves. These are crossed by distant radiating ribs, which are strong and vertical in the middle of the valve or opposite the beaks, and become gradually fainter and finer toward the posterior end, apparently becoming obsolete just below the cardinal border, and also before reaching the anterior cardinal margin. These radiating ribs, on the central parts of the shell especially, cut up the surface into rounded nodes by forming depressions across the concentric undulations. Surface of the shell and hinge-structure not seen, as the specimens are all in the condition of casts in a fine micaceous marl." (Whitfield.)

The dimensions of a large left valve are: length, 41 mm.; height, 27.5 mm., convexity, 9.5 mm.

Remarks.—Stephenson (1923, p. 254) called attention to the fact that the New Jersey specimens had broader costæ and narrower interspaces than the true *C. bella*. The varietal name *texana* was given to very similar forms in Texas and it seems desirable to use this name for the New Jersey specimens.

Range in New Jersey—

MAGOTHY: ? 6

MERCHANTVILLE: ? 8

WOODBURY: 18, 19, 24

WENONAH: 35

Range outside New Jersey: Delaware, Maryland, Georgia, Alabama, Mississippi, Texas.

Type.—Texas; USNM 76517.

Cymella undata (Meek & Hayden) 1856

Plate 27, Figure 9

Pholadomya undata Meek & Hayden, 1856, Proc. Acad. Nat. Sci. Phil., p. 81.

Cymella undata, Weller, 1907, p. 531, pl. 58, fig. 13.

Description.—"Shell transversely broad-ovate, approaching sub-trigonal, moderately gibbous; anterior end rounded; posterior side narrower and a little more compressed, rounded chiefly from below; base forming a regular semiovate curve; dorsal margin sloping rather abruptly in front of the beaks, straighter and declining more gradually behind; hinge-margins straight, and inflected so as to form a well-defined false area both behind and a little in front of the beaks, which are somewhat elevated, incurved at right angles to the hinge-line, and located a little in advance of the middle of the shell. Surface ornamented by about 17 to 20 of the simple, rounded, rather strong, regular, concentric undulations, which are broader than the depressions between, and, as it were, cut by the radiating linear furrows, on the central region of each valve, into about the same number of much smaller, simple, radiating costæ, less than, or nearly equaling, the furrows by which they are separated." (Meek.)

The dimensions of the only specimen observed, a left valve, are: length, 16.5 mm.; height, 12 mm.; convexity, 3.5 mm.

Remarks.—This species is represented in the New Jersey collections by a single individual which agrees very closely with Meek's description and illustration of the species. In only one respect is there any marked difference, and that probably not essential, the number of fine radiating, linear furrows being greater and occupying a wider space on the central portion of the shell. About 30 of these furrows can be clearly distinguished and exceedingly faint ones seem to extend still further towards the posterior and anterior extremities. The shell is associated with *C. bella*, but is clearly distinct from it by reason of the much finer radiating markings, and there are no intermediate forms connecting the two species. (Weller)

Range in New Jersey—

WENONAH: 35

Range outside New Jersey: "Western Interior" including Nebraska, South Dakota.

Type.—Mouth of Judith River, Nebraska; USNM 187.

Family Cuspidariidae

Cuspidaria ventricosa (Meek & Hayden) 1856

Plate 28, Figure 2

Corbula ventricosa Meek & Hayden, 1856, Proc. Acad. Nat. Sci. Phil., vol. 8, p. 83.

Cuspidaria ventricosa, Weller, 1907, p. 533, pl. 58, figs. 16-17.

Description.—"Shell small, nearly or quite equivalve, rather thin, very ventricose in the anterior and central regions; anterior margin somewhat narrowly rounded; base very deeply rounded toward the front, contracted behind; posterior side longer than the other, narrow, compressed and rostriform; dorsum sloping gradually with a concave outline behind the beaks, declining more abruptly in front; beaks prominent, apparently equal not oblique, located a little in advance of the middle; pallial border smooth; surface marked by rather concentric striæ." (Meek.)

The dimensions of a single valve are: length, 13 mm.; height, 7 mm.; convexity, 2.7 mm.

Remarks.—All the examples of this species observed in New Jersey are casts, and these have frequently been more or less distorted in the soft clays and sands where they occur. The form and size of the shell, however, agrees well with those described by Meek from the Fox Hills and Pierre faunas of the west, and there can be no doubt as to their identity. (Weller)

Range in New Jersey—

WENONAH: 35

RED BANK: 59, 60

TINTON: 62

Range outside New Jersey: South Dakota, Nebraska.

Type.—Morcan River, Nebraska; USNM 419.

Cuspidaria jerseyensis Weller 1907

Plate 28, Figure 1

Cuspidaria jerseyensis Weller, 1907, p. 534, pl. 58, figs. 14-15.

Description.—Shell large for the genus, the dimensions of the type specimen being: length, 25.5 mm.; height, 17 mm.; thickness, 13.7 mm. Ventricose in the anterior and central region, compressed and rostriform posteriorly; the beaks incurved, directed backward, situated centrally, the right one a little in advance of the left. From the beaks the anterior margin slopes gently downward in front, passing into the broadly rounded anterior margin, which in turn passes without interruption into the basal margin which is gently rounded anteriorly, becoming straighter posteriorly as it slopes upward to meet the cardinal

margin in an obscure acute angle, the posterior margin restricted to the sharply rounded rostrate extremity of the shell, the post-cardinal margin concave just behind the beaks, becoming straight posteriorly. Surface of the internal cast marked by regular, rounded, concentric undulations a little less than one millimeter apart, and by very obscure radiating lines.

Remarks.—This species is based upon a single nearly complete internal cast from New Jersey and a second less perfect specimen from Alabama. The species differs from *C. ventricosa*, in its larger size, its more nearly central beaks, and in its concentric markings. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 40

Type.—Crawfords Corner, N. J. NJSM 7568.

Family Pleurophoridae

Veniella conradi Morton 1833

Plate 26, Figure 11; Plate 28, Figures 3, 5; Plate 29, Figure 14

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

Veniella trigona Gabb, 1861, Proc. Acad. Nat. Sci. Phil., p. 324.

Goniosoma inflata Conrad, 1869, Am. Jour. Conch., vol. 5, p. 44, pl. 1, fig. 10.

Veniella elevata Conrad, 1870, Am. Jour. Conch., vol. 6, p. 74, pl. 3, figs. 7-7a.

Veniella conradi, Whitfield, 1886, p. 144, pl. 19, figs. 8-10.

Veniella inflata, Whitfield, 1886, p. 147, pl. 19, figs. 4-5.

Veniella elevata, Whitfield, 1886, p. 148, pl. 19, figs. 6-7.

Veniella trigona, Whitfield, 1886, p. 149, pl. 19, figs. 11-14.

Veniella conradi, Weller, 1907, p. 534, pl. 58, figs. 18-19.

Veniella trigona, Weller, 1907, p. 537, pl. 59, figs. 1-3.

Veniella conradi, Gardner, 1916, p. 643, pl. 38, figs. 2-7.

Veniella conradi, Stephenson, 1923, p. 257, pl. 66, figs. 1-5.

Veniella conradi, Wade, 1926, p. 77, pl. 24, figs. 14-16.

Veniella conradi, Stephenson, 1941, p. 168, pl. 27, figs. 6-8.

Veniella conradi, Groot, Organist and Richards, 1954, p. 46.

Description.—The dimensions of an average sized left valve are: length, 26 mm.; height, 23 mm.; convexity, 12 mm. Shell subtrapezoidal in outline. Hinge-line rather strongly curved. Anterior margin straight above, sloping obliquely forward, sharply rounding into the basal margin below; basal margin gently convex, becoming straighter posteriorly; postero-basal extremity angular; posterior

margin obliquely truncate; postero-cardinal extremity obtusely angular, becoming rounder in the larger individuals; postero-cardinal margin rather long, straight or slightly convex. Valves very ventricose, with a sharply angular, curved umbonal ridge. Beaks situated nearly as far front as the anterior extremity of the shell, incurved and directed forward. Post-umbonal slope abrupt, with a shallow sinus extending from the beak to the posterior margin of the shell, and a low subangular ridge curving from the beak to the postero-cardinal extremity; anterior slope convex from the umbonal ridge forward, the curvature of the surface becoming much more abrupt as it approaches the anterior margin. Surface of the shell marked by several, strong, concentric varices which become more remote away from the beak, and upon very large individuals become obsolete upon the outer portion of the shell; they are produced into broad, lamellar extensions of the shell and do not continue across the post-umbonal slope. The shell surface is also marked by more or less irregular concentric lines of growth.

Remarks.—This is one of the long range species in the New Jersey faunas, and is liable to occur at any horizon from the Merchantville to the Tinton. The species does not usually attain so large a size in New Jersey as it sometimes does in some of the southern localities, although individuals 30 mm. in height are sometimes met with. The little shell from Haddonfield described by Conrad as *V. elevata* is only a young individual of *V. conradi*, and the same author's *Goniosomo inflata* is an internal cast of the same. The species occurs most abundantly in the Merchantville, Marshalltown, and Wenonah formations, being rare in the Woodbury. The only place where the shells themselves have been collected in the State is from the Marshalltown clay-marl near Swedesboro. (Weller)

Range in New Jersey—

MERCHANTVILLE: 10, 15, 17

WOODBURY: 20, 22, 24

WENONAH: 34, 35

MT. LAUREL-NAVESINK: 37, 40, 46, 53

RED BANK: 59, 60

TINTON: 62

Range outside New Jersey: Delaware, Maryland, District of Columbia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas, Texas.

Type.—(*V. conradi*) New Jersey

(*V. inflata*) Crosswicks, N. J.; ANSP 18786

(*V. elevata*) Haddonfield, N. J.; ANSP 18785

(*V. trigona*) labelled Boonton, N. J. which is obviously wrong; ANSP 18787.

Veniella (Etea) carolinensis var. aspera Stephenson 1923

Plate 28, Figures 6, 7

Etea carolinensis Weller, 1907, p. 541, pl. 59, figs. 4-6 (not of Conrad 1875).

Veniella carolinensis aspera Stephenson, 1923, p. 266, pl. 66, figs. 13-15

Description.—Proportionally shorter and higher than *Veniella carolinensis* Conrad¹, with more prominent umbones, more sharply defined umbonal ridges, coarser surface sculpture and more strongly sinuous on the posterior margin.

Remarks.—According to Stephenson, these characters are constant suggesting that this might be given specific rather than varietal rank. However since larger collections may show intergradation, it seems best to regard this as a variety. *V. carolinensis aspera* is closely allied to *V. trapezoidea* (Conrad) from the Merchantville clay of New Jersey, but is a little more elongated and more broadly rounded where the posterior margin passes into the dorsal margin.

Range in New Jersey—

MARSHALLTOWN: 28

Range outside New Jersey: North Carolina

Type.—Snow Hill, N. C.; USNM 7715; paratypes (?) ANSP 2299.

Veniella (Etea) trapezoidea Conrad 1860

Plate 28, Figures 8, 9; Plate 29, Figures 7, 15

Veniella trapezoidea Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 282, pl. 47, fig. 7.

Crassatella monmouthensis Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 302, pl. 48, fig. 19.

Crassatella lineata Shumard, 1862, Proc. Bost. Soc. Nat. Hist., vol. 8, p. 201.

Veniella subovalis Whitfield, 1886, p. 150, pl. 19, figs. 1-2.

Veniella trapezoidea, Whitfield, 1886, p. 151, pl. 19, fig. 3.

Etea trapezoidea, Weller, 1907, p. 543, pl. 58, figs. 20-21; pl. 59, fig. 7.

Description.—The dimensions of an average specimen are: length, 26 mm.; height, 18 mm. The specimens sometimes attain a length of 30 mm. or more. Shell very oblique and inequilateral, subtrapezoidal to subelliptical in outline, the beaks situated about one-third the length of the shell from the anterior extremity. Anterior margin rounding into the basal margin; basal margin convex anteriorly and sometimes throughout, often somewhat gibbous in the middle, and usually slightly sinuateposteriorly; postero-basal extremity acutely sub-

¹Kerr's Geol. North Carolina, Appendix, p. 6, pl. 1, fig. 14.

angular, posterior margin obliquely truncate, the postero-dorsal margin straight or slightly curved, sloping from the beak to the posterior hinge extremity, where it meets the truncated posterior margin in an obtuse angle. Valves with an angular or subcarinate umbonal ridge passing from the beak to the postero-ventral extremity of the shell; in front of the umbonal ridge is a more or less obscure depression or broad shallow sinus, which passes obliquely backward from the beak to the sinuosity in the ventral margin. The postero-dorsal slope concave to the cardinal margin, where the surface is inflected to form the escutcheon. In front of the beak the surface of the shell is inflected to form the rather large lunule. In the casts the muscular impressions are of moderate size, inconspicuous or somewhat strongly marked, and the free margins are not crenate. Surface of the shell marked by concentric lines of growth which vary in the strength of their development.

Remarks.—This specific form seems to have been described under several names by different authors, Conrad's name *trapezoidea* having priority. The types of the species *Veniella trapezoidea*, *Crassatella monmouthensis* and *Veniella subovalis* have all been carefully studied in the collection of the Philadelphia Academy of Science. The specimens indicated as types of *C. monmouthensis* are four in number; the smallest of these has "type" marked on it in ink, and seems to be different from the other three; it has the shell preserved, and from its lithologic character seems to have come from one of the marl beds, probably the Navesink; this smaller specimen is apparently not the one which was illustrated by Gabb. The three larger individuals agree with the original illustration of the species in all essential characters, and one of them was doubtless used as the original for the figure; these specimens apparently came from the Merchantville formation, and are identical with *V. trapezoidea* and with the Merchantville clay specimens in the recent collections of the Survey. Whitfield's *Veniella subovalis* is certainly a member of the same species, although its posterior margin is somewhat higher and more nearly vertical than the others. The type of *Crassatella lineata* has not been seen, but the species is represented in the National Museum at Washington by numerous examples from the type locality, and it is unquestionably specifically identical with the Alabama and New Jersey specimens. An examination of a large number of individuals of this species shows considerable variation in some respects, notably in the height of the posterior truncated margin, and in the curvature of the basal margin, which is sometimes slightly sinuate posteriorly and again nearly straight or slightly convex. The species resembles *E. carolinensis*, but it is a shorter shell with a higher posterior margin; the two forms are certainly cogeneric, however, and if it is advisable to recognize *Etea* at all as distinct from *Veniella*, both should be placed in that genus. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 10, 15, 16, 17

WOODBURY: 20

MT. LAUREL-NAVESINK: 58

Type.—(*V. trapezoidea*) Eufaula, Ala.

(*C. monmouthensis*) Monmouth County, N. J. ANSP
18738.

(*C. subovalis*) Crosswicks, N. J.; ANSP 18788.

***Etea delawarensis* (Gabb) 1860**

Plate 28, Figure 4; Plate 29, Figure 11; Plate 31, Figure 1

Crassatella delawarensis Gabb, 1860, Jour. Acad. Nat. Sci. Phila. 2nd ser. vol. 4, p. 303, pl. 48, fig. 20.

Etea delawarensis, Conrad, 1876, Proc. Acad. Nat. Sci. Phila. for 1876 p. 275

Crassatella delawarensis, Whitfield, 1886, p. 210, pl. 27, figs. 14-15.

Etea delawarensis, Weller, 1907, p. 546, pl. 59, figs. 8-9.

Description.—The dimensions of a nearly perfect specimen are: length, 26 mm.; height, 19.5 mm.; thickness, 12.5 mm. Shell cuneately subovate or subtriangular in outline, highest in front, the beaks elevated, rather small, incurved, situated between one-third and one-fourth the length of the shell from the anterior extremity. Antero-cardinal margin rather long, nearly straight or slightly concave, sloping steeply forward from the beaks; anterior margin rather narrowly rounding into the basal margin; basal margin gently convex anteriorly and straight or slightly concave posteriorly; postero-basal extremity sharply rounded or subangular; posterior margin slightly convex, obliquely truncate; postero-cardinal margin long and straight, joining the posterior margin in an obtusely rounded angle. From the beak to the postero-basal angle, a rather broadly rounded umbonal ridge extends in a nearly straight line; the postero-cardinal slope is nearly flat posteriorly, becoming a little convex towards the beak; the cardinal margin is sharply inflected to form the sides of the narrow but rather deeply excavated escutcheon. In front of the umbonal ridge the shell is flattened or slightly sinuate from the beak obliquely backward to the basal margin; in front of the beak the shell is inflected along the cardinal margin to form the rather broad, concave lunule. Surface of the shell marked with moderately fine, but rather strong and regular concentric lines of growth, which become obsolescent back of the umbonal ridge.

In the internal casts the beaks are more prominent, erect and rather widely separate, the shell is rather more pointed posteriorly and the muscular and pallial impressions are of moderate strength. (Weller)

Remarks.—The type specimen is labelled in Gabb's handwriting "Crosswicks, N. J." with the notation "this species is common also in Delaware." In the text Gabb cites "deep cut, Delaware and Chesapeake Canal" as the locality of the species. Both Whitfield and Weller questioned the locality record since the specimens which they referred to this species all came from the Manasquan formation (Eocene) while Gabb's reference to Crosswicks would indicate the Cretaceous, probably the Woodbury.

In addition to the type specimen, the Academy has eight other specimens from Crosswicks. The species is also known from several localities in the Eocene (Clementon, well at Interlaken, Pemberton, and near Farmingdale).

Conrad placed the species in the genus *Etea*, although the sculpture and hinge teeth are not distinct.

Range in New Jersey—

WOODBURY (?) 20

MANASQUAN: (Eocene)

Type.—Crosswicks, N. J. ANSP 18733.

***Geloina ? tenuidens* (Whitfield) 1886**

Plate, 40, Figure 2; Plate 41, Figure 1; Plate 45, Figure 15

Gnathodon ? tenuidens Whitfield, 1886, p. 27, pl. 2, figs. 7-10.

Rangia ? tenuidens, Weller, 1907, p. 635, pl. 73, figs. 6-8.

Rangia ? tenuidens, Richards, 1943, Proc. Acad. Nat. Sci. Phil. p. 21, pl. 4, fig. 2, pl. 5, fig. 1.

Geloina ? tenuidens, Stephenson, 1954, p. 32, pl. 7, figs. 10-14.

Description.—"Shell of moderate size, very ventricose, very broadly ovate or subtriangular, with strong and rather tumid, enrolled beaks, which are directed forward and project considerably beyond the line of the hinge. Posterior hinge border gently arcuate, extending more than two-thirds of the distance from the beak toward the basal margin of the shell. Postero-basal angle sharply rounded, and the basal margin broadly arched; anterior end less sharply and more regularly rounded than the postero-basal. Surface of the shell, as indicated on the partial casts and imprints left in the hardened clay, smooth or marked by fine lines of growth only. On the cast of a right valve there are indications of two principal cardinal teeth beneath the beak, and a long rather slender, lateral tooth. The muscular impressions are not visible on the posterior side, but on one specimen the anterior scars seem to have been large and deep; but this feature is not very satisfactorily determined." (Whitfield.)

Remarks.—Described from casts and consequently the generic determination has been questioned. Stephenson, on the basis of incomplete hinges, tentatively transferred the species to the genus *Geloina*.

a recent genus of the Philippine seas. He adds the following description:

"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."

Range in New Jersey—

RARITAN: 1a

Type.—Sayreville, N. J. NJSM 8839.

***Ambocardia cookii* Whitfield 1886**

Plate 40, Figure 1

Ambocardia cookii Whitfield, 1886, p. 25, pl. 2, figs. 11-14.

Ambocardia cookii, Weller, 1907, p. 548, pl. 60, figs. 1-2.

Ambocardia cookii, Richards, 1943, Proc. Acad. Nat. Sci. Phila, vol. 95, p. 21, pl. 4, fig. 1.

Description.—"Shell large and ponderous, with heavy, massive, incurved beaks, which are strongly enrolled and situated near the anterior end of the shell. Valves very gibbous, very inequilateral and transverse, strongly cuneate in a cardinal view when united, being extremely ventricose opposite the beaks and gradually but rapidly decreasing in depth toward the posterior end; obliquely ovate in outline, with a short, obtusely pointed anterior end, straight but short cardinal line; prolonged but obtusely rounded posterior end; basal line strongly curved, rapidly declining from the anterior end, and distinctly sinuate near the middle of the shell by a broad, shallow, but well-defined oblique sulcus, which passes from the beak to the basal margin just in front of the strongly rounded and prominent umbonal ridge. External ligament strongly marked, and extending the length of the posterior cardinal line and deeply imbedded in a narrow escutcheon. Lunule large and deep, strongly defined, with sharply angular margins. Substance of the shell thick and dense, and

the surface marked with close comparatively strong concentric lines or ridges, and apparently with a thick epidermis. Anterior muscular scar large and deep, situated close to the margin in the pointed anterior end. Other muscular imprints not determined and the features of the hinge are as yet unknown. Pallial line apparently simple." (Whitfield.)

Remarks.—Whitfield based his genus *Ambonicardia* on some large internal casts of this species. Superficially they resemble a *Unio* but the position of the muscular impression and the lack of lateral hinge teeth precludes its reference to that genus. A number of specimens have been found, but in none are the features of the external shell preserved. Not represented in recent collections.

Range in New Jersey—

RARITAN: 1, 2, 3

Type.—Sayreville, N. J. NJSM 7790.

Family Astartidae

Astarte veta Conrad 1869

Plate 40, Figure 9; Plate 41, Figure 4

Astarte veta Conrad, 1869, Am. Jour. Conch., vol. 4, p. 279, pl. 20, fig. 4.

Astarte veta, Whitfield, 1886, p. 23, pl. 2, fig. 1.

Astarte veta, Weller, 1907, p. 549, pl. 60, fig. 3.

Astarte veta, Richards, 1943, p. 19, pl. 4, fig. 9; pl. 5, fig. 4.

Description.—"Mr. Conrad described this species as 'Ovate, from ventral margin to beak, compressed, equilateral; beaks prominent, oblique; anterior ventral margin rounded, posterior obliquely truncated; posterior, end truncated and situated much above the line of the base (cast).' In comparison he says, 'this species is nearly allied to, if not identical with, *Astarte Triasina*, Dunker.'

"I have not been able to obtain specimens agreeing with the above description, nor to find the type specimen used by Mr. Conrad. The form of the shell would indicate that it belonged to the genus *Astarte*, but beyond that there appears to be no real evidence of its generic relations more than there is to other species found in these clays. The outline of the shell might suggest that it was a young individual of what I have herein called *Gnathodon tenuidens*, but the apparent want of gibbosity would not agree. So for the present at least the species will have to be left as it is." (Whitfield.)

Remarks.—The type has been located in the Academy of Natural Sciences, but no further suggestions can be offered regarding the relationship of the species. It does superficially resemble the German

A. triasina Roemer, although even its position within the genus *Astarte* is open to question because the hinge is not visible in the New Jersey shell.

Range in New Jersey—

RARITAN: 4

Type.—Washington (now South River), N. J. ANSP 14360.

***Astarte ? annosa* Conrad 1869**

Plate 40, Figure 8

Astarte annosa Conrad, 1869, Am. Jour. Conch., vol. 4, p. 279, pl. 20, fig. 5.

Astarte annosa Conrad, 1870 Am. Jour. Conch., vol. 5, p. 227.

Corbicula ? annosa, Whitfield, 1886, p. 26, pl. 2, figs. 2-4.

Corbicula ? annosa, Weller, 1907, p. 563, pl. 62, figs. 1-3.

Astarte ? annosa, Richards, 1943, Proc. Acad. Nat. Sci. Phila. vol. 95, p. 20, pl. 4, fig. 8.

Description.—"Suborbicular, convex, very inequilateral, ventral and anterior margins regularly and nearly equally rounded; posterior end truncated, direct (east)." (Conrad).

Remarks.—Conrad's type has apparently been lost. Whitfield referred two specimens to this species and suggested that it should be placed in the genus *Corbicula*. However, a careful comparison of these specimens with Conrad's description and figure suggests that Whitfield did not have Conrad's species. This opinion was concurred in by Dr. Stephenson, who kindly examined Whitfield's material. It therefore seems desirable to retain the name *Astarte ? annosa* for Conrad's species, which it is hoped will eventually be located. Whitfield's two specimens were given the new name of *Corbicula ? whitfieldi*. (Richards, 1943)

Range in New Jersey—

RARITAN: 4

Type.—Washington (South River), N. J.; lost.

***Opis ? elevata biangulata* Stephenson 1954**

Plate 42, Figure 9

Opis ? elevata binagulata Stephenson, 1954, p. 32, pl. 7, figs. 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." (Stephenson)

Range in New Jersey—

RARITAN: 1b

Type.—Sayreville, N. J.; USNM 108624.

***Eriphyla decemnaria* (Conrad) 1869**

Plate 29, Figure 1

Gouldia decemnaria Conrad, 1869, Am. Jour. Conch., vol. 5, p. 48, pl. 9 fig. 4.

Gouldia decemnaria, Whitfield, 1886, p. 124, pl. 18, fig. 4.

Eriphyla decemnaria, Weller, 1907, p. 551, pl. 60, fig. 9.

Description.—"Shell minute, subquadrangular in outline and but slightly convex. Anterior and cardinal margins nearly at right angles with each other, the posterior and cardinal margins being rounded. Surface marked by very prominent, thickened, concentric ribs, parallel to the border of the valve, and separated by smooth, flattened interspaces. Hinge-structure and other internal characters unknown." (Whitfield.)

Remarks.—Rare and not found in recent collections.

Range in New Jersey—

WOODBURY: 24

Type.—Haddonfield, N. J.; ANSP 18794.

Eriphyla declivis (Conrad) 1869

Plate 29, Figure 4

Gouldia declivis Conrad, 1869, Am. Jour. Conch., vol. 5, p. 48, pl. 9, fig. 5.

Gouldia declivis, Whitfield, 1886, p. 126, pl. 18, fig. 11.

Eriphyla declivis, Weller, 1907, p. 551, pl. 60, fig. 10.

Description.—"Minute, triangular, compressed, equilateral, summit acute; posterior extremity angular, disk with numerous very regular, close concentric lines." (Conrad.)

Remarks.—The type specimen of this species seems to have been lost or destroyed, and no others have been met with in any of the more recent collections. The original specimen was only about 2 mm. or a little less in width. The description given above is Conrad's original definition of the species.

Range in New Jersey—

WOODBURY: 24

Type.—Haddonfield, N. J. Lost.

Eriphyla parilis (Conrad) 1853

Plate 29, Figures 3, 5

Astarte parilis Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 276, pl. 24, fig. 16.

Gouldia parilis, Whitfield, 1886, p. 126, pl. 18, fig. 12.

Eriphyla parilis, Weller, 1907, p. 552, pl. 60, fig. 11.

Description.—"Small, triangular, equilateral, compressed; basal margin regularly rounded; angles of the end margins situated at about equal distances from the apex and base; disk concentrically undulated." (Conrad.)

Remarks.—The above is Conrad's original definition of the species. The type specimen in the collection of the Philadelphia Academy of Sciences is so badly injured that its true characters cannot be recognized. The specimen illustrated by Whitfield as a probable member of the species is only an impression of the anterior portion of a *Trigonia*, probably *T. eufaulensis*. No specimens have been found in any recent collections which can be referred to this species.

Range in New Jersey—

MOUNT LAUREL-NAVESINK: Arneytown

Type.—Arneytown, N. J.; ANSP 18732 (missing).

Vetericardia crenalirata (Conrad) 1860

Plate 31, Figures 6-8

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

Vetericardia crenulirata, Whitfield, 1886, p. 128, pl. 18, figs. 5-7.

Vetericardia crenalirata, Weller, 1907, p. 566, pl. 62, figs. 9-10.

Vetericardia crenalirata, Wade, 1926, p. 78, pl. 24, figs. 12-13.

Description.—"Shell small, not exceeding one-fourth of an inch in length in adult individuals, subtriangular or broadly subelliptical in outline, with very ventricose valves and proportionally large, suberect beaks, which are situated a little in advance of the middle. Surface marked by from 13 to 18 concentric varices, according to the size of the shell, which gradually increase in strength with increased growth of the shell. They become obsolete at the margin of the proportionally large and deeply impressed lunule. Interspaces flattened at the bottom and about as wide as the sharply elevated varices. There are also fine, but distinct elevated radiating lines crossing the ridges and interspaces, becoming much stronger on the spaces than on the ridges. In the interior the muscular imprints are faintly marked and of moderate size, and the margin of the valves is strongly and deeply crenulated by the radiating ridges. Hinge-plate moderately strong and the teeth well marked." (Whitfield.)

Remarks.—Abundant at Haddonfield, N. J. The genus is widespread throughout the Cretaceous of the world.

Range in New Jersey—

MERCHANTVILLE: 15

WOODBURY: 24

Type.—Eufaula, Alabama.

Crassatellites carolinensis Conrad 1875

Plate 30, Figure 12

Crassatella carolinensis Conrad, 1875, in Kerr, Geol. Surv. North Carolina Rept. App. A, p. 6, pl. 2, fig. 24.

Crassatella carolinensis Stephenson, 1923, p. 269, pl. 66, figs. 16, 17.

Description.—"Shell suboval, short, equilateral, compressed with distinct lines of growth; posterior end truncated, nearly direct. This rare species occurs in New Jersey, where I found one valve, and one only at Snow Hill." (Conrad)

Remarks.—Known from New Jersey (Conrad), Delaware and Snow Hill member in North Carolina.

Range in New Jersey— ?

Range outside New Jersey: Delaware, North Carolina.

Type.—New Jersey (?); probably lost.

Crassatellites transversus (Gabb) 1861

Plate 29, Figure 8

Crassatella transversa Gabb, 1861, Proc. Acad. Nat. Sci. Phil., p. 364.*Crassatella transversa*, Whitfield, 1886, p. 122, pl. 17, figs. 16-17.*Crassatellites transversus*, Weller, 1907, p. 555, pl. 61, fig. 5.

Description.—The dimensions of an internal cast are: length, 49 mm.; height, 32 mm.; thickness, 20 mm. Shell very inequilateral, higher in front than behind, the beaks pointed in the internal casts and nearly erect, situated about one-third the length of the shell from the anterior extremity. Anterior margin convex in front, rounding to the hinge-line above and into the basal margin below; basal margin convex anteriorly and concave posteriorly; postero-basal margin sharply rounding into the obliquely subtruncate posterior margin, which rounds into the dorsal margin above. Valves with an umbonal ridge extending in a nearly straight line from the beak obliquely backward to the postero-basal extremity of the shell, becoming more angular posteriorly. The postero-cardinal slope rather narrow, flat, slightly concave or slightly convex. Surface of the shell marked with somewhat regular, rather strong, concentric lines of growth which are less conspicuous back of the umbonal ridge. In internal casts the muscular impressions are conspicuous and of about equal size. Free margin of the shell crenate. (Weller)

Remarks.—The type specimen, is a clean cut internal cast with the muscular impressions strong, and without the markings of the external surface of the shell impressed upon it. The Marlboro specimens, however, agree so closely in their general form, size and proportions with the type specimen, that there can be little or no doubt as to their identity. Conrad's illustration of *C. ripleyanus* has much the form of this *C. transversus*, and it is possible that the two forms may be identical.

Range in New Jersey—

WENONAH: 35

Type.—New Jersey; ANSP 18744.**Crassatellites cuneatus** (Gabb) 1860

Plate 31, Figure 2

Crassatella pteropsis Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 395, pl. 68, fig. 28. (Not *C. pteropsis* Conrad.)*Crassatella cuneata* Gabb, 1861, Synop. Moll. Cret. Form., pp. 168, 169 (112, 113).*Crassatella cuneata*, Whitfield, 1886, p. 118, pl. 17, figs. 18-20.*Crassatellites cuneatus*, Weller, 1907, p. 556, pl. 61, figs. 11-12.

Description.—Shell small, the dimensions of a nearly complete internal cast are: length, 16 mm.; height, 10.5 mm.; thickness, 6.5 mm. Subovate in outline, cuneate behind. Beaks erect, rather prominent, situated about one-third the length of the shell from the anterior extremity. Antero-cardinal margin sloping forward from the beak; anterior margin rounding into the basal margin; basal margin convex in front and straight or slightly concave posteriorly; posterior margin short, truncate; post-cardinal margin long, sloping backward from the beak and meeting the posterior margin at the extremity of the hinge-line in an obtuse angle. An obtusely subangular umbonal ridge passes in a nearly straight or slightly concave line from the beak to the postero-basal extremity; the postero-cardinal slope flat or slightly concave, the cardinal margin inflected. Surface of the shell marked with rather strong, regular, concentric lines of growth. In well preserved internal casts the post-cardinal margin and the truncate posterior margin are not sharply differentiated, the posterior extremity of the shell being rather sharply rounded. The muscular scars prominent in the casts. When the internal casts are well preserved to the margin of the shell, the free margins are finely crenate.

Remarks.—This is a small species and can usually be distinguished by its subcuneate posterior extremity. No specimens preserved in such a manner as to exhibit the hinge-characters have been observed, but there can be little or no question as to its proper generic position. The species occurs most commonly in the Merchantville clay-marl. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 10, 15

WENONAH: 34

Range outside New Jersey: Tennessee.

Type.—Hardeman County, Tenn.; USNM 553.

***Crassatellites prorus* Conrad 1869**

Plate 29, Figure 6; Plate 30, Figures 13, 14

Crassatella prora Conrad, 1869, Am. Jour. Conch., vol. 5, p. 43, pl. 1, fig. 8.

Crassatella prora, Whitfield, 1886, p. 120, pl. 17, figs. 10-11.

Crassatellites prorus, Weller, 1907, p. 558, pl. 61, figs. 6-7.

Description.—“Shell below a medium size, transversely subelliptical when considered exclusive of the projection of the beaks, but transversely broad triangular if they are considered. Valves rather ventricose for the genus; beaks very large, nearly central or a little nearest the anterior end, strongly projecting, and in the cast, the only condition in which it is known, nearly erect and moderately distant. Posterior cardinal margin regularly sloping from the beaks to

the narrowly rounded posterior extremity; anterior side of the beaks excavated and the anterior end more broadly rounded than the opposite end; basal line broadly curved. Umbonal ridge scarcely angular. Surface, as shown on the casts, marked by comparatively strong, regular, concentric ridges, and marked just anterior to the umbonal angle by a proportionally broad sulcation passing from near the beaks to the base. Muscular scars distinct." (Whitfield.)

The dimensions of the type specimen are: length, 22.5 mm.; height, 15 mm.; thickness, 10 mm.

Remarks.—This species has been only rarely met with in recent collections. It is of a rather exceptional form for species of this genus in its subelliptical outline and its nearly central beaks. It is quite different in all its characters so far as they are preserved, from typical members of the genus *Etea* where Conrad has referred it, although the hinge characters have not been observed. It seems better, therefore, to allow it to remain in the genus where it was originally placed, than to transfer it to another. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8

WOODBURY: 20

Type.—Crosswicks, N. J.; ANSP 18739.

Crassatellites hodgei Stephenson

Plate 31, Figures 3, 4

Crassatellites hodgei Stephenson, 1923, p. 271, pl. 67, figs. 4-9.

Crassatellites hodgei, Richards, 1954, p. 2, figs. 1, 2.

Remarks.—Several perfect specimens were found in the well at Fellowship, N. J. Some casts from the Wenonah formation near Marlboro, N. J., identified by Weller as *C. transversus* (Gabb) may also be this species. The South Carolina specimens are from the Snow Hill member of the Black Creek formation.

Range in New Jersey—

WOODBURY: 23, 24a

WENONAH †: 33

Range outside New Jersey: South Carolina, Georgia, Alabama.

Type.—Roods Bend, Chattahoochee River, Ala. USNM 31847.

Crassatellites subplanus (Conrad) 1853

Plate 29, Figures 9, 12, 13

Crassatella subplana Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2nd. ser., vol. 2, p. 274, pl. 24, fig. 9.

Crassatella subplana, Whitfield, 1886, (part) p. 121, pl. 18, figs. 14-16. (Synon. excluded.)

Crassallites subplanus, Weller, 1907, p. 553, (part), (Figs. & synon. excluded.)

Crassatellites subplanus, Gardner, 1916, p. 651.

Description.—The dimensions of a small specimen, a nearly perfect right valve, are: length, 36 mm.; height, 28 mm.; convexity, 6 mm. Large individuals grow to a length of 50 mm. or more. Shell broadly subovate in outline, beak obtuse, situated about one-third the length of the shell from the anterior extremity. Antero-cardinal margin straight or slightly concave, sloping downward from the beak; anterior margin rounding into the basal margin, moderately convex throughout to the postero-basal extremity, which is obtusely subangular; posterior margin short, truncated nearly vertically or slightly inclined; postero-cardinal margin gently convex, sloping downward from the beak and meeting the posterior margin in an obtuse angle. Surface of the shell with an obtusely angular umbonal ridge, which passes from the beak to the postero-basal angle in nearly a straight line, the post-cardinal slope slightly concave to the cardinal margin; the post-cardinal margin sharply inflected to form a rather deeply excavated escutcheon; antero-cardinal margin inflected to form a deep but rather ill-defined lunule. Surface of the shell marked by regular, somewhat imbricating, concentric lines of growth, and often by a few broader concentric undulations towards the margin. Hinge of the right valve with a strong cardinal tooth transversely striate on its anterior surface, directly beneath the beak. Behind it is a very large and broad triangular pit, with a much smaller secondary pit just behind the lower end of the tooth; in front of the cardinal tooth is a small triangular pit about equal in size to the secondary pit behind, and in front of this pit a low, obscure, tooth-like ridge extends obliquely forward to the upper margin of the anterior muscular scar. Muscular impressions strong and about equal in size. Inner margin of the free edge of the shell crenate. (Weller)

Remarks.—This differs from *C. vadosus* Morton in its more compressed valves, less anterior umbones and much lighter shell with the consequent thinner hinge plate and less pronounced posterior keel.

Range in New Jersey—

MARSHALLTOWN: 27, 28

WENONAH: 35

NAVESINK: ?

RED BANK: ?

TINTON: ?

Range outside New Jersey: Maryland.

Type.—Arneytown, N. J. ANSP 18743.

Crassatellites vadosus (Morton) 1834

Plate 29, Figure 10

Crassatella vadosa Morton 1834, Syn. Org. Cret. Gr. U. S., p. 66, pl. 13, fig. 12.

Crassatella vadosa Whitfield, 1886, p. 116, pl. 17, figs. 12-15.

Crassatellites subplanus Weller, 1907, p. 553 (part), pl. 61, figs. 1-2?
Not 3, 4 = *C. linteus*.

Crassatellites vadosus Gardner, 1916, p. 649, pl. 39, figs. 1-4.

Crassatellites vadosus Wade, 1926, p. 79, pl. 35, figs. 6-8.

Description.—Shell of medium size, thick, heavy, rudely trigonal in outline; anterior and lateral margins rounded, posterior more or less produced and truncated, ventral margin approximately horizontal; umbones orthogyrate or turned a little forward, proximate, often thickened, flattened upon their summits, placed back from the anterior margin a distance of one-third the total latitude; lunule broadly lenticular, sharply defined, the portion in the left valve a trifle broader and more feebly striated by the incrementals than that of the right; escutcheon more sharply defined, broader and a trifle larger in the right valve than in the left; posterior area outlined by an obtuse ridge passing from the umbones to the posterior ventral margin; external surface sculptured with low, concentric ridges close set but irregular in arrangement, suggesting an exaggerated incremental sculpture; a few pronounced resting stages, usually developed toward the ventral margin; radial sculpture manifested only in the sharp denticulations on the inner margins; hinge plate very heavy, ligament pit a small scoop-shaped affair, extending obliquely backward from directly beneath the tips of the umbones; cardinals two in number in the left valve, three in the right, the anterior cardinal of the right very thin and laminar, and fused at the base with the dorsal margin, the middle cardinal heavy, trigonal, transversely striated; the posterior cardinal laminar largely effaced by the resilium, originating near the base of the anterior cardinal and diverging from it at an angle of approximately 60°, cardinals of the left valve much more nearly equal than those of the right, the posterior rather thin, just under the umbones where it forms the anterior margin of the ligament pit, but expanding rapidly toward its ventral extremity; left cardinals striated on their inner faces, separated by a deep trigonal pit for the reception of the right anterior cardinal, small sulcus near the base of the left posterior cardinal provided for the laminar posterior cardinal of the right valve: no trace of true laterals developed but the posterior dorsal margin of the right valve and the anterior dorsal margin of left valve bevelled to function as laterals and received in grooves in the opposite valves; muscle impressions subequal, placed near the median horizontal, the anterior more deeply excavated than the posterior, anterior

pedal scar very distinct, set under the hinge plate a little dorsal to the anterior adductor; pallial line entire; inner margins finely crenulated from the ventral extremity of the lunule to the ventral extremity of the escutcheon.

C. vadosus Morton shows a wide range of variation in age characters. The young are thin, rather compressed and truncated but not produced posteriorly; with increasing age the form becomes apparently more inflated because of the umbonal thickening, and obliquely produced posteriorly. (Gardner)

Range in New Jersey—

MT. LAUREL-NAVESINK: 37, 47, 53

TINTON: 63

Range outside New Jersey: Maryland, Alabama, Mississippi.

Type.—Prairie Bluff, Ala.; ANSP 19593.

***Crassatellites linteus* (Conrad) 1860**

Plate 30, Figures 1, 2

Crassatella linteus Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 279, pl. 46, fig. 5.

Crassatella subplana Whitfield, 1886, (part) p. 121, pl. 18, figs. 14-16. (Not of Conrad.)

Crassatellites subplanus Weller, 1907, p. 553, (part) pl. 61, figs. 3-4 (not figs. 1-2 = *C. vadosus*).

Crassatellites linteus Gardner, 1916, p. 653, pl. 39, figs. 6-7.

Crassatellites linteus Wade, 1926, p. 80.

Description.—Shell rather small for the genus and rather thin, compressed, subovate to ovate-trigonal in outline; umbones rising a little above the dorsal margin, their apices acute and prosogyrate, slightly anterior in position; lunule and escutcheon clearly differentiated but very narrow because of the compression of the valves; anterior end broadly and symmetrically rounded in front of the umbones; posterior dorsal margin gently sloping; lateral margin obscurely and obliquely truncate; base line rounding smoothly into the anterior lateral margin, obtusely angulated at the union with the posterior; posterior keel obscure but persistent from the umbones to the posterior ventral margin, better defined by the change in the direction of the growth lines than by any variation in the plane; external surface sculptured with a very-irregular concentric lineation, sharpest and most regular in the umbonal region, and with occasional more or less accentuated growth lines and resting stages; ligament external, lodged beneath the umbones, the resilium buttressed ventrally by the posterior cardinal which it has largely effaced; medial right cardinal stout, trigonal, subumbonal, transversely striated laterally; anterior

cardinal laminar; hinge dentition in left valve restricted to two sub-equal cardinals, the posterior a little the larger, both of them striated upon their inner faces; no trace of laterals developed but anterior margin of left valve and posterior margin of right valve bevelled to function as laterals and received in shallow sockets in the corresponding valve; muscle impressions distinct, impressed in the adults, placed high up at the distal extremities of the hinge; pallial line simple, distinct, rather distant from the base line. (Gardner)

Range in New Jersey—

MARSHALLTOWN: 28

WENONAH: ?

Range outside New Jersey: Delaware, Maryland, Alabama, Tennessee.

Type.—Alabama; ANSP 19594.

***Uddenia conradi* (Whitfield) 1886**

Plate 29, Figure 2

Gouldia conradi Whitfield, 1886, p. 125, pl. 18, figs. 1-3.

Eriphyla conradi, Weller, 1907, p. 550, pl. 60, figs. 4-8.

Crassatellites ? *conradi*, Stephenson, 1923, p. 274, pl. 67, figs. 10-16.

Uddenia conradi, Stephenson, 1941, p. 180.

Description.—"Shell small, the largest specimen observed not exceeding three-sixteenths of an inch in its greatest diameter. Valves subtriangular, approaching a quadrangular outline by the truncation of the posterior extremity, which gives the valves when seen from the exterior much the form and character of a young *Crassatella*, which is also added to by their moderate convexity. Beaks small and pointed. Anterior and posterior sides of the cardinal margin straight, forming a little more than a right angle with each other, the posterior side being nearly one-half longer than the anterior, and the basal line somewhat regularly rounded. Surface of the shell marked by concentric undulations, which are abruptly bent in crossing the umbonal ridge. Posterior umbonal slope flattened. Lunule rather long and narrow. Substance of the shell thin. Ligamental pit of the hinge small in the left valve, and the posterior cardinal tooth-cavity linear and extending nearly the entire length of the cardinal border. In the right valve the pit is larger and the anterior lateral tooth-cavity more strongly marked. Muscular scars and pallial line distinctly marked in the right valve (figured), but much less strongly so in the left one, which is thinner in substance, although a slightly larger valve." (Whitfield.)

Remarks.—Rare; Stephenson has assigned this shell to his genus *Uddenia* and designated it as type species. It more properly belongs in the family Crassatellitidæ instead of Astartidæ as proposed by Weller.

Range in New Jersey—

MERCHANTVILLE: 10, 15

WOODBURY: 19, 24

Range outside New Jersey: North Carolina.*Type.*—Haddonfield, N. J.; ANSP 18735.**Scambula perplana** Conrad 1869

Plate 31, Figure 9

Scambula perplana Conrad, 1869, Am. Jour. Conch., vol. 5, p. 48, pl. 9, figs. 7-8.*Scambula perplana*, Whitfield, 1886, p. 123, pl. 18, figs. 8-10.*Scambula perplana*, Weller, 1907, p. 562, pl. 61, figs. 13-14.*Scambula perplana*, Wade, 1926, p. 82, pl. 25, figs. 11, 12, 15, 16.*Scambula perplana*, Stephenson, 1942, p. 183, pl. 26, figs. 11-12.

Description.—"Shell small, triangularly ovate, very transverse, with very sharp, pointed, and recurved beaks, situated just within the middle third of the length of the shell and nearest to the anterior end. Valves flat, marked by fine concentric lines of growth and a few (three or four) broad, oblique undulations of the surface which pass from the posterior hinge-line forward to the basal margin. There are also a few obliquely concentric wrinkles on the antero-cardinal margin which extend only a short distance over the disk of the valve. Along the position of the posterior umbonal ridge, the surface striæ are abruptly deflected upward, marking the position of the ridge and defining the posterior slope of the valve. Posterior end of the valve narrow and truncate; anterior end obtusely angular; basal margin regularly and broadly arcuate. Inner margin of the valves crenulate; muscular scars small and faintly marked." (Whitfield.)

Remarks.—The Lorillard specimens are for the most part fragmentary but are usually larger than those from Haddonfield, one specimen having a length of 25 mm; also the broad, oblique undulations are more conspicuous. The Marlboro specimens do not grow larger than those from Haddonfield and seem to lack entirely the oblique undulations.

Range in New Jersey—

WOODBURY: 18, 24

WENONAH: 35

Range outside New Jersey: Georgia, Mississippi, Tennessee, Alabama, Texas.*Type.*—Haddonfield, N. J. ANSP 18740.

Family Corbiculidae

Corbicula ? whitfieldi Richards 1943

Plate 43, Figures 2, 10

Corbicula annosa Whitfield, 1886, p. 26, pl. 2, figs. 2-4. (not *Astarte annosa* Conrad 1869).

Corbicula annosa, Weller, 1907, p. 563, pl. 62, figs. 1-3.

Corbicula ? whitfieldi, Richards, 1943, Proc. Acad. Nat. Sci. Phila. vol. 95, p. 20, pl. 5, figs. 2-10.

Description.—"I have before me two specimens which I have referred to this species. They are both somewhat distorted by compression and retain but little of the substance of the original shell, other than the epidermis, which has been very strong, and a ferruginous replacement of the ligament. The specimens are both very ventricose, with a somewhat subquadrangular outline and a moderately angular umbonal ridge. The beaks are small and nearly anterior, hinge line short and oblique, with a small ligament. Anterior end short and rounded, while the posterior is broadly truncated, corresponding to the rather broad and abrupt postero-cardinal slope. If I have rightly identified the species, there can be no reason for referring it to *Astarte* in the light afforded by the two specimens, but every appearance would indicate their relations to the genus *Corbicula*, with which I have placed it." (Whitfield.)

Remarks.—This is the species designated to take care of the specimens erroneously referred by Whitfield to *Astarte annosa* Conrad. Little can be added to the description given by Whitfield, although the position of the species in the genus *Corbicula* is open to question.

Range in New Jersey—

RARITAN: 4

Type.—Sayreville, N. J. NJSM 7792.

Corbicula ? emacerata Whitfield 1886

Plate 43, Figure 3

Corbicula ? emacerata Whitfield, 1886, p. 26, pl. 2, figs. 5-6.

Corbicula ? emacerata, Weller, 1907, p. 564, pl. 62, figs. 4-5.

Corbicula ? emacerata, Richards, 1943, Proc. Acad. Nat. Sci. Phila. vol. 95, p. 20, pl. 5, fig. 3.

Description.—"Shell of rather small size, transversely elliptical or subovate in outline, and moderately ventricose. Beaks moderately large but not prominently so, and situated at about the anterior fourth of the length of the shell. Anterior end of the shell the highest, the anterior margin narrowly rounded; basal line strongly curved and the

posterior end narrow and obliquely truncate, the cardinal portion rapidly sloping with a slight curvature to the extremity of the moderately sized ligament; hinge line short and oblique to the axis of the shell. Umbonal angle distinct but not marked, and the cardinal slope narrow and rather abrupt. Surface marked only by fine concentric striæ, which appear to have been confined principally to the epidermal layer." (Whitfield.)

Remarks.—Known only from a few specimens obtained by early collectors. The position of the species in the genus *Corbicula* is open to serious question, but in view of the poor preservation it is impossible to determine the correct genus.

Range in New Jersey—

RARITAN: 1, 2

Type.—Woodbridge, N. J. ANSP 7719; Cotype ANSP 15668.

Family Diceratidae

***Diceras dactyloides* Whitfield 1886**

Plate 30, Figure 3

Diceras dactyloides Whitfield, 1886, p. 131, pl. 18, figs. 26-27.

Diceras dactyloides, Weller, 1907, p. 567, pl. 62, figs. 11-12.

Description.—"A cast of a single valve of what appears to be without question a *Diceras* occurs in the collection. It is rather slender in its proportions, and makes nearly two-thirds of a revolution in its curvature, and is apparently a cast of a left valve, judging from the curvature of the beak. The muscular scar is very large, and has been deeply impressed in the shell, as the scar is considerably raised on the cast and is nearly half as long as the cast itself. On its front margin there is the filling of a deep groove, which is longitudinally marked with lamellose striæ, from the edges of the shell lamellæ; and on the opposite side of the cast occurs a flattened surface from the thickening of the shell below the hinge-tooth, probably.

The striations on the filling of the groove bordering the muscular imprint would lead one to suspect the cast might be of a valve of *Caprina*, but their lamellose character somewhat denies this reference, and the general character of the specimen would rather indicate a *Diceras*. The specimen is quite obscure, besides being the only one known, and consequently affords almost no means of comparison with previously described species. It, however, appears much more slender in its proportions than the species known from Texas and other southern localities, as well as more strongly enrolled." (Whitfield.)

Remarks.—Rare and only known from the type specimen.

Range in New Jersey—

MT. LAUREL-NAVESINK: 46

Type.—Walnford, N. J. NJSM 7579

Family Caprinidae

Caprotina jerseyensis Weller 1907

Plate 30, Figure 4

Caprotina jerseyensis Weller, 1907, p. 568, pl. 62, figs. 13-15.

Description.—The type specimen with a maximum length of 21.5 mm., a width of 13 mm., and a depth of 15 mm. Beaks curving to the left. Lower valve much deeper than the upper, attached by nearly one-half its entire surface, the beak projecting far beyond that of the upper valve. Upper valve moderately convex. The shell substance is preserved only on a portion of the upper valve where the surface markings are seen to be very narrow but rather highly elevated, sharp, radiating costæ, the interspaces being twice as wide as the ribs; the radiating markings are crossed by very fine concentric lines of growth. On the internal cast both the radiating and concentric markings are faintly impressed.

Remarks.—This species is founded upon a single individual preserving both valves. It is for the most part a cast of the interior of the shell, but a portion of the shell itself is preserved upon the upper valve, and sufficient fragments of the shell are still preserved upon the lower valve to show that the surface markings were essentially the same on both. The specimen is nearly complete, the beak only of the lower valve being injured. The species should be compared with *Caprotina cenomanensis* d'Orbigny, from the Upper Cretaceous of France. (Weller)

Range in New Jersey—

NAVESINK: 40

Type.—Crawfords Corner, N. J. NJSM 7547.

Family Unicardiidae

Unicardium umbonata (Whitfield) 1886

Plate 30, Figure 5

Sphaeriola umbonata Whitfield, 1886, p. 152, pl. 19, figs. 17-18.

Unicardium umbonata, Weller, 1907, p. 569, pl. 62, figs. 16-17.

Unicardium umbonata, Groot, Organist and Richards, 1954, p. 46, pl. 5, fig. 9.

Description.—The dimensions of a large left valve are: length, 57 mm.; height, 54 mm.; convexity, 18.5 mm. Shell very thin, sub-

circular or slightly subquadrangular in outline. Cardinal margin arcuate, edentulous; anterior margin broadly rounded, its most anterior point being at or below the middle, rounding below into the basal margin; basal margin curving upward at each end, straighter in the middle; posterior margin usually a little shorter than the anterior, regularly rounded or some times a little straightened in the middle. Beaks strongly incurved, pointing forward, situated at the middle or a little back of the middle of the cardinal margin; umbones prominent, much elevated above the hinge-line. Valves strongly convex or ventricose, the anterior slope somewhat more abrupt than the posterior, slightly compressed towards the cardinal extremities. Surface of the shell marked only by concentric lines of growth which are more or less irregular in the strength of their development.

Remarks.—This species was described by Whitfield from a very imperfect cast of the interior, and was referred to the genus *Sphaeriola* without any knowledge of the hinge characters. In later collections of the Survey specimens preserving the shell have been secured from the Marshalltown clay-marl near Swedesboro, and from these it has been learned that the hinge is edentulous, a character which prohibits its reference to the genus *Sphaeriola*. The hinge characters, as well as the general form and characters of the shell, seem to agree in all essential respects with members of the genus *Unicardium*. (Weller)

Range in New Jersey—

MARSHALLTOWN: 28

MT. LAUREL-NAVESINK: 37, 48

Range outside New Jersey: Delaware.

Type.—New Jersey; ANSP 18748.

Family Lucinidae

Lucina glebula Conrad 1875

Plate 30, Figures 7-9

?.....Conrad, 1869, Amer. Jour. Conch., vol. 5, pl. 9, fig. 14. (Figure without name or description; questionably this species.)

Lucina glebula Conrad, 1875, Geol. Surv. N.C. Rept., vol. 1, (by W. C. Kerr), App. A, p. 7, pl. 1, fig. 18.

Lucina cretacea, Weller, 1907, p. 570, pl. 62, fig. 18.

Lucina glebula, Stephenson, 1923, p. 279, pl. 69, figs. 4-6.

Description.—“Shell broadly subelliptical in outline, equivalve, slightly inequilateral, depressed convex. Beaks low, incurved, approximate, slightly prosogyrate, situated a little in advance of the

midlength. Umbonal ridge depressed, moderately defined, slightly arched in its trend, extending from the beak to the lower posterior extremity. Back of and above the umbonal ridge is a depressed area extending from the beak to the posterior margin, becoming wider posteriorly. Dimensions of the type (?) specimen: Length 31 mm., height 26 mm., convexity 7 mm.

Hinge of right valve with one pseudo-cardinal tooth directed downward and a little backward, in front of the lower end of which is a small pit, and back of which is a broad, oblique, triangular depression. Anterior lateral tooth obsolete; back of the triangular depression is a nearly horizontal, moderately strong nymph, bordered above by the shallow ligamental groove which is rather deeply submerged below the margin. As the hinge of the left valve has corresponding and not alternate prominences and depressions, these features can scarcely be termed teeth and sockets. Linule small and short.

Anterior adductor scar long, relatively narrow, the lower two-fifths of its length separated from the pallial line by a profound sulcus-like indentation; posterior adductor not clearly distinguishable. Pallial line simple. Inner margin finely crenulated on well preserved specimens.

Dorsal margin long, slightly arched back of the beak, slightly concave on front of the beak. Anterior margin truncated above, passing below by a broad, subobtuse angle into the rather broadly and nearly regularly rounded ventral margin; posterior margin truncated and a little concave above the extremity.

Surface of well preserved specimens marked by concentric, somewhat irregularly spaced, prominent, thin lamellae, which curl downward and touch the surface below, forming round, crested, hollow ridges. The interspaces are nearly flat and are marked only by fine growth lines. On the type (?) specimen the prominent down-curling lamellae have been broken or worn away." (Stephenson.)

Remarks.—Conrad labeled a specimen *Lucina cretacea*; however, this name was preoccupied. He apparently later described the species under the name *L. glebula*. The New Jersey specimens are a little smaller than those from North Carolina.

Range in New Jersey—

WOODBURY

Range outside New Jersey: Georgia, North Carolina, Alabama, Arkansas

Type.—Snow Hill, N. C.; USNM 31933.

Lucina swedesboroensis Weller 1907

Plate 30, Figures 10, 11

Lucina swedesboroensis Weller, 1907, p. 571, pl. 62, figs. 19-21.

Description.—The dimensions of a small but nearly perfect individual are: height, 13.5 mm.; length, 14 mm.; thickness, 6 mm. The dimensions of another left valve are: height, 14.5 mm.; length, 16 mm. The larger individuals sometimes attain a height of 20 mm. Shell subcircular, varying from a little higher than long to slightly longer than high. Beaks small, pointing forward. Valves depressed convex with a very obscure arcuate umbonal prominence extending from the beak obliquely to the postero-basal margin; post-cardinal margin sharply inflected to form a narrow and deep escutcheon; in front of the beaks the margin is sharply inflected to form a small but profound lunule. Surface of the shell marked by rather fine, more or less irregular concentric lines of growth. Hinge-line arcuate; hinge of the left valve with a large, triangular cardinal tooth beneath the beak, and another obscure one directed obliquely backward, in front of the beaks is a single lateral tooth beneath the lunule and close to the shell margin, back of the beak and remote from it, extending nearly to the posterior extremity of the hinge-line, is a low, elongate, posterior cardinal tooth. (Weller)

Remarks.—Rare

Range in New Jersey—

MARSHALLTOWN: 28

Type.—Swedesboro, N. J. NJSM 9654.

Lucina parva Stephenson 1923

Plate 31, Figures 10, 11

Lucina parva Stephenson, 1923, p. 281, pl. 69, figs. 7-10.

Description.—“Shell small, equivalve, subequilateral, subcircular broadly subovate in outline, depressed convex. Beaks small, very slightly prominent, approximate, incurved slightly prosogyrate, situated slightly back of the midlength. Umbonal ridge represented by a very slight inflation; back of and above the umbonal inflation is a slightly compressed area extending radially from the beak to the posterior extremity. Approximate dimensions of the type, a right valve: length 7.5 mm., height 7 mm., convexity 1.5 mm. Lunule short and deeply impressed.

Hinge of right valve with one large triangular, slightly bifid cardinal tooth, in front of which is a rather narrow, deep, nearly vertical socket, and back of which is an oblique socket with a very low posterior wall. Slightly in advance of the short, deeply impressed lunule is a short, prominent, anterior lateral tooth; more distant than the anterior lateral tooth is a still shorter, thin, prominent, posterior lateral tooth. Ligamental groove long, partly submerged, moderately impressed, bordered below by a low nymph. Left valve with a deep, triangular, cardinal socket in front of which is a nearly vertical

prominent cardinal tooth, and back of which is an oblique low cardinal tooth. A pair of distant, short, anterior lateral teeth separated by a deep socket and a similar pair of more distant, posterior laterals and socket accommodate the laterals of the right valve.

Anterior adductor scar long, narrow, the lower half separated from and diverging rather widely from the pallial line; posterior adductor scar small, subelliptical. Pallial line simple. Beginning about half-way between the posterior adductor scar and the apex a narrow muscle scar extends obliquely downward and forward nearly to the lower end of the anterior adductor scar. The remaining inner surface is granulated. Inner margin faintly and finely crenulated.

The margins of the shell form a broad subellipse with a slight, nearly vertical posterior subtruncation. Surface marked by concentric, somewhat irregularly spaced, narrow, distinct ridges, which in general become more widely spaced away from the umbonal portion of the shell." (Stephenson.)

Remarks.—The only New Jersey specimens are some from a well at Mount Laurel found associated with *L. glebula*. They were identified by Dr. Stephenson.

Range in New Jersey—

WOODBURY: 22

Range outside New Jersey: North Carolina.

Type.—Snow Hill, N. C. USNM 31757.

Lucina sp.

Plate 30, Figure 6

One specimen found with the type lot of *Lucina cretacea* Conrad (= *L. glebula* Stephenson) may not be that species, but is too poorly preserved for positive identification.

Figured specimen.—Haddonfield, N. J. (WOODBURY); ANSP 18749a.

Family Cardiidae

Cardium wenonah Weller 1907

Plate 32, Figure 1

Cardium wenonah Weller, 1907, p. 576, pl. 63, figs. 14-16 (not figs. 10-13. = *C. welleri* Stephenson, 1941.)

Description.—The dimensions of an average right valve are: height, 12 mm.; width, 12 mm.; convexity, 4 mm. Large individuals rarely attain a height of nearly 20 mm. Shell, exclusive of the projecting beaks, subrhomboidal in outline. Hinge-line nearly straight; anterior margin rounded, most convex above the middle, curving

rather abruptly below into the gently convex basal margin which is subparallel with the hinge-margin; postero-basal margin abruptly rounded; posterior margin gently convex, slightly oblique, straighter than the anterior margin. Beaks small, pointed, incurved, situated at about the middle of the hinge-line and but little elevated above it. Along a line extending from the beak obliquely backward to the postero-basal extremity, is a rounded umbonal prominence, but the most prominent portion of the valve is usually in front of this line near the center of the shell; the posterior slope from the umbonal prominence is rather abrupt, nearly flat or slightly concave, the valves becoming somewhat compressed towards the cardinal extremity; in front the surface curves gently upward to the center of the valve, then downward, becoming a little more abrupt as it approaches the anterior margin. Muscular impressions inconspicuous. Lateral teeth of the hinge strong, nearly horizontal in position, the anterior one sloping downward a little more than the posterior; cardinal teeth not clear in the specimens. Free margins of the valves crenate. Surface of the shell marked by about 30 squarish, flat-topped, radiating costæ, about as wide or a little wider than the interspaces. In the condition in which the type specimens are preserved, these costæ are impressed upon the surface of the casts from the margins to the beaks, but are rounder on top than on the outside of the shell. (Weller)

Remarks.—Weller described this species from Marlboro, N. J., and stated that it was also present at Corsicana, Texas, with the shells perfectly preserved. Stephenson (1941 p. 196) points out "although the New Jersey species exhibits a superficial resemblance in outline and in the number and character of the ribs, the types from the Wenonah sand near Marlboro do not seem to possess the characteristic internal pits, and this, together with the fact that they occupy a stratigraphically lower position, seem to justify separating them from the Texas species." Stephenson therefore described the Texas specimens as *C. welleri*.

Range in New Jersey—

WENONAH: 35

RED BANK: 60

Type.—Marlboro, N. J.; NJSM 7676; Univ. Chicago 18066 (cotypes).

***Cardium eufaulensis* Conrad 1860**

Plate 33, Figures 1, 6, 7

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

Cardium eufaulensis, Weller, 1907, p. 577, pl. 63, figs. 17-20.

Cardium eufaulensis, Gardner, 1916, p. 664, pl. 40, figs. 1-2 (Not *C. eufaulensis*, Whitfield, 1886, p. 132, pl. 20, fig. 17 = *C. whitfieldi* Weller; 18, 19 = *C. tenuistriatum* Whitfield.)

Description.—The dimensions of the internal cast of a left valve are: height, 26.5 mm.; width, 21.5 mm.; convexity, 9 mm. Shell obliquely ovate in outline. Hinge-line arcuate; anterior and basal margins rounding regularly with slightly decreasing curvature from the anterior cardinal extremity to the postero-basal extremity; postero-basal margin rounded; posterior margin gently convex or nearly straight, always straighter than the anterior margin. Beaks small, acute, incurved, only a little elevated above the hinge-line. Valves strongly convex, with a rounded umbonal prominence passing obliquely backward from the beak to the poster-basal extremity; posterior slope short, abrupt, nearly flat or sometimes slightly concave; anterior slope much longer, convex, becoming a little more abrupt anteriorly. Muscular impressions inconspicuous on the casts, the inner free margins of the valves crenate, surface of the casts sometimes smooth, sometimes showing impressions of the radiating ribs half way to the beak from the margin. Outer surface of the valves marked by from 35 to 40 angular, radiating costæ, where the shell is exfoliated these ribs appear to be hollow or tubular and their position is indicated by depressed furrows instead of elevations.

Remarks.—The specimens which have been identified as *C. eufaulensis* in the present report, agree closely with Conrad's original description and illustration, and agree with authentic specimens from the South. They have been recognized only in the Wenonah and Navesink formations where they are associated with *C. longstreeti*, but differ from that species in being more elongate and relatively narrower, and more regularly oval in outline without the subangular postero-basal extremity. The radiating ribs of the two species are also very different, those of *C. eufaulensis* being broader, less abruptly elevated from the interspaces, and lacking the small nodes upon their summits. The specimens observed vary somewhat in outline, some individuals being relatively lower and broader than the one whose dimensions are given. (Weller)

Range in New Jersey—

WOODBURY: 22, 23

MT. LAUREL-NAVESINK: 53

Range outside New Jersey: Delaware, Maryland, D. C., North Carolina?, South Carolina?, Georgia, Alabama, Mississippi.

Type.—Eufaula, Ala.; ANSP 19597—internal cast of type.

***Cardium longstreeti* Weller 1907**

Plate 32, Figures 2, 12

Cardium longstreeti Weller, 1907, p. 579, pl. 63, figs. 21-22.

- ?*Cardium longstreeti*, Stephenson, 1923, p. 289, pl. 71, figs. 4-8.
Cardium longstreeti, Stephenson, 1936, Bull. Geol. Soc. Amer. Vol. 47, p. 377, pl. 2, fig. 1.
Cardium cf. longstreeti, Groot, Organist and Richards, 1954, p. 47, pl. 5, fig. 7.

Description.—The dimensions of the internal cast of a left valve are: height, 33 mm.; width, 31 mm.; convexity, 10 mm. Shell obliquely subovate in outline. Hinge-line arcuate; antero-cardinal margin nearly straight, sloping downward from the beak to the anterior hinge extremity, curving below without break into the anterior margin; anterior and basal margins rounding with a regular, slightly decreasing curvature from the anterior hinge-extremity to the postero-basal extremity; postero-basal extremity subangular, situated considerably above the base of the shell; posterior margin obliquely truncate, rounding above to the posterior hinge-extremity. Beaks small, acute, incurved moderately elevated above the hinge-line, pointing slightly backward at their tips. Valves with an umbonal prominence passing obliquely from the beak to the postero-basal extremity, in the casts it is subangular, but in the shell itself more rounded; the most prominent portion of the shell lies in front of this umbonal ridge; posterior slope narrow, somewhat flattened or concave; anterior slope gently convex across the middle of the shell, becoming more abrupt towards the anterior margin. The inner free margins of the shell strongly crenate, and the radiating ribs present upon the internal casts half way or more to the beaks. Muscular impressions inconspicuous upon the casts. Surface of the shell marked by about 38 rather high, angular ribs with small, more or less distant nodes along their summits; these ribs grow regularly larger in passing from the anterior cardinal extremity to the postero-basal angle, those upon the posterior slope are notably thinner and more sharply angular than those upon the central and anterior portion of the shell, and one, about the second or third from the postero-cardinal extremity, is much higher and more conspicuous than the others. (Weller)

Remarks.—Stephenson questionably refers some specimens from the Snow Hill member of the Black Creek formation to this species.

Range in New Jersey—

WENONAH: 34

Range outside New Jersey: Delaware (?), North Carolina (?), Georges Bank.

Type.—Crawford's Corner, N. J.; NJSM 7673.

***Cardium whitfieldi* Weller 1907**

Plate 32, Figure 3

Cardium eufaulensis, Whitfield, 1886, p. 132, pl. 20, fig. 17 (not figs.)

18-19). (Not *C. eufaulensis* Conrad = *C. tenuistriatum* Whitfield), *Cardium whitfieldi*, Weller, 1907, p. 580, pl. 64, fig. 8.

Description.—The dimensions of an internal cast are: height, 58 mm.; width, 55 mm.; thickness, 38 mm. Shell subcircular in outline; hinge-line nearly straight; anterior and basal margins curving with a regular, slightly decreasing curvature from the anterior hinge extremity to the postero-basal region; postero-basal extremity a little more sharply rounded; posterior margin convex, a little straighter than the anterior. Beaks, in the cast, rather small, nearly erect, acute, incurved, but little elevated above the hinge-line. Valves moderately convex, their greatest prominence along an oblique line from the beak to the postero-basal extremity, the umbonal prominence not at all angular; anterior slope long and gently convex, becoming somewhat compressed towards the cardinal extremity; posterior slope shorter and more abrupt, compressed towards the cardinal extremity, but less so than the anterior. Muscular impressions on the cast inconspicuous, the posterior one much the larger. Lateral hinge-teeth large and strong, horizontal in position, the anterior and posterior ones about equidistant from the beaks; cardinal hinge-teeth moderately strong. Inner free margins of the valves strongly crenate all around. Surface of the shell marked by about 60 to 64 radiating ribs which are impressed upon the casts up to the umbonal region.

Remarks.—Whitfield's figure 17 of his *Cardium eufaulensis* is possibly a representative of this species, but it is proportionately somewhat narrower than any of the specimens which have been observed. The species differs from *C. eufaulensis* in its more nearly circular form, its straighter and practically horizontal hinge-line, and its much larger number of costæ. It is also much larger than the original illustration of that species. (Weller)

Range in New Jersey—

WOODBURY: 18

Type.—Lorillard, N. J.; NJSM 9621.

***Cardium cliffwoodensis* Weller 1907**

Plate 33, Figure 2

Cardium cliffwoodensis Weller 1907, p. 581, pl. 64, figs. 1-4.

Description.—The dimensions of the internal casts of two valves, the larger a right and the smaller a left valve, are: height, 25 mm. and 18 mm.; width, 25 mm. and 18 mm.; convexity, 7 mm. and 6 mm. Shell obliquely subovate in outline; hinge-line arcuate; the anterior and basal margins from the anterior cardinal extremity to the postero-basal extremity, describe a nearly regular semicircle; postero-basal margin more sharply rounded; posterior margin gently convex, straighter than the anterior margin. Beaks situated near the middle

of the hinge-line, small, acute, slightly elevated above the hinge-line in the internal casts. Valves only moderately convex; anterior slope long and regularly convex; posterior slope much shorter, more abrupt, slightly flattened. Muscular impressions on the casts inconspicuous. Lateral hinge-teeth strong, sloping slightly downward from the beak on each side; characters of the cardinal teeth not clear in the casts. Inner free margin of the shell strongly crenate. Surface of the shell marked by about 35 or 40, squarish, flat-topped, radiating costæ, slightly wider than the interspaces, and by fine concentric lines which are stronger upon the tops of the radiating costæ. (Weller)

Range in New Jersey—

MAGOTHY: 5

Type.—Cliffwood Point, N. J. NJSM 7777.

***Cardium lorillardensis* Weller 1907**

Plate 33, Figure 3

Cardium lorillardensis Weller, 1907, p. 582, pl. 64, figs. 5-6.

Description.—The dimensions of the internal cast of a left valve are: height, 30 mm.; width, 25 mm.; convexity, 10 mm. Shell oblique, subovate to subrhomboidal in outline. Hinge-line nearly straight; anterior and basal margins curving with a gradually decreasing curvature from the anterior cardinal extremity nearly to the postero-basal extremity; postero-basal extremity more sharply rounded; posterior margin obliquely truncate, a little convex above and below, straight or nearly straight in the middle. Beaks situated at about the middle of the hinge-line, prominent, elevated above the hinge-line, acute, incurved, pointing anteriorly. Valves with a subangular umbonal prominence or ridge extending from the beak obliquely backward to the postero-basal extremity; anterior slope long and nearly regularly convex, posterior slope abrupt, usually a little concave. Surface of shell marked by about 40 or 45 angular radiating costæ a little narrower than the intervening furrows, and by very fine, concentric, sublamellose lines which are much more conspicuous upon the anterior faces of the radiating costæ. (Weller)

Remarks.—This species can be easily distinguished from any other member of the genus in the New Jersey Cretaceous faunas, by reason of its subangular umbonal ridge, its obliquely truncate posterior margin, and by the peculiarity of the fine, concentric, sublamellose lines upon the surface being much more conspicuous upon the anterior faces of the costæ.

Range in New Jersey—

WOODBURY: 18, 24

Type.—Lorillard, N. J. NJSM 7721.

Cardium ripleyanum Conrad 1869

Plate 32, Figure 4

Cardium ripleyanum Conrad, 1869, Am. Jour. Conch., vol. 5, p. 96, pl. 9, fig. 6.

Cardium ripleyanum, Whitfield, 1886, p. 132, pl. 20, fig. 14.

Cardium ripleyanum, Weller, 1907, p. 582, pl. 65, figs. 4-6.

Description.—The dimensions of an internal cast are: height, 4.5 mm.; width, 4 mm.; thickness, 3 mm. The height of one of the largest individuals observed is 5.3 mm. Shell subcircular in outline, slightly higher than wide, cordate in end view. Hinge-line relatively long, a little arched; anterior, basal, and posterior margins rounded. Beaks rather prominent, elevated above the hinge-line, incurved. Umbones prominent, the surface sloping rather abruptly both in front and behind; shell compressed towards the cardinal extremities, more so behind than in front. Surface of the shell marked with about 22 sub-angular, radiating ribs, slightly narrower than the interspaces, also, by fine, concentric, sublammellose lines.

Remarks.—This little species is not an uncommon member of the Woodbury clay fauna, being less common in the Cliffwood and Merchantville. It was originally described from the Woodbury clay formation near Haddonfield. (Weller)

Range in New Jersey—

MAGOTHY: 5, 6

MERCHANTVILLE: 10, 15, 16

WOODBURY: 18, 19, 24

Type.—Haddonfield, N. J.; ANSP 18794.

Cardium spillmani Conrad 1858

Plate 32, Figures 5, 6

Cardium spillmani Conrad, 1858, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 326, pl. 34, fig. 3.

Cardium (Protocardium) perelongatum Whitfield, 1886, p. 136, pl. 20, figs. 20-21; pl. 21, figs. 4-5.

Pachycardium burlingtonense Whitfield, 1886, p. 138, pl. 21, figs. 6-7.

Cardium spillmani, Weller, 1907, p. 583, pl. 64, figs. 9-11.

Cardium spillmani, Gardner, 1916, p. 666.

Cardium spillmani, Stephenson, 1923, p. 298, pl. 73, figs. 3-5.

Cardium spillmani, Groot, Organist and Richards, 1954, p. 47.

Description.—The dimensions of a nearly perfect internal cast are: height, 87 mm.; width, 55 mm.; thickness, 60 mm. Shell more or less narrowly subovate in lateral view, and cordate in end view. Hinge-

line rather short, arched, extending further downward in front than behind; anterior margin convex, the curvature becoming greater below; basal margin regularly rounded; posterior margin longer and straighter than the anterior, usually slightly convex, sometimes straight or slightly sinuate in the casts a little above the middle. Beaks situated back of the middle of the hinge-line, strongly elevated above it in the casts, pointed, incurved, and distinctly curved forward. Umbones prominent, the most prominent portion of the shell being in an oblique line from the beaks to the postero-basal margin, this umbonal prominence being not at all angular. The posterior slope much more abrupt than the anterior, its surface conspicuously impressed above the middle of the shell about half way between the top of the umbonal prominence and the posterior cardinal extremity. Muscular impressions large, the anterior ones deeply impressed, the posterior ones scarcely or not at all differentiated from the surface of the casts. The left valve with two strong cardinal teeth beneath the beak with a pit between, right valve with a single cardinal tooth; anterior lateral teeth more remote from the cardinal teeth than the posterior ones, and also apparently much stronger. Inner free margin of the valves crenate along the posterior margin, smooth along the basal and anterior margins. Surface of the shell marked by radiating ribs upon the posterior slope, which, in the internal casts at least, continue only from the margin up to the umbonal prominence; central and anterior portions of the shell marked by concentric lines of growth only.

Remarks.—Both of the species described by Whitfield from New Jersey as *Cardium perelongatum* and *Pachycardium burlingtonense*, are certainly internal casts of the shell described by Conrad from Mississippi as *Cardium spillmani*, the example to which the last of the two names was applied being an exceptionally broad specimen. The species is for the most part restricted to the Navesink marl, where it attains its maximum size. The specimens which have been rarely noticed in the Merchantville clay are usually small, although Whitfield's *P. burlingtonense* is a very large example. The internal casts, in which condition the species usually occurs, have some resemblance to those of the species described in this report as *C. kummeli*, but they are usually larger than that species, the beaks have more of a forward curvature, the anterior portion of the hinge-line is longer and extends further down towards the base of the shell, the anterior muscular impressions are lower in position, and the shell is radiately ribbed posteriorly. When the shell itself, with its external markings is preserved, it is not possible to confuse the two species. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 13

MT. LAUREL-NAVESINK: 37, 45, 46, 47, 49

Range outside New Jersey: Delaware, Maryland, North Carolina,

South Carolina, Georgia, Alabama, Mississippi, Arkansas, Texas.

Type.—(*C. spillmani*), Tippah County, Mississippi
(*C. burlingtonensis*) Near Burlington, N. J. ANSP 18751
(*C. perelongatum*) New Jersey; ANSP 19372.

***Cardium kümmeli* Weller 1907**

Plate 33, Figure 4

Cardium kümmeli Weller, 1907, p. 585, pl. 66, figs. 1-3.

Cardium kümmeli, Gardner, 1916, p. 673.

Cardium kümmeli, Wade, 1926, p. 85, pl. 26, figs. 5-6.

Description.—The dimensions of a rather small internal cast of a right valve are: height, 45 mm.; width, 34mm.; convexity, 17.5 mm. Large individuals sometimes attain a height of 70 mm. or more. Shell subovate in lateral view, cordate in end view. Beaks of the internal casts greatly elevated above the hinge-line, pointed and incurved. Hinge-line arcuate; anterior margin regularly rounded from the extremity of the hinge-line to the middle of the basal margin; postero-basal margin a little more sharply rounded; posterior margin convex, a little straighter than the anterior. Valves strongly convex or gibbous, most prominent, but not at all angular, along an oblique line from the beaks to the postero-basal extremity, the posterior slope more abrupt than the anterior. Muscular impressions large, the anterior ones deeply impressed above, the posterior ones scarcely differentiated from the general surface of the casts. Hinge characters not seen. Inner free margins of the valves apparently not crenate. Shell substance thick, rugose externally. The surface markings consist of strongly elevated, rounded, radiating costae, narrower than the interspaces; on a specimen about 55 mm. in length, the distance between these ribs from center to center at the middle portion of the shell margin, is about 2 mm. or a little less. Each third interspace is occupied by a row of strong and thick spines rising one or two millimeters above the tops of the costae when complete, subcircular in cross-section, their bases occupying the entire width of the furrow, the space between successive spines being about equal to the thickness of the spines themselves; in some cases the bases of the spines are thickened longitudinally so that they occupy essentially the entire furrow, in which case the two bounding costae with the row of spines rising from the intervening furrow, appear to form altogether, one broad rib supporting a row of strong spines. The two furrows intervening between the rows of strong spines are each occupied by a row of very much smaller, laterally compressed spines whose bases are more or less connected.

Remarks.—There is considerable variation shown in the surface markings of different individuals of this species, and the extremes might be taken as the representatives of distinct species or even of

distinct subgenera. In its typical form as seen in the Tinton beds, the species exhibits clearly the characteristics of the subgenus *Criocardium*, the rows of spines rising from the interspaces between the radiating costæ of the shell. In some specimens the bases of the larger spines or nodes are confluent and appear to entirely fill the interspace occupied by them, so that the two bounding costæ with the row of spines together seem to constitute a single broad rib crowned with a row of strong nodes. At the same time the rows of secondary nodes are sometimes confluent at their bases and form a continuous secondary rib, perhaps nodose on top, and about equaling in height and size the primary costæ, so that there seem to be three costæ of nearly equal size in the broad interspace between the rows of large nodes and their included bounding costæ. In the extreme development of the rows of secondary nodes their bases are confluent and they increase in size and height so as to occupy the whole of the interspaces, obliterating entirely the primary costæ, so that the surface of the shell is apparently marked by radiating rows of tubercles which apparently do not rise from interspaces between costæ, but directly from the surface, each third row being much larger and stronger than the two intervening ones.

It is possible that larger collections of more perfectly preserved material than this is now available, would show that more than one species has been included under this head, but so far as can be determined from present collections, all these forms seem to run together. The typical form of the species, however, is that in which the nodes rise distinctly from the interspaces, showing the characters clearly of the subgenus *Criocardium*, and which has been recognized only in the Tinton beds.

In its somewhat elongate and slender form, the species in the form of internal casts somewhat resembles the casts of *C. spillmani* and they have sometimes been so identified. It does not grow so large as that species, however, it lacks the radiating ribs usually impressed upon the posterior slope of *C. perelongatum*, and the anterior muscular scar is not so low in position.

In the collections of the National Museum at Washington this species is represented by numerous examples from the South which have usually been referred to *Cardium dumosum*. These Southern specimens are perfectly preserved shells which are smaller than the usual examples from the Tinton Beds in New Jersey, but their surface markings are identical with those of the type specimen. The species differs from *C. dumosum* in its more elongate form and in the much coarser surface markings. *C. tippana* is another allied form in which the surface markings are fully as coarse as in *C. kümmeli*, but there is only a single row of smaller tubercles between the larger ones in that species, instead of two as in *C. kümmeli*. (Weller)

Range in New Jersey—

MT. LAUREL-NAVESINK: 53

TINTON: 60, 61

Range outside New Jersey: Delaware, Maryland, Georgia, Alabama, Mississippi.

Type.—Beers Hill, N. J. NJSM 7495.

Cardium uniformis Weller 1907

Plate 32, Figures 7, 13

Cardium uniformis Weller, 1907, p. 588, pl. 65, figs. 1-3.

Description.—The dimensions of a perfect internal cast are: height, 42 mm.; width, 35.5 mm.; thickness, 28 mm. Shell irregularly subovate in lateral view and narrowly cordate in end view. Beaks situated near the middle of the hinge-line and elevated above it, pointed and incurved. Hinge-line arcuate; anterior margin from the extremity of the hinge-line to the middle of the basal margin almost regularly arcuate; postero-basal margin more sharply rounded into the posterior margin, which is gently convex, being much straighter than the anterior margin. Muscular impressions moderately large, not strongly impressed. Inner free margins of the shell crenate, the corrugations of the external surface of the shell recognizable upon the internal casts to the umbonal region, and in small individuals to the beaks. The most prominent portion of the shell is in a line extending obliquely from the beak to the postero-basal extremity, this umbonal prominence is not at all angular, but the posterior slope is more abrupt than the anterior, becoming slightly concave as it approaches the cardinal extremity. The hinge-teeth, so far as can be recognized from the internal cast, are in every way similar to those of *C. tenuistriatum*. The surface markings, as indicated by impressions of the outside, consist of rather broad, flattened, radiating costæ, with much narrower interspaces. From the bottoms of the interspaces arise rows of spinules, very strongly compressed laterally, which are nearly uniform in size over the main central portion of the shell, there being only a slight suggestion of each third row being slightly larger; upon the anterior slope of the shell, however, each third row of spinules, and near the cardinal extremity every other row, are materially stronger; the same condition is probably true for the posterior slope, but this has not been observed.

Remarks.—The closest ally of this species is the common shell referred to *C. tenuistriatum* in this report, but the two species differ in several respects. The radiating rows of spinules are much more uniform in size on *C. uniformis* than on *C. tenuistriatum*, although upon the anterior and probably upon the posterior lateral slope there are rows of larger and smaller spines. The valves also of *C. uniformis* are less strongly convex than those of *C. tenuistriatum*, and they are slightly compressed towards the posterior cardinal extremity and the corruga-

ions of the exterior are more strongly impressed upon the surface of the internal casts. (Weller)

Range in New Jersey—

WOODBURY: 18

Type.—Lorillard, N. J.; NJSM; 7720.

Cardium trillineatum Weller 1907

Plate 33, Figure 5

Cardium trillineatum Weller, 1907, p. 589, pl. 65, fig. 20.

Description.—Form and dimensions of the shell not known, but probably similar to *C. tenuistriatum*. Surface of the shell marked with flattened radiating costæ, with interspaces about equal to or a little narrower than the costæ. From each fourth interspace, on the central portion of the shell, arises a row of laterally compressed spinules at intervals apart about equaling the width of three costæ and their two intervening interspaces; in each of the three intervening interspaces is a row of minute tubercles much smaller and much closer together than the spinules, about three or three and one-half occupying the space of two spinules. On the lateral slope of the type specimen one space between the rows of spinules is occupied by but two rows of tubercles.

Remarks.—This species is established upon a single specimen, an incomplete impression of the exterior of a shell. This fragment is about 17 mm. in length, but the specimen of which it was a part could not have been less than 30 mm. in length. The surface markings of the shell resemble those of both *C. dumosum* and *C. tenuistriatum*, but differ from both of these species in having three lines of tubercles or smaller spinules between the rows of larger ones instead of two only, the number of rows of smaller spinules upon the lateral slopes of the shell being sometimes reduced to two instead of to one only as in both the other species. Because of our limited knowledge of this species, it is possible that some of the internal casts from the Navesink marl referred to *C. tenuistriatum* may belong here, but that can be determined only by means of more complete collections. (Weller)

Range in New Jersey—

NAVESINK: 37

Type.—Atlantic Highlands, N. J. NJSM 7553.

Cardium dumosum Conrad 1870

Plate 32, Figures 8, 9, 11

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

Cardium (Cricocardium) dumosum, Whitfield, 1886, p. 133, pl. 20, figs. 9 and ? 13 (not figs. 10-12).

Cardium dumosum, Weller, 1907, p. 590 (part) not pl. 65, figs. 7-10.

? *Cardium dumosum*, Gardner, 1916, p. 668.

Cardium dumosum, Stephenson, 1923, p. 293, pl. 72, figs. 5-8.

Cardium dumosum, Wade, 1926, p. 83, pl. 26, figs. 2-3.

Cardium dumosum, Groot, Organist and Richards, 1954, p. 47.

Description.—"Shell of medium thickness, subquadrate in outline, noticeably higher than long, moderately convex, scarcely oblique. Beak slightly prominent, becoming more prominent in large individuals, rather broad, incurved, approximate, nearly direct, situated at about the midlength. Umbonal ridge broadly rounded, not prominent; posterior slope moderately steep and broadly convex. Hinge normal, inner margin of the shell rather finely crenulated. On the inner surface impressed lines corresponding to the interspaces of the outer surface extend from the margin halfway to the beak.

Dorsal margin slightly arched; anterior margin slightly subtruncated, rounding into the slightly truncated ventral margin which inclines somewhat toward the lower posterior extremity; posterior extremity almost squarely truncated, subangular below, rounding into the dorsal margin above." (Stephenson)

Remarks.—Conrad's type came from Haddonfield, N. J. and very similar material has been found at Snow Hill, N. C. The type specimen shows indications of having been subjected to some crushing and has probably been compressed just enough to spread the sides a little, producing a broad and subcircular outline. According to Stephenson, the specimens figured by Weller as *C. dumosum* are nearly circular in outline and have a finer sculpture and probably do not belong to this species.

Range in New Jersey—

MERCHANTVILLE: 11

WOODBURY: 18, 19

WENONAH: 34

RED BANK: 60

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas.

Type.—Haddonfield, N. J.; ANSP 19598.

***Cardium tenuistriatum* Whitfield 1886**

Plate 32, Figure 10

Cardium eufaulensis Whitfield, 1886, p. 132, pl. 20, figs. 18-19, not fig. 17 = *C. whitfieldi* Weller (not *C. eufaulensis* Conrad.)

Cardium (Cricocardium) dumosum, Whitfield, 1886, p. 133, pl. 20,

figs. 10-12, not figs. 9 and ? 13. (= *C. dumosum* Conrad.)

Cardium (*Criocardium*) *multiradiatum*, Whitfield, 1886, (part) p. 135, pl. 21, figs. 1-3. (Not *C. multiradiatum* Gabb.)

Fragum tenuistriatum, Whitfield, 1886, p. 139, pl. 20, figs. 15, 16.

Cardium tenuistriatum, Weller, 1907, p. 591, pl. 65, figs. 13-19.

Cardium tenuistriatum, Gardner, 1916, p. 669.

Cardium tenuistriatum, Wade, 1926, p. 84, pl. 26, fig. 4.

Cardium tenuistriatum, Groot, Organist and Richards, 1954, p. 47, pl. 5, figs. 5, 6.

Description.—The dimensions of an internal cast are: height, 44 mm.; width, 37 mm.; thickness, 35 mm. Large examples sometimes attain a height of over 60 mm. Shell irregularly subovate in lateral view and cordate in end view. Hinge-line arcuate; anterior and basal margins, from the extremity of the hinge-line to the middle of the basal margin, describing a nearly regular, arcuate curve; postero-basal margin curving more sharply around the postero-basal extremity of the shell into the posterior margin; posterior margin much straighter than the anterior, usually gently convex but sometimes nearly or quite straight. Beaks situated at about the middle of the hinge-line, rather prominent, elevated, pointed and incurved, considerably more prominent in the casts than in the specimens with the shell preserved. Valves gibbous, most prominent, but not angular, along a line from the beaks to the postero-basal extremity, the posterior slope more abrupt than the anterior. Muscular impressions rather large, the posterior ones scarcely impressed and often scarcely distinguishable upon the casts; the anterior ones more strongly impressed. Each valve with a strong, somewhat curved cardinal tooth beneath the beak, with a pit for the reception of the tooth of the opposite valve; in each valve is a single anterior and posterior, rather strong, lateral tooth, somewhat remote but nearly equidistant from the cardinal tooth. The inner free margin of the valves is crenate. Externally the shell is marked by flat, radiating costæ wider than the interspaces; from the interspaces rise rows of laterally compressed spinules or tubercles which are longer and stronger upon the anterior and posterior slopes towards the hinge extremities; on the central portion of the shell each third row of processes is more conspicuous than the two intervening rows, the spines being longer and larger, one of them occupying the space of two or three of the smaller ones of the intervening rows, the smaller ones sometimes being scarcely more than tubercles but little elevated above the surface of the ribs of the shell; upon the anterior and posterior slopes of the shell the rows of larger and smaller spines alternate, there being but a single row of smaller spines between the larger ones.

Remarks.—This species is by far the commonest and most widely distributed *Cardium* in the Cretaceous faunas of New Jersey. It exhibits considerable variation, especially in the straightness of the

posterior margin of the shell and in the prominence of the postero-basal extremity, but the casts can almost always be easily recognized by the strong convexity or gibbosity of the valves, and the abrupt posterior slope as compared with the anterior. The surface markings of the shell most closely resemble those of *C. dumosum*, but the radiating costæ are comparatively broader and flatter with narrower interspaces, and consequently the spines upon the surface are more compressed laterally. *C. dumosum* is also more nearly equilateral, with less convex valves than this species, and does not attain so large a size. (Weller)

Range in New Jersey—

MAGOTHY: 5

MERCHANTVILLE: 8, 10, 15, 16, 17

ENGLISHTOWN: 26

MARSHALLTOWN: 27, 28, 31

WENONAH: 35, 54

MT. LAUREL-NAVESINK: 37, 38, 39, 40, 41, 42, 47, 50

Range outside New Jersey: Delaware, Mississippi, Tennessee.

Type.—Marlboro, N. J.

Cardium pilsbryi Weller 1907

Plate 33, Figures 8, 9

Cardium pilsbryi Weller, 1907, p. 594, pl. 65, figs. 11-12.

Description.—Shell rather small, highest posteriorly, usually a little wider than high, the dimensions of one of the type specimens being: height, 19 mm.; width, 21 mm.; convexity of one valve, 9.5 mm. Anterior margin broadly rounded, passing regularly into the moderately convex basal margin; postero-basal extremity subangular; posterior margin obliquely subtruncate or gently convex. Valves gibbous, most prominent along the rounded or subangular umbonal ridge, the post-umbonal slope abrupt, the anterior slope from the umbonal ridge convex; beaks rather small, incurved, directed anteriorly. Surface of the modified casts marked by rather fine radiating ribs.

Remarks.—This species is known only from the somewhat modified internal casts upon which the actual surface features of the shell are not preserved. The species can be distinguished from all other members of the genus in the New Jersey faunas by its comparatively small size, its low and broad form, and its strongly ventricose or gibbous valves. (Weller)

Range in New Jersey—

MERCHANTVILLE: 15

Type.—Lenola, N. J. NJSM 7744.

Cardium sayri Richards 1943

Plate 43, Figure 11

Cardium (Granocardium) sayri Richards, 1943, p. 22, pl. 5, fig. 11.

Description.—Shell moderately small; somewhat convex, subovate, about twice as long as wide. Beak prominent, slightly incurved. Hinge not shown on type specimen. The surface is ornamented with about 35 smooth ribs with rows of spines in the interspaces. The tops of the ribs are almost flat, and there is an indication of a fine line along the center of each rib. The ribs are slightly larger and more triangular in cross section toward both the anterior and posterior margin of the shell. Length 17.0 mm.; width 13.0 mm. (Richards)

Remarks.—This species differs from other species of *Granocardium* although it is fairly close to *Cardium (Granocardium) dumosum* Conrad. It is, however, more ovoid and somewhat larger. It is also related to *Cardium (Granocardium) atlanticum* Stephenson from Georges Bank.

The position of the subgenus *Granocardium* is fully discussed by Stephenson. (1941).

Range in New Jersey—

RARITAN: 1a

Type.—Sayreville, N. J. NJSM 10442.

Cardium raritanensis Richards 1943

Plate 43, Figure 14

Cardium (Granocardium) raritanensis Richards, 1943, p. 22, pl. 5, fig. 14.

Description.—Shell moderately large, probably sub-quadrate in outline. Beak prominently curved. Conspicuous fine ribs with rows of spines in the interspaces. The ribs are more numerous than in *C. sayri*, also the beak is much more curved and the outline of the shell is more convex. The species resembles *Cardium (Granocardium) tenuistriatum* Whitfield from the New Jersey Cretaceous but appears to have finer striations. Length 34.5 mm. (Richards)

Remarks.—Described from an imperfect specimen showing only a portion of the beak. It is much larger than *C. sayri*. Until better specimens are found, it is impossible to discuss its relationships.

Range in New Jersey—

RARITAN: 1a

Type.—Sayreville, N. J. NJSM 10538.

Protocardium jerseyensis Weller 1907

Plate 33, Figure 10

Protocardium jerseyensis Weller, 1907, p. 596, pl. 65, fig. 21.

Protocardium jerseyensis, Groot, Organist and Richards, 1954, p. 47.

Description.—Shell subglobular in form, small, the dimensions of the type specimen being: height, 8 mm.; width, 8.7 mm.; convexity of one valve 3.5 mm. Valves obscurely subquadrangular in outline, the anterior margin rounding from beneath the beaks into the basal margin, ventral margin rounded, becoming a little straighter posteriorly and curving rather abruptly into the nearly vertically subtruncate posterior margin, post-dorsal margin nearly straight and horizontal near the beaks, bending regularly downward into the posterior margin behind. Valves regularly and strongly convex, slightly flattened in the internal casts on the post-umbonal slope. Beaks erect, nearly central in position. Surface of the shell marked by very fine, regular, concentric, depressed lines or grooves which become nearly or quite obsolete on the post-umbonal slope, also by very fine, regular, radiating costæ, which are conspicuous upon the post-umbonal slope, becoming obscure or entirely obsolete in front of the umbonal ridge.

Remarks.—This species is characterized by its small size, the specimen whose dimensions have been given being one of the largest observed. The character of the surface markings is shown in several natural impressions of the exterior. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 10, 16

Range outside New Jersey: Delaware.

Type.—Near Jamesburg, N. J. NJSM 8977.

Fulvia tenuis Whitfield 1886

Plate 33, Figure 11

Fulvia tenuis Whitfield, 1886, p. 139, pl. 20, fig. 8.

Fulvia tenuis Weller, 1907, p. 597, pl. 66, fig. 8.

Description.—"Shell rather small, but little exceeding an inch in length by about half that height; transversely elliptical in outline, and but moderately convex. Beaks very small, appressed, and but very slightly projecting beyond the hinge margin. Anterior end of the shell the shortest, obtusely pointed, or sharply rounded at its extremity, which is situated much above the middle of the height; posterior end more broadly rounded; basal line strongly arcuate and rapidly ascending toward the anterior part. Hinge-line but little declining on either side of the beak. Surface of the valve marked by radiating plications which are very fine at the anterior end, and gradually increase in strength to the extreme posterior margin, where they must have been fully one-sixteenth of an inch wide (the shell being broken at this point). Plications flattened obliquely, so as to give the anterior side a much greater abruptness and only about one-third the width of the posterior side. A few concentric undulations mark the surface,

and very fine concentric striæ cover the entire shell." (Whitfield.)

Remarks.—This species was established by Whitfield upon a single, rather imperfect cast of a right valve, and no additional specimens have been met with in the more recent collections of the Survey.

Range in New Jersey—

MT. LAUREL-NAVESINK: 41

Type.—Holmdel, N. J. NJSM 7588.

Family Isocardiidae

Isocardia cliffwoodensis Weller 1905

Plate 33, Figure 12

Isocardia cliffwoodensis Weller, 1905, Jour. Geol., vol. 13, p. 326, figs. 1-3.

Isocardia cliffwoodensis Weller, 1907, p. 598, pl. 66, figs. 10-12.

Description.—Shell subovate in outline, the dimensions of two type specimens being: length, 18.5 mm. and 15.5 mm.; height, 14.5 mm. and 14 mm.; convexity of one valve, 6.5 mm. and 6.5 mm. Anterior margin rounding regularly from beneath the beak into the ventral margin or sometimes a little more sharply rounded in the middle; ventral margin broadly rounded; posterior margin rather sharply rounded below, sloping forward above to the posterior extremity of the hinge-line with a gently convex curvature. Valves ventricose on the umbo, the most prominent portion situated anterior to the middle of the shell, the beaks small, situated anteriorly, strongly incurved and directed forward; the antero-umbonal slope abrupt, the posterior slope convex, becoming more abrupt as it approaches the posterior margin. Surface of the shell smooth. (Weller)

Remarks.—This species has been observed in the New Jersey collections only in the form of internal casts. The species exhibits some individual variation, especially in the length of the shell, as is indicated by the measurements given above of two of the type specimens, but in all other respects the characters are quite constant. Specimens from Corsicana, Texas, which Weller referred to this species were described as *I. bulbosa* by Stephenson (1942 p. 206)

Range in New Jersey—

MAGOTHY: 5, 6

WOODBURY: 19

WENONAH: 35

Type.—Matawan, N. J. NJSM 7778, 9570 (cotypes).

Isocardia tintonensis Weller 1907

Plate 33, Figure 13

Isocardia tintonensis Weller, 1907, p. 599, pl. 66, fig. 9.

Description.—The dimensions of the type specimen are: length, 28 mm.; height, 23 mm.; convexity of one valve, 9.5 mm. Valves subtriangular in outline, with prominent umbo and strongly incurved beaks situated about three-sevenths of the length of the shell from the anterior extremity. The anterior margin rounding from beneath the beak into the ventral margin, the curvature sharpest at the most anterior point, basal margin gently convex, curving upward in front and behind, the postero-basal extremity rather abruptly rounded into the posterior margin, which is obliquely subtruncate below and curving forward above to the post-cardinal margin. Valves most prominent on and just below the umbo, the anterior slope abruptly convex; the posterior slope convex and rather gentle to the rounded umbonal ridge, beyond which it becomes very abrupt and a little concave, especially above. Surface of the internal cast smooth, the shell itself probably marked by concentric lines of growth. (Weller)

Range in New Jersey—

TINTON: 61

Type.—Beers Hill, N. J. NJS M7509.

Family Pollicidae

Naritra polliciformis Stephenson 1954

Plate 45, Figures 5-7

Naritra polliciformis Stephenson, 1954, p. 32, pl. 7, figs. 7-9.

Description.—“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.” (Stephenson).

Remarks.—Stephenson (1954, p. 31 erected the new genus *Naritra* (by anagram from Raritan) for this species. For further description of hinge teeth and other characteristics, see generic description.

Range in New Jersey—

RARITAN: 1b

Type.—Sayreville, N. J. USNM 108638.

Family Veneridae

Tenea parilis (Conrad) 1860

Plate 31, Figures 12, 13

Mysia (Diplodonta) parilis Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 278, pl. 46, fig. 16.

Dosinia gabbi, Whitfield, 1886, p. 161, pl. 22, figs. 4-5.

Tenea pinguis, Whitfield, 1886, p. 163, pl. 22, figs. 1-2 (not fig. 3)

Tenea parilis, Weller, 1907, p. 572, pl. 63, figs. 1-6.

Tenea parilis, Gardner, 1916, p. 661.

Tenea parilis, Wade, 1926, p. 83, pl. 26, fig. 1.

Tenea parilis, Stephenson, 1941, p. 217, pl. 42, figs. 9-12.

Tenea parilis, Groot, Organist and Richards, 1954, p. 47.

Description.—Shell in large examples attaining a length and height of 38 mm.; the depth of each valve being 13 mm. The valves more or less strongly and evenly convex, subcircular, obscurely subquadrangular or subovate in outline, beaks prominent, directed forward, slightly incurved. The post-cardinal margin deeply inflected. Each valve furnished with two cardinal teeth and no laterals. Muscular impressions rather large but not deeply impressed, pallial line with a deep, narrow, acutely subangular sinus, whose inner extremity is directed towards a point between the beak and the anterior muscular impression. Surface of the shell nearly smooth, marked only by fine lines of growth.

Remarks.—The type specimens of *Lucina pinguis* Con. and *Mysia gibbosa* Gabb, are certainly members of the same species, but that of *Mysia parilis* Con., seems to be a distinct form, although it has frequently been considered as a synonym of the others. Both species are here referred to the genus *Tenea*. *T. pinguis* has not been observed to grow as large as *T. parilis*; it is much more gibbous, the entire shell being almost globular in form, and it seems to have been marked with stronger concentric lines of growth. The only authentic examples of the species seem to have come from the Navesink marl, while *T. parilis* occurs in the lower formations, although it has also been observed in the Red Bank sand. Whitfield's type of *Dosinia gabbi* is a good typical example of the form here considered as *T. parilis*, and one of the specimens he has illustrated as *T. pinguis* is also a typical representative of this species, although somewhat more ovate than usual. The hinge characters have not been observed in any of the examples in the recent collections of the Survey, but the specimen upon which the genus

Tenea was established came from the Woodbury clay near Haddonfield where the fauna is essentially like that at Lorillard. The specimens of *T. parilis* from Lorillard are much larger than the type of the species, but there are specimens of the species in the National Museum from the typical locality in Tippah County, Mississippi, which are much larger than the type. Considerable individual variation is exhibited among different examples of the species, the more usual form is subcircular or obscurely subquadrangular, but occasionally one is met with which is more nearly subovate in outline. Many of the southern examples of the species retain the shell itself, which is very thin and marked only by fine, concentric lines of growth. (Weller)

Range in New Jersey—

MAGOTHY: 5
 MERCHANTVILLE: 10, 15
 WOODBURY: 18, 19, 20, 24
 WENONAH: 34, 35
 MT. LAUREL-NAVESINK: 47
 RED BANK: 59
 TINTON: 62

Range outside New Jersey: Delaware, Maryland, D. C., Tennessee, Mississippi, Alabama, Georgia, Arkansas, Texas.

Type.—Tippah County, Miss.; ANSP Haddonfield, N. J.; ANSP 18747 (cotypes).

***Tenea pinguis* (Conrad) 1853**

Plate 31, Figure 5

Lucina pinguis Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 18.

Mysia gibbosa, Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 302, pl. 48, fig. 17 (not fig. 18).

Tenea pinguis, Whitfield, 1886, p. 163, pl. 22, fig. 3 (not figs. 1-2).

Tenea pinguis, Weller, 1907, p. 574, pl. 63, fig. 7.

Description.—Shell small, the dimensions of one specimen being: height, 7 mm.; width, 8 mm.; thickness, 6 mm.; subcircular or obscurely subquadrangular in outline. Valves extremely ventricose or gibbous, giving to the entire shell a nearly globular form. Umbones very prominent, the beaks incurved and directed forward. Surface of the shell marked by somewhat prominent concentric lines of growth.

Remarks.—The relations of this species to *T. parilis* have been fully considered in connection with the discussion of that species. It apparently differs from *T. parilis* chiefly in its smaller size, its greater gibbosity and its stronger concentric lines of growth. (Weller).

Range in New Jersey—

NAVESINK: 46

Type.—(*T. pinguis*) New Jersey; ANSP 18745.
(*M. gibbosa*) New Jersey; ANSP 18746.

***Dione delawarensis* Gabb 1860**

Dione delawarensis Gabb, 1860, Jour. Acad. Nat. Sci. Phila. 2nd ser. vol. 4, p. 302, pl. 48, fig. 18.

Dione delawarensis, Whitfield, 1886, p. 153, pl. 22, figs. 8-9.
(Not fig. 10 = *Aphrodina eufaulensis* Conrad)

Description.—Shell subquadrate, beaks small, slightly incurved; umbones small, cardinal line gently curved. The pallial impression has a deep sinus; shell marked by concentric lines. (Gabb)

Remarks.—The type specimen is a cast and its exact relationship is uncertain. The other specimen referred to *D. delawarensis* by Whitfield (figure 10) is probably *Aphrodina eufaulensis* Conrad. Gabb's text cites as the locality "Delaware and Chesapeake Canal and New Jersey." The Academy's type specimen is labelled New Jersey.

Type.—New Jersey; ANSP 19402.

***Cyprimeria densata* (Conrad) 1853**

Plate 33, Figures 14, 16

Tellina densata Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 14.

Cyprimeria densata, Whitfield, 1886, p. 157 (part), pl. 22, figs. 20-21, (not 19).

Lucina smockana Whitfield, 1886, p. 130, pl. 18, figs. 21-22.

Cyprimeria heilprini Whitfield, 1886, p. 160, pl. 22, figs. 14-15.

Cyprimeria densata, Weller, 1907, p. 601, pl. 68, fig. 14; pl. 69, figs. 1-2.

Description.—Shell attaining a length of 81 mm., a height of 66 mm., and a thickness of 25 mm. in the type specimen, the proportion of height to length being as 1 : 1.23 in the internal cast, were the actual shell preserved the height would be somewhat greater. Beaks situated about two-fifths of the length of the shell from the anterior extremity. Anterior and basal margins rounded, posterior margin broadly truncate at nearly right angles to the longitudinal axis of the shell, posterior cardinal margin nearly straight or slightly arcuate.

Remarks.—This species is especially characterized by the broad, vertical, posterior truncation of the shell. It also attains a larger size than other species in the New Jersey faunas, although Conrad's type specimen, whose dimensions are given, is probably above the average size.

The shells described by Whitfield as *Cyprimeria heilprini* and *Lucina smockana* have the same broad posterior truncation as the type of *C. densata*; the types have been carefully examined and they do not

differ in any essential respect from *C. densata* and are certainly only smaller individuals of the same species.

This species should be compared with *C. cretacea* from the Woodbury clay, but it is proportionally a somewhat higher and shorter species and the posterior truncation of the shell is much broader. (Weller)

Range in New Jersey—

MERCHANTVILLE: 14, 15

WOODBURY: 20, 22

MT. LAUREL-NAVESINK: 41, 57

Type.—(*C. densata*) Burlington County, N. J. ANSP 18773.

(*C. heilprini*) Crosswicks, N. J. ANSP 18771.

(*L. smockana*) New Jersey; ANSP 18750.

***Cyprimeria excavata* (Morton) 1833**

Plate 33, Figure 15

Cythere excavata Morton, 1833, Am. Jour. Sci., 1st ser., vol. 23, p. 292, pl. 5, fig. 1.

Cyprimeria excavata, Whitfield, 1886, p. 159, pl. 22, figs. 16, 17.

Cyprimeria spissa, Whitfield, 1886, p. 160, pl. 22, fig. 18.

Cyprimeria excavata, Weller, 1907, p. 602, pl. 67, figs. 1-6.

Cyprimeria excavata, Groot, Organist and Richards, 1954, p. 47, pl. 5, fig. 12.

Description.—Shell, in the largest specimen observed, attaining a height of 55 mm., and a length of 60 mm. The proportions of height to length in ten individuals vary from 1 : 1.08 to 1 : 1.20. The average proportions of the ten individuals being 1 : 1.14-. The varying proportions of height to length is in no way correlated with the growth or size of the individuals. The position of the beaks varies in the same ten individuals from .32 to .47 of the length of the shell from the anterior extremity, the average position being .38+.

The anterior margin of the shell is broadly rounded, passing into the rounded basal margin, posteriorly the margin is usually obtusely subangular as it passes from the basal to the posterior region, the posterior margin being subtruncate below and directed posteriorly backward from the posterior extremity of the basal margin; at about the middle of the height of the shell, above the truncate region, the margin bends somewhat abruptly forward and passes to the beak in a long gentle curve, the curvature somewhat increasing as it approaches the beak. In some individuals the post cardinal slope is slightly humped towards the beak by reason of a rather abrupt change in the curvature. Behind the beaks the margins of the valves are strongly and abruptly inflected to form a deeply excavated escutcheon. Valves depressed

convex, the left valve less convex than the right. Beaks of the two valves nearly in contact, lunule obsolete.

The surface of each valve towards the umbo is marked by fine, regular, concentric costæ for a distance of from five to ten millimeters from the beak, from five to eight of the costæ occupying the space of one millimeter. Beyond the umbonal region the surface is marked by more or less irregular concentric lines of growth, which increase in number and become stronger toward the outer margin of adult individuals. On the posterior portion of the valves an arcuate, sub-triangular area extending from the beak to the sub-truncate posterior margin, is more or less sharply differentiated from the remaining surface of the valve by reason of the greater roughness of the concentric lines of growth, this region usually being more sharply differentiated in the left than in the right valve.

Remarks.—This species is well represented in the collection by specimens from near Swedesboro preserving the shell substance. It differs from *C. densata* in the lower, narrower, and oblique posterior truncation of the shell, and from *C. cretacea* in its relatively shorter and higher form, in its larger size and its rougher concentric lines of growth and its finer concentric umbonal costæ. Besides the Swedesboro specimens the species is known from New Jersey in the form of internal casts from the Navesink marl. The specimen from the Navesink marl at Holmdel, referred to *C. spissa* by Whitfield, must also be included in this species. The type of *C. spissa* has apparently been lost or destroyed, but it probably came from the Navesink marl of the Crosswick Creek section and was probably also a member of this species. (Weller)

Range in New Jersey—

MARSHALLTOWN: 28

NAVESINK: 41

Range outside New Jersey: Delaware, Alabama, Mississippi, Texas, Arkansas.

Type.—Arneytown, N. J. ANSP 18774.

Cyprimeria depressa Conrad 1860

Plate 34, Figures 8, 9

Dosinia depressa Conrad, 1860, Jour. Acad. Nat. Sci. Phila. 2nd. ser. vol. 4, p. 278, pl. 46, fig. 6.

? *Sanguinolaria cretacensis* Conrad, 1860, Jour. Acad. Nat. Sci. Phila. 2nd ser. vol. 4, pl. 46, fig. 11.

? *Dosinia haddonfieldensis* Lea, 1861, Proc. Acad. Nat. Sci. Phila. vol. 13, p. 149.

? *Cyprimeria cretacensis*, Conrad, 1867, Amer. Jour. Conch. vol. 3, p. 9.

Cyprimeria cretacea, Conrad, 1869, Amer. Jour. Conch. vol. 5, p. 98, pl. 9, fig. 12.

Cyprimeria depressa, Whitfield, 1886, p. 156, pl. 22, figs. 11, 12, 13 (?).

Cyprimeria depressa, Gardner, 1916, p. 687, pl. 40, figs. 8-10.

Cyprimeria depressa, Stephenson, 1923, p. 307, pl. 74, figs. 6-13.

Cyprimeria depressa, Richards, 1954, p. 3.

Description.—"Shell small, of medium thickness, subovate in outline, varying greatly in the proportion of length to height, depressed convex, both valves bent markedly to the left posterior. Beaks very small, scarcely projecting, slightly prosogyrate, variable in position, but in general situated about two-fifths the length of the shell from the anterior extremity. Umbonal ridge lacking. Dimensions of one specimen: Length 34 mm., height 28 mm.; another more elongated specimen measures 27 mm. in length and 21 mm. in height.

Hinge and internal characters normal. Back of the beak is a long, deep, escutcheon-like area which was partly or wholly occupied by the ligament; the plane of this area meets the outside surface at a sharp, acute angle.

Antero-dorsal margin gently arched; anterior margin regularly rounded; ventral margin broadly and regularly rounded; posterior extremity narrow, sharply rounded, situated a little below the mid-height; postero-dorsal slope truncated and strongly inclined toward the rear, becoming broadly convex anteriorly, thus producing a humped appearance back of the beak.

Surface marked by fine incremental lines which are sharp and regular in the vicinity of the beak; towards the base in the older shells coarser concentric lines and undulations make their appearance; on some specimens a band not very sharply defined, bordering the postero-dorsal margin and extending to the posterior extremity, is somewhat more coarsely marked than the rest of the shell." (Stephenson)

Remarks.—According to Stephenson (1923 p. 308) the specimen from Haddonfield, N. J. figured by Conrad in 1869 under the name of *C. cretacea* is probably an elongated form of *C. depressa*. The Academy of Natural Sciences has similar material from Crosswicks and the well at Fellowship. Other specimens figured by Weller under the name of *C. cretacea* have been referred to *C. welleri* by Stephenson.

Range in New Jersey—

WOODBURY: 20, 23, 24

Range outside New Jersey: Alabama, Georgia, North Carolina.

Type.—Eufaula, Ala. ANSP ?

***Cyprimeria welleri* Stephenson 1923**

Plate 34, Figures 1, 2

Cyprimeria cretacea, Weller, 1907, p. 604, pl. 67, figs. 7, 8 (not

C. cretacensis Conrad)

Cyprimeria welleri Stephenson, 1923, p. 304, pl. 74, fig. 14.

Description.—"Shell moderately thick, broadly subovate in outline, depressed convex, bent a little to the left posteriorly. Beak very small, not prominent, pointing forward, situated about .45 the length of the shell from the anterior extremity. Dimensions of the type: Length 42 mm., height 35 mm. Hinge normal.

Antero-dorsal margin broadly arched; anterior margin broadly and regularly curved; ventral margin very broadly and regularly curved; posterior extremity slightly narrower than the anterior and slightly truncated, the truncation inclining slightly forward; postero-dorsal margin truncated or only slightly convex, inclined at a small angle from the horizontal.

Surface slightly waterworn, but apparently marked by fine incremental lines which become a little coarser toward the base."

Remarks.—Closely related to *C. depressa*, from which it differs in its greater height and more broadly oval outline, the absence of a hump on the posterior dorsal margin and the more nearly horizontal direction of the truncation on this margin. The specimen figured by Weller under the name *C. cretacea* Conrad from Lorillard, N. J. (Woodbury formation) is questionably referred to *C. welleri* by Stephenson, though its postero-dorsal margin appears to incline a little more strongly and the truncation of the posterior margin is narrower.

Range in New Jersey—

MAGOTHY: 6

WOODBURY: 18, 19, 20, 24

WENONAH: 35

Range outside New Jersey: North Carolina.

Type.—Snow Hill, N. C. USNM 31787.

***Aphrodina tippana jerseyensis* Richards new subspecies**

Plate 34, Figure 5

Aphrodina tippana Whitfield, 1886, p. 154, pl. 22, figs. 6, 7 (not *A. tippana* Conrad 1868).

Meretrix tippana, Weller, 1907, p. 607 (part) pl. 68, fig. 3 (not figs. 1, 2 = *A. tippana* Conrad).

Various poorly preserved casts have been referred to *A. tippana* Conrad, but as pointed out by Gardner and others, the New Jersey specimens seem to show at least a subspecific difference. The subspecific name *jerseyensis* is therefore proposed for these specimens. They differ from typical *A. tippana* in their shorter, relatively higher outline and the less produced, more broadly rounded posterior end.

The type specimen measures 33.0 mm. by 26.5 mm. and was collected by T. A. Conrad.

Range in New Jersey—

MERCHANTVILLE: 8, 10, 15

WOODBURY: 24

Type.—"New Jersey"; ANSP 19408.***Aphrodina cretacea* (Conrad) 1870**

Plate 34, Figures 3, 4

Aeora cretacea Conrad, 1870, Am. Jour. Conch., vol. 6, p. 72, pl. 3, fig. 8.*Aeora cretacea*, Whitfield, 1886, p. 167, pl. 23, figs. 16-17.*Meretrix cretacea*, Weller, 1907, p. 608, pl. 68, figs. 4-7.*Meretrix cretacea*, Gardner, 1916, p. 679.

Description.—Shell below medium size, the dimensions of an average example are: height, 16.5 mm.; approximate length, 23 mm.; convexity of one valve, 5 mm.; somewhat triangularly subelliptical in outline. Valves moderately convex, beaks small, situated anterior to the middle; antero-cardinal margin concave; anterior margin rather sharply rounded above, curving more gently below and passing without interruption into the broadly rounded ventral margin; posterior margin rather short, obscurely subtruncate; post-cardinal margin long, gently convex, meeting the antero-cardinal margin at the beak in an angle of about 120°. Postero-cardinal margin somewhat inflected, especially towards the beak; antero-cardinal margin inflected in front of the beak to form a shallow lunule of moderate width. Surface of shell marked by more or less irregular, concentric lines of growth only. Hinge of the left valve with three cardinal teeth diverging from beneath the beak, the two anterior ones of about equal length, extending directly beneath the beak with a triangular pit between them, the posterior one much more oblique and more elongate. In front of the cardinal teeth is a single low lateral beneath the lunule and parallel with the shell margin. In the right valve there are two divergent, bifid cardinal teeth with a pit beneath the lunule for the reception of the anterior lateral tooth of the opposite valve. (Weller)

Remarks: This species was formerly common in the Marshalltown formation at Swedesboro. It is about half the size of *A. tippiana* Conrad (and *A. tippiana jerseyensis* Richards). Also its hinge teeth are different, the bifid anterior cardinal tooth of the right valve (not left as stated by Conrad) is quite different from that of *A. tippiana*.

Range in New Jersey—

WOODBURY: 24

MARSHALLTOWN: 28

Range outside New Jersey: Delaware.*Type.*—Haddonfield, N. J. ANSP 4143.

***Aphrodina eufaulensis* (Conrad) 1860**

Plate 34, Figures 6, 7

Callista eufaulensis Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 282, pl. 46, fig. 24.

Callista delawarensis, Whitfield, 1886, p. 153, pl. 22, fig. 10.

(Not figs. 8-9 = *Dione delawarensis*.)

Meretrix eufaulensis, Weller, 1907, p. 609, pl. 68, figs. 8-10.

Meretrix eufaulensis, Wade, 1926, p. 89, pl. 28, figs. 3-4.

Description.—The dimensions of a very perfect left valve are: height, 16 mm.; length, 19 mm.; convexity, 4 mm. Shell subovate in outline; the beaks at about the anterior third, rather small, directed anteriorly, scarcely incurved. Antero-cardinal margin concave just in front of the beak; anterior, ventral, postero-cardinal margins convex; the posterior margin broader than the anterior. Valves regularly convex, the surface sloping more abruptly to the cardinal margins; in front of the beaks is a narrow, scarcely impressed lunule. Hinge of the left valve with two cardinal teeth diverging from beneath the beak, leaving a triangular pit between, and a much thinner, more elongate tooth directed obliquely backward close up to the ligamental area; in front of the cardinal teeth is a single strong lateral tooth beneath the lunule, parallel with the shell margin. Surface of the shell marked by fine, concentric striae of growth, those covering the area from the beak downward about 10 or 12 millimeters are very regular, the interspaces gradually increasing until the outer ones are about one-half millimeter apart. Beyond this regularly marked area the lines of growth are less conspicuous and not so regular.

Remarks.—The specimens which have been taken as typical representatives of this species are from the Marshelltown clay-marl near Swedesboro, and have the shells perfectly preserved. They agree closely with Whitfield's figure 10, a specimen from Holmdel retaining the shell, but referred by that author to *Callista delawarensis*, probably incorrectly. (Weller)

Range in New Jersey—

MARSHALLTOWN: 28

WENONAH: 34

MT. LAUREL-NAVESINK: 46, 47

Range outside New Jersey: Alabama, Tennessee.

Type.—Eufaula, Ala.

***Callistina ? johnsoni* (Richards) 1943**

Plate 40, Figures 3-4

Aphrodina johnsoni Richards, 1943, p. 24, pl. 4, figs. 3-4.

Callistina johnsoni, Stephenson, 1954, p. 34, pl. 7, fig. 18-21.

Description.—Shell moderately large, subtriangular; conspicuously striated concentrically; type with about 35 striations, closer together near the beak. Valves convex; beak nearly central, very slightly incurved. Hinge not visible on any specimens. Length 23.0 mm.; width 21.0 mm.

Resembles *A. tippana* (Conrad) in general shape but distinguished by its conspicuous concentric striations. Another related form is *A. regia* Conrad from the Cretaceous of North Carolina, South Carolina, Georgia, Alabama, and Mississippi, but this latter species differs by its much larger size and its lack of uniform concentric striations. The markings on the shell of *A. johnsoni* resemble those of *Meretrix eufaulensis* (Conrad) from Coon Creek, Tennessee, although the curved shape of the margins of the shell suggests a relationship closer to *Aphrodina*.

One individual (NJSM 10446; pl. 4, fig. 3) may possibly represent a variety, but more probably is merely a crushed individual of the typical species.

Named in honor of Meredith E. Johnson, New Jersey State Geologist.

Range in New Jersey—

RARITAN: 1a, 1b.

Type.—Sayreville, N. J. NJSM 10454.

Legumen planulatum Conrad 1853

Plate 35, Figure 17

Solyma planulata Conrad, 1853, Jour. Acad. Nat. Sci. Phila. 2nd ser. Vol. 2, p. 274, pl. 24, fig. 11.

Not *Legumen planulatum*, Whitfield, 1886, pl. 25, figs. 3, 4 =
L. ellipticum.

Not *Legumen planulatum*, Weller, 1907, p. 612, pl. 69, figs. 3, 4
= *L. concentricum* Stephenson ?

Description.—"Elliptical, compressed, sides flattened; end margins rounded; hinge and basal margins nearly parallel." (Conrad)

Remarks.—*L. planulatum* was based on an internal cast from "Monmouth County, New Jersey." According to Stephenson this name cannot be applied with certainty to any other than the original type since it might be the internal mold of any one of several species of *Legumen*.

Range in New Jersey—

MONMOUTH COUNTY

Range outside New Jersey: Alabama.

Legumen concentricum Stephenson 1923

Plate 36, Figures 1, 2

Legumen appressum Whitfield, 1886, p. 185, pl. 25, figs. 6-8.

Legumen planulatum Weller, 1907 (part), p. 612, pl. 69, figs. 7
questionably, 5, 6, (not 3, 4 = *L. ellipticum* Conrad).

Legumen concentricum Stephenson, 1923, p. 319, pl. 80, figs. 6-9.

Legumen concentricum Groot, Organist and Stephenson, 1954, p. 48.

Description.—“Shell thin, greatly elongated, subelliptical, inequilateral, compressed; beaks not prominent, approximate, somewhat variable in position on different individuals, but as a rule situated about one-fourth the length of the shell from the anterior extremity. Dimensions of the type: Length 43 mm., height 16 mm., convexity 3 mm. Dimensions of another larger specimen: Length 71 mm., height 22 mm., convexity 3.5 mm.

Dental formula $\frac{L. 101010.}{R. 010101.}$ The posterior cardinal tooth of the

right valve is narrowly bifid and very oblique, being nearly parallel to the postero-dorsal margin; the two anterior cardinals are close together, prominent, nearly vertical, and separated from the posterior cardinal by a wide, deep socket with floor sloping to the interior of the shell. Lateral teeth wanting. The anterior cardinal tooth of the left valve is set between two profound sockets; the two posterior cardinals are long, oblique, narrow, and are separated by a narrow socket not as deep as the two anterior sockets. Neither lunule nor escutcheon is present. Ligamental groove deeply impressed, extending about one-third the distance to the posterior extremity.

Postero-dorsal margin long, straight, nearly horizontal; posterior margin sharply rounded; ventral margin long, slightly convex, nearly parallel with the postero-dorsal margin; anterior margin more sharply rounded than the posterior; antero-dorsal margin descending, slightly convex. The outline of the shell varies somewhat in form on different individuals.

Surface marked by strong, nearly regular, concentric ridges, separated by narrow, rather deeply impressed depressions; the ridges are wider on the posterior portion of the shell and on the postero-dorsal slope of the large individuals assume the form of imbricating lamellae.” (Stephenson)

Remarks.—Closely related to and probably the ancestor of *L. ellipticum* Conrad. *L. concentricum* is distinguished from *L. ellipticum* by its much stronger and coarser concentric sculpture. Both forms are variable in outline, but the beak of *L. concentricum* is in general a little farther removed from the anterior extremity.

Range in New Jersey —

WOODBURY: 24

Range outside New Jersey: Delaware, North Carolina.

Type.—Snow Hill, N. C.; USNM 31798.

Legumen ellipticum Conrad

Plate 36, Figure 3

Legumen ellipticum Conrad, 1858, Jour. Acad. Nat. Sci. Phila. 2nd ser. Vol. 3, p. 325, pl. 34, fig. 19.

Legumen ellipticum Whitfield, 1886, p. 184, pl. 25, fig. 5.

? *Legumen planulatum* Whitfield, 1886, p. 184, pl. 25, figs. 3, 4.

? *Legumen planulatum* Weller, 1907, p. 612 (part) pl. 69, questionably figs. 3-4 (not 5-7 = *L. concentricum* Stephenson).

Legumen planulatum Gardner, 1916, p. 684, pl. 40, figs. 5-7.

Legumen planulatum Wade, 1926, p. 90, pl. 29, fig. 1.

Description.—"Oblong, very inequilateral, very thin; valves flattened or contracted obliquely from beak to base, concentrically lineated; beak not prominent above the hinge line, apex acute; ends regularly and near equally rounded; posterior extremity situated much more nearly on a line with the hinge than the ventral margin." (Conrad)

Remarks.—See under *L. concentricum* Stephenson.

Range in New Jersey —

NAVESINK: 43 (?)

Range outside New Jersey: Maryland, Georgia, Mississippi, Alabama, Tennessee.

Type.—New Jersey; ANSP 16340.

Tellina georgiana Gabb 1876

Plate 36, Figures 4, 5

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

Tellina georgiana, Weller, 1907, p. 615, pl. 70, figs. 1-2.

Tellina (Acropagia) georgiana, Gardner, 1916, p. 692.

Description.—The dimensions of two specimens are: length, 32 mm. and 46 mm.; height, 16 mm. and 23 mm. Shell very broadly subtriangular in outline, the beaks nearly central, and pointing a little backward, the greatest anterior extension at about the mid-height of the shell, the greatest posterior extension considerably below the middle. The anterior and posterior cardinal margins meeting at the beak in an angle of about 140° to 150°, curving gently downward in front and behind; anterior margin rather sharply rounded; ventral margin very long and gently convex; postero-basal extremity sharply rounded or subangular; posterior margin nearly vertically subtruncate below, curving forward above and passing into the cardinal margin. Valves depressed convex, with a subangular umbonal ridge extending from the beak to the postero-basal extremity, the surface sloping with a very gentle convex curve to the anterior, posterior and ventral margins; curving much more abruptly to the cardinal margins, but just before

reaching the margin the surface is deflected in the casts so as to form a rather narrow flattened area extending from the beak in each direction and gradually dying out before reaching the anterior and posterior extremities of the shell; just beneath the beak this flattened area bears the impressions of the hinge-teeth. Surface of the casts smooth except for a few very faint and indistinct radiating costæ just above the postero-cardinal slope of the valves. Pallial sinus very deep, extending beyond the middle of the shell. Hinge-teeth small and weak, situated just beneath the beak, a single one in the left valve with a socket on either side, and two in the right valve with a deep socket between.

Remarks.—Besides several fragments, two good internal casts of this species are present in the collection. The larger of these, a left valve, has lost the anterior extremity of the shell, and the smaller one, a right valve, is injured at its posterior extremity. Between the two, however, all the characters of the shell can be seen. Because of the imperfection of the specimen, the longitudinal dimension of the larger specimen, given above, is subject to slight error, but the smaller one is complete enough for accurate measurement. In the Wenonah sand near Marlboro several fragments of a large *Tellina*-like shell have been collected which resemble this one, the largest of which must have been about 60 mm. in length when complete. These specimens from near Marlboro, however, although internal casts, have had the external markings of the shell impressed upon them by the compression of the soft imbedding material after the solution of the shell itself. These markings are regular concentric lines from one-half to one millimeter apart. It is not possible to determine whether or not the type of the species was marked in a similar manner. These specimens have been compared with Gabb's types of the species in the collection of the Philadelphia Academy of Sciences, and there can be no question as to their specific identity. (Weller)

Range in New Jersey —

WENONAH: 35, 40

Range outside New Jersey: Maryland, Georgia.

Type.—Pataula Creek, Ga.; ANSP 18791.

Tellina gabbi Gardner 1916

Plate 35, Figure 2; Plate 36, Figures 6, 7

Peronaeoderma georgiana Gabb, 1876, Proc. Acad. Nat. Sci. Phil., p. 308.

Peronaeoderma georgiana, Weller, 1907, p. 617, pl. 70, figs. 4-6.

Tellina (Acropagia) gabbi, Gardner, 1916, p. 694, pl. 42, fig. 2.

Description.—The dimensions of a small specimen are: length, 24 mm.; height, 14.5 mm. Shell broadly subtriangular in outline, nearly equilateral, the beak nearly central in position. Anterior and posterior

cardinal margins sloping nearly symmetrically, meeting at the beak in an angle of about 133° ; anterior and posterior margins both sharply rounded and nearly symmetrical, the greatest extension considerably below the middle of the shell; the posterior margin sometimes appearing to be obliquely subtruncate above; basal margin gently convex throughout, curving upward a little more strongly in front and behind. Valves depressed convex, most prominent between the beaks and the center of the shell, the surface curving somewhat abruptly to the cardinal margins, very gently to the anterior, posterior and ventral margins. Upon the post-cardinal slope just within the cardinal margin and subparallel with it, is a narrow and shallow sinus which has a slight downward curvature posteriorly and becomes extinct before reaching the posterior margin. Surface of the shell marked by regular, concentric lines, two or three of which occupy the space of one millimeter. (Weller)

Remarks.—Weller suggested that this might properly belong in the genus *Tellina*, but hesitated to reassign it because the name *T. georgiana* was preoccupied. Gardner reaffirmed the generic relationship and proposed the name *T. gabbi*.

Range in New Jersey —

WOODBURY: 19

WENONAH: 35

RED BANK: Shrewsbury River

Range outside New Jersey: Maryland, Georgia.

Type.—Pataula Creek, Ga.; ANSP 18792.

***Linearia metastriata* Conrad 1860**

Plate 35, Figures 3, 4, 5

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

Linearia metastriata, Whitfield, 1886, p. 165, pl. 23, figs. 6-7.

Linearia metastriata, Weller, 1907, p. 618, pl. 70, figs. 8-9.

Linearia metastriata, Stephenson, 1923, p. 329, pl. 84, figs. 1-5.

Linearia metastriata, Wade, 1926, p. 93, pl. 31, figs. 1-2.

Linearia metastriata, Groot, Organist and Richards, 1954, p. 48, pl. 5, fig. 8.

Description.—The dimensions of a large individual are: length, 25 mm.; height, 16 mm. Shell subelliptical in outline, depressed convex. Beaks small, appressed, but little elevated above the hinge-line, situated nearly centrally. Hinge-line a little arcuate; anterior and posterior cardinal margins meeting at the beak in an angle of about 145° ; anterior and posterior margins both rounded, the anterior a little higher than the posterior; basal margin broadly convex. Valves nearly

regularly convex, the surface sloping more abruptly to the cardinal margin. Surface of the shell marked by fine concentric ribs increasing regularly in size and separated by sharply depressed furrows about equaling the ribs in width; also by radiating furrows which cut through the concentric ridges, giving them more or less the appearance of rows of discontinuous nodes, the radiating furrows are much stronger and more conspicuous upon the anterior and posterior portions of the shell, becoming fainter or sometimes almost obsolete upon the central portion, the furrows on the anterior part are further apart than upon the posterior portion of the shell.

Remarks.—The characteristic features of the surface markings of this shell make it very easily recognizable. It occurs most commonly in the form of casts of the interior and impressions of the external surface, but these latter specimens almost always retain the peculiar surface markings. (Weller)

Range in New Jersey —

MAGOTHY: 6

MERCHANTVILLE: 8, 10, 15

WOODBURY: 19, 24

MARSHALLTOWN: 28

WENONAH: 35

RED BANK: 59

Range outside New Jersey: Delaware, Maryland, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee.

Type.—Eufaula, Ala. ANSP ?

***Linearia ornatissima* Weller 1907**

Plate 35, Figure 6

Linearia ornatissima Weller, 1907, p. 619, pl. 70, figs. 10-12.

Linearia ornatissima, Wade, 1926, p. 94, pl. 30, figs. 6-7.

Description.—Shell small, the dimensions of the type specimen being: length, 6 mm.; height, 4.3 mm.; nearly equilateral, broadly subtriangular in outline with the basal angles rounded; beak central; the cardinal margins meeting at the beak in an angle of about 120°, anterior and posterior margins subequally rounded, their greatest extension below the mid-height of the shell; ventral margin gently convex. Valves depressed convex, most prominent on the umbo, the surface sloping abruptly to the cardinal margins and gently to the lateral and basal margins. Surface marked by strong radiating ribs anteriorly and posteriorly, which gradually become fainter towards the median portion of the ventral margin; on the umbo and on an area extending ventrally from the umbo nearly to the basal margin, the shell is smooth; the anterior and posterior ribs do not continue to the beak but disappear along the margins of the central smooth area; all the ribbed portion of

the shell is also marked by strong, regular, concentric costæ, somewhat stronger in the depressions between the ribs than upon the ribs themselves.

Remarks.—But two specimen of this beautiful little species have been observed, casts of the interior of the shell and impressions of the exterior. It is possible that other specimens may have attained a larger size. The species may be recognized by its beautifully cancellated anterior and posterior regions separated by the smooth median area. These markings are proportionally much stronger than in *L. metastriata*, with the contrast between the extremities and the median portion of the shell much greater; besides its smaller size the species also differs from *L. metastriata* in the greater slope of the cardinal margins, and the lower position of the greatest anterior and posterior extremities of the shell. The hinge characters of the shell have not been observed, the generic identification being based solely upon its general form and ornamentation. (Weller) The Coon Creek, Tennessee specimens are somewhat larger and more highly sculptured on the umbonal region.

Range in New Jersey —

WOODBURY: 18, 19, 24

Range outside New Jersey: Tennessee, Mississippi.

Type.—Lorillard, N. J.; NJSM 9605.

***Linearia contracta* Whitfield 1886**

Plate 36, Figure 8

Linearia contracta Whitfield, 1886, p. 167, pl. 23, fig. 5.

Linearia contracta, Weller, 1907, p. 620, pl. 70, fig. 13.

Description.—“Shell small and moderately convex, transversely ovate in outline, broad in front and abruptly contracted behind the beaks, the anterior end forming about three-fifths of the shell's length. Beaks small and inconspicuous. Anterior end broadly rounded and the posterior more narrowly rounded. Basal line broadly curved. Surface of the shell as seen in a matrix, marked by fine radiating striæ which extend over the entire surface, but are less strongly developed on the middle of the valve. Also marked by fine concentric grooves parallel to the margin of the shell.” (Whitfield.)

Remarks.—“This species differs from *L. metastriata* in being proportionally longer, in the abrupt contraction of the posterior end, in its ovate instead of oval form, greater convexity, and in being marked by radiating striæ throughout instead of having the central part of the valve nearly or quite destitute of this marking.” (Whitfield.)

This species has not been met with in any of the recent collections of the Survey, and Whitfield's type specimen seems to have been lost or destroyed. It is altogether probable that the specimen was an abnormal or perhaps distorted individual of *L. metastriata*. (Weller.)

Range in New Jersey—

NAVESINK: 41

Type.—Holmdel, N. J. NJSM 7602.

***Linearia lirulifera* Stephenson 1954**

Plate 45, Figure 4

Linearia lirulifera Stephenson, 1954, p. 34, pl. 7, figs. 22-25.

Description.—“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 midheight, 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.” (Stephenson)

Range in New Jersey —

RARITAN: 1

Type.—Sayreville, N. J. USNM 108650.

Tellinimera eborea (Conrad) 1860

Plate 36, Figures 9, 10

Tellina (*Tellinimera*) *eborea* Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 278, pl. 46, fig. 14.

Tellimera eborea, Whitfield, 1886, p. 164, pl. 23, figs. 12-13.

Tellinimera eborea, Weller, 1907, p. 621, pl. 70, figs. 14-23.

Tellinimera eborea, Gardner, 1916, p. 695, pl. 42, figs. 5-6.

Tellinimera eborea, Wade, 1926, p. 92.

Description.—The dimensions of an average specimen are: length, 13.5 mm.; height, 9 mm.; convexity, 2 mm. Shell triangularly subovate or very broadly subtriangular, depressed convex. Beaks small, appressed, situated considerably back of the middle of the shell. Anterior and posterior cardinal slopes meeting at the beak in an angle of about 140°; anterior margin rounded; basal margin broadly convex; posterior margin subtruncate below. A rounded ill-defined umbonal ridge extends from the beak to the postero-basal extremity; the posterior slope short, more or less abrupt, often somewhat flattened; the anterior slope very long and gently convex, becoming somewhat abrupt towards the antero-cardinal margin. Surface of the shell marked by fine concentric, impressed lines at regularly increasing distances apart, which are bent abruptly upward in crossing the umbonal ridge. (Weller)

Remarks.—This species has been observed most commonly in the Wenonah sand near Marlboro, in the form of internal casts. These casts rarely retain the surface markings of the shell, but these characters can be clearly seen on the Haddonfield specimen. In its general form and size this species closely resembles the shells described as *Aenona eufaulensis*, but when the shell substance is preserved the two species may be distinguished by the presence of the fine, regular, concentric marking on *T. eborea*. *T. eborea* is also more compressed and more inequilateral than *Aenona eufaulensis*.

Range in New Jersey —

MERCHANTVILLE: 10

WOODBURY: 24

WENONAH: 35

RED BANK: 60

Range outside New Jersey: Maryland, Alabama, Mississippi.

Type.—Haddonfield, N. J. ANSP 18769; Ripley County, Miss. (cotypes) ANSP.

Aenona eufaulensis (Conrad) 1860

Plate 35, Figures 7, 8

Tellina eufaulensis Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 277, pl. 46, fig. 15.

Aenona eufaulensis, Whitfield, 1886, p. 168, pl. 23, figs. 2-3.

Aenona eufaulensis, Weller, 1907, p. 623, pl. 70, figs. 24-25.

Aenona eufaulensis, Gardner, 1916, p. 697, pl. 42, figs. 3-4.

Aenona eufaulensis Wade, 1926, p. 92, pl. 30, figs. 4-5.

Description.—"Shell small, triangularly ovate in outline, three-fourths as high as long, with the small beaks situated a little more than one-third of the length from the anterior end. Cardinal margins rapidly sloping from the beaks, the anterior most rapidly, and the anterior end sharply rounding just above the basal line; posterior end more broadly rounded, but still narrowed; basal line broadly curved. Surface of the valve smooth and semipolished, the disk rather highly convex for a *Tellina*-like shell, with very small pointed beaks, a slight angularity of the umbonal region just in front of it, and a very narrow but distinctly circumscribed lunule. In the interior the hinge-plate is very narrow, with a single small cardinal tooth in the right valve and very small and narrow lateral teeth. Muscular markings unknown." (Whitfield.)

Remarks.—This species is recognized in the Cretaceous faunas of New Jersey only from Haddonfield.

Range in New Jersey—

WOODBURY: 24

Range outside New Jersey: Maryland, Georgia, Alabama.

Type.—Eufaula, Ala.

***Aenona papyria* Conrad 1870**

Plate 35, Figure 9

Aenona papyria, Conrad, 1870, Am. Jour. Conch., vol. 6, pl. 74.

Aenona papyria, Whitfield, 1886, p. 169, pl. 23, fig. 4.

Aenona papyria, Weller, 1907, p. 624, pl. 70, fig. 26.

Description.—"Subelliptical, inequilateral, extremely thin in substance, convex, anterior side narrowed; posterior end obliquely truncated; ventral margin regularly curved; surface marked by microscopic concentric close lines. Length, $\frac{1}{8}$ inch." (Conrad.)

Remarks.—According to Weller, the type and only specimen was badly injured. The specimen is now completely destroyed and it is impossible to determine its relationship. Weller pointed out that *A. papyria* differed from *A. eufaulensis* in the absence of the polished surface of the shell, in the presence of the uneven, strong, concentric lines, in the flattening of the shell at the anterior end, and in the shell substances being much thinner.

Range in New Jersey—

WOODBURY: 24

Type.—Haddonfield, N. J. ANSP 18772 (missing).

***Solyma lineolatus* Conrad 1870**

Plate 35, Figure 10; Plate 37, Figure 5

Solyma lineolatus Conrad, 1870, Am. Jour. Conch., vol. 6, p. 75, fig. 9.*Solyma lineolata*, Whitfield, 1886, p. 182, pl. 25, figs. 11-13.*Solyma lineolata*, Weller, 1907, p. 629, pl. 71, figs. 3-6.*Solyma lineolata*, Gardner, 1916, p. 701, pl. 36, figs. 20-21.*Solyma lineolatus*, Groot, Organist and Richards, 1954, p. 48.

Description.—The dimensions of the type specimen are: length, 26 μ m.; height, 15.5 mm. Shell subquadrangular in outline, a little broader behind than in front; beaks broad, rather strongly elevated above the hinge-line, nearly central in position and directed anteriorly. Hinge-line nearly straight, the anterior and posterior portions sloping very gently on each side of the beak; antero-cardinal margin concave; anterior margin rounding from the cardinal into the basal margin; basal margin nearly straight or slightly convex in the middle, curving upward a little more abruptly in front than behind; postero-basal extremity rounded; posterior margin nearly vertically truncate; post-cardinal extremity obtusely subangular; post-cardinal margin straight. Valves moderately convex, with an obscure, rounded, umbonal ridge along both the anterior and posterior umbonal slopes; the cardinal margins inflected both in front and behind the beaks. Surface of both valves in the casts marked by rather fine, more or less irregular, concentric lines of growth.

Remarks.—This shell, in its general outline, somewhat resembles *Periplomya elliptica*, but with the extremities of the shell reversed, the anterior extremity of that species being the broader and the beak being directed backward. In *Solyma lineolata*, however, the posterior margin is truncate while the anterior margin of *P. elliptica* is rounded, and the anterior extremity is much broader than the posterior extremity of that shell. The two more or less obscure umbonal ridges are also a distinguishing mark of this species, but these ridges have been made too conspicuous in Whitfield's illustration of the species. Upon one of the internal casts of this species which has come under observation, there seems to be an impression of a very deep pallial sinus extending forward to the center of the shell. (Weller)

Range in New Jersey—

MAGOTHY: 6

MERCHANTVILLE: 8, 10, 15

WOODBURY: 22, 24

WENONAH: 34, 35

MT. LAUREL-NAVESINK: 37, 47, 49

RED BANK: 60

Range outside New Jersey: Delaware.*Type.*—Haddonfield, N. J.; ANSP 16327.

Solyma elliptica (Gabb) 1861

Plate 26, Figure 7

Anatina elliptica Gabb, 1861, Proc. Acad. Nat. Sci. Phil., p. 324.*Periplomya elliptica*, Whitfield, 1886, p. 177, pl. 23, figs. 14-15.*Periplomya truncata*, Whitfield, 1886, p. 220, pl. 28, figs. 20-21.*Veleda nasuta*, Whitfield, 1886, p. 217, pl. 28, fig. 23.*Periplomya elliptica*, Weller, 1907, p. 522, pl. 42, figs. 8-11.*Periplomya elliptica*, Gardner, 1916, p. 633.*Periplomya elliptica*, Wade, 1926, p. 74, pl. 24, fig. 2.

Description.—"Shell small, inequivalve, and very inequilateral, subovate in outline, largest across the anterior side of the beaks, and strongly constricted just behind them, the posterior end being narrowed on the hinge-line and excavated at this point. Valves somewhat ventricose, the right one less convex than the left, and very decidedly depressed in the central region and toward the basal line, showing a decided twist or arcuation of the valves as seen in a basal view. Anterior end broadly rounded, and the posterior pointedly rounded. Beaks, small, appressed, incurved, and apparently directed backward, as is usual in this group of shells, from the expansion or inflation of the anterior side of the hinge line. Cardinal margin, as seen on the cast, inflected both in front and behind the beaks, forming an apparent lunule and escutcheon on the cast, probably produced mainly from a thickening of the hinge-plate within. Muscular imprints and pallial line and hinge not observed." (Whitfield.)

The dimensions of the specimen illustrated by Whitfield are: length, 31 mm.; height, 27.5 mm.; thickness, 10 mm.

Remarks.—The species was referred to the Manasquan formation (Eocene) by Weller. However, the type in the Academy of Natural Sciences is from Mullica Hill and is probably from the Navesink formation.

Only the type specimen is known from New Jersey. A single imperfect specimen is known from the Monmouth formation (Upper Cretaceous of Maryland; this shows the compressed valves, the acute umbones and the constriction behind the umbones. It is also known from the Dave Weeks place near Coon Creek, Tennessee, which is also of Cretaceous age. Stephenson (1941, p. 225) places this species in the genus *Solyma*.

Range in New Jersey—

NAVESINK: 53

Range outside New Jersey: Maryland, Tennessee.

Type.—Mullica Hill, N. J. ANSP 18767.

Family Solenidae

Leptosolen biphlicata (Conrad) 1858

Plate 37, Figure 1

Siliquaria biphlicata Conrad, 1858, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 324, pl. 34, fig. 17.

Leptosolen biphlicata, Whitfield, 1886, p. 183, pl. 25, figs. 1-2.

Leptosolen biphlicata, Weller, 1907, p. 624, pl. 70, figs. 30-31.

Leptosolen biphlicata, Gardner, 1916, p. 703, pl. 42, figs. 7-8.

Leptosolen biphlicata, Stephenson, 1923, p. 332, pl. 85, figs. 10-13.

Leptosolen biphlicata, Wade, 1926, p. 94, pl. 31, figs. 4, 7.

Leptosolen biphlicata, Stephenson, 1941, p. 226, pl. 43, figs. 4-5.

Description.—The dimensions of an average specimen are: length, 35 mm.; height, 11 mm.; convexity, 3 mm. The largest example observed is nearly 60 mm. in length. Shell elongate, with straight, sub-parallel dorsal and ventral margins, the anterior and posterior margins rounded, the anterior usually a little more sharply rounded than the posterior, the greatest anterior extension at or above the mid-height of the shell. Gaping at both ends, more widely so posteriorly. Beaks small, scarcely elevated above the hinge-line, situated a little more than one-fourth the length of the shell from the anterior extremity. Valves nearly regularly convex from the dorsal to the ventral margin, the slope to the cardinal margin usually a little more abrupt; the anterior extremity of the shell compressed, with two obscure, sometimes obsolete plications extending obliquely forward and downward from the beak. In the casts a strong furrow passes from the beak downward towards the ventral margin, with a slight posterior obliquity, growing shallower below and becoming obsolete at a point about three-fourths the height of the shell from the dorsal margin. Surface of the casts marked by more or less inconspicuous concentric lines of growth. (Weller)

Remarks.—This is a strongly marked species which cannot be mistaken for any other in the New Jersey Cretaceous faunas. The strong furrow extending downward from the beak in the casts represents a thickened rib upon the inner surface of the valve and would not be recognized upon the external surface of the shells. The species has a wide geologic and geographic range.

Range in New Jersey—

MAGOTHY: 6

MERCHANTVILLE: 8, 10, 15

WOODBURY: 24

WENONAH: 34, 35

MT. LAUREL-NAVESINK: 37, 47, 49

RED BANK: 60

Type.—Owl Creek, Miss. ANSP 16326.

Leptosolen ? terminalis Weller 1907

Plate 37, Figure 2

Leptosolen ? terminalis Weller, 1907, p. 626, pl. 70, fig. 29.

Description.—The dimensions of the type specimen are: length, 19.5 mm.; height, 10 mm.; convexity, 4 mm. Shell subquadrangular in outline, broadest a little back of the middle; beaks low and small, terminal. Hinge-line straight, about one-half the length of the shell; anterior margin gently convex, nearly vertically subtruncate; basal margin nearly straight, curving a little upward in front; posterior margin broadly rounded below, its greatest extension above the mid-height, above it curves far forward to the posterior extremity of the hinge-line. Valves rather strongly convex, divided nearly in half by a subangular umbonal ridge extending from the beak diagonally across the shell to the postero-basal angle; both the dorsal and ventral slopes gently convex. In the internal cast a strong and deep, sharply defined furrow passes almost directly downward from the beak towards the ventral margin of the shell, becoming shallower below and bending abruptly backward for a short distance just before reaching the margin; another similar, but narrower, furrow originates beneath the beak with the first one, and extends backward, just below the hinge-line, to a point somewhat back of the middle of the hinge-line; just within the posterior margin of the shell and parallel with it, a very narrow impressed line seems to have been formed by a fold of the shell from its inner surface. Surface of the cast marked by more or less irregular, concentric lines of growth.

Remarks.—This species is established upon an internal cast which resembles the casts of *Leptosolen biplicata* in the presence of the strong furrow extending towards the ventral margin from beneath the beak, but it differs in several fundamental respects from that species, and the two can hardly be cogenetic. In *L. biplicata* the shell is gaping at both ends, while in this one it is apparently closed; the beak in this shell is situated at the anterior extremity of the hinge-line, the furrow is very near the anterior margin of the shell instead of about one-fourth of the length back, and it has a distinct backward turn near the margin. The shape of the two shells is also different, the dorsal and ventral margins of *L. ? terminalis* diverging posteriorly.

There seems to be no genus in which this shell can be properly placed, and eventually it will probably be necessary to construct a new one for its reception. (Weller) It is related to *Leptosolen ? laevis* Stephenson (1941, p. 229.)

Range in New Jersey—

MERCHANTVILLE: 10

Type.—Jamesburg, N. J. NJSM 7756.

Leptosolen ? elongata Weller 1907

Plate 37, Figure 3; Plate 40, Figure 7

Leptosolen ? elongata Weller, 1907, p. 627, pl. 70, figs. 27-28.*Leptosolen ? elongata*, Richards, 1943, Proc. Acad. Nat. Sci. Phila., vol. 95, p. 24, pl. 4, fig. 7.

Description.—The dimensions of the type specimen, a cast of a left valve, are: length, 24 mm.; height, 8 mm.; convexity, 2.5 mm. Shell elongate, dorsal and ventral margins subparallel; anterior margin rounded, its greatest extension above the mid-height; posterior margin probably rounded or truncate, not completely preserved. Beaks small, terminal, but little elevated above the hinge-line. Valves closed in front, apparently gaping behind; the surface regularly convex from the dorsal to the ventral margin, curving a little more abruptly above and inflected to the hinge-line in the anterior half of the shell; curving abruptly to the anterior margin in front. In the cast a strong, deep, sharply defined furrow extends downward from the beak towards the ventral margin, and a little obliquely backward, curving a little posteriorly near its lower extremity; another much less conspicuous furrow originates beneath the beak with the first one, and extends backward, parallel with the hinge-line, becoming obsolete near the center of the shell. Surface of the cast apparently smooth.

Remarks.—This shell is not a true *Leptosolen*, but seems to be cogenetic with the shell which has been described as *Leptosolen ? terminalis*. It differs from that species in the nearly or quite parallel dorsal and ventral margins, in its greater proportional length, and in the absence of the diagonal umbonal ridge. (Weller)

Range in New Jersey—

RARITAN: 1b

RED BANK: 59, 60

Type.—Near Middletown, N. J. NJSM 10220 (holotype);
Red Bank, N. J.; NJSM 7518 (paratype)

Siliqua cretacea (Gabb) 1860

Plate 37, Figure 4

Cultellus cretacea Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 303, pl. 48, figs. 24 a-b.

Siliqua cretacea, Whitfield, 1886, p. 186, pl. 25, figs. 9-10.*Siliqua cretacea*, Weller, 1907, p. 628, pl. 71, figs. 1-2.

Description.—“Shell of moderate size, the internal cast, and the only one known, being nearly one and three-fourth inches long, and for the genus very convex, rather strongly curved, and widely gaping at each extremity, the valves only coming in contact in the middle of the

basal margin; posterior end most widely gaping. Beaks distinct, but not elevated, situated a little within the anterior third of the shell's length. On the cast they slightly project above the general line of the hinge. Hinge slightly concave posterior to the beaks, and the margin considerably thickened, as indicated by the form of the cast. Anterior to the beaks the cardinal line declines at a low angle from the direction of the posterior side. Basal line very strongly curved; extremities rounded, the anterior the most sharply so. Anterior muscular scar moderately large, triangularly ovate, bordered by a rounded furrow on the posterior side, indicating a slightly thickened rib on the interior of the shell. Posterior scar larger, triangular, and faintly marked. Pallial sinus deep and extending to near the middle of the shell's length. Hinge features unknown. Indications exist on the cast of a divided tooth-like projection on the left valve, with a socket-like plate on the right." (Whitfield).

Remarks.—This species has not been met with in the recent collections of the Survey, and the type specimen described by Gabb seems to be the only example which has ever been recognized. In Whitfield's illustration of this type specimen, the furrow behind the anterior muscular scar is represented somewhat deeper than it actually is upon the specimen. (Weller)

Range in New Jersey —?

Type.—Burlington County, N. J.; ANSP 16325.

Siliqua ? ventricosa Richards new species

Plate 35, Figure 14

Ospriosolen ventricosa Conrad MS.

Description.—Shell of moderate size and known only from a single internal cast. Hinge not visible, but about two-thirds toward the anterior extremity of the shell. Anterior end somewhat gaping. Faint traces of ribs and even fainter traces of fine radial lines. Dimensions: 32 mm. by 16.5 mm.

Differs from *S. cretacea* Gabb by being much shorter and by the presence of the ribs.

Remarks.—One specimen is in the collections of the Academy of Natural Sciences labelled *Ospriosolen ventricosa* Conrad, but this is apparently a manuscript name. Its assignment to the genus *Siliqua* is open to question. It resembles a *Solyma* but its beak is more off-center.

Range in New Jersey— ?

Type.—New Jersey; ANSP 17179.

Family Mactridae

Mactra pentangularis Weller 1907

Plate 37, Figure 6

Mactra pentangularis Weller, 1907, p. 631, pl. 71, figs. 7-8.

Description.—Shell subpentagonal in outline, the dimensions of the best type specimen being: height, 17 mm.; length, 18 mm.; convexity, 5 mm.; another somewhat distorted example is proportionally longer. Beaks subcentral, the cardinal margins sloping away on either side at an angle of about 122° ; anterior and posterior margins both nearly vertically subtruncate, the anterior margin being slightly more convex, and both rounding below into the gently convex basal margin; greatest convexity of the valves on the median line above the middle, the surface sloping almost equally to the anterior and posterior margins, with a very slight posterior umbonal ridge. Surface marked only by fine, concentric lines of growth which become somewhat stronger and more crowded towards the margin.

Remarks.—The hinge characters of this species are not clearly shown in the casts from which it has been described, but there is an elongate lateral tooth in front of the beaks certainly, and apparently also behind; the characters beneath the beak have not been seen at all. The species differs from other Mactridae in the New Jersey faunas in the proportionally greater height of the shell and its more nearly equal height and length. (Weller)

Range in New Jersey—

WOODBURY: 18

Type.—Lorillard; NJSM 7731.

Cymbophora trigonalis Stephenson 1923

Plate 35, Figures 11, 12

Veleda lintea Conrad, 1875, Kerr's Geol. N. Car., App., p. 9, pl. 1, fig. 26.

? *Cymbophora lintea*, Weller, 1907, p. 632 (part) pl. 171, figs. 9-11
(Not figs. 12-13=*C. lintea* Conrad).

Cymbophora trigonalis Stephenson, 1923, p. 336, pl. 85, figs. 1-6.

Description.—“Shell subtrigonal in outline, thin, equivalve, moderately convex. Beaks small, moderately prominent, slightly separated, prosogyrate, situated slightly in advance of the midlength. Umbonal ridge not sharply defined, but represented by a slight inflation; dorsal slopes steep, the anterior one the steeper and slightly concave toward the beak, and the posterior one rounding to the margin. Dimensions of the type: Length 23 mm., height 17 mm., convexity 5.5 mm.

Hinge relatively wide below the beak. On the right valve the chond-

rophore is rather deeply sunken in the hinge plate, concave outward, oblique toward the rear, bordered behind by an upturned oblique, carina-like callosity which is separated from the ventral margin above by a deep slit, and in front by a similar callosity which is partly fused with the cardinal tooth in front of it. Cardinal teeth two, prominent, fused above, diverging widely, the posterior one slightly oblique backward, the anterior one strongly oblique forward and partly fused with the carina-like margin above. Posterior claspers rather distant, long narrow, the upper one fused against the margin of the shell, separated by a narrow socket with corrugated sides; anterior claspers approximate to the cardinal teeth, short, the upper one fused against the margin, the separating socket deep and corrugated on the sides. Left valve with chondrophore similar to that of right valve with upturned edges prominent; in front of the chondrophore is a deltoid or bifid cardinal tooth which is received between the two cardinal teeth of the right valve.

Lateral teeth narrow, prominent, corrugated on the sides. Inner margin of shell smooth. Adductor scars subequal, small, peripheral. Pallial sinus not uncovered, but in nearly related species from Mississippi and Texas is distinctly developed and of moderate size.

Postero-dorsal margin slightly humped above the claspers, behind which it is nearly straight and descending; posterior margin sharply rounded, becoming subtruncated in adult specimens; ventral margin broadly and evenly rounded; anterior margin rather sharply and evenly rounded; antero-dorsal margin slightly arched and shorter than the postero-dorsal margin.

Surface nearly smooth on the beak with only fine incremental lines, becoming marked toward the outer margin with numerous distinct, regular, concentric ridges, wider than the interspaces." (Stephenson)

Remarks.—Three of the specimens referred to *C. linteae* Conrad by Weller may be this species according to Stephenson.

Range in New Jersey—

MAGOTHY: 5, 6

MERCHANTVILLE: ? 8, 10

Range outside New Jersey: North Carolina, Georgia, Alabama.

Type.—Snow Hill, N. C. USNM 31952.

***Cymbophora linteae* (Conrad) 1860**

Plate 35, Figures 15, 16

Cardium (Protocardium) linteum Conrad, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 278, pl. 46, fig. 17.

Veleda linteae, Whitfield, 1886, p. 172, pl. 23, figs. 18-21.

Cymbophora linteae, Weller, 1907, p. 632, (part) pl. 71, figs. 12-13.

Description.—The dimensions of two separate valves of this species, the larger specimen a right and the smaller a left valve, are: length, 18.5 mm. and 16 mm.; height, 15 mm. and 13 mm.; convexity, 5 mm. and 3.5 mm. Shell ovate-subtriangular in outline. The anterior and posterior cardinal margins meeting at the beak in an angle of about 110°, curving regularly into the anterior and posterior margins below; anterior margin rather sharply rounded, its greatest extent below the mid-height of the shell; ventral margin broadly convex; posterior margin more or less sharply rounded or somewhat pointed below, oblique above, subtruncate or gently convex. Beaks a little in front of the middle of the shell or sometimes nearly central in position, slightly incurved, pointing forward, elevated a little above the hinge-line. Valves moderately convex, with a more or less obscure umbonal ridge extending obliquely from the beak to the postero-basal extremity; post-umbonal slope rather abrupt, central portion of the valve gently convex, the anterior and posterior cardinal slopes about equally abrupt. In the casts the umbonal ridge is usually rounded, while in the shell itself it is often slightly angular. Surface of the shell marked with regular concentric lines, which are very fine in the young shells, becoming much stronger with the increased size of the shell. In the larger shells the surface markings seem sometimes to have been nearly or quite eroded, leaving the shell nearly smooth. (Weller)

Remarks.—This is a common species in certain localities in New Jersey, especially in the Cliffwood clay and the Wenonah sand. Specimens from different localities exhibit considerable variation, especially in the distinctness of the concentric surface markings. The smaller and younger individuals possess these markings most clearly, but in the larger examples they seem usually to have been more or less eroded. Figures 9-11 which Weller called *C. lintea* may represent *C. trigonalis* Stephenson, but it is impossible to be sure because the New Jersey specimens are merely casts.

Range in New Jersey—

MAGOTHY: 5, 6
 MERCHANTVILLE: 8, 10
 WOODBURY: 19, 24
 MARSHALLTOWN: 28
 WENONAH: 34, 35
 RED BANK: 59, 60
 TINTON: 62

Range outside New Jersey: Georgia, Alabama, Mississippi.

Type.—Eufaula, Ala.

Cymbophora tellinoides (Whitfield) 1886

Plate 37, Figure 7

Veleda tellinoides Whitfield, 1886, p. 173, pl. 23, fig. 23.

Cymbophora tellinoides, Weller, 1907, p. 633, pl. 71, fig. 22.

Description.—"Shell large for the genus, the cast, the only form under which it is known, being fully one and a quarter inches in length; form transversely ovate, largest at the anterior end, and two-thirds as high as long. Valves depressed convex with small appressed beaks and a slight angulation passing from the beak to the posterior extremity, forming a narrow posterior cardinal slope. Surface, as shown on the cast, marked by fine concentric lines of growth. Muscular scars proportionally large and moderately distinct, and an indication of a rather deep sinus in the pallial line." (Whitfield).

Remarks.—"This species differs from *C. linteata* in the more transverse form, less angular umbonal ridge, which is also situated nearer to the cardinal border; in the less elevated form and more arcuate basal margin, and also conspicuously in want of the coarse, regular, concentric markings of the surface seen on that one. In regard to its generic affinities there may be a little doubt, as the hinge has been much less thickened and consequently the impressions of the teeth are less conspicuous and consequently less certain." (Whitfield).

Range in New Jersey—

WENONAH: 35

Type.—Marlboro, N. J. NJSM 9768.

Schizodesma appressa Gabb 1876

Plate 37, Figure 8

Schizodesma ? appressa Gabb, 1876, Proc. Acad. Nat. Sci. Phil., vol. 28, p. 306.

Veleda transversa Whitfield, 1886, p. 174, pl. 23, fig. 22.

Schizodesma appressa, Weller, 1907, p. 634, pl. 71, figs. 14, 15, 16, 20 (Not fig. 19 = *Cymbophora scabellum* Stephenson; not figs. 17, 18 = *C. subtilis* Stephenson).

Description.—The dimensions of an average right valve are: length, 23 mm.; height, 15.5 mm., convexity, 4 mm. Shell inequilateral, subovate or ovate-subcuneate in outline. Anterior and posterior cardinal margins meeting at the beak at an angle of about 125°; anterior margin regularly rounding from the antero-cardinal margin above into the basal margin below; basal margin gently convex throughout, becoming a little straighter posteriorly; postero-basal extremity subangular; posterior margin shorter than the anterior, obliquely truncate; posterior cardinal extremity obtusely subangular. Beaks prominent, nearly erect, slightly incurved, situated a little in front of the middle of the shell. Valves most prominent on the umbo, sloping rather abruptly to the cardinal margins, the most gentle slope being to the postero-basal extremity; a more or less obscure rounded or subangular umbonal ridge passes from the beak obliquely backward to

the postero-basal extremity. Surface of the shell marked by regular, fine concentric lines, which become regularly stronger in passing from the beak to the shell margin, and becoming nearly obsolete upon the post-umbonal slope.

Remarks.—Gabb's type of this species has never been illustrated, but the New Jersey examples have been compared with the original specimen and their specific identity can be safely assumed. *Veleda transversa* was described by Whitfield from "dark micaceous clays below the Lower Marls at Marlborough," and the horizon indicated can be no other than the summit of the Wenonah sand as seen near Marlboro. Whitfield's type specimen has been compared with various specimens in the recent collections of the Survey, from the same horizon at a neighboring locality. These show the characters of his species and demonstrate its specific identity with Gabb's species from Georgia. The specimens from the Cliffwood clay which have been referred to the species, usually differ from the Wenonah sand examples in their somewhat higher and more vertically truncated posterior margin, these specimens also seem usually to have suffered a greater degree of erosion of the shell, which has more or less destroyed their surface markings. (Weller)

Stephenson (1941 p. 230) discusses this species and its allied forms in Texas.

Range in New Jersey—

MAGOTHY: 5, 6

WENONAH: 34, 35

Type.—Pataula Creek, Georgia.

Family Corbulidae

***Corbula manleyi* Weller 1907**

Plate 41, Figures 6-9

Corbula manleyi Weller, 1907, p. 636, pl. 72, figs. 1-8.

Corbula manleyi, Richards, 1943, Proc. Acad. Nat. Soc. Phil., vol. 95, p. 21, pl. 5, figs. 6-9.

Description.—The dimensions of a perfect specimen are: length, 15 mm.; height, 10.3 mm.; thickness, 7.8 mm. Shell inequivalvate, subcuneate, subtrigonal in outline; beaks prominent, incurved, nearly in contact, situated at or a little in front of the anterior third of the shell. Anterior and posterior cardinal margins meeting at the beak in an angle of about 100°, anterior slope much shorter than the posterior; anterior margin rounding regularly from the cardinal into the basal margin; basal margin slightly convex in front, becoming straight behind; postero-basal extremity angular; posterior margin very short, curving almost immediately into the post-cardinal margin

above; post-cardinal margin long, nearly straight: Valves ventricose in the umbonal region, the surface curving abruptly and inflected to the antero-cardinal margin; sloping rather steeply with a slightly convex curve to the anterior and ventral margins, and more gently to the postero-basal extremity; each valve with an angular umbonal ridge, that of the left valve much the more conspicuous; post-umbonal slope of the right valve narrow, slightly concave, inflected to the hinge-line towards the beak; that of the left valve much broader, concave, sloping much more abruptly, not inflected. Surface of the right valve marked by rather regular, moderately fine, rounded, concentric costæ, which seem to terminate at the umbonal ridge; the left valve marked by more or less irregular concentric lines of growth which are not raised into distinct, rounded ribs, and on the anterior portion of the valve by a few indistinct radiating costæ.

On the internal casts the surface is smooth, the muscular impressions are indistinct, and the beaks are widely separated and erect. The general form and contour of the valves is the same.

Remarks.—The specimens which have been used in the description of this species were collected by Mr. John M. Manley, of New Brunswick, at Furman's clay pits, Sayreville, New Jersey. They are of special interest because they were collected from near the base of the Raritan formation, at a horizon which has rarely yielded invertebrate fossils. The species is a very peculiar and distinct one, and is quite different from any other *Corbula* in the faunas of the New Jersey Cretaceous beds. (Weller)

Stephenson (1948, p. 143) questionably refers some specimens from the Raritan section of the Bethards well near Berlin, Maryland, to this species.

Range in New Jersey—

RARITAN: 1c

Range outside New Jersey: Maryland ?

Type.—Sayreville, N. J.; Chicago 10833.

***Corbula manleyi duplex* Richards 1943**

Plate 42, Figure 6

Corbula manleyi duplex Richards, 1943, p. 21, pl. 6, fig. 6.

Description.—Similar in size and shape to *C. manleyi* Weller, but characterized by its more irregular striations, many of which appear to consist of double bands separated by an interspatial groove. Length 10 mm; width 15 mm. (Richards)

Range in New Jersey—

RARITAN: 1a

Type.—Sayreville, N. J. NJSM 10537.

Corbula bisulcata, Groot, Organist and Richards, 1954, p. 48, pl. 5, fig. 10.

Description.—The dimensions of a partially restored specimen, a plaster cast taken from a natural mould, are: length, 13.5 mm.; height, 8 mm.; thickness, 6.5 mm. Shell subcuneate behind, full and rounded in front. Beaks small, incurved, situated back of the middle, pointing posteriorly. Antero-cardinal margin long, straight near the beaks and curving gently downward in front, subparallel with the basal margin; anterior margin regularly rounded; basal margin nearly straight, curving upward in front; postero-basal extremity angular; post-cardinal margin concave. Valves strongly ventricose in front, compressed behind, the ventral margin of the right valve overlapping that of the left and its posterior extremity more produced, beaks of the two valves subequal; an angular umbonal ridge is present on the right valve, with a narrow slightly concave post-umbonal slope; on the left valve the umbonal ridge is obsolete. Surface of the valves marked by rather fine, concentric lines of growth.

Perfect internal casts are subcuneate, but not so greatly produced posteriorly as the shells, the muscular impressions are conspicuous the whole area of the casts between the muscular impressions and the pallial line being strongly inflated. (Weller)

Remarks.—Various casts have been referred to this species by Weller; however, Stephenson questions their identification.

Range in New Jersey—

MAGOTHY: 5, 6

MERCHANTVILLE: 8, 10, 15

WOODBURY: 24

Range outside New Jersey: Delaware, Maryland, North Carolina.

Type.—Snow Hill, N. C. probably lost.

***Corbula foulkei* Lea 1861**

Plate 38, Figures 1, 5, 14

Corbula foulkei Lea, 1861, Proc. Acad. Nat. Sci. Phil., p. 149.

Corbula subcompressa, Whitfield, 1886, p. 180, pl. 23, fig. 26.
(not of Gabb.)

Corbula foulkei, Weller, 1907, p. 640, pl. 72, figs. 23-26.

Description.—The dimensions of a nearly complete individual, a plaster cast taken from a natural mould, are: length, 12.5 mm.; height, 9 mm.; thickness, 6 mm. The dimensions of the perfect internal cast of the same individual are: length, 11 mm.; height, 8 mm.; thickness, 5.5 mm. Shell subtriangular in outline; the beaks slightly in front of the center, moderately incurved, pointing a little forward. Hinge-line arcuate; anterior and posterior cardinal margins sloping

***Corbula lorillardensis* Weller 1907**

Plate 39, Figures 1-3

Corbula lorillardensis Weller, 1907, p. 637, pl. 72, figs. 9-14.

Description.—The dimensions of an internal cast are: length, 10.5 mm.; height, 5.5 mm.; thickness, 4 mm. Shell elongate subovate in outline, broader in front than behind; the beaks central or a little in front of the center, broadly obtuse, a little incurved; right valve overlapping the left along the ventral margin. Anterior and posterior cardinal margins sloping downward in front and behind the beak, meeting at an angle of about 142° ; anterior margin regularly rounding from the cardinal into the basal margin; basal margin long, gently convex; postero-basal extremity angular; posterior margin nearly vertically truncate, sometimes slightly oblique; the post-cardinal extremity angular or subangular. Surface of the valves strongly convex from the dorsal to the ventral margins, slightly convex longitudinally across the greater portion of the central part of the shell, and curving rather abruptly to the anterior margin; an angular umbonal ridge passes from the beak to the postero-basal extremity; the post-umbonal slope abrupt, usually a little concave; the posterior extremity of the right valve compressed and a little produced. Surface of the shell, as seen in impressions of the exterior, marked by rather fine, more or less irregular, concentric lines of growth, which become more conspicuous near the ventral margin and upon the post-umbonal slope. In the casts the surface is smoother, the umbonal ridge is less angular and the muscular impressions are inconspicuous.

Remarks.—This is the commonest member of the genus in the nodules at Lorillard, and can be recognized from all other species in New Jersey, by its elongate form, with the dorsal and ventral margins more or less subparallel. (Weller)

Range in New Jersey—

WOODBURY: 18, 24

Type.— ?

***Corbula bisulcata* Conrad 1875**

Plate 38, Figure 7; Plate 39, Figure 4

Corbula bisulcata Conrad, 1875, Kerr's Geol. N. Car., App., p. 11, pl. 2, figs. 13-14.

Corbula foulkei, Whitfield, 1886, p. 180, pl. 23, figs. 27-29.

(not *C. foulkei* Lea.)

Corbula bisulcata, Weller, 1907, p. 638, pl. 72, figs. 15-22.

Corbula bisulcata, Gardner, 1916, p. 711.

Corbula bisulcata, Stephenson, 1923, p. 343, pl. 86, figs. 6-12.

symmetrically on either side of the beak, and meeting at an angle of about 122° ; anterior margin rounding from the cardinal into the basal margin; basal margin moderately convex, curving upward more abruptly in front than behind; postero-basal extremity angular; posterior margin obliquely truncate, meeting the post-cardinal margin in a broadly obtuse angle. Valves moderately and subequally convex, with an angular umbonal ridge; middle portion of the valve gently convex, the surface curving somewhat abruptly to the antero-cardinal margin; post-umbonal slope narrow, concave rather abrupt. Surface of shell marked by inconspicuous lines of growth. In the internal cast the beaks are broader and blunter, and the left valve seems to be slightly more convex than the right; the muscular impressions are strongly impressed, indicating a thickening of the shell at these points, and giving to the area between them and the pallial line a somewhat inflated appearance.

Remarks.—The specimen which has been used as the basis for the preceding description is a very perfect internal cast with the accompanying natural mould of the exterior from which a cast has been taken to show the external features of the shell. This cast has the right valve complete except for a slight restoration along the ventral margin, the left valve being less complete. This specimen has been compared with the type of the species, which has never been illustrated, and the agreement is close except that the specimen here illustrated is larger. The casts of this species somewhat resemble those of *C. bisulcata*, but the central portion of that species is much more inflated, with more deeply impressed muscular impressions. Whitfield's illustration of *C. subcompressa*, on comparison with the type of that species, proves to be entirely different, and the specimen from which it was drawn is believed to be an example of *C. foulkei*. (Weller)

Range in New Jersey—

MERCHANTVILLE: 16

WOODBURY: 19, 22, 24

Type.—Haddonfield, N. J.; ANSP 18766.

***Corbula crassiplica* Gabb 1860**

Plate 38, Figure 6

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

Corbula crassiplica, Whitfield, 1886, p. 178, pl. 23, fig. 30.

Corbula crassiplica, Weller, 1907, p. 641, pl. 72, figs. 27-28.

Corbula crassiplica, Gardner, 1916, p. 713, pl. 43, figs. 6-7.

Corbula crassiplica, Stephenson, 1941, p. 234, pl. 44, figs. 16-17.

Corbula crassiplica, Wade, 1926, p. 96, pl. 31, figs. 9, 13.

Corbula crassiplica, Groot, Organist and Richards, 1954, p. 48.

Description.—The dimensions of a right valve are: length, 6 mm.; height, 5 mm. Shell subtriangular in form. Beaks large, inflated and enrolled, situated a little in front of the middle of the shell. Hinge-line arcuate; antero-cardinal margin sloping rather abruptly forward to the anterior extremity of the shell below the middle; basal margin convex anteriorly through the greater portion of its length, becoming concave behind; postero-basal extremity angular; posterior margin short, vertically truncate, curving rather abruptly above into the long sloping postero-cardinal margin. Right valve strongly ventricose, with an angular umbonal ridge which is faint or obsolete towards the beak, becoming conspicuous as it approaches the postero-basal angle of the shell; in front of the umbonal ridge in the lower half of the shell is a rather narrow but distinct sinus which forms the posterior sinuosity in the basal margin; the post-umbonal slope concave. Surface of the valve marked with nine or ten strong, rounded, elevated, concentric costae, which continue from the anterior margin of the shell to the sinus in front of the umbonal ridge, the interspaces about equaling the ribs in width. On the umbo the concentric markings are reduced rather abruptly from the strong costae to fine concentric lines; passing over the umbonal ridge and down the posterior slope, are rather fine, sublamellose, concentric lines of growth. Left valve much less ventricose than the right and the beak much less produced, the surface marked only with more or less irregular concentric lines without the strong costae.

Remarks.—This species has a long range in the Cretaceous beds of New Jersey, and can always be easily recognized by the peculiar markings of the right valve which can frequently be seen as impressions in the matrix. The species is quite characteristic of the Woodbury clay, in which formation it sometimes occurs in great numbers. In most of the other formations, however, it is comparatively rare. The only other New Jersey species with which it is in danger of being confused is *C. cliffwoodensis* which is much larger and lacks the sinus in front of the umbonal ridge. (Weller)

Range in New Jersey—

MERCHANTVILLE: 8, 10, 14, 15, 16

WOODBURY: 18, 22, 24

WENONAH: 34, 35

MT. LAUREL-NAVESINK: 46, 54

RED BANK: 59, 60

Range outside New Jersey: Delaware, Maryland, Georgia, Alabama, Mississippi, Arkansas, Texas.

Type.—“from a cut in the Memphis and Charleston Railroad where it crosses the Tennessee and Mississippi state line.”

Corbula cliffwoodensis Weller 1907

Plate 38, Figure 2

Corbula cliffwoodensis Weller, 1907, p. 643, pl. 72, figs. 29-30.

Description.—The dimensions of an internal cast of a right valve are: length, 9.5 mm.; height, 8 mm.; convexity, 3.5 mm. Shell subtriangular in outline; the beak large and broad, incurved. Hinge-line arcuate; antero-cardinal margin sloping abruptly downward to below the middle of the valve; anterior margin rounding from the anterior extremity of the hinge-line into the basal margin; basal margin convex; postero-basal extremity sharply rounded; post-cardinal margin concave. Right valve strongly ventricose in the middle, rounding abruptly to the anterior and antero-cardinal margin, with an angular umbonal ridge extending obliquely backward from behind the beak in a concavely curved line to the postero-basal extremity; post-umbonal slope abrupt, concave; the valve compressed towards the posterior extremity. Surface of the right valve marked by strong, rounded, concentric ribs, which originate at the antero-cardinal margin, grow stronger in the middle of the shell and become obsolete just before reaching the umbonal ridge; about 26 of these ribs are recognizable on a shell 8 mm. in height, which regularly increase in strength from the umbo to the ventral margin; post-umbonal slope marked only by concentric lines of growth. (Weller)

Remarks.—Only the right valve of this species has been observed. It is a close ally of *C. crassiplica*, but grows much larger, with comparatively finer concentric ribs, and it lacks the distinct sulcus in front of the umbonal ridge. The specimens are all internal casts and impressions of the exterior.

Range in New Jersey—

MAGOTHY: 5

Type.—Cliffwood Point, N. J. NJSM 9579.

Corbula jerseyensis Weller 1907

Plate 38, Figure 3

Corbula jerseyensis Weller, 1907, p. 644, pl. 72, figs. 37-38.

Description.—The dimensions of a perfect internal cast are: length, 6 mm.; height, 4 mm.; thickness, 3 mm. The dimensions of a larger left valve are: length, 9 mm.; height, 6 mm. Shell ovate-subcuneate in outline, the ventral margin of the right valve overlapping the left; beaks subcentral, pointing slightly forward, that of the right valve a little more elevated and sharper in the cast than that of the left. Hinge-line arcuate; anterior and posterior cardinal margins sloping symmetrically from the beak, where they meet in an angle of about 120°; anterior margin regularly rounded; ventral margin gently

convex; postero-basal extremity angular; posterior margin truncate below, subangular above or curving into the postero-cardinal margin. Valves gently convex in their central portion, the surface curving abruptly to the antero-cardinal border; posteriorly an angular umbonal ridge separates the body of the shell from the post-umbonal slope; post-umbonal slope short, abrupt, concave. Surface of the shell nearly smooth, marked only by fine, inconspicuous lines of growth which become a little more prominent on the post-umbonal slope. In the cast the angular umbonal ridge of the exterior of the shell is nearly or quite obsolete, and the muscular impressions are inconspicuous. (Weller)

Range in New Jersey—

MAGOTHY: 5

Type.—Cliffwood Point, N. J. NJSM 9578.

***Corbula swedesboroensis* Weller 1907**

Plate 38, Figure 4

Corbula swedesboroensis Weller, 1907, p. 644, pl. 72, figs. 33-36.

Description.—The dimensions of a nearly perfect right valve are: length, 12.5 mm.; height, 9 mm.; convexity, 3.5 mm.; a larger imperfect valve is 15 mm. in length. Shell subovate in outline; the beak in front of the middle, rather small, a little incurved, pointing forward. Anterior and posterior cardinal margins meeting at the beak is an angle of about 133° ; anterior margin regularly rounded from the cardinal to the basal margin; ventral margin gently convex, with a slight sinuosity just in front of the posterior extremity; postero-basal extremity angular; posterior margin short, truncate, slightly oblique; postero-cardinal extremity obtusely angular; postero-cardinal margin nearly straight. Right valve with a low, angular, slightly sigmoidal umbonal ridge; the most prominent portion of the valve below the beak, the surface curving somewhat abruptly to the antero-cardinal margin and more gently towards the umbonal ridge, just in front of which, in the lower half of the shell, is a shallow and inconspicuous sinus; post-umbonal slope rather gentle, concave. Surface of the valve marked by fine, concentric costæ, which become more pronounced towards the ventral margin and upon the post-umbonal slope. Left valve not known.

Remarks.—This species is described from a nearly perfect right valve, from the Marshalltown clay-marl near Swedesboro. The shell substance is preserved and all the external characters are clearly visible. The shell resembles *C. subgibbosa* Con., in general form, but has the beaks pointing forward instead of posteriorly, as in that species. It also resembles the original illustration of *C. subcompressa* Gabb, but it has the beak further forward and the posterior margin less oblique.

A single internal cast of *Corbula* from the Cliffwood clay has been referred to this species; the beak is somewhat more obtuse, the umbonal ridge less angular, and the posterior margin somewhat narrower than in the specimen preserving the shell, but these are all differences which might be expected in a cast of the interior of the shell. Another somewhat distorted internal cast from the Woodbury clay near Haddonfield, is also placed in this same species. Both of these internal casts retain traces of the concentric surface markings, which agree closely with those of the shell itself. (Weller)

Range in New Jersey—

MAGOTHY: 5, 6

MERCHANTVILLE: 8

WOODBURY: 24

MARSHALLTOWN: 28

Type.—Near Swedesboro, N. J.; NJSM 9653.

***Corbula greywaczi* Richards 1943**

Plate 40, Figure 10

Corbula greywaczi, Richards, 1943, p. 22, pl. 4, fig. 10.

Description.—Shell small, trigonal in outline, moderately inflated. A narrow, sharply defined carina-ridge extends from the beak to the posterior extremity; beak prominent, incurved, about $\frac{2}{5}$ the length of the shell from the anterior extremity; posterior part of the shell more pointed than the anterior. Shell surface covered with even concentric ridges. Length 5.0 mm.; width 7.5 mm. (Richards)

Remarks.—The shell is smaller than *C. manleyi* Weller, less elongate with a less prominent ridge and with more even concentric ridges. It is closer to *C. latona* Stephenson from Banquereau, Nova Scotia, but has coarser ridges and a slightly more prominent carina-ridge.

Named in honor of Mrs. Kathryn B. Greywacz, Curator of the New Jersey State Museum.

Range in New Jersey—

RARITAN: 1a

Type.—Sayreville, N. J. NJSM 10543 (squeeze of type ANSP 15662).

***Caryocorbula ? ovisana* Stephenson 1953**

Plate 45, Figure 11

Caryocorbula ovisana Stephenson, 1953, U. S. Geol. Surv. Prof. Paper 242, p. 129, pl. 32, figs. 9-15, 1952 = 1953.

Caryocorbula ? ovisana Stephenson, 1954, p. 34, pl. 7, fig. 26.

Description.—“This species is represented by one incomplete ex-

ternal 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 from 7 mm, convexity about 3 mm." (Stephenson)

Range in New Jersey—

RARITAN: 1b

Range outside New Jersey: Texas (Woodbine formation).

Type.—4.2 miles northeast of Savoy, Fannin County, Texas (on Sheep Creek); USNM 105535.

Family Saxicavidae

Panopea decisa Conrad 1853

Plate 38, Figure 8; Plate 39, Figure 5

Panopaea decisa Conrad, 1853, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 19.

Panopea decisa, Whitfield, 1886, p. 181, pl. 24, figs. 5-8.

Panopea decisa, Weller, 1907, p. 646, pl. 73, figs. 3-5.

Panopea decisa, Gardner, 1916, p. 721.

Panopea decisa, Wade, 1926, p. 98, pl. 32, figs. 8-9.

Panopea decisa, Groot, Organist and Richards, 1954, p. 48, pl. 5, fig. 11

Description.—The dimensions of a large specimen are: length, about 80 mm.; height, 51 mm.; thickness, 35 mm. Shell more or less subelliptical in outline, widely gaping behind and closed in front. Beaks central or a little in front of the center of the shell, moderately large and incurved. Hinge-line nearly straight; anterior margin rounded, its greatest extension below the middle; basal margin nearly straight or gently convex; usually subparallel with the hinge-line; posterior margin curving more or less abruptly upward and backward from

the basal margin, obliquely truncate below, rounding into the cardinal margin above. Valves rather ventricose, with a rounded, oblique, anterior, umbonal ridge becoming broader and more or less obsolete below; from the umbo the surface slopes rather abruptly in front and gently behind; from the posterior side of the beak a rather broad, shallow, indefinite sinus extends obliquely backwards towards the posterobasal angle, usually becoming obsolete in the outer portion of large individuals. Surface of the shell marked by strong, more or less irregular, concentric undulations.

Remarks.—This species has a rather long range in the New Jersey Cretaceous beds, but it is most characteristically a member of the Merchantville fauna. It reaches its largest size at this horizon, those of the higher formations rarely exceeding 50 mm. in length, and usually being even smaller than this. (Weller)

The most closely related species are probably *P. elliptica* Whitfield from the Manasquan formation (Eocene) of New Jersey and *P. monmouthensis* from the Monmouth formation of Maryland.

Range in New Jersey—

MAGOTHY: 5

MERCHANTVILLE: 8, 10, 14, 15, 16, 17

WOODBURY: 20, 24

WENONAH: 35

MT. LAUREL-NAVESINK: 37, 40, 47

RED BANK: 59

Range outside New Jersey: Delaware, North Carolina, South Carolina, Georgia, Mississippi.

Type.—Burlington County, N. J., ANSP 16380.

Family Gastrochenidae

***Gastrochaena whitfieldi* Weller 1907**

Plate 38, Figure 9

Gastrochaena whitfieldi Weller, 1907, p. 648, pl. 73, figs. 10-12.

Description.—Diameter of the tube 14.5 mm. at its larger, closed extremity, decreasing to 11 mm. in a distance of 22 mm. Shell broadly gaping ventrally and posteriorly, the beaks anterior; the dimensions of the type specimen are: length, 16 mm.; height, 8.5 mm. Valves somewhat twisted, subtriangular in outline, truncated behind and pointed in front, but with the anterior pointed extremity inflected almost at a right angle so that in lateral view the valves appear to be quadrangular, the dorsal margin gently convex posteriorly. A low, obtusely angular, very oblique umbonal ridge extends from the beak to the postero-basal angle, below this ridge the surface is slightly concave to the ventral margin, above it is convex nearly to the dorsal

margin where it becomes a little concave. Surface of the shell marked by fine, concentric lines of growth which bend upward abruptly at the oblique umbonal ridge; upon the ventral region and especially upon the inflected anterior extremities of the valves, the markings become somewhat sublamellose.

Remarks.—This species is based upon a single very perfect cast of a complete shell, with a partial impression of the external surface showing the surface markings. A cast of the inner portion of the tube was also originally preserved, but this has been partially destroyed in removing the shell. The tube differs from those in the Vincentown limestone which have been described as *G. americana*, and of which the shell has never been observed, in its less slender form and in the absence of the conspicuous, irregular annulations. (Weller)

Range in New Jersey—

NAVESINK: 46

Type.—Walnford, N. J., NJSM 7580.

***Gastrochaena linguiformis* Weller 1907**

Plate 38, Figure 11

Gastrochaena linguiformis Weller, 1907, p. 649, pl. 73, fig. 9.

Gastrochaena linguiformis, Groot, Organist and Richards, 1954, p. 48.

Description.—Tube of the type specimen with a diameter of 11 mm. Dimensions of the right valve: height, 7.3 mm.; length, about 19 mm. Valves of the shell linguiform, the dorsal and ventral margins nearly straight and subparallel, the posterior margin regularly rounded, the anterior margin not preserved in the type. Right valve gently convex throughout, the left valve a little more convex and somewhat twisted. Valves marked by concentric lines of growth. (Weller)

Remarks.—This species may be easily distinguished from *G. whitfieldi* by its more elongate and linguiform valves and the rounded posterior margin. It is too poorly preserved for comparison with other species.

Range in New Jersey—

MERCHANTVILLE: 10, 16

Range outside New Jersey: Delaware.

Type.—?

***Kummelia americana* (Gabb) 1860**

Gastrochaena americana Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 393, pl. 68, fig. 20.

Gastrochaena americana, Whitfield, 1886, p. 203, pl. 26, figs. 17-18.

Gastrochaena americana, Weller, 1907, p. 649, pl. 73, fig. 13.

Gastrochaena americana, Wade, 1926, p. 99, pl. 32, figs. 5-7.

Kummelia americana, Stephenson, 1937, Jour. Wash. Acad. Sci., vol. 27, pp. 58-64, figs. 1-8.

Description.—Tubes solitary, elongate-conical, the larger extremity rounded; attaining a length in the largest examples of 75 mm., and a maximum diameter of about 12 mm.; the minor diameter is usually about 5 or 6 mm.; diameter increasing gradually and more or less irregularly, usually being 1 mm. in a length of from 6 mm. to 16 mm. Surface irregularly marked by annular wrinkles and constrictions arising from what have been the rounded extremity of the tube at different stages of its growth. Some specimens have almost the appearance of worn specimens of *Orthoceras*, but with the septa convex towards the larger instead of the smaller extremity. No remains of a bivalve shell have ever been observed. (Weller)

Remarks.—This species, although reported only from the Vincen-town formation of New Jersey, is known from the Cretaceous of Delaware (?), Mississippi and Tennessee.

Type.—Timber Creek, N. J., ANSP 13403.

***Pholas cithara* Morton 1834**

Plate 39, Figures 7, 9

Pholas cithara Morton, 1834, Synop. Org. Rem. Cret. Gr. U.S., p. 68, pl. 9, fig. 10.

Pholas cithara Whitfield, 1886, p. 187 (part). Not pl. 25, fig. 16.

Pholas cithara Weller, 1907, p. 651 (part). Not pl. 74, fig. 7.

Pholadidea ? cithara Stephenson, 1923, p. 350, pl. 87, figs. 14-15.

Pholas cithara, Groot, Organist and Richards, 1954, p. 48.

Description.—"Shell subovate-elongate in outline, narrowest posteriorly, inequilateral, equivalve, moderately convex, fullest anteriorly, becoming rather strongly compressed posteriorly. Beaks broad, not strongly prominent, incurved, prosogyrate, situated about one-fourth the length of the shell from the anterior extremity. Dimensions: Length about 20 mm.; height about 10 mm.; convexity, 5 mm. Hinge line straight. Antero-dorsal margin apparently convex; anterior margin rather sharply rounded; ventral margin slightly convex, subparallel to the hinge line; posterior margin slightly rounded.

A sharply impressed line extends from the beak obliquely downward and backward to the middle of the ventral margin, dividing the surface into two areas; the forward area is marked by about 20 rather fine, acute growth ridges; the posterior area immediately back of the impressed line is marked by an equal number of similar growth ridges which join the impressed line at a broad obtuse angle to the growth ridges in front of it, and which become obscure on the postero-dorsal slopes; just back of the impressed line the surface is cancellated by about six radiating lines which become obscure posteriorly; these radiating lines are a little weaker than the growth ridges." (Stephenson.)

Remarks.—According to Stephenson, the specimen figured by

Whitfield as *Pholas cithara* is not similar to Morton's type and should properly be referred to *Pholas* (?) *pecterosa* Conrad. The specimen figured by Weller (Plate 47, figure 7) as *P. cithara* from the Woodbury clay at Lorillard is also not that species and is described in this report as *P. lorillardensis*.

Range in New Jersey—?

Range outside New Jersey: Delaware ?, North Carolina.

Type.—"Blue Marl of Monmouth County."

***Pholas pectrosa* Conrad 1852**

Plate 39, Figure 10

Pholas pectrosa Conrad, 1852, Proc. Acad. Nat. Sci. Phila., p. 200.

Pholas cithara, Whitfield 1886, p. 187, pl. 25, figs. 14-16 (part)

Pholas cithara, Weller, 1907, p. 651, pl. 74, fig. 7 (part)

Pholas pectrosa, Gardner, 1916, p. 724, pl. 44; fig. 1.

Pholas pectrosa, Stephenson, 1941, p. 251, pl. 45, figs. 1-2.

Description.—"Ovate cuneate; anteriorly inflated, contracted in the middle; posterior side cuneiform; disk with radiating ribs, largest anteriorly, and interrupted by concentric furrows; anterior side very short, margin obtusely rounded or subtruncated; basal margin rounded anteriorly, contracted medially, straight posteriorly." (Conrad)

Remarks.—Confused with *P. cithara* and *P. lorillardensis*. For further discussion see under those species. In view of the confusion in this genus, it is difficult to determine the range of the various species.

Range in New Jersey—

MERCHANTVILLE ? : 8

WOODBURY ? : 18, 20

WENONAH ? : 34, 35

TINTON:63

Range outside New Jersey: Maryland, Mississippi, Texas.

Type.—Tinton Falls, N. J.; ANSP 16272.

***Pholas lorillardensis* Richards new species**

Plate 39, Figure 6

Pholas cithara Morton, Weller, 1907, p. 651 (part), pl. 74, fig. 7.

(Not *P. cithara* Morton, 1834).

Description.—Shell ovate in outline as in illustration. Growth lines fine near beak, becoming coarser toward the margin of the shell. Closely resembles *Pholas cithara* Morton with which it has been confused, but differs by being more truncate and by its coarser sculpture. Dimensions: 31 mm. by 16.5 mm.

Remarks.—The type is represented by a cast and mold. It was re-

ferred to *Pholas cithara* Morton by Weller (1907). However, Stephenson (1923, p. 351) questions its identity with that species. Therefore the new name is proposed.

Range in New Jersey—

WOODBURY: 18

*Type—*Lorillard, N. J.; NJSM 9597.

Family Pholadidae

***Xylophagella irregularis* (Gabb) 1860**

Plate 39, Figures 17-19

Teredo tibialis Morton, 1834, Synop. Org. Rem. Cret. Gr. U.S., p. 68
(in part).

Teredo irregularis, Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser.,
vol. 4, p. 393, pl. 68, fig. 19.

Teredo contorta, Gabb, 1861, Proc. Acad. Nat. Sci. Phil., p. 323.

Teredo irregularis, Whitfield, 1886, p. 191, pl. 25, figs. 18-19.

Teredo irregularis, Weller, 1907, p. 656, pl. 74, figs. 1-3.

Teredo irregularis, Gardner, 1916, p. 729.

Xylophagella irregularis, Stephenson, 1941, p. 247.

Description.—Tubes as shown by their casts gregarious, exceedingly tortuous and contorted, sometimes annulated, increasing gradually in size from their point of origin, the larger ones reaching a diameter of 10 mm. or more. Shell subglobular, cordate in outline from in front, the beaks a little in front of the middle of the hinge-line, widely gaping behind and open in front; the postero-cardinal extremity somewhat produced in a rounded lobe. Anterior margin rounding from the hinge-line above into the upper margin of the large, deep, subrectangular, antero-basal hiatus which reaches above the mid-height of the shell; basal margin short; posterior margin obliquely subtruncate below, bent abruptly backward near the hinge-line, and continuing around the postero-cardinal lobe of the shell. Valves ventricose, the beaks prominent, much elevated above the hinge-line and strongly incurved or enrolled; the surface curving steeply towards the antero-cardinal extremity and then deflected shortly before reaching the margin, curving less abruptly to the postero-cardinal extremity. In the casts a very deep and prominent furrow passes from the hinge-line just back of the beaks to the posterior margin just below the post-cardinal lobe of the shell; another faint groove which is less conspicuous upon the larger individuals, crosses the post-umbonal slope in a nearly vertical direction from the lower margin of the deep groove already described behind the beaks to the posterior extremity of the basal margin; surface of the anterior half of the shell, as shown in impressions of the exterior, marked by exceedingly fine, regular, concentric striae, parallel with the shell margin, 20 or more of which occupy the space of 1 millimeter. These

striae towards the antero-cardinal extremity, are crossed by finer radiating striae, which produce an exceedingly fine reticulate pattern upon the shell surface. Markings of the posterior half of the shell unknown. (Weller)

Remarks.—Casts of the irregular burrows of this species are sometimes of common occurrence in the Merchantville clay, penetrating masses of fossil wood, and on tracing these burrows to their termination, casts of the shell can usually be found, sometimes in excellent condition. Some masses of the tubes are all much smaller than those in other masses, but all the tubes in one group are usually of approximately the same dimensions. It was at first thought possible that the different sized tubes indicated different species, but the shells are all essentially the same, whether from large or small tubes, in all masses observed in the Merchantville clay-marl. A mass of essentially identical tubes has been found in the Marshalltown clay-marl, however, associated with many individuals of *Martesia bisulcata*, which have a very different shell, described in this report as *Turnus kümmeli*. Other similar tubes occur sometimes in the Navesink marl, but the accompanying shells have not been observed; these tubes, however, seem to be straighter, and they probably belong to another species.

The type specimen of *T. irregularis* is without data as to locality or horizon, and the description of the shell itself is too meagre to be of any use in identification. Inasmuch, however, as the Merchantville clay-marl is the horizon where burrows of this sort most frequently occur, and as Gabb described numerous fossils from this horizon in Burlington County, New Jersey, it is altogether probable that the type specimen is specifically identical with the shell here described.

Morton evidently applied the name *Teredo tibialis* to all the Teredo-like tubes he found in New Jersey, but the name is still retained for the tubes like those which he illustrated, which are found only in the Vincentown limesand. The specimens which he referred to from "the friable marls" which are preserved as "casts in lignite" were in all probability representatives of the species *T. irregularis*.

The type of *Teredo contorta* Gabb, which is preserved in the collection of the Philadelphia Academy of Science, has been carefully compared with examples which are here referred to *T. irregularis*, and there can be no doubt as to their specific identity; it is also without doubt a Merchantville clay marl specimen, and it is safe to conclude that it is a synonym of *T. irregularis*. (Weller)

Stephenson (1941, p. 247) places this species in the genus *Xylophagella*.

Range in New Jersey—

MERCHANTVILLE: 8, 11, 14, 16

WOODBURY: 20

Range outside New Jersey: Delaware, Maryland.

Type.—(*X. irregularis*) New Jersey; ANSP 15900.

(*T. contorta*) Burlington County, N. J.; ANSP 15908.

***Xylophagella kummeli* (Weller) 1907**

Plate 39, Figures 11, 12

Turnus kummeli Weller, 1907, p. 652, pl. 74, figs. 4-6.

Xylophagella kummeli, Stephenson, 1941, p. 249.

Description.—Tubes penetrating masses of wood, exceedingly tortuous and contorted, gradually increasing in size from their point of origin and so far as observed, reaching a maximum diameter of 9 mm. The dimensions of a large shell are: length, 10 mm.; height, 9 mm.; depth of one valve, 5.5 mm. The hinge-line is about .7 of the total length of the shell. In anterior view the shell is cordate in outline, each valve being irregularly subovate in lateral view. Beaks in front of the middle of the shell, pointed and strongly incurved, umbones very prominent, the valves compressed posteriorly and not gaping. The antero-basal hiatus rectangular, large and deep, occupying nearly the entire anterior side of the shell, its upper margin two-thirds the total height of the shell from the ventral margin. Ventral and posterior margins rounded. Umbonal sulcus deep and narrow and slightly oblique, on each side the surface of the valve is raised in a slight rib which becomes stronger, especially the posterior one, towards the ventral margin of the valve. In the internal cast a shallow ill-defined furrow originates on the posterior side of the beak and extends obliquely backward towards the postero-ventral margin, becoming almost obsolete as it approaches the margin. On the anterior side of the beak a narrower and shallower, but more sharply defined furrow originates and continues to the inner angle of the anterior hiatus of the valve. The finer surface markings are not well shown upon the internal cast, but they apparently consist of fine and inconspicuous lines of growth.

Remarks.—A single example of the species has been observed from the Merchantville formation at Lenola. This specimen is a smaller one, only 6.5 mm. in length, and is a very imperfect internal cast. So far as can be determined it has essentially the same form and proportions as the type, but the two furrows originating upon the anterior and posterior sides of the beak can not be detected, and seem to have been absent. This may be due to the smaller and possibly younger shell. (Weller)

According to Stephenson, this should be referred to the genus *Xylophagella* but the specimen does not retain the surface characteristics necessary for a critical comparison with other species of that genus.

Range in New Jersey—

MERCHANTVILLE: 15

MARSHALLTOWN: 28

Type.—Cotype—Chicago, 18548.

Martesia cretacea (Gabb) 1860

Plate 38, Figure 12; Plate 39, Figure 8

Pholas cretacea Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 393, pl. 68, fig. 18.

Martesia cretacea, Gabb, 1876, Proc. Acad. Nat. Sci. Phil., p. 304.

Martesia cretacea, Whitfield, 1866, p. 190, pl. 25, fig. 23. (Not figs. 20-22.)

Martesia cretacea, Weller, 1907, p. 654, (Not figs. 8-11.)

? *Martesia cretacea*, Gardner, 1916, p. 727.

Martesia cretacea, Stephenson, 1941, p. 250.

Martesia cretacea, Groot, Organist and Richards, 1954, p. 49.

Description.—Shell small, subhemispherical in front, cuneate behind, the beaks strongly incurved, umbones prominent. The anterior margin rounding regularly from the anterior extremity of the hinge-line into the straight basal margin, posterior margin subtruncate, post-cardinal margin sloping backward from the posterior extremity of the hinge-line. Surface of each valve marked by a deep, narrow groove, extending from the beak obliquely backward to the ventral margin which it meets in front of the middle of the shell; in most individuals a second groove close to and parallel with the first, but a little wider and shallower, is introduced a short distance below the beak and continues to the margin. The anterior region of the shell is marked by fine costæ which bend abruptly upward in front of the oblique grooves, continuing to above the middle of the shell, where they make a nearly rectangular turn and continue in a horizontal direction to the anterior margin, surrounding two sides of, and sharply differentiating, a smooth, triangular, slightly raised area in the antero-ventral region of each valve. The posterior region of the shell is marked by broader, rounded costæ, parallel with the margin of the valves.

The dimensions of a specimen of average size are: length, 7 mm.; height, 4.5 mm.; greatest thickness, 4.8 mm.

Remarks.—The name *Pholas cretacea* was originally applied to a group of casts of the tubes of one of the *Pholadidae*, without any knowledge of the shell characters. At a later date the original author of the species described a single individual of a shell and referred it to the same species as the previously described tubes "because it is of about the proper size to form such tubes." In themselves, the tubes of this group of pelecypods possess no characters which can be used for specific determination, and consequently the species *Pholas cretacea*, afterwards referred to the genus *Martesia*, may be considered as founded upon the shell described by Gabb. Whitfield has illustrated Gabb's specimen and redescribed it, but he saw no additional specimens. In the recent collections of the Survey 50 or more individuals of this species have been observed in a fragment of fossil wood from 1 to 1½ inches in diameter and 8 inches long. The entire surface of

this wood is filled with the burrows of this species, and in each burrow is a well preserved shell or the internal cast of a shell. These specimens show some variation in several characters, but a comparison with Gabb's type of *M. cretacea* has shown them to be not essentially different from that species. Some of the examples are shorter than usual and consequently taper more abruptly to the posterior extremity than the average form, but the most important variation is the presence or absence of the supplementary oblique furrow in front of the primary one extending from the beak to the ventral margin. In the majority of individuals this furrow is present and its absence is more apt to be a feature of the smaller and presumably younger shells. In a few specimens of nearly maximum size this furrow is nearly obsolete, being noticeable only near the ventral margin, and in one specimen it is absent from one valve although faintly indicated on the other. (Weller)

Range in New Jersey—

MERCHANTVILLE: 15, 16

MARSHALLTOWN: 28

Range outside New Jersey: Delaware, Maryland ?

Type.—Near Union, Raritan Bay; ANSP 15875.

***Martesia cretacea magnatuba* Richards 1943**

Plate 43, Figures 1, 2

Martesia cretacea magnatuba Richards, 1943, p. 25, pl. 7, figs. 1-2.

Description.—Similar in general appearance to *M. cretacea* (Gabb) but considerably larger than any heretofore recorded specimen of that species. (Richards)

Remarks.—The type consists of a large piece of wood completely replaced by limonite with numerous borings made by the clams. None of the original shells are preserved, and it is therefore impossible to give an adequate description.

M. cretacea (Gabb) was originally described from a group of casts of tubes without knowledge of shell characters. The new variety resembles the type of *M. cretacea* in general appearance and preservation, but differs from it in size. The type of *M. cretacea* (ANSP 15875) measures 2.6 mm. in length and 0.9 mm. in greatest diameter while the type and average specimen of variety *magnatuba* measures 3.0 mm. in length and 1.4 mm. in greatest diameter.

Gabb's locality for *M. cretacea* was merely given as "Raritan Bay, N. J."; however, the type at the Academy is labelled "near Union, Raritan Bay, N. J." This is probably part of the Merchantville formation.

Gabb subsequently described a single individual of a shell (ANSP 2283) and referred it to the same species; no locality was given other than "New Jersey."

The New Jersey State Museum has specimens of *P. cretacea* from the Merchantville formation (Lenola, N. J.) and the Marshalltown formation (Swedesboro, N. J.) identified by Weller, and the Academy has specimens from the Merchantville formation at Maple Shade, N. J., and Merchantville, N. J.

In view of the close resemblance between the Raritan specimens and Gabb's original type and also in view of the probable long geological range of the species, it seems wisest merely to give a varietal name to the new form which belongs to a slightly older geological formation than the typical *M. cretacea*.

A relationship was also noted to *M. constricta* (Phillips) from the Lower Cretaceous and basal Upper Cretaceous of England and with *M. prisca* (Sowerby) from the Lower Cretaceous of England.

The large mass of tubes in the limonitized wood was collected by Meredith E. Johnson and is the property of the New Jersey State Museum. A few individual tubes from the same mass are in the collections of the Academy of Natural Sciences.

Range in New Jersey—

RARITAN: 1b

Type.—Sayreville, N. J.; NJSM 10472. PARATYPE—ANSP 15872.

Goniochasma sp.

Plate 39, Figures 13-16

Martesia cretacea Whitfield, 1886, p. 25 (part), pl. 25, figs. 20-22 (not fig. 23). (Not *M. cretacea* Gabb.)

Martesia cretacea Weller, 1907, p. 654 (part), pl. 74, figs. 8-11 (?), not synonymy. (Not of Gabb.)

Goniochasma sp. Stephenson, 1941, p. 250.

Description.—"One internal mold, figured by Whitfield, probably incorrectly as *Martesia cretacea* (Gabb), and two internal molds from the Marshalltown clay of New Jersey, figured by Weller under the same name, also probably incorrectly, appear to belong in the subgenus *Goniochasma*." (Stephenson, 1941, p. 250).

Range in New Jersey—

MARSHALLTOWN: 28

Figured specimens.—Swedesboro, N. J.

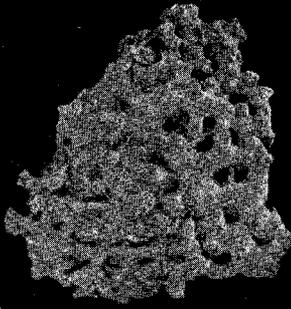
Miscellaneous specimens

Stephenson (1954) noted and figured twelve pelecypods from the Raritan formation at Sayreville, N. J. with only generic identification. These were *Breviarca* spp. A and B, *Pinna* sp., *Pedalion* sp., *Exogyra* sp., *Pecten* (*Camptonectes*) sp., *Fulpia* sp., *Cardium* spp. A., B. and C., *Cardium* (*Granocardium*) sp., and "*Corbula*" sp.

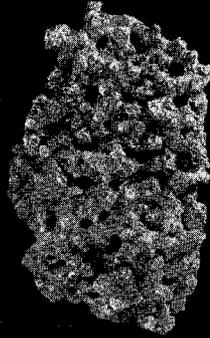
Plates

PLATE 1

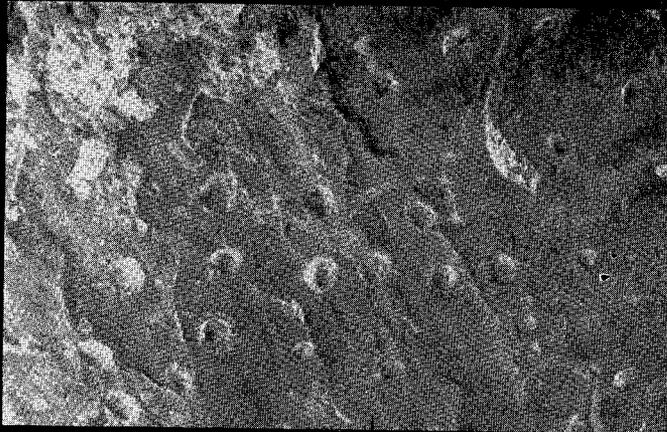
<i>Figure</i>	<i>Page</i>
1. <i>Cliona cretatica</i> Fenton and Fenton, Mullica Hill, N.J. ANSP 2234 x 1	29
2. <i>C. cretatica</i> Fenton and Fenton, Mullica Hill, N. J. ANSP 2234 x 1	29
3. <i>C. cretatica</i> Fenton and Fenton, New Egypt, N.J. NJSM 8185 x 4	29
4. <i>C. cretatica</i> Fenton and Fenton, New Egypt, N.J. NJSM 8185 x $\frac{3}{4}$	29
5. <i>C. cretatica</i> Fenton and Fenton, Chesapeake and Delaware Canal ANSP x 1	29



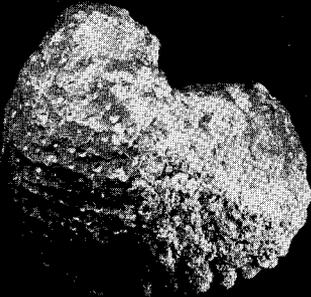
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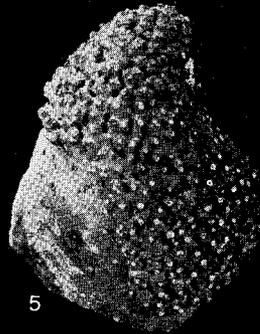
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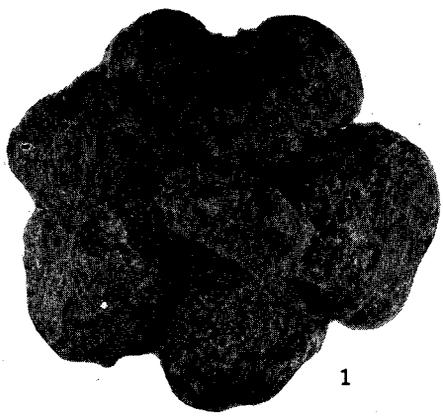


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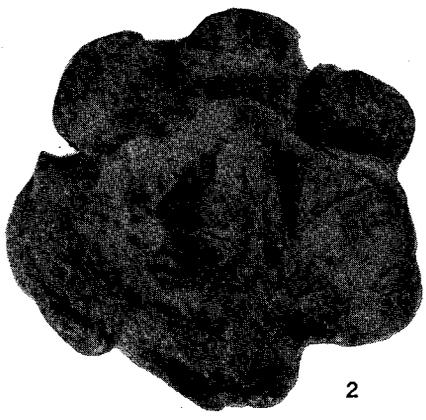
PLATE 1

PLATE 2

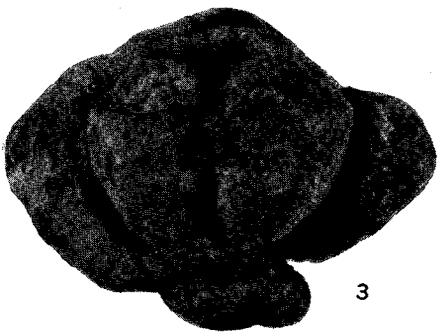
<i>Figure</i>	<i>Page</i>
1-3. <i>Corynella jerseyensis</i> Howell n. sp. (TYPE), New Jersey, PU 76407 x 1	31
4, 5. <i>Coeloptychium jerseyensis</i> Shimer and Powers (TYPE) USNM 31176 x 1	30
6. <i>Cliona microtuberum</i> Stephenson ? North of New Egypt, N.J. NJSM 9848 x 1/2	29



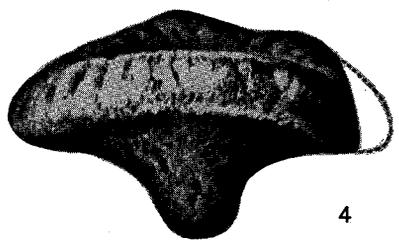
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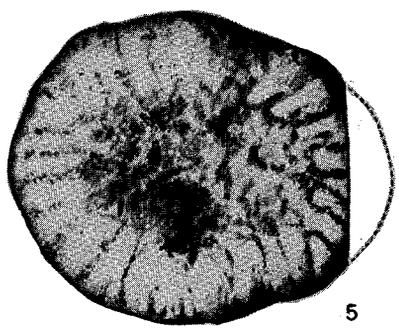
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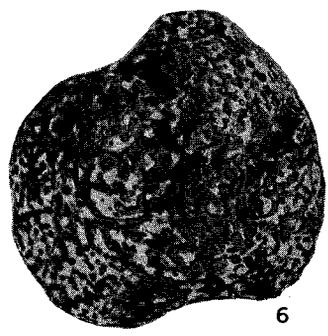
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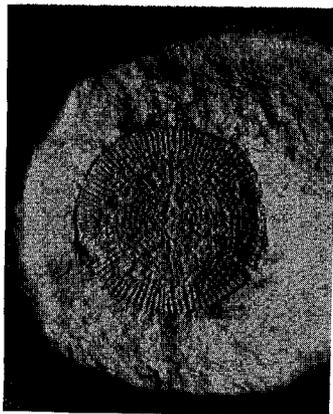
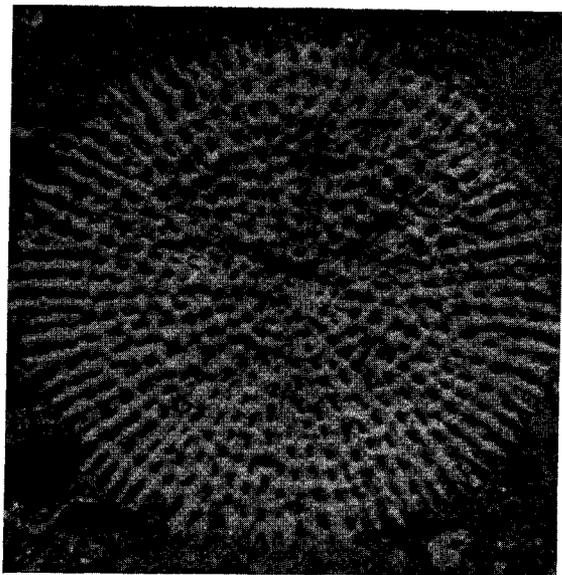


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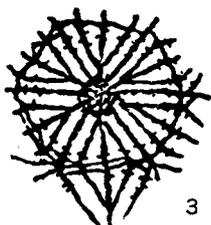
PLATE 2

PLATE 3

<i>Figure</i>	<i>Page</i>
1. <i>Micrabacia cribraria</i> Stephenson. Asbury Park, N. J. well at 628-629 feet. NJSM x 9	33
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5. Same specimen as Figure 4 x 9 (calyx)	34
6. Another specimen, "much enlarged" (costae)	34



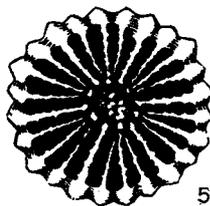
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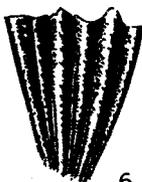
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PLATE 3

PLATE 4

<i>Figure</i>	<i>Page</i>
1. <i>Serpula circularis</i> Weller (TYPE) Swedesboro, N.J. NJSM 7712 x 3	37
2. <i>Hamulus wenonahanus</i> Howell (TYPE) Marlboro, N.J. NJSM 9683a x 2	38
3. <i>Hamulus falcatus</i> (Conrad), Mount Laurel, N.J. well ANSP 683a x 2	37
4. <i>H. falcatus</i> (Conrad), Mount Laurel, N.J. well NJSM 683b x 2	37
5. <i>Longitubus lineatus</i> (Weller), Maple Shade, N.J. ANSP 91 x 1	40
6. <i>H. falcatus</i> (Conrad), Mount Laurel, N.J. well ANSP 683 x 2	37
7. <i>H. falcatus</i> (Conrad), Crosswicks, N.J. ANSP 15267 x 2	37
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10. <i>H. falcatus</i> (Conrad), Maple Shade, N.J. x 2	37
11. <i>H. falcatus</i> (Conrad) (COTYPE) Crosswicks, N.J. ANSP 14891b x 2	37

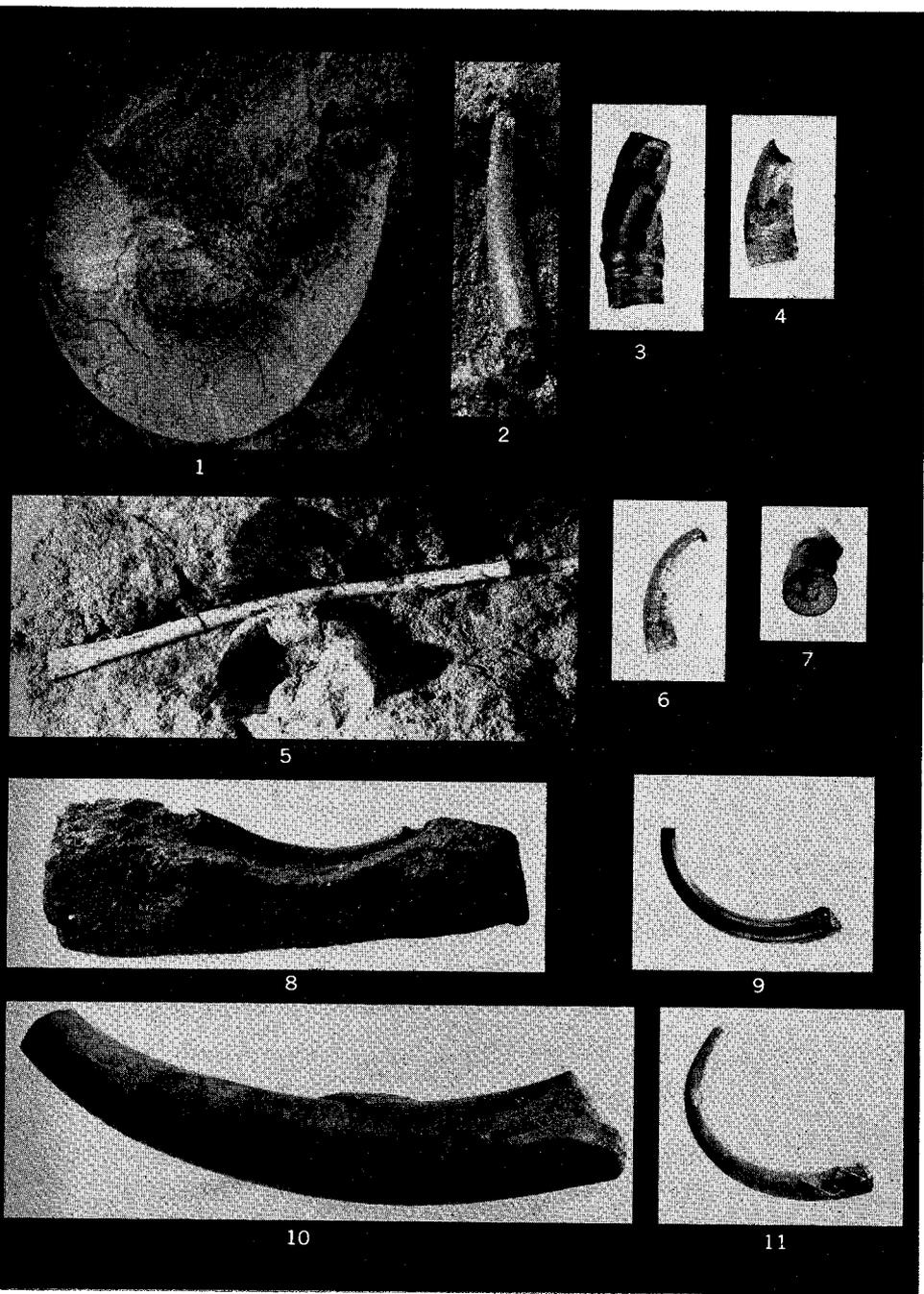


PLATE 4

PLATE 5

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9. <i>Hamulus walkerensis</i> Stephenson, Crosswicks, N.J. ANSP 15085 x 2	39
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12. <i>D. harbisonae</i> Howell, Crosswicks, N.J. ANSP 15425 x 1	41

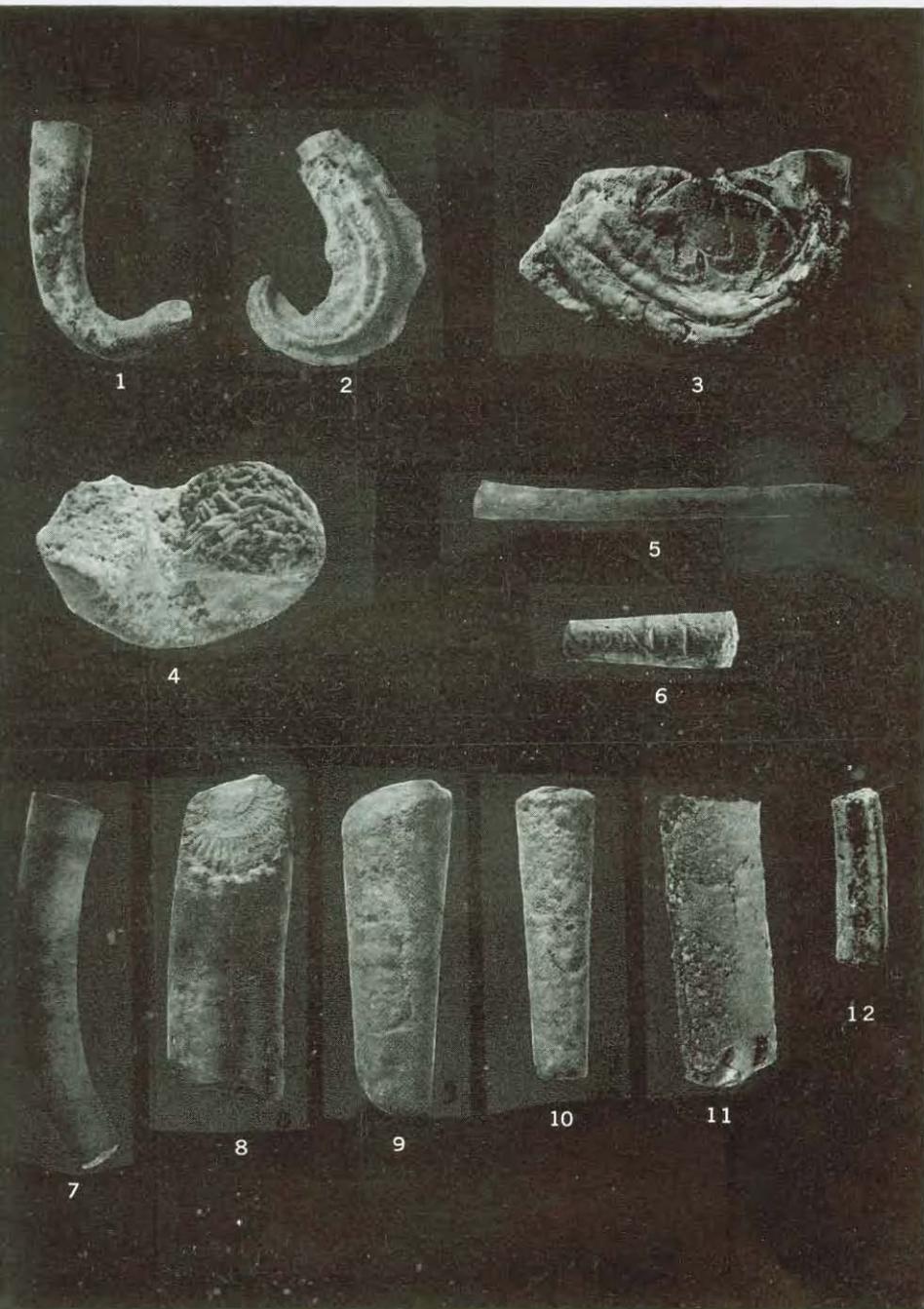
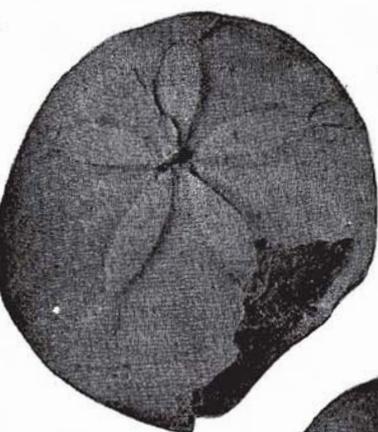


PLATE 5

PLATE 6

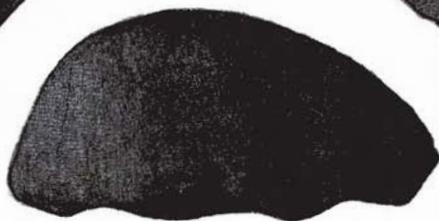
<i>Figure</i>	<i>Page</i>
1-3. <i>Faujasia geometrica</i> (Morton), Chesapeake and Delaware Canal, Del. USNM 17753 (top, bottom and left side) x 1.....	45
4-7. <i>F. geometrica</i> (Morton), Chesapeake and Delaware Canal, Del. ANSP 1496 (top, bottom, left side and right side of TYPE) x 1	45



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PLATE 6

PLATE 7

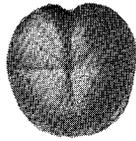
<i>Figure</i>	<i>Page</i>
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4, 5. <i>C. marylandicus</i> Clark, Brightseat, Md. (top and bottom of another specimen, probably TYPE) x 1 (after Clark)	51
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15-18. <i>Hardouinia florealis</i> (Morton), Chesapeake and Delaware Canal, Del. ANSP 1495 x 1 (after Cooke, 1953)	48



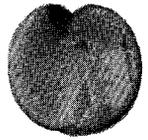
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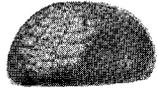
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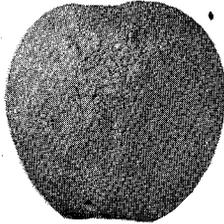
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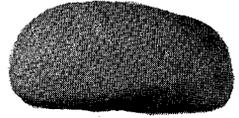
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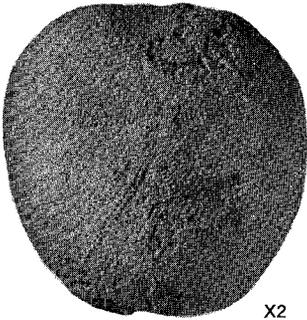
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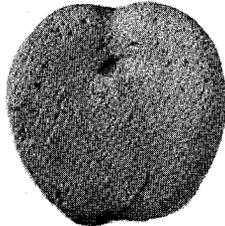


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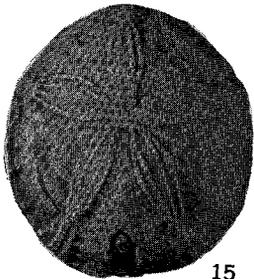


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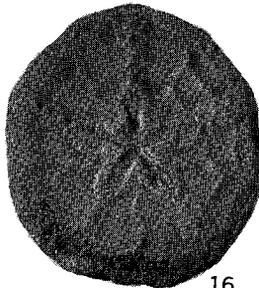
x2



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16



18

PLATE 7

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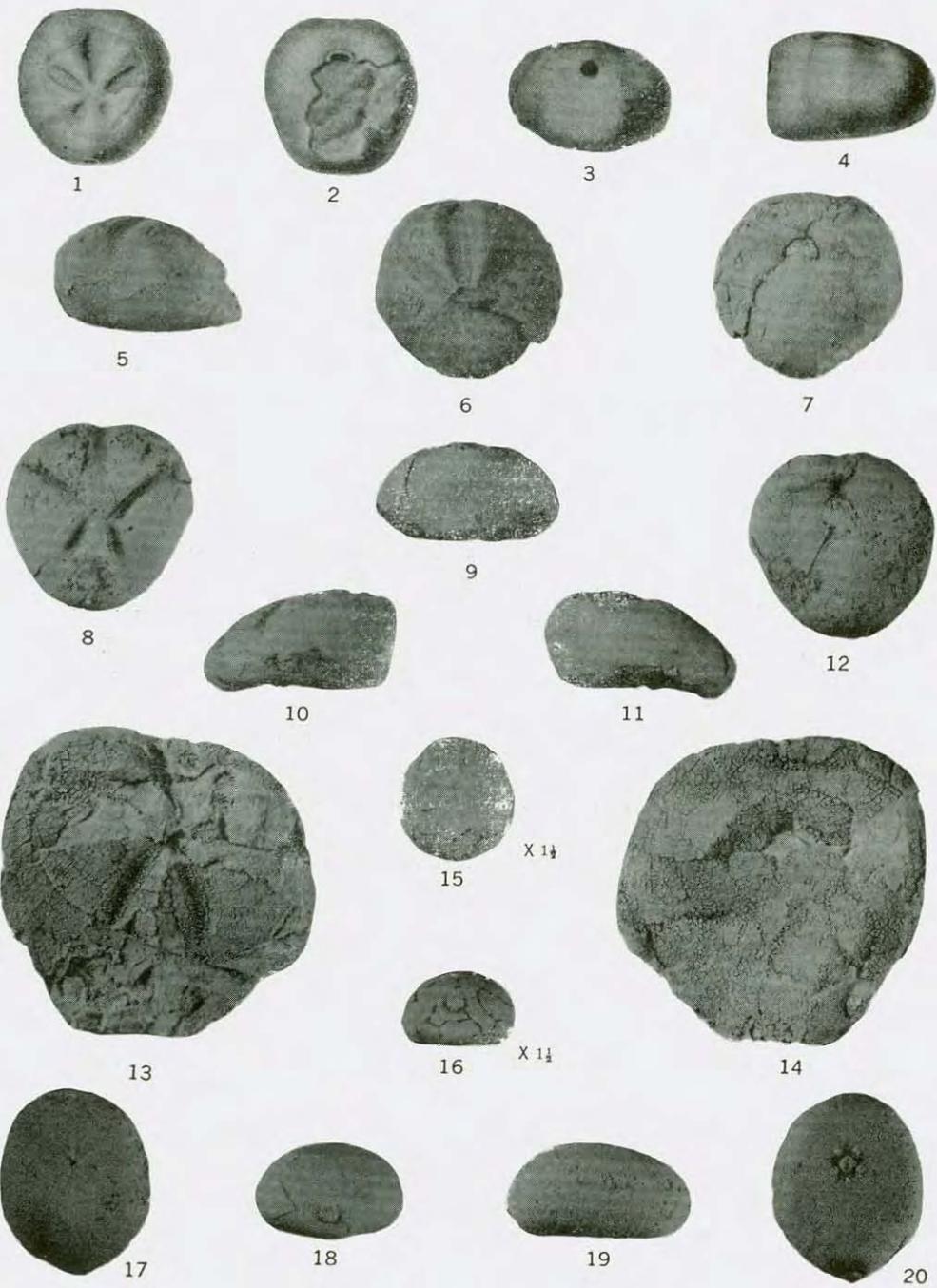
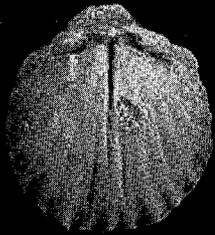


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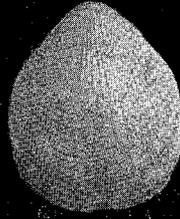
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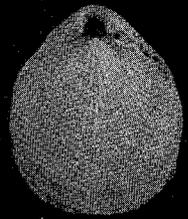
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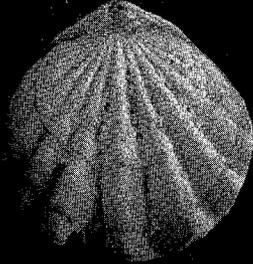
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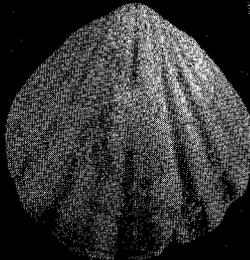
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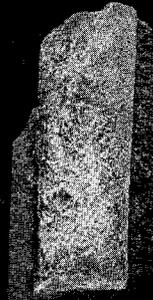
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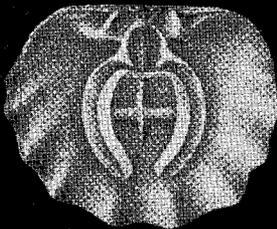
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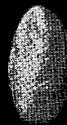
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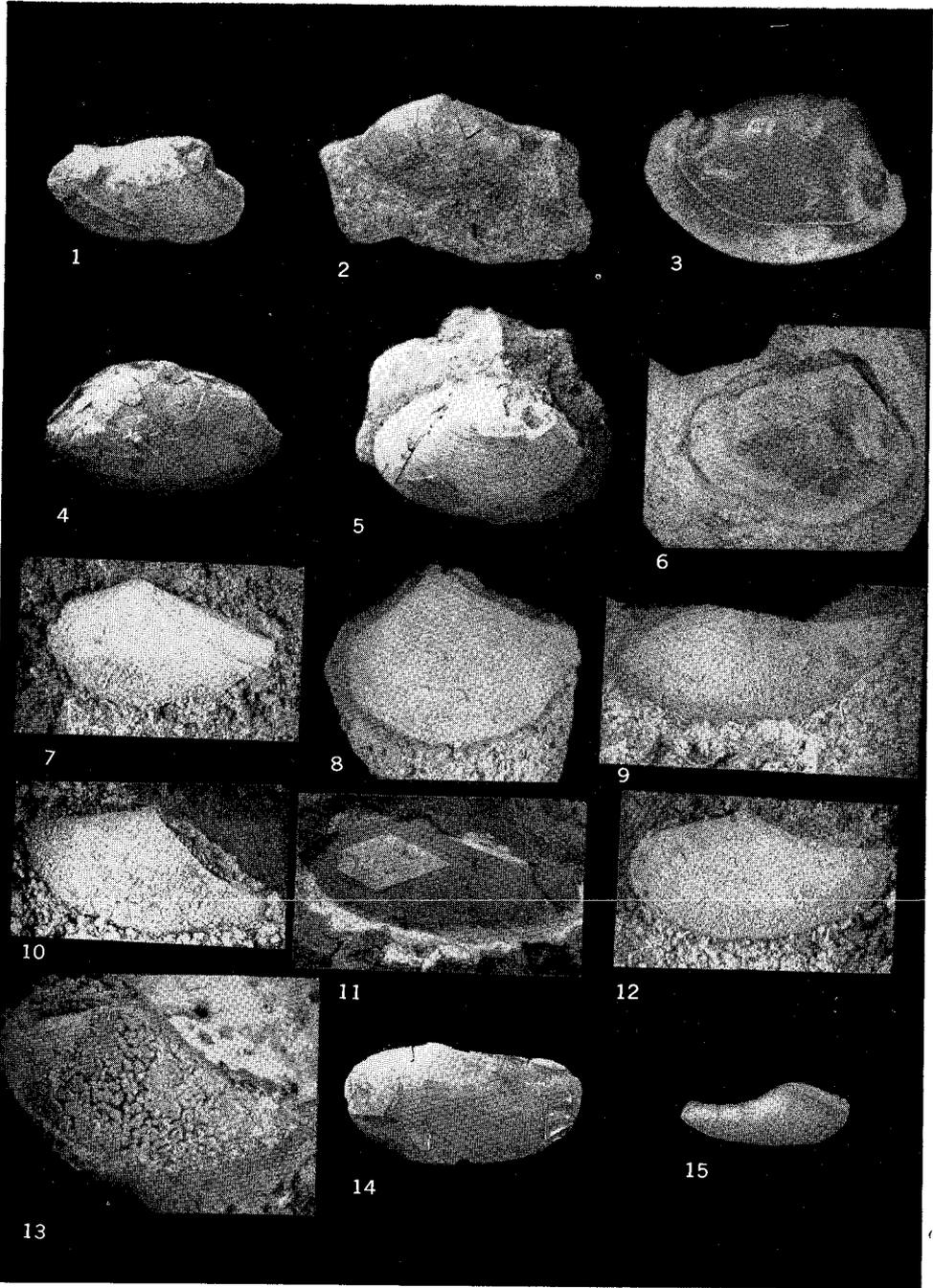


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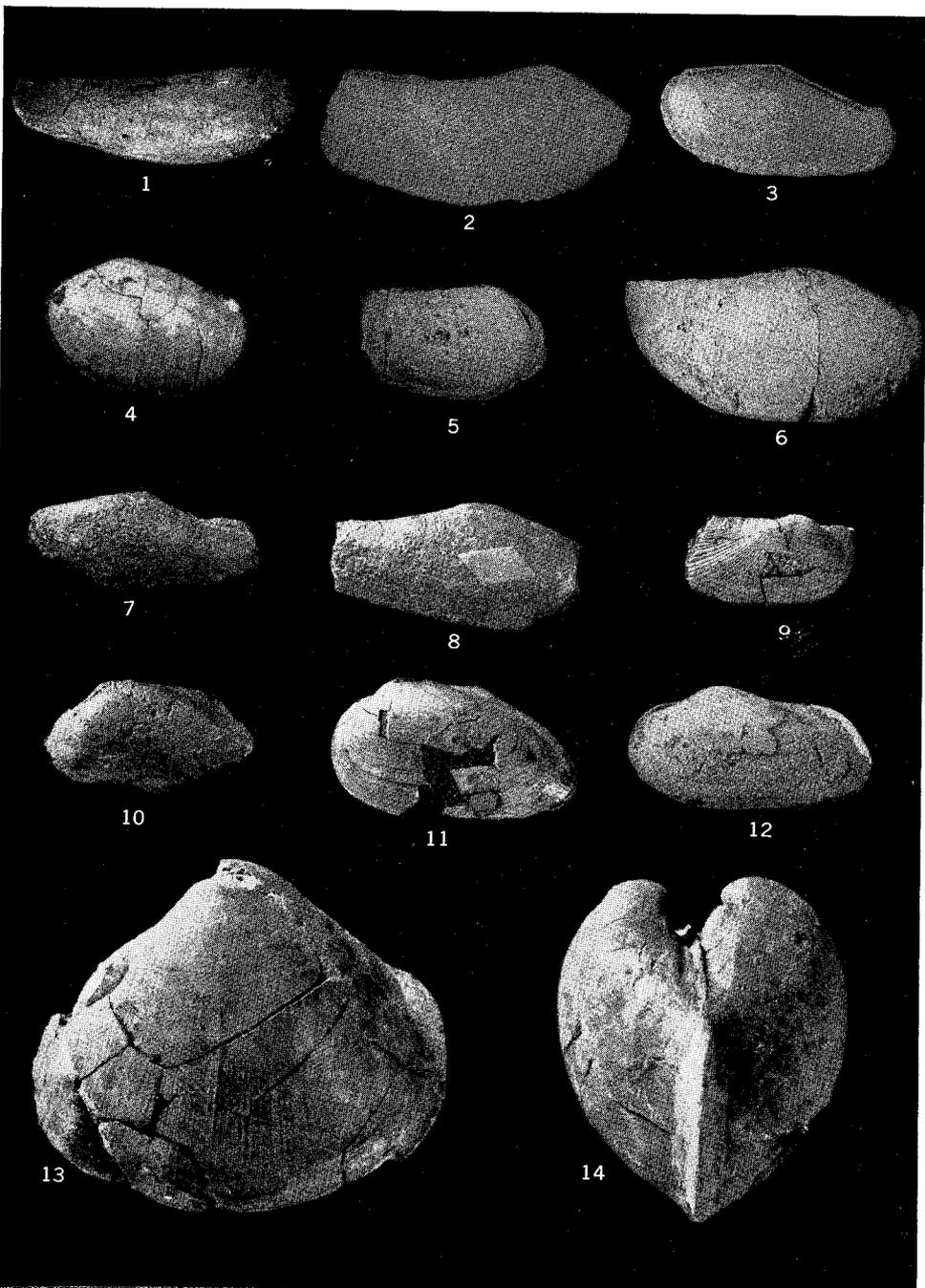


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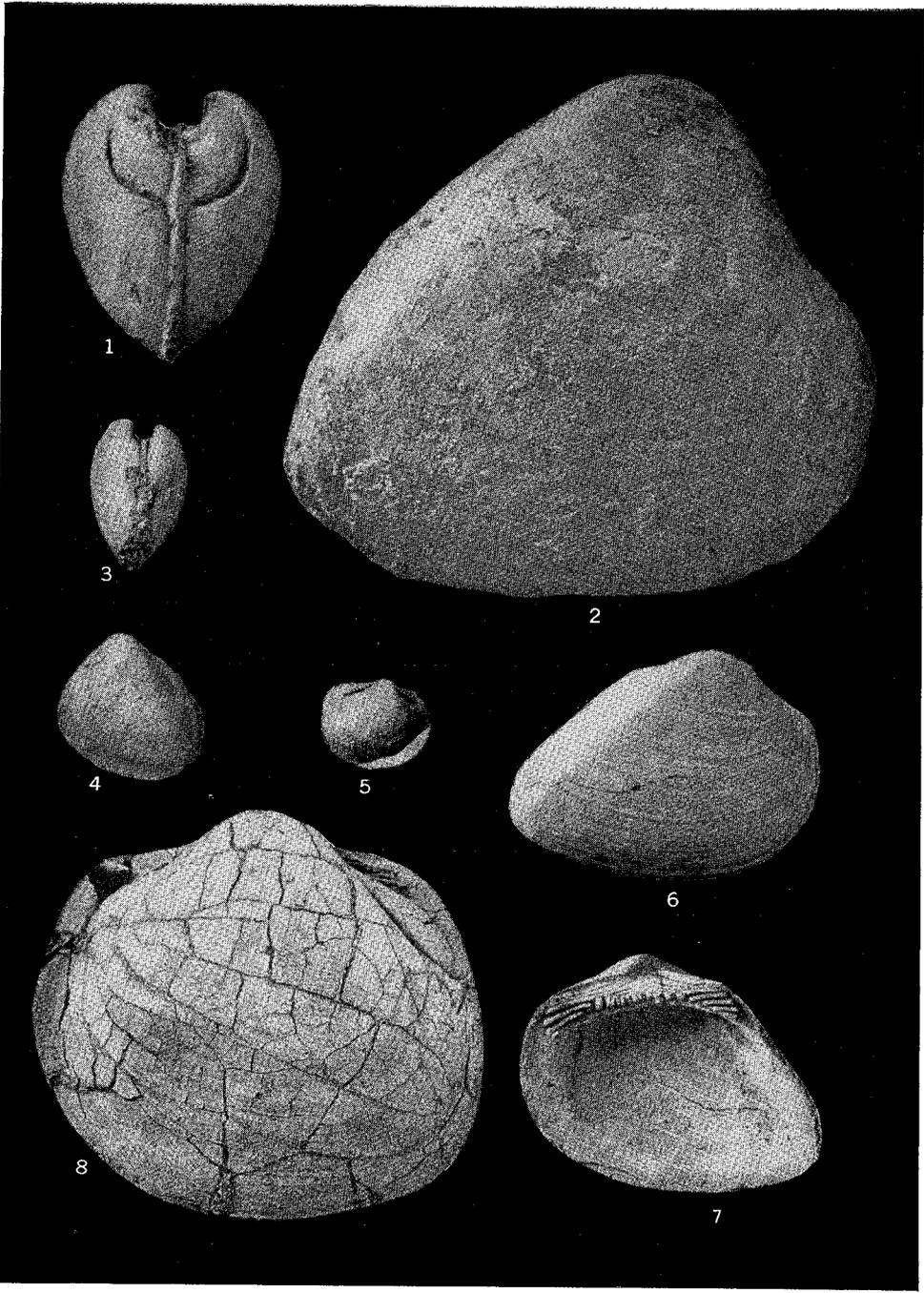


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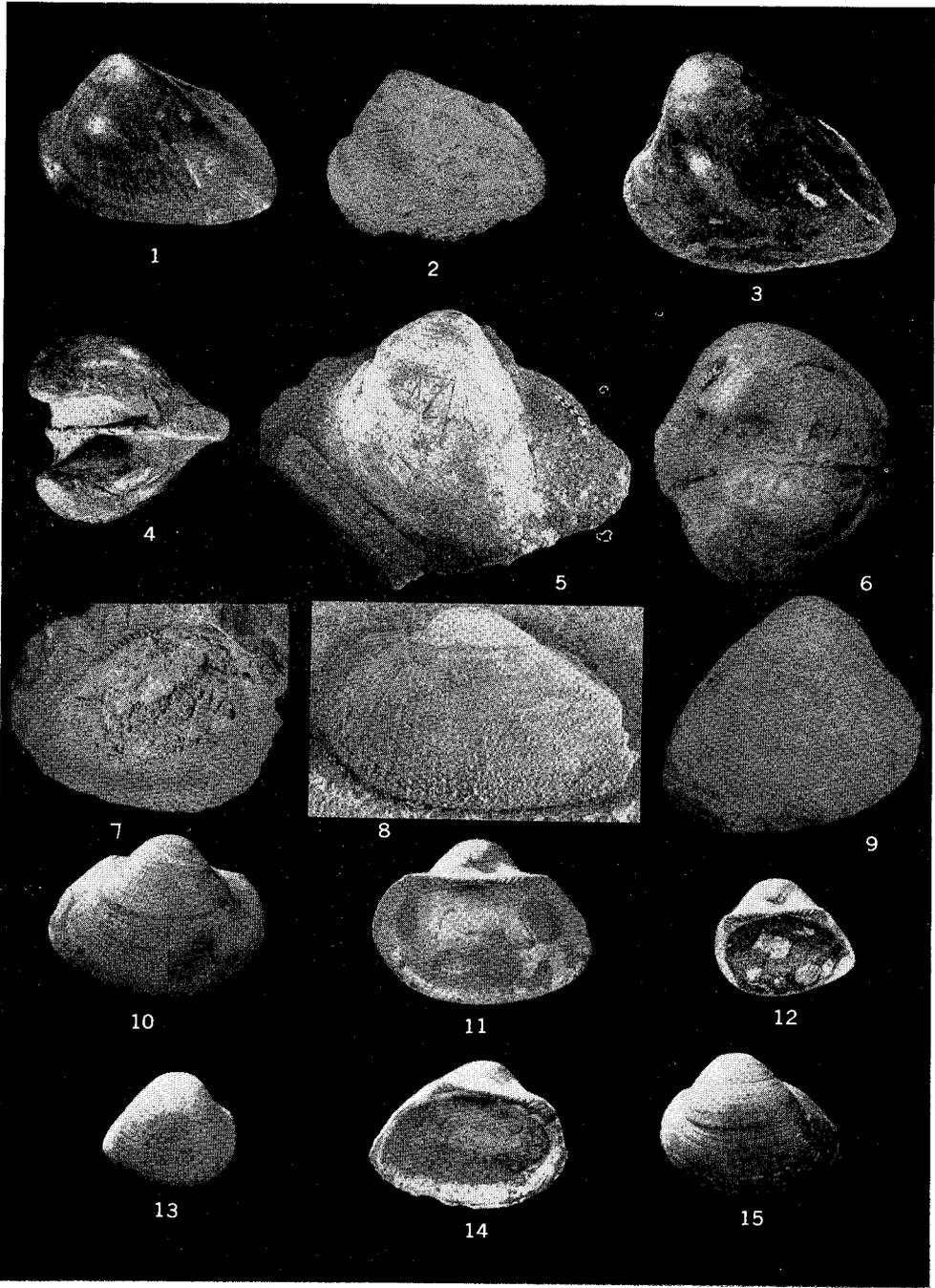


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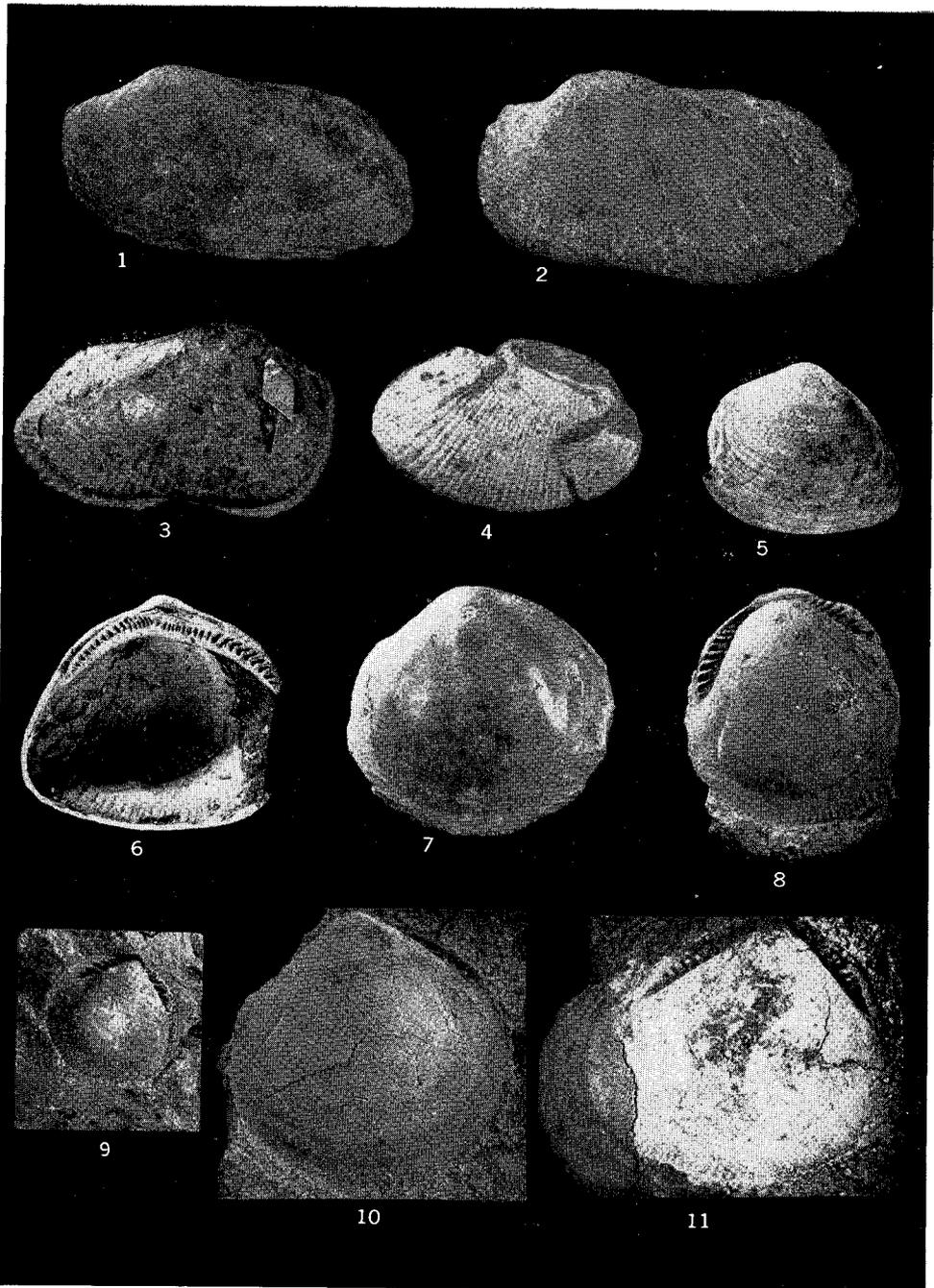


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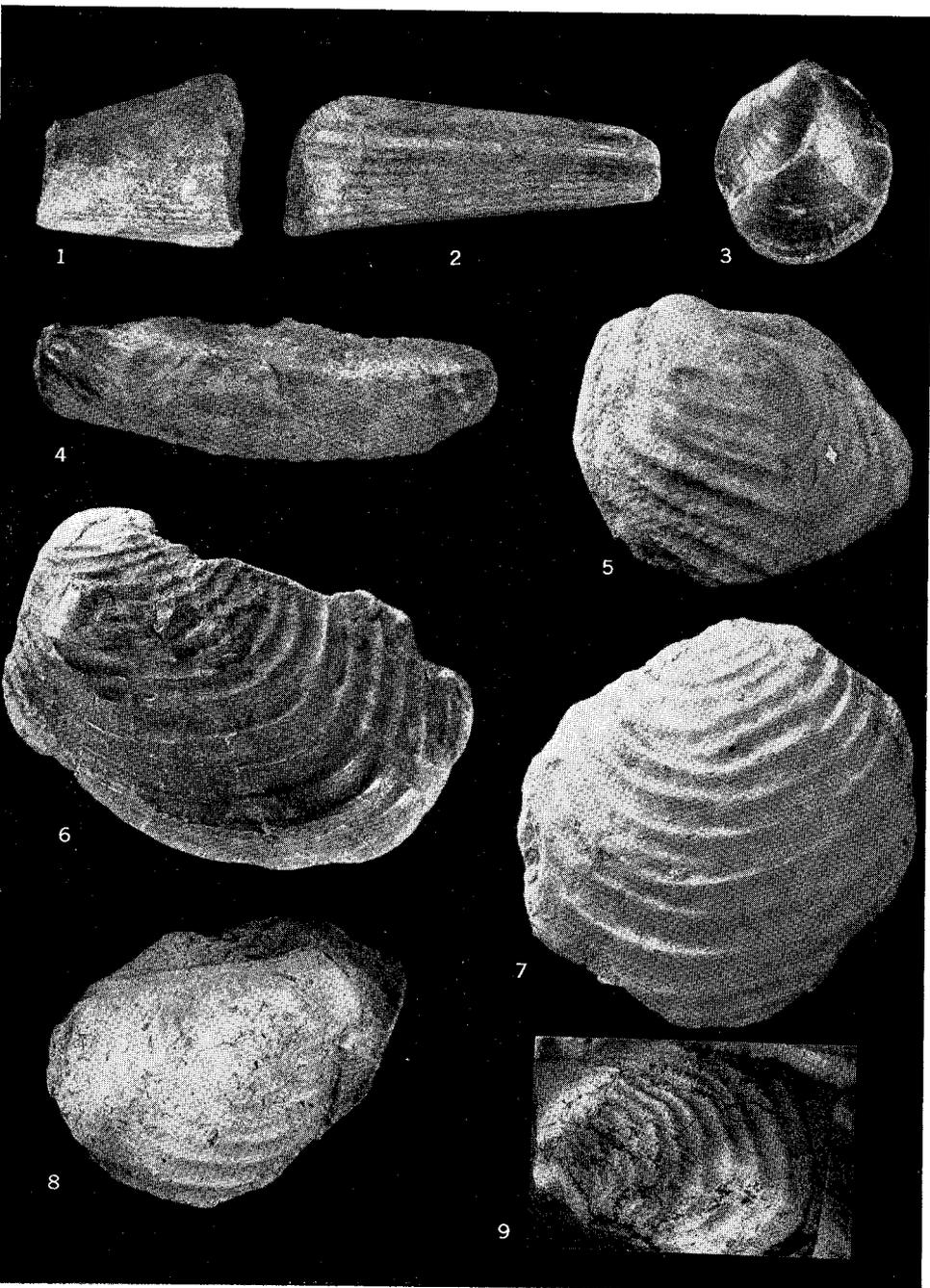


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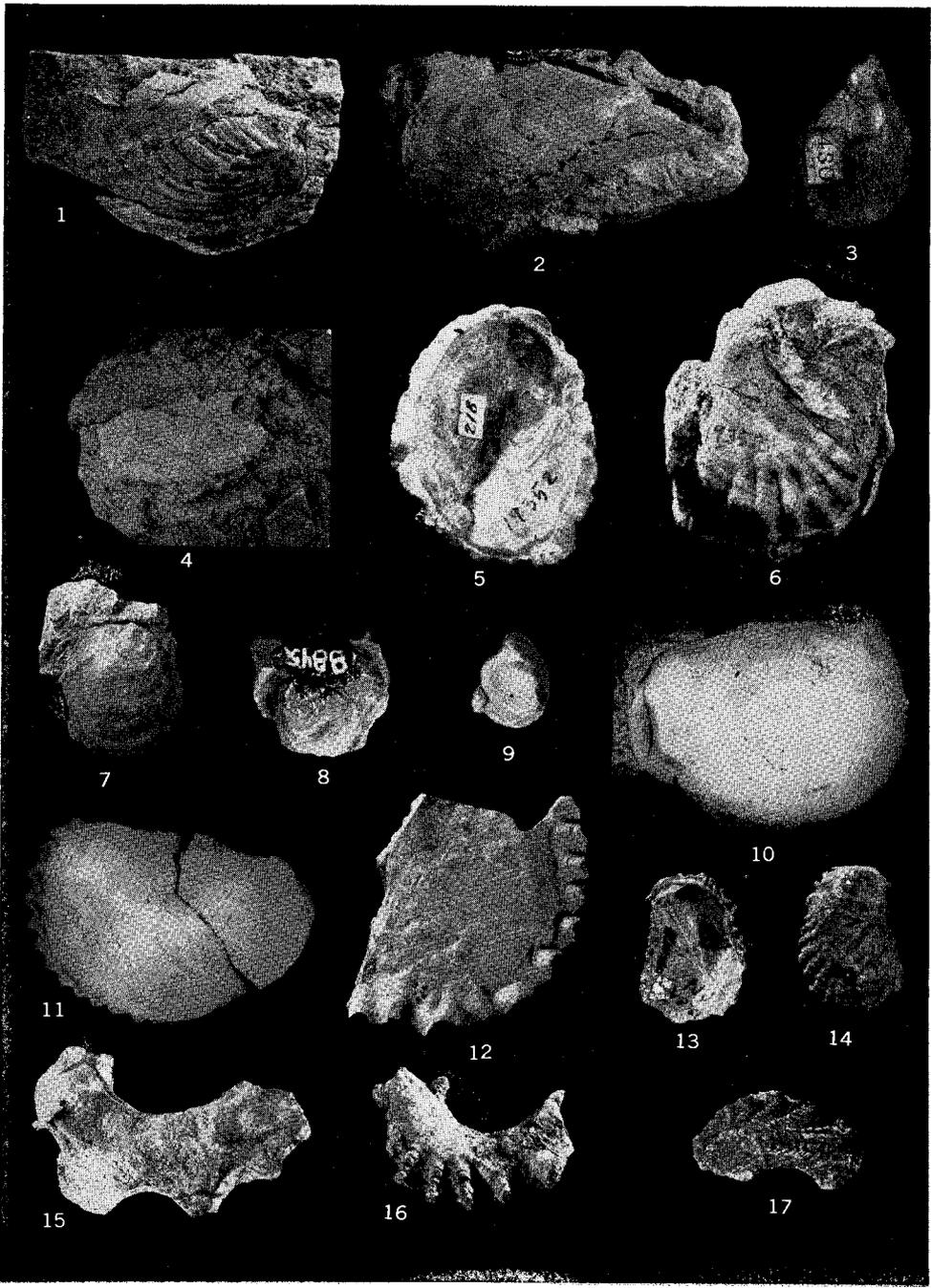


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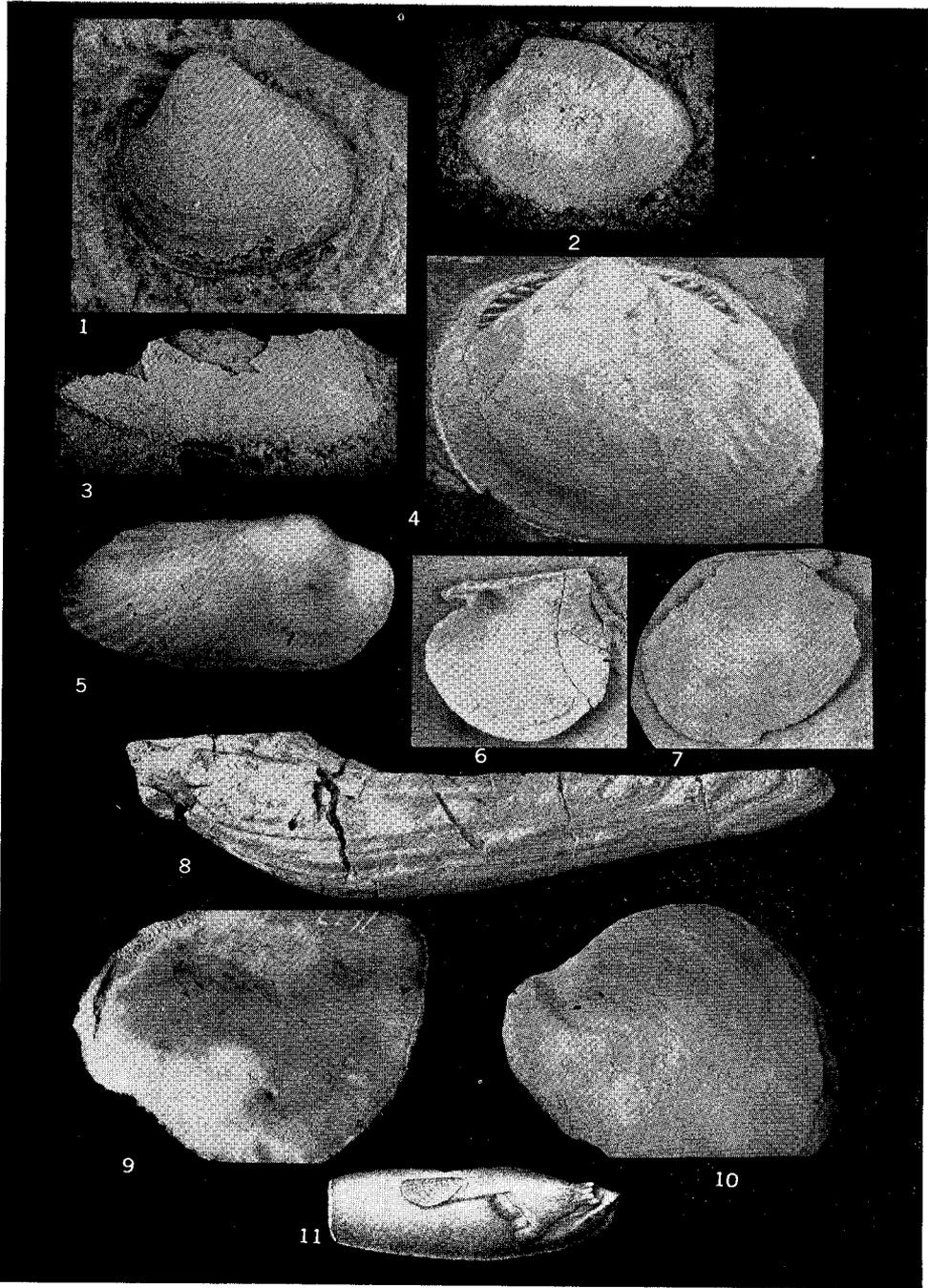


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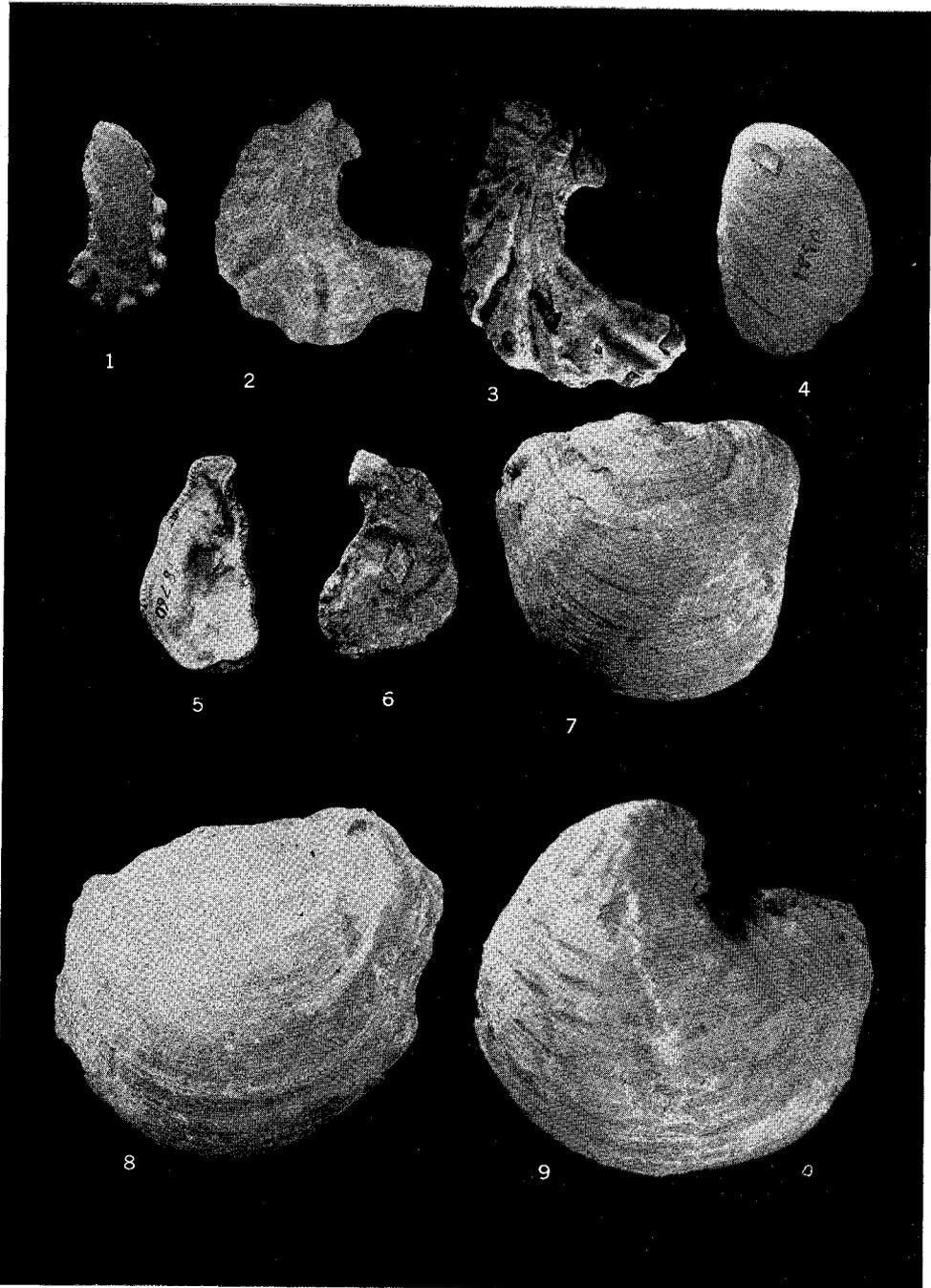
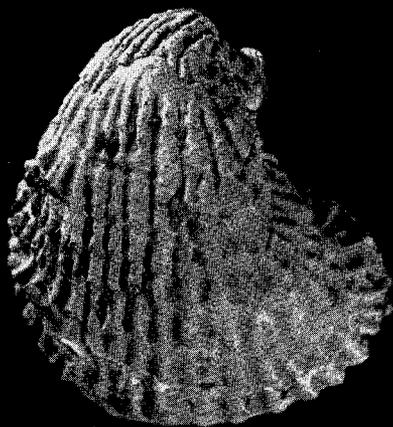


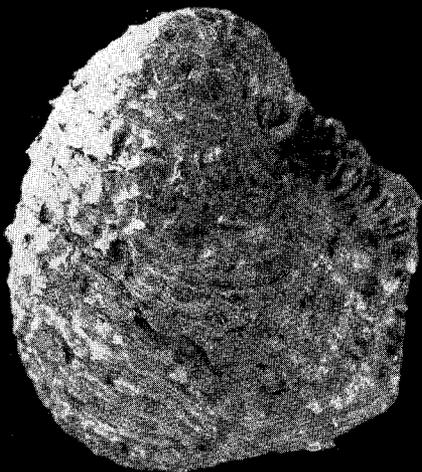
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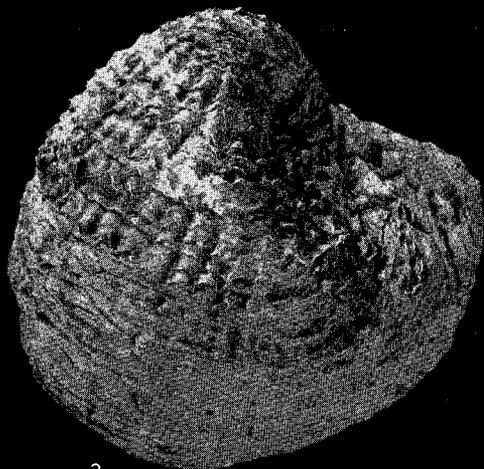
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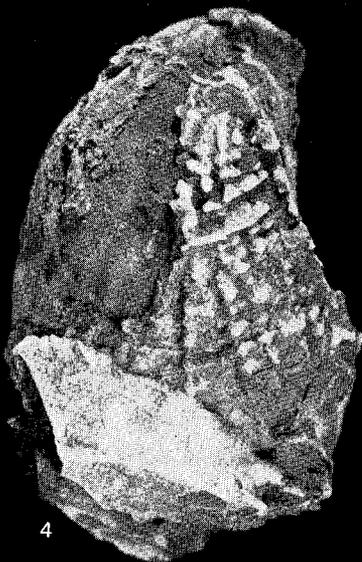
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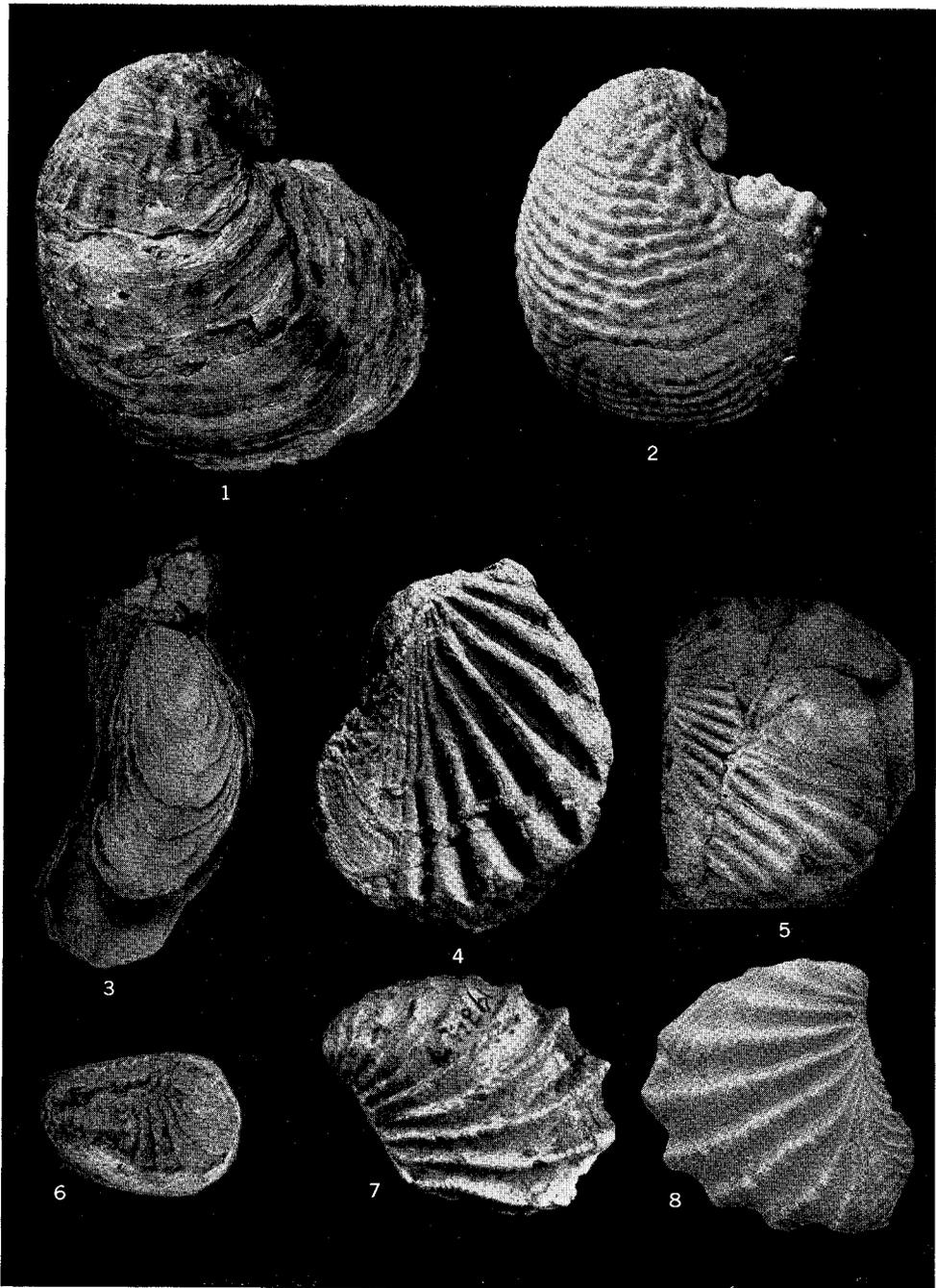


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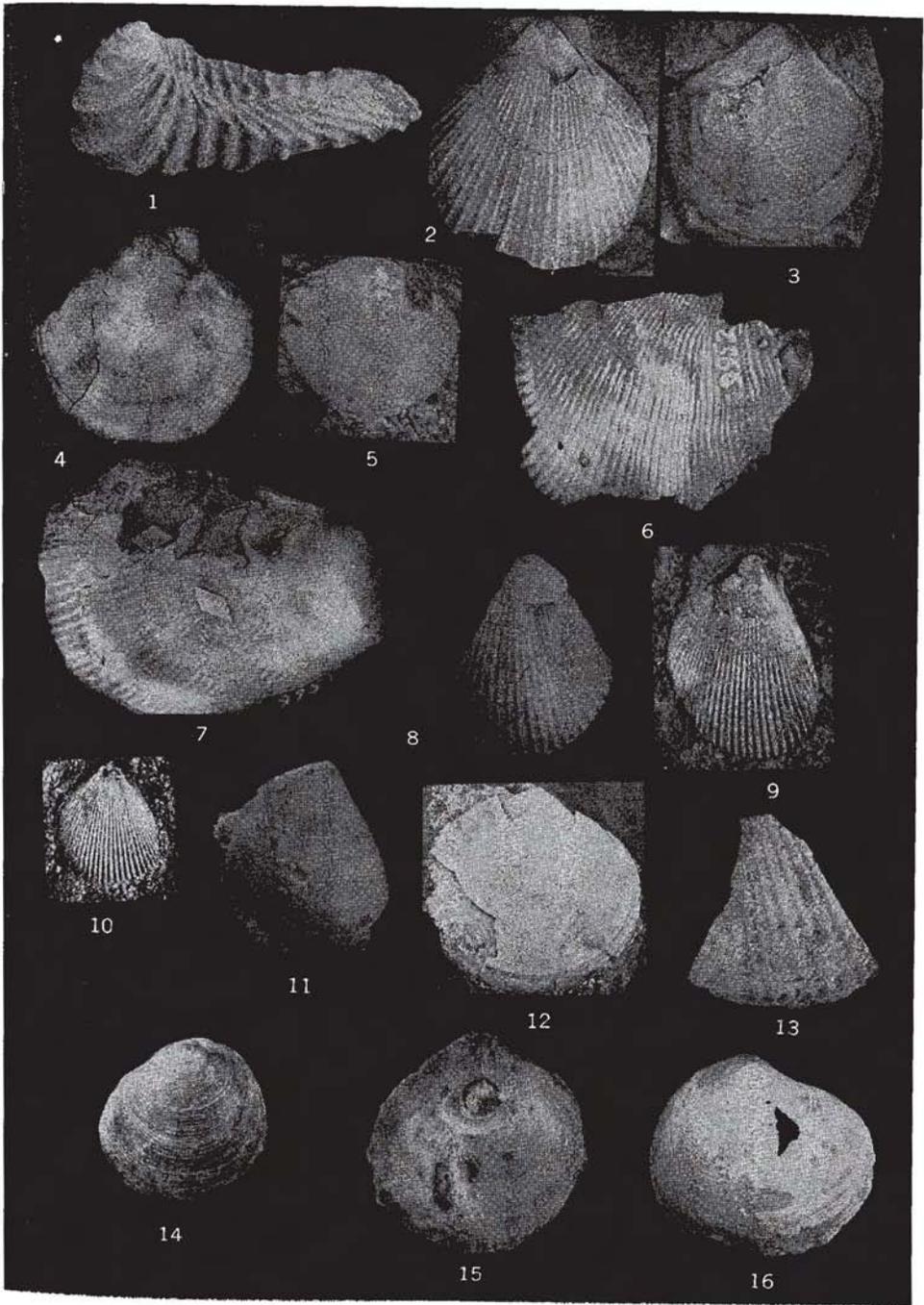


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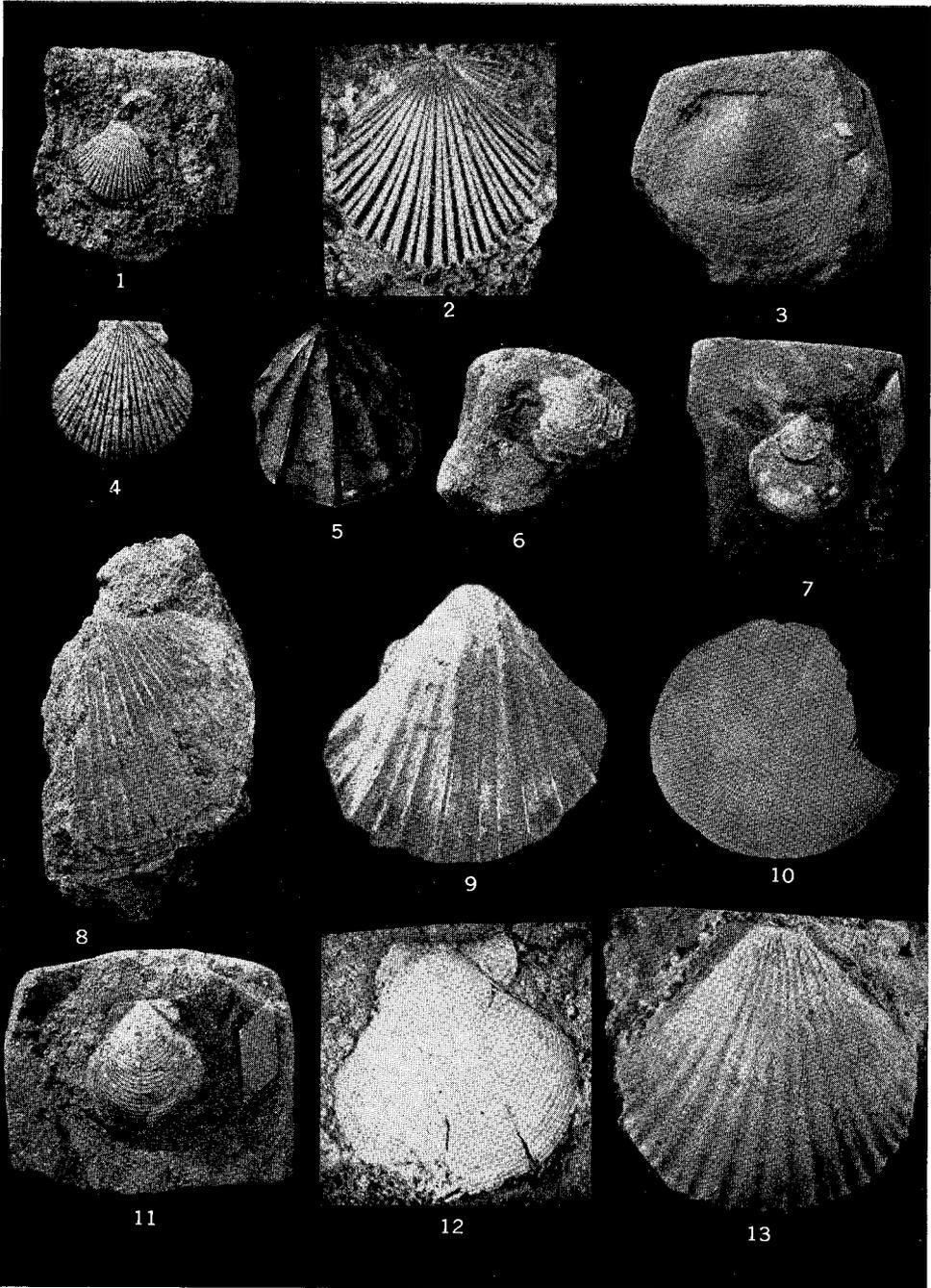


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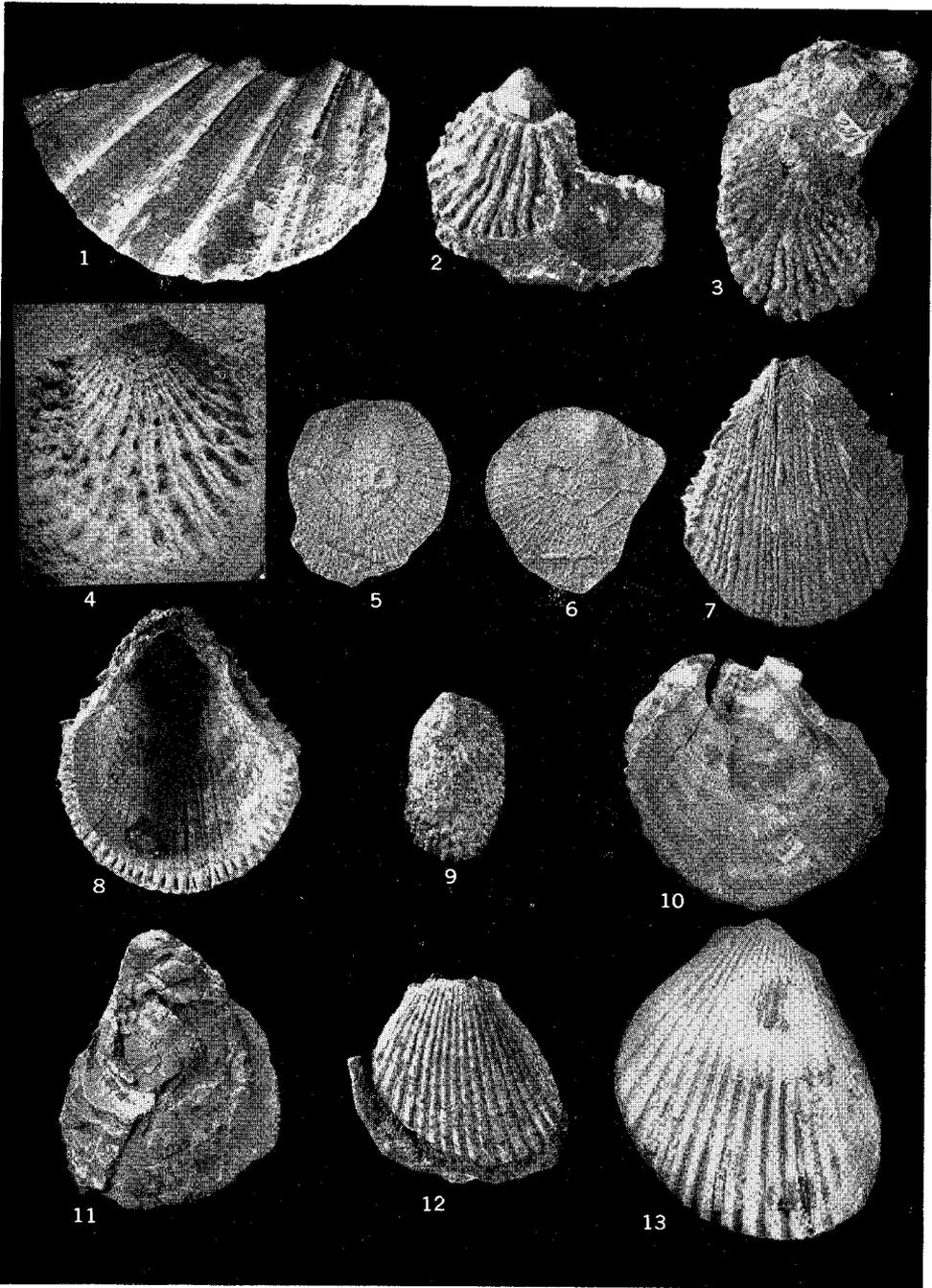


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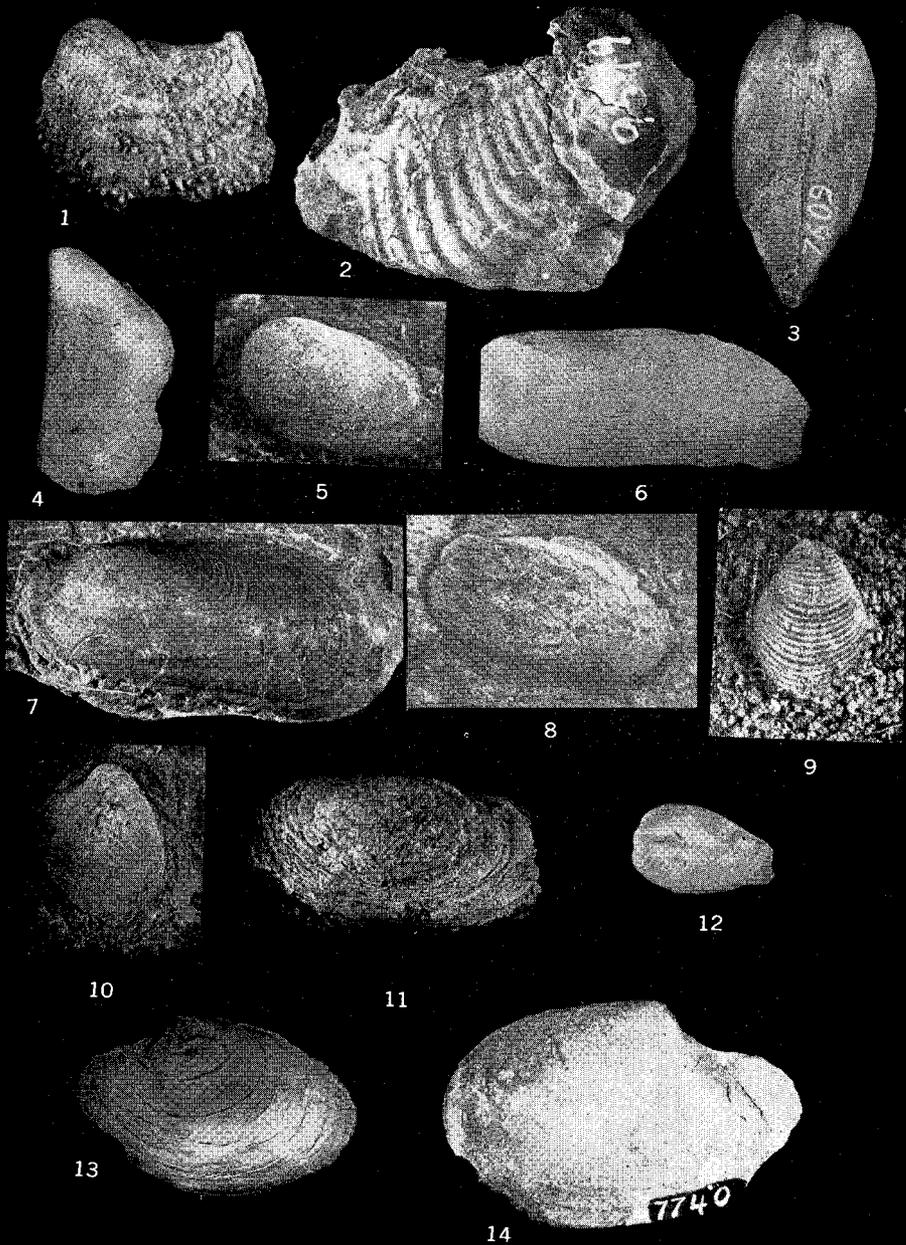


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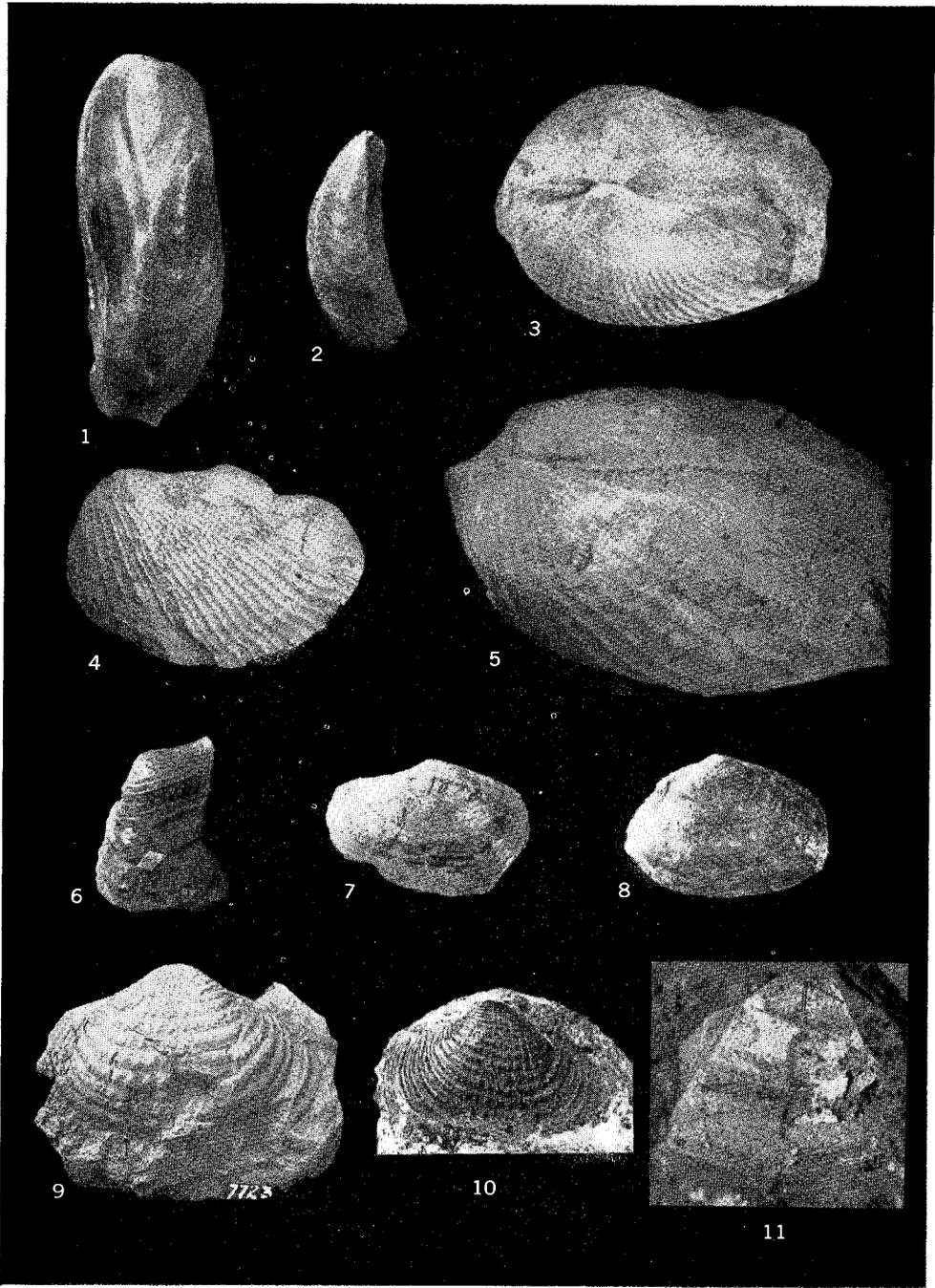


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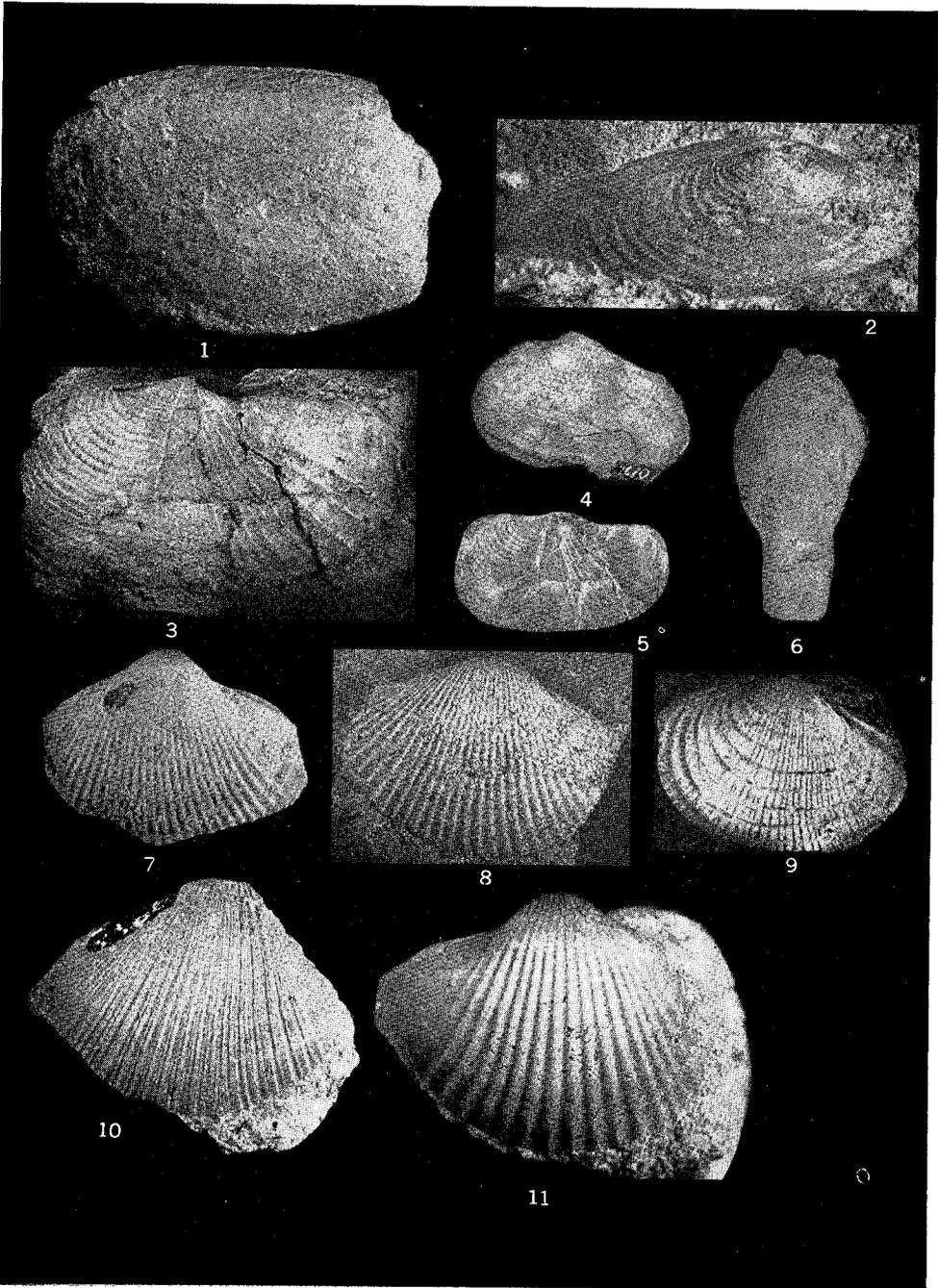
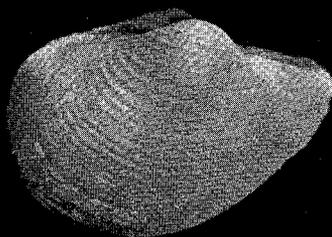


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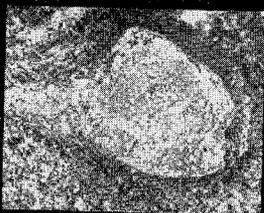
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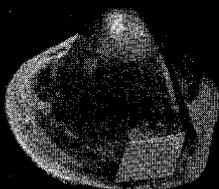
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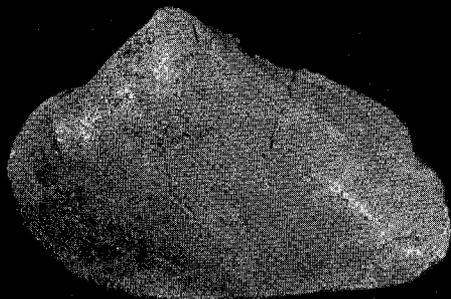
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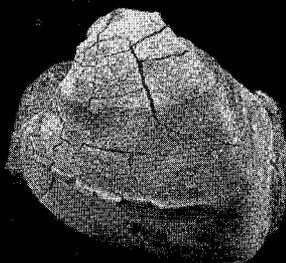
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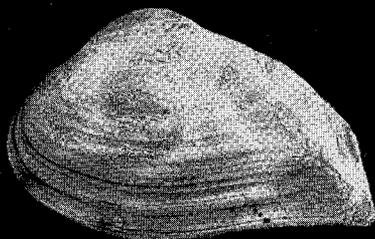
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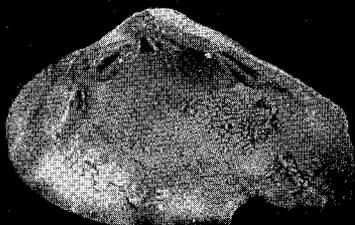
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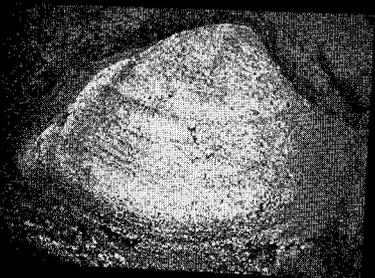
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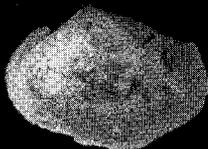
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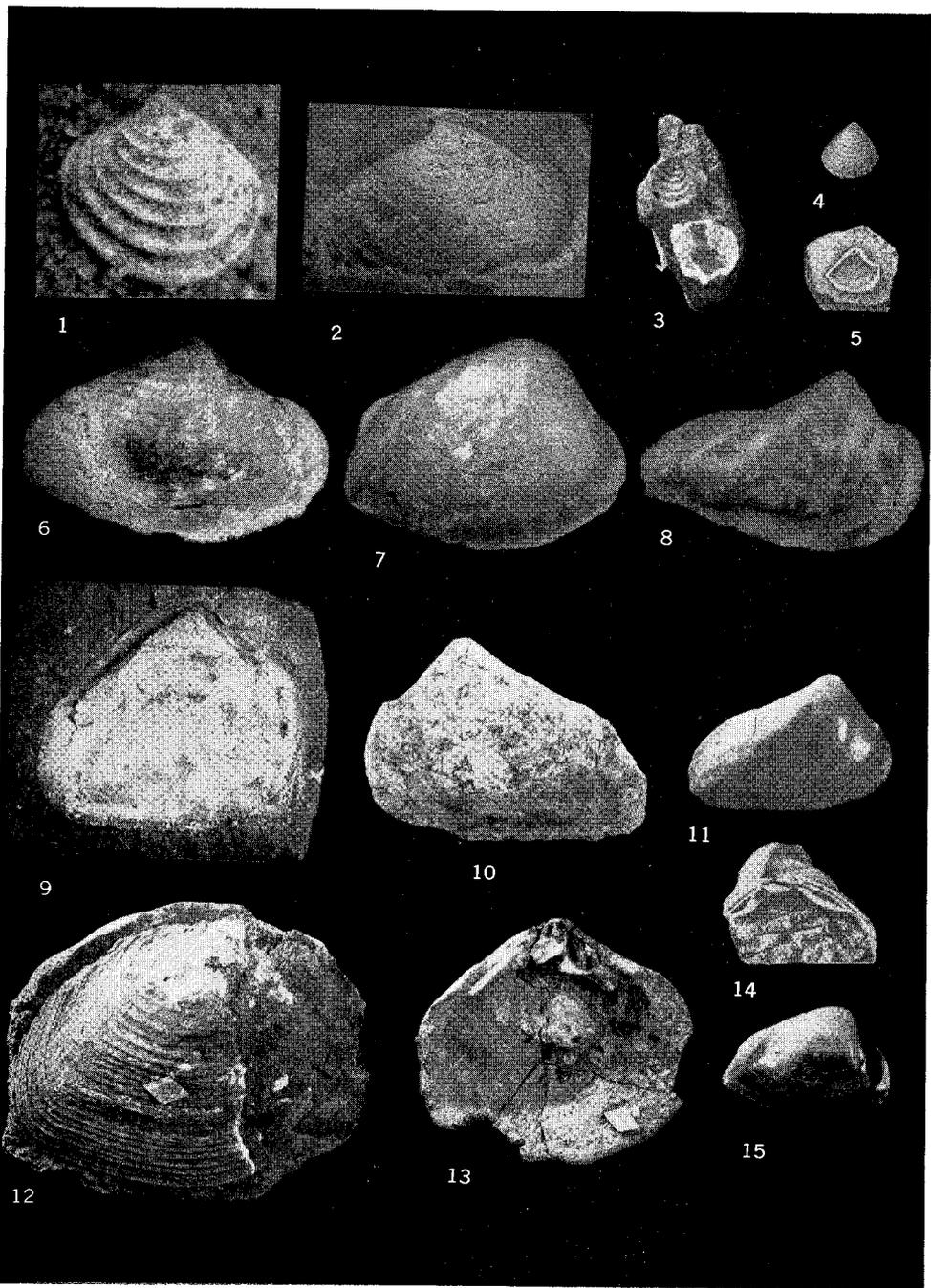


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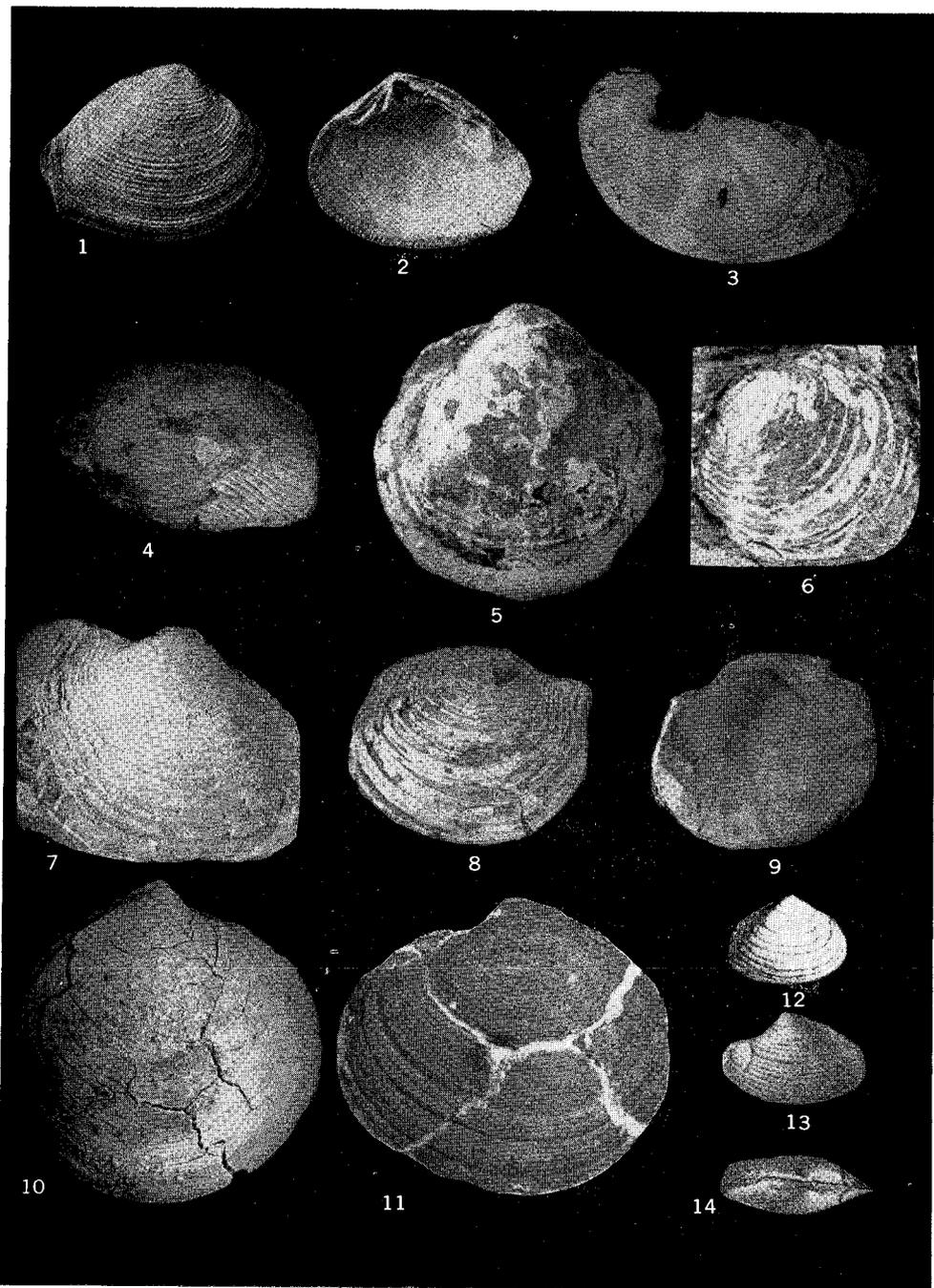


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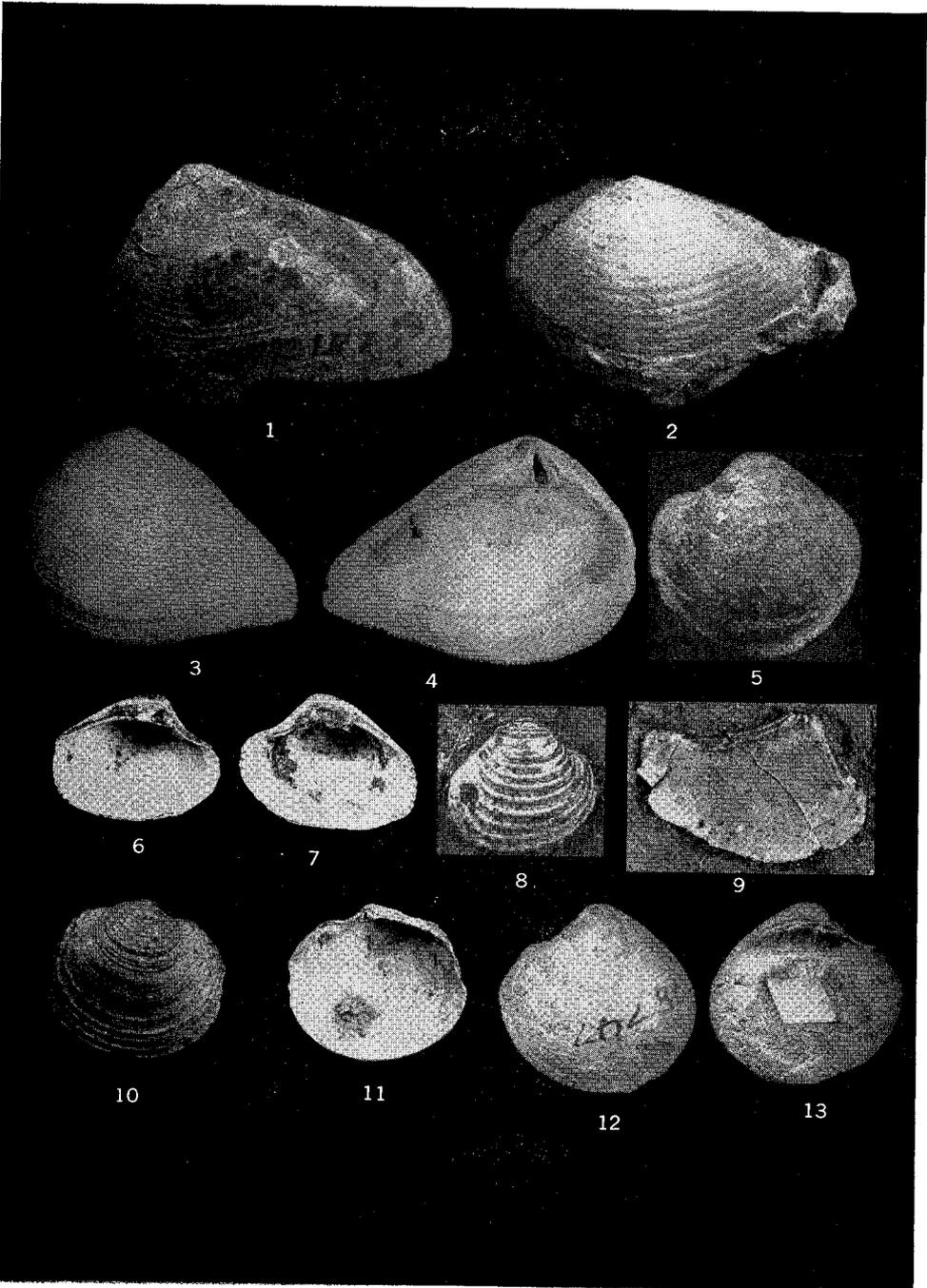


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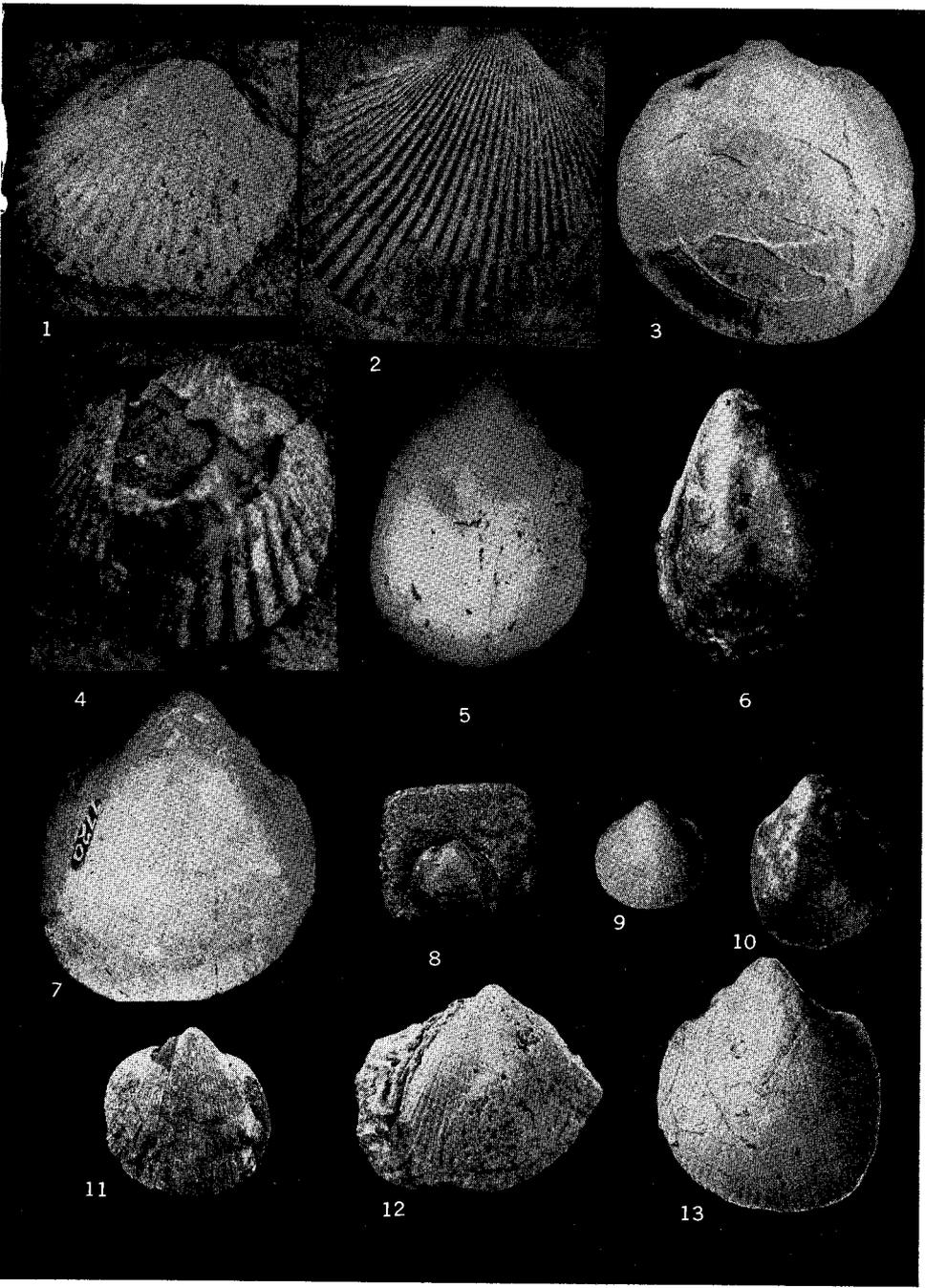


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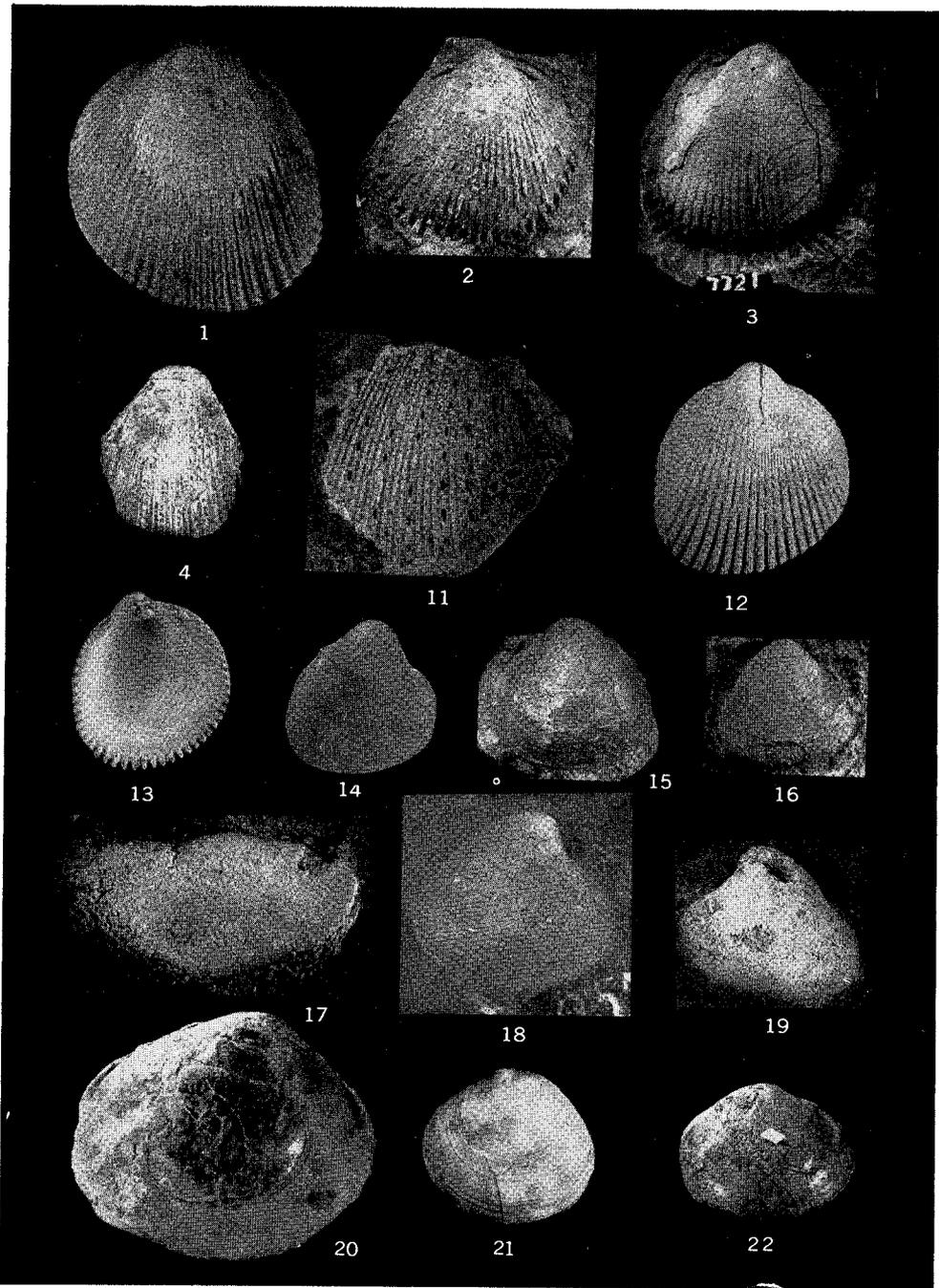


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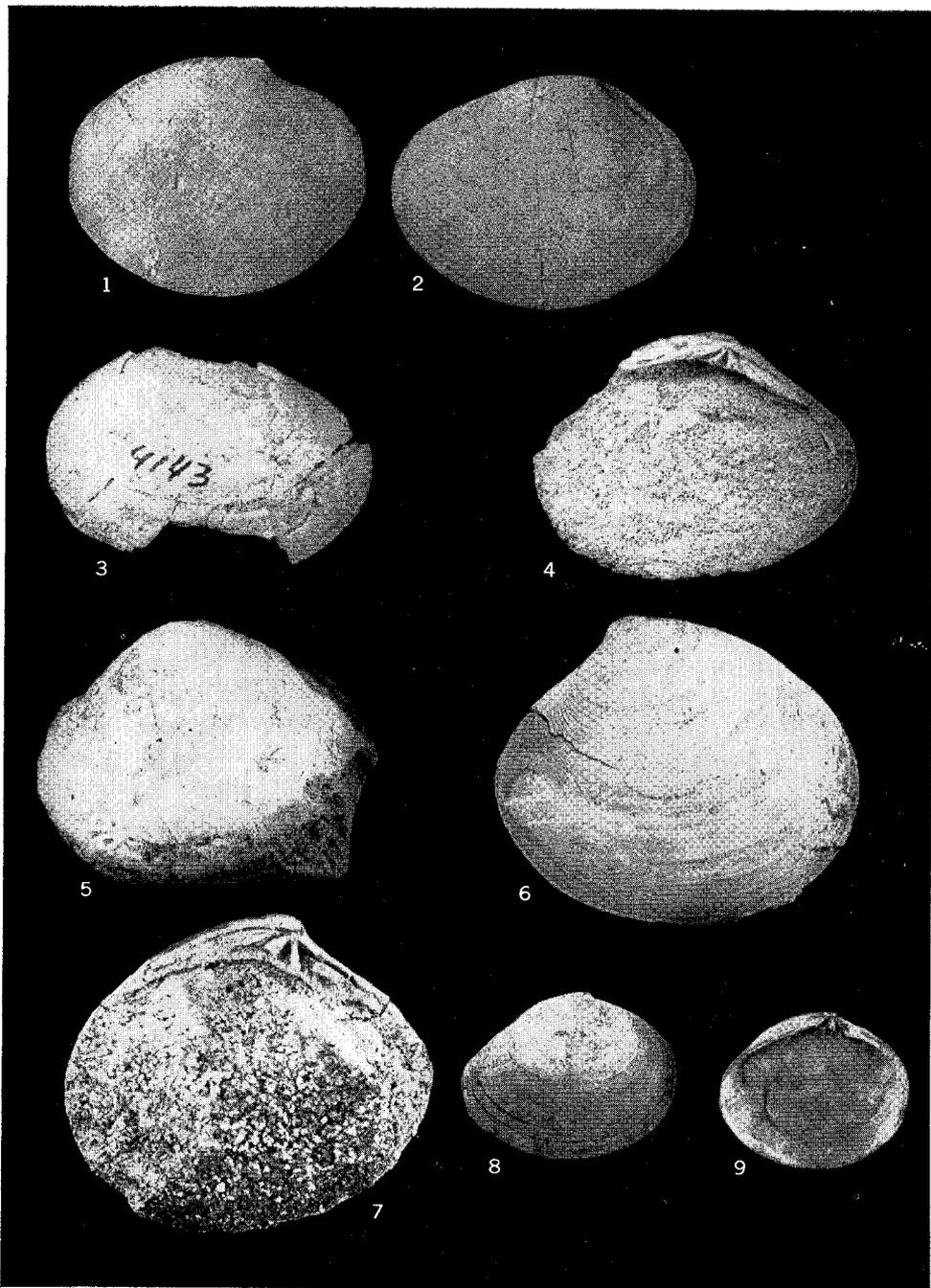


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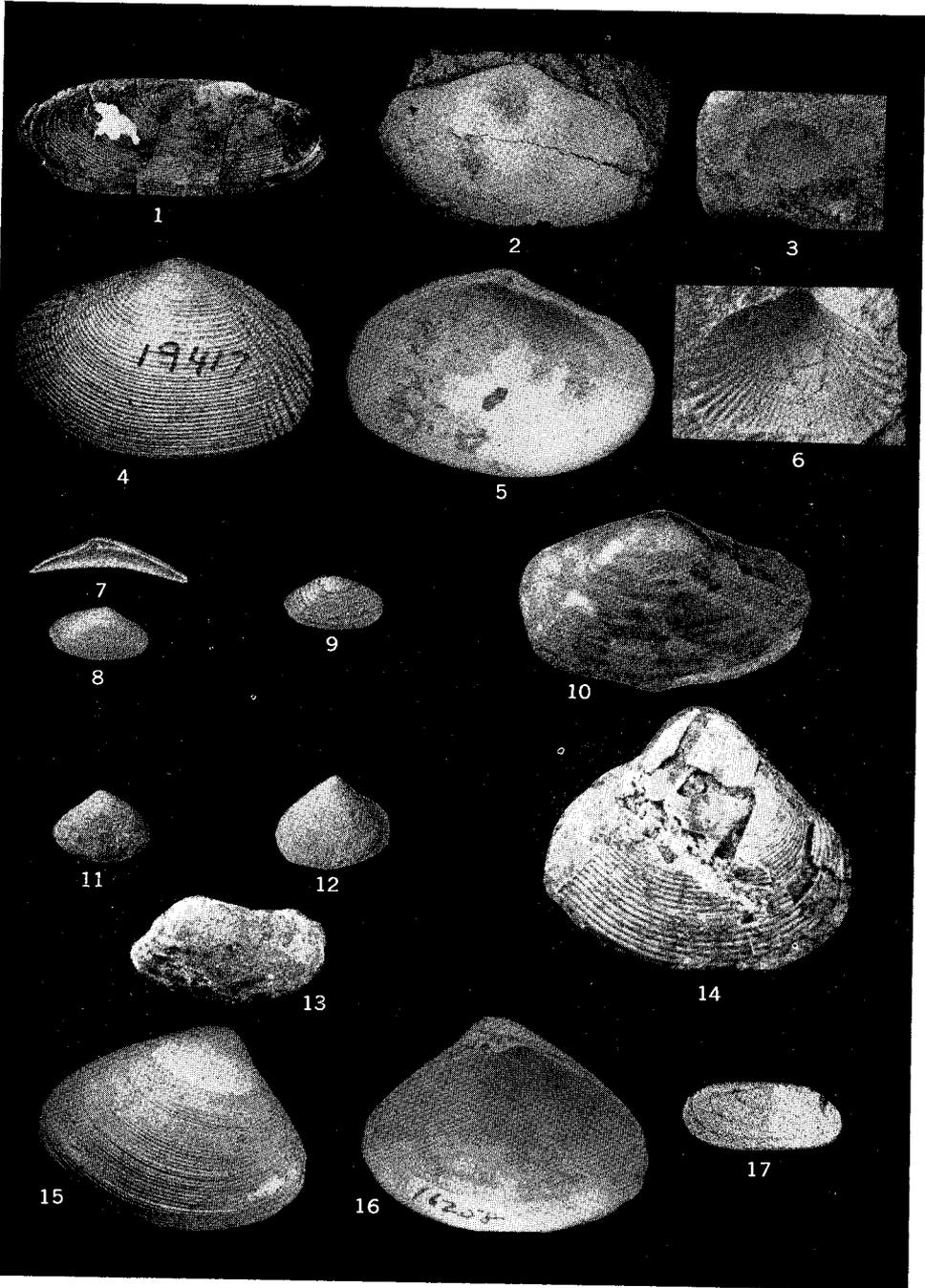


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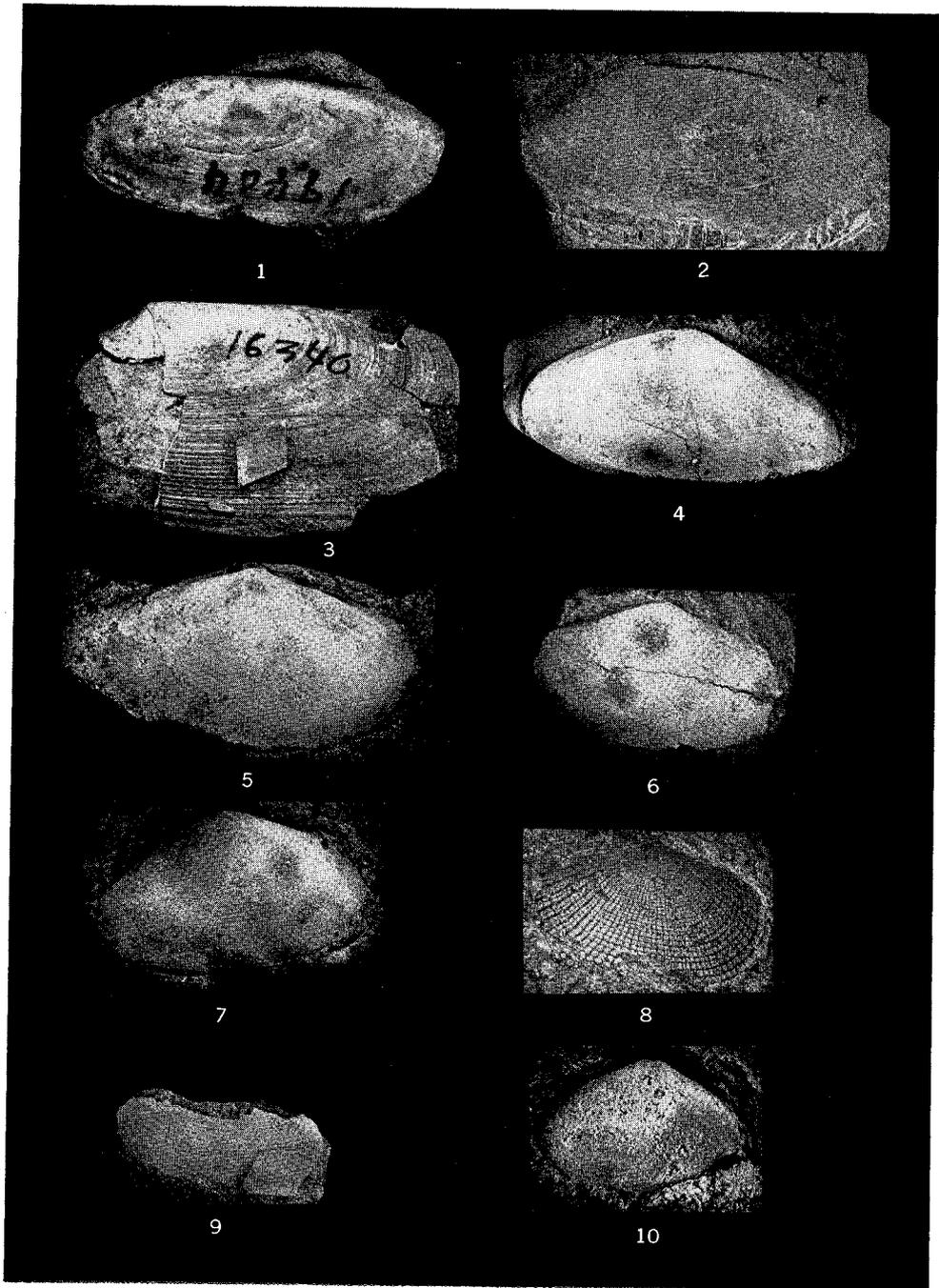
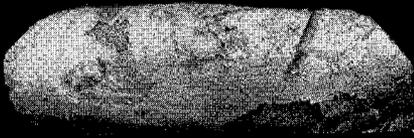


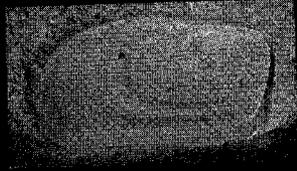
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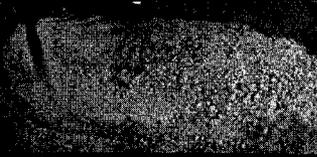
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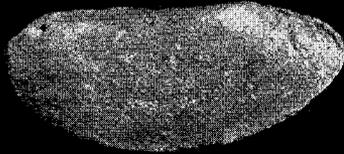
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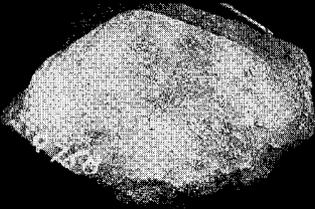
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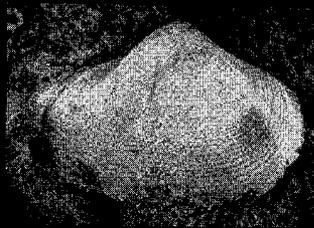
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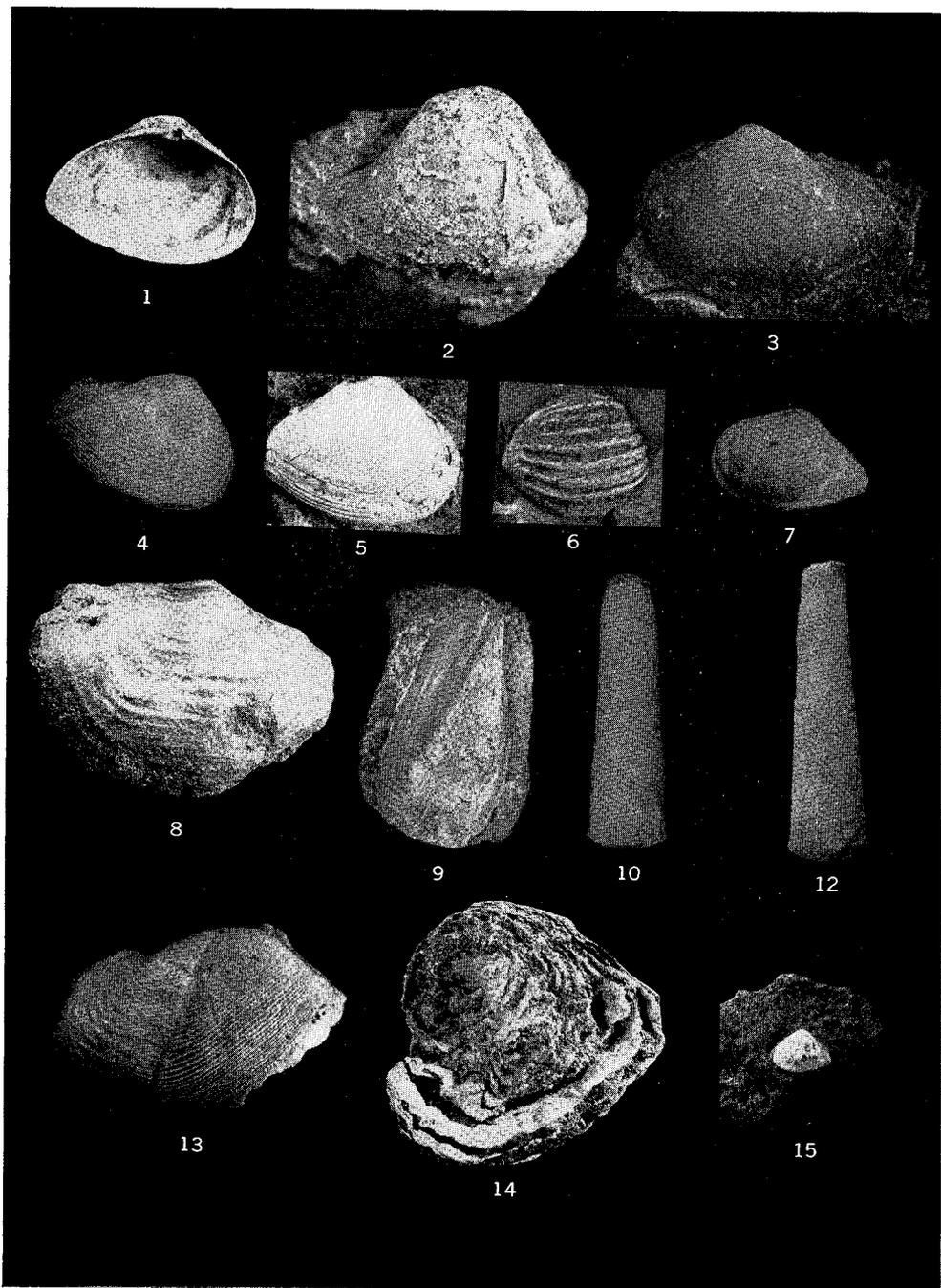


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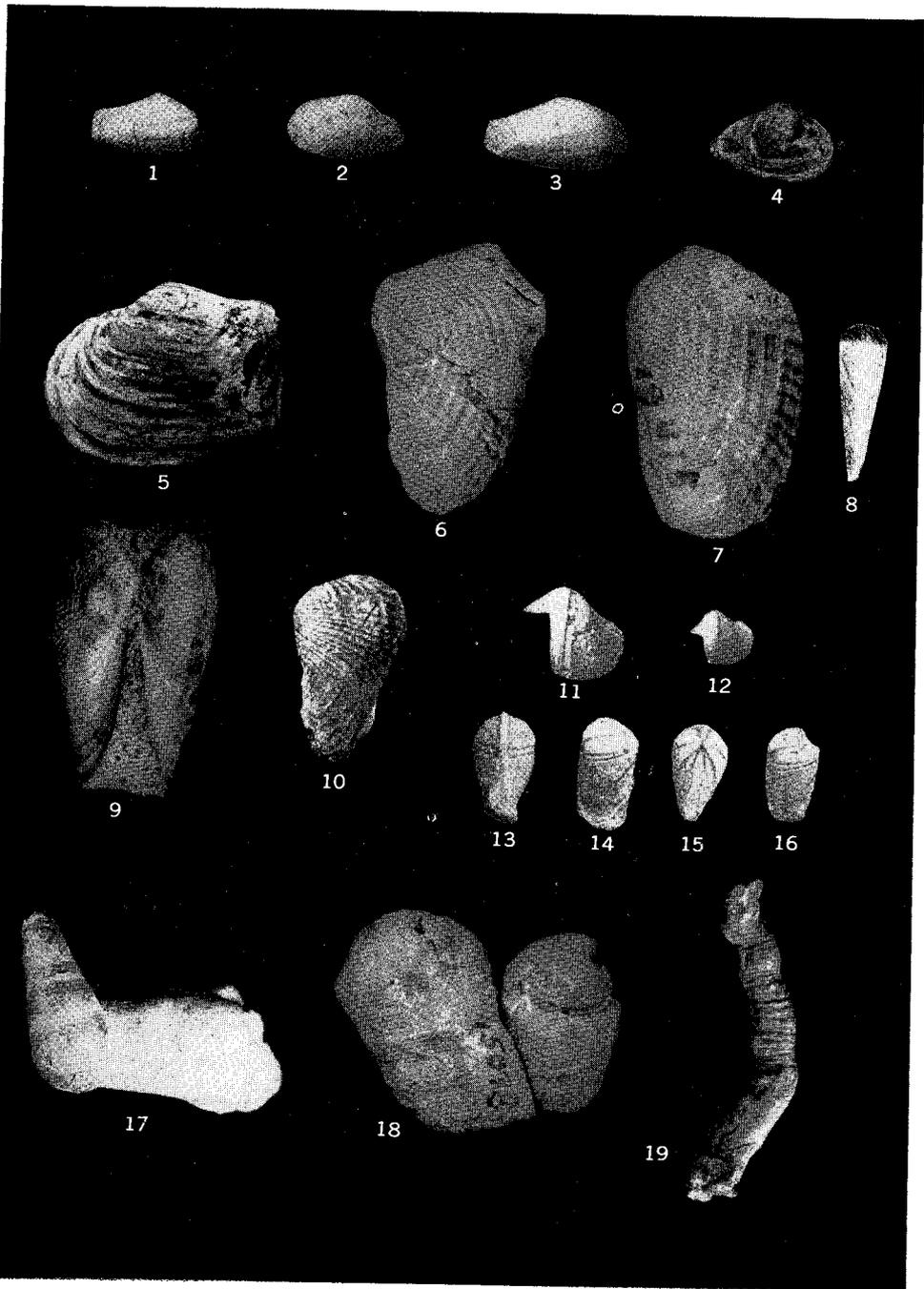


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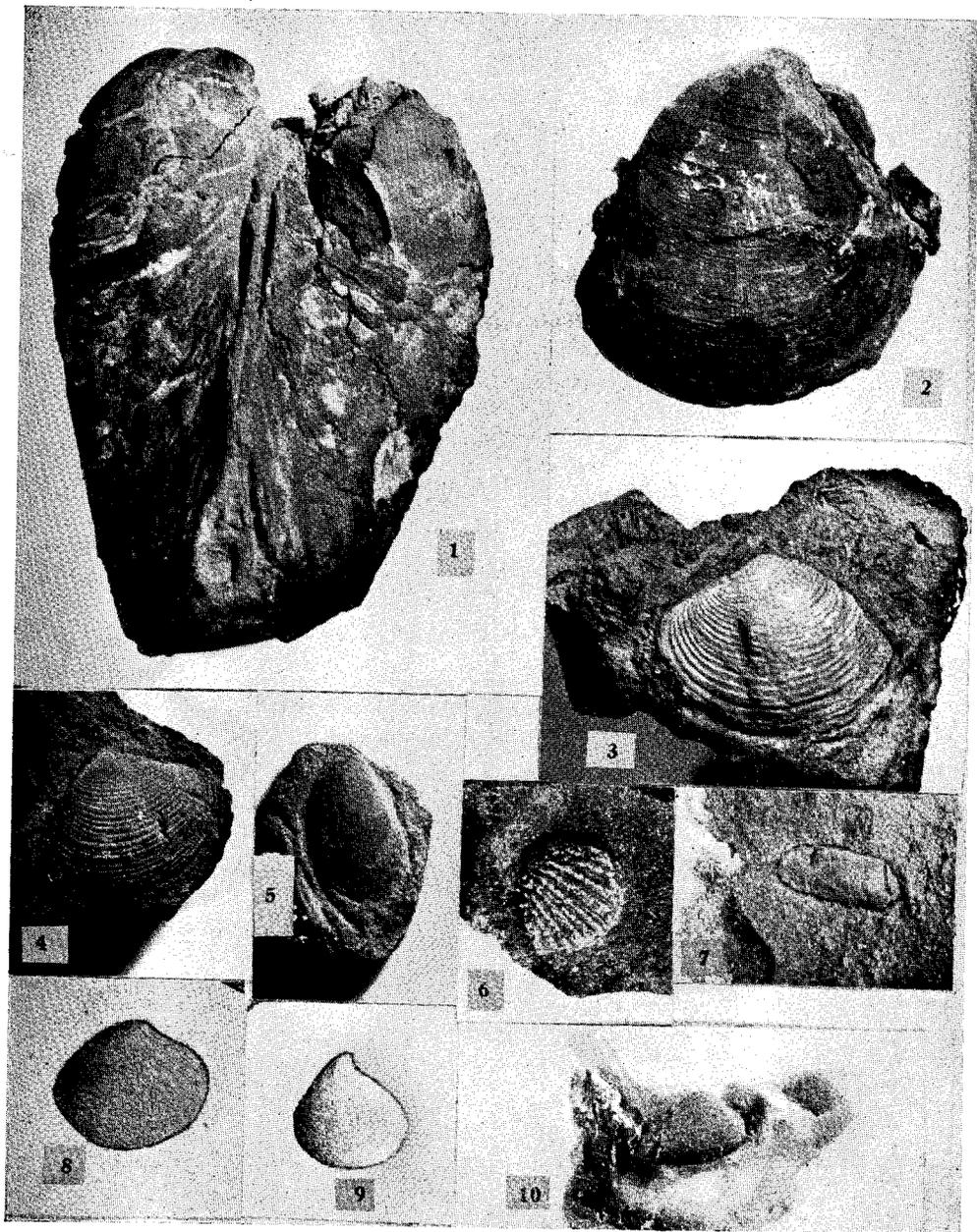


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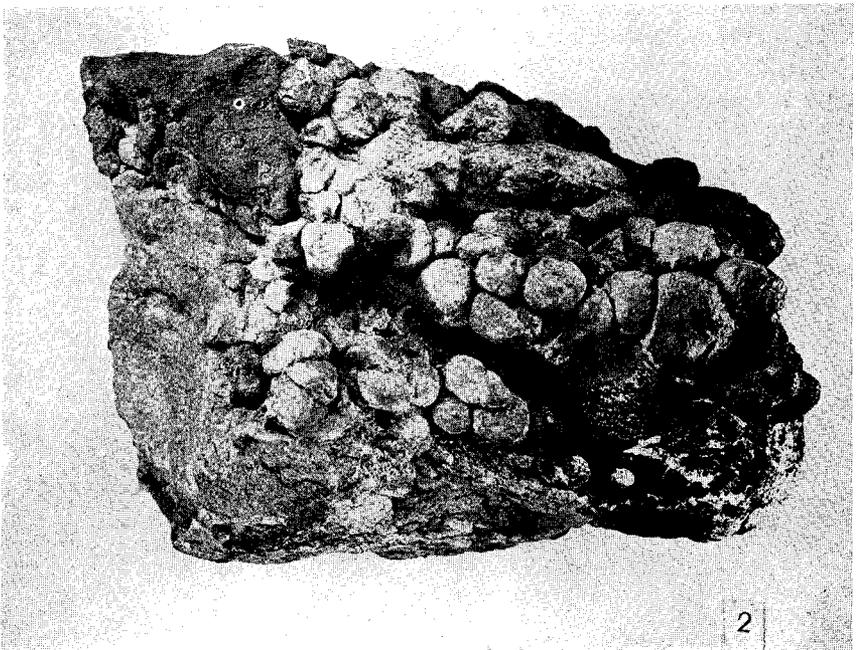
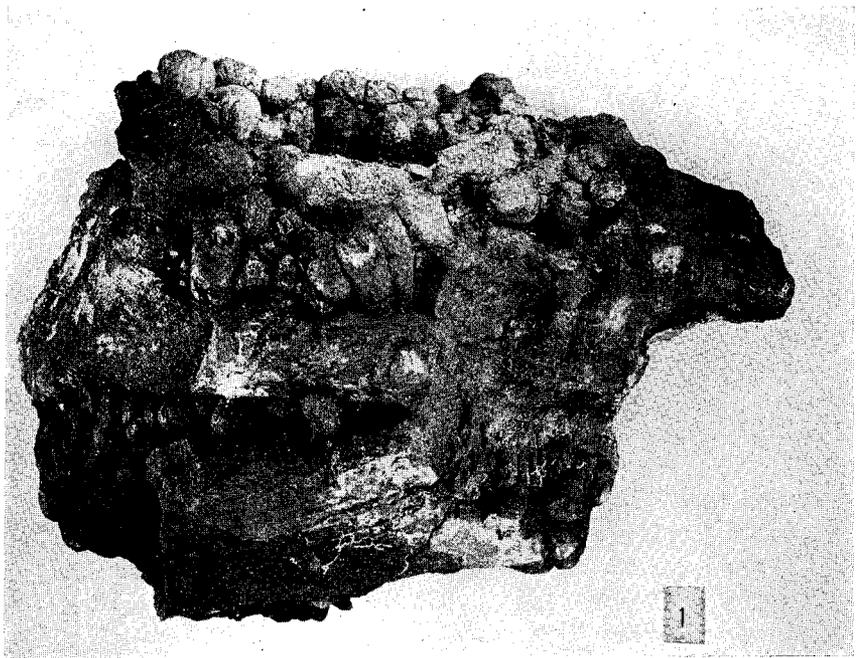
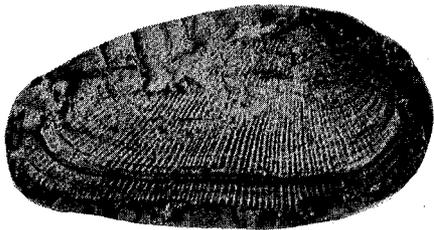


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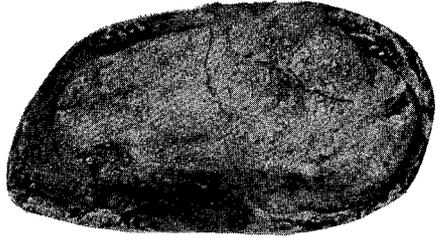
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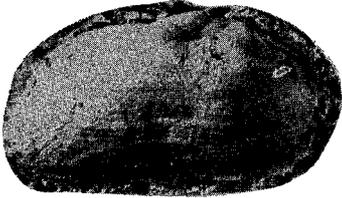
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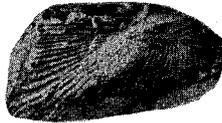
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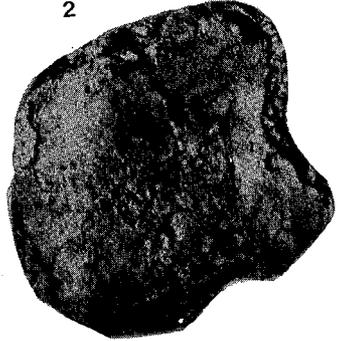
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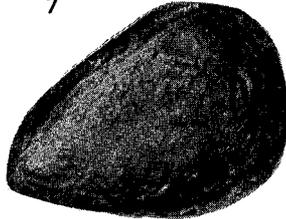
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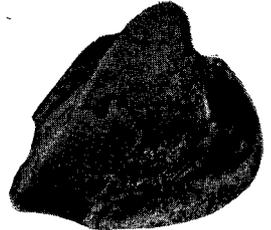
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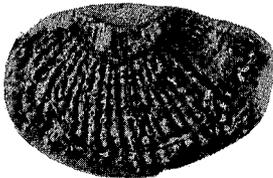
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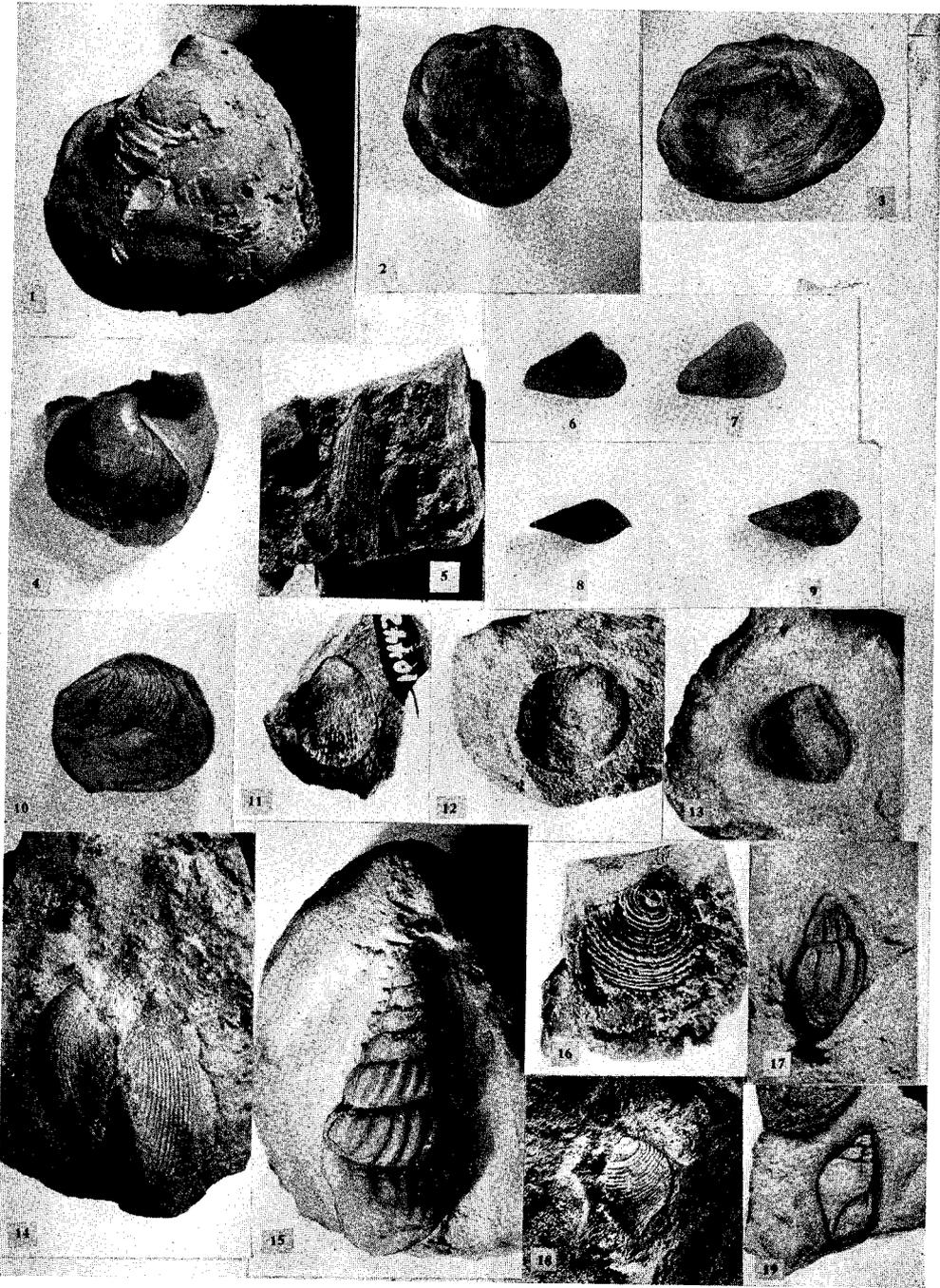


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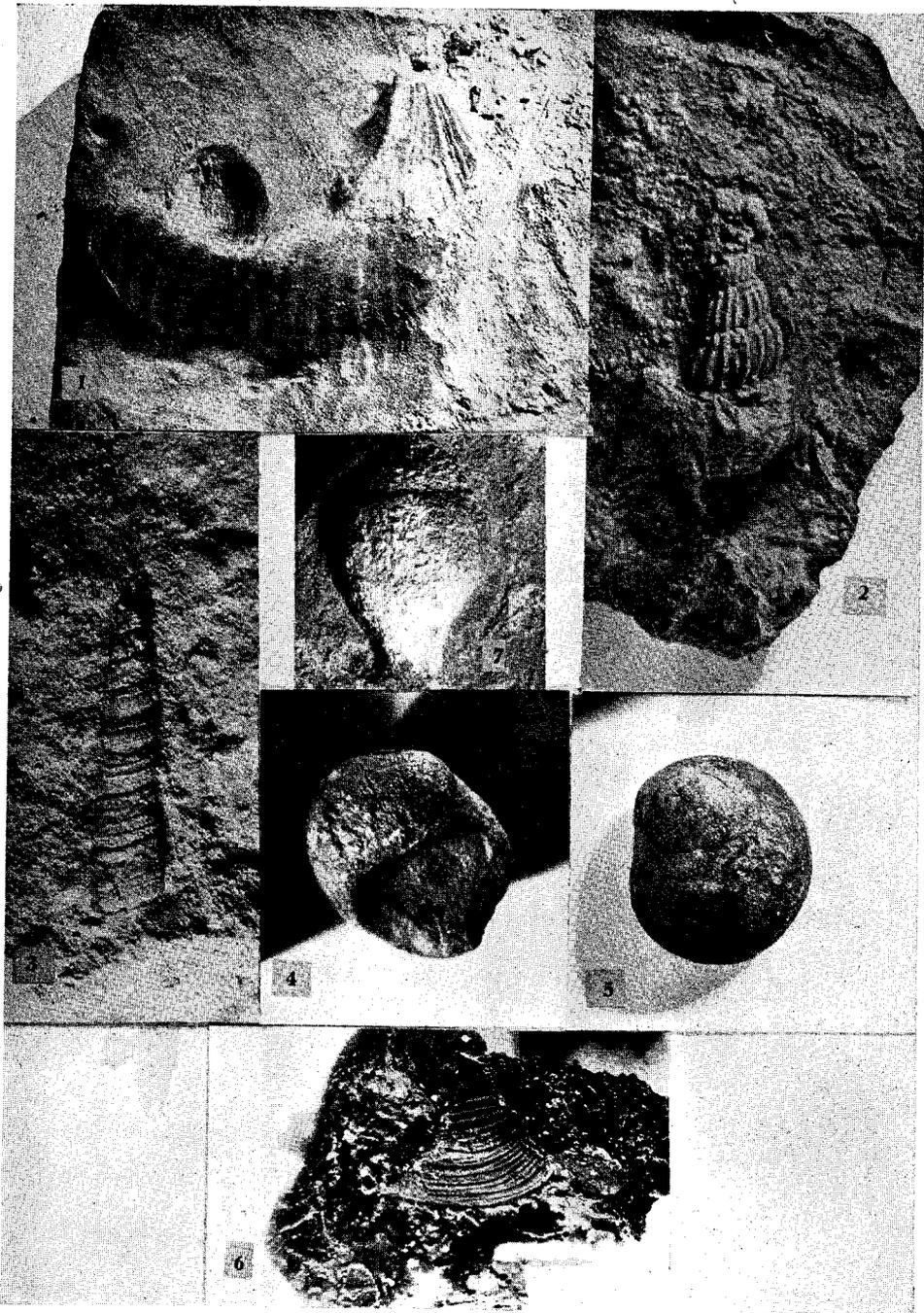


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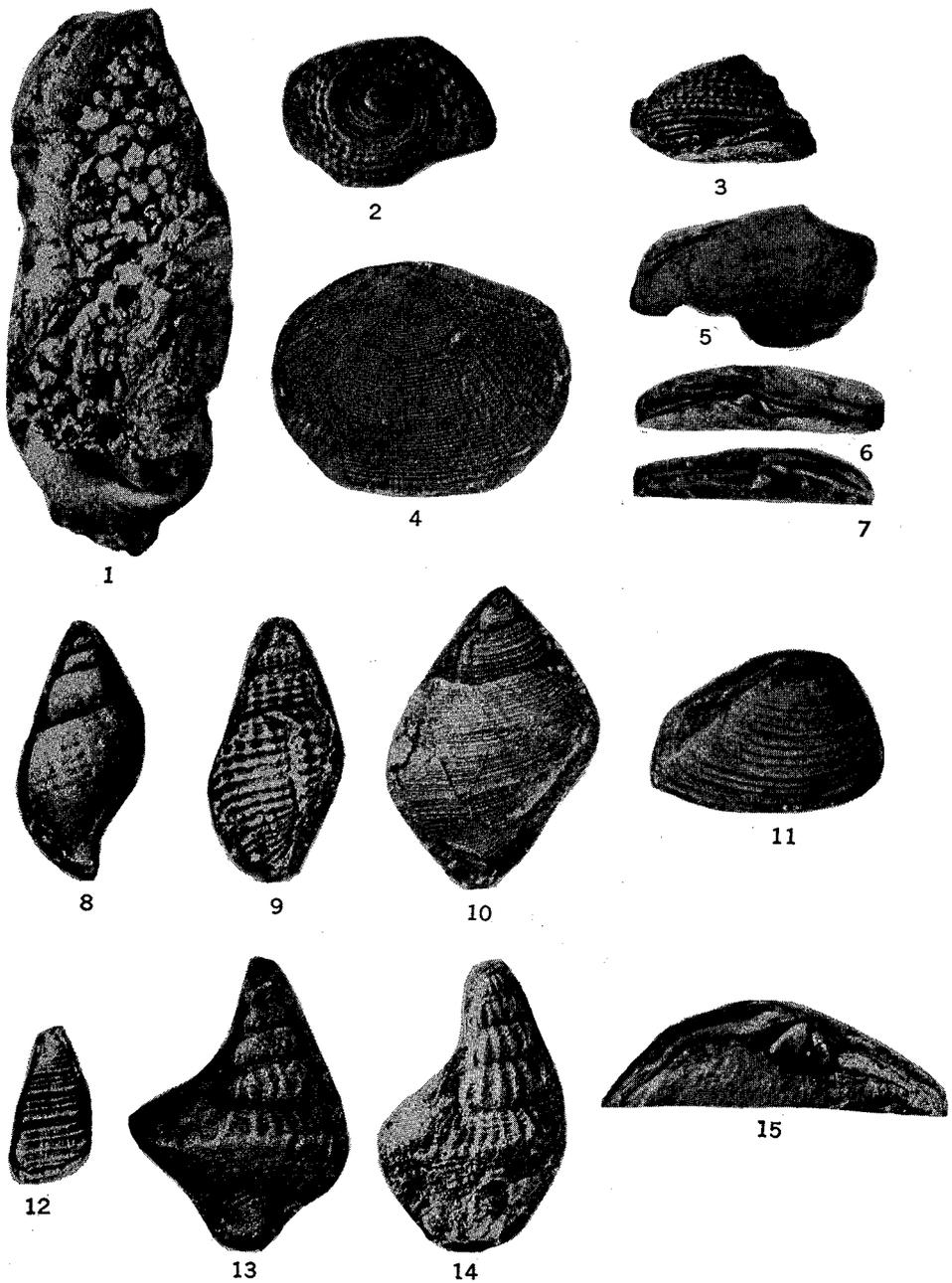
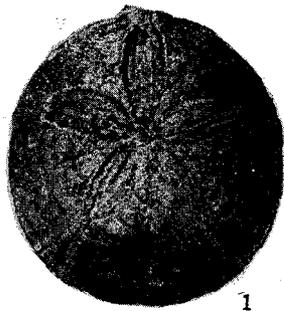


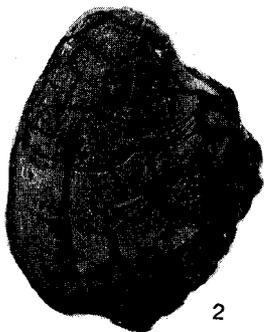
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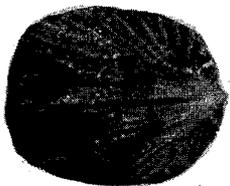
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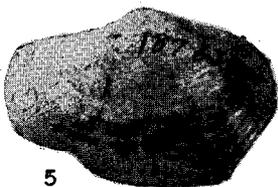
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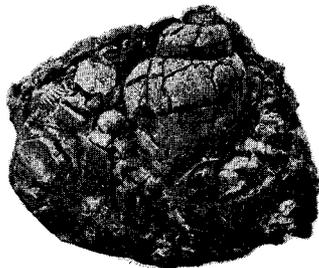
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