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**UNITED STATES DEPARTMENT OF THE INTERIOR**

**MOLLUSCA FROM THE MIOCENE AND  
LOWER PLIOCENE OF VIRGINIA  
AND NORTH CAROLINA**

**PART 1. PELECYPODA**

**GEOLOGICAL SURVEY PROFESSIONAL PAPER 199-A**



UNITED STATES DEPARTMENT OF THE INTERIOR

Harold L. Ickes, Secretary

GEOLOGICAL SURVEY

W. C. Mendenhall, Director

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Professional Paper 199-A

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MOLLUSCA FROM THE  
MIOCENE AND LOWER PLIOCENE OF  
VIRGINIA AND NORTH CAROLINA

PART 1. PELECYPODA

BY

JULIA GARDNER

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WITH A SUMMARY OF THE STRATIGRAPHY

By W. C. MANSFIELD



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# MOLLUSCA FROM THE MIOCENE AND LOWER PLIOCENE OF VIRGINIA AND NORTH CAROLINA

## PART I. PELECYPODA

By JULIA GARDNER

### ABSTRACT

A brief sketch of the stratigraphy of the Miocene of Virginia and the Miocene and Pliocene of North Carolina was prepared by Dr. W. C. Mansfield before his death in July 1939. His purpose was "to provide a background of formational nomenclature" for the taxonomic treatment of the molluscan faunas. The physical nature and distribution of the upper Tertiary formations within those States are discussed, characteristic sections given, and diagnostic molluscan species listed.

Part 1 of the systematic report covers the Pelecypoda. A monographic treatment is not attempted, but 132 previously known species are considered, and 62 new species and subspecies are described and figured.

### INTRODUCTION

Some 20 years ago I studied collections made in the course of investigations upon the later Tertiary formations by the State Surveys of Virginia and North Carolina. The taxonomic work was completed, and illustrations were made for all the new and most of the previously described species. This first report was not published.

The present report covers the same general field. It includes descriptions and illustrations of the new species, of several previously described species that were figured in publications not widely distributed or easily accessible, and of forms for which some biologic or stratigraphic information has been added. The report makes no claim to consistency of treatment or to completeness.

The greater number of the collections on which my early work was based were assembled before the details of the stratigraphy and the interrelationship to the faunas were understood. The late Dr. W. C. Mansfield, who was responsible for practically all the refinements of the stratigraphic sections that have been made during recent years and for the careful correlation of the faunas contained in these sections, was good enough to check the distribution of the species represented in my old collections and thus to give to them any stratigraphic significance that they may possess.<sup>1</sup> The ac-

<sup>1</sup>The important "Stratigraphic study of the mollusks of the Calvert and Choptank formations of southern Maryland," by Lois Schoonover, in Bull. Am. Paleontology, vol. 25, No. 94 B, pp. 1-135, 1941, unfortunately was received too late for Miss Schoonover's results to be given adequate consideration in this paper. Her zonal studies, particularly of the *Pectan* and *Astarte* groups, are essential alike to the stratigrapher and the paleontologist concerned with the molluscan faunas of the Middle Atlantic seaboard.

companying chapter on the stratigraphy, by Dr. Mansfield, is based upon work done by him alone.

I am greatly indebted both to Miss Frances Wieser, who has so skillfully retouched the photographs, and to Miss N. L. Bowen, who has sustained the drudgery of reworking an old manuscript with a cheerful patience and an ever alert mind and eye.

### STRATIGRAPHY OF THE MIOCENE OF VIRGINIA AND THE MIOCENE AND PLIOCENE OF NORTH CAROLINA

By W. C. MANSFIELD

This summary of the stratigraphy of the Miocene of Virginia and the Miocene and Pliocene of North Carolina is intended to provide a background of formational nomenclature for Dr. Julia Gardner's systematic descriptions of Miocene and Pliocene Mollusca from those States. Though the literature pertaining to the region is extensive, a bibliography has been omitted. However, this omission is not a serious lack, for a bibliography of publications on the Miocene and Pliocene of Virginia to 1912 was compiled by Clark and Miller<sup>2</sup> and a similar bibliography for North Carolina by Miller and Stephenson.<sup>3</sup> Most of the important later publications have been noted in several papers by me.<sup>4</sup>

This chapter is based in part on information that has been published from time to time during recent years and on unpublished field and laboratory observations made by the writer.

### SUMMARY

#### MARYLAND

*Miocene (Chesapeake group).*—The Miocene deposits of Maryland (the Chesapeake group) were admirably

<sup>2</sup>Clark, W. B., and Miller, B. L., Physiography and geology of the Coastal Plain province of Virginia: Virginia Geol. Survey Bull. 4, pp. 19-45, 1912.

<sup>3</sup>Clark, W. B., Miller, B. L., and Stephenson, L. W., The physiography and geology of the Coastal Plain of North Carolina: North Carolina Geol. and Econ. Survey, vol. 3, pp. 44-73, 1912.

<sup>4</sup>Mansfield, W. C., New fossil mollusks from the Miocene of Virginia and North Carolina, with a brief outline of the divisions of the Chesapeake group: U. S. Nat. Mus. Proc., vol. 74, art. 14, pp. 1-11, 1929; The Chesapeake Miocene basin of sedimentation as expressed in the new geologic map of Virginia: Washington Acad. Sci. Jour., vol. 19, p. 266, fig. 2, 1929; Stratigraphic significance of Miocene, Pliocene, and Pleistocene Pectinidae in the southwestern United States: Jour. Paleontology, vol. 10, No. 3 1936; Additional notes on the molluscan fauna of the Pliocene Croatan sand of North Carolina: Idem, No. 7, pp. 665-668, 1936.

described in 1904 by Clark, Shattuck, and Dall,<sup>5</sup> and this brief characterization is based largely upon their report.

The deposits of the Chesapeake group lie wholly within the tidewater region, on the Eastern Shore, between Chesapeake Bay and the Delaware River, in a broad belt between the Chester River on the north and Fishing Bay on the south; on the Western Shore, between Chesapeake Bay and the Potomac River, extending inland as far as the District of Columbia. On both sides of Chesapeake Bay the strike of the beds is northeast.

In Maryland the Chesapeake group has been separated into three formations, all of middle Miocene age—in ascending order, the Calvert formation, the Choptank formation, and the St. Marys formation. The Yorktown, the uppermost formation of the Chesapeake group in Virginia, has not been recognized in Maryland.

The Calvert formation, 200 feet thick, is divided by Shattuck<sup>5a</sup> into the Fairhaven diatomaceous earth member, which is subdivided into three zones (zones 1-3); and the Plum Point marl member, which is subdivided into twelve zones (zones 4-15). The Fairhaven member is especially characterized by diatomite. The Plum Point member consists of a series of sandy clays and clayey sands ranging in color from bluish-green to buff and containing a large assemblage of vertebrate and invertebrate remains.

The Choptank formation, 80 feet thick, consists of reddish, yellowish, or greenish sand and sandy clay. Locally the materials are consolidated into hard rock. The formation is divided by Shattuck<sup>6</sup> into five zones (zones 16-20). Zones 17 and 19 contain well-preserved fossils in great abundance.

The St. Marys formation, 74 feet thick, consists of clay, sand, and clayey sand. The clay is usually of a dark color. The formation is divided by Shattuck<sup>7</sup> into four zones (zones 21-24). The basal zone (zone 21) consists mainly of drab clay and appears to be devoid of fossils. The three other zones are fossiliferous, some parts being almost entirely composed of shells.

*Pliocene.*—No certain Pliocene deposits have been recognized in Maryland.

#### VIRGINIA

*Miocene (Chesapeake group).*—The Chesapeake group of Virginia, 575 feet thick, is divided into four formations, in ascending order, the Calvert, Choptank, St. Marys, and Yorktown.

The Calvert formation, 200 feet thick, consists of dark-gray or olive sandy clay, usually diatomaceous.

The Choptank formation, 50 feet or more thick, consists of dark-brown, rather soft sand and greenish-gray clayey sand alternating with indurated sandstone layers. It is not recognized widely.

The St. Marys formation, 180 feet thick, contains a lower part, "stratum A," that consists of nearly unfossiliferous dark sandy plastic clay; and an overlying fossiliferous part, of bluish clay and light-colored sand, that is divided into two faunal zones.

The Yorktown formation, 145 feet thick, consists dominantly of gray to buff sands. It is divided into two faunal zones, and the upper zone is subdivided into three minor parts.

The divisions of the Chesapeake group, as recognized by me,<sup>8</sup> are as follows:

#### Upper Miocene:

##### Yorktown formation:

##### Zone 2, or *Turritella alticostata* zone:

Upper part (beds at Suffolk).

Middle part (beds at Yorktown).

Lower part (including *Chama*-bearing bed).

##### Zone 1, or *Pecten clintonious* zone.

#### Middle Miocene:

##### St. Marys formation:

##### Zone 2, or *Crassatellites meridionalis* zone.

##### Zone 1, or *Bulliopsis quadrata* zone.

##### Stratum A (unfossiliferous dark clay).

##### Choptank formation.

##### Calvert formation.

*Pliocene.*—No certain Pliocene deposits have been recognized in Virginia.

#### NORTH CAROLINA

*Miocene.*—The lower formations of the Chesapeake group are not exposed in North Carolina. The uppermost part of the St. Marys formation may be present in the lowest part of some exposures, but the entire Yorktown formation is represented, though not all exposures may be accurately placed in the formation. The Yorktown (late Miocene) in the northern part of North Carolina contains a fauna suggestive of deposition in colder water than that forming the environment of the fauna of the Miocene beds in the southern part of the State.<sup>9</sup> The deposits in the southern part of the State, the Duplin marl, represent the uppermost Miocene and are equivalent to the uppermost Yorktown, though constituting a warm-water facies. At no place are the Miocene deposits, as now exposed, more than 50 feet thick.

*Pliocene.*—The Croatan sand, in the northeastern

<sup>5</sup> Clark, W. B., Shattuck, G. B., and Dall, W. H., The Miocene deposits of Maryland: Maryland Geol. Survey, Miocene, pp. xxi-clv, pls. 1-9, 1904.

<sup>5a</sup> Shattuck, G. B., Maryland Geol. Survey, Miocene, pp. lxxii-lxxvii, 1904.

<sup>6</sup> Idem, pp. lxxxii-lxxxii.

<sup>7</sup> Idem, p. lxxxv.

<sup>8</sup> Mansfield, W. C., New fossil mollusks from the Miocene of Virginia and North Carolina, with a brief outline of the divisions of the Chesapeake group: U. S. Nat. Mus. Proc., vol. 74, art. 14, pp. 1-2, 1929.

<sup>9</sup> Mansfield, W. C., The Chesapeake Miocene basin of sedimentation as expressed in the new geologic map of Virginia: Washington Acad. Sci. Jour., vol. 19, p. 266, fig. 2, 1929.

part of the State,<sup>10</sup> and the Waccamaw formation, in the southern part,<sup>11</sup> represent the Pliocene epoch. Both are thin superficial deposits.

#### OTHER STATES ON THE ATLANTIC COAST

In listing the distribution of species in the systematic part of this work, various other formations of Tertiary and Quaternary age in States north of Maryland and in South Carolina, Georgia, and Florida are cited. Most of these formations are shown in table 1, and also the commonly accepted correlations with European divisions of the later Tertiary.

#### MIocene STRATA OF VIRGINIA

##### NOMENCLATURE

As indicated in the summary on page 2, all the formations of the Chesapeake group are present in Virginia. The existence of these deposits was recognized in early geologic work in the region, and though for long only a very simple nomenclature was applied to them, the terminology now in use eventually appeared. As it may be of interest to record in compact form the usage of the various authors who have dealt with the Miocene strata, the appended list is presented.

The list gives the name of the author, the year of his publication, and the name or names used by him for the Miocene deposits or a brief statement of his results. The name cited may include more deposits than are now referred to the Miocene epoch. If the item cited refers to a State other than Virginia, this is indicated.

- 1809. Maclure, William:  
Alluvial (in part).
- 1820. Hayden, H. H.:  
Alluvial (in part).
- 1822. Cleveland, Parker:  
Alluvial (in part).
- 1824. Finch, John:  
Tertiary (in part).
- 1825. Van Rensselaer, Jeremiah:  
Tertiary, Virginia (in part).  
Upper Marine and London clay (?), Maryland.
- 1828. Vanuxem, Lardner, and Morton, S. G.:  
Tertiary (in part).
- 1829. Morton, S. G.:  
Upper Marine in Maryland and probably southward.
- 1830. Conrad, T. A.:  
Upper Marine in Maryland.
- 1832. Conrad, T. A.:  
Upper Marine or upper Tertiary.
- 1833. Lea, Isaac:  
Older Pliocene.
- 1834. Conrad, T. A.:  
Pliocene.

- 1835. Conrad, T. A.:  
Older Pliocene (in part).
- 1835. Conrad, T. A.:  
Medial Pliocene (in part).
- 1835. Rogers, W. B.:  
Middle Tertiary=Miocene of Lyell.
- 1836. Rogers, W. B.:  
Miocene.
- 1836 or 1837. Conrad, T. A.:  
Medial Tertiary or older Pliocene.
- 1837. Rogers, W. B.:  
Miocene.
- 1838. Conrad, T. A.:  
Medial Tertiary or older Pliocene.
- 1838. Rogers, W. B.:  
Miocene.
- 1839. Rogers, H. D., and W. B.:  
Miocene (Miocene).
- 1840. Conrad, T. A.:  
Medial Tertiary.
- 1840. Rogers, W. B.:  
Miocene=Horizontal beds (?).  
Yellow marl.  
Blue marl.
- 1841. Rogers, W. B.:  
Miocene (Miocene).
- 1842. Conrad, T. A.:  
Medial Tertiary or Miocene.
- 1842. Lyell, Charles:  
Miocene [less] excluded infusorial beds.
- 1843. Tuomey, Michael:  
Miocene (includes infusorial beds).
- 1843. Conrad, T. A.:  
Miocene.
- 1843. Rogers, W. B.:  
Miocene (includes infusorial beds).
- 1844. Rogers, H. D.:  
Miocene (includes infusorial beds).
- 1845. Conrad, T. A.:  
Medial Tertiary or Miocene.
- 1845. Lonsdale, William:  
Miocene.
- 1845. Lyell, C.:  
Miocene=Crag of England and faluns of Loire.
- 1846. Lea, H. C.:  
Miocene.
- 1850. Wyman, J.:  
Miocene (includes infusorial beds).
- 1853. Hitchcock, E.:  
Miocene (includes infusorial beds).
- 1853. Marcou, Jules:  
Miocene.
- 1861. Conrad, T. A.:  
Medial Tertiary or Miocene.
- 1861. Rogers, W. B.:  
Miocene (Miocene) (infusorial beds).
- 1862. Conrad, T. A.:  
Miocene or Upper Tertiary.
- 1863. Dana, J. D.:  
Yorktown or Miocene.
- 1864. Meek, F. B.:  
Miocene.
- 1866, 1868, 1869. Conrad, T. A.:  
Miocene.
- 1877. Stodder, C.:  
Miocene (for Richmond, infusorial deposit).
- 1880. Dana, J. D.:  
Miocene, Yorktown period (in part).

<sup>10</sup> Mansfield, W. C., Notes on Pleistocene faunas from Maryland and Virginia and Pliocene and Pleistocene faunas from North Carolina: U. S. Geol. Survey Prof. Paper 150, pp. 129-133, 1928; Additional notes on the molluscan fauna of the Pliocene Croatan sand of North Carolina: Jour. Paleontology, vol. 10, no. 7, pp. 665-668, 1936.

<sup>11</sup> Miller, B. L., Tertiary formations: North Carolina Geol. and Econ. Survey, vol. 3, pp. 256-258, 1912.

1882. Heilprin, A. :  
Miocene:  
Marylandian (uncertain for lower bed).  
Virginian.
1884. Heilprin, A. :  
Miocene:  
Virginian.  
Carolinian (not unlikely).
1888. Heilprin, A. :  
Metagene (used instead of Miocene).
1891. Darton, N. H. :  
Miocene, Chesapeake group. (Separates it into three beds.)
1892. Dall, W. H., and Harris, G. D. :  
Miocene, Chesapeake group.
1893. Harris, G. D. :  
In Maryland:  
St. Marys fauna.  
Jones Wharf fauna.  
Plum Point fauna.
1893. Dall, W. H., and Harris, G. D. :  
In Maryland: St. Marys, Jones Wharf, and Plum Point.  
Virginia: Yorktown considered younger.
1895. Dana, J. D. :  
Miocene period (Yorktown epoch).
1896. Darton, N. H. :  
Miocene, Chesapeake group.
1898. Dall, W. H. :  
Miocene, Chesapeake group=Helvetian of Europe.
1902. Shattuck, G. B. :  
For Maryland:  
St. Marys formation.  
Choptank formation.  
Calvert formation.
1904. Clark, W. B., and others :  
For Maryland:  
Chesapeake group:  
St. Marys, 4 zones.  
Choptank, 5 zones.  
Calvert, 15 zones.
1904. Dall, W. H. :  
For Atlantic and Gulf:  
Duplin (North Carolina).  
Suffolk (Virginia).  
Yorktown (Virginia).  
Alum Bluff (Florida).  
St. Marys (Maryland).  
Choptank (Maryland).  
James River (Virginia).  
Calvert (Maryland).  
Petersburg (Virginia).
1909. Berry, E. W. :  
Places Richmond diatomaceous deposits in Calvert formation.
- 1910 (read in 1908). Miller, B. L. :  
Yorktown.  
St. Marys.  
Calvert.
- 1910 (Read in 1908). Miller, B. L. :  
Yorktown.  
St. Marys.  
Choptank.  
Calvert.
1911. Watson, T. L. :  
Yorktown.  
St. Marys.  
Calvert.
1911. Berry, E. W. :  
Richmond; fossil plants assigned to Calvert=middle Miocene.
1912. Clark, W. B., and Miller, B. L. :  
Chesapeake group:  
Yorktown.  
St. Marys.  
Calvert.
1913. Sanford, S. :  
Chesapeake group:  
Yorktown.  
St. Marys.  
Choptank (?)  
Calvert.
1914. Olsson, A. :  
Suggests placing Petersburg fauna with St. Marys or younger.
1916. Watson T. L. :  
Yorktown.  
St. Marys.  
Calvert.
1916. Berry, E. W. :  
Places Calvert in middle Miocene or equivalent to Tortonian.
1917. Olsson, Axel :  
Miocene:  
Upper:  
Yorktown stage.  
Murfreeshboro stage.  
Middle:  
St. Marys stage.  
Lower:  
Choptank stage.  
Calvert stage.
1921. Cooke, C. Wythe :  
Duplin and Yorktown (North Carolina, Virginia)=upper Miocene.  
Calvert, Choptank, and St. Marys=middle Miocene.
1922. Olsson, Axel :  
Miocene:  
Upper:  
Yorktown stage.  
Murfreeshboro stage.  
Middle:  
St. Marys stage.  
Choptank stage.  
Calvert stage.
- 1929, 1936. Mansfield, W. C. :  
Miocene:  
Upper:  
Yorktown formation:  
zone 2 (*Turritella alticostata*).  
zone 1 (*Pecten clintonius*).  
Middle:  
St. Marys formation:  
zone 2 (*Crassatellites meridionalis*).  
zone 1 (*Bullioopsis quadrata*).  
stratum A.  
Choptank formation.  
Calvert formation.

#### CALVERT FORMATION

*Lithologic character and thickness.*—The material composing the Calvert formation consists largely of dark-gray or olive sandy, usually diatomaceous clay, which changes to a lighter color when weathered. It is

TABLE 1.—Correlation of the Atlantic and Gulf Coastal Plain deposits ranging in age from the upper part of the middle Miocene to the Pleistocene

		European equivalent		New Jersey	Maryland	Virginia		North Carolina		South Carolina	Georgia	Florida	
Pleistocene.					Deposits at Wailes Bluff. <sup>1</sup>					Deposits on Yorges Island. <sup>1</sup>		Marl on North Creek. <sup>1</sup>	
Pliocene.	Upper.	Sicilian (Arnian).						(?)		(?)		Deposits on Myakka River. <sup>2</sup>	
	Middle.	Astian.						(?)		(?)		(?)	
	Lower.	Plaisancian.						Croatan sand to north.	Waccamaw formation to south.	Waccamaw formation. <sup>3</sup>		Limestones of Tamiami Trail. <sup>4</sup> Caloosahatchee marl.	
Miocene.	Upper.	Sahelian.	Pontian.			Yorktown formation.	Zone 2.	Beds at Suffolk, with bed at Biggs Farm at top.	Uppermost Yorktown, with bed at Mt. Gould at top.	Duplin marl.	Duplin marl.	Choctawhatchee formation.	Cancellaria zone (upper part).
								Beds at Yorktown.	Equivalent to the beds at Yorktown, Va.				Cancellaria zone (lower part).
								Chama-bearing bed.	Chama-bearing bed.				"Aluminous clay."
			Sarmatian.					Zone 1.		Zone 1.	Raysor marl.		Ecphora zone.
	Middle.	Tortonian or upper Vindobonian.			(?)	St. Marys formation.	Zone 2.	?St. Marys formation. <sup>5</sup>					Arca zone (upper part).
					St. Marys formation.		Zone 1.	(?)					Arca zone (lower part). Yoldia zone.
					Choptank formation.	Choptank formation.							Shoal River formation.
		Helvetian.		Kirkwood formation.	Calvert formation.	Calvert formation.							Oak Grove sand. <sup>6</sup>

<sup>1</sup> The fossiliferous beds in the Pleistocene not necessarily correlated.

<sup>2</sup> The fauna included by Dall in the Myakka River fauna may include some Pleistocene.

<sup>3</sup> Beds at Grove Plantation tentatively put in the Waccamaw formation by Cooke; may be older.

<sup>4</sup> Position relative to Caloosahatchee marl not precisely known.

<sup>5</sup> Mainly concealed except at low-water stage.

<sup>6</sup> Exact correlation with the Calvert formation not fully established.





believed to attain a maximum thickness of 200 feet. The formation is exposed in the Horsehead, Stratford, and Nomini Cliffs (see p. 5) and forms the lower 40 feet of the section at Carter Wharf, on the Rappahannock River. Diatomaceous deposits at Richmond and Petersburg have usually been referred to the Calvert.

**Stratigraphic relations.**—The Calvert formation rests unconformably upon either the Eocene or older deposits and is overlain, apparently unconformably, either by the Choptank formation or by a later deposit.

**Paleontologic character.**—The molluscan fauna is sparse and poorly preserved. The following species were collected by me and appear to be the more abundant forms: *Ephora tricostata* Martin, *Pedalion maxillatum* (Deshayes), and *Pecten madisonius* Say. Certain deposits have yielded vertebrate remains and fossil plants. A separation of the deposits into faunal

lected by me: *Arca staminea* Say, *Pecten marylandicus* Wagner, *Astarte obruta* Conrad. It is believed that Shattuck's zones 16 to 20 of the Maryland sequence<sup>13</sup> may be recognized in Virginia.

The Horsehead, Stratford, and Nomini Cliffs<sup>14</sup> form a series of northward-facing bluffs about 6 miles long, extending from a point a mile east of the mouth of Popes Creek eastward nearly to Currioman Bay. These cliffs afford exposures of the upper part of the Calvert formation, all of the Choptank formation, and the lower part of the St. Marys formation. In general the formations are less fossiliferous here than in the Calvert Cliffs, on Chesapeake Bay in Calvert County, Md., though at one place in the lower part of the Nomini Cliffs fossils are abundant in the Choptank formation. The stratigraphic and structural relationships of the formations exposed in the cliffs are shown in figure 1.

The Calvert formation in these sections consists

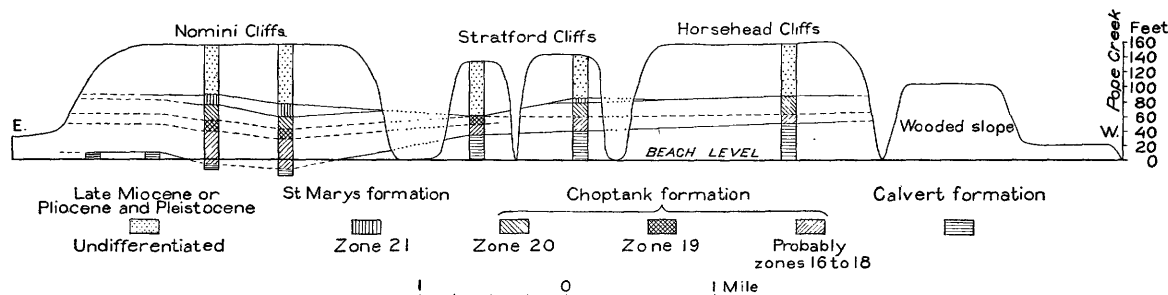


FIGURE 1.—Columnar sections of Horsehead, Stratford, and Nomini Cliffs, Va.

zones corresponding to those recognized by Shattuck<sup>12</sup> in the Calvert of Maryland is impracticable because of the lack of faunal data.

#### CHOPTANK FORMATION

**Lithologic character and thickness.**—The material composing the Choptank formation consists of dark-brown, rather soft fossiliferous sand alternating with indurated sandstone layers. Its thickness is not definitely determined in Virginia but may exceed 50 feet.

**Distribution.**—The areal distribution of the Choptank in Virginia is not precisely known. It is believed, however, that this formation underlies the St. Marys formation in part of the area between the Potomac and Rappahannock Rivers. It appears that this formation thins southward and finally disappears, and where it is absent the younger St. Marys formation rests upon the Calvert instead of the Choptank. At only two localities were fossil remains found that established the presence of this formation in Virginia—one in the Nomini Cliffs, about 1½ miles west of the east end of the cliffs, and the other near Carter Wharf, on the Rappahannock River. The section in the Nomini Cliffs is described below.

**Paleontologic characters.**—The molluscan fauna is poorly preserved. The following characteristic species, in addition to others of longer range, were col-

lected by me: *Arca staminea* Say, *Pecten marylandicus* Wagner, *Astarte obruta* Conrad. It is believed that Shattuck's zones 16 to 20 of the Maryland sequence<sup>13</sup> may be recognized in Virginia.

The lowest bed of the Choptank formation, believed to represent Shattuck's zones 16 to 18, consists of greenish-gray clayey sand and at a locality 1½ miles west of the east end of the Nomini Cliffs contains two zones of fossils, one within 3 feet above the beach and the other 10 to 12 feet higher. In the lower layer are *Crassatellites turgidulus* (Conrad), *Phacoides crenulatus* (Conrad), *Diplodonta subvexa* (Conrad)?, a large variety of *Isocardia fraterna* (Say), *Cardium* sp., and *Venus plena* (Conrad)?. In Maryland *Crassatellites turgidulus* occurs only in zone 17 of the Choptank formation.

The middle part of the Choptank formation, assigned to zone 19, consists of dark-brown soft fossiliferous sand, with a sandstone layer about 2 feet thick at the top containing many individuals of *Pecten madisonius* Say. In this sand are also *Arca staminea* Say, *Pecten marylandicus* Wagner, *Astarte obruta* Conrad, *Crassa-*

<sup>12</sup> Shattuck, G. B., Maryland Geol. Survey, Miocene, pp. lxxii-lxxvii, 1904.

<sup>13</sup> Shattuck, G. B., Maryland Geol. Survey, Miocene, pp. lxxxi-lxxxii, 1904.

<sup>14</sup> Stephenson, L. W., Cooke, C. W., and Mansfield, W. C., 16th Internat. Geol. Cong. Guidebook 5, pp. 25-28, 1932.

*tellites marylandicus* (Conrad), *Thracia* sp., *Dosinia* sp., and *Corbula idonea* Conrad. In the Choptank formation of Maryland *Crassatellites marylandicus* has been found only in zone 19.

The upper part of the Choptank formation consists of sandy clay that contains a few vertebrate fossils but no invertebrates. It is believed to correspond to zone 20.

The next higher bed, which represents the lower part of the St. Marys formation and is assigned to zone 21, consists of very plastic clay. At the west end of the Stratford Cliffs this clay, though only a few feet thick, contains *Turritella plebeia* Say, *Turritella variabilis* Conrad, *Glycymeris subovata* (Say) var., *Arca* sp. (young individual), *Ostrea disparilis* Conrad, *Astarte* aff. *A. obruta* Conrad, *Euloxa latisulcata* (Conrad), *Chione* cf. *C. athleta* Conrad, *Spisula confraga* (Conrad), and *Corbula* sp.

#### ST. MARYS FORMATION

The St. Marys formation in Virginia may profitably be subdivided. The lower, nearly unfossiliferous part is designated "stratum A." The overlying fossiliferous part is subdivided into two faunal zones—zone 1, or *Bulliopsis quadrata* zone, below, and zone 2, or *Crassatellites meridionalis* zone, above. It attains a thickness of 180 feet.

*Stratum A.*—Stratum A consists of dark-gray sandy clay, soft when wet and stiff when dry. It is the highest bed in the Miocene sequence in the Nomini Cliffs. Near Ethel and Garlands Mill, between the Potomac and Rappahannock Rivers, it is the lowest bed exposed. It is believed to represent Shattuck's zone 21 and perhaps zone 22.<sup>15</sup>

*Zone 1, or Bulliopsis quadrata zone.*—Zone 1 consists predominantly of blue to greenish sandy clay. It crops out at an altitude of 75 to 80 feet at Garlands Mill and near Warsaw, Richmond County; below Bowlers Wharf, on the Rappahannock River, and at Essex Mill, about 5 miles south of Tappahannock, Essex County. It is believed to correspond to zones 23 and 24 of Shattuck, and it carries a well-preserved and characteristic molluscan fauna. Conspicuous species are *Terebra simplex* Conrad, *Conus diluvianus* Green, *Bulliopsis quadrata* Conrad, *Turritella plebeia* Say, *Glycymeris tumulus* (Conrad), *Arca idonea* Say, and *Pecten santamaria* Tucker.

*Zone 2, or Crassatellites meridionalis zone.*—Zone 2 consists of bluish sandy clay overlain by loose light-colored beachlike sands. It crops out along the Rappahannock River from Jones Point southward to a point just below Burhans Wharf; along the James River from Cobham Bay, where it dips below water level, to a point a little above Claremont Wharf. South of

the James River no surface outcrops or exposures were found in the stream channels. It is apparently unconformable with the overlying Yorktown. This apparent unconformity is indicated not only by an abrupt faunal change but also by the fragmental nature of the upper part of the St. Marys formation.

The fauna of zone 2 is closely allied to that of zone 1, differing mainly in containing slightly more modern types. Prominent species are *Turritella plebeia* Say, *Glycymeris tumulus* (Conrad) (or a closely related form), *Pedalion maxillatum* (Deshayes), *Pecten santamaria middlesexensis* Mansfield, *P. eboreus urbanaensis* Mansfield, *Crassatellites meridionalis surryensis* Mansfield, and *C. undulatus urbanaensis* Mansfield.

*Stratigraphic sections.*—The following sections show the relations of the strata at two localities on the James River and one locality near Lanexa, on the Chickahominy River.

*Section of right bank of James River at Schmidts Bluff, 8½ miles below Claremont Wharf, Surry County, Va.*

	Feet
Pleistocene: Reddish gravelly clay and sand-----	20-25
Unconformity.	

#### Miocene:

Yorktown formation, probably zone 2:

Gray indurated fossiliferous marl bed resembling one at Marlboro, Va-----	4-5
Unfossiliferous reddish sand-----	3-4

Yorktown formation, zone 1: Grayish to buff sand containing *Turritella variabilis pilsbryi* Gardner, *Glycymeris subovata* (Say), *Pecten clintonius* Say, *Pecten jeffersonius* Say, *Pecten eboreus watsonensis* Mansfield, *Astarte exaltata* Conrad, *Astarte undulata deltoidea* Gardner, *Astarte undulata vaginulata* Dall, *Crassatellites undulatus cyclopterus* Dall, *Phacoides (Pseudomiltha) anodonta* Say, *Venericardia granulata* Say, *Venus rileyi* Conrad, *Spisula confraga* Conrad, and *Kuphus calamus* H. C. Lea. *Pedalion maxillatum* does not occur in this bed. Contact with underlying bed is evident but not very irregular-----

8

St. Marys formation, zone 2: Material in the upper part similar to the overlying bed but containing a different fauna. The following species were collected here: *Glycymeris* cf. *G. tumulus* (Conrad), *Arca (Barbatia) centenaria* Say, *Arca idonea* Say, *Pecten santamaria middlesexensis* Mansfield, *Pedalion maxillatum* (Deshayes). *Pedalion maxillatum* and *Pecten madisonius* are abundant. The lower part contains more clay-----

25

*Section of right bank of James River just above Sunken Marsh Creek, 2 miles below Claremont Wharf, Surry County, Va.*

Pleistocene:	Feet
Yellowish to red sandy loam with gravel at the base--	10-12
Band of large pebbles and cobbles as much as 1 foot in diameter-----	1
Cross-bedded reddish gravel with 1-foot band of clay at base-----	6

<sup>15</sup> Shattuck, G. B., Maryland Geol. Survey, Miocene, p. lxxxv, 1904.

Section of right bank of James River just above Sunken Marsh Creek, 2 miles below Claremont Wharf, Surry County, Va.—Continued

Unconformity.

Miocene:

Yorktown formation, zone 1:

Brown to gray medium-grained sands with fossil impressions-----	9
Highly fossiliferous fine gray to buff sands, with a few black grains intermixed, containing <i>Turritella variabilis pilsbryi</i> Gardner, <i>Fissuridea redimicula</i> Say, <i>Pecten jeffersonius</i> Say, <i>Crassatellites undulatus</i> Say, <i>Isocardia fraterna</i> Say, <i>Astarte undulata vaginulata</i> Dall, <i>Astarte undulata deltoidea</i> Gardner, <i>Astarte exaltata</i> Conrad, and <i>Dentalium attenuatum</i> Say-----	15
Covered-----	2

St. Marys formation, zone 2:

Blue medium- to fine-grained clayey sand with <i>Turritella plebeia carinata</i> Gardner, <i>Dentalium attenuatum</i> Say, <i>Arca idonea</i> Conrad, <i>Pecten santamaria middlesexensis</i> Mansfield, <i>Crassatellites meridionalis surryensis</i> Mansfield, <i>Astarte perplana</i> Conrad, <i>Pleuropygia centenaria</i> Conrad-----	8
Blue clayey sand with many fossils, especially <i>Arca</i> , <i>Pecten</i> , and <i>Pedalion</i> -----	10
Blue clayey sand with <i>Turritella</i> , <i>Scapharca</i> , and <i>Pedalion maxillatum</i> . The following species were collected 8 to 20 feet above water level: <i>Turritella plebeia carinata</i> Gardner, <i>Fissuridea</i> near <i>F. nassula</i> Conrad, <i>Dentalium attenuatum</i> Conrad, <i>Glycymeris subovata</i> (heavy form), <i>Arca idonea</i> Conrad, <i>Arca virginiae</i> Wagner, <i>Pecten santamaria middlesexensis</i> Mansfield, <i>Crassatellites meridionalis surryensis</i> Mansfield, <i>Venericardia granulata</i> Say, <i>Phacoides contractus</i> Say, <i>Dosinia acetabulum</i> Conrad, <i>Chione dalli</i> Olsson, <i>Corbula inaequalis</i> Say-----	10
Blue fine-grained clayey sand, slightly fossiliferous-----	4
Blue fine-grained clayey sand containing <i>Turritella plebeia carinata</i> Gardner, <i>Arca idonea</i> Conrad, <i>Pecten santamaria middlesexensis</i> Mansfield, <i>Ostrea disparilis</i> Conrad, <i>Pleuropygia centenaria</i> (Conrad)-----	4
(The series of blue clays forming zone 2 do not contain the black grains observed in other beds.)	

Section in Chesapeake & Ohio Railway cut one-third of a mile below Lanexa, near left bank of the Chickahominy River, New Kent County, Va.

Pleistocene:

Reddish sandy clay, forming a nearly vertical cliff--	8-10
Thinly laminated pink to mottled clays separated by narrower bands of sand-----	8-10
Laminated, slightly cross-bedded mottled clays, pink predominating-----	27-30
Greenish-gray coarse sandy clay with a 2- to 3-inch ferruginous band at the base-----	3
Clayey sand-----	3½

Unconformity.

Miocene:

Yorktown formation, zone 1: Indurated shell bed in a matrix of gray to buff glauconitic sand containing many <i>Pecten jeffersonius</i> Say and <i>Ostrea disparilis</i> Conrad-----	3
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---

Section in Chesapeake & Ohio Railway cut one-third of a mile below Lanexa, near left bank of the Chickahominy River, New Kent County, Va.—Continued

Miocene—Continued.

Unconformity.

St. Marys formation, zone 2:

Loose unfossiliferous fine-grained buff sand----	4
Sand similar to above but containing <i>Pecten eboreus urbannaensis</i> Mansfield in great abundance, as well as <i>Pedalion maxillatum</i> (Deshayes)-----	11
Concealed to railroad tracks-----	10-12

The base of the *Pecten jeffersonius* bed is about 50 feet above sea level.

#### YORKTOWN FORMATION

The Yorktown formation has been conveniently divided into two faunal zones—zone 1, or *Pecten clintonius* zone, below and zone 2, or *Turritella alticostata* zone, above. Zone 2 may in turn be subdivided into three minor divisions, to which for reference have been applied the terms, in ascending order, “*Chama*-bearing bed,” “beds at Yorktown,” and “beds at Suffolk.” The Yorktown formation attains a thickness of 145 feet.

*Zone 1, or Pecten clintonius zone.*—Zone 1 consists largely of medium-grained gray to buff sands. It constitutes the earliest deposit referred to the Yorktown formation and apparently rests unconformably on the St. Marys formation. Its upper limit is less distinctly marked, though the overlying deposits are usually glauconitic and in many places contain coarse sediments. Its contact with the St. Marys formation dips to the southeast at a rate of 3 to 5 feet to the mile. The thickness of this zone probably does not exceed 25 feet.

This zone is exposed at Bellefield, on the York River, where for a short distance the bed rises 2 to 3 feet above the beach; and at several localities between the York and Rappahannock Rivers. Along the James River it is exposed at many places between old Kings Mill Wharf and a point 2 miles below City Point. (See fig. 2, bed v.) From Cobham Bay, on the right bank of the James River, to Claremont Wharf, zone 1 rests on the St. Marys formation, rising to an altitude of 30 to 35 feet at Claremont Wharf.

The fauna of this zone is characterized not only by the presence of certain peculiar species but also by the initiation of several species that are represented by many individuals in later deposits. Some of the restricted species are *Fusinus propeparilis* Mansfield, *Glycymeris subovata plagia* Dall, *Pecten clintonius* Say, *Astarte undulata vaginulata* Dall, and *Astarte undulata deltoidea* Gardner. Some of the species that appear here first are *Conus marylandicus* Green, “*Drillia*” *lunata* (H. C. Lea), *Pecten jeffersonius* Say, *Phacoides cribrarius* (Say), *Divaricella quadrisulcata* (D’Orbigny), and *Cardium virginianum* Conrad. Other fossils are listed on page 9.

Zone 1 includes in part the Murfreesboro stage of Olsson.<sup>16</sup> The term "Murfreesboro" is preoccupied, having been used by Safford and Killebrew<sup>17</sup> to designate the lowest limestone of the Central Basin of Tennessee. As the fauna of this zone is more closely related to the fauna of the Yorktown formation than to that of the St. Marys formation, I have placed it in the Yorktown.

*Zone 2, or Turritella alticostata zone.*—Zone 2 is divisible into three minor parts.

The lowest part consists of coarse sand containing many specimens of *Chama* and other fossils; it is excellently exposed in a bluff on the north shore of the James River east of the old Kings Mill Wharf. In a section of the bluff given by Stephenson, Cooke, and Mansfield<sup>18</sup> (see fig. 2), the *Chama*-bearing bed is indicated by "bed *w*" and is underlain by zone 1 of the formation. Higher beds in the lower part of zone 2, exposed in the same bluff above the *Chama*-bearing bed, are indicated by "beds *x, y, z*" and consist of gray to buff sands and laminated clay. Equivalent beds are present on the York River southeast of Yorktown and are indicated<sup>19</sup> in figure 3 by "beds *a, b, c, d*." Fossils of the lowest part of zone 2 are listed on page 10.

The middle part of zone 2, the fragmental beds, consists of sands and cross-bedded clays containing broken and entire shells and is typically exposed in the bluffs at Yorktown. This part is indicated in figure 3 by "beds *e, f*." Fossils of the middle part of zone 2 are listed on page 10.

The upper part of zone 2 overlies the fragmental beds and is typically exposed at Suffolk, Va. These beds consist largely of gray to blue sands that oxidize to buff. The molluscan fauna is well preserved. The more abundant forms are *Pecten eboreus eboreus* Conrad, *P. jeffersonius* Say (having 8 or 9 ribs), *P. jeffersonius edgecombensis* Conrad, and *Arca improcera* Conrad. Among the mactroids, *Mulinia congesta* Conrad is represented by a large, elongate form and *Spisula delumbis* Conrad by a light, thin form. On the York River above Yorktown the beds exposed as far as Indian Creek appear to lie in a synclinal trough and to be higher in the series than the fragmental beds (middle part of zone 2) exposed at Yorktown. At the first exposure above Yorktown a fragmental bed lies at the base of the section, but it soon disappears beneath the beach a short distance above. A blue clayey sand rests upon this bed, and its fauna is characterized by the presence of many small dark-colored oysters, *Ostrea sculpturata*. Similar sediments containing the dark-

colored oyster were noted near water level 1½ miles below Indian Field Creek and in the bluffs on both sides of this stream. Upon the blue clayey sand rests a buff to gray fine-grained sand, which can be observed from half a mile to 1 mile above Yorktown. It is the *Yoldia* bed of Harris. Fossils from the beds above Yorktown are listed on page 10.

*Bed at Biggs farm.*—Fossils collected by me in 1922 on the Biggs farm, 3 miles west of Franklin, Southampton County, and about 21 miles nearly west of Suffolk, Va., are of special interest because they appear to be more closely related to those of the Duplin marl at the Natural Well, North Carolina, than any others so far collected from Virginia. This fauna may have lived near or at the end of the last Miocene marine invasion in Virginia and apparently at a time a little later than the fauna in the neighborhood of Suffolk, Va., but not much later. The cooler-water fauna at Suffolk is usually regarded as largely contemporaneous with the warmer-water fauna of the Duplin marl to the south. I place the exposure at the Biggs farm in the uppermost part of zone 2 of the Yorktown formation.

The bed at the Biggs farm lies 6 to 8 feet below the surface and is overlain by a coarse gray sand, probably of Pleistocene age. The material is a gray sand containing many entire and broken shells. The top of the bed is estimated to be 50 feet above sea level.

In 1929<sup>20</sup> I suggested the contemporaneity of the deposit at the Biggs farm and the Duplin marl, and in 1930<sup>21</sup> I noted the presence of *Conus adversarius* Conrad and *Fasciolaria rhomboidea* Rogers at this locality.

The species collected from this locality are listed below. Those whose names are preceded by an asterisk especially show relationship to the fauna of the Duplin marl.

- Acteocina (fragment).
- Terebra (fragment).
- "Drillia" cf. *D. myrmecoon* Dall.
- \**Conus adversarius* Conrad.
- \**Olivella nitidula* (Dillwyn).
- Marginella bella* Conrad var.
- Marginella limatula* Conrad.
- Mitramorpha* cf. *M. mitrodita* Gardner.
- \**Fasciolaria rhomboidea* Rogers.
- Fulgur canaliculatum canaliferum* Conrad.
- Ilyanassa* cf. *I. schizopyga* Dall.
- Ilyanassa granifera* Conrad.
- Nassa* cf. *N. johnsoni* Dall.
- Urosalpinx trossulus* Conrad.
- Seila adamsi* (H. C. Lea).
- Turritella* sp.
- Petalocochus sculpuratus* (H. C. Lea)?
- Crepidula fornicata cymbaeformis* Conrad.
- Crepidula aculeata costata* Morton.

<sup>16</sup> Olsson, Axel, The Murfreesboro stage of our east coast Miocene: Bull. Am. Paleontology, vol. 5, No. 28, pp. 153-164, 1917.

<sup>17</sup> Safford, J. M., and Killebrew, J. B., The elements of the geology of Tennessee, p. 125, 1900.

<sup>18</sup> Stephenson, L. W., Cooke, C. W., and Mansfield, W. C., 16th Internat. Geol. Cong. Guidebook 5, p. 35, 1932.

<sup>19</sup> Idem, p. 32.

<sup>20</sup> Mansfield, W. C., The Chesapeake Miocene basin of sedimentation as expressed in the new geologic map of Virginia: Washington Acad. Sci. Jour., vol. 19, No. 13, p. 266, fig. 2, 1929.

<sup>21</sup> Mansfield, W. C., Miocene gastropods and scaphopods of the Choctawhatchee formation of Florida: Florida Geol. Survey Bull. 3, pp. 32, 63, 1930.

*Polinices duplicatus* Say.  
*Calliostoma mitchelli* (Conrad).  
*Fissuridea* sp. cf. specimen from Darlington, S. C.  
*Cadulus thallus* (Conrad).  
*Nuculana acuta* (Conrad).  
*Glycymeris subovata tuomeyi* Dall?  
*Eontia tringintinarea* (Conrad) MacNeil (identified by MacNeil).  
*Ostrea sculpturata* Conrad.  
*Pecten* cf. *P. eboreus eboreus* Conrad (fragments).  
*Plicatula marginata* Say.  
*Crassinella galvestonensis* Harris.  
*Venericardia granulata* Say var.  
*Venericardia perplana abbreviata* Conrad.  
*Cardita arata verdevilla* Gardner.  
*Phacoides crenulatus* Conrad.  
 \**Phacoides trisulcatus multistriatus* Conrad.  
*Semele subovata* (Say) var.  
 \**Gemma magna* Dall.  
*Corbula inaequalis* Say.  
*Mulinia congesta* Conrad (a large form).

Fossils that appear to be at the same horizon as those of the Biggs bed occur in North Carolina in Greene

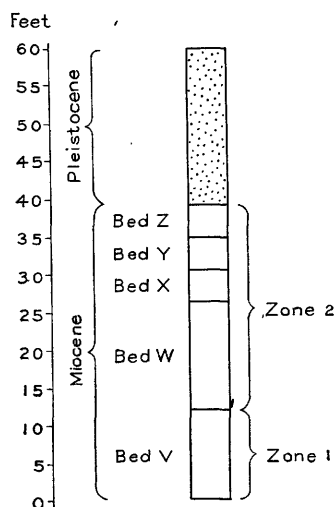


FIGURE 2.—Section on shore of the James River, east of old Kings Mill Wharf, Va.

County, 8 miles northwest of LaGrange (U. S. G. S. sta. 11822); in Wayne County, 1½ miles east of Fremont (sta. 11836); and in Craven County, at Rock Landing, on the right bank of the Neuse River 16½ miles above Newbern (sta. 10898). The localities in Greene and Wayne Counties indicate that the upper Yorktown, with a cooler-water fauna, transgressed a considerable distance inland.<sup>22</sup>

*Sections in the Yorktown formation.*—A line of bluffs on the north shore of the James River 6½ to 7 miles southeast of Williamsburg exposes the upper part of zone 1 and the lower part of zone 2 of the Yorktown formation. The best section, in a bluff about half a mile east of the old Kings Mill Wharf (1¼ miles

northwest of the old Grove Wharf), is represented in figure 2. Bed *v* is the upper part of zone 1; bed *w* is the lowest part of zone 2; beds *x*, *y*, and *z* the remainder of the lower part of zone 2. A list of the more common fossils found here and of the less common ones that are useful in zonal differentiation is given below:

#### Zone 1 (bed *v*):

##### Mollusks:

*Conus marylandicus* Green (rare).  
*Scaphella* (*Aurinia*) *mutabilis* (Conrad) (rare).  
*Fusinus propeparilis* Mansfield (rare).  
*Turritella pilsbryi* Gardner.  
*Crucibulum grande* (Say) (rare).  
*Glycymeris subovata plagia* Dall.  
*Ostrea disparilis* Conrad (rare?).  
*Pecten jeffersonius* Say.  
*Pecten clintonius* Say (occurs in the lower part of the bed).  
*Modiolus pulchellus* Olsson.  
*Astarte undulata vaginulata* Dall.  
*Astarte undulata deltoidea* Gardner.  
*Astarte exaltata* Conrad (common).  
*Crassatellites undulatus cyclopterus* Dall.  
*Venericardia granulata* Say.  
*Phacoides anodonta* (Say).  
*Cardium virginianum* Conrad (rare).  
*Isocardia carolina* Dall (rare).  
*Chione cortinaria* (Rogers) (rare).  
*Kuphus calamus* H. C. Lea.

##### Coral:

*Septastrea marylandica* (Conrad).

#### Zone 2 (beds *w* to *z*):

##### Mollusks:

*Turritella alticostata* Conrad (rare).  
*Calliostoma philanthropum* (Conrad) (rare).  
*Fissuridea redimicula* (Say) (rare).  
*Arca* (*Noëtia*) *incile* Say.  
*Arca* (*Striarca*) *centenaria* Say.  
*Ostrea sculpturata* Conrad (rare).  
*Pecten decemrarius* Conrad (rare).  
*Pecten virginianus* Conrad (rare).  
*Pecten jeffersonius edgecombensis* Conrad.  
*Astarte coheni* Conrad (rare?).  
*Astarte undulata* Say.  
*Astarte arata* Conrad (rare).  
*Crassatellites undulatus* (Say).  
*Chama congregata* Conrad.  
*Cardita arata* (Conrad) (rare).  
*Venericardia granulata* Say.  
*Mulinia congesta* (Conrad) (occurs near the top of zone 2).

##### Corals:

*Astrangia lineata* (Conrad).  
*Septastrea marylandica* (Conrad) (occurs in the lower part of zone 2).

The type section of the Yorktown formation is exposed in a series of bluffs along the south shore of the York River within 2 miles southeast of the ferry landing. (See fig. 3.) Only the beds of zone 2 are exposed in these bluffs. A notable structural feature is the northwestward dip, contrasting with the normal regional dip to the east or southeast. Beds *a* to *d* are

<sup>22</sup> Mansfield, W. C., The Chesapeake Miocene basin of sedimentation as expressed in the new geologic map of Virginia: Washington Acad. Sci. Jour., vol. 19, p. 266, fig. 2, 1929.

part of the lowest unit of zone 2, and beds *e* and *f* are the middle unit. Farther upstream (west), beyond the section shown in the diagram, are exposures assigned to the upper unit of zone 2.

The following lists indicate the more common and more significant species of fossil organisms found in the beds of the Yorktown formation shown in figure 3.

**Beds *a* and *b*:**

"Drillia" lunata (H. C. Lea).  
Oliva sayana Ravenel.  
Lirosoma sulcosa (Conrad).  
Fusinus exilis (Conrad).  
Ptychosalpinx altilis (Conrad).  
Ptychosalpinx laqueata (Conrad).  
Scalaspira strumosa Conrad.

Semele subovata (Say).  
Mulinia congesta (Conrad).  
Panope reflexa (Say).

**Bed *f*:**

Caecum stevensoni Meyer.  
Glycymeris americana (De France).  
Ostrea disparilis Conrad.  
Pecten jeffersonius edgecombensis Conrad.  
Plicatula marginata Say.  
Crassatellites undulatus (Say).  
Venericardia granulata Say.  
Astarte concentrica Conrad.  
Venus tridacnoides Lamarck.

About 2½ miles above Yorktown an exposure reveals alternating beds of clay and marl carrying entire and broken shells. These beds lie stratigraphically above

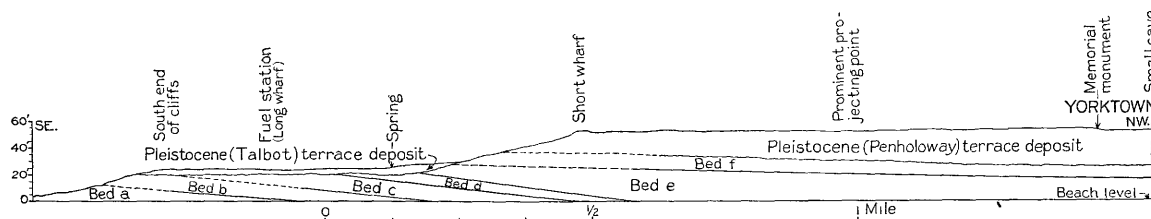


FIGURE 3.—Diagrammatic representation of the beds of zone 2 of the Yorktown formation within 2 miles southeast of Yorktown, Va.

Turritella alticostata Conrad (abundant).  
Crepidula aculeata costata Morton.  
Calliostoma philanthropum (Conrad).  
Calliostoma virginicum (Conrad).  
Fissuridea redimicula (Say).  
Yoldia laevis (Say).  
Arca (Noëtia) incile Say.  
Ostrea sculpturata Conrad.  
Pecten jeffersonius edgecombensis Conrad.  
Pecten virginianus Conrad.  
Pecten decemarius Conrad.  
Phacoides (Lucinoma) contractus (Say).  
Cardium virginianum Conrad.  
Dosinia acetabulum Conrad.  
Callocardia sayana (Conrad).  
Kuphus calamus (H. C. Lea).

**Bed *c*:**

"Drillia" pyrenoides Conrad.  
Turritella alticostata Conrad.  
Crepidula aculeata costata Morton.  
Crepidula plana Say.  
Fissuridea redimicula (Say).  
Arca (Striarca) centenaria Say.  
Arca (Noëtia) incile Say.  
Ostrea sculpturata Conrad.  
Pecten jeffersonius edgecombensis Conrad.  
Crassatellites undulatus (Say).  
Crassinella galvestonensis Harris.  
Venericardia granulata Say.  
Venus plena (Conrad).  
Pleuropygia centenaria (Conrad).

**Bed *e*:**

Glycymeris subovata (Say).  
Pecten jeffersonius edgecombensis Conrad.  
Astarte symmetrica Conrad.  
Crassatellites undulatus (Say).  
Crassinella galvestonensis Harris.  
Venericardia granulata Say.  
Cardium acutilaqueatum Conrad.

the *Yoldia* bed of Harris, and the fauna is closely related to that in the beds at Suffolk, the uppermost unit of zone 2. The species collected here are as follows:

Conus marylandicus Green.  
Turritella alticostata Conrad.  
Crepidula fornicata (Linnaeus).  
Polynices heros (Say)?  
Glycymeris subovata (Say).  
Glycymeris americana (DeFrance).  
Arca incile Say.  
Pecten eboreus yorkensis Dall.  
Pecten jeffersonius edgecombensis Conrad.  
Plicatula marginata Say.  
Astarte symmetrica Conrad.  
Astarte undulata Say.  
Cardita arata (Conrad).  
Venericardia granulata Say.  
Rangia clathrodon (Conrad).  
Venus rileyi Conrad.

The stratum at water level between Indian Field Creek and Felgates Creek is the same stratum that crops out at the foot of the bluff along the James River between old Kings Mill Wharf and old Grove Wharf and is stratigraphically lower than the basal bed below Yorktown. This stratum (part of zone 1) was observed for a short distance only, at one place, between the mouths of the two streams. Here it arches 2 or 3 feet above the shore.

Near Felgates Creek the beds stratigraphically above the basal bed assume the regional dip to the east. The material consists of coarse-grained glauconitic sand and contains well-preserved and fragmentary shells. This fauna is heterogeneous, including *St. Marys*, Yorktown, and perhaps later species, and indicates re-

deposition of an earlier fauna in later sediments. The species have, therefore, little value for correlation.

These observations of the bluffs were made before the new Yorktown-Williamsburg road (which parallels these bluffs) was constructed. On my last visit there (1936) I was unable to find the former bluff at Bellefield and assumed that it had been leveled down in the process of landscaping. Along a creek that the new road crosses about 1½ miles east of Williamsburg I observed zone 1 of the Yorktown formation in the stream bed and above it the *Chama*-bearing bed, these units exhibiting the same relationships as in the bluffs below old Kings Mill Wharf.

#### MIocene STRATA OF NORTH CAROLINA

The St. Marys formation is doubtfully recognized in the northern part of North Carolina. It is probably exposed at very low stages of some of the streams, though certain identification has not been made.

The Yorktown formation, on the other hand, is widely exposed in the northern part of the State. Apparently the whole formation is represented, though it is not easy to place all the exposures exactly within the formation. It contains a fauna suggestive of deposition in colder water than that of the Miocene beds in the southern part of the State.<sup>23</sup> The cold-water fauna apparently lived in an embayment whose waters transgressed the older rocks of the Piedmont Plateau; the fauna, especially that near the inner shore line, was consequently somewhat protected from the influence of the warmer oceanic waters that lay east of the embayment.

In the southern part of the Coastal Plain the Duplin marl, uppermost Miocene, equivalent to the uppermost part of the Yorktown formation, occurs in patches; as at Natural Well. The formation contains a fauna suggestive of deposition in warmer water than that of corresponding deposits farther north in North Carolina and Virginia.

The Miocene rocks, as exposed, probably do not anywhere exceed 50 feet in thickness.

#### YORKTOWN FORMATION

The beds assigned to the Yorktown formation are for convenience grouped into units lettered *A* to *F*, *A* being the lowest and *F* the highest. Groups *A* to *C* are well shown in the section on the Meherrin River near Murfreesboro, Hertford County, which follows:

*Section of right bank of Meherrin River one-eighth mile above highway bridge and extending up ravine to Murfreesboro, Hertford County, N. C.*

Pleistocene: Blue fine-grained sandy laminated clay bed containing mica flakes, with pebbles at the base 2 inches in diameter (thickness estimated)-----	Feet 20
----------------------------------------------------------------------------------------------------------------------------------------------------------	------------

<sup>23</sup> Mansfield, W. C., The Chesapeake Miocene basin of sedimentation as expressed in the new geologic map of Virginia: Washington Acad. Sci. Jour., vol. 19, No. 13, p. 266, fig. 2, 1929.

*Section of right bank of Meherrin River one-eighth mile above highway bridge and extending up ravine to Murfreesboro, Hertford County, N. C.—Continued*

Unconformity.

Miocene:

Yorktown formation, zone 2:

Bluish to gray sands with shell impressions-----	Feet 4
--------------------------------------------------	-----------

Bluish to gray clayey sands containing many *Mulinia congesta*, especially near the base and top. The following species were collected near the top of this 12–15 foot bed: *Fissuridea* cf. specimens from Suffolk, Va., *Glycymeris subovata tuomeyi* Dall, *Pecten jeffersonius* Say, *Pecten eboreus eboreus* Conrad, *Crassatellites undulatus* Say, *Phacoides orenulatus* Conrad, *Venus tridacnoides* (Lamarck), *Mulinia congesta* Conrad-----

12–15

Brownish coarse sands containing dark particles and a few pebbles 1 inch or less in diameter.

*Ostrea* is the most common fossil-----

3

Clayey sands, sparsely fossiliferous. The following species were collected above zone 1: *Urosalpinx trossulus* Conrad, *Lirosoma sulcosa* Conrad, *\*Turritella alticostata* Conrad (like form from *Chama*-bearing bed below old Kings Mill Wharf, James River, Va.), *Crepidula aculeata costata* Morton, *Fissuridea redimicula* Say, *Solarium nuperum* Conrad, *Dentalium attenuatum* Say, *Mytilus conradinus* D'Orbigny? *\*Astarte arata* Conrad, *Venericardia granulata* Say, *Chama congregata* Conrad, *Phacoides contractus* Say, *\*Venus tridacnoides* Lamarck, *Mulinia congesta* Conrad. Those with an asterisk (\*) came from that part of the bed directly above zone 1-----

3

Yorktown formation, zone 1: Soft medium-grained greenish-gray sand, oxidizing to light yellow, containing many black particles; contains *Pecten clintonius* in great numbers, also *Isocardia*, but no *Mulinia congesta*. The following species were collected from the basal bed (zone 1): *Glycymeris subovata tuomeyi* Dall, *Pecten jeffersonius* Say, *Pecten clintonius* Say, *Ostrea disparilis* Conrad, *Phacoides contractus murfreesboroensis* Mansfield, *Astarte hertfordensis* Gardner, *Astarte undulata deltoidea* Gardner, *Venericardia granulata* Say, *Isocardia carolina* Dall-----

4

*Groups A and B.*—At Murfreesboro (see stratigraphic section), on the Meherrin River, zone 1 of the Yorktown formation forms the lower bed (group *A*) and is directly overlain by a bed (group *B*) corresponding to the bed in the lowest part of zone 2 that contains many *Chama* in the cliffs below old Kings Mill Wharf on the James River, Va. A similar fauna occurs around Halifax, at Bell's old bridge over the Tar River, Edgecombe County; and at several other places in North Carolina.

*Group C.*—The highest beds (group *C*) in the section at Murfreesboro contain the latest identifiable fauna (U. S. G. S. sta. 10225) in the bluff. Beds that carry a similar fauna, although all may not be exactly at the same horizon, are found at the following localities: 6.8 miles below Murfreesboro (sta. 11225); in Edge-



combe County, at Shiloh Mills, on the Tar River above Tarboro (sta. 10911); in Pitt County, at Greenville (sta. 10918) and 1½ miles west of Greenville (sta. 11232). The fauna at most of the above-named localities includes *Pecten jeffersonius*, *Pecten eboreus eboreus*, *Astarte undulata* (like the form occurring in the *Chama*-bearing bed), and many individuals of *Mulinia congesta*. No specimens of *Astarte arata* or *A. roanokensis* were noted in these faunas. The position of the fauna as a whole at these localities ranges from the *Chama*-bearing bed up to the fragmental series as exposed in the bluffs at Yorktown—that is, the lower and middle parts of zone 2 of the Yorktown formation of Virginia.

*Group D.*—The faunas at the following localities are very similar in character and appear to represent about the same horizon: Lower bed at Colerain Landing, Chowan River; bed along Tar River about 6 miles below Greenville (sta. 10916); bed about 1 mile north of Grimesland, Pitt County (sta. 11835), and beds in the vicinity of Chocowinity, Beaufort County (sta. 11837). In these faunas *Turritella variabilis* var. is common; *Pecten eboreus eboreus* is also very common; *P. jeffersonius edgecombensis* is rare; *Astarte berryi* is present at two or three localities.

The horizon of the faunas is believed to be about the same as that of the beds at Suffolk, Va., or at a somewhat lower horizon—that is, essentially the upper part of zone 2 of the Yorktown formation of Virginia.

*Group E.*—The fossils collected at Rock Landing and at other localities in North Carolina are regarded as a little younger than those in the beds of group *D*. The localities are mentioned under the discussion of the bed at the Biggs farm in Virginia (p. 8).

*Group F, bed at Mount Gould Landing.*—In eastern North Carolina, along the Chowan River in Bertie and Hertford Counties and in Martin County, a marl bed crops out that is believed to have been deposited during the time of the last invasion of the Miocene sea into this part of the State. Its deposition appears to have succeeded closely that of the bed at the Biggs farm in Virginia, and it is therefore a little higher stratigraphically than the highest part of the Yorktown in Virginia. The bed at Mount Gould Landing contains a cooler-water fauna than that of the Duplin marl to the south but in age is nearly contemporaneous with some part of the Duplin, perhaps with that part deposited south of the Cape Fear River in Robeson and Bladen Counties, which appears to represent rather late Duplin time. Stratigraphically group *F* is placed in the uppermost part of zone 2 of the Yorktown formation.

The type exposure is in the right bank of the Chowan River about three-quarters of a mile below Mount Gould Landing, Bertie County, where the bed rises about 10 feet above the beach and is unconform-

ably overlain by about 25 of cross-bedded sand and clay.

The species collected from the type locality (U. S. G. S. sta. 11999) are as follows:

*Acteocina canaliculata* Say.  
*Mangilia* aff. *M. magnoliana* Olsson.  
*Marginella limatula* Conrad.  
*Marginella bella* Conrad.  
*Olivella mutica* Say.  
*Oliva nitidula* (Dillwyn).  
*Scaphella mutabilis* Conrad.  
*Busycon canaliculatum canaliferum* Conrad.  
*Uzita chowanensis* Gardner.  
*Ilyanassa granifera sexdentata* Conrad.  
*Anachis milleri* Gardner.  
*Seila adamsi* (H. C. Lea).  
*Turritella variabilis* Conrad (stout variety).  
*Crepidula fornicata cymbaeformis* Conrad.  
*Nucula proxima* Say.  
*Nuculana acuta* (Say).  
*Glycymeris subovata* Say.  
*Eontia carolinensis* (Conrad).<sup>24</sup>  
*Arca improcera* Conrad.  
*Ostrea sculpturata* Conrad.  
*Pecten eboreus bertiensis* Mansfield.  
*Modiolus ducateilli* Conrad.  
*Astarte concentrica* Conrad.  
*Crassatellites undulatus* Say.  
*Venericardia granulata* Say (a low form).  
*Phacoides multistriatus* Conrad.  
*Callocardia sayana* Dall.  
*Tellina declivis* Say.  
*Cumingia medialis* Conrad.  
*Spisula delumbis* Conrad?  
*Corbula inaequalis* Conrad.  
*Panope goldfussii* Wagner, var.

The most characteristic species in this bed are *Eontia carolinensis* (Conrad) and *Pecten eboreus bertiensis* Mansfield.<sup>25</sup>

No specimens of *Mulinia congesta* Conrad were collected at Mount Gould Landing. This species is rare at this horizon, as only about half a dozen specimens are in the National Museum collection from Tar Ferry (sta. 11230). The specimens of the genus *Spisula* are more common. No specimens of *Dentalium carolinense* Conrad were collected in deposits referred to this horizon in Bertie, Hertford, and Martin Counties. Other localities at which the fauna of group *F* occurs are station 13814, upper bed at Colerain Landing (not the lower 3-foot bed in the bluff), Bertie County; station 11230, Tar Ferry, Wiccacon Creek, Hertford County; station 13798, upper bed at Beaver Dam, Martin County; station 12004, Poplar Landing, Martin County; station 11833, near Shelmerdine and station 11827, Hanrahan, Pitt County. Most of the species near Shelmerdine and Hanrahan are poorly preserved. The fauna in Pitt County includes, besides other forms,

<sup>24</sup> Identified by F. S. MacNeil.

<sup>25</sup> Mansfield, W. C., A new species of *Pecten* from the upper Miocene of North Carolina: Washington Acad. Sci. Jour., vol. 27, No. 1, pp. 10-12, 1937.



many individuals of *Spisula* and one fragment of *Dentalium carolinense* Conrad.

#### DUPLIN MARL

The Duplin marl includes deposits that occur in thin patches in Duplin, Sampson, Bladen, and Robeson Counties, in the southern part of North Carolina. The fauna is suggestive of deposition in warmer water than that of the Yorktown formation, though it is fairly sure that the beds containing Duplin fauna were contemporaneous with the upper part of zone 2 of the Yorktown of Virginia.

#### PLIOCENE STRATA OF NORTH CAROLINA

In the eastern part of North Carolina the Croatan sand is exposed in the right bank of the Neuse River 2 to 15 miles below Newbern and in Onslow County and contains well-preserved fossils.<sup>26</sup>

In the southern part of the State abundantly fossiliferous strata of the Waccamaw formation overlies Cretaceous beds at Neills Eddy Landing, at Walkers Bluff on the Cape Fear River,<sup>27</sup> and elsewhere.

#### GEOLOGIC RANGES OF CERTAIN SPECIES

Table 2 shows, so far as known, the geologic ranges of species of mollusks in deposits in Virginia and North Carolina extending in age from the medial Miocene (Calvert formation) to the Pliocene (Waccamaw formation).

In preparing this table I have had before me a table prepared by Miss Julia Gardner with a list of the species and the locality or localities at which they occur. The localities given in Miss Gardner's table do not indicate, at localities where there is more than one horizon, the positions in the sections at which the species were taken, as at the time the collections were made, either the different stratigraphic units as now interpreted were not recognized, or stratigraphic information concerning the material was not recorded.

During my field work in Virginia and North Carolina I collected fossils from each bed or faunal unit in the sections, and relying in part upon the information thus obtained I have endeavored to interpret the range of the species in Miss Gardner's table. However, I have relied mainly upon her identification of species and record of localities at which they are reported to occur.

Under these circumstances it is impracticable to divide in the table zone 2 of the Yorktown formation

into lower, middle, and upper parts; consequently zone 2 in Virginia includes the species that range through deposits from the *Chama*-bearing bed (lower part of zone 2) to the beds at and in the vicinity of Suffolk (upper part of zone 2).

For North Carolina, zone 2 includes species ranging from the *Chama*-bearing bed to the top of the Yorktown formation. The geographic separation of the Yorktown formation, carrying a colder-water fauna, from the Duplin marl, carrying a warmer-water fauna, is shown by line *c-c* on the map included in my paper of 1929.<sup>28</sup>

The faunas at Neills Eddy Landing and Walkers Bluff on the Cape Fear River<sup>29</sup> are placed in the Pliocene Waccamaw formation. Certain beds at Wilmington are now considered of Pliocene age.<sup>30</sup>

The observed geologic ranges of a few important species that are not included in table 2 are shown in the following list:

<i>Terebra</i> ( <i>Hastula</i> ) <i>simplex</i> Conrad.....	St. Marys.
<i>Conus diluvianus</i> Green.....	Do.
<i>Conus marylandicus</i> Green.....	Yorktown, zone 1 and higher beds.
<i>Oliva eboreus</i> Conrad.....	St. Marys.
<i>Busycon coronatum</i> Conrad.....	Do.
<i>Busycon coronatum rugosum</i> Conrad.....	Calvert, Choptank, and St. Marys.
<i>Busycon maximum filosum</i> Conrad.....	Yorktown and higher beds.
<i>Fusinus parilis</i> Conrad.....	St. Marys.
<i>Fusinus propeparilis</i> Mansfield.....	Yorktown, zone 1.
<i>Alectrion peralta</i> Conrad.....	St. Marys.
<i>Turritella plebeia</i> Say.....	Calvert, Choptank, and St. Marys.
<i>Turritella plebeia carinata</i> Gardner.....	St. Marys.
<i>Turritella pilsbryi</i> Gardner.....	Yorktown, zone 1.
<i>Turritella terstriata</i> Rogers.....	Do.
<i>Calliostoma humile</i> Conrad.....	St. Marys.
<i>Glycymeris tumulus</i> (Conrad).....	Not above the St. Marys.
<i>Glycymeris americana</i> DeFrance.....	Yorktown, zone 2 and higher beds.
<i>Arca incile</i> Say.....	Yorktown, <i>Chama</i> -bearing bed and higher beds.
<i>Arca idonea</i> Conrad.....	St. Marys.
<i>Arca virginiae</i> Wagner.....	Do.
<i>Pedalion maxillatum</i> (Deshayes)---	Calvert, Choptank, St. Marys, mechanically mixed with zone 1 of Yorktown.
<i>Astarte perplana</i> Conrad.....	St. Marys.
<i>Astarte symmetrica</i> Conrad.....	Yorktown, zone 2, middle and upper parts.
<i>Cardium taeniopleura</i> Dall.....	Yorktown, zone 2.
<i>Chione dalli</i> Olsson.....	St. Marys.

<sup>26</sup> Mansfield, W. C., Notes on Pleistocene faunas from Maryland and Virginia and Pliocene and Pleistocene faunas from North Carolina: U. S. Geol. Survey Prof. Paper 150, pp. 129-133, 1928; Additional notes on the molluscan fauna of the Pliocene Croatan sand of North Carolina: Jour. Paleontology, vol. 10, No. 7, pp. 665-668, 1936.

<sup>27</sup> Miller, B. L., Tertiary formations: North Carolina Geol. and Econ. Survey, vol. 3, pp. 256-258, 1912.

<sup>28</sup> Mansfield, W. C., The Chesapeake Miocene basin of sedimentation as expressed in the new geologic map of Virginia: Washington Acad. Sci. Jour., vol. 19, p. 266, fig. 2, 1929.

<sup>29</sup> Miller, B. L., Tertiary formations: North Carolina Geol. and Econ. Survey Rept., vol. 3, pp. 256-258, 1912.

<sup>30</sup> Mansfield, W. C., Additional notes on the molluscan fauna of the Pliocene Croatan sand of North Carolina: Jour. Paleontology, vol. 10, pp. 665-668, 1936.



[illegible]

1 Fide Gardner.

<sup>2</sup> Collected near Franklin by Mansfield.



## LOCALITIES IN VIRGINIA AND NORTH CAROLINA

The numbers assigned to the key localities in the list that follows correspond to those on the index map, figure 4. On the index map the numbers are arranged serially, beginning with the northernmost localities in Virginia and progressing southward. The numbers within each county are likewise arranged from north to south.

## Virginia:

## Westmoreland County:

1. Horsehead, Stratford, and Nomini Cliffs.

## Northumberland County:

2. 8184, east bank of Hull Creek.

## Richmond County:

3. Carter Wharf, 1½ miles west of.
4. Farnham, 2½ miles south of.
5. Union Mill.

## Essex County:

6. Bowlers Wharf, 1 to 2 miles below and 2½ miles below.
7. Jones Point, a quarter of a mile above.

## Middlesex County:

8. Urbanna.
9. Burhans Wharf.

## King and Queen County:

10. Walkerton, 3 miles northeast of.

## New Kent County:

11. Lanexa.

## James City County:

12. Kings Mill Wharf.

## York County:

13. Yorktown, three-quarters of a mile above.
14. Bellefield.

## Gloucester County:

15. Ware River.

## Prince George County:

16. Near mouth of Baileys Creek.

## Surry County:

17. Claremont, old Claremont Wharf, Claremont Wharf, 6¾ miles below Claremont, Sunken Marsh Creek 2 miles below Claremont, and 8½ miles below Claremont Wharf (probably Schmidts Bluff).
18. Schmidts Bluff.
19. Scotland Wharf.
20. Cobham Wharf.

## Dinwiddie County:

21. Petersburg.

## Isle of Wight County:

22. Smithfield, 2 miles northwest of, 1½ miles west of, three-quarters of a mile northeast of, 1½ miles northeast of, and 5 miles northeast of.
23. Benns Church.
24. Zuni, 1½ miles above, 2½ to 3 miles northwest of, 6½ to 7 miles below, 7 to 7½ miles below, and 8 to 8½ miles below.

## Greensville County:

25. Hitchcock.

## Southampton County:

26. Biggs farm.
27. Delaware Park.
28. Sycamore Church.

## Nansemond County:

29. Chuckatuck, a quarter of a mile north of.
30. Everets, a quarter of a mile east of.

## Virginia—Continued.

## Nansemond County—Continued.

31. Exit.
32. Reids Ferry, 1½ miles southeast of.
33. Suffolk, 5½ miles northwest of, 2½ miles northwest of, 1½ miles northwest of, 1½ miles north of, 1¼ miles north of, 1 mile west of, half a mile below the Suffolk waterworks dam, 1 mile northeast of Suffolk, 1½ miles northeast of Suffolk, 1½ miles southeast of Suffolk.
34. Drainage ditch of Norfolk & Western Railway just east of Jericho ditch.

## North Carolina:

## Halifax County:

35. Halifax, Durham's farm, near Halifax.
36. Palmyra Bluff, 3½ miles below.

## Northampton County:

37. Branches Bridge, 1½ miles above, 1 mile above and 1½ to 2 miles below.

## Hertford County:

38. Murfreesboro, near Murfreesboro, 1 mile above, 1½ miles above, and 2½ miles northwest of.
39. Tar Ferry, above Tar Ferry, 1½ miles below and 3 to 4 miles below.

## Bertie County:

40. Colerain Landing.
41. Mount Gould Landing.
42. Edenhouse Point, half to three-quarters of a mile above.

## Edgecombe County:

43. Rocky Mount, 2 miles west of, 3½ miles northwest of, and 6 to 7 miles below.
44. Bells Bridge, half a mile above, 15½ miles above, an eighth of a mile below, and 1 to 1¼ miles below; New Bridge, two-thirds of a mile north of, 6½ miles below, and 5 miles below.
45. Shiloh Mills.
46. Tarboro.

## Martin County:

47. Williamston, 3 miles west of, 4 miles northwest of, 2½ miles northwest of, and 1 mile northwest of.
48. Hamilton Landing, a third of a mile below and 2 miles southeast of.

## Wilson County:

49. Wilson, Hominy Swamp, 1 mile west of, 3 miles east-southeast of, 5 miles south of.
50. Stantonsburg, 1 mile northwest of.

## Pitt County:

51. Tugwell, 2 miles southeast of, and Toddy Station near Tugwell.
52. Standard, 2½ miles north of.
53. Farmville, 1½ miles northeast of and 3 miles south of.
54. Greenville, south of county bridge, 8 or 9 miles west of Greenville, 3 miles west of Greenville, 2 miles west of Greenville, 1½ miles west of Greenville, 1½ miles northwest of Greenville, 1½ miles east of Greenville, 6 miles below Greenville at Cherry Landing, 6¾ miles below Greenville at Tafts Landing, 8 to 10 miles south of Greenville.
55. Grimesland, three-quarters of a mile north of.
56. Grifton, 3 miles east of.

## Beaufort County:

57. Chocowinity, 1½ miles northwest of, 2 miles northwest of, 2½ miles northwest of.

## Greene County:

58. Lizzie, half a mile east of, 1 mile east of, and 4 miles east of (in Dog Swamp).
59. Castoria, 1 mile north of.

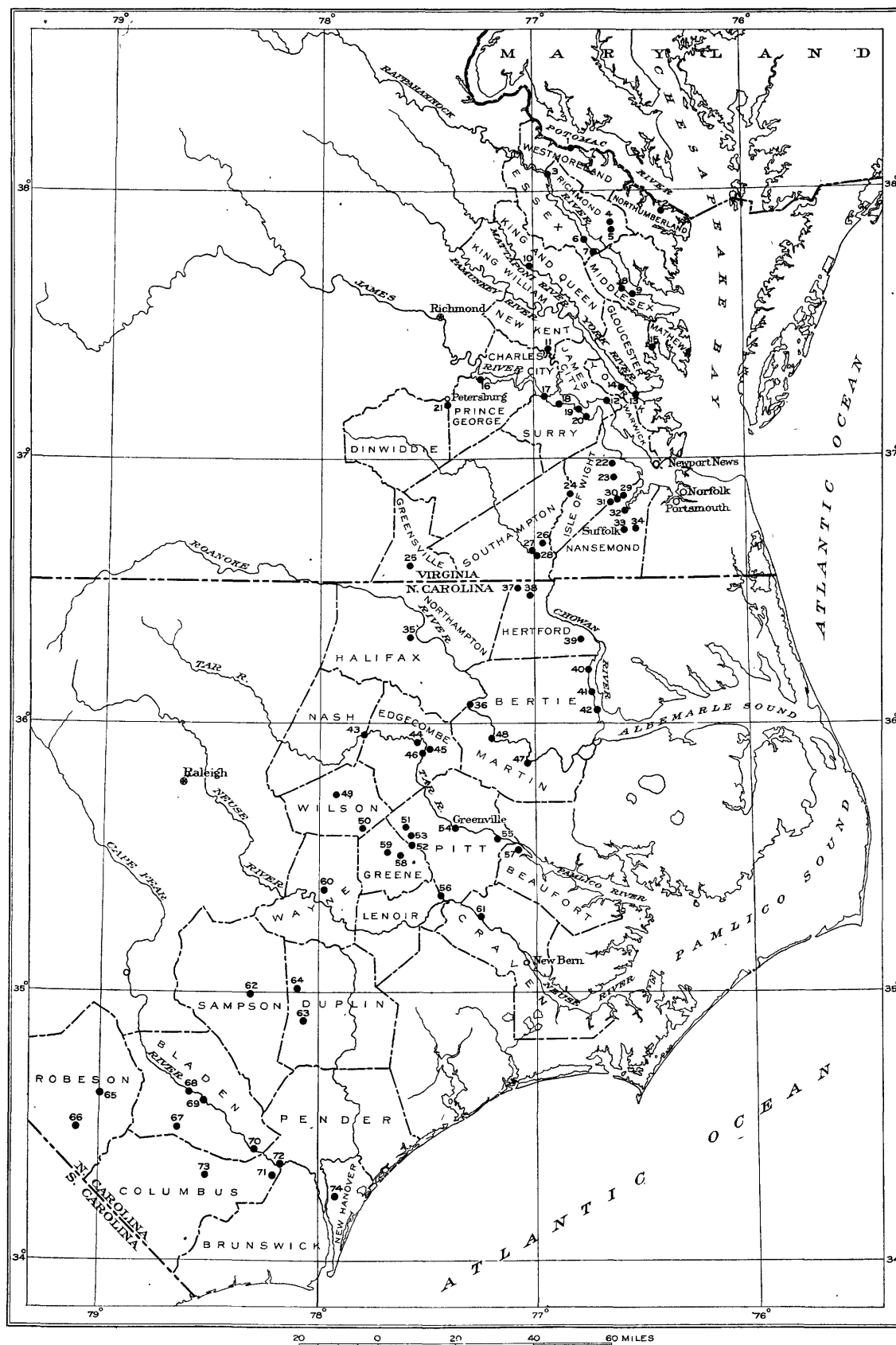


FIGURE 4.—Index map showing Miocene and lower Pliocene localities in Virginia and North Carolina. The numbers refer to the list on pages 17 and 19.

## North Carolina—Continued.

## Wayne County:

60. Goldsboro, 6 miles west of.

## Craven County:

61. Rock Landing.

## Sampson County:

62. Clinton, 2½ miles south of, 3 miles south of, and 4 miles south of.

## Duplin County:

63. Natural Well and environs.

64. Warsaw, 2 miles northeast of.

## Robeson County:

65. Lumberton, near the bottling works, 1 mile west of Lumberton, 2 miles below Lumberton, and 4 to 5 miles below Lumberton.

66. Fairmont, 1½ miles northeast of, 4 miles northeast of, and Ashpole (near Fairmont).

## Bladen County:

67. Clarkton, 4 miles south of.

68. Elizabethtown, 4 miles south of, and 4 miles east of.

69. Walkers Bluff.

70. Black Rock Landing.

## Columbus County:

71. Cronly.

72. Neills Eddy Landing.

73. Lake Waccamaw.

## New Hanover County:

74. Wilmington, city rock quarry near Wilmington.

## SYSTEMATIC DESCRIPTIONS

By JULIA GARDNER

Phylum MOLLUSCA

Class PELECYPODA

Order PRIONODESMACEA

Superfamily NUCULACEA

Family NUCULIDAE

Genus NUCULA Lamarck

- 1799.
- Nucula*
- Lamarck, Prodrôme d'une nouvelle classification des coquilles: Soc. histoire nat. Paris Mém., p. 87.

Type by monotypy: *Arca nucleus* Linnaeus. Recent in the European seas. The group has been exhaustively treated by Schenck.<sup>31</sup>

Valves not gaping; shell nacreous in texture, small, trigonal to subcircular to elliptical. Umbones subcentral or posterior, proximate, opisthogyrate. Escutcheon, and more rarely the lunule, clearly indicated though not sharply defined. External surface commonly concentrically striate or rugose with a more or less obvious subcutaneous radial lineation. Two series of crowded, chevron-shaped hinge teeth, the anterior the longer and the individual teeth diminishing rapidly in size along the margin of the chondrophore; the posterior series shorter and more uniform in size and direction. Chondrophore narrow, inclined

obliquely forward. Anterior and posterior muscle scars subequal, inconspicuous. Pallial line simple. Inner margin finely crenate in harmony with the radial lineation.

Schenck<sup>32</sup> refers to *Nucula* s. s. the Lower Cretaceous species, *Nucula gaultana* J. Starkie Gardner, and closely related forms earlier included under *Nucula* have been described from the Paleozoic. The wide distribution of the Recent species suggests a stock deeply rooted in the past. Though characteristic of the boreal and temperate oceans today, the group has also a meager representation in the tropical seas. It is found in both shallow and deep water and on both sandy and muddy bottoms.

*Nucula proxima* Say

Plate 1, figures 1, 2, 4, 5

- 1820.
- Nucula obliqua*
- Say, Am. Jour. Sci., 1st ser., vol. 2, p. 40. Not
- Nucula obliqua*
- Lamarck, 1819.

- 1822 (August).
- Nucula proxima*
- Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 270.

- 1856.
- Nucula proxima*
- Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 53, pl. 17, figs. 7-9.

- 1858.
- Nucula proxima*
- Say. Holmes, Post-Pleiocene fossils of South Carolina, p. 17, pl. 3, fig. 6.

- 1889.
- Nucula proxima*
- Say. Dall, U. S. Nat. Mus. Bull. 37, p. 42, pl. 56, fig. 4.

- 1894.
- Nucula proxima*
- Say. Whitfield, U. S. Geol. Survey Mon. 24, p. 50, pl. 7, figs. 7-10.

- 1898.
- Nucula proxima*
- Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 574.

- 1904.
- Nucula proxima*
- Say. Glenn, Maryland Geol. Survey, Miocene, p. 398, pl. 108, figs. 5, 6.

- 1906.
- Nucula proxima*
- Say. Clark, idem, Pliocene and Pleistocene, p. 207, pl. 65, figs. 1-4.

- 1932.
- Nucula proxima*
- Say. Mansfield, Florida Geol. Survey Bull. 8, p. 30, pl. 1, figs. 3, 4, 5.

Valves obliquely subtriangular, obsoletely striate transversely, one or two of the striae more conspicuous; numerous, hardly perceptible longitudinal striae; anterior and posterior sides forming an acute angle; umbo obtuse; apex acute; teeth angulated, prominent, cavity at the apex of the hinge profound, rather long; basal margin denticulatocrenate. Greatest length one-fifth of an inch.—Say, 1820.

If a geographical series of this species be examined, it will be noticed that the northern specimens are almost smoothly truncate behind, the escutcheon is not impressed to any marked degree, and there is no angle at the margin below the escutcheon. On the other hand, the specimens from the southern coast, whence Say's type was derived, have a thinner shell with an impressed escutcheon, the middle of which points more or less strongly; the valve margin below the escutcheon has a projecting angle; the shell is somewhat compressed, compared with the northern form, and has a paler and more delicate epidermis. \* \* \* Most of the conchologists of the United States having resided north of Delaware, the northern form is the more familiar both in books and collections, but it is not the original type, and I have therefore given it a varietal name.—Dall, 1898.

<sup>31</sup> Schenck, H. G., The classification of nuculid pelecypods: Mus. royal histoire nat. Belgique Mém., vol. 10, No. 20, pp. 1-78, pls. 1-5, 1934.

<sup>32</sup> Idem, p. 22.

Type locality: Upper Marlboro, Md., is cited as the type locality. The collector was Mr. J. Gilliams, of Philadelphia, who submitted a specimen of a large species of fossil "*Perna*," later referred to *Melina maxillata*. The *Nucula* and several other species were taken from the "compact earth" included between the two "*Perna*" valves. No record of *Melina maxillata* from the immediate vicinity of Upper Marlboro has since been published.

This exceedingly variable form is by far the most common *Nucula* of the east coast Miocene and Pliocene. The range in the outline of the valves of the Recent species, coincident with the geographic range, has already been noted by Dall. One would scarcely expect to find, as is the case, that the contour characteristic of the northern inhabitants among the Recent species is, in the fossil representatives, limited for the most part to the late Miocene and early Pliocene forms of southern North Carolina.

The number of the hinge teeth varies with the age. It is not uncommon to find young forms with only 4 posterior and 10 anterior teeth nor adults with 12 posterior and 25 anterior teeth. The radial sculpture is another inconstant character, in both the number and the prominence of the impressed lines. These are, for the most part, visible only under magnification, but in occasional individuals they seem to be altogether wanting, while in others they may be readily noted with the naked eye.

A single valve, quite certainly an abnormal *Nucula proxima* Say, was collected one-third of a mile below Hamilton Landing. The shell is subquadrangular in outline, with almost terminal beaks, sharply truncated posteriorly, though rounded anteriorly.

The variety *truncula*, suggested by Dall, has not been separated from the true *proxima*, as the criteria which he gives—the outline, convexity, escutcheon characters, etc.—have proved in the material under investigation to bear no constant relation to one another.

Distribution: Virginia: Miocene, St. Marys formation(?) Nomini Cliffs, Westmoreland County. St. Marys formation, Union Mills, 2½ miles south of Farnham, Richmond County; ¼ mile above Jones Point, 1 to 2 miles below Bowlers Wharf, Essex County; Urbanna, Middlesex County. Yorktown formation. ⅝ mile above Yorktown, Yorktown, York County; 1½ miles west of Smithfield, Benns Church, 1½ miles below Blackwater Bridge, Blackwater River, Isle of Wight County; Hitchcock, Greensville County; a quarter of a mile north of Chuckatuck, Exit, ¼ mile east of Everets, 1½ miles southeast of Reids Ferry, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 5½ miles northwest of Suffolk, 2½ miles northwest of Suffolk, 1 mile west of Suffolk, 1½ miles northeast of Suffolk, ¼ mile below Suffolk waterworks dam, and drainage ditch of Norfolk & Western Railway, just below Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation. 1 mile above Branches Bridge, 1½ miles below Branches Bridge, and 1½ to 2 miles below Branches Bridge, Northampton County; Murfreesboro, 1½ miles above Murfreesboro, Tar Ferry, 1½ miles

below Tar Ferry, 3 to 4 miles below Tar Ferry, Dogwood Landing, and Mount Pleasant Landing, Hertford County; Cole-rain Landing, Mount Gould Landing, and ½ to ¾ mile above Edenhouse Point, Bertie County; Palmyra Bluff, Halifax County; Hamilton Landing, ½ mile below Hamilton Landing, 2 miles southeast of Hamilton Landing, 4 miles northwest of Williamston, and 2½ miles northwest of Williamston, Martin County; 2 miles west of Rocky Mount, ½ mile above Bells Bridge, Shiloh Mills, and Tarboro, Edgecombe County; 2 miles below Toddy Station, 1¼ miles northeast of Farmville, 2½ miles north of Standard, 3 miles southwest of Frog Level, 8 to 9 miles west of Greenville, Hardee Creek, 3½ miles from Tar River, 1 mile northwest of Galloway Crossroads, Pitt County; 1 mile west of Wilson, Wilson County; 4 miles east of Lizzie, Greene County. Duplin marl, 4 miles south of Clinton, and 10 miles south of Clinton, Sampson County; Natural Well and environs, Duplin County; 1½ miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation. Walkers Bluff, Bladen County; Lake Waccamaw, Cronly, and Neills Eddy Landing, Columbus County; city rock quarry, Wilmington, New Hanover County.

The species is common at most of these localities and in the environs of Hamilton Landing, N. C., is exceedingly abundant and practically the only form of molluscan life represented.

Outside distribution: Miocene, Calvert formation, Shiloh, Jericho, and Bridgeton, N. J.; Church Hill, 3 miles west of Centerville, Fairhaven, Chesapeake Beach, Plum Point, and Trumans Wharf, Md. Choptank formation, Dover Bridge and Cordova, Md. Duplin marl, Darlington, Darlington County, S. C.; Porters Landing, Effingham County, Ga. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C. Caloosahatchee marl, Sanford, Seminole County, Fla.; Kissimmee, Osceola County, Fla.; Caloosahatchee River and Shell Creek, Fla.; Pleistocene, Dismal Swamp Canal, posts 15 to 16, Va.; quarantine station well, North Carolina; Wailes Bluff, near Cornfield Harbor, Md.; Simmons Bluff, Savannah River, S. C.; Rose Bluff, Nassau County, Fla.; Eau Gallie, Brevard County, Fla.; Daytona, Volusia County, Fla. Recent, Cape Hatteras to Charlotte Harbor, Fla., in 2 to 100 fathoms; variety *trunculus* Dall, from Nova Scotia south to Hatteras.

### *Nucula diaphana* H. C. Lea

Plate 1, figures 3, 9

1846. *Nucula diaphana* H. C. Lea, Am. Philos. Soc. Trans., vol. 9, p. 243, pl. 34, fig. 26.

1898. *Nucula diaphana* H. C. Lea. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 577.

Shell transverse, inequilateral, subelliptic, rounded anteriorly and posteriorly, inflated, diaphanous, thin, smooth, polished, pearly within; umbonal slope somewhat flattened; basal margin curved; dorsal margin curved; beaks prominent; teeth very arcuate, 5 anterior, 12 posterior; fosset rhomboidal, oblique; internal margin crenulated.

Diameter 0.04, length 0.11, breadth 0.15 inch.

This little shell, in common with the preceding [*Nucula dolabella* H. C. Lea] has some resemblance to the *N. obliqua* Say, but it may be distinguished by its elliptical shape, thin and diaphanous substance, smooth surface, and rhomboidal fosset. The teeth are also more arcuate, and there is a greater disparity between the posterior and anterior series.

In outline, this species is closely allied to the *N. antiqua* Mighels and Adams, from the post-Pliocene of Massachusetts.—H. C. Lea, 1846.



Lea's illustration is so very poor that it is impossible to be sure whether or not the specimen, No. 1591, from the Academy of Natural Sciences in Philadelphia, labeled *diaphana*, and reproduced in figure 3, is that described and figured by Lea. The measurements closely correspond, and the species represented seems distinct from the common *N. proxima* Say. It has not, however, been identified in the later collections.

Type locality: Petersburg, Va.

#### Family NUCULANIDAE

#### Genus YOLDIA Möller

1842. *Yoldia* Möller, Index molluscorum Groenlandiae, p. 18.

Type by subsequent designation (Verrill and Bush, Am. Jour. Sci., 4th ser., vol. 3, p. 55, 1897): *Yoldia arctica* Möller (not Gray) = *Yoldia hyperborea* (Loven) Gould. Recent in the Arctic seas.

The genus differs from the old "*Leda*" in the posterior gape of the valves, the longer siphons, and the consequently deeper pallial sinus. It is more produced transversely and more markedly rostrate than the southern analog, *Orthoyoldia* Verrill and Bush, the length of the anterior and posterior series of teeth is more discrepant, and the chondrophore is relatively larger and higher.

#### *Yoldia laevis* (Say) Conrad

Plate 1, figure 10

1824. *Nucula laevis* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 141, pl. 10, fig. 5.  
 1831. *Nucula laevis* Say, American conchology, pl. 12, right-hand figures, descriptive text.  
 1845. *Nucula limatula* Conrad, Fossils of the medial tertiary of the United States, p. 57, pl. 30, fig. 4. Not *N. limatula* Say, 1831.  
 1856. *Nucula limatula* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 52, pl. 17, figs. 13-15. Not *N. limatula* Say, 1831.  
 1863. *Yoldia laevis* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 581.  
 1864. *Yoldia laevis* (Say) Conrad. Meek, Miocene check list; Smithsonian Misc. Coll., No. 183, p. 5.  
 1894. *Yoldia "limatula"* Whitfield, U. S. Geol. Survey Mon. 24, p. 51 (part), pl. 7, figs. 11, 12.  
 1898. *Yoldia laevis* Say. Dall, Wagner Free Inst., Sci. Trans., vol. 3, pt. 4, p. 596.  
 1904. *Yoldia laevis* (Say). Glenn, Maryland Geol. Survey, Miocene, p. 397, pl. 108, figs. 3, 4.

Transversely elongate-subovate, rostrated, nearly smooth. Shell compressed, thin, fragile, polished, smooth, slightly wrinkled toward the base; beaks nearly central, hardly prominent beyond the hinge margin, rounded, approximate; series of teeth subrectilinear, a little arcuated behind; teeth prominent; hinge margin exteriorly both before and behind the beaks rather abruptly compressed; posterior margin rounded; anterior margin somewhat rostrated, the anterior hinge margin rectilinear, very little reflected at tip; inner margin simple.

Length nearly half an inch, breadth nearly 1 inch—Say, 1824.

Type locality: Maryland.

The synonymy of this species gives evidence of the close resemblance to its Pleistocene and Recent descendant, *Yoldia limatula* (Say). The outlines of both forms vary widely, and little reliance can be placed upon this character. As a rule, however, the Tertiary species is relatively lower, more rostrate posteriorly, and with a less pronounced umbonal slope. The hinge teeth and the character of the chondrophore furnish the best distinctions. In *Yoldia laevis* the teeth are more closely set and the series extends farther down toward the basal margin than in *Yoldia limatula*. In both forms the number of teeth varies with the age of the individual. The chondrophore of *Yoldia laevis* is more conspicuous and tends to be transversely elongated rather than subtriangular as in *Yoldia limatula* (Say).

The Tertiary species is common in the more northern localities but, like the Recent *Yoldia*, diminishes in prominence and finally disappears toward the south.

Distribution: Virginia: Miocene, Yorktown formation, Hitchcock, Greensville County;  $\frac{3}{4}$  mile above Yorktown, Yorktown, York County; Claremont Wharf, Surry County; Fergusons Wharf,  $1\frac{1}{2}$  miles west of Smithfield, and 5 miles northeast of Smithfield;  $1\frac{1}{2}$  miles below Blackwater Bridge,  $2\frac{1}{2}$  to 3 miles south of Zuni, 7 to  $7\frac{1}{2}$  miles below Zuni, Isle of Wight County; 2 to  $2\frac{1}{2}$  miles below South Quay, Blackwater River,  $\frac{1}{4}$  mile north of Chuckatuck,  $\frac{1}{4}$  mile east of Everets, Exit,  $5\frac{1}{2}$  miles northwest of Suffolk,  $2\frac{1}{2}$  miles northwest of Suffolk,  $1\frac{1}{2}$  miles northwest of Suffolk;  $1\frac{1}{2}$  miles north of Suffolk, 1 mile west of Suffolk,  $\frac{1}{2}$  mile below the Suffolk waterworks dam, 1 mile northeast of Suffolk, and  $1\frac{1}{2}$  miles northeast of Suffolk, Nansemond County.

North Carolina: Yorktown formation, 1 mile above Branches Bridge,  $1\frac{1}{2}$  to 2 miles below Branches Bridge, and Branches Bridge, Northampton County;  $2\frac{1}{2}$  miles northwest of Murfreesboro,  $1\frac{1}{2}$  miles above Murfreesboro, 1 mile above Murfreesboro, Murfreesboro, Tar Ferry, and Mount Pleasant Landing, Hertford County; Durham's farm near Halifax, Palmyra Bluff, and  $3\frac{1}{2}$  miles below Palmyra Bluff, Halifax County; Hamilton Bluff,  $\frac{1}{4}$  mile below Hamilton Landing, 3 miles west of Williamston,  $2\frac{1}{2}$  miles northwest of Williamston, and 1 mile northwest of Williamston, Martin County; 6 to 7 miles below Rocky Mount, 5 miles below New Bridge,  $15\frac{1}{2}$  miles above Bells Bridge,  $\frac{1}{2}$  mile above Bells Bridge, mouth of Swift Creek, and Shiloh Mills, Edgecombe County; 2 miles below Toddy Station, 3 miles southwest of Frog Level; 8 to 9 miles west of Greenville, 3 miles west of Greenville, 6 miles below Greenville,  $6\frac{3}{4}$  miles below Greenville, 8 to 9 miles south of Greenville, and 9 to 10 miles south of Greenville, Pitt County; 1 mile west of Wilson, Wilson County; 1 mile east of Lizzie,  $\frac{1}{2}$  mile east of Lizzie, and 4 miles east of Lizzie in Dog Swamp, Greene County;  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhouse Point, Bertie County. Duplin marl,  $1\frac{1}{2}$  miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown and Walkers Bluff, Bladen County.

Outside distribution: Miocene, Calvert formation, Jericho and Shiloh, Cumberland County, N. J.; Church Hill, Fairhaven, Parker Creek, Lyons Creek, Plum Point, and Whites Landing, Md. Hawthorn formation, Porters Landing, Savannah River, Effingham County, Ga. Choptank formation, Jones Wharf and Sand Hill, Md. St. Marys formation, Cove Point, St. Marys River, and Langleys Bluff, Md.

## Superfamily ARCACEA

## Family ARCIDAE

- 1935 (August). Reinhart, P. W., Classification of the pelecypod family Arcidae: Mus. royal histoire nat. Belgique Mém., vol. 11, No. 13, pp. 1-68.

## Genus ARCA (Linnaeus) Lamarck

1758. Linnaeus, Systema naturae, 10th ed., p. 693.  
1799. Lamarck, Prodrome d'une nouvelle classification des coquilles: Soc. histoire nat. Paris Mém., p. 87.

*Arca noae* Linnaeus, Recent in the Mediterranean, and the *Arca* cited in the Prodrome, was long accepted as the type and has to its credit the authentic designations of Schmidt, 1818, and Gray, 1847. The citation of Schumacher, 1817 (Essai d'un nouveau système des habitations des vers testacés, p. 172), "Pour le type du genre j'ai donné la fig. 2, pl. XIX, de la charnière de l'*Arca antiquata* Lin. qu'on trouve figurée dans Chemn. 7, pag. 201, tab. 55, fig. 548," may justly claim priority. As Reinhart<sup>33</sup> remarked, however, "It is a debatable question whether Schumacher was here designating a type species or merely illustrating a type of hinge structure." A request that *Arca noae* be established as the type species has been presented to the International Commission on Zoological Nomenclature by Reinhart.<sup>33</sup> This seems on the whole a wiser method of salvaging a widely accepted type than an attempt to invoke "virtual tautonymy" in its behalf.

In the hope of a favorable decision from the commission *Arca noae* has been retained as the type of the genus in this report.

The Arcas typified by *A. noae* are equivalve, inequilateral, transversely elongate, rudely quadrate, or oval, commonly irregular in outline, and gaping anteriorly. The beaks are prominent, placed well forward and separated by a wide cardinal area scarred with oblique, discontinuous cartilage grooves. The radials that adorn the outer surface differ in prominence and spacing on different parts of the shell. The hinge line is straight; the teeth are numerous, short, subequal, and transverse. The adductor impressions are distinct, the pallial line is simple, and the inner margins are smooth or feebly crenate at the extreme edge in harmony with the radial ornamentation of the exterior.

## Genus BARBATIA Gray

1842. *Barbatia* Gray, Synopsis of the contents of the British Museum, 44th ed., p. 81. Described but no species mentioned.  
1847. *Barbatia* Gray, Zool. Soc. London Proc., pt. 15, p. 197.

Type by subsequent designation, Gray, 1847: *Arca barbata* Linnaeus. Recent in the Mediterranean.

The *Barbatia* are elongated shells, covered with a hairy periostraca; the teeth on the middle of the line are small, of the ends large and oblique.—Gray, 1842.

The shell of *Barbatia*, like that of *Arca*, is usually of at least moderate dimensions, inequilateral, transversely elongate, with a byssal gape at the ventral margin, anterior or subcentral beaks, a multivincular ligament, numerous taxodont teeth, rather large muscle scars, a simple pallial line, and, as a rule, a crenate inner margin.

The shell is usually less deformed in *Barbatia* than it is in *Arca*; the byssal gape is not so wide; the posterior portion of the shell is broadly rounded rather than rostrate; the beaks are less prominent and the cardinal area is consequently lower; the dentition is less regular than that of *Arca* and is usually obliterated medially in the adult by the encroachment of the cardinal area. The shells of both genera are radially sculptured, but that of *Barbatia*, though irregular in many species, is less sharply differentiated on the anterior and posterior areas.

True *Barbatia* has been recognized in the Upper Cretaceous of the east coast and Gulf regions (Stephenson, 1923; Wade, 1926) and the genotype is a Recent species.

## Subgenus GRANOARCA Conrad

1862. *Granoarca* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 14, p. 290.

Type by monotypy: *Arca propatula* Conrad. Miocene of Virginia and the Carolinas.

*Barbatia* (*Granoarca*) *propatula* (Conrad) Conrad

## Plate 2, figure 1

1844. *Arca propatula* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 323.  
1845. *Arca propatula* Conrad, Fossils of the medial Tertiary of the United States, p. 61, pl. 32, fig. 1.  
1856. *Arca hians* Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 34, pl. 14, figs. 4, 5. Not *Arca hians* Bronn, 1842, nor Reeve, 1844.  
1863. *Barbatia* (*Granoarca*) *propatula* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 580.  
1898. *Barbatia* (*Granoarca*) *propatula* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 627.  
1916. *Arca propatula* Conrad. Sheldon, Palaeontographica Americana, vol. 1, No. 1, p. 18, pl. 4, fig. 1.  
1932. *Barbatia* (*Granoarca*) *propatula* Conrad. Mansfield, Florida Geol. Survey Bull. 8, p. 43, pl. 4, figs. 1, 2, 3.

Rhomboidal, thick, and ponderous; posterior side produced; sides flattened, slightly concave toward the base; umbonial slope rounded, rather elevated; ribs about 32, square, not profoundly prominent, about equal in width to the interstices, which have transverse imbricated lines; ribs largest about the umbonial slope, very distinct on the posterior slope, which is concave toward the hinge line; posterior margin oblique, concave, extremity widely rounded; summit of umbo moderately elevated, slightly retuse; cardinal area wide, with diverging grooves; series of teeth slightly sinuous anteriorly; teeth numerous; at the posterior extremity the series suddenly becomes dilated and the teeth interrupted or tubercular; inner margin crenate, crenae profound, and remote posteriorly. Length, 4 inches; height, rather more than 1½ inches.

Locality: James River below City Point, Petersburg, Mr. Tuomey, Ware River, Gloucester County, Va., Mr. Ruffin—Conrad, 1844.

<sup>33</sup> Reinhart, P. W., op. cit., p. 16.

This species strikingly illustrates the characteristic of the section—the disintegration of the distal teeth. The shell is larger than *Granoarca virginiae* (Wagner), the beaks are not so high and less tumid, the posterior margin is less produced, and the ribs are more numerous. The byssal gape, though narrow, is distinct.

Mansfield has indicated the essential resemblance of *Granoarca propatula* to the much smaller *G. campyla* Dall, an abundant and diagnostic species of Floridian Pliocene. In Florida *G. propatula* is reported only from the *Cancellaria* zone, the time equivalent of the upper beds of the Yorktown formation.

Distribution: Virginia. Miocene, Yorktown formation, Petersburg, Dinwiddie County (Tuomey); below City Point on the James River, Prince George County (Tuomey); Ware River, Gloucester County (Ruffin).

Outside distribution: Miocene, Duplin marl, Darlington, S. C. Choctawhatchee formation, *Cancellaria* zone in Leon County, Fla.

#### Genus ANADARA Gray

1847. *Anadara* Gray, Zool. Soc. London Proc., pt. 15, p. 198.

1925. *Diluvarca* Woodring, Carnegie Inst. Washington Pub. 366, p. 40. Suppressed in favor of *Anadara* by Woodring, Carnegie Inst. Washington Pub. 385, p. 18, 1928.

Type by monotypy: *Arca antiquata* Linnaeus. Habitat not determined.

*Anadara* is a moderately heavy, transversely elongate shell with a rather wide range in size. The outline and the sculpture are more regular than in *Barbatia*. The byssal gape is much less pronounced and does not warp the shell. The beaks are full, and the cardinal area is relatively high and scarred with concentric chevronlike ligament grooves diverging beneath the tips of the umbones. The dental series is not broken medially, as it is in the adult *Barbatia*, but the distal teeth are larger than the medial, more oblique, and less closely spaced. In the larger shells the muscle scars are prominent and the inner margins deeply fluted.

The group includes a great number of our Tertiary and Recent east coast and Gulf species.

#### *Anadara lienosa* (Say) Mansfield

Plate 2, figures 4, 7

1832. *Arca lienosa* Say, American conchology, pl. 36, fig. 1, and descriptive text.

1856. *Arca lienosa* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 40, pl. 15, figs. 2, 3.

1858. *Arca lienosa* Say (part). Holmes, Post-Pleiocene fossils of South Carolina, p. 20.

1858. *Arca lienosa* Say. Emmons, North Carolina Geol. Survey Rept., p. 284, fig. 204.

1863. *Scapharca lienosa* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 579.

1864. *Scapharca lienosa* (Say) Conrad. Meek, Checklist of the invertebrate fossils of North America, Miocene; Smithsonian Misc. Coll., No. 183, p. 6.

1887. *Arca lienosa* Say. Heilprin, Wagner Free Inst. Sci. Trans., vol. 1, p. 97.

1898. *Scapharca* (*Scapharca*) *lienosa* Say. Dall, idem, vol. 3, pt. 4, p. 636.

1916. *Arca lienosa* Say. Sheldon, Palaeontographica Americana, vol. 1, No. 1, p. 35 (part), pl. 7, figs. 26–28; ? pl. 8, figs. 1, 2.

1932. *Arca* (*Anadara*) *lienosa* Say (part). Mansfield, Florida Geol. Survey Bull. 8, p. 50, pl. 3, fig. 8.

Shell rather thin, transversely oblong; ribs about 40, somewhat flattened and much broader than the intervening spaces, which are very narrow, and with a longitudinal impressed line, particularly on those of the posterior margin, which are almost bifid; and with numerous slightly elevated transverse lines, which being divided by the longitudinal striae appear granulated; beak but little prominent, and nearly opposite to the posterior [anterior] third of the length of the hinge margin; area narrow and elongated; hinge margin rectilinear, angulated at each extremity; teeth numerous, small; posterior [anterior] margin obliquely rounded inward, no part of it extending farther backward than the angle; anterior [posterior] margin obliquely truncate; inner margin crenate.

A fossil shell from the same locality as the preceding [the Santee River, below the confluence of the Congaree and Wateree Rivers] and also sent to me by Mr. Elliott.—Say, 1832.

This species has always been rather rare and has been confounded with its undoubted descendant, the *Arca floridana* of Conrad, found living in Florida waters. Nevertheless, the recent and the fossil shells are readily distinguished on comparison. \* \* \* In *A. lienosa* there are about 40 ribs in a specimen 108 millimeters long; these ribs are deeply grooved down the center, and the ridges on either side of the grooves are likewise longitudinally grooved with one or two incised lines. The interspaces between the ribs are narrower than the ribs; the beaks are less anterior than in *A. secticostata* [= *A. floridana* Conrad]. In the latter the ribs are much narrower than their interspaces, flat-topped, and distally for a little more than half their length in the adult the top of the rib has a broad, shallow channel. In no case are there any subsidiary grooves. Minute concentric ridges are quite obvious in both species, but the fossil has the ridges more generally and conspicuously beaded. In other respects the shells are extremely similar.—Dall, 1898.

Within the area under discussion there is no species with which this rare but very conspicuous form is readily confusable.

*Anadara lienosa* is essentially warm-temperate or subtropical in its distribution. The records from the cooler faunas of the Yorktown formation are fragmentary. This, in itself, is evidence against the inclusion in the synonymy of *Arca protracta*, described by the Rogers brothers from Prince George County, Va. In Florida, Mansfield reports *Alienosa* from several localities in both the *Ecphora* and the *Cancellaria* zones of the Choctowhatchee. Related species include *Arca* (*Scapharca*) *henekeni* from the Dominican Republic and the Machapoorie horizon in Trinidad and *Barbatia* (*Diluvarca*) *halidonta oresta* Woodring from the Bowden of Jamaica. The middle Miocene West Indian forms recall not only *lienosa* of the upper Miocene and Pliocene distribution but also the abundant and widely distributed group which includes *hypomela* (Dall) of the Chipola and *dodona* (Dall) of the Oak Grove.

Distribution: North Carolina: Miocene, Duplin marl, 1 mile south of Clinton, Sampson County; Natural Well, 1½ miles north of Magnolia, Duplin County; 4 miles northeast of Fairmont, Robe-

son County. Pliocene, Waccamaw formation, Neills Eddy Landing, 3 miles north of Cronly, Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida. Duplin marl, Brunswick River bed, Brunswick, Glynn County, Ga. Pliocene, Waccamaw formation. Nixons, Todds Ferry, and Tillys Lake, Horry County, S. C. Caloosahatchee marl. Caloosahatchee River, Shell Creek, and Alligator Creek, Fla. Pleistocene, Simmons Bluff, Savannah River, S. C.

**Anadara protracta (Rogers and Rogers) Gardner**

Plate 2, figure 5; plate 3, figure 3

1837. *Arca protracta* W. B. and H. D. Rogers, Am. Philos. Soc. Trans., n. ser., vol. 5, p. 332.

1839. *Arca protracta* W. B. and H. D. Rogers, idem., vol. 6, pl. 26, fig. 5.

1845. *Arca (Anomalocardia* [in plate description only]) *protracta* Rogers. Conrad, Fossils of the medial Tertiary of the United States, p. 58, pl. 30, fig. 5.

1898. *Arca protracta* Rogers. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 627.

1916. *Arca lienosa* Say (part). Sheldon, Palaeontographica Americana, vol. 1, no. 1, p. 35, pl. 8, figs. 1, 2.

Shell rather thick, very oblong transversely; ribs about 40, not very prominent, hardly wider than the intercostal spaces, and longitudinally furrowed by three narrow grooves, the central one much the widest; a very indistinct granulation of the ribs, arising from the numerous minute transverse lines of growth crossing the longitudinal ridges of the ribs; beaks prominent and distant, opposite a point less than one-third the length of the hinge margin from the posterior extremity; area wide, with numerous distinct undulated grooves, parallel to the hinge margin; hinge margin rectilinear, with numerous minute straight teeth, those in the anterior half directed a little obliquely toward the anterior margin; posterior margin rounded slightly outward, extending a little farther backward than the angle; anterior margin much elongated, extending in an oval curve far in advance of the end of the hinge; basal margin contracted opposite the middle of the hinge, and deeply crenate. Length,  $3\frac{1}{2}$  inches.

Locality, Shell banks, Prince George County, [Va.].—Rogers and Rogers, 1837.

In the orientation of the shell, the anterior and posterior margins have been reversed. This species is undoubtedly very close to *Anadara lienosa* (Say). The two may be identical but as the type has not been available for consultation it does not seem wise to unite them. *A. protracta* has apparently a greater relative width than the normal *A. lienosa* of Say, with a more marked contraction of the basal margin and a wider cardinal area. Furthermore the known distribution of *A. lienosa* does not include a fauna of so cool water as that indicated by the type locality of *protracta*.

Distribution: The species is not represented in the material under discussion nor in any of the collections to which access has been gained.

**Anadara callicestosa (Dall) Mansfield**

Plate 3, figures 2, 6

1898. *Scapharca (Scapharca) callicestosa* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 638, pl. 34, figs. 17, 18.

1916. *Arca callicestosa* Dall. Sheldon, Palaeontographica Americana, vol. 1, No. 1, p. 43, pl. 10, figs. 3-5.

1932. ?*Arca (Anadara) callicestosa* (Dall). Mansfield, Florida Geol. Survey Bull. 8, p. 49, pl. 5, figs. 7, 8.

Shell of moderate size, rather thin, rhomboidal, with small, prominent, mediusulcate, prosocoelous beaks situated at about the anterior third of its length; left valve with about 37 squarish subequal radial ribs, separated by narrower channeled interspaces; on the tops of these ribs are 4 longitudinal threads, the inner pair larger and more prominent but separated by a somewhat deeper sulcus than those external to the inner threads; concentric sculpture of fine, close, rounded, slightly elevated threads, which overrun the whole shell, ribs, and interspaces, and at short intervals, at the intersection with the inner pair of rib threads they become minutely nodulous, while the reticulations have a punctate appearance, giving a surface somewhat like fine lace and peculiar, as far as observed, to this species; cardinal area short, rather narrow, with sharply elevated boundaries and a single incised set of grooves forming a lozenge-shaped figure anteriorly; hinge line short, teeth in two adjacent series, anterior with 15, posterior with 26 or 27 teeth set vertically, a little oblique at the distal ends of the series; each individual tooth more or less grooved or striate in the direction of motion, as in some recent species; anterior end of shell produced, rounded; posterior end subtruncate, base slightly arched; inner margin of the valves with rather long, deep flutings, corresponding to the external ribs. Longitude 32, altitude 27, diameter 20 millimeters (twice the diameter of the single valve).

A single valve of this very elegant species was obtained by Mr. Burns. Its sculpture differentiates it from all our other Tertiary species. *Arca callipteura* Conrad, in which the ribs have a minute nodular sculpture, has the radial threading predominant, while in this species the concentric threads overrun all the rest. The two species are entirely distinct otherwise—Dall, 1898.

Holotype: U. S. Nat. Mus. 146264.

Type locality: U. S. G. S. station 2833. Upper bed (Miocene) at Gaskins Wharf, on the Nansemond River, 16 miles below Suffolk, Va., F. Burns.

The specimens from the *Ecphora* and *Cancellaria* zones of the Choctawhatchee referred by Mansfield to *A. callicestosa* are not typical and may, as Mansfield suggests, prove to be subspecifically distinct. The specimen figured by Mansfield seems closer to *magnoliana* than to the holotype of *callicestosa*, but it is relatively higher than the North Carolina species and has developed a much wider cardinal area. With so little material, it is difficult to discriminate between individual, age, and taxonomic differences.

Distribution: Virginia: Miocene, Yorktown formation, Gaskins Wharf, Nansemond County. The type is still unique.

**Anadara callicestosa wilsoni Gardner, n. subsp.**

Plate 3, figures 8, 9, 12

The subspecies is based on the following criteria: *Anadara callicestosa* subsp. *wilsoni* is a relatively higher form than *A. callicestosa* (Dall), the base line is more rounded, the anterior margin less produced, the posterior margin more produced and more obliquely truncated, the umbones are more convex, the cardinal area is higher and marked with 2 or 3 irregular groovings

instead of a single half-diamond groove; the hinge characters are practically identical; the ribs, however, number 33 instead of 37 as in the type of the species, and the intercostal areas approximately equal the costae in width; the general type of sculpture of the individual costae is the same, but the nodular effect is somewhat lost by the wider separation of the ribs.

Dimensions of holotype: Height 30.6 millimeters, width 34.3 millimeters, convexity of single valve, 12.5 millimeters.

Holotype: U. S. Nat. Mus. 325488.

Type locality: Frank Wilson's marl pit near Magnolia, N. C.

Further material may show these variations to be merely individual instead of subspecific, but in the absence of a connecting series it seems better to keep the forms separate.

Distribution: North Carolina: Miocene, Duplin marl. The subspecies is described from a single left valve from the marl pit of Frank Wilson near Magnolia, Duplin County.

*Anadara magnoliana* Gardner, n. sp.

Plate 3, figures 1, 4, 5, 7

Shell thin, inflated, inequilateral, roughly rhomboidal, gently rounded anteriorly, slightly produced and obliquely truncated posteriorly. Umbones prosocoelous, fairly prominent, placed near the anterior third of the hinge line. Cardinal area narrow, sharply delimited, sculptured with 2 diamond-shaped grooves. Length of hinge approximately three-fifths of the total length of the shell. Teeth very short and close-set beneath the beaks, becoming larger and less crowded distally; anterior denticles 17, slightly concave forward; posterior denticles 28; in the type the proximal 10 are perpendicular to the hinge, the 10 behind them with a slight backward slant, the final 8 slanting a little forward; both anterior and posterior distal teeth, grooved on each side. Radial sculpture of 37 costae, which over the greater part of the disk are strongly arched, becoming narrower and less prominent toward the anterior lateral margin and on the posterior portion of the shell broadening and flattening upon the summits; intercostal areas subequal to the costal and to one another, squarely channeled over the mesial and posterior parts of the shell, though less angular anteriorly; each individual costal sculptured with 4 longitudinal riblets, of which the second and third are the most elevated; riblets strongest on the anterior part of the disk, less prominent near the anterior lateral margin, and posteriorly becoming almost or altogether obsolete; characteristic effect of the sculpture due largely to the undulation of the crests of the medial and anterior costae; riblets strongest upon the crests of the waves, evanescent in their troughs, thus lending a subnodular aspect to the radial ornamentation; entire surface of shell covered with crowded in-

crementals; interior flutings corresponding to exterior costae.

Dimensions of holotype: Height 34.3 millimeters, width 46.7 millimeters, convexity of single valve, 12.0 millimeters.

Holotype: U. S. Nat. Mus. 325486.

Type locality: Natural Well, Duplin County, N. C.

The peculiar lacelike pattern of the surface sculpture, which was noted in the original description of *A. callicestosa* (Dall), is reproduced in *magnoliana*. The shells differ widely, however, in outline and in the characters of the cardinal area and hinge teeth. The species has not been observed, except from the marls in the vicinity of Magnolia, Duplin County, N. C.

The form has been described from a single valve—the right. Another right valve, from near the same locality, exhibits a shorter and relatively higher outline; the ribs are more closely crenulated than those of the type and, on the disk, exhibit 3 instead of 4 riblets; the anterior and posterior costae, however, do not differ in sculpture detail from those of the type.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well, and 1½ miles north of Magnolia, Duplin County.

*Anadara carolinensis* (Wagner) Gardner

Plate 2, figure 6

1848. *Arca carolinensis* W. Wagner. Bronn, Handbuch Geschichte Natur, Index palaeontologicus, pt. 1, p. 93 (nomen nudum).

1849. *Arca carolinensis* W. Wagner. Bronn, idem, pt. 2, p. 281 (nomen nudum). Not *Barbatia* (*Plagiarca*) *carolinensis* Conrad, 1875.

1897. *Arca carolinensis* Wagner, Wagner Free Inst. Sci. Trans., vol. 5, p. 9, pl. 1, fig. 4. Explanatory text by Dall.

1898. *Scapharca* (*Scapharca*) *carolinensis* Wagner. Dall, idem, vol. 3, pt. 4, p. 639, pl. 33, fig. 11.

1916. *Arca carolinensis* Wagner. Sheldon, Palaeontographica Americana, p. 42, pl. 10, figs. 1, 2.

Shell large, solid, squarish, moderately inflated, with subcentral, prosocoelous, rather elevated beaks; left valve with about 30 ribs, with subequal interspaces, the anterior ribs squarish, with a shallow median sulcus near the margin, and irregular concentric ripples; the ribs of the middle of the valve not sulcate, with less rippling, more closely adjacent, the interspaces very squarely channeled; the posterior ribs smaller, rounded, and more closely set; cardinal area short, rather wide, smooth or longitudinally striate, with 3 concentric lozenge-shaped groovings; hinge line short, solid; the teeth not interrupted, strong, about 45 in all, the anterior more vertical, the middle teeth inclining towards the middle line of the area, the posterior teeth distally more oblique and longer; margins of the shell strongly fluted. Longitude 56, altitude 55, diameter 43 millimeters (type specimen).

As this species seems never to have been described, the references in Bronn being merely to Wagner's unpublished plates, I have given a diagnosis from Professor Wagner's original type specimen and refigured the interior of the left valve. The shell is remarkable for its squarish form, which is rather distantly approached by some specimens of *A. idonea*. It is singular that in all the years which have elapsed since this shell was collected and figured by Professor Wagner no one has recognized or described it.—Dall, 1898.

The species differs from *Arca idonea* Conrad in the more equidimensional outline and the lower cardinal area. The type locality is not known, but Dall (1897) reports that "a valve in the collection of the United States National Museum was obtained from the upper Miocene of Duplin County, N. C."

Distribution: Virginia: Miocene, St. Marys formation?, Nomini Cliffs, Westmoreland County. St. Marys formation, Union Mill, 2½ miles south of Farnham, Richmond County. Very rare at both localities.

North Carolina: Miocene, Duplin marl, 4 miles south of Clinton, Sampson County; Natural Well and 1½ miles north of Magnolia, Duplin County.

#### Section CUNEARCA Dall

1898. *Cunearca* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 618.

Type by monotypy: *Arca incongrua* Say. Recent from Hatteras to Aspinwall and the western Gulf of Mexico.

The section *Cunearca* is characterized by the short, high outline, the inequality of the valves, the left the larger of the two, the discrepancy in their sculpture, and the full, erect umbones topping a high, subsymmetrical cardinal area.

#### *Anadara (Cunearca) scalaris* (Conrad) Dall

Plate 2, figure 2

1844. *Arca scalaris* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 324.  
 1845. *Arca scalaris* Conrad, Fossils of the medial Tertiary of the United States, p. 59, pl. 31, fig. 1.  
 1856. *Arca scalaris* Conrad, Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 43, pl. 16, figs. 1, 2.  
 1858. *Arca scalaris* Conrad, Emmons, North Carolina Geol. Survey Rept., p. 284.  
 1863. *Scapharca scalaris* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 580. (Name only.)  
 1864. *Scapharca scalaris* Conrad, Meek, Checklist of invertebrate fossils of North America; Smithsonian Misc. Coll. No. 183, p. 6.  
 1898. *Scapharca (Cunearca) scalaris* Conrad, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 634.  
 1916. *Arca scalaris* Conrad, Sheldon, Palaeontographica Americana, vol. 1, No. 1, p. 57, pl. 13, figs. 10, 11.  
 1932. *Arca (Cunearca) scalaris* Conrad, Mansfield, Florida Geol. Survey Bull. 8, p. 53, pl. 7, fig. 4.

Obliquely rhomboidal, elevated, ventricose, ribs about 23, broad, square, prominent, profoundly and robustly crenate, wider than the interstices, 7 on the posterior slope, prominent; posterior slope flattened; umbonial slope angulated; summit elevated, narrowed; anterior margin obliquely truncated; anterior basal margin obliquely subtruncated; posterior extremity subangulated; beaks remote; area with transverse slightly impressed lines; cardinal teeth irregular, oblique toward the extremities of the hinge line; within with furrows corresponding to the ribs; margin profoundly crenate. Length 2 inches, height 1½ inches.

Locality: Petersburg, Va., Mr. Tuomey. Allied to *A. incongrua* Say. The description applies to the left valve only, as the opposite one has not yet been found—Conrad, 1844.

Tuomey and Holmes found it necessary to give the criteria for discriminating this species from *Arca transversa* Say, a species with which it has nothing in com-

mon but the subgeneric characters. The real affinities are with *Anadara scalarina* (Heilprin) of the Pliocene and *A. incongrua* Say of the Recent fauna.

*Anadara scalarina* is larger and heavier but strikingly similar in general aspect, particularly as regards the left valves. The right valve of the Pliocene species develops a secondary rib intermediate between the primaries of the disk, and of this there is no trace on the earlier *scalaris* or on the Pleistocene and Recent *incongrua*—a species much smaller, however, than *scalaris* and lacking the conspicuous inflation of the umbones.

Mansfield reports the species from both the *Eophora* and the *Cancellaria* zones of the Choctawhatchee.

Distribution: Virginia: Miocene, Yorktown formation, Petersburg, Dinwiddie County. Although Conrad's type was presumably collected at Petersburg, the species has not been reported from this or any other Virginia locality since his day.

North Carolina: Miocene, Duplin marl, W. H. Kornegay's marl pit near Magnolia, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County. The species is extremely rare at both these localities.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida.

#### Family GLYCYMERIDAE

##### Genus GLYCYMERIS Da Costa

1778. *Glycymeris* Da Costa, Historia naturalis testaceorum Britanniae, or The British conchology, p. 168.

Type by subsequent designation (Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 607, 1898). *Glycymeris orbicularis* Da Costa = *Arca glycymeris* Linnaeus. Recent off the British Isles and the coast of Europe.

Shell heavy, equivalve, equilateral or subequilateral, suborbicular; the anterior extremity usually the more produced and rounded. Beaks almost straight, only slightly incurved. Outer surface concentrically or radially striate or sulcate. Ligament amphidetic, multivincular, the ligament furrows arranged in concentric rhombs. Hinge margin arcuate, set with two series of strong transverse teeth, chevron-shaped medially, the distal teeth oblique to horizontal; teeth progressively obliterated during growth by the subsidence of the ligament area. Adductor scars distinct, the posterior butressed. Pallial line simple or very slightly sinuous. Inner margins crenulate in harmony with the outer ribbing.

The genus is first recognized in the Cretaceous; it culminated in the mid-Tertiary and is represented in the Recent fauna by about 80 species, widely distributed in the shallower waters of the warm and temperate seas.

#### *Glycymeris laevis* (Tuomey and Holmes) Dall

Plate 1, figure 11

1848. *Pectunculus virginiae* W. Wagner. Bronn, Index paleontologicus, pt. 1, p. 940.  
 1849. *Pectunculus virginiae* W. Wagner. Bronn, idem, pt. 2, p. 283.  
 1856. *Pectunculus laevis* Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 50, pl. 17, fig. 5.



1897. *Pectunculus virginiae* Wagner. Wagner Free Inst. Sci. Trans., vol. 5, p. 11, pl. 3, fig. 5. Explanatory text by Dall.
1898. *Glycymeris laevis* Tuomey and Holmes. Dall, idem, vol. 3, pt. 4, p. 609.

Somewhat oval, thick, inequilateral, concentrically striate, or grooved; buccal margin rounded; anal side somewhat produced, obliquely truncate; many teeth; lip crenate.

The teeth extend without interruption around the hinge. The pallial and muscular impressions are well defined, and in young individuals the shell is slightly angular near the umbones. Umbones pointed and closely approximating.

Locality, Waccamaw.—Tuomey and Holmes, 1856.

Wagner's name, though earlier, is not entitled to standing, as his figure was never published. The plate on which it appears is, according to Dall, 1898, in the possession of the Wagner Free Institute of Science in Philadelphia.

The species is characterized by the absence of radiating sculpture.

Distribution: Wagner's locality is not known, and the species is not represented in any of the later Virginia collections.

Outside distribution: Pliocene: Waccamaw formation, Waccamaw, S. C. (Tuomey and Holmes).

#### *Glycymeris tumulus* (Conrad) Dall?

Plate 1, figures 6, 12–15

1845. *Pectunculus tumulus* Conrad, Fossils of the medial Tertiary of the United States, p. 72, pl. 41, fig. 4.
1898. *Glycymeris americana* (Defrance) (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 609.

Suborbicular, ventricose, surface with numerous radiating slight furrows and fine decussated striae; margins rounded, umbo and summit profoundly elevated; dorsal margin equally and profoundly oblique, beaks distant; cardinal area wide and marked with well-defined diverging grooves; cardinal teeth large, robust, nearly straight, the series very oblique and widely interrupted in the middle by a crenulated rectilinear space.

Locality, near Petersburg, Va.—Conrad, 1845.

The collection of further material and the careful comparison with Conrad's type by W. C. Mansfield seem to justify the rehabilitation of this species, which had been lost in the lengthy synonymy of *G. americana*.

Shell evenly rounded ventrally, cuneate dorsally, decidedly tumid in the umbonal region. Radial sculpture absent laterally, obsolete ventrally, consisting of about 21 feebly impressed grooves; faint secondary striae occasionally discernible on the interareas. Growth lines prominent near the ventral margin. Cardinal area high, ornamented with broad, shallow furrows. Hinge line strongly arched. Hinge teeth in two discrete series, 12 or 13 in each; denticles coarse, obliquely set, the dorsal surface finely striated horizontally. Muscle scars conspicuous, semielliptical, united by a simple pallial line. Marginal flutings corresponding in number to the primary lines of the exterior surface.

Figured specimen: Height 44.5 millimeters, width

44.7 millimeters, maximum convexity 28.4 millimeters.

The presence of secondary radial striae recalls *Glycymeris americana* (Defrance). It is separable from that species, however, by the cuneate outline of the dorsal portion of the shell, the high, tumid umbones, and the less prominent radial sculpture. The outline of the shell serves also to distinguish it from *Glycymeris parilis* (Conrad), the common Maryland representative of the group.

Distribution: Virginia: Miocene, St. Marys formation, Nomini Cliffs, Westmoreland County. The species is represented in the single formation at several localities.

#### *Glycymeris duplinensis* Dall

Plate 2, figure 3; plate 5, figure 5

1898. *Glycymeris duplinensis* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 613, pl. 34, figs. 6, 7.

Shell small, rounded-triangular, solid, moderately convex, with pointed, small, low beaks and a flattened lunular area; sculpture of strong, distally bifurcated radial ribs, separated by slightly narrower channeled interspaces; 9 anterior and 9 posterior ribs on the lateral slopes are smaller, while on the middle of the shell are about 10 larger ribs; transverse sculpture of regularly spaced, elevated concentric lines overrunning the whole shell; cardinal area small and short, with 3 or 4 concentric angular grooves; teeth small, vertically striated, 6 or 7 on each side, the line strongly arched and uninterrupted; anterior margin straight, base rounded, posterior slightly arcuate; basal inner margin with about 10 flutings. Largest valve, longitude 9, altitude 10, diameter 6.5 millimeters.

This pretty little species is readily distinguished from any of the varieties of *G. pectinata* by its bifurcated and prettily sculptured ribs. It seems to be rather abundant at the locality mentioned.—Dall, 1898.

Holotype: U. S. Nat. Mus. 114941.

Type locality: Natural Well, Duplin County.

Distribution: North Carolina: Miocene, Yorktown formation, 1 mile north of Castoria and 1 mile east of Lizzie, Greene County; 2 miles southwest of Maple Cypress and Rock Landing, Craven County. Duplin marl, Natural Well, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County.

#### *Glycymeris americana* (Defrance) Dall

Plate 1, figures 16–21

1826. *Pectunculus americanus* Defrance, Dictionnaire des sciences naturelles, vol. 39, p. 225.
1832. *Pectunculus pulvinatus* Lamarck. Conrad, Fossil shells of the Tertiary formations of North America, p. 17, pl. 2, fig. 2. Not *P. pulvinatus* Lamarck, 1819.
1835. *Pectunculus lentiformis* Conrad, idem, 2d ed., p. 36, corrigenda.
1841. *Pectunculus quinquerrugatus* Conrad, Am. Jour. Sci., 1st ser., vol. 41, p. 346.
1845. *Pectunculus lentiformis* Conrad, Fossils of the medial Tertiary of the United States, p. 64, pl. 36, fig. 1.
1845. *Pectunculus tricenarius* Conrad, idem, p. 63, pl. 35, fig. 1 (immature shell).
1845. ? *Pectunculus quinquerrugatus* Conrad, idem, p. 63, pl. 34, fig. 3.
1845. *Pectunculus passus* Conrad idem, p. 64, pl. 35, fig. 3.

1856. *Pectunculus lentiformis* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 48, pl. 17, fig. 2.  
 1856. ? *Pectunculus quinquerrugatus* Conrad. Tuomey and Holmes, idem, p. 49, pl. 17, fig. 4.  
 1858. *Pectunculus carolinensis* Holmes, Post-Pleiocene fossils of South Carolina, p. 15, pl. 3, fig. 4. Not *P. carolinensis* Conrad, 1841.  
 1858. *Pectunculus lentiformis* Emmons, North Carolina Geol. Survey Rept., p. 286.  
 1886. *Pectunculus undatus* Linnaeus. Dall, Harvard Coll. Mus. Comp. Zoology Bull., vol. 12, p. 238.  
 1898. *Glycymeris americana* DeFrance (part). Dall Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 609.  
 1932. *Glycymeris americana* (DeFrance). Mansfield, Florida Geol. Survey Bull. 8, p. 39, pl. 2, fig. 7.

Pétoncle américain. *Petunculus americanus* DeFrance. Coquille suborbiculaire, aplatie et couverte de larges côtes longitudinales peu élevées et finement striées. Longueur plus de 2 pouces. On la trouve à la Caroline du Nord.—DeFrance, 1826.

A very careful and conscientious scrutiny of a large number of specimens has resulted in the above synonymy. *G. passa* is the normal adult; *G. lentiformis*, the senile adult; *G. tricenaria* is a half-grown, well-developed form; *G. carolinensis* Holmes is a variety with feeble ribbing, obsolescent at the ends of the shell; *G. transversa* Tuomey and Holmes (non Deshayes) is founded on the internal cast of a rather wide young shell; *G. tumulus* Conrad is founded on a rather inflated half-grown specimen. The only form which may possibly be varietal, but which I am inclined to refer to some pathologic cause, is *G. quinquerrugata*. This is almost entirely confined to Duplin County, N. C. Well-marked specimens have on each dorsal slope, from the beaks laterally, 3 to 6 little irregular ripples, which are much more conspicuous in the young. These might indicate the presence of some parasite in the individual. They are never uniform or regular; some specimens have them only on one side, in others they are obsolete, and, finally, others do not have them; and between the normal *americana* and the *quinquerrugata* without rugae there is absolutely no distinction to be made. The recent shell is identical with Miocene specimens and reaches fully as large a size.—Dall, 1898.

*Pectunculus tumulus* Conrad, however, included by Dall under this species, is undoubtedly distinct.

Of the bivalves occurring within the area under consideration, the only one confusable with *G. americana* is the very rare *pennacea* (Lamarck). Though resembling each other in the general character of the fine radiate sculpture, they are readily separable by more basic differences in outline and hinge. *G. americana* reaches a much greater maximum diameter, the valves are normally equilateral, and the umbonal slopes are evenly rounded. In the smaller *G. pennacea* the anterior lateral margin is more or less sharply truncated and the anterior umbonal slopes are more or less angular. The cardinal area of *pennacea* is wider than in an *americana* of the same size, the hinge is thicker, the teeth are fewer and heavier and set in a higher curve.

The young of *americana* are pretty little forms, subcircular in outline, except for the hinge truncation, with a dainty, minutely granular, radiate sculpture.

In Florida Mansfield found that the distribution of the species was restricted to the *Eophora* and *Can-*

*cellaria* zones of the Choctawhatchee formation, the supposed time equivalents of zones 1 and 2 of the Yorktown.

Distribution: Virginia: Miocene, Yorktown formation. Yorktown, York County; Petersburg, Dinwiddie County; 1½ miles northeast of Smithfield and ¾ mile northeast of Smithfield, Isle of Wight County; ½ to ¾ mile above the lower Seaboard Railway bridge, Southampton County; ¼ mile north of Chuckatuck, 1¼ miles north of Suffolk, 1 mile northeast of Suffolk, ½ mile below the Suffolk waterworks dam, Suffolk, and the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation. Halifax, Halifax County; 2½ miles northwest of Williamston and 1 mile northwest of Williamston, Martin County; ½ mile above Bells Bridge and ½ mile below Bells Bridge, Edgecombe County; 2½ miles north of Standard, 3 miles south of Farmville, Pinelox Branch, 8 to 9 miles west of Greenville, 3 miles west of Greenville, 2 miles west of Greenville, 1½ miles west of Greenville, 8 to 9 miles south of Greenville, and 9 to 10 miles south of Greenville, Pitt County; 2½ miles northwest of Chocowinity and 2 miles northwest of Chocowinity, Beaufort County; 1 mile west of Wilson and 3 miles east-southeast of Wilson, Wilson County; ½ mile east of Lizzie, 2 miles northeast of Lizzie, 4 miles east of Lizzie, Greene County; 1½ miles below Tar Ferry and 3 to 4 miles below Tar Ferry, and Dogwood Landing, Hertford County; Colerain Landing, Bertie County; Rock Landing, Craven County. Duplin marl, Natural Well and marl pits in the immediate vicinity, Duplin County; 1 mile west of Lumberton, Lumberton, 2 miles below Lumberton, 4 to 5 miles below Lumberton, and Ashpole, Robeson County; 4 miles south of Clarkton, Bladen County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Lake Waccamaw, Cronly, and Neills Eddy Landing near Cronly, Columbus County; Wilmington and the city rock quarry near Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin marl, Darlington, Darlington County, S. C. Pliocene, Waccamaw formation, Nixons, Tillys Lake, and Todds Ferry, Horry County, S. C.; Waccamaw, S. C., Choctawhatchee formation, northern Florida. Caloosahatchee marl, Caloosahatchee River, Fla. Pleistocene, Simmons Bluff, S. C. Recent, Hatteras to Santa Marta, Brazil, in 15 to 63 fathoms.

#### Superfamily MYTILACEA

The Mytilacea were included by Dall under a group which he called the dysodonta—the imperfectly toothed forms—a term first used by Neumayr but in a more comprehensive sense. In the early generic separations the teeth were perhaps considered too casual a character, and the form and surface sculpture too heavily weighted. However, Dall recognized the dentition to be of major importance in determining the relative position of the dysodonts and considered the dysodont hinge to be essentially a taxodont hinge modified by umbonal torsion. The full significance of the mytiloid hinge in establishing the mode of development of the lamellibranch dentition was first perceived by Bernard,<sup>34</sup> who detected in it the key to the problem

<sup>34</sup> Bernard, Felix, Troisième note sur le développement et la morphologie de la coquille chez les lamellibranches (anisonyaires): Soc. géol. France Bull., sér. 3, vol. 24, pp. 412–449, 1896; Recherches ontogéniques et morphologiques sur la coquille des lamellibranches: Annales sci. nat. zool. et pal., sér. 8, vol. 8, pp. 1–208, pls. 1–12, 1898.



of evolution of the bivalve hinge by reason of the lack of acceleration in its development and the ease with which the stages of growth may be separated one from the other. Bernard made no attempt to incorporate his results in the current systematic classifications, but Jukes-Browne,<sup>35</sup> impressed by their importance, "reconsidered the generic values of the characters presented by the shells of the Mytilidae" and realigned the genera. In his revision the position of the umbones and the surface sculpture were treated as characters of secondary importance, whereas the dentition, which commonly reflects an important embryonic character, the position of the ligament, and the number and character of the muscle impressions were given primary consideration. The resulting classification is based on wider study than the earlier taxonomic arrangements and has been followed in the present paper.

#### Family MYTILIDAE

##### Genus BRACHIDONTES Swainson

1840. *Brachidontes* Swainson, Treatise on malacology, p. 384.

1905. *Brachyodontes*, Jukes-Browne, Malacol. Soc. London Proc., vol. 6, p. 222.

Type by monotypy: *Modiola sulcata* Lamarck. Recent in the Indian Ocean.

*Brachidontes* has been commonly considered a subgenus or section of *Modiolus* signalized by a radially sulcate sculpture. It was given generic status by Jukes-Browne because of the crenulate posterior margin, an important embryonic character retained in the adults of this group. Another constant feature of the genus as defined and restricted by Jukes-Browne is the musculature, indicated by a small but distinct anterior adductor scar and by a much larger posterior adductor to which is united the scars of the median and posterior byssal retractors. The hinge line is for the most part straight and its union with the posterior lateral margin angular. The ligament is short and marginal or submarginal. The position of the umbones varies with the development of the anterior portion of the shell, and although the external surface is characteristically sculptured with a fine bifurcate ribbing, a few species are wrinkled or smooth.

The form of Swainson's name has bothered the classical scholars who have followed him. *Brachyodontes* has been commonly used in place of *Brachidontes*, and Jukes-Browne has further purified the barbarism by converting it to *Brachyodontes*. However, article 19 of the International Rules of Zoological Nomenclature, Monaco, 1913, provides that "the original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami*, or a typographical error is evident."

##### Subgenus ISCHADIUM Jukes-Browne

1905. *Ischadium* Jukes-Browne, Malacol. Soc. London Proc., vol. 6, p. 223.

Type by original designation: *Ischadium hamatum* (Say). Miocene to Pleistocene along the eastern seaboard; Recent from Rhode Island to the West Indies and Texas.

Shell oblong or pyriform in outline, sculptured all over with strong raised divaricating ribs. Umbones slightly divergent; anterior riblets well marked and corresponding with a variable number of dysodont teeth. Ligament long, without crenulations behind it. Anterior adductor scar absent, and anterior byssal scar small. Posterior byssal scar large and broadly united to that of the posterior adductor. Type, *I. hamatum* (Say).—Jukes-Browne, 1905.

##### *Brachidontes (Ischadium) recurvus* (Rafinesque) Gardner

Plate 1, figures 7, 8

1820. *Mytilus recurvus* Rafinesque, Monographie des coquilles bivalves fluviatiles de la rivière Ohio, Annales gén. sci. phys. Bruxelles, vol. 5, p. 320.

1822. *Mytilus hamatus* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 265. Binney's reprint of Say, pp. 91, 204, pl. 1.

1832. *Mytilus hamatus* Say, American conchology, pl. 50, figs. 1, 2, and unpaginated text.

1837. *Modiola carolinensis* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 243, pl. 20, fig. 6.

1869. *Brachyodontes hamatus* Perkins, Boston Soc. Nat. History Proc., vol. 13, p. 156.

1898. *Mytilus (Hormomya) hamatus* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 789.

1906. *Mytilus hamatus* Say. Clark, Maryland Geol. Survey, Pliocene and Pleistocene, p. 203, pl. 60, figs. 5, 6.

Moule recourbée. Test obovale, cunéiforme, recourbé, à striés longitudinales de trois longueurs; épiderme noirâtre; nacre-violette; becs obliques, à un angle décurrent, de chaque côté; bord inférieur et intérieur strié, crénelé; largeur 7-12; diamètre 5-12 de la longueur, longueur 1 à 2 pouces. Elle se trouve dans le Mississippi près de la Nouvelle-Orléans. Les striés sont souvent bifides. Partie baillante oblongue, latérale.—Rafinesque, 1820.

Shell very much contracted and incurved at the base, which is acute; valves striated on every part of the exterior with longitudinal, elevated lines, which are bifid and sometimes trifid toward the tip; color dark fuscous; within dark purpurescent, with a whitish margin.

Length 1½ inches, breadth nearly ¾ inch.

Inhabits the Gulf of Mexico.

Cabinet of the Academy and Philadelphia Museum.

A common species in the Gulf of Mexico, and is frequently carried to market at New Orleans attached to the common oyster.—Say, 1822.

Undoubtedly the species can be definitely determined from Rafinesque's description published in the obscure monograph on the bivalves of the Ohio River, and for that reason it should receive his name, which antedates the commonly accepted *Mytilus hamatus* of Say by 2 years.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown and Bellefield, York County.

North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, Columbus County.

<sup>35</sup> Jukes-Browne, A. J., A review of the genera of the family Mytilidae: Malacol. Soc. London Proc., vol. 6, pp. 211-224, 1905.

Outside distribution: Pliocene, Caloosahatchee marl, Caloosahatchee River, Fla. Pleistocene, Sankaty Head, Mass.; Wailes Bluff, near Cornfield Harbor, St. Marys County, Md. Recent, Rhode Island to Costa Rica in less than 50 fathoms.

**Genus CRENELLA Brown**

1827. *Crenella* Brown, Illustrations of the conchology of Great Britain and Ireland, pl. 31, figs. 12-14.

1844. *Crenella* Brown, Illustrations of the Recent conchology of Great Britain and Ireland, 2d ed., p. 75, pl. 23, figs. 12-14.

Type by monotypy: *Mytilus decussatus* Montagu. Recent off the coast of Greenland and in North Atlantic waters.

***Crenella precursor* Gardner, n. sp.**

Plate 3, figures 14-16

Shell both large and heavy for the genus; evenly ovate, moderately inflated. Umbones acute, prosogyrate, incurved. Sculpture of about 70 low, flat, radiating lirations, rarely dichotomous toward the ventral margin; interareas slightly narrower; incrementals mostly microscopic, 3 or 4 of them exaggerated. Inner margin obscurely crenulated. Interior lined with a calcareous layer continued to the pallial line. Hinge non-crenulate. Ligament furrow shallow, extending from beneath the umbones about one-fourth the distance down the posterior margin. Anterior adductor muscle impression elongated; posterior semioval. Pallial line faintly sinuous.

Dimensions of holotype: Height 7.6 millimeters, width 6.4 millimeters, convexity 2.1 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325498.

Type locality: 1 mile northeast of Suffolk, Nansemond County, Va.

*Crenella precursor* has little but the generic characters in common with the minute *Crenellas* of the *C. divaricata* type. Its nearest relative and its probable descendant is the Recent *C. glandula* Totten of the North Atlantic coast. It is separated from this by the more regularly ovate outline, the more acute, prosogyrate beaks, the fewer, broader, flatter, less divaricate radials. The single valve from which the description has been made is probably senile. Younger individuals would doubtless show a crenulated hinge and a more strongly crenulated margin.

Distribution: Virginia: Miocene, Yorktown formation, 1 mile northeast of Suffolk, Nansemond County.

**Superfamily PECTINACEA Reeve**

**Family PECTINIDAE Lamarck**

**Genus PECTEN Müller**

1776. *Pecten* Müller, Zoologiae danicae prodromus, p. 248.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einricht., etc., pp. 67, 177, Gotha, 1818): *Ostrea maxima* Linnaeus. Recent in the north European seas.

Shell approximately equilateral, inequivalve, auriculate; right valve, as a rule, the more convex, not adherent but attached by a byssus. Hinge line straight, the

cardinal margin of the right auricles curved downward. Resilium central, internal, triangular; interlocking grooves and ridges diverging from the apex of the resilial pit. Pallial line simple. Monomyarian. Adductor impression rounded, posterior.

The earliest *Pecten* known is from the Cretaceous. The Recent species exceed 200 in number, and their distribution is world-wide.

**Subgenus EUVOLA Dall**

1898. *Euvola* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 694.

Type by original designation: *Pecten ziczac* Linnaeus. Southern Florida and the West Indies.

*Euvola* is characterized by the high inflation of the right valve, the flat or slightly concave left valve, a radial sculpture that is less strong and less regular than that of *Pecten* s. s., and the development of a single pair of cardinal crurae.

***Pecten (Euvola) raveneli* Dall**

Plate 4, figure 4

1898. *Pecten (Pecten) raveneli* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 721, pl. 29, fig. 10.

1934. *Pecten raveneli* Dall. Johnson, Boston Soc. Nat. History Proc., vol. 40, No. 1, p. 23 (synonymy in part excluded).

1936 (March). *Pecten (Pecten) raveneli* Dall. Tucker, Am. Midland Naturalist, vol. 17, No. 2, p. 483, pl. 2, fig. 4.

1936 (April). *Pecten (Euvola) raveneli* Dall. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 182, 184, 185.

Shell much of the size and form of *P. medius* Lamarck but with 21 or 22 strong ribs; dichotomous in the right valve but rounded and simple in the left, with 3 or 4 finer threads on the submargins; interspaces of the right valve smaller than the squarish ribs, on the left subequal; right valve with subequal ears, each with 3 or 4 strong, rounded riblets; notch shallow; ears of the left valve concave, 2-ribbed, with less pronounced sculpture; surface of both valves covered with close-set, concentric, elevated lines; interior fluted, crura moderately developed. Altitude 42, latitude 47, diameter 13 millimeters.

This neat little species differs from *P. medius* in its coarser sculpture, and from the young of *P. hemicyclius* by its more numerous ribs and details of surface.—Dall, 1898.

Holotype, a right valve: U. S. Nat. Mus. 107750.

Type locality: Pliocene of the Caloosahatchee River, Fla.

The right valve of *Pecten raveneli* Dall is very much inflated, the left valve slightly concave. The species is represented in the area under consideration by a single adult right valve and a valve of a young form. The dichotomous ribs, the small, squarish auricles, and the delicate concentric sculpturing are, however, sufficient to characterize it.

Distribution: North Carolina: Miocene, Duplin marl, Fairmont, Robeson County. The species is represented by a single valve.

Outside distribution: Pliocene, Caloosahatchee marl, Caloosahatchee River, Fla. (?) Recent, dredged off Cape Fear with other fossil species in 15 fathoms. Johnson, 1934, reports the species from North Carolina to the West Indies.

Subgenus **PLAGIOCTENIUM** Dall

1898. *Plagiectenium* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 696.

Type by original designation: *Pecten ventricosus* Sowerby = *Pecten circularis* Sowerby. Pleistocene of California. Recent from Monterey, Calif., to the Gulf of California and Paita, Peru.

Resembling *Aequipecten* but without radial striation; the concentric sculpture in looped lamellae; the ribs strong, frequently smooth above; the submargins impressed below the subequal auricles; the valves well inflated with a tendency to oblique growth in the adult.

To this very natural group belong nearly all the shallow-water pectens of our own coasts.—Dall, 1898.

*Plagiectenium* differs further from *Aequipecten*, under which it was included by Verrill and the earlier systematists, in the stronger, more regular ribbing and in the relative convexity of the valves. In *Plagiectenium*, as in *Pecten* s. s., the right valve is the more inflated. In *Chlamys* and in the subgenus *Aequipecten* the left valve is more convex than the right. Because of the form and outline the group has been referred to *Pecten* rather than to *Chlamys*.

***Pecten (Plagiectenium) gibbus* (Linnaeus) Dall**

Plate 5, figure 3

1758. *Ostrea gibba* Linnaeus, Systema naturae, 10th edition, p. 698.

1822. *Pecten dislocatus* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 260.

1858. *Pecten dislocatus* Say. Holmes, Post-Pleocene fossils of South Carolina, p. 12, pl. 2, fig. 12.

1889. *Pecten irradians* var. *dislocatus* Say. Dall, U. S. Nat. Mus. Bull. 37, p. 34.

1898. *Pecten (Plagiectenium) gibbus* Linnaeus. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 745.

1936. *Pecten (Chlamys) gibbus* Linnaeus. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 182, 185.

O. testa radiis 20 glabris, gibba. Habitat in M. Americano.—Linnaeus, 1758.

Closely related but not specifically identical forms have been recovered from a few localities in the Miocene of Virginia and North Carolina. *Pecten gibbus gibbus* has not, however, been recorded from beds below the Pliocene. The distribution of the group is governed largely by temperature. In both the Tertiary and the Recent it is widely distributed and diversified in the Floridian and mid-American faunas. The waters in which the middle and late Tertiary deposits of Virginia and North Carolina were laid down were apparently too cold for its favorable development.

Distribution: North Carolina: Pliocene, Waccamaw formation, Lake Waccamaw, Columbus County; Wilmington, New Hanover County.

Outside distribution: Pliocene, Caloosahatchee marl, De Leon Springs, Volusia County, Fla.; Kissimmee well (at a depth of 150 feet), Osceola County, Fla.; Caloosahatchee River, Shell Creek, Alligator Creek, and Myakka River, Fla. Croatan sand, Slocums Creek and Mallisons, Craven County, N. C. Pliocene (?), Charlton formation, Orange Bluff, St. Marys

River, and 3 miles southeast of Folkston, Nassau County, Fla. Pleistocene, Simmons Bluff, S. C.; Orient, Hillsborough County, Fla.; North Creek, Manatee County, Fla.; Kissimmee (at a depth of 96 feet), Osceola County, Fla.; and Torch Key, Fla. Recent, Hatteras to Brazil in less than 50 fathoms; Hatteras down to and including west Florida, the Gulf of Mexico, the West Indies, and the Antilles, all in more than 50 fathoms.

Genus **CHLAMYS** (Bolten) Roeding

1798. *Chlamys* (Bolten) Roeding, Museum boltenianum, pt. 2, Conchylia, p. 161.

Type by subsequent designation, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 695, 1898: *Pecten islandicus* Müller. Pleistocene of the boulder clays of the northeast coast and Recent from the Arctic region to the Chesapeake Bay.

Shell small or of moderate dimensions; inequilateral. Right valve slightly more compressed than the left but not conspicuously so. Dorsal margins steeply sloping. Sculpture radial, the lirae usually numerous and increasing by intercalation, imbricated by the concentric sculpture, persistent to the ventral margins, which are scalloped by the ribbing. Anterior auricles larger than the posterior, the right anterior notched for the extrusion of the byssus. The margin below the byssal notch pectinated. The cardinal margin of the auricles of both valves bent inward over the inconspicuous ligament—those of the right valve more forcibly so. Resilium short and strong. Chondrophore small, trigonal, and subumbonal. Cardinal crurae not conspicuous. Characters of interior usually obscure, usually with ribs and double flutings corresponding to the external ribbing.

*Chlamys* is widely distributed. Many of the species are active swimmers and very brightly colored, especially those living in the warmer waters.

***Chlamys decemnaria* (Conrad) Dall**

Plate 5, figures 1, 2, 6, 7

1834. *Pecten decemnarius* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 151.

1840. *Pecten decemnarius* Conrad, Fossils of the medial tertiary of the United States, p. 49, pl. 24, fig. 2.

1845. *Pecten dispalatus* Conrad, idem, p. 74, pl. 42, fig. 3 (very poor).

1863. *Pecten decemnarius* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 581.

1898. *Pecten (Chlamys) decemnarius* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 741.

1936 (April). *Pecten (Chlamys) decemnarius* Conrad. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 178, 184.

1936 (November). *Chlamys (Chlamys) decemnarius* (Conrad). Rowland, Am. Midland Naturalist, vol. 17, p. 1009, pl. 8, figs. 5, 6.

Shell ovate, slightly convex, with about 10 broad, flattened ribs disappearing on the umbo, some of them sulcated; radiating striae numerous, distinct, subscabrous; ears unequal.

I possess but a single superior valve of each of these pectens. Locality, same as the preceding [James River, Va.].—Conrad, 1834.

This species is notably irregular in its sculpture, the disk being sculptured either by numerous more or less distinctly

fasciculated, small, radial threads, or the fasciculi may be replaced partially by stout, elevated, rounded ribs, with wide, radially threaded interspaces. The radial sculpture may be nearly smooth or covered with a conspicuous, dense, concentric lamellation. Three or four of the ribs may be more prominent than the others, and the smaller ones uneven in size and rugose, forming the variety *dispalatus*. When the fasciculi are riblike they are usually dichotomous. The umbonal region in typical *decemnarius* is usually feebly sculptured, but in the variety *dispalatus* the ribbing approaches the beaks more nearly. The type of the latter has been carefully compared, and the ears and surface agree exactly with those of the *decemnarius* form. Large valves of the latter attain a height and width of 68 millimeters; the type of *dispalatus* measures 24 millimeters. The cardinal crura are parallel with the hinge line and moderately developed. The byssal notch is wide and conspicuous, the posterior ears small.

In sculpture this form almost exactly parallels the recent northwest American *P. hericeus* in its mutations.—Dall, 1898.

The plates represent end members of complete series of this exceedingly variable form.

Distribution: Virginia: Miocene, Yorktown formation. Indian Field Point, Yorktown, and Bellefield, York County; Sycamore and a quarter to half a mile below Sycamore, Southampton County.

North Carolina: Miocene, Yorktown formation. 1½ miles above Murfreesboro and 1 mile above Murfreesboro, Hertford County; Halifax, Halifax County; ½ mile above Bells Bridge and ⅓ mile below Bells Bridge, Edgecombe County; 2 miles west of Greenville, Pitt County.

#### Subgenus *LYROPECTEN* Conrad

1862. *Lyropecten* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 291.

Type by subsequent designation, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 695, 1898: *Lyropecten estrellanus* Conrad. Miocene of the Pacific coast.

Inequivalve, radiately costate; hinge with a triangular pit as in *Pecten* and diverging prominent teeth on each side the ligament cavity.—Conrad, 1862.

The valves are generally large and coarse and both convex, the left valve slightly more inflated than the right. The costals, unlike those of *Chlamys* s. s., are relatively few in number but very heavy and not dichotomous.

*Lyropecten* is the dominant group in the Chesapeake Miocene, conspicuous both by reason of its abundance and by the large size of the individuals. The beginnings in the lower Miocene are very modest, possibly because the group had not reached the peak of its development, or possibly because the cooler climate of the Chesapeake was more favorable. The heavy pectens of the Miocene of south Europe, *Gigantopecten* Rovereto and its synonym *Macrochlamys* Sacco, are referable to *Pecten* rather than *Chlamys* because of the absence of a byssus. They differ from *Pecten* s. s. only in the slight convexity of the left valve.

#### *Chlamys* (*Lyropecten*) *madisonia* (Say) Glenn

Plate 4, figure 5; plate 9, figure 7

1824. *Pecten madisonius* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 134.

1840. *Pecten madisonius* Say. Conrad, Fossils of the medial Tertiary of the United States, p. 48, pl. 24, fig. 1.  
 1858. *Pecten madisonius* Say. Emmons, North Carolina Geol. Survey Rept., p. 282, fig. 200.  
 1863. *Pecten madisonius* Say. Conrad, Acad. Nat. Sci., Philadelphia Proc. for 1862, vol. 14, p. 581.  
 1894. *Pecten madisonius* Say. Whitfield, U. S. Geol. Survey Mon. 24, p. 30, pl. 2, fig. 8; pl. 4, figs. 1-5.  
 1898. *Pecten* (*Lyropecten*) *madisonius* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 724 (synonymy excluded).  
 1904. *Pecten* (*Chlamys*) *madisonius* Say. Glenn, Maryland Geol. Survey, Miocene, p. 377, pl. C, fig. 1.  
 1909. *Pecten* (*Chlamys*) *madisonius* Say. Grabau and Shimer, North American index fossils, vol. 1, p. 502, fig. 673c.  
 1928. *Pecten madisonius* Say. Mansfield, U. S. Nat. Mus. Proc., No. 2759, vol. 74, p. 10, pl. 2, fig. 1; pl. 3, fig. 1.  
 1936. *Pecten* (*Chlamys*) *madisonius* Say. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 176, 177, 184.

Much compressed, with about 16 striated ribs.

Shell rounded, much compressed; the whole surface covered with scaly striae; ribs elevated, rounded, with about 3 striae on the back of each; intervening grooves rather profound; ears equal, sinus of the ear of the superior valve profound, extending at least one-third of the length of the ear.

Length rather more than 4½ inches; breadth 4¼ inches. In magnitude this shell is justly entitled to compare with the preceding [*Pecten jeffersonius* Say]; but it differs in being much less convex, and in having a much more profound sinus in the ear of the superior valve.—Say, 1824.

Type locality, Maryland.

*Chlamys* (*Lyropecten*) *madisonia*, when properly discriminated, is confined to the Calvert and Choptank formations. The later *C. jeffersonia* may, through *santamaria* Tucker and the subspecies *middlesexensis* Mansfield, be in the direct line of descent.

Typical *Chlamys* (*Lyropecten*) *madisonia* are relatively wide—wider than *C. jeffersonia*—and usually with 15 or 16 ribs. Each rib bears 3 scabrous lirae; and other lirae, less elevated than those upon the summits of the primaries, crowd the sides and the intercostal channels. The ears are low but wide, the byssal notch is very deep and the ctenolium coarse.

Distribution: Virginia: Miocene, Calvert and Choptank formations, Nomini Cliffs, Westmoreland County.

Outside distribution: Miocene, Calvert formation, Shiloh and Jericho, Cumberland County, N. J.; Church Hill, Centerville, Reeds and Wye Mills, Queen Annes County, Md.; Fairhaven and Lyons Creek, Anne Arundel County, Md.; Whites Landing, Magraders Ferry, and Trumans Wharf, Prince Georges County, Md.; Chesapeake Beach and Plum Point, Calvert County, Md. Choptank formation, Greensboro, Caroline County, Md.; Skipton, Cordova, Peach Blossom Creek, Dover Bridge, Trappe Landing, and Sand Hill, Talbot County, Md.; Governor Run, Flag Pond, and St. Leonard Creek, Calvert County, Md.; Jones Wharf, Cuckold Creek, Turner, and Pawpaw Point, St. Marys County, Md.

#### *Chlamys* (*Lyropecten*) *jeffersonia* (Say) Glenn

Plate 4, figure 2

1824. *Pecten jeffersonius* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 133, pl. 9, fig. 1.

1840. *Pecten jeffersonius* Say. Conrad, Fossils of the medial Tertiary of the United States, p. 46, pl. 22, fig. 1.  
 1858. *Pecten jeffersonius* Say. Emmons, North Carolina Geol. Survey Rept., pp. 281, 282, figs. 199, 201.  
 1863. *Pecten jeffersonius* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 581.  
 1898. *Pecten (Lyropecten) jeffersonius* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 722.  
 1904. *Pecten (Chlamys) jeffersonius* Say. Glenn, Maryland Geol. Survey, Miocene, p. 378, pl. C., fig. 2.  
 1909. *Pecten (Chlamys) jeffersonius* Say. Grabau and Shimer, North American index fossils, vol. 1, p. 502, fig. 673f.  
 1932. *Chlamys (Lyropecten) jeffersonius* Say. Mansfield, Florida Geol. Survey Bull. 8, p. 59, pl. 11, fig. 1.  
 1936. *Pecten (Chlamys) jeffersonius* Say, Jour. Paleontology, vol. 10, pp. 174, 178, 179, 181, 184, 185.

Subequivalve, with from 9 to 11 striated ribs.

Shell rounded, convex, not quite equivalved, one of the valves being a little more convex than the other; the whole surface covered with approximate, scaly striae; ribs elevated, rounded, with 6 or 7 striae on the back of each; intervening grooves profound; ears equal; sinus of the ear of the superior valve not profound, being barely one-eighth part of the length of the ear; within with broad, rounded, flattened ribs.

Length  $5\frac{3}{10}$  inches, breadth  $5\frac{7}{10}$  inches.—Say, 1824.

Type locality: Maryland [?].

*Chlamys jeffersonia* s. s. is a subcircular, somewhat inflated shell; the byssal ear is separated from the disk by a rather shallow notch and an ill-defined fasciole; the primary ribs number from 9 to 12 and are, in the adults, rather low, broad, and evenly rounded; in the young they are more angular; the secondary lirae, both on the disk and on the auricles, are subequal, fine, and minutely laminated; 4 to 7 is the usual number on the top of each primary.

Within the limits of the species, in the restricted sense, the most conspicuous variations occur in the degree of inflation of the valves; in the character of the byssal notch, which may approach that of *Lyropecten madisonius* Say in depth, though in such individuals the ear is higher and its dorsal margin more rounded than in the latter; in the primary ribs, which range in number from 9 to 15 and in character from broad and gently undulatory costae to sharply angular ones separated by equally angular interspaces, a type commonly exemplified in the young but rarely in the adults; and in the secondary threads, which may be almost smooth or may become minutely spinose.

*Pecten magnolia* Conrad, 1857, from the Miocene of California, so closely resembles *C. jeffersonia* that Grant and Gale considered them specifically identical. Mansfield (op. cit., p. 179) has indicated the differences. *Lyropecten* was one of the widely distributed and characteristic elements in the Miocene faunas of the New World, particularly in the cooler waters.

The following table shows the range in the number of ribs of 323 *Lyropecten* valves from 64 localities. The number seems to be fairly constant in a single locality, a fact that would invalidate the results unless the collection were very well balanced. The *Chlamys jeffersonia* material is, in all probability, sufficiently abundant and representative to correct all such errors. It is interesting to note the clear definition of the nodes, which indicate the triple separation of the species.

The italicized figures are quoted from Dall's computations.

Number of ribs	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
<i>Chlamys (Lyropecten) jeffersonia</i> (Say)-----	1	9	14	37	36	33	26	14	13	20	29	7	1	1	1	0	1
		3	11	18	28	13	7	1	5	2	2	1					
<i>Chlamys (Lyropecten) jeffersonia</i> (Say) s. s.-----				37	35	32	24	4	3	3							
				18	28	13											
<i>Chlamys (Lyropecten) jeffersonia</i> subsp. <i>septenaria</i> (Say)-----	1	9	13														
		3	11														
<i>Chlamys (Lyropecten) jeffersonia</i> subsp. <i>edgecombensis</i> (Conrad)-----					1	1	2	10	10	17	29	7	1	1	1	0	1
							7	1	5	2	2	1					

*Chlamys (Lyropecten) jeffersonia* (Say) s. s. is most abundantly represented in the Yorktown formation in Virginia at Lanexa, along the James River, and in Southampton County; and in North Carolina in Hertford, Halifax, Edgecombe, and Pitt Counties. In Virginia the usual number of primary ribs is 9 or 10; in North Carolina, 11 or 12.

Distribution: Virginia: Miocene, Yorktown formation, Lanexa, New Kent County; Yorktown, Bellefield, and Indian Field Point, York County; 3 miles northeast of Walkerton, King and Queen County; near the mouth of Baileys Creek, Prince George County; Petersburg, Dinwiddie County; Kings Mill, James City County; old Claremont Wharf, Claremont Wharf, Schmidts Bluff,  $6\frac{3}{4}$  miles below Claremont Wharf, Suiken Marsh Creek, Cobham Wharf, Surry County;  $1\frac{1}{2}$  miles west of Smithfield,  $1\frac{1}{2}$  miles above Zuni,  $2\frac{1}{2}$  to 3 miles northwest of Zuni,  $6\frac{1}{2}$  to 7 miles below

Zuni, 7 to  $7\frac{1}{2}$  miles below Zuni, and 8 to  $8\frac{1}{2}$  miles below Zuni, Isle of Wight County; Hitchcock, Greensville County; Delaware Park, Maddelys Bluff, 3 to 4 miles above the lower Seaboard Railway bridge, and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above the lower Seaboard Railway bridge, Southampton County;  $\frac{1}{4}$  mile east of Everets, Exit,  $1\frac{1}{2}$  miles southeast of Reids Ferry,  $1\frac{1}{2}$  miles north of Suffolk,  $5\frac{1}{2}$  miles northwest of Suffolk, 1 mile west of Suffolk, and  $\frac{1}{2}$  mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation,  $1\frac{1}{2}$  miles above Branches Bridge, 1 mile above Branches Bridge, Branches Bridge, Northampton County;  $2\frac{1}{2}$  miles northwest of Murfreesboro,  $1\frac{1}{2}$  miles above Murfreesboro, 1 mile above Murfreesboro, near Murfreesboro, Dogwood Landing, Hertford County; Halifax,  $1\frac{1}{2}$  miles northeast of Enfield,  $\frac{1}{2}$  mile west of Enfield, and Palmyra Bluff, Halifax County; Compass Creek (1 mile from mouth),  $15\frac{1}{2}$  miles above Bells Bridge,  $\frac{1}{2}$  mile above Bells Bridge,  $\frac{1}{8}$  mile below Bells Bridge, 1 mile below Bells Bridge,

Tarboro, 1 mile above old Sparta Bridge, and Shiloh Mills, Edgecombe County; 8 to 9 miles west of Greenville, 3 miles west of Greenville, 2 miles west of Greenville, 1½ miles west of Greenville, and Greenville (just south of the county bridge), Pitt County; 1¼ miles northeast of Chocowinity, Beaufort County; 6 miles west of Goldsboro, Wayne County; 4 miles east of Lizzie, Greene County.

Outside distribution: Duplin marl, Porters Landing on the Savannah River, Effingham County, Ga.; Brunswick River bed, Brunswick, Glynn County, Ga. Choctawhatchee formation, northern Florida.

***Chlamys (Lyropecten) jeffersonia septenaria* (Say) Mansfield**

Plate 4, figure 1

1824. *Pecten septenarius* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 136, pl. 9, fig. 3.  
 1840. *Pecten septenarius* Say. Conrad, Fossils of the medial Tertiary of the United States, p. 47, pl. 22, fig. 2.  
 1856. *Pecten septenarius* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 31, pl. 13, figs. 1-4.  
 1863. *Pecten septenarius* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 581.  
 1898. *Pecten jeffersonius* var. *septenarius* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 722.  
 1904. *Pecten jeffersonius* var. *septenarius* Say. Glenn, Maryland Geol. Survey, Miocene, p. 379, pl. C, fig. 4.  
 1936. *Pecten (Chlamys) jeffersonius septenarius* Say. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 179, 184, 185.

Shell convex, suborbicular; auricles subequal; surface with numerous slightly scaly striae, and about 7 remote ribs, of which the 3 intermediate ones are much elevated, rounded, or slightly flattened on the top.

Length nearly 2.7 inches. The striae are equally distinct on the ribs and in the intermediate spaces. The scales are rather thick, very small, and not confined to the striae, but are also observable in the spaces between the striae.—Say, 1824.

Type locality: Maryland[?].

*Chlamys (Lyropecten) jeffersonia* subsp. *septenaria* is characterized by fewer primary ribs, normally 7 or 8, rarely only 6. As might be inferred, these are broader and usually stronger than in the forms on which the costae are more numerous.

The subspecies is less abundant and more restricted stratigraphically than *Chlamys jeffersonia*. (See Mansfield, op. cit., p. 179.)

Distribution: Virginia: Miocene, Yorktown formation. Lanexa, New Kent County; Claremont Wharf, Schmidts Bluff, 8½ miles below Claremont Wharf, Sunken Marsh Creek, Surry County; Petersburg, Dinwiddie County; James River, 7 to 7½ miles below Zuni, Isle of Wight County; 3 to 4 miles above the lower Seaboard Railway bridge, at the lower Seaboard Railway bridge, Southampton County; Exit, 1 mile west of Suffolk, and ½ mile below Suffolk, Nansemond County.

North Carolina: 1 mile above Branches Bridge, Northampton County; Miocene, Yorktown formation. Halifax and Palmyra, Halifax County; ½ mile below Bells Bridge, ¾ mile below Bells Bridge, 1 mile below Bells Bridge, and Shiloh Mills, Edgecombe County; 8 to 9 miles west of Greenville and at Greenville, Pitt County. Duplin marl, Natural Well?, Duplin County.

***Chlamys (Lyropecten) planicosta* Gardner, n. sp.**

Plate 9, figure 1

Valves large, subcircular, slightly convex; primary radials 19 in number, very low, broad, rectangular in cross section, reaching a maximum of 7 millimeters in breadth, sculptured with very faint striae, obsolete except toward the margin; interradials half as wide as the radials, filled mostly with a strongly rounded intercalary tending to bifurcate near the ventral margin; concentric sculpture very fine, visible principally in the spaces between the primaries and the midrib; anterior right ear only preserved and that badly broken; notch probably rather deep; fasciole conspicuous, lamellar; right auricle sculptured with 7 unequal striae separated by unequal interspaces; resilial pit wide and rather shallow; ligamental groove deep, bounded on the inner margin by a cardinal rib which, however, becomes obsolete anteriorly; two pairs of narrow, pinched ridges radiating from the apex of the pit—one at the margin of the pit, the other halfway down the sides—which may or may not be an accidental character.

Dimensions of holotype: Height 111.0 millimeters, width 118.0±millimeters. Holotype, a right valve: U. S. Nat. Mus. 325493.

Type locality: 3 miles southwest of Frog Level (on J. A. Noble's branch), Pitt County, N. C.

The single valve, though badly battered, is so distinct and so well characterized that it has seemed worth while to describe it. It may be readily isolated by the rectangular cross section of the primary ribs, their very fine radial striation, and the prominence of the intercalated midrib.

Distribution: North Carolina: Miocene, Yorktown formation, 3 miles southwest of Frog Level (on J. A. Noble's branch), Pitt County.

**Section NODIPECTEN Dall**

1898. *Nodipecten* Dall, Wagner Free Inst. Sci. Trans. vol. 3, pt. 4, p. 695.

Type by original designation: *Ostrea nodosa* Linnaeus. Pliocene of Florida, Pleistocene and Recent of the Gulf of Mexico and the Antilles.

Shell-like *Lyropecten*, but the ribs intermittently nodose, with more or less prominent hollow nodes or bullae; radial striation pronounced; ears unequal, the posterior smaller, the valves often more or less oblique; imbricate surface layer sometimes very marked.—Dall, 1898.

***Chlamys (Lyropecten) ernestsmithi* (Tucker) Tucker**

Plate 6, figures 6-8

1931. *Pecten ernestsmithi* Tucker, Indiana Acad. Sci. Proc., vol. 40, p. 244, pl. 1, figs. 1, 3, 4.  
 1933. *Pecten ernestsmithi* Tucker, Bull. Am. Paleontology, vol. 18, p. 66, pl. 11 (2), fig. 13.  
 1936. *Pecten (Chlamys) ernestsmithi* Tucker. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 183, 185.

Shell ovate, rather large, heavy, with 5 ribs, 3 of which are better developed. The ribs are broad and rounded on their



summits and show a marked tendency to become nodose from the umbonal region to the periphery. Interspaces wider than the ribs and deeply channeled. Both ribs and interspaces strongly radially threaded. A fragment of a right valve shows a strongly developed, concentric sculpture of scaly lamellae over both ribs and interspaces. Beak narrow and quite pointed. Submargins narrow, the outer margins nearly smooth, the inner radially threaded like the rest of the disk. Ears large, unequal, and radially threaded. Anterior byssal ear quite pointed and somewhat corrugated along the cardinal margin. Posterior ear somewhat less strongly threaded. Byssal sinus deep, narrow, and inconspicuous. Fasciole broad. Interior fluted to the umbones. Margins crenulated. Ctenolium consists of 6 prominent denticles. Resilial pit narrow, trigonal; lateral margins elevated. Cardinal margin of the right valve bent over the left. Provinculum strongly developed. Valve retains traces of a blotchy color pattern. Height 85, length 82.5, length of hinge line 60, and convexity about 20 millimeters.

This species differs from *P. caloosaensis* Dall in the shape of the ears, in the width of the interspaces, and in sculpture. *P. ernestsmithi* shows a well-developed sculpture of radial threads, while in *caloosaensis* the interspaces are sculptured only with feeble concentric lines. The anterior byssal ear of *ernestsmithi* is much more pointed at the cardinal margin than that of *caloosaensis*.

Holotype: Deposited Museum Paleontology, Cornell University.

Range: Pliocene.

Locality: Keith's marl pit, Neills Eddy Landing, Cape Fear River, 5 miles from Acme, N. C.—Tucker, 1931.

The specimens figured from the collections in the United States National Museum are rather better than the holotype.

Shell large, moderately convex. Primary radial sculpture of 4 or 5 strong, undulating ribs and of 2 slightly less prominent ones near the submargins; secondary, of strong, rounded cords numbering 6 to 8 on each primary, equal in strength on the radial and interradial areas, separated from one another mostly by linear interspaces; the medial riblet of the intercostals occasionally made more conspicuous than the others by wider channels, which set it apart from the adjacent secondaries. The concentric sculpture—the characteristic feature of the shell—consists of very close-set imbrications that override the secondaries of both the costal and the intercostal areas; in many individuals a suggestion of concentric undulations on the primaries, but these are never so strongly developed as in the type of *Nodipecten*. Submargins rather wide, not very sharply differentiated; inner submargins sculptured with concentrically imbricated lirations, usually 5 to 8; outer submargins smooth, the posterior wider than the anterior, the latter often obsolete in the right valve. Auricles large, widest at the cardinal margin; distal angles acute; right ear sculptured with 5 or 6 strong radial threads, separated by linear interspaces and overrun by concentric imbrications similar to those on the disk; left auricle sculptured with 8 to 12 feeble striations, unequal in width and separated by unequal interspaces, concentrically wrinkled but not imbricated;

left ear in some individuals joined to the disk by a sharp angulation, in others by a concave area. Byssal notch probably deep; fasciole conspicuous. Ctenolium well-developed. Resilial pit narrow, deep, somewhat oblique. Hinge area in young furnished with feeble cardinal crura, which become obsolete in adults and are replaced by a wide ligamental area. Muscle scar slightly posterior and dorsal. Inner surface of valves strongly undulated by primaries. Ventral margin crenulated by secondaries.

Dimensions of figured specimens (U. S. Nat. Mus. No. 325492): Right valve: Height 70.0 millimeters, width 67.0 millimeters. Left valve of another individual: Height 101.5 millimeters, width 100.0 millimeters.

Both the figured specimens were collected from the Waccamaw formation at Walkers Bluff, Bladen County, N. C.

This fine species is separated from *C. caloosaensis* Dall, of the Florida Pliocene, by the sculptured intercostal areas; and from *C. peedeensis* (Tuomey and Holmes) (pl. 6, fig. 5), of the South Carolina Miocene, and from *C. nodosa* Linnaeus, of the Recent fauna of the east coast, by the absence of well-defined nodes, by the fewer, coarser primaries, and by the stronger, more crowded concentric imbrications.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, Columbus County. This species, though by no means abundant, is fairly well represented at these two localities.

#### Subgenus *AEQUIPECTEN* Fischer

1886. Fischer, Manuel de conchyliologie, p. 944.

Type by monotypy: *Ostrea opercularis* Linnaeus. Recent in European waters.

Shell rather thin, brittle, of moderate dimensions, the circumference between the dorsal margins an arc of not far from 270°. Left valve more inflated than the right and more deeply colored. Primary ribbing regular, the number not increased by intercalation; a secondary liration frequently developed on both radial and interradial areas. Auricles fairly large, subequal. Byssal notch deep; ctenolium strong. Dorsal margin of right valve bent sharply downward to contact the erect margins of the left valve. Inner dorsal margins reinforced by a single pair of cardinal crurae. Marginal ligament grooves shallow, the chondrophore rather small and not very deep. Single muscle impression obscure, circular, and included mostly within the upper posterior quadrant. Inner margins crenate, in harmony with the primary ribbing.

*Aequipecten* is set apart by the not very marked difference in the inflation of the valves, the gently sloping dorsal margins, and the absence of intercalated primaries.

***Chlamys (Aequipecten) eborea* (Conrad) Mansfield**

Plate 7, figures 1, 5, 6, 8

1833. *Pecten eboreus* Conrad, Am. Jour. Sci., 1st ser., vol. 23, p. 341.  
 1840. *Pecten eboreus* Conrad, Fossils of the medial Tertiary of the United States, p. 48, pl. 23, fig. 2; pl. 24, fig. 3.  
 1843. ?*Pecten vicenarius* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 306. (Immature shell.)  
 1844. ?*Pecten holbrookii* Ravenel, idem, vol. 2, p. 96.  
 1855. *Pecten eboreus* Conrad, Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 28, pl. 11, figs. 1-5.  
 1858. *Pecten eboreus* Emmons, North Carolina Geol. Survey Rept., p. 279, fig. 197.  
 1898. *Pecten (Plagioctenium) eboreus* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 749.  
 1932. *Chlamys (Plagioctenium) eboreus eboreus* Conrad. Mansfield, Florida Geol. Survey Bull. 8, p. 60, pl. 12, fig. 11.  
 1936. *Pecten (Chlamys) eboreus eboreus* Conrad. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 180, 181, 184.

Shell suborbicular, compressed, thin, a little oblique; ribs about 22, rounded, little elevated, and smooth; inferior valve nearly flat. Length 2 inches. Locality, Suffolk, Va., Upper marine.—Conrad, 1833.

Computations on the primary radials of 404 valves of this species yield the following results:

17-----	2	24-----	95
18-----	2	25-----	59
19-----	7	26-----	31
20-----	26	27-----	5
21-----	32	28-----	2
22-----	70	29-----	1
23-----	72		

As in *Lyropecten*, the number of ribs at a single locality is fairly constant; furthermore, the tendency toward uniformity is exhibited not only by all individuals of a species but also by all species of a group. Thus in the very fine, clean, sandy marls of Lanexa, in which the 8-, 9-, and 10-ribbed *Chlamys (Lyropecten) jeffersonia* were very abundant, the primary costae of *C. (Aequipecten) eborea* run as follows:

19-----	1	22-----	14
20-----	4	23-----	3
21-----	5	24-----	1

In the coarser and slightly higher sands 1½ miles north of Suffolk, on the other hand, the many-ribbed forms of *C. jeffersonia* are abundant, and the following table shows the prevalence of the more numerous costae among the specimens of *eborea*:

22-----	1	26-----	7
23-----	1	27-----	0
24-----	6	28-----	0
25-----	3	29-----	1

The subdivisions established by Dall on the variations in the minor details of the sculpture have not been used here because of the many intermediate forms and the almost endless combinations of minor differences,

The length of the locality lists is conclusive evidence of the extensiveness of its occurrence. In most beds—particularly toward the south and in the later formations—it is by far the most profuse representative of the genus.

Distribution: Virginia: Miocene, Yorktown formation, 3 miles northeast of Walkerton, King and Queen County; Petersburg, Dinwiddie County; 2 miles northwest of Smithfield, 1½ miles west of Smithfield, ¾ mile northeast of Smithfield, 1½ miles northeast of Smithfield, 5 miles northeast of Smithfield, at Benns Church, 6½ to 7 miles below Zuni, 7 to 7½ miles below Zuni, Isle of Wight County; Hitchcock, Greensville County; Sycamore and ½ to ¾ mile above the lower Seaboard Railway bridge over Meherrin River, Southampton County; ¼ mile north of Chuckatuck, ¼ mile east of Everets, Exit, 1½ miles southeast of Reids Ferry, 5½ miles northwest of Suffolk, 2½ miles northwest of Suffolk, 1½ miles northwest of Suffolk, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 1½ miles northeast of Suffolk, 1½ miles southeast of Suffolk, and the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, Branches Bridge, Northampton County; 2½ miles northwest of Murfreesboro, 1½ miles above Murfreesboro, near Murfreesboro, 3 to 4 miles below Tar Ferry, Tar Ferry, 1½ miles below Tar Ferry, Dogwood Landing, and Mount Pleasant Landing, Hertford County; Colerain Landing, Mount Gould Landing, and ½ to ¾ mile above Edenhause Point, Bertie County; Halifax, Palmyra Bluff, and 3½ miles below Palmyra Bluff, Halifax County; Hamilton Bluff, 4 miles northwest of Williamston, 2½ miles northwest of Williamston, and 1 mile northwest of Williamston, Martin County; 3½ miles northwest of Rocky Mount, 2 miles west of Rocky Mount, ¾ mile north of New Bridge, 5 miles below New Bridge, 6½ miles below New Bridge, 15½ miles above Bells Bridge, ½ mile above Bells Bridge, ½ mile below Bells Bridge, 1 to 1¼ miles below Bells Bridge, Shiloh Mills, Tarboro, and 1 mile below old Sparta Bridge, Edgecombe County; 2 miles below Toddy Station, 2 miles southeast of Tugwell, 1½ miles northeast of Farmville, 3 miles south of Farmville, 2½ miles north of Standard, 3 miles southeast of Frog Level, 8 to 9 miles west of Greenville, 3 miles west of Greenville, 2 miles west of Greenville, 1½ miles northwest of Greenville, Greenville (just south of the county bridge), 1½ miles east of Greenville, 6 miles below Greenville (at Cherry Landing), 6¾ miles below Greenville (at Taft's Landing), 9 to 10 miles south of Greenville, Hardees Creek (about 3½ miles from the Tar), 1 mile northwest of Galloway Crossroads, ¾ mile north of Grimesland, Grifton, and 3 miles east of Grifton, Pitt County; 2½ miles northwest of Chocowinity and 1½ miles northwest of Chocowinity, Beaufort County; Hominy Swamp near Wilson, 1 mile west of Wilson, 3 miles east-southeast of Wilson, 5 miles south of Wilson, and 1 mile northwest of Stantonsburg, Wilson County; 1 mile north of Castoria, ½ mile east of Lizzie, 1 mile east of Lizzie, 2 miles northeast of Lizzie, and 4 miles east of Lizzie, Greene County; 6 miles west of Goldsboro, Wayne County; Rock Landing, Craven County. Duplin marl, 2½ miles south of Clinton, 3 miles south of Clinton, and 4 miles south of Clinton, Sampson County; 2 miles northeast of Warsaw, Natural Well and environs, Duplin County; 1 mile west of Lumberton, Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, Fairmont, 1½ miles northeast of Fairmont, and 4 miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Black Rock Landing, 4 miles east of Elizabethtown, and Walkers Bluff, Bladen County; Neills Eddy Landing, Columbus County; Wilmington, New Hanover County.



Outside distribution: Miocene, Choctawhatchee formation, northern Florida. Duplin marl, Darlington, Darlington County, S. C.; Porters Landing on the Savannah River, Effingham County, Ga., Pliocene, (?) Santa Rosa and Santa Maria Tetetla, Vera Cruz, Mexico; Tuxtepec, Oaxaca, Mexico. Waccamaw formation, Todds Ferry, Horry County, S. C., Caloosahatchee marl, Caloosahatchee River, and Shell Creek, Fla.

***Chlamys* (*Aequipecten*) *comparilis* (Tuomey and Holmes)  
Mansfield**

Plate 7, figures 2, 3, 4, 7

1855. *Pecten comparilis* Tuomey and Holmes. Pleiocene fossils of South Carolina, p. 29, pl. 11, figs. 6-10.  
1898. *Pecten eboreus* var. *comparilis* Tuomey and Holmes. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 750.  
1932. *Chlamys* (*Plagiocentrum*) *comparilis* Tuomey and Holmes. Mansfield, Florida Geol. Survey Bull. 8, p. 61, pl. 11, figs. 5, 6.  
1936. *Pecten* (*Chlamys*) *comparilis* Tuomey and Holmes. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 180, 181, 184, 185.

Shell orbicular, convex, somewhat thick, equivalve, with concentric lines of growth, ears nearly equal. Lower valve, buccal ear notched, radiately and coarsely ribbed, with 5 to 6 ribs; anal ear, ribs smaller and more numerous. Upper valve, ears with the radiating lines equal, ribs and interstices nearly equal.

This fossil is distinguished from *P. eboreus* by having the ribs more raised and convex, both valves more convex, and by the coarse ribs of the buccal ear of the lower valve.—Tuomey and Holmes, 1855.

The characters that separate *C. comparilis* from *C. eborea*, with which it has been commonly confused, are well illustrated in the original figures.

The species is restricted to a few localities at the top of the Miocene and the base of the Pliocene scattered from southern Virginia to Florida. In Florida *C. comparilis* has been recognized only in the *Cancellaria* zone.

Distribution: The recorded distribution of *Pecten comparilis* Tuomey and Holmes (Pleiocene fossils of South Carolina, p. 29, pl. 11, figs. 6-10) is as follows: Yorktown formation at Petersburg and 16 miles below Suffolk, Nansemond River, Va., one specimen in the United States National Museum collected by the late Frank Burns from each locality; upper Miocene at Darlington, S. C. (Tuomey and Holmes); Pliocene at Goose Creek, S. C.; upper Miocene bed at Porters Landing on the Savannah River, Ga.; and upper Miocene (*Cancellaria* zone), Florida.—Mansfield, W. C., Jour. Paleontology, vol. 10, No. 3, p. 180, April 1936.

**Subgenus *PLACOPECTEN* Verrill**

1897. *Placopecten* Verrill, Connecticut Acad. Arts and Sci. Trans., vol. 10, p. 69.

Type by original designation: *Pecten clintonius* Say. Miocene of Virginia.

Verrill describes *Placopecten* as a subgenus of *Chlamys*. A number of authors, including Dall, have considered it closer to *Pecten*, although Dall mentions the similarity of a *Placopecten clintonius* to a hypothetical *Lyropecten jeffersonius* with obsolete primary ribbing. *Placopecten* resembles *Chlamys* in the rela-

tively greater compression of the right valve. In true *Pecten* the right valve is more highly inflated than the left. The byssal sinus of *Placopecten* is more shallow than that of true *Chlamys*, and the pectenidial teeth are usually obsolete in the adults. In form and texture the *Placopecten* approach *Amusium*, but they are sharply separable by the absence of internal ribbing.

***Chlamys* (*Placopecten*) *clintonia* (Say) Verrill**

Plate 6, figures 1, 4

1824. *Pecten clintonius* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 135, pl. 9, fig. 2.  
1834. *Pecten magellanicus* Conrad, idem, 1st ser., vol. 7, p. 153. Not *Ostrea magellanica* Gmelin, 1792.  
1840. *Pecten clintonius* Say. Conrad, Fossils of the medial Tertiary of the United States, p. 47, pl. 23, fig. 1.  
1858. *Pecten princepoides* Emmons, North Carolina Geol. Survey Rept., p. 280, fig. 198.  
1863. *Pecten clintonius* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 581.  
1897. *Chlamys* (*Placopecten*) *clintonius* Say (part). Verrill, Connecticut Acad. Arts and Sci. Trans., vol. 10, p. 78.  
1898. *Pecten* (*Placopecten*) *clintonius* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 725.  
1904. *Pecten* (*Chlamys*) *clintonius* Say. Glenn, Maryland Geol. Survey, Miocene, p. 375, pl. 99, fig. 5.  
1936. *Pecten* (*Chlamys*) *clintonius* Say. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 178, 184, pl. 22, fig. 4.

Auricles equal; surface with from 140 to 180 elevated longitudinal lines.

Shell suborbicular, compressed, with very numerous, regular, elevated striae, which are muricated with minute scales formed by transverse wrinkles that are sparse in the middle of the length and crowded on each side of the shell; the intervening spaces are regularly concave and in parts very distinctly wrinkled; auricles equal, striated like the general surface; within simple, margin striated.

Length 4 inches, breadth rather more.

This is a very fine shell comparable with the *magellanica*; but the sides below the auricles decline much more rapidly toward the base, and the striae, judging from Bruguiere's figure, are much more prominent and distinct.—Say, 1824.

Type locality: Maryland [?].

Verrill united the Miocene species with the Recent *Pecten magellanicus*, its undoubted descendant, but Dall, op. cit, 1898, later excluded the Recent species because of "the shorter hinge line, higher auricles, much narrower resiliary pit, and usually the smaller and less central adductor scar of the Recent shell. \* \* \* As a rule the radiating threads in the fossil are markedly coarser than those of the living species. In both, the byssal notch of the adult is represented by a shallow sinuation, and the ctenolium, present in the immature stages, is usually buried in shelly matter in the adult."

The species is well characterized by the thin, compressed shell, the hyaline texture of the interior surface, and the very numerous, irregularly wrinkled, radial lirations of the exterior surface, which are coarser than those of the Recent *magellanica*. The concentric ornamentation is visible only in the interspaces and on the auricles and submargins, where it is sometimes strong

enough to muricate the lirae. It is interesting to note that in the closely allied Recent species the individuals that develop a sculpture most nearly akin to that of *Placopecten clintonius* (Say) come from warmer waters.

The pectens described by Say in 1824 are among the most common in the Miocene faunas of the middle States of the Atlantic seaboard. They were included in "a very large and fine collection of fossil shells which Mr. John Finch obtained with much labor and some expense in Maryland and which that gentleman with great liberality submitted" to Thomas Say for examination. The following footnote attends *Pecten Clintonius*: "Mr. Finch requested that three species of his collection that might prove to be new should be dedicated to the distinguished men whose names these shells bear." Thomas Jefferson, James Madison, and DeWitt Clinton were thus honored. DeWitt Clinton was in 1824 a prominent national figure. He had been United States Senator from New York, mayor of New York City, governor of New York, and in 1812 a formidable candidate for the presidency. The Great Lakes to Hudson River Canal was begun and completed largely through his efforts. He was an educator and a naturalist, the second president of the American Academy of Art, and the founder and an early president of the New York Historical Society.

Mansfield (op. cit., p. 178) has expressed on the printed page the doubt held by many students that the Finch collection included only Maryland shells. It is highly probably that not only *Pecten clintonius* Say but also Say's *P. jeffersonius* and *P. septenarius* came from the Yorktown formation in Virginia, at a horizon higher than any recognized in the Miocene section of Maryland.

Distribution: Virginia: Miocene, Yorktown formation. Lanexa, New Kent County; Indian Field Point and Yorktown, York County; mouth of Baileys Creek, Prince George County; old Claremont Wharf, Schmidts Bluff, 8½ miles below Claremont Wharf, Sunken Marsh Creek, and Cobham Wharf, Surry County; Kings Mill, James City County; 1 mile above Zuni, just south of Zuni, 6½ to 7 miles below Zuni, and 7 to 7½ miles below Zuni, Isle of Wight County; Sycamore, Southampton County.

North Carolina: Miocene, Yorktown formation, 1½ miles above Branches Bridge, Northampton County, 2½ miles above Murfreesboro, 1 mile above Murfreesboro, and near Murfreesboro, Hertford County; Halifax, Halifax County; 3 miles west of Greenville and 2 miles west of Greenville, Pitt County.

#### *Chlamys* (*Placopecten*) *marylandica* (Wagner) Glenn

Plate 5, figure 4; plate 6, figures 2, 3

1839. *Pecten marylandicus* Wagner, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 8, p. 51, pl. 1, fig. 2.  
 1863. *Pecten marylandicus* Wagner. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 581.  
 1898. *Pecten* (*Placopecten*?) *marylandicus* Wagner (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 728.

1904. *Pecten* (*Chlamys*) *marylandicus* Wagner (part). Glenn, Maryland Geol. Survey, Miocene, p. 376, pl. 99, fig. 6.  
 1936. *Pecten* (*Chlamys*) *marylandicus* Wagner. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 176, 177, 184.

Shell ovate, compressed; ribs numerous, consisting of narrow, nearly smooth striae disposed in pairs; interstitial spaces each with a carinated line; ears unequal; inferior valve very slightly convex; ribs similar to those of the opposite valve; inner margin of the valve with profoundly elevated lines.

Locality, Meherrin [Meherrin] River, N. C. [?] This *Pecten* is allied to *Pecten madisonius* Say but can readily be distinguished by its want of broad, elevated ribs and a surface destitute of scales.—Wagner, 1839.

In external ornamentation the species ranges from individuals showing uniform radiating lirae similar to those of *Placopecten clintonius*—though stronger and consequently less numerous—to individuals exhibiting true ribs that recall those of *Lyropecten* and that are sufficiently strong to crenulate the interior of the valves. The ribs do not, however, become so strong as in the typical *madisonius*, nor are they ever reduced to interareas between impressed lines, as in *virginianus* and certain representatives of *tenuis*. The delicate, concentric sculpture is visible in the interspaces, as in *clintonius*, but it does not imbricate the radial striae, as in many individuals of *tenuis*.

Distribution: Virginia: Miocene, Choptank formation, Nomini Cliffs, Westmoreland County.

Outside distribution: Miocene, Choptank formation, Dover Bridge, Queen Annes County, Md.; Governor Run, Flag Pond, and St. Leonard Creek, Calvert County, Md.; Jones Wharf, Patuxent River, St. Marys County, Md.

#### *Chlamys* (*Placopecten*) *virginiana* (Conrad) Tucker

Plate 4, figure 3

1840. *Pecten virginianus* Conrad, Fossils of the medial Tertiary of the United States, p. 46, pl. 21, fig. 10.  
 1863. *Pecten virginianus* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 582.  
 1898. *Pecten* (*Placopecten*) *virginianus* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 727.  
 1934. *Chlamys* (*Placopecten*) *virginianum* Conrad (part). Tucker, Am. Midland Naturalist, vol. 15, p. 617.  
 1936. *Pecten* (*Chlamys*) *virginianus* Conrad. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 178, 184.

Shell orbicular; inferior valve convex, with numerous irregular, impressed, radiating lines; sinus of the ear profound, and a deep groove margins the ear to the apex; the groove minutely pectinated.

Locality, near City Point, Va.—Conrad, 1840.

Later collections have revealed this species at several localities of the Yorktown though it is nowhere an abundant form. It shares with *C. clintonia* (Say) the thin convex valves and hyaline texture, though it exhibits a peculiar translucency not noted in any representative of *C. clintonia*. It differs, furthermore, in the smaller size, the deeper byssal notch, the more strongly developed ctenolium, and the details of the external sculpture. In place of the raised lirae of *C. clintonia*, it has irregular impressed lines that are

irregularly spaced and that number 75 on the type.

The dimensions are as follows: Height 57.8 millimeters, width 58.8 millimeters, semidiameter 4.1 millimeters.

Distribution: Virginia: Miocene, Yorktown formation, City Point (Conrad) and the mouth of Baileys Creek, Prince George County; 12 to 14 miles below Zuni, Isle of Wight County; Delaware Park, Southampton County.

North Carolina: Miocene, Yorktown formation, 1½ miles above Murfreesboro, Hertford County.

#### Genus *AMUSIUM* (Bolten) Roeding

1798. *Amusium* (Bolten) Roeding, Museum boltenianum, pt. 2, p. 165).

Type by subsequent designation (Herrmannsen, Indiciis generum Malacozoorum, vol. 1, p. 47, 1846): *Ostrea pleuronectes* Linnaeus. Recent in the Indo-Pacific.

The valves are commonly large, thin, feebly convex, and, like those of the true pectens, not attached by a byssus. Radial sculpture is sometimes suggested by the color pattern but is rarely developed and is never strong. A concentric imbrication may be observed in some species, particularly toward the ventral margin. The discrepancy in ornamentation so common in *Pseudamusium* is reflected in the discrepant coloring in *Amusium* s. s. In *A. papyraceum*, the Recent Antillean shell, the right valve is white or bordered with pale yellow, but the left is a deep reddish or purplish brown. This general type of color holds throughout *Amusium* s. s. The lirae developed upon the inner surface of the disk are perhaps the most constant feature of the genus.

Like *Pecten*, *Amusium* may be traced back to the Mesozoic. The thin, internally lirate shells of *Amusium* require a much more specialized habitat than the heavy, externally ribbed shells of most of the *Pecten* group, and perhaps for this reason the genus is relatively rare.

#### *Amusium mortoni* (Ravenel) Conrad

Plate 8, figures 1, 2

1844. *Pecten mortoni* Ravenel, Acad. Nat. Sci. Philadelphia Proc., vol. 2, p. 96.

1855. *Pecten mortoni* Ravenel. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 27, pl. 10, figs. 1, 2.

1858. *Pecten mortoni* Emmons, North Carolina Geol. Survey Rept., p. 281.

1863. *Amusium mortoni* Ravenel. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 582.

1898. *Pecten (Amusium) mortoni* Ravenel. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 757.

1904. *Pecten (Amusium) mortoni* Ravenel. Glenn, Maryland Geol. Survey, Miocene, p. 372, pl. 99, fig. 1.

1906. *Amusium mortoni* Ravenel. Böse, Inst. geol. Mexico Bol. 22, pp. 24, 74, pl. 1, figs. 3, 6, 7, 9; pl. 8, figs. 1, 2; pl. 9, fig. 3.

1909. *Pecten (Amusium) mortoni* Ravenel. Grabau and Shimer, North American index fossils, vol. 1, p. 508, fig. 680.

1932. *Amusium mortoni* Ravenel. Mansfield, Florida Geol. Survey Bull. 8, p. 64, pl. 11, figs. 2, 4.

1936. *Amusium mortoni* Ravenel. Mansfield, Jour. Paleontology, vol. 10, pp. 174, 180, 184, 185.

Orbicular, thin, both valves moderately convex, one more so than the other; outside, with numerous concentric obsolete striae; inside, with from 18 to 24 radiating double ribs, slightly elevated; ears large, subequal, striated externally.

This species is nearly allied to the *P. pleuronectes* and *P. japonicus*. It is found on my plantation, The Grove, in St. Thomas' Parish, about 17 miles from Charleston, and also on Goose Creek, at Mr. Henry Smith's, about 7 miles southwest from The Grove deposit, and 11 miles from Charleston; Cooper River being between these localities.

This shell is abundant at The Grove, but being large and thin it is generally broken in getting out the marl, and with the exception of a few small specimens I have not been able to procure a perfect valve.

The largest specimen in my possession, although not perfect, is sufficiently so to determine its size; it is 8¾ inches in diameter.

I take much pleasure in designating this shell by the name of our distinguished geologist, Dr. Samuel George Morton, of Philadelphia.—Ravenel, 1844.

Mansfield reports fragments of the species from a number of localities in the *Ecphora* and *Cancellaria* zones of northern Florida.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well, 1½ miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Lake Waccamaw, Columbus County; Black Rock Landing on the Cape Fear River, Bladen County.

Outside distribution: Miocene, Santa Rosa and Santa Maria Tetetla, Vera Cruz, Mexico. St. Marys formation, Cove Point and Drum Point, Calvert County, Md. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Todds Ferry, Horry County; The Grove, Cooper River, and Smith's, Goose Creek, Berkeley County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla.

#### Family SPONDYLIDAE

##### Genus *PLICATULA* Lamarck

1801. *Plicatula* Lamarck, Système des animaux sans vertèbres, p. 132.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einrichtung, etc., pp. 61, 177, Gotha, 1818): *Spondylus plicatus* Linnaeus. Recent in the Orient.

Shell small, inequivalve, flattened or slightly convex, trigonal-ovate to subcircular, often irregular, attached as a rule in the adult by the umbo of the right valve, which is the larger. Outer surface generally plicate, the folds commonly bifurcating. Ligament internal, lodged in a subumbonal cartilage pit between the two heavy, divergent, transversely striated cardinal crurae. A single muscle impression in the adult, excentric and posterior. Pallial line entire. Margin fluted in harmony with the outer ribbing.

*Plicatula* differs from *Spondylus* in its small size, less ornate sculpture, and absence of auricles.

The genus, which is recorded in the early Mesozoic, culminated in the late Mesozoic and is represented by fewer than a dozen Recent species, mostly oriental in habitat.

*Plicatula marginata* Say

Plate 11, figures 6, 8, 13, 14

1824. *Plicatula marginata* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 136, pl. 9, figs. 4a, b.  
 1845. *Plicatula marginata* Say. Conrad, Fossils of the medial Tertiary of the United States, p. 75, pl. 43, fig. 5.  
 1855. *Plicatula marginata* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 24, pl. 7, figs. 11-14.  
 1858. *Plicatula marginata* Emmons, North Carolina Geol. Survey Rept., p. 283, fig. 203.  
 1863. *Plicatula marginata* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 582.  
 1898. *Plicatula marginata* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 764.  
 1932. *Plicatula marginata* Say. Mansfield, Florida Geol. Survey Bull. 8, p. 66, pl. 12, figs. 9, 10.

Shell ovate-cuneiform, somewhat arcuated at base; with about 3 much elevated folds, producing very profound undulations on the edge of the shell; the intermediate fold is bifid; the whole surface is marked by rather gross concentric wrinkles; inner margin dusky or blackish, with a series of granules on one valve, received into corresponding cavities in the opposite valve.

Length  $1\frac{1}{2}$  inches, breadth 1 inch.—Say, 1824.

Type locality: Maryland (?).

So far as the form of the shell is concerned, this species cannot be discriminated from *P. gibbosa*, but none of the specimens show any trace of the dark venous lines which are so characteristic of both recent and fossil specimens of *gibbosa*. In a very large series of the recent shell a few specimens will usually be found which have a diffused brownish blush instead of the brown lines; but these are so exceptional that I have felt the present species might be separated with propriety. In both, the differences of sculpture due to situs pass through a parallel series of mutations.—Dall, 1898.

This species is the only common representative of the genus occurring within the Virginia-North Carolina area. As is normal with attached forms, it shows a considerable amount of variation in outline and in the number and character of the radial plications. The narrow trigonal outline is characteristic of the forms with few ribs; the subcircular, of the forms with many. The species is exceedingly abundant along the Tar River, in Pitt County, N. C., and farther southeast, in the vicinity of Lizzie, in Greene County, N. C. A particularly large collection was made by L. W. Stephenson at Dog Swamp, 4 miles east of Lizzie. The range of variation in the number of ribs at this locality is as follows: 3 ribs, 2 right valves, 1 left valve; 4 ribs, 22 right valves, 40 left valves; 5 ribs, 77 right valves, 101 left valves; 6 ribs, 54 right valves, 36 left valves; 7 ribs, 14 right valves, 10 left valves; 8 ribs, 1 right valve, 3 left valves. The data, based on the consideration of 170 right valves and 191 left valves, indicate that 5 is the average number of ribs and that there is a tendency toward fewer ribs in the left valve than in the right.

Distribution: Virginia: Miocene, Yorktown formation, 4 miles northwest of Walkerton and 3 miles northeast of Walkerton, King

and Queen County; Yorktown and Bellefield, York County; Claremont Wharf and old Claremont Wharf, Surry County; 2 miles below Peters Bridge, Sussex County; 1 mile north of Zuni, 7 to  $7\frac{1}{2}$  miles below Zuni, 12 to 14 miles below Zuni, 2 miles northwest of Smithfield,  $1\frac{1}{2}$  miles west of Smithfield,  $\frac{3}{4}$  mile northeast of Smithfield,  $1\frac{1}{2}$  miles northeast of Smithfield, 5 miles northeast of Smithfield, and Benns Church, Isle of Wight County; Sycamore,  $\frac{1}{4}$  to  $\frac{1}{2}$  mile below Sycamore, Maddelys Bluff, Southampton County; a quarter of a mile north of Suffolk,  $1\frac{1}{2}$  miles northeast of Suffolk, 1 mile northeast of Suffolk, and half a mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation,  $1\frac{1}{2}$  miles above Branches Bridge, 1 mile above Branches Bridge, and Branches Bridge, Northampton County;  $1\frac{1}{2}$  miles above Murfreesboro, 1 mile above Murfreesboro, and near Murfreesboro, Hertford County; Palmyra Bluff, Halifax County; 3 miles west of Williamston,  $2\frac{1}{2}$  miles northwest of Williamston, 1 mile northwest of Williamston, and Hamilton Bluff, Martin County;  $6\frac{1}{2}$  miles below New Bridge, Swift Creek,  $15\frac{1}{2}$  miles above Bells Bridge,  $\frac{1}{2}$  mile above Bells Bridge,  $\frac{1}{2}$  mile below Bells Bridge, Shiloh Mills, Tarboro (at L. E. Fountain's farm), and 1 mile below old Sparta Bridge, Edgecombe County; 2 miles below Toddy Station,  $1\frac{1}{4}$  miles northeast of Farmville, 3 miles south of Farmville,  $2\frac{1}{3}$  miles north of Standard, 8 to 9 miles west of Greenville (on the east side of Pinelog Branch), 3 miles west of Greenville, 2 miles west of Greenville,  $1\frac{1}{2}$  miles west of Greenville (on Schoolhouse Branch), Greenville (just east of the county bridge), 8 to 9 miles southeast of Greenville, 9 to 10 miles south of Greenville, and 1 mile northwest of Galloway Crossroads, Pitt County; 2 miles northwest of Chowinity, Beaufort County; 2 miles southwest of Maple Cypress, Craven County; 1 mile west of Wilson (at Hominy Swamp), 1 mile south of Wilson, 3 miles east-southeast of Wilson, 1 mile northwest of Stantonsburg, Wilson County; 1 mile north of Castoria,  $\frac{1}{2}$  mile east of Lizzie, 2 miles northeast of Lizzie, 4 miles east of Lizzie, and  $1\frac{1}{2}$  miles east of Ormondsville, Greene County,  $1\frac{1}{2}$  miles below Tar Ferry, 3 to 4 miles below Tar Ferry, and Dogwood Landing, Hertford County; Colerain Landing and Mount Gould Landing, Bertie County; Rock Landing, Craven County. Duplin marl,  $2\frac{1}{2}$  miles south of Clinton, 3 miles south of Clinton, and 4 miles south of Clinton, Sampson County; 3 miles northeast of Warsaw, Magnolia, and Natural Well and environs, Duplin County; 4 miles north of Lumberton, 1 mile west of Lumberton, Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, Fairmont, and  $1\frac{1}{2}$  miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Lake Waccamaw, Cronly, and Neills Eddy Landing, Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida. Duplin marl, Darlington, Darlington County, S. C.; Porters Landing on the Savannah River, Effingham County, Ga. Pliocene, Waccamaw formation, Nixons, Tillys Lake, and Todds Ferry, Horry County, S. C. Caloosahatchee marl, De Leon Springs, Volusia County, Fla. Caloosahatchee River, Shell Creek, and Alligator Creek, Fla.

## Superfamily ANOMIACEA

## Family ANOMIIDAE

Genus *PODODESMUS* Philippi 1837

1837. *Pododesmus* Philippi, Wiegmann, Archiv Naturgeschichte, Jahrgang 3, Band 1, p. 385.

Type by monotypy: *Pododesmus decipiens* Philippi = *Pododesmus rudis* Broderip. Recent in the West Indies.

Section *MONIA* Gray

1849. *Monia* Gray, Zool. Soc. London Proc., pt. 17, p. 121.

Type by subsequent designation (Bucquoy, Dautzenberg, and Dollfus, Mollusques marins du Roussillon, vol. 2, p. 41, 1888): *Anomia zealandica* Gray. Recent in New Zealand.

Shell ovate, not plicated; radiately ribbed. Perforation of lower valve large, only slightly embracing the large thin plug.—Gray, 1849.

The genus differs from *Pododesmus* in the possession of a much larger foramen.

*Pododesmus* (*Monia*?) *philippi* Gardner, n. sp.

Plate 3, figures 10, 11, 13

1904. ?*Anomia aculeata* Gmelin. Glenn, Maryland Geol. Survey, Miocene, p. 369, pl. 98, figs. 2–5. Not *A. aculeata* Gmelin, 1792.

Shell of medium size, moderately compressed, sub-circular, unusually symmetrical for the genus. Umbones slightly prominent, central, almost but not quite terminal. Sculpture of irregular but mostly continuous divergent striae, numbering about 24 to the centimeter, separated by linear interspaces; concentric sculpture of a few exaggerated growth lines, which override and groove the radials. Characters of interior generally effaced by weathering. Valves usually lined with a calcareous layer. Margins of ligament scar in the left valve sometimes thickened to form irregular crura—a variable feature, however, not exhibited by all individuals of the species. Byssal scar very large, placed directly beneath the umbones but a little behind the center of the valve. Adductor scar decidedly smaller than the byssal, situated in front of and a little to the left of the latter. Pallial line simple. Right valve represented by such fragmentary material that its characters are doubtful.

Holotype, a left valve: U. S. Nat. Mus. 325497.

Dimensions of holotype: Height 35.7 millimeters, width 36.0 millimeters, convexity 7.6 millimeters.

Type locality: 2½ miles below Bayport, Middlesex County, Va.

As the section *Monia* is based primarily on the nature of the foraminal opening, the assignment of the species to this group is only tentative.

Externally the species suggests an abnormally large and regular *Anomia aculeata* Gmelin, though on the latter the radiating lirae are discontinuous and crowded with minute prickles, whereas on the former they are continuous, simple, or rather dissected by the concentric striae. The figured types in the collection of the Maryland Geological Survey are not sufficiently well preserved to show the diagnostic interior characters. The radials are more deeply furrowed by the concentric lines than in the majority of specimens from Virginia, but otherwise the forms are identical. The species is represented at several localities in Vir-

ginia, and along the Rappahannock and James Rivers it is quite abundant.

Distribution: Virginia: Miocene, St. Marys formation, 2½ miles below Bowlers Wharf, Essex County; 2½ miles below Bayport, Middlesex County; old Claremont Wharf, Schmidts Bluff, and 8½ miles below Claremont Wharf, Surry County.

## Superfamily OSTRACEA

## Family OSTREIDAE

Genus *OSTREA* (Linnaeus) Lamarck

1758. Linnaeus, Systema naturae, 10th ed., p. 696.

1799. Lamarck, Prodrome d'une nouvelle classification des coquilles: Soc. histoire nat. Paris Mém., p. 81.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einricht, etc., pp. 69, 177, Gotha, 1818): *Ostrea edulis* Linnaeus. Recent off the European shores from Iceland to the Adriatic.

*Ostrea waccamawensis* Gardner, n. sp.

Plate 3, figure 17

Shell of medium size, ovate-elliptical, nonplicate, the ventral margin very broadly and evenly rounded. Attached valve—the only one known—moderately concave. External sculpture of narrow, closely plicated laminae, densely packed on the surface of the shell; radial sculpture dominant in young, and concentric laminae not developed, the resultant sculpture suggesting that of *Anomia aculeata* Gmelin. Hinge character obscured by extraneous material on the interior of the shell; hinge area probably narrow and rather low, with a moderately deep median groove. Shell margins finely rugose for approximately one-third of the distance from the beak to the ventral margin. Muscle impression not visible.

Dimensions of holotype: Height 68.0 millimeters, width 57.0 millimeters.

Holotype: U. S. Nat. Mus. 497063.

Type locality: Cronly, Columbus County, N. C.

*Ostrea waccamawensis* is conspicuously distinct from all the known east coast oysters by reason of the regularity of the outline and the heavy decoration of narrow, crinkled lamellae.

Distribution: North Carolina: Pliocene, Waccamaw formation, Cronly, Columbus County.

## Order ANOMALODESMACEA

The Anomalodesmacea are a polyphyletic group, many of them modified by adaptation to a highly specialized habitat. Although they have been shuttled about in systematic arrangements, as a whole and in parts, they are commonly assigned a place following the Teleodesmacea. As they include several characteristic Mesozoic genera, such as *Pholadomya* and *Liopistha*, the evidence of the primitive stock seems sufficiently strong to warrant their retention near the Prionodesmacea. Later, as the evolutionary changes are traced in the nepionic shells, it may be possible to treat the group in a less arbitrary manner.

## Superfamily ANATINACEA

## Family PERIPLOMATIDAE

## Genus PERIPLOMA Schumacher

1817. *Periploma* Schumacher, Essai d'un nouveau système des habitations des vers testacés, p. 115.

Type by monotypy: *Periploma inaequalis* Schumacher. Recent in the West Indies.

Shell subnacreous, inaequivalve, nearly closed, oval or rounded; umbones opisthogyrate. Ligament internal, supported by two vertically or anteriorly directed chondrophores. Hinge edentulous. Muscle impressions unequal. Pallial sinus broad and shallow.

The genus is rare in the Tertiary, and the Recent forms are mostly confined to the eastern coasts of the Americas.

## Subgenus COCHLODESMA Couthouy

1839. *Cochloidesma* Couthouy, Monograph on the family Ostodesmacea: Boston Jour. Nat. History, vol. 2, p. 170.

Type by monotypy: *Anatina leana* Conrad. Recent from the Gulf of St. Lawrence to North Carolina.

The subgenus is characterized by the compressed, telliniform outline and by the absence of a calcified rib supporting the chondrophore.

*Periploma (Cochloidesma) antiqua* Conrad

Plate 10, figure 3

1834. *Anatina antiqua* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 130.  
 1838. *Periploma antiqua* Conrad, Fossils of the medial Tertiary of the United States, p. 16, pl. 8, fig. 3.  
 1863. *Periploma antiqua* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 572.  
 1873. *Cochloidesma antiquatum* Conrad, Verrill, Invertebrate animals of Vineyard Sound: U. S. Comm. Fish and Fisheries Rept., p. 673.  
 1903. *Periploma (Cochloidesma) antiqua* Conrad, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1530.

Shell ovate, rather elevated, convex, thin, and fragile; with obsolete concentric sulci; beaks slightly prominent; fosset not oblique, elongated. Length 2 inches, height about 1½ inches. Locality, Yorktown, Va.—Conrad, 1834.

The type remains unique. The fragment of a valve strongly suggesting Conrad's species but not possessing sufficient characters for a definite determination was collected from the Waccamaw marls at Walkers Bluff, in Bladen County, N. C. Another fragment, unlike any known species of *Periploma* but too imperfect to describe, has been found in the Yorktown 2½ miles northwest of Chocowinity, in Beaufort County, N. C.

Distribution: Virginia: Yorktown formation, Yorktown, York County.

## Family THRACIIDAE

## Genus THRACIA (Leach ms.) De Blainville

1824. *Thracia* (Leach ms.) De Blainville, Dictionnaire des sciences naturelles, vol. 32, p. 347.

1825. *Thracia* (Leach ms.) De Blainville, Manuel de malacologie, p. 564.

1827. *Thracia* De Blainville, idem, planches, p. 660, pl. 76, fig. 7.

1839. *Thracia* Leach. Couthouy, Boston Jour. Nat. History, vol. 2, p. 129.

1903. *Thracia* Blainville. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1522.

Type by elimination: *Thracia corbuloidea* De Blainville. Recent in the Mediterranean.

In 1824 De Blainville described at length the shell of *Thracia* and placed under it two sections: (A) Species that have a spoon-shaped process (cuilleron) in one valve only; sole example, *T. corbuloidea*; (B) species that have a spoon-shaped process in each valve; sole example, *T. pubescens* Leach = *Mya pubescens* Linnaeus. De Blainville's description in 1825 was a replica of that of 1824 except that in the next to the last line of the description of 1824 he wrote "une ligule abdominale;" in 1825, "une ligule paléale." In 1827 De Blainville published the figures to accompany the text of 1825 and also a few pages of "Nouvelles additions et corrections au genera," in which he made the following note on *Thracia* "Supprimez la division B, établie sur une coquille que je n'avais pas vue, et qui paraît n'être autre chose que celle qui sert de type au genre OSTÉODESME \* \* \*."

As De Blainville's observations were not entirely correct, his A and B divisions are no longer recognized; but he clearly expressed the wish to eliminate the shell he had not seen. *T. corbuloidea*, then, remains the unique example.

The shell of *Thracia* is thin, not nacreous but cellulocrystalline, transversely ovate to ovate-trigonal, broadly rounded in front, more or less produced, truncate, and gaping posteriorly. The right valve is larger and more inflated than the left, the right umbo higher than the left, and the ventral margin of the right valve extends beyond that of the left. The umbones are broad, placed a little in front of the medial line, inrolled, and at the extreme tips turned slightly backward. They are so closely in contact in some of the species, notably *Thracia conradi* Couthouy, that the shell is frequently worn through by friction of the opposing surfaces. The anterior lateral margin is, as a rule, broadly rounded, the ventral margin broadly constricted in front of the obtuse rostrum, and the posterior truncate or rounded. The only sculpture is a concentric wrinkling, incremental in character, and a surficial granulation. The living species are in some degree protected by a delicate periostracum. The ligament is short, marginal, and sunken. It is attached on each side to modifications of the posterior dorsal margins, which in the closed valves are spoon-shaped. The hinge is edentulous. In some species—but not in all—the inner extremity of the anterior dorsal margin of the left valve is raised into an inconspicuous subumbonal tubercle, and in other species an inconspicuous ossicle is



developed on the anterior dorsal margin a little in front of the umbo. In most *Thracia* the shell is so thin that the muscle scars and moderately insinuated pallial line are difficult to observe.

*Thracia* is reported from the early Mesozoic on to the Recent. The Tertiary species, like the Recent, are widely scattered, but individuals are rarely abundant. Many of the east coast American forms are associated with northern faunas.

#### *Thracia conradi* Couthouy

Plate 10, figure 4

1831. *Thracia declivis* Conrad, Am. marine conchology, No. 2, p. 44, pl. 9, fig. 2. Not *Mya declivis* Pennant, 1778.  
 1839. *Thracia conradi* Couthouy, Boston Jour. Nat. History, vol. 2, p. 153, pl. 4<sup>2</sup>, fig. 2.  
 1869. *Thracia conradi* Couthouy, Am. Jour. Conchology, vol. 4, app. p. 54.  
 1870. *Thracia conradi* Couthouy. Gould, Invertebrata of Massachusetts, Binney ed., p. 69, fig. 384.  
 1889. *Thracia conradi* Couthouy. Dall, U. S. Nat. Mus. Bull. 37, p. 64, pl. 69, fig. 9.  
 1903. *Thracia conradi* Couthouy. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1524.  
 1904. (?) *Thracia conradi* Couthouy. Glenn, Maryland Geol. Survey, Miocene, p. 359, pl. 95, fig. 4.  
 1906. *Thracia conradi* Couthouy. Rogers, Shell book, p. 329, pl. 74, opp. p. 323, fig. 1.  
 1932. *Thracia conradi* Couthouy. Mansfield, Florida Geol. Survey Bull. 8, p. 72, pl. 14, fig. 11.

Shell transversely ovate, ventricose, very light, brittle, and thin, rather faintly diaphanous by reason of its want of thickness, subequilateral, slightly gaping at both extremities, inequivalve, the right valve being the more convex, its whole margin projecting considerably beyond that of the left; beaks protuberant, large, and cordiform, inclining a little backward, the summit of the right one excavated or emarginate to receive the opposing one; incremental striae numerous and distinct, occasionally forming feeble concentric ridges; the anterior portion of the shell is regularly rounded and its superior margins very thin; the posterior extremity is rather narrower and somewhat truncated, with an obtuse carination extending obliquely from the beaks to the angle of the basal and posterior margins; between this carination and the superior and posterior margins, the shell is slightly compressed. The basal margin is sinuous, curving outwardly in its central portion, corresponding to the most convex part of the shell. Ligament externally very prominent, and prolonged in a thin membrane the whole length of the corselet, which is strongly marked and extends from the beaks to the extremity; the internal portion of the ligament is attached to a strong, thick, nymphal callosity, projecting obliquely along the cardinal edge in each valve, wider toward the beaks, and having its surface but very slightly hollowed. Hinge destitute of a cardinal ossiculum. External color a pale ashy white, surface covered with a thin, light, cinereous epidermis, strongly adherent and forming numerous irregular, minute corrugations at the extremities, especially on the posterior one, but not shagreened as in *T. corbuloides*. Internal color a chalky white, not glossy, but somewhat inclining to nacre near the cardinal edge. Muscular impressions tolerably large, remote; the anterior narrow, elongated, contracted, and tapering to a point toward the hinge margin; the posterior subtriangular or pyriform; pallial impres-

sion very superficial like the others, with a profound, subangular excavation posteriorly.

Length  $2\frac{1}{2}$  inches, height  $2\frac{1}{2}$  inches, diameter  $1\frac{1}{2}$  inches. Inhabits probably the whole coast of New England.—Couthouy, 1839.

The individuals from Maryland are more compressed than either the Tertiary representatives in the area to the south or the Recent form and should probably be excluded altogether from *T. conradi* Couthouy s. s., although the material is too imperfect to serve as a foundation of a new species.

In the Choctawhatchee of Florida, *Thracia conradi* has been recognized from the upper part of the middle Miocene—the *Arca* zone through the *Ecphora* zone.

Distribution: Virginia: Miocene, Yorktown formation, 5 miles northeast of Smithfield, Isle of Wight County;  $\frac{1}{4}$  to  $\frac{1}{2}$  mile below Sycamore, Southampton County;  $1\frac{1}{2}$  miles north of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, (?) 1 mile above Branches Bridge, and Branches Bridge over the Meherrin River, Northampton County; Watsons Mill on Kirbys Creek,  $2\frac{1}{2}$  miles northwest of Murfreesboro, and  $1\frac{1}{2}$  miles above Murfreesboro on the Meherrin River, Hertford County; Halifax (on Quankey Creek) and Palmyra Bluff (on the Roanoke River), Halifax County;  $\frac{1}{2}$  mile above Bells Bridge over the Tar River, Edgecombe County. Duplin marl,  $1\frac{1}{2}$  miles northeast of Fairmont, Robeson County.

Outside distribution: Miocene, Calvert formation, Fairhaven, Lyons Creek, Plum Point, and Chesapeake Beach, Md. Choctawhatchee formation, northern Florida. Recent, Labrador to Cape Hatteras in 3 to 15 fathoms. Most abundant on sandy or gravelly bottoms in about 10 fathoms of water.

#### *Thracia transversa* H. C. Lea

Plate 10, figures 5-10

1846. *Thracia transversa* H. C. Lea, Am. Philos. Soc. Trans., new ser., vol. 9, p. 237, pl. 34, fig. 11.  
 1863. *Thracia? transversa* H. C. Lea. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 572.  
 1903. *Thracia transversa* H. C. Lea. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1525.

Shell subelliptical, very inequilateral, acuminate rounded posteriorly, truncate anteriorly, subcompressed, thin, smooth centrally, striate posteriorly and anteriorly; umbonal slope rounded; basal margin curved; dorsal margin angular in the middle, posteriorly convex, anteriorly concave; beaks somewhat acute; nymphal callosity small, oblique. Diameter 0.10, length 0.18, breadth 0.28 of an inch.

From the shape of the anterior margin, I conclude that the shell must have gaped considerably there, but as I have no pair of valves I cannot be certain. The sinus of the pallial impression is deep and near the anterior cicatrix. In this character it differs from the rest of the genus.

This is, I believe, the first *Thracia* found in our Tertiary deposits. Deshayes, in his tables, gives 4 as the number of European Tertiary species. The present one is the smallest of the genus.—H. C. Lea, 1846.

Figured specimens: Acad. Nat. Sci., Philadelphia 1585; U. S. Nat. Mus. 325509.

Type locality: Petersburg, Va.

Lea has confused the anterior and posterior ends of the shell. The posterior end is shorter and is squarely truncated.

The true affinities of the small *Thracias* in our study collections are very puzzling. They occur in the Calvert, the St. Marys, the Yorktown, and the Waccamaw formations, and, though showing considerable variation among themselves, show no more perhaps than might be covered by a species in which the valves are unequal in size and convexity. They can be very closely matched among the young of *Thracia truncata* Mighels and Adams and of *T. phasianella* Lamarck—both of them Recent species in which the young vary rather widely. The Tertiary individuals are, however, fairly uniform in size, and none of them exceed 10 millimeters in latitude. No trace of any larger forms except *T. conradi* Couthouy, a species with a rather shallow and angular pallial sinus, has been found.

*T. maddelysensis* n. sp. is relatively higher and shorter; the incrementals are strong and regular on the umbones that evanesce distally; in Lea's form the incremental sculpture is least feeble near the distal margins, particularly the posterior margin; the sinus of *T. transversa*, though almost equally profound and evenly rounded as that of *T. maddelysensis*, is decidedly less broad.

Distribution: Virginia: Miocene, Yorktown formation, (?) Yorktown, York County; Petersburg, Dinwiddie County; (?) Everets farm, Everets, and (?) 1½ miles north of Suffolk, Isle of Wight County.

North Carolina: Miocene, Yorktown formation, half a mile above Bells Bridge, Edgecombe County. Pliocene, Waccamaw formation, (?) Neills Eddy Landing, Columbus County.

***Thracia maddelysensis* Gardner, n. sp.**

Plate 10, figures 1, 2

Shell small, rather heavy, inflated, irregularly and transversely ovate, inequilateral, probably gaping posteriorly. Umbones tumid, rather prominent, the apices proximate and directed toward each other and situated about two-thirds of the distance across to the posterior margin. Lunule and escutcheon absent. Anterior end produced, broadly and evenly rounded; posterior end squarely truncate; dorsal slope very low; base line gently arcuate. Posterior area defined by an obtuse angulation extending from the umbones to the junction of the truncated posterior lateral margin and the base line. Incrementals close, strong, and regular in the umbonal region, becoming discontinuous and evanescent toward the margins. Ligament external, opisthodetic, mounted on delicate linear nymphs; valve fissured beneath the umbones, probably for the reception of the internal ligament; all traces of the lithodesma lost. Hinge edentulous; anterior margin raised, however, into a triangular toothlike process just in front of umbones. Adductor muscle impressions small and rather high, the anterior angular and irregular in outline, and posterior oval. Pallial line obscure.

Sinus very broad, semielliptical, projected forward almost to the median vertical. Inner margins entire.

Dimensions of holotype: Height 4.0 millimeters, width 5.0 millimeters, convexity 1.05 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325508.

Type locality: Maddelys Bluff, Southampton County, Va.

Except for its small size, this species shows no indication of being the young of a larger form. The shell is moderately heavy for the genus, and the character of the incremental sculpture suggests an adult rather than a young individual. It is very much higher, relatively, than *Thracia transversa* H. C. Lea and differs from *T. conradi* Couthouy, which it most closely resembles in general proportions, by the very broad, deep, and evenly rounded pallial sinus—a character which in the latter is angular and much more shallow.

The species is known only from a single right valve collected at Maddelys Bluff, on the Meherrin River.

Distribution: Virginia: Miocene, Yorktown formation, Maddelys Bluff on the Meherrin River, Southampton County.

**Family PANDORIDAE**

**Genus PANDORA (Bruguère) Lamarck**

1798. *Pandora* Bruguère, Tableau encyclopédique et méthodique, vol. 1, pl. 250, figs. a-c. (No text.)

1799. *Pandora* Lamarck, Prodrome d'une nouvelle classification des coquilles, Soc. histoire nat. Paris Mém., p. 88.

Type by monotypy: *Tellina inaequalis* Linnaeus. Recent from the Channel Islands to the Mediterranean.

The shells are highly nacreous, transversely elongate, and rather alate, inequivalve, and inequilateral. The right valve is flattened or even slightly concave; the left, rather convex. The flattened, erect beaks are set far forward, and the anterior extremity is usually broadly rounded. The posterior dorsal margin is, in many species, slightly concave, the arcuate base line curving winglike to meet it. A narrow posterior area cut off by a cordate rostrum is developed in both valves. There is no lunule, but the narrow escutcheon is well defined. A narrow cartilage extends obliquely downward and backward from the tips of the umbones and is lodged in a shallow groove with slightly raised margins. The lithodesma, developed in some but not in all groups of *Pandora*, is on the anterior side of the ligament. The teeth are crude and vary in number and position in different subgenera. The mantle is loosely attached to the inner surface so that the pallial line may be discontinuous. The margin of the convex left valve commonly extends beyond the slightly reflexed basal margin of the right valve, and there is a slight gape at the narrow truncated extremity of the posterior area. The adductor scars are small, distinct, and strongly dorsal in position.

The genus includes only about 20 Recent species, but these are distributed from the Arctic seas to the Indian



Ocean. In time, the group extends backward to the Cretaceous.

Subgenus **KENNERLIA** Carpenter

1864. *Kennerlia* Carpenter, Zool. Soc. London Proc., p. 602.

Type by subsequent designation (Stoliczka, India Geol. Survey Mem., Cretaceous fauna southern India, vol. 3, p. 61, 1871): *Pandora* (*Kennerlia*) *bicarinata* Carpenter, 1864=*Pandora bilirata* Conrad, 1855. Forrester Island, Alaska, to Point Abreojos, Lower California.

The subgenus is characterized by the presence of a lithodesma and by the development of a radial lineation. The dentition does not vary greatly from that of *Pandora* s. s.

***Pandora* (*Kennerlia*) *arenosa* Conrad**

Plate 10, figures 16, 19, 20

1834. *Pandora arenosa* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 130.

1838. *Pandora arenosa* Conrad, Fossils of the medial Tertiary of the United States, p. 2, pl. 1, fig. 3.

1846. *Myodora arenosa* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 3, p. 21.

1863. *Pandorella arenosa* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 572.

1867. *Pandora arenosa* Conrad, Am. Jour. Conchology, vol. 3, p. 269.

1885. *Pandora carolinensis* Bush, Connecticut Acad. Sci. Trans., vol. 6, pt. 2, p. 474.

1903. *Pandora* (*Kennerleyia*) *arenosa* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1518.

Shell elliptical; obtusely pointed behind; dorsal margin rectilinear, with a submarginal raised line passing from the beak to the extremity; anterior side short, margin rounded. Length two-thirds of an inch.

Locality, Yorktown, Va. \* \* \* Compared with *P. trilineata* of Say, it is more elliptical, smaller, and the teeth are remarkably small.—Conrad, 1834.

Shell inequivalve, inequilateral, nacreous within. Outline irregularly elliptical. Width approximately double the height. Left valve convex. Right valve flattened or slightly concave. Umbones inconspicuous, slightly incurved, anterior. Lunule very small, linear-lanceolate. Escutcheon sublinear, its outer margin strongly carinated. Anterior extremity broadly expanding in front of the lunule. Posterior dorsal margin subrectilinear. Strong submarginal carinae developed in both valves, slightly wider in the left than in the right valve. A very broad but shallow depression in front of the carina, which contracts the margin and gives to the posterior part of the shell an alar aspect. Base arcuate. Edge of flattened right valve turned backward at the margin in order to coincide with the incurved overlapping edge of the convex left valve. Surface sculptured with concentric growth lines that are strongest anteriorly and on the posterior rostrum. Anterior area—between one-quarter and one-third of the entire valve—differentiated in the right valve by the much stronger incremental

sculpture and, in the left, by the less feeble incrementals and the slight but abrupt depression, which is marked chiefly by a sharp break in the growth lines. Radial sculpture absent or obsolete in the convex valve; in the flattened right valve about 11 sharp, irregular, and often bifurcating sulci in the exterior prismatic layer, not radiating directly from the umbones but originating along the dorsal submargin as well, though largely obsolete on the dorsal half of the valve. Ligament and resilium internal, partly separated in the left valve by an incipient shelly ridge; resilial pit in left valve buttressed by a low laminar elevation along the dorsal half of its anterior margin. Hinge of right valve bearing 2 cardinals—a very prominent, roughly hatchet-shaped tooth, and behind it and on the other side of the resilial pit a less elevated, obliquely produced, inverted V-shaped ridge; dentition in the left valve reduced to a low laminar buttress on the anterior side of the resilial pit and, in adults, often confounded with it. Margin just in front of umbones strongly incurved and bearing a heavy flange. Adductor muscle impressions equal, irregularly rotund, well up toward the dorsal margin. Pallial line punctate, not sinuated, extending but little in front of the medial horizontal.

*Pandora arenosa* Conrad is the smallest representative of the genus within the area under discussion. It is lower both relatively and absolutely than other members of the subgenus, and it has a less concave, more nearly rectilinear, posterior, dorsal margin.

Dimensions of figured topotypes: Double valves, height 8.5 millimeters, width 16.6 millimeters, diameter 3.2 millimeters. Left valve of another individual, height 8.0 millimeters, width 14.5 millimeters, diameter 2.6 millimeters.

Figured topotypes from Yorktown, Va. (the right and left valves of one individual and the left valve of a second individual): U. S. Nat. Mus. 325505.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; 1 mile northeast of Suffolk, Nansemond County. Rare.

Outside distribution: Pliocene, Caloosahatchee marl, Shell Creek, Fla. Recent, Hatteras to Yucatan in 15 to 124 fathoms.

***Pandora* (*Kennerlia*) *dalli* Gardner, n. sp.**

Plate 10, figures 21, 24, 26

Shell of medium size, inequivalve, inequilateral, rather strongly compressed, concavo-convex, slightly flexuous, alate. Umbones very low, inconspicuous, the apices perforate in the type, set about one-quarter of the length back from the anterior margin. Lunule not defined. Escutcheon linear-lanceolate, very much elongated, strongly rostrate on its outer margin. Anterior extremity broadly rounded. Posterior dorsal margin slightly concave. Ventral margin curved wing-like from the arched anterior end up to the dorsal line.

Submarginal posterior rostrum very pronounced, slightly wider and less strongly angulated in the left valve than in the right, thrown into sharp relief in the latter by the broad depression in front of it. Anterior area not differentiated in the right valve; in the left it constitutes between one-quarter and one-third of the entire valve and is outlined by a very slight but abrupt depression, which is more pronounced ventrally, and by a sudden break in the direction of the growth lines. Incremental sculpture strongest on the anterior area and the posterior rostrum. Radial sculpture confined to external prismatic layer of the right valve, which is unfortunately badly decorticated. Ligament and resilium internal, attached in the right valve between the two cardinals; in the left, produced obliquely backward and largely concealed by the overhanging dorsal margin. Hinge of right valve bears a prominent hatchet-shaped process, and behind it, on the other side of the resilial pit, a somewhat lower, obliquely produced dental ridge; anterior edge of the resilial pit raised to form an amorphous denticle; anterior dorsal margin beveled in the right valve; in the left valve it is slightly convex on its outer border and modified into a conspicuous flange on its inner. Adductor muscle impressions slightly depressed—the posterior a little smaller and more rotund than the anterior. Pallial line obscure, not sinuous, punctate, about two-thirds the way down from the beaks toward the ventral margin.

Dimensions of holotype: Height 11.1 millimeters, width 19.8 millimeters, diameter 2.9 millimeters.

Holotype, the right and left valves of a single individual and paratype: U. S. Nat. Mus. 325503.

Type locality: One-quarter of a mile below Jones Point, Essex County, Va.

*Pandora dalli* n. sp. is most closely related to *P. arenosa* Conrad. It is larger, however, and more compressed, less strongly inequivalve, and relatively higher; the dorsal line is gently concave instead of subrectilinear, as in Conrad's species; the margin is not abruptly contracted in front of the keel; the muscle impressions are larger; and the pallial line is less distant from the ventral margin. From *P. (Clidiophora) crassidens* Conrad, which it most closely resembles in general outline, it is separated by the absence of a left anterior cardinal.

Distribution: Virginia: Miocene, St. Marys formation, a quarter of a mile below Jones Point, Essex County.

*Pandora (Kennerlia) naviculoides* Gardner, n. sp.

Plate 10, figures 22, 23

Only the left valve is known. Shell rather heavy, the valve strongly inflated, alar in outline; width roughly twice the height. Umbones set back from the anterior margin, about one-quarter of the total length, very low, perforate in the type; umbonal region in-

curved and flattened for some distance ventral to the apices. Lunule not developed. Escutcheon linear-lanceolate, strongly angulated on its outer margin. Anterior end short, the dorsal margin sloping rather gently, the lateral margin obtusely truncate. Posterior dorsal margin concave and somewhat distorted. Ventral margin curved winglike to the posterior rostrum. Rostrum strongly defined by the sharpness of the angle and thrown into relief by the depression of the valve and the contraction of the margin in front of it. Anterior area differentiated only by a break in the growth lines. Incremental sculpture fine, irregular, with no conspicuous stages. Ligament and resilium internal; resilial pit cuneiform, obliquely produced posteriorly, and largely concealed by the overhanging escutcheon. No cardinals developed. Margin in front of umbones heavily calloused and bearing on the inner surface a heavy flange; convex and cordate on the outer surface and simulating a lunule. Anterior adductor muscle impression sunken, rotund, well up under the dorsal margin, and about halfway between the umbones and the anterior lateral margin; posterior adductor scar obscure, halfway down the posterior dorsal margin. Pallial characters obliterated.

Dimensions of holotype: Height 8.9 millimeters, width 16.6 millimeters, convexity 4.1 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325504.

Type locality: Neills Eddy Landing, Columbus County, N. C.

*Pandora naviculoides* n. sp. is the most convex of the Tertiary east coast species. *P. arenosa* Conrad, which most nearly approaches it in outline, is smaller and is not only much less scoop-shaped but also has a much straighter dorsal margin and a less conspicuous keel. The escutcheon does not overhang the cavity, as in the more inflated species, and a low but distinct cardinal tooth is developed near the anterior margin of the resilial pit.

Distribution: North Carolina: Pliocene, Waccamaw formation, Neills Eddy Landing, 3 miles north of Cronly, Columbus County. The type is unique.

#### Subgenus CLIDIOPHORA Carpenter

1864. *Clidiophora* Carpenter, Zool. Soc. London Proc., p. 596.

Type by original designation: *Clidiophora claviculata* Carpenter. Lower California to Panama.

The diagnostic feature of the group is the much produced posterior dental lamina, developed in both the right and the left valve. There is also a partial calcification of the cartilage. The shells are mostly of moderate size, relatively compressed, and rather short.

*Pandora (Clidiophora) crassidens* Conrad

Plate 10, figures 17, 18

1838. *Pandora crassidens* Conrad, Fossils of the medial Tertiary of the United States, p. 2, pl. 1, fig. 2.

1863. *Pandora crassidens* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 572.  
 1867. *Cleidiophora crassa* Conrad, Am. Jour. Conchology, vol. 3, p. 269. (Lapsus.)  
 1903. *Pandora (Clidiophora) crassidens* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1519.  
 1904. *Pandora (Clidiophora) crassidens* Conrad. Glenn, Maryland Geol. Survey, Miocene, p. 357, pl. 95, figs. 1, 2.  
 1932. *Pandora (Clidiophora) crassidens* Conrad. Mansfield, Florida Geol. Survey Bull. 8, p. 73, pl. 12, figs. 4, 7.

Shell perlaceous, concentrically wrinkled; the large valve extending much beyond the posterior base of the lesser; anterior side very short, margin widely subtruncate; posterior obtusely rounded inferiorly, terminating above in a very short and obtuse rostrum; dorsal submargin of the larger valve with 2 approximate carinae; lesser valve with only one distinct carina placed very near the margin; anterior cardinal tooth of the larger valve very long, thick, and slightly oblique, the posterior one very near the dorsal line, sulcate or fosset-shaped; the middle one short and linear; in the flat valve, two oblique, very thick and prominent teeth, anterior to which is a shallow groove, bounded anteriorly by a rudimentary linear tooth; muscular impressions impressed; pallial impression punctate.

Locality, James River, near Smithfield, Va.

This species is very rare; I formerly referred it to the recent *P. trilineata*, but it differs greatly in the teeth and also in having the valves very unequal, the superior valve being slightly concave and the lower half of the inferior valve inflated, giving it a capacious interior. Say remarks of the *trilineata* that there is not much difference in the convexity of the valves.—Conrad, 1838.

Conrad has apparently considered the raised margin of the resilial pit as the left posterior cardinal. The young of *P. crassidens* are relatively lower and more alate in outline than the adults. They are not, however, so slender and winglike as in *P. tuomeyi*, nor are they so thin or so compact in texture. The tendency toward an impressed radial striation in the right valve is very much stronger in the *P. crassidens* s. s. and constitutes one of the best criteria for the separation of the young of the species from the very similar adults of the subspecies. The subspecies *prodromos* is shorter and more quadrate than *crassidens* s. s., with a more concave dorsal margin and more of a flip to the posterior dorsal extremity.

*P. crassidens* is rare in the *Ecphora* zone of the Choctawhatchee formation in Florida.

Distribution: Virginia: Miocene, Yorktown formation, 5 miles northeast of Smithfield and at Smithfield, Isle of Wight County; Sycamore, Southampton County; 1½ miles northeast of Suffolk and 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, 6 to 7 miles below Rocky Mount, 15½ miles above Bells Bridge, and ½ mile above Bells Bridge over the Tar River, Edgecombe County; 6 miles below Greenville and 6¾ miles below Greenville (at Tafts Landing), Pitt County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County.

Outside distribution: Miocene, St. Marys formation, Cove Point and St. Marys River, Md. Choctawhatchee formation, upper bed of Alum Bluff (on the Apalachicola River), Calhoun County, Fla.

*Pandora (Clidiophora) crassidens majorina* Gardner, n. subsp.

Plate 10, figures 25, 28

The shell attains a size double that of the average *Pandora crassidens*; roughly rectangular in outline; the right valve flat, the left valve moderately compressed. Umbones anterior, subterminal. Lunule absent. Escutcheon linear-lanceolate, wider in the left valve than in the right, strongly angulated on its outer border. Anterior margin of valve broadly rounded to subtruncate. Posterior lateral margin subtruncate, rounding evenly into the base. Dorsal margin slightly concave. Submarginal carina rather narrow, emphasized, particularly in the right valve, by the shallow sulcus below it and extending from the umbones to the posterior lateral margin. Differentiation of anterior area less feeble in left valve than in right; area marked by a change in the direction of the growth lines—most obvious in the contour of the base line—and by the abrupt obsolescence of the resting changes. External surface sculptured with fine, irregular, discontinuous, incrementals and, in the older forms, undulated by the pronounced resting stages; a radial sculpture of faintly impressed, more or less dendritic sulci developed in the external, prismatic layer of the right valve and sometimes discernible on eroded surfaces in the left. Ligament internal; lodged in the right valve between the middle and posterior cardinals; surface of attachment in the left valve bilobed, produced obliquely backward and more or less concealed by the overhanging dorsal margin. Dentition of right valve consists of a very heavy, hatchet-shaped, middle cardinal; a linear, anterior cardinal in front of it; and at an equal distance behind it, an obliquely produced, cuneiform cardinal. Dentition of left valve limited to an anterior dorsal process—heavy, rude, and expanded dorsally into a wide flange—and a low, sublinear, posterior process placed at the anterior edge of the resilial pit, and in the adults fused with it. Inner surface of anterior margin in front of the anterior cardinal usually planed off so that all the concentric layers that make up the shell are exposed. Adductor impressions sunken—the anterior subrotund and rather high, the posterior vertically elliptical and higher than the anterior. Pallial line punctate, only moderately distant from the base.

Dimensions of holotype: Height 37.8 millimeters, width 59.6 millimeters, semidiameter (left valve) 8.2 millimeters.

Holotype, U. S. Nat. Mus. 325501; paratype, U. S. Nat. Mus. 325500.

Type locality: Holotype, Halifax on Quankey Creek, Halifax County, N. C.; paratype, Sycamore, Southampton County, Va.

*Pandora crassidens majorina* seems to be something more than merely the gerontic phase of *P. crassidens* Conrad. The diagnostic characters are the much

heavier and larger shell and the conspicuous flange borne on the left anterior cardinal. The incipient flange in some individuals referable to *P. crassidens* s. s. and more frequently in the closely related Recent *P. gouldiana* Dall indicates that this character is not of specific value.

Distribution: Virginia: Miocene, Yorktown formation, Madelys Bluff on the Meherrin River and Sycamore, Southampton County.

North Carolina: Miocene, Yorktown formation, Halifax on the Roanoke River, Halifax County; Shiloh Mills on the Tar River, Edgecombe County.

***Pandora (Clidiophora) prodromos* Gardner and Aldrich**

Plate 11, figures 2, 3, 11, 12

1919. *Pandora (Clidiophora) prodromos* Gardner and Aldrich, Acad. Nat. Sci. Philadelphia Proc., p. 44, pl. 4, figs. 9, 11, 12, 14.

Shell of moderate dimensions, rather heavy, compressed, inequivalve, strongly inequilateral, subquadrate in outline. Umbones very low and inconspicuous, often perforate, strongly anterior. Lunule not developed. Escutcheon persists to the extremity of the posterior dorsal margin and is sublinear and sharply delimited. Anterior extremity broadly rounded. Posterior extremity quite squarely truncate. Dorsal margin feebly concave. Ventral margin broadly arcuate. Submarginal carina outlined in the right valve by a linear sulcus and in the left by a subacute ridge. Anterior area very obscurely differentiated, occupying approximately one-third of the entire valve. Radial sculpture not developed. Incremental sculpture somewhat undulatory on the early portion of the valve, laminar and crowded toward the ventral margin. Ligament internal; lodged in the right valve between the middle and posterior cardinals and, in the left valve, in a bilobed pit posteriorly produced along the dorsal margin. Hinge dentition robust; anterior cardinal of right valve almost entirely obsolete; middle cardinal elongate, rhombic, strongly and abruptly elevated. Posterior cardinal compressed, elongate-cuneate, wedging out dorsally. Anterior cardinal of left valve, which extends from the apex of the umbones to the anterior adductor scar, is uniformly elevated and widens slightly toward the umbones. Posterior cardinal linear, inconspicuous, outlining the anterior margin of the resilial pit. Adductor impressions small, slightly sunken, irregularly rotund, placed well up toward the dorsal margin. Pallial line punctate, broadly arcuate, remote from ventral margin.

Dimensions of holotype: Height 21.0 millimeters, width 33.0 millimeters, diameter 6.0 millimeters.

Holotype, double valves of a single individual: U. S. Nat. Mus. 325499.

Type locality: Yorktown, York County, Va. Yorktown formation.

The species was described in order to bring out the

close relationship that apparently exists between the Tertiary Pandoras of the east coast and those of the Recent. In the Recent the subgenus *Clidiophora* is represented south of the Hatteras axis by the delicate, alate little form, *Pandora trilineata* Say. The northern analog, *P. gouldiana* Dall, is larger, heavier, and rudely rectangular in outline. The differences between the northern and southern analogs have apparently been inherited from their Tertiary precursors, *P. tuomeyi* of the Duplin and Waccamaw faunas and *P. prodromos* of the Yorktown. *P. prodromos* is a little higher relatively than *P. gouldiana* Dall, and the posterior margin in it is not so sharply constricted below the submarginal keel. The dentition of the Tertiary species is very much heavier than that of the Recent. The middle and posterior cardinals of the right valve and the anterior cardinal of the left are, in *P. gouldiana* Dall, compressed into little more than linear ridges, whereas in *P. prodromos* they are decidedly heavy and robust. *P. prodromos* is neither so large nor so heavy, however, as the coexistent *P. crassidens* Conrad; it shows no trace of the linear radial sculpture that characterizes *crassidens*, and the dorsal portion of the anterior cardinal of its left valve is not expanded into a well-defined flange as in Conrad's species.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; 1½ miles north of Suffolk, 1½ miles east of Suffolk, 1 mile northeast of Suffolk, 1 mile west of Suffolk, and ½ mile below the waterworks dam at Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, Tar Ferry on Wicaccan Creek (opposite Harrellsville), Hertford County.

Collections: United States National Museum, Johns Hopkins University, and Academy of Natural Sciences of Philadelphia.

***Pandora (Clidiophora) tuomeyi* Gardner and Aldrich**

Plate 10, figure 27; plate 11, figures 9, 10

1856. *Pandora trilineata* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 76, pl. 20, fig. 13. Not *P. trilineata* Say, 1822.

1903. *Pandora (Clidiophora) trilineata* Say (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1519.

1919. *Pandora (Clidiophora) tuomeyi* Gardner and Aldrich, Acad. Nat. Sci. Philadelphia Proc., p. 45, pl. 4, figs. 8, 10, 13.

Shell of medium size, rather thin, transversely alate in outline, slightly flexuous, compressed, inequivalve, but only to a slight degree; strongly inequilateral. Umbones very low, the apices usually perforate, strongly anterior but not terminal. Lunule absent. Escutcheon sublinear, almost as long as the posterior dorsal margin, strongly angulated on its outer border. Anterior end of valve rounded or obtusely pointed. Posterior dorsal margin gently concave; submarginal carinae very sharp, wider and more depressed posteriorly in the left valve than in the right. Ventral margin curved winglike from the anterior expansion to the posterior

rostrum; margin in front of rostrum contracted in left valve by the anterostral depression. Right carina outlined by a linear sulcus. Anterior area between one-third and one-half the entire valve, differentiated only in the left valve and then merely by a somewhat obsolete, linear sulcus, and by the abrupt upcurving of the growth lines toward the front. Incremental sculpture fine, irregular, often discontinuous, with no very pronounced resting stages. Radial sculpture usually absent even in the right valve. Ligament internal; lodged in the right valve between the middle and posterior cardinals and, in the left valve, in a bilobed pit, obliquely produced beneath the dorsal margin. Hinge dentition moderately robust; anterior cardinal of right valve obsolete; middle cardinal compressed, rhomboidal, or hatchet-shaped; posterior cardinal compressed, obliquely produced, often acutely pointed medially or ventrally; anterior cardinal of left valve a moderately prominent ridge of uniform elevation that extends from the umbones to a point just dorsal to the medial line of the anterior adductor; posterior tooth linear, inconspicuous, merely the upraised anterior margin of the resilial pit. Adductor muscle impressions slightly sunken, irregularly rotund. Pallial line punctate, non-sinuuous, nearer the base anteriorly than posteriorly.

Dimensions of holotype, a left valve: Height 9.5 millimeters, width 21.0 millimeters, convexity 2.0 millimeters. Paratype, an incomplete right valve: Height 11.0 millimeters, convexity 1.5 millimeters.

Holotype (a left valve) and paratype (an incomplete right valve): U. S. Nat. Mus. 325502.

Type locality: Walkers Bluff on the Cape Fear River, Bladen County, N. C.

*Pandora tuomeyi* is confused in the old collections with the Recent *P. trilineata* of Say, a rather smaller, relatively lower species, more tapering in outline posteriorly. The chief difference, however, is in the dentition. In general, the cardinals of the Recent species are more compressed, more produced, and more sharply cut; in particular, the inner surface of the right valve of the Tertiary form, in front of the middle cardinal, is not thickened but is often feebly channeled; the middle cardinal is hatchet-shaped or rhomboidal and is shorter than the elevated laminar tooth of *P. trilineata*; the posterior cardinal is shorter, heavier, and less uniform in elevation, and the inequality between the two right cardinals is much more marked in the fossil than in the Recent species. In the left valve the resilial pit in *P. tuomeyi* is broader and less produced, and the upraised anterior margin is shorter and less sharp; the left cardinal in *P. trilineata* has strongly defined margins, bears a flange on the dorsal half of its inner surface, and terminates ventrally near the dorsal end of the anterior adductor impression; the anterior cardinal of *P. tuomeyi*, on the other hand, suggests much more strongly a kinship to the subgenus *Kenner-*

*lia*; its anterior limit is often ill defined, and the hiatus between such a tooth and the incurved and calloused inner surface of the anterior margins of *Kennerlia* is not great; the cardinal in *P. tuomeyi*, furthermore, is not expanded dorsally into a flange and is placed farther forward so that its ventral termination is at the medial line of the adductor impression.

The young of *Pandora crassidens* s. s., though similar in dentition, are relatively higher, less alate, heavier, and less compact in shell texture, and show a stronger tendency toward a radial sculpture in the right valve. The individual selected as the type is unusually wide.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; 1½ miles north of Suffolk, 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, 1 mile west of Suffolk, and ½ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, Tar Ferry on Wicaco Creek (opposite Harrellsville), Hertford County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County.

Outside distribution: Miocene, Duplin marl, Darlington, Darlington County, S. C.

#### *Pandora (Clidiophora) trilineata* Say

Plate 11, figure 7

1822. *Pandora trilineata* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 261.  
 1830. *Pandora trilineata* Say, American conchology, pl. 2, and unpaginated text.  
 1842. *Pandora trilineata* Say. Conrad, Nat. Inst. Promotion Sci. Proc., 2d Bull., p. 190.  
 1886. *Pandora (Clidiophora) trilineata* Say. Dall, Harvard Coll. Mus. Comp. Zoology Bull., vol. 12, p. 312.  
 1886. *Pandora (Clidiophora) floridana* (Dall ms.). Dall, idem, p. 312.  
 1889. *Pandora (Clidiophora) trilineata* Say. Dall, U. S. Nat. Mus. Bull. 37, p. 68.  
 1902. *Pandora (Clidiophora) trilineata* Say. Dall, U. S. Nat. Mus. Proc. 1264, vol. 24, p. 511, pl. 31, fig. 4.  
 1903. *Pandora (Clidiophora) trilineata* Say (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1519.  
 Not *Pandora trilineata* Say. Tuomey and Holmes, 1856.  
 Not *Pandora trilineata* Say of New England authors to 1870=*P. gouldiana* Dall.

Shell white, subpellucid, concentrically wrinkled; hinge placed at the posterior slope, which is very abrupt, and forming a very considerably obtuse angle with the hinge margin; hinge margin concavely much arquated, the surface flattened, and bounded on its edges by two elevated approximate lines, originating at the beak and continued to the tip, which is rostrated; rostrum ascending; a distinct, slightly impressed line originates at the beaks and passes to the middle of the basal margin; right valve a little convex; left valve flat.

Length ⅝ inch, greatest breadth 1⅞ inch.

Inhabits the American coast.

Cabinet of the Academy and Philadelphia Museum.

I first discovered a single valve of this curious shell several years ago at Great Egg Harbor, on the shores of New Jersey; since which, I have found two or three others on the coast of Georgia and east Florida, so that it may be said to inhabit our whole southern and middle coast. The inner edge of the hinge margin of one valve closes over that of the other.—Say, 1822.

*Pandora trilineata* Say has been reported from a number of localities in both the Duplin and the Waccamaw formations. All the Carolinian individuals examined, however, both in the material under study and in the available reference collections, show specific differences and have been assigned to *P. crassidens* and its subspecies *tuomeyi*.

Superfamily POROMYACEA

Family VERTICORDIIDAE

Genus VERTICORDIA (Searles Wood ms.) Sowerby

1844. *Verticordia* (Searles Wood ms.) Sowerby, Mineral conchology, vol. 7, pl. 639.

Type by monotypy: *Verticordia cardiiformis* Sowerby. Pliocene (Coralline Crag) of Suffolk, England.

Shell nacreous, equivalve, usually though not always small, and suborbicular. Umbones subcentral or anterior, prominent, prosogyrate, and often strongly involute. Lunule false, somewhat depressed. External sculpture strongly radial. Ligament submarginal, continued to apices of umbones; internal cartilage supported by lithodesma. Strong subumbonal cardinal usually present in the right valve. Posterior lateral developed in one group. Left valve often devoid of true teeth, sometimes developing a posterior lateral, more rarely a subumbonal cardinal; valvular margins somewhat modified to function as laterals. Adductor impressions small, often obscure. Pallial line simple or feebly sinuous. Inner margins denticulated by the radiating costae.

*Verticordia* has, as might be inferred, only a meager representation in the east coast Tertiary deposits. The genus is characteristically a deep-water form, one species occurring at a depth of almost 1,700 fathoms, whereas the Miocene and Pliocene of Virginia and North Carolina are essentially shallow-water deposits.

Subgenus TRIGONULINA D'Orbigny

1846. *Trigonulina* D'Orbigny, in De la Sagra, Histoire physique, politique et naturelle de l'île de Cuba; Mollusques, vol. 2, p. 291.

Type by monotypy: *Trigonulina ornata* D'Orbigny. Recent in the West Indies.

*Trigonulina* is set apart from *Verticordia* s. s. by the less regularly spaced radials, the deeper lunule and ligament groove, and the greater development of the dental process in the right valve and of the dorsal lamina in the left.

*Verticordia (Trigonulina) rogersi* Gardner, n. sp.

Plate 10, figures 12, 13

Shell very small, moderately inflated, transversely oval, inequilateral. Anterior end expanded in front of the lunule. Posterior a parabolic curve. Umbones subcentral, acute, prosogyrate. Lunule minute but deeply excavated. External sculpture very conspicuous; 7 subequal, strongly elevated, moderately broad,

evenly rounded radials on the anterior and medial parts of the valve, separated mostly by narrower interspaces but tending to widen posteriorly; 2 similar radials on the posterior submargin separated by triple or quadruple interspaces from those in front of them; entire external surface sculptured with microscopic radial granulation. Ligament inset, linear, continued under the apices of the umbones. Subumbonal cardinal of right valve short, moderately stout. Right posterior margin grooved down to the median horizontal for the reception of the elongated, posterior lateral of the left valve. Hinge of left valve not definitely known, but bearing, in all probability, the normal *Trigonulina* dentition. Adductor impressions and pallial line obscure. Margins strongly denticulated by external costae.

Dimensions of holotype: Height 2.5 millimeters, width 2.8 millimeters, convexity 0.7 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325506.

Type locality: Three quarters of a mile northeast of Smithfield, Isle of Wight County, Va.

*Verticordia rogersi* n. sp. is differentiated from the entire group of forms closely allied to the *V. emmonsii* by its smaller size, its much more inflated valves, its transversely oval outline, and its relatively broad and rounded radials, which are separated by narrower interradians. The radials are, furthermore, less numerous than in *V. emmonsii* Conrad, though, unlike those of the latter, they corrugate the entire valve with the exception of a smooth area in front of the posterior submargin. The hinge is decidedly less vigorous than in the other Tertiary Trigonulinas, though the difference is of degree rather than of kind.

The species is known only from two right valves, both collected from the Yorktown marls along the James River, in Isle of Wight County.

The species was named in honor of W. B. Rogers, the eminent director of the Geological Survey of Virginia from 1835 to 1842 and one of the founders and the president of the Massachusetts Institute of Technology from 1862 until his death in 1882.

Distribution: Virginia: Miocene, Yorktown formation.  $\frac{3}{4}$  mile northeast of Smithfield (on Mrs. Chalmers' farm; type locality) and Bennis Church,  $\frac{1}{4}$  mile from the old church, Isle of Wight County; 1 mile west of Suffolk, Nansemond County.

*Verticordia (Trigonulina) emmonsii* Conrad

Plate 10, figure 14

1858. *Verticordia* sp. Emmons, North Carolina Geol. Survey Rept., p. 286, fig. 206.

1862. *Verticordia emmonsii* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 289.

1863. *Verticordia emmonsii*, Conrad, idem, p. 579.

1903. *Verticordia (Trigonulina) emmonsii* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1512.

Conrad gave no description but merely affixed a name to Emmons' unnamed figure.



Shell with 9 anterior and 2 posterior widely separated ribs, the surface covered with a coarse granulation arranged in radial lines. Longitude 6.5, altitude 5.3, diameter 2.5 millimeters. The teeth are strong, and the sinuation of the pallial line [is] conspicuous though shallow.

This is the largest of the species of this division of the genus and with much the most conspicuous granulation. From the recent *V. (T.) ornata* Orbigny it is distinguished by its size and by the fact that the recent species has such minute granulation that it is difficult to make it out.—Dall, 1903.

Shell nacreous, small, compressed, subcircular, inequilateral. Umbones subcentral, the apices acute and prosogyrate. Margin directly in front of umbones deeply excavated by false lunule. Escutcheon absent. Anterior end somewhat expanded. Posterior margin a parabolic curve from the umbones to the arcuate base. External sculpture conspicuous; nine subequal, strongly elevated, linear lirae radiating from the umbones to the anterior semicircle in gentle curves, convex posteriorly; interradians no wider than the radials anteriorly, broadening to more than double their width toward the medial portion of the valve; a single isolated radial more feeble than any of those in front of it a little less than halfway between the median vertical and posterior margin; posterior submarginal radial of normal strength. Entire external surface covered with microscopic radial granulation; incrementals sometimes discernible on the summits of the costae. Ligament deeply inset, continued to the apices of the umbones. Right subumbonal cardinal moderately stout, tubercular; posterior dorsal margin sulcated almost to the base to receive the elongated lateral of the left valve; lunular margin of left valve thickened to function as a denticle; no left cardinal developed. Adductor impressions small. Pallial line conspicuously distant from margin; sinus very shallow. Margin strongly denticulated by external costae.

Dimensions of figured specimen: Height 6.0 millimeters, width 6.8 millimeters.

Figured specimen, a right valve: U. S. Nat. Mus. 145332.

Type locality: North Carolina.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well, 1½ miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin marl, 5 miles southeast of Mayesville, Sumter County, S. C. Pliocene, Caloosahatchee marl, Caloosahatchee River, Fla.

*Verticordia (Trigonulina) chowanensis* Gardner, n. sp.

Plate 10, figures 11, 15

Shell nacreous, obliquely elliptical, greatly compressed. Umbones subcentral, acute, prosogyrate; margin directly in front of umbones deeply excavated by false lunule. Escutcheon absent. Anterior end evenly expanded in front of lunule. Posterior end a parabolic curve from the umbones to the arcuate base. External sculpture radial, very conspicuous; nine

gently curved, narrow, much elevated costae on the anterior half of the valve; intercostal spaces fully twice the width of the costals except on the extreme anterior margin; 2 proximate radials, slightly less prominent than those in front of them, midway between the median vertical and posterior margin; posterior marginal and submarginal costae of normal strength; radial granulation and incrementals microscopic. Interior of only the right valve is known. Hinge similar to that of *V. emmonsii* Conrad—a deeply inset ligament continued to the apices of the umbones, a moderately stout subumbonal cardinal, a deeply grooved dorsal margin for the reception of the left lateral, and a lunular margin modified to assist in the dentition. Adductor muscle impressions small, rather obscure. Pallial line conspicuously distant from margin; feebly sinuated. Margins strongly denticulate.

Dimensions of holotype: Height 5.1 millimeters, width 5.6 millimeters, convexity, 1.0 millimeter.

Holotype, a right valve: U. S. Nat. Mus. 325507.

Type locality: Colerain Landing on the Chowan River, Bertie County, N. C. Yorktown formation. Only the type and topotypes are known.

*Verticordia chowanensis* differs from *V. emmonsii* Conrad in the more compressed, obliquely elliptical outline, the more uniform and somewhat closer spacing of the costae on the anterior half of the shell, the two ribs (instead of only a single rib) on the midposterior half, and the presence of both a marginal and a submarginal posterior rib. The group of forms closely allied to *V. emmonsii* Conrad is peculiar in that each locality exhibits a perfectly well defined local variation. The material is, unfortunately, so meager that it is difficult to know just how much value should be placed on these mutant characters. Until intergrading individuals have been reported, it seems better, however, to keep the forms quite distinct.

#### Order TELEODESMACEA

#### Superfamily ASTARTACEA

#### Family ASTARTIDAE

#### Genus ASTARTE Sowerby

1816. *Astarte* Sowerby, Mineral conchology of Great Britain, vol. 2, p. 85, pl. 137.

Type by original designation: *Venus scotica* Maton and Rackett = *Pectunculus sulcatus* Da Costa. Recent off the British coast.

#### *Astarte symmetrica* Conrad

Plate 12, figures 1-4

1834. *Astarte symmetrica* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 134.

1840. *Astarte symmetrica* Conrad, Fossils of the medial Tertiary of the United States, p. 44, pl. 21, fig. 7.

1863. *Astarte symmetrica* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.

1894. *Astarte symmetrica* Conrad. Whitfield, U. S. Geol. Survey Mon. 24, p. 54, pl. 8, figs. 1, 2.  
 1903. *Astarte symmetrica* Conrad (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1488.  
 1904. *Astarte symmetrica* Conrad. Glenn, Maryland Geol. Survey, Miocene, p. 352.

Shell subtriangular, convex, with concentric impressed lines or undulations; anterior, posterior, and basal margins regularly rounded; apex rather prominent, acute, nearly central; lunule concave, ovate-acute; cardinal teeth very prominent, striated; margin crenulated. Length three-quarters of an inch, height rather less.

Locality, Yorktown, Va.

This species may be distinguished from *A. vicina* Say by the lunule, which is much less excavated; and the shell is also less convex than in the latter species.—Conrad, 1834.

The outline is usually subrotund rather than subtriangular, and the valves are less convex than might be surmised from Conrad's unmodified adjectives. Both the lunule and the escutcheon are narrow and not very conspicuously defined. The teeth are normal for the genus—an obsolete anterior cardinal, a prominent, sub-trigonal middle cardinal, and a laminar posterior cardinal in the right valve; a vigorous anterior, subequal middle, and an obsolete posterior cardinal in the left valve.

*Astarte symmetrica* Conrad is the most nearly discoidal of all the coexistent *Astartes*. *A. coheni* Conrad, which sometimes approaches it, is larger, relatively higher, as a rule, and exhibits narrower and more prominent umbones and a much more deeply channeled concentric grooving. *A. arata* Conrad, which has been erroneously used as a synonym of *A. symmetrica*, is decidedly higher, more convex, and sculptured with an irregular incremental undulation that is supplemented with faint but distinct secondary striations.

Distribution: Virginia: Miocene, Yorktown formation, City Point, Prince George County; Yorktown, York County; Petersburg, Dinwiddie County; a quarter of a mile north of Chuckatuck, Nansemond County.

North Carolina: Miocene, Yorktown formation, 2½ miles northwest of Murfreesboro, near Murfreesboro, and 1½ miles above Murfreesboro on the Meherrin River, Hertford County; Palmyra Bluff, Halifax County; 15½ miles above Bells Bridge over the Tar River, Edgecombe County; 8 to 9 miles west of Greenville, Pitt County; 2 miles northeast of Lizzie, Greene County.

#### *Astarte exaltata* Conrad

Plate 12, figures 5-8

1841. *Astarte exaltata* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 29.  
 1842. *Astarte exaltata* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 8, p. 185.  
 1845. *Astarte exaltata* Conrad, Fossils of the medial Tertiary of the United States, p. 66, pl. 37, fig. 6.  
 1863. *Astarte exaltata* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.  
 1903. *Astarte exaltata* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1489.

1904. *Astarte vicina* Say (part). Glenn, Maryland Geol. Survey, Miocene p. 350.

Obovate, acute, convex; umbo sulcated; apex very prominent; lunule elongated and profound. Height and length equal, ⅝ inch.—Conrad, 1841.

Figured specimens, a right and left valve of different individuals, U. S. Nat. Mus. 325519.

Type locality: Calvert Cliffs, Md.

Shell rather small for the genus but conspicuously heavy. Outline high, rounded-trigonal, inflated. Anterior end concavo-convex, deeply excavated in the lunular region, sharply bowed from the lunule to the base. Posterior dorsal slope steep; lateral margin obscurely truncate. Ventral margin broadly arcuate medially; upturned distally. Umbones subcentral, elevated, rather narrow and somewhat gibbous, and very prominent—the apices acute and prosogyrate. Lunule very wide and deeply sunken. Escutcheon also wide, clearly delimited, coincident in length with the dorsal margin. External surface quite strongly undulated from the umbones to the base; sculpture sharply defined only in the young and on the apices of the umbones. Ligament external, opisthodontic; nymph narrow, bordered dorsally by the angular, ligamentary groove. Hinge plate narrow. Dentition vigorous; anterior cardinal of right valve obsolete; middle cardinal robust, cuneiform; posterior cardinal thin and laminar. Anterior and middle cardinals of left valve divergent on each side of the profound subumbonal socket—the anterior cardinal slightly the shorter and stouter of the two. Posterior cardinal of left valve obsolete or fused with the ligamentary nymph. Muscle impressions distinct—the anterior subrotund or reniform, the posterior rudely quadrate. Pallial line entire. Inner margins strongly denticulated.

One of the best distinctions of *Astarte exaltata* Conrad is the character implied in its name. Its elevated umbones, together with the stoutness of the small valves, are usually sufficient to isolate the species. *A. roanokensis* Gardner, the only other form that equals it in the degree of elevation of the umbones, is decidedly larger and has more strongly arcuate basal and lateral margins and a less strongly undulated external surface. *A. arata* Conrad and the closely allied *A. stephensoni* Gardner are also larger, decidedly more oblique, and less profoundly excavated in the lunular region.

Distribution: Virginia: Miocene, Yorktown formation, mouth of Baileys Creek, Prince George County; Claremont Wharf, Schmidts Bluff, 8½ miles below Claremont Wharf, and near the mouth of Sunken Marsh Creek, Surry County; Zuni, 6½ miles below Zuni, and 7 to 7½ miles below Zuni on the Blackwater River, Isle of Wight County.

North Carolina: Miocene, Yorktown formation, 1½ to 2 miles above Branches Bridge over the Meherrin River, Northampton County.

Outside distribution: Miocene, Calvert formation, Maryland.



*Astarte coheni* Conrad

Plate 12, figure 15

1840. *Astarte coheni* Conrad, Fossils of the medial Tertiary of the United States, p. 43, pl. 21, fig. 5.

1863. *Astarte coheni* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.

1903. *Astarte coheni* Conrad (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1489.

Shell suborbicular, thick, slightly ventricose, equilateral; disks with wide, angulated, somewhat regular undulations; posterior extremity obtusely rounded; beaks prominent, curved forward; lunule large, cordate, very profound; inner margin crenulated.

Locality, Lancaster County, Va.

This species was presented by Dr. Cohen, of Baltimore. The matrix is sand, mixed with a very large proportion of the green grains derived originally from the secondary Green-sand formation.—Conrad, 1840.

*Astarte coheni* Conrad is larger, relatively higher, and more evenly rounded than *A. symmetrica* Conrad. Among the rest of the coexistent species of the group, it is remarkable for the rather compressed valves, the subcentral umbones, and the arcuate ventral and lateral margins. The lunule is only moderately wide and not at all "profound" in the sense in which the lunule of *A. exaltata* is profound. The concentric sulci are deeper, more sharply channeled, and more uniform over the surface of the disk than in any other member of this feebly sculptured group; and the sculpture, combined with an outline suggesting roughly the quadrant of a circle, forms the most valuable diagnostic of the species. The hinge is normal and the inner margin crenate at the resting stages.

Distribution: Virginia: Miocene, Yorktown formation, Petersburg, Dinwiddie County; Cobham Bay, Surry County; 1 mile north of Zuni, Isle of Wight County; Sycamore on the Nottoway River, and  $\frac{1}{4}$  to  $\frac{1}{2}$  mile below Sycamore,  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above the lower Seaboard Railway bridge, and Maddelys Bluff on the Meherrin River, Southampton County; (?) 1 mile northeast of Suffolk and (?) the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

*Astarte roanokensis* Gardner, n. sp.

Plate 12, figures 9, 10

Shell large for the group, not very heavy, elevated and rounded, or somewhat obliquely trigonal in outline. Anterior margin concave in the lunular region, bowed outward in front of the lunule. Posterior dorsal slope very steep and usually exceeding half the total height. Lateral margin rounded or obscurely truncate. Basal margin feebly arched, upturned more strongly and evenly toward the anterior than toward the posterior end. Umbones subcentral, conspicuous by reason of their elevation, their apices acute and prosogyrate. Lunule smooth, rather wide, cordate, and excavated. Escutcheon relatively wide, clearly delimited. External sculpture very feeble, except at the

apices of the umbones, on which the concentric undulations are quite strong and regular. Apical sculpture quickly and abruptly replaced by the irregular and feeble undulation due to the resting stages; a faint secondary striation usually introduced near the ventral margin in the adults; suggestions of faint radials often visible toward the posterior margin. Ligament marginal, opisthodetic; ligamentary nymph sublinear; groove behind it deep. Hinge plate narrow, trigonal. Dentition vigorous. The right valve has an obsolete anterior, a stout, trigonal middle, and a compressed posterior cardinal; the left valve, has subequal anterior and middle cardinals—the latter a little more compressed and produced—and a posterior cardinal fused with the ligamentary nymph; contiguous surfaces of cardinals transversely striate. Posterior dorsal margin of right valve and lunular margin of left beveled to function as laterals. Adductor muscle impressions distinct—the anterior oblong or slightly reniform, the posterior roughly quadrate. Pallial line entire. Inner margins crenate at the resting stages.

Dimensions of a cotype, a right valve: Height 24.4 millimeters, width 23.9 millimeters, convexity 7.2 millimeters. Left valve of another individual: Height 24.2 millimeters, width 23.9 millimeters, convexity 6.5 millimeters.

Type material: 2 cotypes, the right and left valves of different individuals: U. S. Nat Mus. 325523.

Type locality: Halifax, Halifax County, N. C.

*Astarte roanokensis* is remarkable for its narrow, prominent umbones, which, though they range in position from the median vertical to the anterior third, never lose their diagnostic beaklike aspect. The valves are more compressed and usually thinner than in any of the closely related, obliquely trigonal forms, such as *A. stephensoni*, n. sp. *A. roanokensis* occurs in the Yorktown marls along the Nottoway, Meherrin, Roanoke and Tar Rivers, but it is abundant only at the type locality—Halifax, on the Roanoke River, in Halifax County.

Distribution: Virginia: Miocene, Yorktown formation, Sycamore on the Nottoway River,  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County.

North Carolina: Miocene, Yorktown formation, 1 mile above Branches Bridge, Northampton County;  $1\frac{1}{2}$  miles above Murfreesboro, Hertford County; Halifax on Quankey Creek, Mr. Durham's farm,  $\frac{1}{2}$  mile above the Atlantic Coast Line Railroad bridge, and Palmyra Bluff, Halifax County;  $15\frac{1}{2}$  miles above Bells Bridge and  $\frac{1}{2}$  mile above Bells Bridge over the Tar River, Edgecombe County.

*Astarte hertfordensis* Gardner, n. sp.

Plate 12, figures 11, 12, 21

Shell of medium size and thickness, moderately inflated, ovate-trigonal. Anterior end concavo-convex. Posterior end obliquely produced and narrowly rounded; basal margin feebly arcuate, more broadly

and evenly upcurved anteriorly than posteriorly. Umbones prominent, set a little in front of the median line, flattened and pointed at the slightly prosogyrate apices. Lunule elongate-cordate, excavated, slightly wider in the left valve than in the right. Escutcheon lanceolate, slightly wider in the right valve than in the left. External surface smooth except for the concentric undulations of the apices, the irregular and rather ill-defined resting stages—most conspicuous, toward the anterior margin—the faint, discontinuous, concentric striations developed near the ventral and posterior margins, and a feeble suggestion of radials on the posterior half of the shell. Ligament marginal, opisthodontic; nymph linear; groove behind it sharply channeled. Hinge plate heavy. Dentition robust; anterior cardinal of right valve obsolete; middle cardinal stout, trigonal; posterior cardinal greatly compressed, almost laminar. Anterior cardinal of left valve cuneiform; middle cardinal slightly more produced and more compressed than the anterior and separated from it by a deep, triangular, subumbonal socket; posterior cardinal obsolete, fused with the ligamentary nymph; posterior dorsal margin of right valve and lunular margin of left beveled to function as laterals, and received by corresponding grooves in the opposite valve. Adductor impressions of medium size, largely below the median horizontal—the anterior oblong or slightly reniform, the posterior quadrate. Pedal adductor a small rotund depression just dorsal to the upper limit of the anterior adductor. Pallial line entire. Inner margins strongly crenate.

Dimensions of holotype (paired valves): Height 23.0 millimeters, width 25.7 millimeters, diameter 14.4 millimeters.

Holotype: U. S. Nat. Mus. 325526.

Type locality: Murfreesboro, Hertford County, N. C.

*Astarte hertfordensis* s. s. is the most convex of all the obliquely trigonal *Astartes* of the region under discussion, except *A. arata* Conrad, a relatively higher and less inequilateral form. Its nearest relative is probably *A. stephensoni* Gardner, a less inflated and usually less solid shell, with more oblique umbones and, as a rule, noticeably more narrow in the umbonal region.

*A. hertfordensis* Gardner is apparently limited in distribution, for it has been found only in the Yorktown marls in the vicinity of Murfreesboro, in Hertford County.

Distribution: North Carolina: Miocene, Yorktown formation, Watsons Mill on Kirbys Creek, 2½ miles northwest of Murfreesboro, and near Murfreesboro, Hertford County.

*Astarte hertfordensis meherrinensis* Gardner, n. subsp.

Plate 12, figure 18

Shell less inflated and usually less solid than that of *Astarte hertfordensis* s. s. Relative proportions somewhat variable but less so than in the type of the species.

A narrower lunule and escutcheon concomitant with the more compressed valve. Surface sculpture varies somewhat in the extent of the concentric undulations in the umbonal region and in the strength and uniformity of the resting stages. Hinge and adductor characters are normal for the species but vary slightly with the outline of the shell.

Dimensions of the holotype: Height 23.0 millimeters, width 24.8 millimeters, convexity 6.3 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325531.

Type locality: Branches Bridge over the Meherrin River, Northampton County, N. C.

The peripheral individuals of this thinner, flatter, and usually higher subspecific type sometimes approach *Astarte roanokensis* on the one hand, and *A. stephensoni* on the other. The subspecies does not attain, however, the relative height of the form from the Roanoke River, nor are the umbones ever so narrow or so hooked. It is usually a little heavier than *A. stephensoni* and less produced posteriorly, with wider and more nearly erect umbones. The secondary concentric striation is very faint and often obsolete altogether, whereas the posterior rays, which have not been noted in any of the *A. stephensoni*, are often quite distinct; the resting stages are also more uniform in *A. hertfordensis meherrinensis*. The subspecies occurs along the Meherrin River, in both Virginia and North Carolina.

Distribution: Virginia: Miocene, Yorktown formation, 12 to 14 miles below Zuni on the Blackwater River, Isle of Wight County; Maddelys Bluff, 3 to 4 miles above the lower Seaboard Railway bridge, and ½ to ¾ mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County.

North Carolina: Miocene, Yorktown formation. 1½ miles above Branches Bridge, 1 mile above Branches Bridge, Branches Bridge, Northampton County; Watsons Mill on Kirbys Creek, 2½ miles northwest of Murfreesboro, 1½ miles northwest of Murfreesboro, 1 mile above Murfreesboro, and at Murfreesboro, Hertford County.

*Astarte stephensoni* Gardner, n. sp.

Plate 12, figures 16, 17

Shell of medium size, compressed, inequilateral, obliquely trigonal. Anterior end shorter than the posterior, concavo-convex in outline. Posterior end obliquely produced, rounded, or obscurely truncate laterally. Ventral margin feebly arcuate medially, gently upturned distally. Umbones rather narrow. Apices acute, anterior, prosogyrate. Lunule elongate-cordate, smooth, sunken, moderately wide, slightly wider in the left valve than in the right. Escutcheon lanceolate, slightly wider in the right valve than in the left. Surface sculpture well defined only on the apices of the umbones, which are deeply furrowed concentrically; resting stages usually indistinct and unequally spaced; a very fine and irregular secondary striation developed near the ventral margin. Liga-

ment marginal, opisthodontic, mounted on a linear nymph bounded dorsally by an angular groove. Dentition normal. The right valve has an obsolete anterior cardinal, a stout, trigonal middle cardinal, and a laminar posterior cardinal; the left valve, a robust anterior cardinal, and, on the other side of the deep subumbonal socket, an almost equally strong and slightly more produced middle cardinal; left posterior cardinal fused with the ligamentary nymph. Adductor impressions usually distinct—the anterior obliquely oblong or somewhat reniform, the posterior roughly quadrate. Pedal scar a rotund depression just dorsal to the anterior adductor. Pallial line entire, inner margins crenate.

Dimensions of holotype: Height 22.7 millimeters, width 24.2 millimeters, convexity 6.3 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325528.

Type locality: Halifax on Quankey Creek, Halifax County, N. C.

*Astarte stephensoni* is characterized by the compressed valves, obliquely trigonal outline, obliquely directed umbones, and the faint but distinct secondary striation developed near the ventral margin. *A. roanokeensis* Gardner is higher both relatively and absolutely, usually less inequilateral, and more strikingly narrow and excavated in the umbonal region. *A. hertfordensis* s. s. is characterized by the heavy, inflated valves, but the subspecies *meherrinensis* is often quite as compressed, though rarely so thin, as *A. stephensoni*. The latter is quite constantly more produced and more angular posteriorly, usually narrower toward the umbones, and less regularly (though more vigorously) sculptured. The resting stages, which in the species from the Meherrin River are almost always distinctly though not strongly defined and uniform in strength, are in *A. stephensoni* almost or altogether obsolete; the secondary striation, on the other hand, is characteristic of the latter, though not confined exclusively to it.

Certain higher, more rounded, and less inequilateral forms from the vicinity of Murfreesboro have been referred rather dubiously to this species. It is quite possible that they should be given subspecific or perhaps even higher rank, but the imperfect state of preservation of the material makes their exact relationship doubtful.

The species is named in honor of Dr. L. W. Stephenson of the Federal Geological Survey, who stands alone in his detailed and general information on the Upper Cretaceous from Maryland to Texas.

It is remarkable that *Astarte stephensoni*, as well as the two forms to which it is most closely related, should, with the exception of a single occurrence, be confined to the Yorktown marls of southern Virginia and northern North Carolina.

Distribution: Virginia: Miocene, Yorktown formation, mouth of Baileys Creek near its confluence with the James River,

Prince George County; Delaware Park, Delaware, and a quarter to half a mile below Sycamore on the Nottoway River, Southampton County.

North Carolina: Miocene, Yorktown formation, 1½ miles above Murfreesboro on the Meherrin River, Hertford County; Halifax on the Roanoke River, Halifax County.

#### *Astarte arata* Conrad

Plate 12, figures 13, 14

1840. *Astarte arata* Conrad, Fossils of the medial Tertiary of the United States, p. 42, pl. 20, fig. 8.

1863. *Astarte arata* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 577.

1903. *Astarte symmetrica* Conrad (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1488.

Shell ovate-trigonal, convex, with concentric scalariform sulci and fine intermediate striae; lunule very large, ovate, deeply concave; base very regularly arched; posterior extremity subtruncated; margin crenulated.

Locality, near City Point, Va.; rare.—Conrad, 1840.

Shell heavy, relatively inflated, high, rounded, trigonal. Anterior end concavo-convexo. Posterior end with a steep dorsal slope and an obscure lateral truncation. Base line evenly but not strongly arched. Umbones prominent, inflated; apices acute and prosogyrate. Lunule smooth, deeply sunken, elongate-cordate. Escutcheon clearly delimited, moderately wide, lanceolate. Surface sculptured with irregular, concentric undulations—strongest and most regular near the umbones, evanescent ventrally, particularly on the posterior half of the shell. Fine, irregular, discontinuous, concentric striations developed in the adults—most conspicuous near the basal and posterior margins. Ligament external; nymph narrow; ligamentary groove sharply channeled. Dentition vigorous. In the right valve an obsolete anterior cardinal, a stout, triangular middle cardinal, and a laminar posterior cardinal; in the left valve a robust, somewhat cuneiform anterior cardinal, a slightly more compressed middle cardinal, and an obsolete posterior cardinal; posterior margin of right valve and lunular edge of left valve modified to function as laterals. Muscle impressions distinct, more than half their area below the median horizontal. Anterior adductor ellipsoidal or slightly reniform; posterior, semielliptical to rudely quadrate. Pallial line entire. Inner margins crenate.

*Astarte arata* Conrad is heavier and higher, more triangular, and less rotund than *A. symmetrica* Conrad, with which it has been rather unaccountably confused in the synonymies. The lunule is wider and more deeply sunken. The secondary concentric striation, which is apparently a constant character in *A. arata*, has not been noted in any individuals of *A. symmetrica*.

The diagnostic features of *Astarte arata* Conrad are the high, inflated umbones, the irregular wrinkling of the external surface by the growth sculpture, and the very distinct secondary striation. The two species most readily confounded with it are *A. stephensoni*—a relatively lower and more compressed form—and *A.*

*hertfordensis*, n. sp., which is also lower and more feebly, though more regularly sculptured.

Distribution: Virginia: Miocene, Yorktown formation, near the mouth of Baileys Creek, Prince George County; a quarter to half a mile below Sycamore on the Nottoway River, Southampton County.

North Carolina: Miocene, Yorktown formation, Halifax on the Roanoke River, Halifax County.

*Astarte berryi* Gardner, n. sp.

Plate 12, figures 23, 24

Shell relatively large for the genus, thick and heavy, rather strongly inflated, particularly toward the apices of the umbones. Subrotund or transversely oblong. Posterior dorsal slope moderately steep, merging into the rounded or obscurely truncated lateral margin. Anterior end convex in the vicinity of the lunule, bowed out in front of the lunule. Base evenly and rather strongly arched. Umbones subcentral, often a little in front of the median line, moderately prominent; apices acute, turned toward each other. Lunule strongly depressed, elongate-cordate. Escutcheon elongate-lanceolate, well defined by the angulation of the valve and by the abrupt weakening and change in direction of the growth lines. External surface sculptured near the apices of the umbones with strong, rather regular concentric furrows, which quickly broaden and flatten into ill-defined undulations that are most distinct near the anterior margin; secondary, irregular, concentric striations usually present; traces of obscure radials often faintly visible in front of the escutcheon. Ligament marginal, opisthodontic; nymph moderately robust; groove behind it deep and angular. Dentition vigorous. Anterior cardinal of right valve almost altogether obsolete; middle cardinal stout, cuneiform, its distal surfaces transversely striate; posterior cardinal laminar, often broken away. Anterior cardinal of left valve prominent, laterally sulcated, separated from the shorter and more compressed middle cardinal by the wide and deep subumbonal socket; posterior cardinal of left valve almost obsolete; posterior dorsal margin of right valve and anterior lunular margin of left valve beveled to function as laterals. Muscle impressions very distinct, extending but little above the median horizontal. Anterior impression elliptical or slightly reniform. Posterior irregularly oblong to subquadrate. Pedal impression an irregular rotund dent dorsal to the anterior adductor. Pallial line entire. Inner margins strongly crenate at the resting stages.

Dimensions of holotype: Height 25.0 millimeters, width 27.2 millimeters, convexity 8.8 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325533.

Type locality: 2½ miles northwest of Chocowinity, Beaufort County, N. C.

*Astarte berryi* is separated from the obliquely trigonal *A. stephensoni* and *A. hertfordensis*, with its

subspecies *meherrinensis*, by the more rounded outline. The valves are also heavier and the umbones more inflated than in the majority of individuals referable to the latter group of species. In general outline *A. berryi* suggests Conrad's *A. coheni*, though it differs conspicuously in its larger size, heavier and more inflated valves and umbones, and much less sharply defined and uniform concentric sculpture.

I am pleased to name this *Astarte* in honor of Dean Berry, of Johns Hopkins University, who, though best known for his paleobotanical studies on the Cretaceous and Tertiary of the east coast and the Gulf, has collected extensively and most effectively from the faunas of the eastern and southern Tertiary deposits.

*A. berryi* is most abundant in the Yorktown marls of Pitt and Beaufort Counties, N. C., particularly in the environs of Chocowinity, and in the Yorktown at Colerain Landing, on the Chowan River.

Distribution: Virginia: Miocene, Yorktown formation. ½ to ¾ mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County; 1¼ miles north of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1½ miles above Murfreesboro, Mount Pleasant Landing, Hertford County; Colerain Landing, Bertie County; 2 miles below Toddy Station, 2 miles southeast of Tugwell (on Jacobs Branch), 1¼ miles northeast of Farmville, 2½ miles north of Standard, 2 miles west of Greenville (on Harris Mill Run), 1½ miles west of Greenville (on Schoolhouse Branch), 9 to 10 miles south of Greenville, and 1 mile northwest of Galloway Crossroads, Pitt County; 2½ miles northwest of Chocowinity, 1¼ miles northeast of Chocowinity, 1 mile northeast of Chocowinity, Beaufort County; 1 mile north of Castoria, Greene County.

Subgenus *ASHTAROTHA* Dall

1903 (July). *Ashtarotha* Dall, U. S. Nat. Mus. Proc., vol. 26, p. 936.

Type by original designation: *Astarte undulata* Say. Miocene of the middle Atlantic seaboard.

Umbones concentrically sculptured and conspicuously flattened; disk smoother outside of the flattened area; otherwise like *Astarte*.—Dall, 1903.

*Astarte (Ashtarotha) rappahannockensis* Gardner, n. sp.

Plate 12, figures 19, 20

Shell moderately large, heavy, and convex for the section. Rounded trigonal, not strongly inequilateral. Anterior end slightly expanded in front of the lunule, rounding broadly and gently into the base. Posterior dorsal margin descends uniformly and rather rapidly from the umbones almost to the upcurved base line. Lateral margin very short, obscurely truncate. Base line arcuate. Umbones subcentral, moderately flattened, the apices acute and feebly prosogyrate. Lunule smooth, elongate-cordate, depressed. Escutcheon smooth, lanceolate, delimited by the posterior angulation. External sculpture confined to the flattened parts of the umbones, which are concentrically ridged with 10 to 15 relatively fine, subequal, and sub-equispaced

elevations. Feeble incrementals usually discernible on the anterior part of the shell and near the ventral margin. Ligament marginal, short, deeply inset. Hinge vigorous; anterior and posterior cardinals of right valve feeble or almost obsolete; middle cardinal stout, cuneiform, inserted in the deep subumbonal socket of the left valve between the strong, subequal, anterior and middle left cardinals; posterior left cardinal obsolete. Adductor muscle impressions distinct and submedial, the anterior slightly oval, the posterior irregularly quadrate. Pedal impression a small dent just dorsal to the anterior adductor. Pallial line distinct, more distant from the ventral margin anteriorly than posteriorly. Inner margins finely and rather feebly crenate at the resting stages, apparently smooth during the growing stages.

Dimensions of holotype: Height 25.8 millimeters, width 28.6 millimeters, convexity 7.2 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325527.

Type locality: Rappahannock River Bluffs near Urbanna, Va.

*Astarte rappahannockensis* is probably the St. Marys descendent of the *A. obruta* Conrad of the lower part of the Chesapeake group. It differs in the relatively higher, heavier, more convex shell, the more nearly equilateral outline—owing to the less produced posterior end—and the finer, closer, and more uniform sculpturing on the umbones. It is separated from *A. undulata* Say, the only other coexistent member of the subgenus *Ashtarotha*, by the less conspicuously flattened umbones and by the uniform slope of the posterior dorsal margin.

The species is confined apparently to the drainage basin of the Rappahannock River.

Distribution: Virginia: Miocene, St. Marys formation,  $\frac{1}{4}$  mile below Jones Point, Essex County;  $2\frac{1}{2}$  miles south of Farnham, at Union Mill, Richmond County; Urbanna, Middlesex County.

*Astarte (Ashtarotha) griftonensis* Gardner, n. sp.

Plate 12, figures 22, 28

Valves compressed, trigonal, subequilateral, suggesting rudely the quadrant of a circle. Anterior end feebly excavated in the lunular region, broadly and evenly arched in front of the lunule. Umbonal angle only a little over  $90^\circ$ . Posterior dorsal slope approximately uniform although somewhat broken by the slight, almost imperceptible, forward bend of the umbones. Posterior lateral margin obscurely truncate, merging gradually into the broad arch of the base. Umbones subcentral, low, flattened, and with a tendency toward a forward twist. Apices acute and slightly prosogyrate. Lunule smooth, rather narrow, its length often not exceeding one-third of the total height of the valve, sharply defined by the angulation of its dorsal margin. Escutcheon also rather narrow and relatively

short. Umbonal region sculptured with 2 to 5 concentric undulations, which rapidly broaden and flatten away from the umbones and evanesce altogether halfway down to the ventral margin, leaving the gently convex surface smooth except for faint, linear, concentric striations. Ligament marginal, opisthodontic; groove behind the nymph angular and deeply channeled. Dentition vigorous and clean cut. Anterior cardinal of right valve obsolete; middle cardinal stout, cuneiform; posterior cardinal laminar, fused with the ligamentary nymph. Anterior and middle cardinals of left valve subequal, cuneiform, divergent on each side of the deep, subumbonal socket; posterior tooth obsolete; contiguous surfaces of all the cardinals transversely striate. Muscle impressions large, submedial; anterior slightly reniform; posterior roughly quadrate. Pallial line entire, rather distant. Inner margins finely crenate.

Dimensions of holotype: Height, 23.8 millimeters, width, 27.0 millimeters; convexity, 6.8 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325524.

Type locality: 2 miles east of Grifton, Pitt County, N. C.

*Astarte griftonensis* is remarkable for its regular and rounded outline and its low, broad, concentric undulations, very few in number and limited to the dorsal half of the valve. *A. undulata* Say is usually heavier and more angular, the posterior dorsal slope is relatively longer and distinctly shouldered near the apices of the umbones, and the concentric undulations are more numerous, narrower, and much sharper. *A. thisphila* Glenn is also distinctly shouldered and much more vigorously sculptured. *A. rappahannockensis* is more convex and is ornamented with an umbonal sculpture of 10 to 15 subequal concentric lirae instead of the 2 to 5 low rounded undulations that rapidly broaden away from the apices. *A. obruta* Conrad is a heavier and slightly more convex shell, with a more produced posterior dorsal margin; it differs, furthermore, in the flattening of the umbones, which are almost at right angles to the vertical plane instead of following the uniform curvature of the valve from the apices to the ventral margin, as in the *A. griftonensis*; the apical sculpture is much sharper in the Calvert species and usually more limited in extent and more abruptly evanescent.

The species is fairly abundant at the single locality at which it is represented, the Yorktown sands, 2 miles east of Grifton, in Pitt County, N. C.

Distribution: North Carolina: Miocene, Yorktown formation, 2 miles east of Grifton (on the property of J. F. Brooks), Pitt County.

*Astarte (Ashtarotha) undulata* Say

Plate 12, figures 25, 31

1824. *Astarte undulata* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 150, pl. 9, fig. 5.

1834. *Astarte undulata* Say. Conrad in Morton, Synopsis of organic remains, App., p. 3.
1840. *Astarte undulata* Say (part). Conrad, Fossils of the medial Tertiary of the United States, p. 41, pl. 20, fig. 7; pl. 21, fig. 4 (young excluded).
1856. *Astarte undulata* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 70, pl. 20, figs. 1, 2.
1858. *Astarte undulata* Say. Emmons, North Carolina Geol. Survey Rept., p. 289, fig. 213.
1863. *Astarte undulata* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 578.
1903. *Astarte (Ashtarotha) undulata* Say (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1491.

Shells trigonate, umbones flattened, and with profound undulations; apices very acute.

Basal half of the shell coarsely wrinkled, the remaining half deeply, regularly, and widely undulated on the flattened umbo; lunule large, oblong, subovate, concave, separated from the disk, particularly near the beaks, by an acute angle; beaks prominent, approximate, acute, turned a little backward at tip; ligament margin concave nearly to the basal angle, and separated from the disk, near the beaks, by an acute angle; ligament very short; teeth regularly crenated on each side; basal angles rounded; basal edge nearly rectilinear or very obtusely arcuated; within finely crenated; smaller muscular impression very distinct.

Length four-fifths of an inch, breadth rather less than nine-tenths of an inch.

A very distinct species, unlike any other yet described. It varies in proportional length, some being longer than broad, and others broader than long.—Say, 1824.

Shell varies widely in relative proportions and thickness. Umbones central or slightly anterior, conspicuously flattened and bent forward, thus giving to the posterior margin a gibbous aspect that is very characteristic. Apices of umbones acute, proximate. Lunule and escutcheon always smooth and clearly defined but varying in width with the outline of the individual. External sculpture exceedingly inconstant in strength and character; a few sharp, constant concentric ridges on the umbones; ridges sometimes, as in Say's figured type, covering the entire valve to the ventral margin; more frequently broadening, flattening, and finally evanescent about halfway down the valve. Ligament marginal, mounted on a narrow, oblique nymph but little longer than the cardinals. Anterior cardinal of right valve almost obsolete; posterior cardinal very feeble; middle cardinal robust, cuneiform, inserted in the deep, subumbonal pit of the left valve between the vigorous anterior and middle left cardinals; posterior left cardinal obsolete. Muscle impressions distinct; anterior adductor oval or reniform; posterior, subquadrate; pedal an irregularly rotund dent just dorsal to the anterior adductor. Pallial line simple, distinct, distant from the base; inner margins finely crenate.

Type locality: "Maryland" (?).

This protean species is by far the most abundant of the genus in the Yorktown of Virginia and North Carolina. Its manifestations in outline and sculpture are so diverse that specific relationship between the

peripheral forms would not be surmised without the complete intergrading series, which establishes the consanguinity of the widely separated end members. The umbones constitute the most characteristic feature of the species. These are conspicuously flattened, strongly sculptured, and bent forward just ventral to the apices, so that they give to the posterior dorsal margin a diagnostic hunch.

The representatives of two of the most striking lines of variation have been isolated subspecifically.

Distribution: Virginia: Miocene, St. Marys formation, 2½ miles below Bayport and Urbanna, Rappahannock River, Middlesex County. Yorktown formation, Yorktown, York County; near the mouth of Baileys Creek, near its confluence with the James River, Prince George County; Lieutenant Run, Petersburg, Dinwiddie County; 5 miles northeast of Smithfield, 1½ miles northeast of Smithfield, ¾ mile northeast of Smithfield, ¼ mile from Benns Church, 8 to 8½ miles below Zuni, 12 to 14 miles below Zuni, Blackwater River, Isle of Wight County; Sycamore, ¼ to ½ mile below Sycamore, on the Nottoway River, Maddylys Bluff, lower Seaboard Railway bridge, and ½ to ¾ mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County; ¼ mile north of Chuckatuck, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1½ to 2 miles above Branches Bridge, 1 mile above Branches Bridge, at Branches Bridge, Northampton County; 2½ miles northwest of Murfreesboro, 1½ miles above Murfreesboro, 1 mile above Murfreesboro, near Murfreesboro, 3 to 4 miles below Tar Ferry, Hertford County; Colerain Landing on the Chowan River, Bertie County; Halifax and Palmyra Bluff on the Roanoke River, Halifax County; Swift Creek, 15½ miles above Bells Bridge, ½ mile above Bells Bridge, ½ mile above Bells Bridge, 1 mile above Bells Bridge, 1¼ miles above Bells Bridge over the Tar River, Shiloh Mills, and 1 mile below old Sparta Bridge, Edgecombe County; 2 miles below Toddy Station, 2 miles southeast of Tugwell (on Jacobs Branch), 1¼ miles northeast of Farmville, 3 miles south of Farmville, 2½ miles north of Standard, 3 miles southwest of Frog Level (on J. A. Noble's branch), 8 to 9 miles west of Greenville (on the east side of Pinelog Branch), 3 miles west of Greenville (on Harris Mill Run), 2 miles west of Greenville, 1½ miles west of Greenville (on Schoolhouse Branch), Greenville (just east of the country bridge), 8 to 9 miles southeast of Greenville, 9 to 10 miles south of Greenville, 1 mile northwest of Galloway Crossroads, and 3 miles north of Grifton (on the property of James Dawson), Pitt County; 2½ miles northwest of Chocowinity, 1¼ miles northeast of Chocowinity, 1 mile northeast of Chocowinity, Beaufort County; 3 miles east-southeast of Wilson, 1 mile northwest of Stantonsburg, Wilson County; 6 miles west of Goldsboro, Wayne County; 1 mile north of Castoria, half a mile east of Lizzie (on the property of David Summeril), Greene County; Rock Landing on the Neuse River, Craven County. Duplin marl, Lumberton (near the bottling works), Robeson County.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida. Duplin marl, Sumter district, S. C.; Porters Landing on the Savannah River, Effingham County, Ga.

#### *Astarte (Ashtarotha) undulata vaginulata* Dall

Plate 12, figures 26, 27

1903. *Astarte undulata* var. *vaginulata* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1491.

This differs from the typical *undulata* in being more triangular, with a straighter base, smaller, flattened area on the beaks,



with finer concentric sulcation which extends in most specimens to the base of the shell, though somewhat irregularly.—Dall, 1903.

Dimensions of lectotype: Height 22.4 millimeters, width 27.5 millimeters, convexity 8.3 millimeters.

Lectotype, a right valve: U. S. Nat. Mus. 146121.

Type locality: Grove Wharf on the James River, Va.

The subspecies is notably thick and convex, the posterior end more or less produced, the area behind the posterior keel abnormally wide, the escutcheon less clearly defined and occupying a smaller proportion of the entire posterior slope than in *A. undulata* s. s. The flattening of the umbones, which is made more prominent in *vaginulata* by the thickness and convexity of the shell, gives to the finely sculptured subspecies a transversely flexuous aspect that is distinct from the more angular contour of the normal compressed type with its sharp, concentric, umbonal ridges rapidly broadening ventrally.

Distribution: Virginia: Miocene, Yorktown formation, 3 miles northeast of Walkerton, Mattaponi River, King and Queen County; Lanexa, New Kent County; Claremont Wharf, Schmidts Bluff, 8½ miles below Claremont Wharf, James River, Surry County; 6½ to 7 miles below Zuni, 7 to 7½ miles below Zuni, 8 to 8½ miles below Zuni, 12 to 14 miles below Zuni on the Blackwater River, Isle of Wight County; Delaware on the Nottoway River and 3 to 4 miles above the lower Seaboard Railway bridge over the Meherrin River, Southampton County.

*Astarte (Ashtarotha) undulata deltoidea* Gardner, n. subsp.

Plate 12, figures 29, 30, 35, 36

1840. *Astarte undulata* Say var. Conrad, Fossils of the medial Tertiary of the United States, p. 41, pl. 21, fig. 4.

Shell heavy, conspicuously elevated. Umbonal angle as small as 30°. Posterior slope very steep, rounding rather abruptly into the rectilinear ventral margin. Anterior end very slightly expanded in front of the lunule, broadly and evenly arching into the base. Umbones slightly anterior, flattened, and bent forward near the apices. Tips of umbones sculptured with a few sharp ridges, which rapidly broaden and flatten and become in some individuals altogether obsolete less than halfway down the valve. Hinge formula normal for the species but with the cardinals much more produced and relatively more slender.

Dimensions of holotype: Height 23.5 millimeters, width 24.7 millimeters, convexity 6.0 millimeters. Dimensions of paratype, an extreme individual: Height 22.5 millimeters, width 19.0 ± millimeters, convexity 6.5 millimeters.

Types: Holotype, a right valve: U. S. Nat. Mus. 325525; paratype, a right valve: U. S. Nat. Mus. 325532.

Conrad's figured *A. undulata* Say var. was collected near City Point, on the James River, Va. The holotype is from 7 to 7½ miles below Zuni; the paratype from Zuni, Isle of Wight County, Va.

The subspecies includes those *A. undulata* that are

remarkable for their high deltoid outline. They are further characterized, as a rule, by a heavier shell, and by broader, less numerous, and more rapidly evanescent concentric undulations.

Distribution: Virginia: Miocene, Yorktown formation, Indian Field Point, York County; mouth of Baileys Creek, Prince George County; Claremont Wharf, Schmidts Bluff, 8½ miles below Claremont Wharf, Sunken Marsh Creek, and Cobham Bay on the James River, Surry County; Kings Mill, James City County; Fergusons Wharf, James River, 1 mile north of Zuni, Zuni (near the pumping station), 6½ to 7 miles below Zuni, 7 to 7½ miles below Zuni, Blackwater River, Isle of Wight County; Delaware (on the Nottoway River) and Maddelys Bluff (on the Meherrin River), Southampton County.

North Carolina: Miocene, Yorktown formation, 1½ miles above Murfreesboro, 1 mile above Murfreesboro, and near Murfreesboro on the Meherrin River, Hertford County.

*Astarte (Ashtarotha) concentrica* Conrad

Plate 12, figure 32–34, 40

1834. *Astarte concentrica* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 133.

1840. *Astarte concentrica* Conrad, Fossils of the medial Tertiary of the United States, p. 44, pl. 21, fig. 6.

1863. *Astarte concentrica* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 578.

1903. *Astarte (Ashtarotha) concentrica* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1492.

Shell subtriangular, compressed, with numerous concentric rounded costae, crowded on the basal margin; umbones slightly flattened; apex acute, central; lunule large, concave, lanceolate; posterior margin concave; submargin acutely angular, straight; extremity obtusely rounded; cardinal teeth strongly striated; margin crenulated. Length 1½ inches, height ¾ inch. Locality, Yorktown, Va.—Conrad, 1834.

Outline ovate-trigonal, compressed, inequilateral. Posterior end rounded. Anterior end expanded in front of the lunule, rounding broadly and evenly into the ventral margin. Umbones low, not conspicuous. Apices acute, feebly prosogyrate. Lunule smooth, sharply defined, narrow-elongate. Escutcheon lanceolate, about half the total height of the valve. Surface sculptured with 30 to 35 equal, concentric lirae, separated by linear interspaces; lirae mostly uniform and continuous across the disk, though tending to break up near the posterior margin. Ligament external; nymphs rather short and slender. Dentition robust; anterior cardinal of right valve feeble; middle cardinal cuneiform, strong, and prominent; posterior cardinal obliquely produced, compressed. Posterior cardinal of left valve obsolete; middle and anterior cardinals vigorous, diverging beneath the umbones. Inner margins of hinge teeth of both right and left valves transversely striated. Anterior lunular margin of right valve and posterior margin of left feebly sulcated to receive corresponding beveled edges of opposite valves. Adductor impressions rather large—the anterior oval or slightly reniform, the posterior semielliptical or rudely quadrate. Pallial line simple. Inner margins more or less strongly crenate.

*Astarte concentrica* Conrad is unique among its congeners in the possession of a lirate concentric sculpture that covers the entire valve. The species, which varies somewhat in outline and strength of sculpture, gives rise to Conrad's *A. bella*, an abnormally high type with an abnormally fine and close sculpture.

The form prevalent in the Duplin and Waccamaw formations seems also sufficiently distinct to be worthy of isolation, characterized as it is by a relatively low, heavy, and somewhat flexuous shell, with a more produced posterior end and a less uniform, concentric sculpture.

*A. concentrica* Conrad, though present throughout the Miocene and Pliocene of Virginia and North Carolina, is most abundant in the Yorktown formation.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown and 1¼ miles below Yorktown, York County; Petersburg, Dinwiddie County; 2 miles northwest of Smithfield, 1½ miles northeast of Smithfield, ¾ mile northeast of Smithfield, ¼ mile from Benns Church, and Everet's farm near Benns Church, Isle of Wight County; ¼ mile north of Chuckatuck, 1½ miles southeast of Reids Ferry, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 1 mile northeast of Suffolk; ½ mile below the Suffolk waterworks dam, drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, Tar Ferry on Wiccacon Creek (opposite Harrellsville), 1½ miles below Tar Ferry, 3 to 4 miles below Tar Ferry, Dogwood Landing on the Chowan River, Mount Pleasant Landing, Hertford County; Colerain Landing and ½ to ¾ mile above Edenhouse Point on the Chowan River, Bertie County; Palmyra Bluff, Halifax County; 2½ miles northwest of Williamston (on the land of Joseph Cherry), 1 mile northwest of Williamston, 1 mile southeast of Williamston, Martin County; 15½ miles above Bells Bridge, ½ mile above Bells Bridge, ¼ mile below Bells Bridge, 1 mile below Bells Bridge, Shiloh Mills, Tarboro, Tar River, Edgecombe County; 2 miles below Toddy Station, 2 miles southeast of Tugwell (on Jacobs Branch), 1¼ miles northeast of Farmville, 2¼ miles north of Standard, 8 to 9 miles west of Greenville (on the east side of Pinelog Branch), 3 miles west of Greenville (on Harris Mill Run), 2 miles west of Greenville, 1½ miles west of Greenville (on Schoolhouse Branch), 8 to 9 miles southeast of Greenville, 9 to 10 miles south of Greenville, 3 miles north of Grifton (on James Dawson's farm), Pitt County; 2½ miles northwest of Chocowinity, 1 mile northeast of Chocowinity, Beaufort County; 1 mile west of Wilson (on Frank Barnes' land at Hominy Swamp), Wilson County; 1 mile east of Lizzie (on the land of T. N. Lassiter), Greene County. 2 miles southwest of Maple Cypress on the Neuse River, Rock Landing on the Neuse River, Craven County. Duplin marl, 3 miles south of Clinton (on Gum Chimney Branch), 10 miles south of Clinton (on the property of J. N. Powell), Sampson County; Natural Well, 1½ miles north of Magnolia and Frank Wilson's and W. H. Kornegay's marl pits near Magnolia, Duplin County; 4 miles north of Lumberton (on the Berry Godwin plantation), 1 mile west of Lumberton (on the property of Charles Rowland), Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, Fairmont (Ashpole), 1½ miles northeast of Fairmont (on the land of Andrew Jones), 4 miles northeast of Fairmont (at D. E. Lewis'), Robeson County. Pliocene, Waccamaw formation, Lake Waccamaw, Cape Fear

River, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Miocene, Duplin marl, Porters Landing on the Savannah River, Effingham County. Pliocene, Waccamaw formation, Nixons and Todds Ferry, Horry County, S. C.

*Astarte (Ashtarotha) concentrica conradi* Gardner, n. subsp.

Plate 12, figures 37, 41

Shell relatively small, low, heavy, and convex; slightly flexuous posteriorly. Anterior end more strongly produced and contracted than is normal for the species. Base line broadly arcuate. Umbones set a little in front of the median line, slightly incurved and prosogyrate. Lunule elongate-cordate; both lunule and escutcheon relatively broad. Sculpture rather more elevated than in *A. concentrica* s. s., and less uniform. Dentition vigorous and clean-cut; transverse striations on the inner surfaces of the cardinals very distinct. Character of adductor impressions and palial line normal. Inner margins finely crenate.

Dimensions of cotypes: Right valve, height 15.7 millimeters, width 19.0 millimeters, convexity 5.3 millimeters, left valve of another individual, height 16.8 millimeters, width 21.3 millimeters, convexity 6.0 millimeters.

Cotypes: U. S. Nat. Mus. 325530.

Type locality: 4 to 5 miles below Lumberton, Robeson County, N. C.

*Astarte concentrica conradi* is remarkable for its relatively small, heavy shell, which is inflated anteriorly, slightly depressed, produced, and contracted posteriorly, and ornamented with rather coarse, crowded, concentric lirae that lack the uniformity normal to the species. The subspecies, though occurring at a few isolated localities in the St. Marys formation and north of the Hattaras axis, is particularly characteristic of the Duplin marl south of the Hattaras.

Distribution: Virginia: Miocene, St. Marys formation, a quarter of a mile below Jones Point on the Rappahannock River, Essex County. Rare.

North Carolina: Miocene, Yorktown formation, 9 to 10 miles south of Greenville, Pitt County. Duplin marl, 2½ miles south of Clinton (on Gum Chimney Branch) and 4 miles south of Clinton, Sampson County; Natural Well, 1½ miles north of Magnolia, and W. H. Kornegay's marl pit near Magnolia, Duplin County; 4 miles north of Lumberton (on the Berry Godwin plantation), 1 mile west of Lumberton (on the property of Charles Rowland), Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, 1½ miles northeast of Fairmont (on the land of Andrew Jones), and at Fairmont (Ashpole), Robeson County. Pliocene, Waccamaw formation, Lake Waccamaw and Neills Eddy Landing (3 miles north of Cronly), Columbus County.

*Astarte (Ashtarotha) concentrica bella* Conrad

Plate 12, figures 38, 39

1846. (?) *Astarte lineolata* H. C. Lea, Am. Philos. Soc. Trans., 2d ser., vol. 9, p. 241, pl. 34, fig. 20.

1856. *Astarte concentrica* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 71, pl. 20, fig. 3.



1858. *Astarte concentrica* Conrad. Emmons, North Carolina Geol. Survey Rept., p. 289, fig. 212.  
 1863. *Astarte bella* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, pp. 577, 585.  
 1863. (?) *Astarte lineolata* H. C. Lea. Conrad, idem, p. 578.  
 1866. *Astarte compsonema* Conrad, Am. Jour. Conchology, vol. 2, p. 72, pl. 4, fig. 18.  
 1903. *Astarte concentrica* var. *bella* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1492.

Triangular, compressed; marked by very regular, closely arranged, fine, concentric lines.

*A. concentrica* Tuomey and Holmes (not Conrad), Pleiocene fossils of South Carolina, 71, 20, 3; Emmons, North Carolina Geol. Survey Rept. 289, 212.

Locality, Virginia.

Differs from *concentrica* in being proportionally shorter and in its much finer and more regular lines.—Conrad, 1863.

The *lineolata* of H. C. Lea is a very young shell and is undeterminable, even specifically. The subspecies *bella* is separated from *A. concentrica* s. s. by its higher outline and by its finer, closer, and even more regular concentric sculpture—all of which characters are of little systematic importance in the *Astartes*. The form has a place in the literature, however, and though rare is readily recognizable.

Distribution: Virginia: Miocene, Yorktown formation, Petersburg, Dinwiddie County.

North Carolina: Miocene, Yorktown formation, Branches Bridge over the Meherrin River, Northampton County.

Outside distribution: Pliocene, Waccamaw formation, Waccamaw, S. C.

#### Family CRASSATELLITIDAE

##### Genus CRASSATELLITES Krüger

1799. *Crassatella* of authors, not *Crassatella* Lamarck (Soc. histoire nat. Paris Mém., p. 85. Sole species, *Mactra cygnea* Chemnitz).  
 1823. *Crassatellites* Krüger, Geschichte der Urwelt, vol. 2, p. 466.

Type by monotypy?: *Crassatellites sinuatus* Krüger. Eocene of the Paris Basin.

Through the kindness of W. J. Fox, the assistant librarian and editor at the Academy of Natural Sciences in Philadelphia, I received the following copy of Krüger's original description:

*Crassatellites sinuatus*. *Crassatella bossue*.

Mit sehr dicken Schalen, tiefen Muskeleindrücken und einzelnen Querreifen, welche auf der Oberfläche mit dem untern Rande der Schalen gleichlaufen. Häufig bei Grignon.

Dall, following Bronn, and many others including myself, following Dall, have considered Krüger's *C. sinuatus* as synonymous with *Crassatella gibbosula* Lamarck. This doubtless arose from Deshayes' citation in 1824 of *Crassatella bossue* as *Crassatella gibbosula* Lamarck.

Stewart<sup>36</sup> indicated the difficulty in reconciling

Krüger's description of *sinuatus* with Lamarck's *gibbosula* and the much closer correspondence of that description to Lamarck's *plumbea*. From an examination of the descriptions of Deshayes, 1860, and the illustrations of Cossmann and Pisarro, 1906, Stewart observed<sup>36</sup> that "of the eight species of '*Crassatella*' cited by Deshayes from Grignon, only one, '*Crassatella plumbea*,' corresponds to the meager description of '*Crassatellites sinuatus*'" of Krüger. This is doubtless true, though Deshayes included in his synonymy of *Crassatella plumbea*, *Crassatella tumida*, which Stewart has accepted as a distinct species and as the type of '*Crassatella* Lamarck.

In our collections from Grignon the heavy shells labeled *C. tumida* Lamarck might well pass for the original of Krüger's description. *C. tumida* Lamarck, 1807, is considered synonymous with *C. gibba* Lamarck, 1801 (*gibbosa* Lamarck of Deshayes, 1860, by an error), and has been designated as the type of *Crassatella*. As the French *bossue* is a literal translation of the Latin *gibba*, it seems reasonable to suppose that Krüger had before him an example of *C. gibba* Lamarck, 1801. His reason for selecting *sinuatus* as the specific name of his species is not obvious. It seems to have nothing to do with *Crassatella sinuata* Lamarck, 1818, from the environs of Bordeaux. If the description and situs of his species were not so closely in accord with the heavy crassatellids of the Paris Basin, it might be reasonably conjectured that Krüger had two rather than a single species in mind and that *Crassatellites sinuatus* and *Crassatella bossue* referred to different forms. Access to larger collections and knowledge of the relative abundance and distribution of the forms in question are necessary for an adequate identification of Krüger's type.

There is a conspicuous lack of uniformity in usage of the generic name to be given to the group under discussion. It is admitted by all workers that *Crassatella* Lamarck, 1799, was founded on a *Mactra*. The French school have retained *Crassatella* on the plea that Lamarck cited in 1801, under practically the same description, *Crassatella gibba*=*Crassatella tumida* Lamarck, 1807. The name *Crassatellites* is also in disfavor because Krüger, like Schlotheim, used the suffix *ites* to indicate merely the occurrence of the given genus in the fossil state. There has been no uniformity in the acceptance or rejection of names so compounded. Cox<sup>37</sup> probably takes the most easily tenable position, in holding that "the adoption of *Crassatellites* seems, however, to be the easiest solution of the problem caused by Lamarck's inconsistency."

Shell slightly inequivalve, inequilateral, subquadrate or subtrigonal in outline. Umbones anterior and usually prominent. Lunule and escutcheon distinctly depressed. Surface sculpture concentric, usually fee-

<sup>36</sup> Stewart, R. B., Gabb's California Cretaceous and Tertiary type Lamellibranchs: Acad. Nat. Sci. Philadelphia, Special Pub. 3, p. 136, 1930.

<sup>37</sup> Cox, L. R., India Geol. Survey Mem., n. ser., vol. 15, p. 210, 1930.

ble, and commonly confined to the umbonal area. Ligament and resilium internal. Dentition vigorous; three cardinals in the right valve—the posterior frequently effaced by the resilium—and two in the left. Anterior margin of right valve and the posterior margin of the left grooved to receive the beveled edge of the opposite valve. Muscle scars distinct, impressed. Pallial sinus simple. Ventral inner margins dentate.

The distribution of *Crassatellites* is without new stratigraphic significance. As the group was well established in the Seaboard and the Gulf Provinces in the Upper Cretaceous, there is no reason to doubt that the Tertiary representatives are autochthonous. The Recent forms are included in about 40 species, the majority tropical in habitat.

#### Genus *CRASSINELLA* Guppy

1874. *Crassinella* Guppy, Geol. Mag., new ser., dec. 2, vol. 1, p. 450.

1875. *Crassinella* Guppy, idem, vol. 2, p. 42.

Type by monotypy: *Crassinella martinicensis* d'Orbigny=? *Thetis parva* C. B. Adams. Recent in the West Indies.

The genus is characterized by the small, trigonal, compressed outline; the acute, erect, or slightly opsthogyrate subcentral umbones; the internal ligament; the 2 delicate cardinals in each valve; and some form of lateral armature. Although it has been commonly considered as a subgenus of *Crassatellites*, the characters that separate the 2 groups seem sufficiently important to be considered generic.

#### *Crassinella lunulata* (Conrad) Dall

Plate 19, figure 30

1834. *Astarte lunulata* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 133.  
 1840. *Astarte lunulata* Conrad, Fossils of the medial Tertiary of the United States, p. 44, pl. 21, fig. 8.  
 1856. *Astarte lunulata* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 72, pl. 20, fig. 4.  
 1858. *Astarte lunulata* Conrad (part). Holmes, Post-Pleiocene fossils of South Carolina, p. 32, pl. 6, fig. 9.  
 1863. *Gouldia lunulata* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.  
 1903. *Crassatellites* (*Crassinella*) *lunulatus* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1477, pl. 49, fig. 15.  
 1932. *Crassinella lunulata* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 82, pl. 15, fig. 6.

Shell small, triangular, compressed, with about 13 acute, concentric, prominent lines; anterior slope rectilinear, angular at the extremity; basal margin rounded; beaks central, apex acute; lunule much elongated. Length and height nearly equal, about a quarter of an inch. Locality, Suffolk, Va.—Conrad, 1834.

Shell minute, moderately compressed, cuneiform, subequilateral in the adult stages. Dorsal slopes steep, subequal, the posterior sometimes slightly concave and produced. Basal margin strongly arcuate, forming with the dorsal slopes a 30° to 45° segment. Umbones

acute, opisthogyrate, central or slightly anterior. Lunule and escutcheon sublinear, the latter slightly more expanded; both of them coextensive with the dorsal margins; clearly defined by the angulation of the valve and the abrupt disappearance of the sculpture. Surface ornamentation of 11 to 15 equisized and equispaced concentric folds, which are pinched into sharply elevated free lamellae toward the margins and often over the entire disk; feeble and irregular secondary concentric striations sometimes present; crowded radial striations also visible in well preserved individuals and under high magnification, least feeble on the dorsal slopes of the lamellae near the base. Ligament internal; resilial pit narrow, somewhat oblique. Dentition of right valve reduced to a couple of simple, compressed cardinals in front of the ligament pit; anterior dorsal margin feebly sulcated; posterior dorsal margin beveled to function as a lateral. Two cardinals present also in the left valve—the posterior nothing more than a low laminar ridge bordering the resilium, the anterior simple, obliquely produced, moderately robust. Anterior dorsal margin beveled and grooved slightly toward the ventral margin; posterior lateral lamina strongly developed, parallel to the dorsal margin throughout its length; more prominent near the ventral end. Adductor impressions small, often obscure, the anterior irregularly rotund, the posterior oval or slightly reniform. Pallial line entire, rather distant from the base. Inner margins simple.

Figured specimen, U. S. Nat. Mus. 6123, from the Natural Well, Duplin County, N. C. Height 5.9 millimeters, width 6.7 millimeters.

*Crassinella lunulata* (Conrad) exhibits within its narrow limits a wide range of variation. The characters are, on the whole, more stable in the fossil than in the Recent forms, though they are inconstant at all ages. The species varies in convexity, in thickness, in relative proportions, and in the curvature of the base line; the posterior dorsal slope may be oblique and similar to the anterior, or, as is frequently true of the young, it may be convex and more produced than the anterior. The variations in sculpture are the most obvious. The concentric sculpture, which is typically sharpest and strongest near the margins, broadens slightly and flattens medially; in many of the young, in a few of the adults, and in many of the senile forms the sculpture is either undeveloped or obsolete on the medial portion of the disk and usually less conspicuous anteriorly than posteriorly. This tendency is so extreme in some individuals that it has seemed wise to isolate them under the subspecies *harrisi*. In a few of the relatively higher and heavier forms, on the other hand, the laminae may number up to 18 or 20 and may persist with undiminished strength across the entire valve. The radial sculpture—supposed to have been developed only in the Recent representatives of the

species—is discernible on the fossils also if the individual is sufficiently well preserved and the magnification sufficiently high.

The species is among the most abundant, the most widely distributed, and the most readily recognizable of all the minute bivalves. It is particularly prolific in the Yorktown along the York River, in Nansemond County in the environs of Suffolk, along the Chowan River, in Hertford and Bertie Counties, and in the Duplin and Waccamaw formations. It is recognized also in both the *Arca* zone and the *Cancellaria* zone of the Choctawhatchee of Florida.

Distribution: Virginia: Miocene, Yorktown formation, 4 miles northeast of Walkerton on the Mattaponi River, King and Queen County;  $\frac{3}{4}$  mile above Yorktown, Yorktown,  $1\frac{1}{4}$  miles below Yorktown, and 2 miles below Yorktown, York County; old Claremont Wharf on the James River, Surry County; Lieutenant Run near Petersburg, Dinwiddie County;  $\frac{3}{4}$  mile northeast of Smithfield, Benns Church ( $\frac{1}{4}$  mile from the old church), J. J. Everet's farm near Benns Church,  $\frac{3}{4}$  mile north of Zuni, and 12 to 14 miles below Zuni on the Blackwater River, Isle of Wight County; Maddelys Bluff,  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above the lower Seaboard Railway bridge, and  $2\frac{1}{2}$  to 3 miles below the lower Seaboard Railway over the Meherrin River, Southampton County;  $\frac{1}{4}$  mile north of Chuckatuck,  $1\frac{1}{2}$  miles southeast of Reids Ferry, Exit,  $5\frac{1}{2}$  miles northwest of Suffolk,  $2\frac{1}{2}$  miles northwest of Suffolk,  $1\frac{1}{2}$  miles north of Suffolk,  $1\frac{1}{2}$  miles northwest of Suffolk,  $1\frac{1}{2}$  miles northeast of Suffolk, 1 mile east of Suffolk, 1 mile west of Suffolk,  $\frac{1}{2}$  mile below the Suffolk waterworks dam, and  $\frac{1}{2}$  mile from the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation,  $1\frac{1}{2}$  miles above Branches Bridge and Branches Bridge, Northampton County;  $1\frac{1}{2}$  miles above Murfreesboro, 1 mile above Murfreesboro, Tar Ferry on Wiccacon Creek (opposite Harrellsville),  $1\frac{1}{2}$  miles below Tar Ferry, 3 to 4 miles below Tar Ferry, Dogwood Landing and Mount Pleasant Landing (on the Chowan River), Hertford County; Colerain Landing and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhous Point, Bertie County; Palmyra Bluff, Halifax County;  $15\frac{1}{2}$  miles above Bells Bridge, 100 yards below Bells Bridge,  $\frac{1}{8}$  mile below Bells Bridge, 1 mile below Bells Bridge, Shiloh Mills, L. E. Fountain's farm at Tarboro, Tar River, Edgecombe County; 2 miles below Toddy Station,  $3\frac{1}{4}$  miles northeast of Farmville, 3 miles south of Farmville,  $2\frac{1}{2}$  miles north of Standard, 8 to 9 miles west of Greenville (on the east side of Pinelog Branch), 8 to 9 miles southeast of Greenville, and 9 to 10 miles south of Greenville, Pitt County; 1 mile west of Wilson (in Hominy Swamp, on the farm of Frank Barnes), Wilson County; 1 mile north of Castoria,  $\frac{1}{2}$  mile east of Lizzie (on the farm of David Summeril), 1 mile east of Lizzie (on the farm of T. N. Lassiter), Greene County;  $2\frac{1}{2}$  miles northwest of Chocowinity, Beaufort County; 2 miles southwest of Maple Cypress, and Rock Landing, Craven County. Duplin marl,  $2\frac{1}{2}$  miles south of Clinton (on Gum Chimney Branch, on the land of Hugh Moore), 10 miles south of Clinton (on the land of J. N. Powell), Sampson County;  $1\frac{1}{2}$  miles north of Magnolia, at the Natural Well, and W. H. Kornegay's marl pit, Duplin County; Fairmont and  $1\frac{1}{2}$  miles northeast of Fairmont (on the farm of Andrew Jones), Lumberton (near the bottling works), 2 miles below Lumberton, and 4 to 5 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek, on the land of Mrs. Clark) and at Walkers Bluff on the Cape Fear River, Bladen County; Lake Waccamaw, Cronly

( $\frac{1}{2}$  mile east of the factories), and Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin marl, Darlington, Darlington County, S. C. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Nixons and Todds Ferry, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River, Shell Creek, and Alligator Creek, Fla. Croatan sand, Slocums Creek, Craven County, N. C. Pleistocene, (?) Labelle, Caloosahatchee River, Fla. (Vaughan).

*Crassinella lunulata harrisi* Gardner, n. subsp.

Plate 14, figure 45

1903. *Crassatellites* (*Crassinella*) *galvestonensis* Harris. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1478, pl. 49, fig. 14. Not *Eriphyla galvestonensis* Harris, 1895.

Shell subject to the same variation in outline as that of *Crassinella lunulata* (Conrad) but generally higher and decidedly heavier. Umbones of the thicker forms flattened above. Subspecies based primarily on obsolete external sculpture; traces of low but regular concentric undulations, which are visible along the posterior dorsal margin and, more feebly, along the anterior, sometimes persist across the disk near the base, but are never pinched into free lamellae as in *C. lunulata* s. s. Hinge and pallial characters normal for the species.

Dimensions of holotype: Height 5.1 millimeters, width 5.2 millimeters.

Holotype, a left valve, U. S. Nat. Mus. 1630.

Type locality: Yorktown, Va.

The form figured by Dall in the Transactions of the Wagner Free Institute under the name *C. galvestonensis* may serve as a type for the subspecies. Harris' type from the Galveston well and all the individuals in the available reference collections are very young. They are, however, more heavy and rude in both outline and dentition than any of the young of *C. lunulata* in the extensive collections of east coast materials, and there are no intermediate forms to warrant their union with those from Yorktown. On the other hand, a complete intergrading series has been established that unites the forms in which the sculpture is quite obsolete—except along the posterior dorsal margin—with those in which the sharply elevated lamellae continue with undiminished strength from the posterior across to the anterior margin.

The tendency toward an evanescent sculpture, though widespread in time and space, is strongest in the Yorktown of Virginia, and all of the forms to which subspecific rank has been given are confined to that formation and area. In the Recent representatives, unlike those of the Tertiary, the sculpture often lingers longest near the umbones.

Distribution: Virginia: Miocene, Yorktown formation,  $\frac{3}{4}$  mile above Yorktown, Yorktown, and  $1\frac{1}{4}$  miles below Yorktown, York County;  $\frac{1}{4}$  mile north of Chuckatuck,  $1\frac{1}{2}$  miles southeast of Reids Ferry, 1 mile northeast of Suffolk, and  $\frac{1}{2}$  mile below the Suffolk waterworks dam, Nansemond County.

**Crassinella galvestonensis (Harris)**

1895. *Eriphyla galvestonensis* Harris, Bull. Am. Paleontology, vol. 1, No. 3, pl. 1, figs. 2, 2a, 2b.

Form as indicated by the figures; hinge as in *E. lunulata*; exterior smooth, slightly undulating concentrically near the beaks; beaks, as in many species of *Astarte* and *Crassatella*, slightly flattened at the very apex but very gibbous just below.—Harris, 1895.

Locality: Galveston well, Texas, from 300 to 2,600 feet.

No convincing evidence for the existence of the species from the Galveston well, in the east coast Tertiary deposits, has been presented. The forms figured under that name in the Wagner papers have proved to be a subspecies of *Crassinella lunulata* and have received the name *harrisii*.

Outside distribution: Miocene, Galveston well, Texas, 300 feet to 2,600 feet.

**Crassinella dupliniana Dall**

Plate 13, figures 10, 11

1903. *Crassatellites* (*Crassinella*) *duplinianus* Dall, Wagner, Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1478, pl. 50, figs. 5, 6.

1932. *Crassinella dupliniana* Dall. Mansfield, Florida Geol. Survey Bull. 8, p. 83, pl. 15, fig. 9.

Shell small, subtriangular, solid, with markedly acute beaks, which incline backward; anterior slope convexly arcuate, long; posterior slope nearly a straight or slightly concave line, shorter; lunule and escutcheon extending the whole length of their respective slopes, long and narrow, the latter more excavated than the former and wider; both are smooth; base arcuate; disk sculptured with rather close-set, regular, subequal, flattish, concentric ridges with narrower interspaces; these are sometimes feebly elevated but preserve their general close-set, regular character; hinge well developed, the posterior cardinal in the left valve often conspicuous. Height 3.2 [3.1], breadth 3.2, diameter 1.7 millimeters.

This species is especially characterized by the closeness, regularity, and smoothness of its concentric ridges and the long and narrow lunule and escutcheon.—Dall, 1903.

Holotype (double valves): U. S. Nat. Mus. 114922.

Type locality: Natural Well, Duplin County, N. C.

Mansfield reports the species from the *Cancellaria* zone of the Choctawhatchee formation of Florida.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well, 1½ miles north of Magnolia, and W. H. Kornegay's marl pit near Magnolia, Duplin County; 2 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek, on the property of Mrs. Clark), Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Miocene, Duplin marl, Porters Landing on the Savannah River, Effingham County, Ga. Pliocene, Waccamaw formation, Tillys Lake, Horry County, S. C.

**Crassinella nansemondensis Gardner, n. sp.**

Plate 13, figures 18, 27

Shell minute, compressed, ovate-trigonal, inequilateral. Posterior end somewhat shorter and more angular than the anterior; posterior dorsal slope steep,

its union with the arcuate ventral margin abrupt; anterior dorsal slope more gentle, rounding evenly into the base. Umbones low; apices acute, proximate, opisthogyrate. Lunule and escutcheon sublinear, coextensive with the dorsal margins, clearly defined by the angulation of the valves and the abrupt disappearance of the surface ornamentation. Sculpture of 15 to 20 equal, continuous, concentric lirae, separated by linear interspaces. Dentition normal for the subgenus; resilial pit narrow, oblique; hinge of right valve armed with 2 simple, oblique, compressed cardinals, the posterior cardinal being stronger; posterior cardinal of left valve merely a low, laminar elevation bordering the resilium; anterior cardinal simple, comparatively robust; dorsal margins strongly modified to function as laterals; anterior dorsal margin of right valve feebly sulcated; posterior dorsal margin strongly beveled; anterior dorsal margin of left valve, beveled, the posterior lateral lamina strongly developed, parallel to the dorsal margin throughout its length. Adductor impressions rotund, submedial, often obscure. Pallial line entire. Inner margins simple.

Dimensions of types: Right valve (paratype), height 2.7 millimeters, width 3.1 millimeters, sem diameter 0.5 millimeter. Left valve of another individual (holotype), height 3.3 millimeters, width 3.5 millimeters, semidiameter 0.5 millimeter.

Types Holotype, U. S. Nat. Mus. 325514; paratype, U. S. Nat. Mus. 325515.

Type localities: Holotype, ½ mile below the Suffolk waterworks dam on the Nansemond River; paratype, 1½ miles southeast of Reids Ferry, Nansemond County, Va.

*Crassinella nansemondensis* n. sp. of the Yorktown fauna is the analog of *C. dupliniana* Dall of the Duplin and Waccamaw faunas. The former is, however, a trifle less minute, decidedly more compressed, and more inequilateral than the southern species and shows less variation in the character and strength of the concentric sculpture.

Distribution: Virginia: Miocene, Yorktown formation, 1½ miles southeast of Reids Ferry and ½ mile below the Suffolk waterworks dam, Nansemond County.

**Superfamily CYRENACEA****Family CYRENIDAE****Genus CORBICULA Megerle von Mühlfeldt**

1811. *Corbicula* Megerle von Mühlfeldt, Entwurf eines neuen Systems der Schalthiergehäuse, Magazin der Gesellschaft Naturforschender Freunde, 5ter Jahrgang, Berlin, p. 56.

Type by monotypy: *Tellina fluminatis* Müller. Recent in the Euphrates River.

Shell usually heavy, subtrigonal or cordate; not markedly inequilateral. Umbones subcentral, high, and prominent. Lunule and escutcheon not defined. External surface smooth or concentrically furrowed.

Epidermis polished. Cardinals 3 in each valve, diverging fanlike beneath the umbones. Both anterior and posterior laterals developed, finely striate transversely. Pallial line little or not at all sinuated.

*Corbicula* is abundantly represented in the nonmarine Cretaceous and Lower Tertiary deposits of the Western Interior, in a few restricted localities in the marine Tertiary of the east coast and Gulf, and in the Eocene of the Paris Basin. The Recent species are confined exclusively to rivers and lakes of the Eastern World.

***Corbicula densata* (Conrad) Emmons**

Plate 15, figures 3, 4, 7, 8

1844. *Cyrena densata* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 324.  
 1845. *Cyrena densata* Conrad, Fossils of the medial Tertiary of the United States, p. 68, pl. 39, fig. 2.  
 1856. *Cyrena densata* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 77, pl. 20, fig. 14.  
 1858. *Corbicula densata* Conrad. Emmons, North Carolina Geol. Survey Rept., p. 290, fig. 215A.  
 1863. *Corbicula densata* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
 1865. *Cyrena densata* Conrad. Prime, Monograph Am. Corbiculadae, Smithsonian Misc. Coll., No. 145, p. 31.  
 1903. *Corbicula densata* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1450.

Subtriangular, thick, convex, with robust lines of growth; anterior margin obtusely rounded; basal margin profoundly and regularly curved to the posterior extremity, which is subtruncated, direct, and greatly above the line of the base; beaks central, summits elevated; teeth large, robust, very prominent, three in one valve and two in the opposite; middle tooth of the right valve bifid; lateral teeth elongated, robust; anterior tooth truncated, suddenly deflected at the extremity; posterior tooth distant. Length  $1\frac{1}{2}$  inches, height  $1\frac{1}{8}$  inches.

Locality, vicinity of Petersburg, Va.; Mr. Tuomey; rare.—Conrad, 1844.

Shell of medium size, rounded-trigonal to oblate-spheroidal, strongly inflated in the umbonal region, subequilateral. Anterior end quite evenly rounded, nearly semielliptical. Posterior dorsal margin more oblique and more steeply descending than the anterior. Posterior slope more or less depressed, often obscurely carinated. Umbones strongly gibbous, involute, proximate, often very much eroded. Surface sculptured with fine, irregular, and discontinuous incrementals and stronger resting stages, many of which are only on the anterior half of the shell and become obsolete near the median vertical. Ligament marginal, opisthodontic, mounted on a short but conspicuously strong nymph. Three cardinals in each valve diverge fanlike beneath the umbones—the middle and posterior cardinals in the right valve and the anterior and middle cardinals in the left valve robust, subequal, feebly sulcate; the middle cardinals somewhat stouter and more regularly sulcate than the distal; and the anterior cardinal of right valve and the posterior cardinal of the left very slender and laminar. Laterals

of the left valve sharply elevated, transversely striated, with gently arcuate ridges extending almost to the median horizontal and received between the double laterals of the right valve. Adductor impressions irregular, submedial. Pallial line entire, distant from the base.

This species, the only representative of the genus in the east coast Tertiary, is conspicuous for the symmetrical arrangement of the triple cardinals and the very strong, curved laterals.

Distribution: North Carolina: Miocene, Yorktown formation, 3 miles south of Farmville, Pitt County; 1 mile west of Wilson (in Hominy Swamp, on the property of Frank Barnes), Wilson County. Duplin marl, 2 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Neills Eddy Landing (3 miles north of Cronly) and Lake Waccamaw, Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin marl, Darlington district, Darlington County, S. C. Pliocene, Waccamaw formation, Nixons, Horry County, S. C. Croatan sand, Slocums Creek, Craven County, N. C.

**Superfamily CYPRINACEA**

**Family EULOXIDAE**

**Genus EULOXIA Conrad**

1863. *Euloxia* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, pp. 578, 585.

Type by monotypy: *Venus latisulcata* Conrad. Miocene of Virginia.

Subtriangular, posteriorly sulcated; cardinal teeth three in the left valve, the two posterior teeth oblique; two teeth in the right valve, the posterior one oblique; sinus of pallial impression truncated or slightly emarginate posteriorly.—Conrad, 1863.

*Euloxia* has been shuttled about from the Astartidae to the Veneridae and the Cyprinidae. It certainly is closer to the Astartes than to the venerids and probably closer to the cyprinoids than to the Astartes. The heavy chalky shell and the simple pallial line suggest *Astarte* and *Corbicula*. The definition of the lunule and escutcheon is less clear than that of *Astarte* but much more decided than that of *Corbicula* or the cyprinoids. The cardinal dentition approaches most closely that of the cyprinoids. The conspicuously heavy, trigonal cardinal is the middle cardinal of the left valve and not that of the right, as in *Astarte*. There is no trace of a lateral dentition. The cyprinoids include a number of genera of diverse characters and seem much less uniform in their development than the Astartes. The family apparently permits a wider variation within its ranks than that of the Astartes, and *Euloxia* has been left tentatively under that heterogeneous group.

***Euloxia latisulcata* (Conrad) Conrad**

Plate 15, figures 1, 2

1840. *Venus latisulcata* Conrad, Fossils of the medial Tertiary of the United States, p. 40, pl. 20, fig. 6.

1852. *Astarte latisulcata* D'Orbigny, Prodrôme paléontologie, vol. 3, p. 112, No. 2089.  
 1863. *Euloxa latisulcata* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, pp. 578, 585.  
 1872. *Euloxa latisulcata* Conrad, Acad. Nat. Sci. Philadelphia Proc., p. 52, pl. 1, fig. 5.  
 1903. *Euloxa latisulcata* Conrad, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1502.

Shell subtriangular, with coarse lines of growth and a few deeply impressed lines; posterior side with a wide concave furrow bounded by the umbonal slope, which is profoundly angulated; posterior extremity truncated obliquely inward, and emarginate; inferior angle slightly prominent; lunule large, ovate, not well defined; cardinal teeth thick and prominent.

Locality, Middlesex County, near Urbanna, Va.—Conrad, 1840.

Shell heavy, porcellaneous, subtriangular to subquadrate, convex, strongly inequilateral. Umbones strongly anterior, in some individuals set within the anterior sixth, their apices slightly flattened, acute, prosogyrate. Lunular area cordate, depressed, but not sharply delimited. Escutcheon outlined by an obtuse carina. Anterior end of valve slightly expanded in front of the lunule. Posterior dorsal margin oblique or subrectilinear. Lateral margin squarely truncate but contracted medially by the broad and deep gutter that depresses the valve from the umbones to the lateral margin—limited posteriorly by the fold that outlines the escutcheon, anteriorly by a more angular ridge that persists with uniform vigor from the umbones to the posterior ventral margin. Base line subrectilinear, feebly warped in front of the posterior keel. Surface sculptured only by incrementals, which are stronger and more crowded toward the ventral margin. Ligament external, opisthodontic, mounted on a narrow nymph a little longer than the posterior cardinal. Hinge armature of right valve reduced to an isolated, sturdy middle cardinal and to an obliquely elongated and compressed posterior cardinal. Three unequal cardinals in the left valve—the anterior cardinal short, compressed, almost vertical; the middle stout, triangular, somewhat oblique; the posterior oblique, very slender, and elongate. Posterior dorsal margin of right valve slightly modified to fit into shallow sulcus of left valve; no true laterals developed. Anterior adductor impression semielliptical, more prominent than the irregularly quadrate posterior adductor. Pallial line simple. Inner margins entire.

Figured specimen, U. S. Nat. Mus. 214407, from the lower bed at old Claremont Wharf on the James River, Va.; Height 20.0 millimeters, width 23.4 millimeters.

Until the discovery of two additional valves by Dr. L. W. Stephenson of the United States Geological Survey—one valve from the St. Marys formation of the Rappahannock River, the other from the James River—Conrad's type from the Rappahannock River at Urbanna remained unique. The form is apparently

exceedingly rare, for it is not probable that a species of medium dimensions so strongly characterized would pass unnoted.

Distribution: Virginia: Miocene, St. Marys formation, Urbanna, Middlesex County (Conrad); half a mile below Jones Point on the Rappahannock River, Essex County; old Claremont Wharf on the James River. A single valve has been collected at each of these three localities.

#### Family PLEUROPHORIDAE Dall

##### Genus CORALLIOPHAGA de Blainville

1824. *Coralliophaga* de Blainville, Dictionnaire sci. nat., vol. 32, p. 343.

Type by tautonymy: *Coralliophaga coralliophaga* Gmelin. Pliocene of Florida; Pleistocene and Recent of mid-America.

Shell thin, slightly gaping posteriorly. Outline irregular, very inequilateral, oblong, subcylindrical, often modiolariform. Umbones low, not far from the anterior margin. Surface smooth, radially or concentrically sculptured. Hinge with two very oblique cardinals, one of them bifid, and one posterior laminar lateral. Pallial sinus broad but shallow.

*Coralliophaga*, as may be inferred from the name, is a boring form inhabiting the hard parts of other organisms, especially corals and even rocks.

A number of species have been recorded from the Eocene; the Recent forms are mostly inhabitants of southern seas.

##### *Coralliophaga? microreticulata* Gardner, n. sp.

Plate 9, figures 2-6

Shell exceedingly thin, gaping posteriorly. Outline modiolariform. Umbones strongly anterior but not terminal; umbonal region sculptured with a fine microscopic reticulation, which becomes obsolete posteriorly. Posterior end irregularly corrugated by the incrementals. Hinge and pallial characters lost. Burrows funicular, averaging about 17.0 millimeters in maximum diameter and about 40.0 millimeters in length above the stem. Stem slightly constricted medially, suggesting in cross section a figure 8. Larger diameter, 5 millimeters; smaller diameter, 2 millimeters. Matrix apparently a bryozoan colony.

Cotypes: U. S. Nat. Mus. 325560.

Type locality: Half a mile below the Suffolk waterworks dam, Nansemond County, Va.

Though the evidence at hand does not conclusively establish *Coralliophaga* in the east coast Tertiary, yet all the known facts indicate that *microreticulata* should be referred to this genus. The shells are so thin and so much less resistant than the burrows to which they closely adhere that it was found impossible to extract even one of them in good condition. As the fragmentary nature of the types is due less to the want of material than to the mode of occurrence, it has seemed



best to give the data already available, unsatisfactory and inconclusive though it may be.

Distribution: Virginia: Miocene, Yorktown formation, half a mile below the Suffolk waterworks dam, Nansemond County.

#### Superfamily ISOCARDIACEA

#### Family ISOCARDIIDAE

#### Genus ISOCARDIA Lamarck

1799. *Isocardia* Lamarck, Prodrôme d'une nouvelle classification des coquilles, Soc. histoire nat. Paris Mém., p. 86.

Type by monotypy: *Chama cor* Linnaeus, 1767 = *Cardium humanum* Linnaeus, 1758. Recent off the European coasts and fossil in the Pliocene and Pleistocene of the Celtic Province.

Shell equivalve, heavy, cordiform, inflated. Umbones distant, prominent, prosogyrate. Lunule not clearly delimited. Surface smooth or concentrically furrowed; inner margins entire. Ligament entirely external, sunk in a deep groove. Teeth cyclodont; cardinals two in each valve, erect, lamelliform, approximately parallel to the dorsal margin. Posterior lateral of left valve received in toothlike socket of right; anterior lateral rarely present. Adductor impressions subequal. Pallial line entire.

This genus of large, heavy, cordate shells originates apparently in the Jurassic. From that time on it has been represented by a few conspicuous species. The Recent species, including the type, are most abundant along the European shores.

#### *Isocardia fraterna* Say

Plate 11, figure 15

1824. *Isocardia fraterna* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 143, pl. 11, figs. 1a, 1b.

1838. *Isocardia rustica* Conrad (part), Fossils of the medial Tertiary of the United States, p. 20, pl. 11, fig. 1.

1852. *Isocardia conradi* D'Orbigny, Prodrôme paléontologie, vol. 3, p. 121.

1854. *Glossus rusticus* Sowerby. Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 29.

1863. *Bucardia fraterna* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.

1900. *Isocardia fraterna* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1066.

Cordate-globose, slightly oblique, with rather large concentric wrinkles, and lines of growth; an elevated undulation on the anterior submargin, marking the greatest length of the shell; umbones not very prominent, apex rather suddenly incurved, acute; impressed space behind the beaks, dilated and rather profound; anterior tooth striated externally and placed on the middle of the anterior margin. Large specimen, greatest length (taken obliquely) 3½ inches, breadth rather less.

Small specimen, greatest length rather over 1½ inches, breadth nearly 1¼ inches.—Say, 1824.

Type locality: Maryland [?].

The umbones are anterior, the "impressed space behind the beaks" is the lunule, and the "anterior tooth" is the posterior lateral.

The shell is heavy, often massive, but rather crumbly; the valves vary somewhat in the relative propor-

tions and in the degree of obliquity. The umbones are tumid, flattening near their tips, rather distant, strongly involute and prosogyrate. The depression in front of the posterior fold is usually, though not always, strong enough to undulate the shell from the umbones to the base. The growth lines are prominent and rather crowded toward the ventral margin. The opisthodontic ligament is deeply inset and the ligamentary nymph very heavy. The hinge is rude and massive; the two cardinals of the right valve are lamelliform and subequal, the ventral cardinal being a little shorter, stouter, and more anterior than the dorsal. There are no right laterals, but a profound groove is placed about halfway down the posterior slope for the reception of the lateral of the opposite valve. The ventral cardinal of the left valve is stout and subconical, the dorsal very much compressed and elongated parallel to the arcuate dorsal margin; the posterior lateral is the solitary shelly peak, approximately midway between the umbones and the base. The muscle impressions are strongly defined, the posterior being much larger than the anterior; the pallial line connecting them is simple and moderately distant from the basal margin.

Distribution: Virginia: Miocene, St. Marys formation, Urbanna on the Rappahannock River, Middlesex County. Yorktown formation, Sunken Marsh Creek and Schmidts Bluff (8½ miles below Claremont Wharf), Surry County.

#### *Isocardia fraterna carolina* Dall

Plate 11, figure 5; plate 23, figure 39

1900. *Isocardia carolina* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1067, pl. 46, fig. 22.

Shell large, solid, rotund, rather thin for its size, with involute beaks, inflated and inequilateral valves; anterior end short, subangular above, rounding evenly into the base below; hinge line forms a segment of a circle, and, except the anterior angle, the outline of the valve is nearly suborbicular; near the umbo behind are traces of two radial ridges separated by a shallow sulcus, but these rapidly become obsolete and the surface of the valves smooth except for incremental lines, which become stronger and more disposed in undulations near the anterior base in senile specimens; hinge normal, strong—the lateral smooth and well developed, the left cardinal duplex, compressed, with a small deep pit for the opposite cardinal below the junction; anterior adductor scar small, impressed; posterior scar much larger. Longitude 95, altitude 92, diameter 74 millimeters.

This species is represented by two left valves in the National collection, obtained from North Carolina and Virginia. It forms a marked contrast to *I. fraterna* in its nearly smooth subglobular form and greater size. It may be that to specimens of this species Conrad referred when in his description of *I. rustica* (= *fraterna*) he said that it "attains in North Carolina a larger size than the *I. cor* with which Deshayes considers it identical." If Deshayes had specimens of this sort his conclusion would not seem so unreasonable as it does when one compares a good series of *I. fraterna* with *I. cor* (= *humana*). The present species, though very much less ponderous than *I. fraterna*, is thicker than *I. humana* and has its hinge less compressed, especially the cardinals, of which the profile forms a broad M with a conical pit below it; the lateral is also stronger and proportionately more distant



from the cardinals; the posterior adductor scar is larger than in *humana* of the same dimensions, while the umbo of *I. carolina* is smaller, more pointed, less involute, and is distant 6.5 millimeters from the hinge margin; while, in a specimen of *I. humana* slightly larger than that of *I. carolina*, the umbo of the same valve is 18 millimeters from the margin. Correlatively, the excavation in front of the beaks is considerably smaller in *I. carolina*. The largest senile specimens of *I. humana* are higher and less orbicular than the types of *I. carolina*, which are evidently senile specimens also.

On the whole, in spite of the fact that the material is scanty, there seems to be reason to think that in the Upper Miocene there is a type of *Isocardia* leading from the older Miocene forms of Maryland in the direction of the *I. humana* of the European fauna.—Dall, 1900.

Holotype: U. S. Nat. Mus. 1657.

Type locality: Edgecombe County, N. C.

The type of *Isocardia carolina* Dall is distinct from *I. fraterna* Say. The shell of the former is much thinner and more evenly inflated; the flattening of the central umbones is less pronounced, and usually their tips are less strongly incurved; the posterior angulation is merely suggested and does not affect the contour of the shell, whereas in *I. fraterna* not only the fold is clearly defined but the depression in front of it is usually strong enough to contract the base to a slight degree; the hinge is less robust, but the difference is no greater than normal for a form with a thinner shell.

The connecting series is so complete and so convincing, however, and the combination of characters so diverse, that the specific rank of *I. carolina* can scarcely be maintained. None of the supposedly diagnostic characters of the form are constant; individuals with heavy shells—presenting the typical outline of Say's species—attain a height of 87 millimeters, a length of 113 millimeters, and a semidiameter of 44 millimeters; the outline varies from obliquely-ovate to subrotund to subquadrate; the shell may be thin or massive and, concomitant with the thinner shell, are less conspicuous incrementals.

Distribution: Virginia: Miocene, Yorktown formation (?), Grove Wharf, Surry County (U. S. National Museum); Delaware Park and Delaware, Southampton County.

North Carolina: Miocene, Yorktown formation, Murfreesboro, Hertford County. "Edgecombe County." C. Dall.

*Isocardia fraterna glenni* Gardner, n. subsp.

Plate 16, figures 1, 2

1904. *Isocardia fraterna* Say. Glenn, Maryland Geol. Survey, Miocene, p. 317, pl. 85, figs. 3, 4.

1909. *Isocardia fraterna* Say, Grabau and Shimer, North American index fossils, vol. 1, p. 561, fig. 770.

Specimens from Maryland are smaller and less rounded and have a more pronounced ridge and a basal angle where the dorsal and posterior slopes and margins meet. These differences seem constant but are not deemed of sufficient importance to justify separating the Maryland forms from those from Virginia.—Glenn, 1904.

Shell rather thin, crumbly. Valves rudely quadrate in outline; inflated anteriorly, somewhat depressed

posteriorly. Anterior lateral margin produced in front of the lunular area, broadly and evenly rounded or obscurely truncate. Posterior lateral margin also rounded to subtruncate along a line parallel to the vertical axis. Base line straight medially, upcurved laterally. Umbones strongly anterior, flattened on their summits, involute, and prosogyrate. Posterior carina clearly defined, so sharp dorsally that the umbones are distinctly angulated, becoming increasingly broader, lower, and more rounded ventrally, but persistent to the basal margin; a second keel developed behind the carinal ridge but more feeble and usually evanescent about halfway down to the base. Valves slightly contracted in front of the posterior keel by a broad and very shallow depression. Lunular area strongly excavated but not sharply differentiated. Sculpture restricted to incrementals and, near the basal margin, to well defined and crowded resting stages. Ligament opisthodontic; ligamentary groove deeply channeled, undercutting the umbones to their very tips; nymphs heavy. Dentition rude. Two cardinals in each valve; those of the right valve lamelliform, the ventral cardinal a little sharper, more compressed laterally, and more anterior than the dorsal cardinal; groove between them profound. No true laterals in right valve; toothlike socket developed just dorsal to the posterior truncation. Cardinals of left valve unequal, the dorsal cardinal very much compressed and elongated parallel to the arcuate hinge margin, the ventral cardinal much shorter and less compressed. Adductor muscle impressions often obscure, the anterior sometimes sunken, rather small, and rudely semielliptical in outline; the posterior larger, more irregular and usually more obscure. Pallial line entire, and usually not very distinct.

Dimensions of holotype: Height 59 millimeters, width 73 millimeters, convexity 29 millimeters.

Holotype: Maryland Geological Survey, Johns Hopkins University, Baltimore, Md.

Type locality: Jones Wharf on the Patuxent River, St. Marys County, Md. Choptank formation.

*Isocardia fraterna glenni* is remarkable for its angular subquadrate outline, strongly defined posterior keel, antecarinal undulation, and flattened umbones. It is not known to occur south of the Nomini Cliffs on the Potomac River.

#### Superfamily CARDITACEA

#### Family CARDITIDAE

#### Genus CARDITAMERA Conrad

1838. *Carditamera* Conrad, Fossils of the medial Tertiary of the United States, p. 11.

Type by subsequent designation (Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1408, 1903): *Cypriocardia arata* Conrad.

Shell equivalve, oblong; cardinal tooth in the right valve single, much elongated, compressed and nearly parallel with

the basal margin; in the left valve 2, profoundly diverging, the posterior one corresponding with that in the opposite valve; lateral teeth two, distant, short, pyramidal; muscular impressions large; pallial impression entire.

The genus is nearly allied to *Cypricardia* but wants the three cardinal teeth and the long lateral tooth of that genus; from *Cardita* it is distinguished by the lateral teeth. The projection of the lunule in the right valve gives it the appearance of having two cardinal teeth. I know of this fossil species only, and a recent one nearly allied to it on the coast of Florida.—Conrad, 1838.

Superficially, *Carditamera* recalls some of the members of *Mytilicardita* Anton, notably *Cardita variegata* Bruguière. Laterals are lacking in the Recent species, whereas in *Carditamera* the short remote anterior lateral of the left valve is well developed and is received within a clasping socket of the right valve, and a similar socket in the left valve receives the short but sharp posterior lateral of the right valve. In both the clasping sockets the inner margin is elevated and acute. Such a departure from the dentition of those groups that develop only cardinals is of generic value.

*Carditamera arata verdevilla* Gardner, n. subsp.

Plate 15, figures 5, 6

Shell compressed, strongly inequilateral, transversely oblong, broadly and feebly contracted medially. Umbones low, flattened on their summits, involute, slightly prosogyrate, only about one-fifth of the way back from the anterior margin. Approximately 15 radial costae, the 4 anterior ones rounded and closely, rather conspicuously imbricated; the medial costae low, broad, and flat, and even less affected by the incrementals than their subequal interspaces; the 2 costae that radiate from the umbones to the posterior ventral margin the most conspicuous on the valve, their summits strongly arched and coarsely imbricated; 2 smaller primaries and an adventitious secondary behind them. Hinge and pallial characters normal to the species and subgenus.

Dimensions of holotype: Height 22.3 millimeters, width 46.0 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325511.

Type locality: 8 to 9 miles south of Greenville, Pitt County, N. C.

The absence of concentric imbrications on the low, broad, medial costae strongly emphasizes the very feeble medial depression and, together with the relatively produced and compressed outline, suggests *Cardita protracta* Conrad rather than *C. arata*. The medial ribs of the former, however, are characteristically trigonal and often imbricated, whereas the summits of the latter are very low, very broad, and very flat, and destitute of sculpture. In the type, the concentric sculpture is abruptly discontinued on the fourth rib and abruptly reintroduced on the posterior half of the eleventh rib.

The type of the subspecies was collected a few miles

south of Greenville, where it occurs together with the normal *C. arata* (Conrad) and intergrading individuals. The young, which are rather abundant, are all normal. In Florida *Carditamera arata* occurs in the *Cancellaria* zone of the Choctawhatchee formation and possibly in the *Ecphora* zone.

Distribution: North Carolina: Miocene, Yorktown formation, 8 to 9 miles southeast of Greenville, and 9 to 10 miles south of Greenville (on the property of Fred Haddock), Pitt County; Rock Landing on the Neuse River, Craven County.

*Carditamera columbiana* Gardner, n. sp.

Plate 15, figures 9, 10

Shell heavy, convex. Umbones broad, high, inflated, very much less strongly anterior than in *C. arata*. Radial sculpture of 15 to 17 costae, their summits rounded, rather conspicuously imbricated, subequal in size and spacing, the ribs on the ill-defined posterior area slightly more narrow. Dentition normal for the genus in number and general arrangement but abnormally concentrated and equilateral, consequent on the outline of the valve.

Dimensions of holotype: Height 27.5 millimeters, width 37.0 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325510.

Type locality: Neills Eddy Landing on the Cape Fear River, Columbus County, N. C.

There is a strong tendency in the later and more southern members of this species toward a heavier, shorter, and much more convex shell, but it is not certain whether this is a variation that is due to age or to latitude. The type of the subspecies from the Waccamaw at Neills Eddy Landing is certainly very distinct from the individuals collected abundantly in Virginia, but the gradational series is so complete that there is no doubt about the true relations of the forms.

*Carditamera columbiana* may well be the precursor of *C. tamiamiensis* Mansfield, described from the early Pliocene of the Tamiami Trail, 42 miles west of Miami, Fla. It is a smaller shell, possibly a little higher relatively, with more elevated umbones and less prominent radials.

Distribution: North Carolina: Pliocene, Waccamaw formation, Neills Eddy Landing on the Cape Fear River (3 miles north of Cronly), Columbus County.

Genus *GLANS* Megerle von Mühlfeld

1811. *Glans* Megerle von Mühlfeld, Gesellschaft Naturforschender Freunde zu Berlin, Magazin für die neuesten Entdeckungen in der gesamten Naturkunde, year 5, p. 68.

Type by monotypy: *Chama trapezia* Linnaeus. Recent in the Mediterranean.

*Glans* s. s. differs from most of the other carditids by the small size, subquadrate outline, and the development of both anterior and posterior laterals.

Subgenus *PLEUROMERIS* Conrad

1867. *Pleuromeris* Conrad, Am. Jour. Conchology, vol. 3, p. 12.

Type by monotypy: *Pleuromeris decemcostata* Conrad=*Glans (Pleuromeris) tridentata* (Say) var. *decemcostata* Conrad. Recent off the Florida coast; fossil in the Pliocene and Pleistocene of the southern Atlantic coast.

Equivalve, triangular, radiately ribbed; hinge in the right valve with one broad, nearly direct, concave or broadly furrowed recurved tooth, the upper extremity acute and opposite or above the apex of the shell; hinge in the left valve with three teeth, the anterior one small and fitting into a cavity in the opposite valve.—Conrad, 1867.

Also in the left valve is a short anterior lateral that is received within a double socket in the right valve; a very low posterior lateral in the right valve is received within a double socket in the left valve.

*Pleuromeris* is generically distinct from *Cardita*, with which it has been commonly united. The type designation of *Cardita* has been the object of much discussion. Possibly the most comprehensive résumé is that of Stewart.<sup>38</sup> Stewart attributes *Cardita* to Bruguière, 1792, and considers *Cardita sulcata* Bruguière=*Chama antiquata* Linnaeus, as the type of genus. The designation was made by Children, 1823. The small size and the development of a lateral dentition ally *Pleuromeris* with *Glans* rather than with *Cardita*.

*Glans (Pleuromeris) tridentata* (Say) Gardner

1826. *Venericardia tridentata* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 5, p. 216.

1832. *Cardita tridentata* Say, American conchology, pl. 40, figs. 1-5 with explanatory text.

1858. *Cardita tridentata* Say. Holmes, Post-Pleiocene fossils of South Carolina, p. 31, pl. 6, fig. 8.

1863. *Actinobolus tridentata* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.

1889. *Cardita (Venericardia) tridentata* Say. Dall, U. S. Nat. Mus. Bull. 37, p. 46.

1903. *Venericardia (Pleuromeris) tridentata* Say (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1433.

Not *Cardita tridentata* Reeve, 1843.

Shell suborbicular, subequilateral, thick, and ponderous, with about 18 convex longitudinal ribs cancellate by concentric elevated lines, which do not penetrate into the interstitial narrow spaces, and which are obsolete on the umbo and on the anterior side; inner margin deeply crenate; hinge with 2 diverging teeth, separated by a large cavity on one valve, and on the other, a single large triangular prominent recurved tooth, closing into the cavity.

Length a quarter of an inch, breadth rather more.

This curious shell was discovered by Mr. Stephen Elliott on the coast of South Carolina. \* \* \* This species will be regarded as an interesting addition to the fauna of the present world. The first recent species was described by Lamarck as a native of New Holland. All other known species are found only in the fossil state.—Say, 1826.

Shell rounded, trigonal, subequilateral, moderately convex. Anterior end a little shorter, as a rule, and

more evenly rounded. Posterior dorsal margin obliquely truncate, merging inferiorly into the rounded, lateral margin. Base line straight or slightly arcuate, upturned distally. Umbones subcentral or somewhat anterior, varying widely in height and degree of prominence; the apices acute and feebly prosogyrate. Lunule minute, cordate. Escutcheon minute, lanceolate. Surface sculptured with rather low, gently arched radiating costae, averaging about 15 and separated by narrower and mostly linear interspaces. Radials overridden by crowded, concentric lirations, most conspicuous anteriorly, obsolete in the interradial channels. Ligament external, opisthodontic. Dentition of right valve reduced apparently to a single cardinal, the anterior cardinal being fused, except in the very young, with the anterior margin of the valve and the posterior fused with the ligamentary nymph; middle cardinal strong and prominent, triangular, the apex of the triangle directly beneath the apices of the umbones; anterior lateral socket short, double; posterior lateral tooth very low and inconspicuous; two cardinals in the left valve, of which the anterior is shorter and stouter, divergent on each side of the large subumbonal socket. Anterior left lateral short, posterior lateral socket shallow. Adductor impressions usually obscure. Pallial line simple. Inner margins denticulated in harmony with the external ribbing.

Say's species includes 2 distinct races in the fossil faunas, and these same distinctions, though somewhat less obvious, persist in the Recent representatives: the one a moderately heavy and convex shell with not very conspicuous umbones and about 15 rather low costae overridden by concentric lirae, which are not strong enough to nodulate the ribs; the other, a very heavy and convex little bivalve with very high and very prominent umbones and 10 to 13 or 14 vigorous radials overridden by nodulose concentric lirae. The smaller, less ornate form prevails north of the Hatteras axis during the Tertiary and off the Carolina coast in the Recent waters. The larger, more heavily sculptured race is especially characteristic of the Duplin and Waccamaw formations, and its somewhat reduced descendants still exist along the Florida coast and among the Keys.

The young, particularly in the Yorktown, are much less angular than the adults and quite frequently present a regularly transverse oval outline. The concentric lirae are usually strongest in the young, though in some of the northern individuals—both young and adult—they are almost obsolete.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County;  $\frac{3}{4}$  mile northeast of Smithfield, Bennis Church,  $\frac{1}{4}$  mile from the old church and at Mr. Everet's farm near Bennis Church, Isle of Wight County;  $\frac{1}{4}$  mile north of Chuckatuck,  $1\frac{1}{2}$  miles southeast of Reids Ferry,  $5\frac{1}{2}$  miles northwest of Suffolk, 1 mile west of Suffolk,  $1\frac{1}{2}$  miles northeast of Suffolk, 1 mile northeast of Suffolk,  $\frac{1}{2}$  mile below the Suf-

<sup>38</sup> Stewart, R. B., Gabb's California Cretaceous and Tertiary type Lamellibranchs: Acad. Nat. Sci. Philadelphia, Special Pub. 3, p. 149, 1930.

folk waterworks dam and along the drainage ditch east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, Palmyra Bluff, Halifax County; 4 miles northwest of Williamston, Martin County; 6½ miles below New Bridge, 1 mile below Bells Bridge on the Tar River, Edgecombe County; 2 miles southeast of Tugwell, 1¼ miles northeast of Farmville, 3 miles south of Farmville, 2½ miles north of Standard, 3 miles west of Greenville, 8 to 9 miles south of Greenville, 9 to 10 miles south of Greenville, 3 miles north of Grifton, and 2 miles east of Grifton, Pitt County; 2½ miles northwest of Chocowinity, Beaufort County; 1 mile west of Wilson (in Hominy Swamp, on the farm of Frank Barnes), Wilson County; 1 mile north of Castoria, and 1 mile east of Lizzie (on the farm of T. N. Lassiter), Greene County; Tar Ferry on Wiccacon Creek (opposite Harrellsville) and 1½ miles below Tar Ferry, Hertford County; Colerain Landing and ½ to ¾ mile above Edenhouse Point, Bertie County; Rock Landing on the Neuse River, Craven County. Duplin Marl, Natural Well, 1½ miles north of Magnolia, and W. H. Kornegay's marl pit near Magnolia, Duplin County. Pliocene, Waccamaw formation, Lake Waccamaw, Cronly (half a mile east of the factories), and Neills Eddy Landing (3 miles north of Cronly), Columbus County.

Outside distribution: Miocene, Duplin marl, Porters Landing on the Savannah River, Effingham County, Ga. Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C. Caloosahatchee marl, De Leon Springs, Volusia County, Fla.; Kissimmee well (at a depth of 150 feet), Osceola County, Fla.; Caloosahatchee River, Fla. Croatan sand, Slocums Creek and Mallisons, Craven County, N. C. Pleistocene, Dismal Swamp canal, posts 15 to 16, Virginia; Simmons Bluff and Wadmalaw, S. C.; Kissimmee well (at a depth of 96 feet), Osceola County, Fla.; Eau Gallie, Brevard County, Fla.; Labelle, Hendry County, Fla. Recent off Hatteras in both shallow and deep water; off the Florida coast in shallow water only.

**Glans (*Pleuromeris*) *tridentata decemcostata* (Conrad) Gardner**

Plate 13, figures 1-4

1845. *Cardita tridentata* Say (part). Conrad, Fossils of the medial Tertiary of the United States, p. 76, pl. 43, fig. 11.  
 1856. *Cardita tridentata* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 67, pl. 19, figs. 9, 10.  
 1858. *Cardita abbreviata* Emmons, North Carolina Geol. Survey Rept., p. 302, fig. 236. Not *C. abbreviata* Conrad, 1841.  
 1867. *Pleuromeris decemcostata* Conrad, Am. Jour. Conchology, vol. 3, p. 12.  
 1903. *Venericardia* (*Pleuromeris*) *tridentata* Say (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1433.  
 1932. *Venericardia* (*Pleuromeris*) *tridentata decemcostata* Conrad. Mansfield, Florida Geol. Survey. Bull. 8, p. 89, pl. 16, figs. 3, 4.

Triangular; ribs 12, rounded, ornamented by numerous angular or transverse tubercles over all the ribs.—Conrad, 1867.

Shell very heavy, convex, trigonal, subequilateral. Anterior end rather evenly rounded. Posterior end obliquely truncate dorsally, rounded laterally. Base line straight. Umbones high, heavy, prominent, and erect except at the apices, which are slightly prosogyrate. Lunule minute, stoutly cordate. Escutcheon minute, lanceolate. Surface strongly corrugated, with about 13 elevated costae radiating fanlike from the

umbones; interrational channels deep and narrower than the radials. Radials overridden and more or less nodulated, particularly on the anterior half of the shell, by the vigorous, concentric lirae which, however, do not penetrate the interrational channels. Dentition normal in number for the species, but much more robust, especially the subumbonal cardinal of the right valve. Muscle impressions submedial or a little below the median horizontal and rather small—the anterior reniform, the posterior roughly rotund or elliptical. Pallial line simple, rather distant. Inner margins strongly fluted by the external costae.

This stout, ornately sculptured form of *Pleuromeris tridentata* Say apparently reaches its maximum size and vigor of sculpture during the Waccamaw. The same features, however, that have led to its subspecific isolation from the type prevalent north of the Hatteras axis still persist, though to a lesser degree, and characterize the representatives of the species that inhabit the Florida shores and Keys.

In Florida in the Choctawhatchee, *Glans* (*Pleuromeris*) *tridentata decemcostata* is common in both *Ecphora* and *Cancellaria* zones.

Distribution: North Carolina: Miocene, Yorktown formation, 3 miles southwest of Frog Level, Pitt County. Duplin marl, 2½ miles south of Clinton, Sampson County; Natural Well, 1½ miles north of Magnolia and the marl pits of Frank Wilson and W. H. Kornegay, Duplin County; 4 miles north of Lumberton (on the Berry Godwin plantation), 1 mile west of Lumberton (on the property of Charles Rowland), Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, 1½ miles northeast of Fairmont, and at Fairmont (Ashpole), Robeson County; 4 miles south of Clarkton, Bladen County. Pliocene, Waccamaw formation, 50 miles above Wilmington and at Walkers Bluff, on the Cape Fear River, Bladen County; Lake Waccamaw and Neills Eddy Landing (3 miles north of Cronly on the Cape Fear River), Columbus County; Wilmington (on Smiths Creek and at the city rock quarry), New Hanover County.

Outside distribution: Miocene, Duplin marl, Sumter district, Sumter County, S. C. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River, Fla. Recent off the coast of Florida in shallow water.

**Subgenus? *PTEROMERIS* Conrad, 1862**

1862. *Pteromeris* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 290.

Type by original designation: *Cardita perplana* Conrad.

Triangular, not oblique, with radiating ribs; beaks medial; hinge of left valve, anterior tooth direct or directed slightly toward the anterior margin; posterior tooth double or bifid.—Conrad, 1862.

Only faint traces of a lateral dentition can be observed in this small group. It does not seem sufficiently important to be given generic rank, but it differs so markedly in form and dentition from *Glans*, probably its closest ally, that I hesitate to unite them generically.

**Glans (*Pteromeris*) *perplana* (Conrad) Gardner**

Plate 13, figures 6-9

1841. *Cardita perplana* Conrad, Am. Jour. Sci., 1st ser. vol. 41, p. 347, pl. 2, fig. 16.  
 1845. *Astarte radians* Conrad, Fossils of the medial Tertiary of the United States, p. 77, pl. 43, fig. 13.  
 1846. *Astarte flabella* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 3, p. 24, pl. 1, fig. 3.  
 1856. *Cardita perplana* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 68, pl. 19, fig. 11.  
 1858. *Cardita perplana* Conrad. Emmons, North Carolina Geol. Survey Rept., p. 302, fig. 235.  
 1863. *Actinobolus (Pteromeris) radians* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.  
 1885. *Venericardia obliqua* Bush, Connecticut Acad. Trans., vol. 6, p. 478.  
 1903. *Venericardia (Pteromeris) perplana* Conrad. Dall, Acad. Nat. Sci. Philadelphia Proc. for 1902, p. 705.  
 1903. *Venericardia (Pteromeris) perplana* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1434.

Trigonal, nearly flat; ribs about 11, angular, minutely granulated.—Conrad, 1841.

Type locality: Natural Well, Duplin County, N. C.

Shell small, trigonal-ovate, compressed to apparent flatness. Lunule and escutcheon sublinear-lanceolate, the latter only a little longer and narrower than the former. Umbones high, compressed, with acute and feebly prosogyrate apices, placed about one-third the length in front of the posterior margin; apical angle running between 70° and 85°. Anterior end obliquely produced. Dorsal margins slightly concave in lunular region. Lateral margin evenly rounded. Posterior dorsal slope much more steep than anterior, merging rather abruptly into the base. Ventral margin horizontal medially, strongly upcurved distally. Surface corrugated with 10 to 15 or 16 rather low, broadly arched, radial costae, separated mostly by linear inter-radials; radials overridden by microscopic undulatory growth lines. Ligament external, opisthodontic; nymph relatively broad, bounded dorsally by a deep groove. Hinge dentition vigorous; in the right valve, a feeble laminar anterior cardinal and a very stout, triangular, medially sulcate, middle cardinal; posterior right cardinal fused with ligament nymph; in the left valve, two bifid cardinals—the anterior shorter and more compressed—separated by the deep subumbonal socket; anterior lateral margin of right valve and posterior margin of left feebly grooved to receive the more or less beveled edges of the opposite valve. Adductor muscle impressions usually distinct, the posterior semi-elliptical and slightly higher than the reniform anterior scar. Pallial line entire, distant. Inner margin crenulated in harmony with the external ribbing.

*Pteromeris perplana* Conrad is notably unstable during the Late Tertiary. The species varies in convexity and outline from relatively high and less compressed forms, which are isolated under the subspecies *abbreviata*, to broader individuals in which the cavity is

scarcely thicker than the outer shell covering. In the Recent species, the radials rarely number fewer than 12 or more than 14, whereas in the Miocene they may number as few as 10 and, if the subspecies *abbreviata* be included, up to 18 or 20. In the Waccamaw, the species attains its maximum size and compression. The dimensions of a valve from Walkers Bluff are as follows: Height 10.3 millimeters, width 9.6 millimeters, convexity 1.6 millimeters, thickness of shell itself 1.0 millimeter. Individuals pursuing this line of development are further characterized, as a rule, by a more distant and angular radial sculpture and by a broader, less elevated hinge dentition.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; 5½ miles northwest of Suffolk, 1 mile west of Suffolk, 1 mile northeast of Suffolk, and at Suffolk (½ mile below the waterworks dam), Nansemond County.

North Carolina: Miocene, Yorktown formation, 1¼ miles northeast of Farmville, 8 to 9 miles southeast of Greenville, and 9 to 10 miles south of Greenville, Pitt County; 3 to 4 miles below Tar Ferry, Hertford County; Colerain Landing on the Chowan River, Bertie County; Rock Landing on the Neuse River, Craven County. Duplin marl, 10 miles south of Clinton, Sampson County; Natural Well, 1½ miles north of Magnolia, and W. H. Kornegay's marl pit near Magnolia, Duplin County; Lumberton and 2 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Lake Waccamaw, Cronly, and Neills Eddy Landing on the Cape Fear (3 miles north of Cronly), Columbus County; city rock quarry near Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin marl, Porters Landing, Effingham County, Ga. Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla. Croatan sand, Slocums Creek, Craven County, N. C. Pleistocene, Kissimmee well (at a depth of 96 feet), Osceola County. Recent, Hatteras to Charlotte Harbor in 14 to 52 fathoms.

**Glans (*Pteromeris*) *perplana abbreviata* (Conrad) Gardner**

Plate 13, figures 19-22

1841. *Cardita abbreviata* Conrad, Am. Jour. Sci., 1st ser., vol. 41, p. 347, pl. 2, fig. 17.  
 1845. *Astarte abbreviata* Conrad, Fossils of the medial Tertiary of the United States, p. 77, pl. 43, fig. 12.  
 1856. *Cardita abbreviata* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 69, pl. 19, fig. 12.  
 1863. *Actinobolus (Pteromeris) abbreviata* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.  
 1903. *Venericardia (Pteromeris) perplana* var. *abbreviata* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1435.  
 1932. *Venericardia (Pleuromeris) perplana* var. *abbreviata* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 88, pl. 16, fig. 5.

Trigonal, elevated, convex-depressed, ribs about 11, convex, minutely granulated; posterior extremity angulated. This and the preceding species [*Cardita perplana*] belong to the genus *Venericardia* of Lam.—Conrad, 1841.

Type locality: Wilmington, N. C.

*Venericardia perplana abbreviata* Conrad is a little less compressed than *perplana* s. s., is higher, and never

attains the size of the latter. The radials vary in number from 10 to 20, and their prominence is inversely proportional to their number. Concomitant with the variation in outline is also a variation in the character of the hinge—particularly toward a narrow ligamentary nymph—and a greater inequality of the two left cardinals.

Both the subspecies and the species originated apparently in the Yorktown formation. North of the Hatteras axis *abbreviata* is distinctly the prevailing type; south of it *perplana* s. s. is equally prominent in the Duplin and Waccamaw and, after the close of the Pliocene, quite excludes the relatively higher and more inflated form. In Florida *abbreviata* is common in the *Eophora* zone of the Choctawhatchee formation and rare in the *Cancellaria* zone above it.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Bennis Church,  $\frac{1}{4}$  mile from the old church and Everet's farm near Bennis Church, Isle of Wight County;  $\frac{1}{4}$  mile north of Chuckatuck,  $1\frac{1}{2}$  miles southeast of Reids Ferry,  $5\frac{1}{2}$  miles northwest of Suffolk, 1 mile west of Suffolk, 1 mile northeast of Suffolk, Suffolk, and  $1\frac{1}{2}$  miles below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 3 to 4 miles below Tar Ferry, Hertford County; 3 miles south of Farmville, 8 to 9 miles south of Greenville, 9 to 10 miles south of Greenville, 2 miles east of Grifton (on J. F. Brooks' farm), Pitt County; 2 miles southwest of Maple Cypress, Rock Landing, Craven County; 1 mile west of Wilson (on Frank Barnes property in Hominy Swamp), Wilson County; 1 mile north of Castoria, Greene County. Duplin marl, Natural Well,  $1\frac{1}{2}$  miles north of Magnolia, and W. H. Kornegay's marl pit near Magnolia, Duplin County; 1 mile west of Lumberton (on the property of Charles Rowland), Lumberton (near the bottling works), 2 miles below Lumberton, and  $1\frac{1}{2}$  miles northeast of Fairmont (on the property of Andrew Jones), Robeson County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Lake Waccamaw and Neills Eddy Landing, on the Cape Fear River (3 miles north of Cronly), Columbus County; and city rock quarry near Wilmington, New Hanover County.

Outside distribution: Miocene, Hawthorn formation, Porters Landing, Effingham County, Ga. Duplin marl, Darlington, Darlington County, S. C. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C. Caloosahatchee marl, Shell Creek, Fla. Croatan sand, Slocums Creek, Craven County, N. C.

#### Family CONDYLOCARDIIDAE Bernard

This family was instituted by Bernard for some extremely minute bivalves, related to the *Carditidae* but which retain in the adult state the immaturity of hinge characters which characterizes the nepionic shells of *Cardita* and, moreover, have the resilium sunken and centrally located between the valves. The prodissococonch in this group is of the usual size but appears very prominent on account of the relatively small additions made to it in growth.—Dall,<sup>39</sup> 1903.

<sup>39</sup> Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1436, 1903.

#### Genus ERYCINELLA Conrad

1845. *Erycinella* Conrad, Fossils of the medial Tertiary of the United States, p. 74.

Type by monotypy: *Erycinella ovalis* Conrad.

This genus is nearly allied to *Erycina* of Lamarek but has four teeth in the left valve. In the opposite valve the two teeth diverge, are rather long, and curving slightly inward, and the posterior one inclining to be double.—Conrad, 1845.

Shell small, oval, radially sculptured, with an external ligament and internal resilium situated between the cardinals, of which there are 2 in each valve; in the left valve the edges of the resiliary chondrophore are somewhat raised, so that when worn the valve appears to contain four cardinals, but I think these ridges are not of the nature of true teeth; in the right valve the posterior cardinal is stout and triangular and feebly grooved; there is a feeble, elongate, posterior right and anterior left lateral, which fits into a groove in the margin of the opposite valve; the inner margins of the valves are crenulated.—Dall,<sup>40</sup> 1903.

This genus includes a few Tertiary and Recent species from the cooler waters.

In addition to the 2 well-developed cardinals in the right valve, there is a third—a laminar, somewhat rudimentary anterior cardinal. It is the middle and not the posterior cardinal that is stout and trigonal.

#### *Erycinella ovalis* Conrad

Plate 14, figure 46

1845. *Erycinella ovalis* Conrad, Fossils of the medial Tertiary of the United States, p. 74, pl. 42, fig. 5.

1857. *Erycina ovalis* (Conrad). D'Orbigny, Prodrome paléontologie, vol. 3, p. 115.

1863. *Erycinella ovalis* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 578.

1864. *Erycinella ovalis* Conrad. Acad. Nat. Sci. Philadelphia Proc. for 1864, p. 212.

1903. *Erycinella ovalis* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1438, pl. 53, fig. 2.  
Not *Erycinella ovalis* S. V. Wood, 1853.

Very small, obliquely oval from beak to base, convex, with indistinct radiating lines; posterior side shorter than the anterior; basal margin obliquely rounded; cardinal teeth robust; inner margin crenulated. Locality, Yorktown, Va.—Conrad, 1845.

Shell minute, moderately convex, but heavy and rude, oval, slightly oblique, and inequilateral. Anterior margin descending at a very steep angle from the umbones almost to the base, with which it unites in a broad, even curve. Posterior dorsal margin a trifle convex and produced. Lateral margin squarely or somewhat obliquely truncated but rounding gently into the base. Umbones moderately inflated even to their apices, which are proximate, involute, and very feebly prosogyrate. Sculpture of some 20 to 30 very low,

<sup>40</sup> Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1436, 1903.



relatively broad radials that are least feeble near the ventral margin and are, as a rule, quite obsolete in the umbonal region; 3 or 4 resting stages usually discernible under magnification. Ligament both external and internal; external ligament mounted on minute linear nymphs, which run parallel to the posterior dorsal margin; internal ligament lodged in a subumbonal resiliial pit between the cardinals. Hinge of right valve armed with 3 cardinals—the anterior cardinal rudimentary and laminar; the middle rude but robust, roughly trigonal, simple, or feebly sulcate; the posterior simple, oblique, and compressed. Left cardinals 2 in number—the anterior cardinal oblique, compressed, sometimes longitudinally sulcate; the posterior somewhat shorter and more compressed than the anterior; distal edges of resiliial pit raised, thus simulating cardinals, particularly in the more weathered individuals. Muscle impressions small, slightly below the median horizontal—the anterior somewhat reniform, the posterior oval-elongate. Inner margins feebly crenulated.

*Erycinella ovalis* Conrad is the only representative of this minute but well-characterized genus in the east coast Miocene. Though not confined exclusively to the Yorktown formation of Virginia, it is abundant only along the York River and in the environs of Suffolk.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Benns Church,  $\frac{1}{4}$  mile from the old church and Mr. Everet's farm near Benns Church, Isle of Wight County;  $\frac{1}{4}$  mile north of Chuckatuck,  $1\frac{1}{2}$  miles southeast of Reids Ferry, 1 mile west of Suffolk, 1 mile northeast of Suffolk, half a mile below the Suffolk waterworks dam, and along the drainage ditch just east of the Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, Greenville (just east of the county bridge) and 9 to 10 miles south of Greenville, Pitt County (very rare); Tar Ferry on Wicacoon Creek (opposite Harrellsville), Hertford County; Colerain Landing, Bertie County.

#### Pelecypoda (incertae sedis)

Plate 14, figures 33-36

Shell minute but solid. Valves evenly inflated, obliquely ovate in outline. Umbones low and very obtuse, placed within the posterior third of the shell. Lunule and escutcheon not differentiated. Posterior end quite evenly rounded from the umbones to the ventral margin. Anterior end obliquely produced, but rounding evenly into the base. Ventral margin less strongly upcurved before than behind. Outer surface with a dull luster, devoid of sculpture. Hinge moderately heavy for the size of the shell. Ligament external, lodged in a short, shallow, marginal groove behind the umbones. Resilium internal, lodged in a small resiliial pit behind the cardinals, separated from the ligament by a shelly buttress. Cardinals three in number in each valve; anterior cardinal of right valve elongated, laminar; middle cardinal heavy, trigonal, feebly sul-

cated on its ventral margin; posterior cardinal either rudimentary or broken, probably the former, as the two valves were found united; anterior cardinal of left valve also laminar and elongated but less than that of the right; medial cardinal moderately heavy, simple; posterior cardinal placed near the medial, very short and quite slender. Muscle scars obscure, the anterior pyriform and placed a little below the median horizontal, the posterior elliptical, submedial in position. Pallial line indistinct, entire. Inner margins simple.

Dimensions of figured specimen: Height 1.7 millimeters, width 1.8 millimeter; diameter  $1.0 \pm$  millimeter.

Figured specimen: U. S. Nat. Mus. 325557.

Even the more distant affinities of this minute bivalve are exceedingly doubtful. The diagnostic characters are the posterior position of the obtuse umbones; the smooth external surface; the internal resilium placed behind the cardinals and not between them; the peculiar, short, slender, posterior cardinal of the left valve; and the absence of any pallial sinus.

The form is persistently suggestive of *Erycinella* Conrad in spite of quite radical differences, and for that reason it has been placed tentatively with the latter near the *Condylocardiidae* of Bernard. It differs from other members of the family by the establishment of the resilium behind the cardinals instead of between them; by the presence of 3 left cardinals instead of 2; and by the absence of any suggestion of radial sculpture either externally or on the inner ventral margins. The absence of a lunule or escutcheon, the blunt posterior umbones, and the entire pallial line suggests, however, a comparatively primitive form. The absence of laterals and the discrepant cardinals exclude it from the *Cyrenacea*. It has therefore been placed among the primitive *Carditacea*, although its position is by no means assured.

Distribution: Virginia: Miocene, Yorktown formation, Suffolk, Nansemond County.

#### Superfamily LUCINACEA

##### Family LUCINIDAE

A comprehensive and valuable study of the relationships of the lucinoids has been made by Chavan,<sup>41</sup> who illustrates the genera and offers a chronological table of the evolution of the Lucinas.

##### Genus CTENA Mörch

1861. *Ctena* Mörch, Malakozoologische Blätter, vol. 7, p. 201.

1869. *Jagonia* Récluz, Soc. linnéenne Bordeaux Actes, vol. 27 (ser. 3, vol. 7), p. 37.

Type by subsequent designation (Dall, Bartsch, and Rehder, B. P. Bishop Museum Bull. 153, p. 128, 1938): *Codakia pectinata* Carpenter (not Gmelin) = *C. mexicana* Dall. Lower California to Panama and Ecuador.

<sup>41</sup> Chavan, A., Essai critique de classification des Lucines: Jour. conchyliologie, vol. 81, pp. 133-153, 198-216, 237-282, 1937; vol. 82, pp. 59-97, 105-130, 215-241, 1938.



Shell of medium size, suborbicular to transversely oval, moderately compressed. Beaks small, pointed, median or slightly posterior. Lunule narrow, lanceolate, depressed. Ligament covered with a calcareous coating and typically inset with the resilium. Two cardinals and anterior and posterior laterals in each valve. Anterior muscle scar elongated, the posterior rudely quadrate. Pallial line simple. Outer surface radially corded and concentrically threaded. Inner margin smooth or feebly crenate.

The group, formerly referred to *Codakia* (*Jagonia*), is separated from *Codakia* Scopoli by its more prominent, more posterior umbones, larger lunule, relatively stronger radial sculpture, and its heavier posterior laterals.

Both the Tertiary and the Recent species of *Otena* are restricted in number of both species and individuals but have a fairly wide distribution in the tropical and temperate faunas.

*Otena speciosa* (Rogers and Rogers) Gardner

Plate 13, figure 33

1837. *Lucina speciosa* Rogers and Rogers, Am. Philos. Soc. Trans., new ser., vol. 5, p. 333, pl. 26, fig. 6.  
 1840. *Lucina squamosa* Conrad, Fossils of the medial Tertiary of the United States, p. 38, pl. 20, fig. 1. Not *L. squamosa* Lamarck, 1818.  
 1856. *Lucina squamosa* Lamarck. Tuomey and Holmes, Pleocene fossils of South Carolina, p. 57, pl. 18, figs. 6, 7.  
 1858. *Lucina squamosa* Lamarck. Emmons, North Carolina Geol. Survey Rept., p. 291 (name only).  
 1863. *Codakia speciosa* Rogers. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 577.  
 1903. *Codakia (Jagonia) speciosa* Rogers. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1350.

Shell subelliptical, inequilateral, inflated, rather thin, with equal, close-set, rather elevated, longitudinal ribs and regular, very close, concentric striae; lunule small, very distinct, and ovate-lanceolate; beaks small, pointed, and slightly prominent beyond the general curve of the margin, placed about one-third the transverse length of the shell from the anterior end; cardinal teeth small, diverging; lateral teeth equal, distinct, and nearly equidistant from the anterior cardinal; hinge margin regularly arcuated; the rest of the margin, especially the posterior side, crenate within; posterior muscular impression elongated and slightly curved. Diameter three-tenths, length eleven-twentieths, height nine-twentieths of an inch.

This very beautiful shell occurs in nearly all the localities of the Miocene in the James River region.—W. B. and H. D. Rogers, 1837.

A right valve (U. S. Nat. Mus. 145067) from the Yorktown formation at Bellefield, Va., is figured. It measures 14.1 millimeters in height and 16.4 millimeters in width.

The Rogerses' species is larger than *Otena magnoliana* (Dall), is decidedly convex, and the sculpture, though of the same general type, is much coarser.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown on the York River, York County: "James River region" (W. B. and H. D. Rogers).

North Carolina: Miocene, Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County.

Outside distribution: Miocene, Duplin marl, Darlington, Darlington County, S. C. Pliocene, Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla. Pleistocene, Labelle, Hendry County, Fla. (Vaughan).

*Otena magnoliana* (Dall) Gardner

1903. *Codakia (Jagonia) magnoliana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1349, pl. 52, fig. 17.  
 1932. *Codakia (Jagonia) magnoliana* Dall. Mansfield, Florida Geol. Survey Bull. 8, p. 93, pl. 20, fig. 1.

Shell small, thin, inequilateral, the beaks five-elevenths of the whole length in front of the posterior end; both ends rounded, base arcuate, lunule narrow, lanceolate, no distinct dorsal areas; sculpture of numerous, even, fine, close-set, rarely divaricate, similar, radial riblets, crossed by fine, rounded, equal, close-set threads, narrower than the riblets, and which in crossing the latter are slightly arcuate convexly towards the beaks, making a very elegant though minute type of sculpture; hinge thin and delicate, but the teeth, especially the right laterals, very distinct; scars normal; margins delicately crenulate. Height 9.5, length 11.5, diameter 4.5 millimeters.

This species is of the fully differentiated *Jagonia* type, and its sculpture is notably elegant.—Dall, 1903.

Holotype, a right valve: U. S. Nat. Mus. 115113.

Type locality: Magnolia, Duplin County, N. C. Duplin marl.

The distribution of *Otena magnoliana* in Florida is restricted to the *Cancellaria* zone of the Choctawhatchee formation.

Distribution: North Carolina: Miocene, Duplin marl. Natural well and 1½ miles north of Magnolia, Duplin County. Rare.

*Otena microimbricata* Gardner n. sp.

Plate 13, figures 31, 32

Shell small, thin, moderately inflated, transversely ovate, inequilateral. Umbones rather tumid, only a little more than one-third the total length in front of the posterior margin, their apices flattened and proximate. Lunule elongate-lanceolate, smooth; depressed, but not bounded by an incised line. Escutcheon absent. Anterior end more produced than the posterior; semi-elliptical. Posterior dorsal margin more oblique than the anterior dorsal, merging gradually into the rounded lateral margin. Base line arcuate. Entire external surface covered with closely appressed concentric imbrications, overlapping dorsally, and evenly and minutely crenulated by the fine, crowded radials. Ligament inset, opisthodetic, mounted on a narrow, obliquely elongated nymph. Anterior cardinal of right valve short and thin; right posterior cardinal subumbonal, moderately compressed, feebly sulcated. Anterior and posterior laterals sharp, distant, triangular, and prominent though slender. Muscle impressions obscure. Pallial line entire. Marginal crenulations delicate.

Dimensions of holotype: Height 9.8 millimeters, width 11.2 millimeters, convexity 2.8 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325540.

Type locality: Natural Well, Duplin County, N. C. Duplin marl.

*Otina microimbricata*, n. sp., constitutes the end member of a very interesting series, which includes *C. speciosa* (Rogers and Rogers) and *C. magnoliana* (Dall), and in which the sculpture, though of the same general type throughout, becomes increasingly fine and more delicate. The Duplin forms never equal the Rogerses' species in size or degree of convexity. The radials in all three of the species are approximately uniform in strength over the entire external surface and are frequently bifurcating. In valves of the same size, the radials of *C. speciosa* number  $2\frac{1}{2}$  to the millimeter, those of *C. magnoliana* 3, and those of *C. microimbricata* 4. The concentric elevations run about 6 to the millimeter in *C. speciosa*, 9 in *C. magnoliana*, and 13 in *C. microimbricata*. A corresponding increase in regularity and in closeness of the appression to the surface is evident. In the new species the detail of the sculpture is microscopically fine. Concomitant with the thinner shell is the thinner and more delicate hinge and the finer marginal crenulation. The hiatus between *C. speciosa* and *C. magnoliana* is very much less obvious than that between *C. magnoliana* and *C. microimbricata*.

The species is described from a single right valve.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well, Duplin County.

#### Genus PHACOIDES Blainville

1825. *Phacoides* Blainville, Manuel de malacologie et de conchyliologie, vol. 1, p. 550.

Type by monotypy: *Lucina jamaicensis* Lamarck = *Tellina pectinata* Gmelin. Recent in the West Indies.

Shell more or less lenticular; compressed, as a rule, or only slightly tumid. Umbones low, subcentral, erect or prosogyrate. Lunule commonly profound. Escutcheon obsolete. Anterior and posterior dorsal areas usually differentiated. Sculpture dominantly concentric. Ligament external, in many specimens deeply sunken; normal dentition of right valve consisting of a simple anterior cardinal, a bifid posterior cardinal, and heavy anterior and posterior laterals; normal dentition of left valve consisting of a bifid anterior cardinal, a simple posterior cardinal, and heavy anterior and posterior lateral sockets; laterals in many specimens, and cardinals in some, obsolete. Muscle impressions strongly marked, the posterior oval, the anterior narrow, elongated, parallel to the pallial line. Pallial line entire. Inner margins smooth or crenulated.

The genus is abundantly represented in the Tertiary, and related forms are present in the Mesozoic and possibly in faunas even more ancient. The living species number more than 100, and, though most prolific in the tropics, they are present in the temperate seas as well.

#### Subgenus CARDIOLUCINA Sacco

1901. *Cardiolucina* Sacco, I Molluschi dei Terreni Terziarii del Piemonte e della Liguria, pt. 29, p. 89.

Type by original designation: *Cardium agassizii* Michelotti. Middle and upper Miocene of northern Italy.

*Cardiolucina*, as Woodring indicated in 1925, includes many of the common east coast Miocene and Pliocene lucinoids formerly referred to *Cavilucina*. They are characterized by small, commonly inflated valves, broadly rounded and produced anterior margins, a short, deep, lunular depression, inconspicuously differentiated dorsal areas, a strong concentric sculpture, with or without a feeble radial component, a well-developed cardinal and lateral dentition, and a finely crenate inner margin.

Chavan,<sup>42</sup> 1937, considered *Cardiolucina* a synonym of *Bellucina* Dall, 1901.

In order to place some of the species from the American Tertiary, he erected the genus *Cavilinga* and designated as the type *Lucina trisulcata* Conrad of the upper Miocene and Pliocene faunas of the southeastern United States. He included under *Cavilinga* not only the group of Upper Tertiary forms commonly referred to *Cardiolucina* but also a number of middle and upper Eocene species, such as *L. pomilia* Conrad and *L. alveata* Conrad. There are no examples of Sacco's subgenotype in the collections of the U. S. National Museum, and the acceptance of Chavan's subgenus is delayed in the hope of later consulting material upon which Sacco based his *Cardiolucina*.

Woodring observed that *Cardiolucina* is one of many Middle and Upper Tertiary groups persistent in the Recent West Indian faunas but not recorded from European seas.

#### *Phacoides (Cardiolucina) trisulcatus multistriatus* (Conrad)

Plate 13, figures 25, 26

1843. *Lucina multistriata* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 307.

1863. *Codakia multistriata* Conrad (part), Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 577.

1903. *Phacoides (Cavilucina) trisulcatus* var. *multistriatus* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1370.

1932. *Phacoides (Cardiolucina) trisulcatus multistriatus* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 96, pl. 20, figs. 15, 16.

Oval, equilateral, slightly ventricose, with fine, prominent, closely arranged, concentric, and minute radiating lines; disk with 2 or more distinct undulations on the inferior half; beaks prominent; dorsal margins profoundly declining; anterior lateral tooth distinct, remote; inner margin minutely crenulated; lunule elliptical, slightly impressed. Height, one-third of an inch.

Locality, Wilmington, N. C.—Conrad, 1843.

<sup>42</sup> Chavan, A., Essai critique de classification des Lucines (Suite), Jour. conchyliologie, vol. 81, p. 205, 1937.

The figured left valve (U. S. Nat. Mus. 325538), measures 5.8 millimeters in height and 6.3 millimeters in width. It is from the Waccamaw formation in the city rock quarry at Wilmington, N. C.

Shell small, rudely circular or ellipsoidal, moderately gibbose. Lunule very small but very deeply excavated. Escutcheon absent. Umbones usually a little behind the median line, acute, prosogyrate, thrown into prominence by the profound lunular pit in front of them. Anterior end produced, very broadly rounded or obscurely truncated laterally. Posterior end shorter. Posterior dorsal margin oblique or slightly convex; lateral margin broadly rounded or squarely truncate. Base line broadly arcuate. Posterior dorsal area defined by an obscure carina and by a change in direction and character of the concentric lamination. Surface sculptured with strong, closely spaced, concentric lirae, which are finer and more crowded on the adolescent shell; a feeble radial striation, which is absent in the *trisulcatus* s. s., is rather evident in the subspecies. Ligament marginal. Normally, a simple anterior cardinal and a bifid posterior cardinal in the right valve; a bifid anterior and a simple posterior cardinal in the left valve; anterior cardinals becoming obsolete with age, and even the posterior cardinals sometimes affected; laterals rude but prominent; short anterior and posterior lateral denticles in the right valve; anterior and posterior lateral grooves in the left valve—the inner margins raised into toothlike prominences. Adductor impressions often obscure; the anterior linguiform, the posterior oval. Pallial line simple. Marginal denticulation very fine.

*Phacoides (Cardiolucina) crenulatus* (Conrad), the only species with which *P. trisulcatus* is confusable, is a much thinner and usually smaller shell with a more evenly rounded outline, and with more uniformly central and less prominent umbones, a much less deeply excavated lunule, a finer concentric sculpture, and a less rude and vigorous dentition. The aspect of the interior of the valve of *P. trisulcatus* is very characteristic—the posterior dorsal margin ascending with a slight convexity to the acute apices, the small but almost semi-circular lunule pit in front of the umbones, and the anterior dorsal margin sloping gently to the lateral truncation.

The subspecies differs from the normal type only in having a feeble radial sculpture. Unlike *P. trisulcatus* s. s., it is apparently restricted in the Carolinas to the Duplin and Waccamaw formations. In the Choctawhatchee of Florida it has been reported only from the *Cancellaria* zone. The *P. (Cardiolucina) trisulcatus* group is reported by Olsson from both Tertiary and Recent faunas of mid-America.

Distribution: North Carolina: Miocene, Duplin marl, 4 miles north of Lumberton and 1½ miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; city rock quarry near Wilmington, New Hanover County.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida.

***Phacoides (Cardiolucina) postalveatus* Gardner, n. sp.**

Plate 13, figure 17

Shell small, heavy, subglobose. Umbones central with prosogyrate apices, high enough to break the even curve of the valvular margins. Lunule subrotund; depressed but not excavated. Surface concentrically sculptured with broad, heavy, tabulated elevations, which are more or less fused in the adult. Ligament opisthodontic, elongated, sunken. Dentition rude but vigorous. Left anterior cardinal feebly bifid; posterior simple; anterior and posterior lateral pits small but deep. Dentition of right valve unknown. Inner margins finely crenulate.

Dimensions of holotype: Height 3.3 millimeters, width 3.4 millimeters, convexity 1.4 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325539.

Type locality: Yorktown, York County, Va. Yorktown formation.

This sturdy little species is set apart from the coexistent *Cardiolucinas* by the broadly tabulated concentric elevations. It is, however, differentiated with greater difficulty from certain mutants of the Eocene *P. (Cardiolucina) alveatus* Conrad, prolific in the sands of the Claiborne group. Only 2 valves—both left valves—of the Yorktown species have been recovered. The larger of these is apparently adult. It is smaller than the average *alveatus* and is more regular in outline because of the less prominent umbones. The fusion of the concentric sculpture is seemingly more complete in the later form, for in *alveatus* some trace of the component costae is usually retained in more or less feeble striations that are continuous across the disk. These do not occur in *postalveatus* except on the extreme distal margins. On the contrary, the 3 broad elevations formed by the fusion of the costae on the lower two-thirds of the valve are smooth and polished and are slightly undercut by the channels behind them.

*P. (Cardiolucina) postalveatus* may possibly be the much reduced descendant of the flourishing *alveatus* of the Early Tertiary.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown on the York River, York County.

**Subgenus LUCINISCA Dall**

1901. *Luciniscia* Dall, U. S. Nat. Mus. Proc., vol. 23, p. 805.

1937. *Luciniscia* Chavan, Jour. conchyliologie, vol. 81, p. 238.

Type by original designation: *Lucina nassula* Conrad. Hatteras to Cuba and west to Mobile Bay in 7 to 200 fathoms.

Shell lentiform, white, with well-marked dorsal areas, the sculpture reticulate and muricate, the right anterior cardinal obsolete.—Dall, 1901.

***Phacoides (Luciniscia) cribrarius* (Say) Dall**

Plate 13, figures 23, 24, 29, 30

1824. *Lucina cribraria* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 147, pl. 13, fig. 1.

1856. *Lucina cribraria* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 58, pl. 18, figs. 8, 9.  
 1863. *Codakia cribraria* Say (part). Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 577.  
 1903. *Phacoides (Luciniscia) cribrarius* Say (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1372.  
 1904. *Phacoides (Luciniscia) cribrarius* (Say). Glenn, Maryland Geol. Survey, Miocene, p. 341.  
 1932. *Phacoides (Luciniscia) cribrarius* (Say). Mansfield, Florida Geol. Survey Bull. 8, p. 97, pl. 21, figs. 22, 23.  
 1937. *Lucina (Luciniscia) cribraria* Say. Chavan, Jour. conchyliologie, vol. 81, p. 240, fig. 6.

Orbicular, convex, with numerous longitudinal costae, and distinct elevated concentric lines.

Shell with close-set, longitudinal, equal, granulated ribs, and more or less elevated, distinct, concentric lamellae; hinge margin obtusely and not prominently angulated at its anterior and posterior terminations; anterior margin with a dilated, slightly impressed, and not very obvious groove; lunule oblong-oval, very distinct, the edge near the beaks extending inward beside the primary teeth; lateral teeth very distinct, the posterior one placed nearly under the middle of the lunule; within crenate on the edge; posterior muscular impression rectilinear.

Length half an inch, breadth  $1\frac{1}{2}$  of an inch.

Type locality: Maryland.—Say, 1824.

The figured right valve (U. S. Nat. Mus. 325536) is from the Yorktown formation, 5 miles northeast of Smithfield, Va., and measures 12.8 millimeters in height and 12.9 millimeters in width. The figured left valve (U. S. Nat. Mus. 325535), from the Yorktown formation at Yorktown, Va., measures 10.0 millimeters in height and 10.6 millimeters in width.

*Phacoides cribrarius* is one of several species described by Say in 1824 which were collected, according to him, in Maryland by John Finch but which have not been noted by later observers. It is probable that they came from Virginia.

Shell of medium size, moderately compressed, subcircular in outline. Umbones subcentral, low and not very conspicuous, their apices acute and prosogyrate. Lunule, a small but profoundly excavated pit in front of the umbones. False lunule, or anterior dorsal area, depressed, elongate-cordate, defined by an incised line and an abrupt change in ornamentation; posterior dorsal area sharply defined by a depression of the valve and a conspicuous change in the character of the sculpture. Surface ornamented with about 30 radial lirae, low and flat-topped on the medial part of the disk, more elevated and arched toward the anterior and posterior margins; interspaces sublinear medially, widening somewhat distally; radials overridden by 12 to 18 sharply elevated, concentric lamellae, which, though completely fused medially, are somewhat broken up into concentric imbrications toward the distal margins; anterior dorsal area sculptured with 3 or 4 closely imbricated radials; sculpture on posterior dorsal area inconstant; usually 4 or 5 low, crowded lirae, with 1 to 3 more prominent radials behind them; concentric lamellae fused except on the stronger marginal ribs, where they break up into free scales. Ligament opisthodetic, elongated,

inset. Anterior cardinal of right valve obsolete; posterior not very stout; anterior cardinal of left valve affected somewhat by the invagination of the lunule; posterior left cardinal very slender; posterior right and anterior left cardinals bifid only in the young. Anterior and posterior laterals distant, sharp little teeth cut off from the margin by a moderately deep sulcus; receiving pits of left valve small but moderately deep, their inner edges elevated into toothlike prominences. Anterior adductor impression very narrow, elongated to fully half the total altitude; posterior irregularly oval or quadrate. Inner margins strongly denticulated in harmony with the external costae.

No other coexistent *Phacoides* combines so vigorous a radial sculpture with so conspicuous a concentric ornamentation. Mansfield reports that *Phacoides (Luciniscia)* occurs in abundance in the *Cancellaria* zone of the Choctawhatchee formation and, less commonly, in the *Ecphora* zone.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; mouth of Bailey's Creek, Prince George County; Claremont Wharf (upper bed), Surry County; Zuni, Ferguson's Wharf (on the James River), and 5 miles northeast of Smithfield, Isle of Wight County; a quarter to half a mile below Sycamore (on the Nottoway River), Southampton County.

North Carolina: Miocene, Yorktown formation,  $1\frac{1}{2}$  to 2 miles above Branches Bridge,  $\frac{1}{2}$  mile below Branches Bridge, and Maddelys Bluff (on the Meherrin River), Northampton County; Murfreesboro, Hertford County; Halifax,  $\frac{1}{2}$  mile above the Atlantic Coast Line Railroad bridge (on Mr. Durham's farm), and Palmyra Bluff, Halifax County;  $2\frac{1}{2}$  miles northwest of Williams-ton (on Joseph Cherry's farm), Martin County,  $15\frac{1}{2}$  miles above Bells Bridge and  $\frac{1}{2}$  mile above Bells Bridge, Edgecombe County. Duplin marl, 4 miles south of Clinton, Sampson County.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida. Duplin marl, Darlington, S. C.; Porters Landing on the Savannah River, Effingham County, Ga.

#### Subgenus PARVILUCINA Dall

1901. *Parvilucina* Dall, U. S. Nat. Mus. Proc., vol. 23, p. 806.  
 1937. *Parvilucina* Chavan, Jour. conchyliologie, vol. 81, p. 208.

Type by original designation: *Lucina tenuisculpta* Carpenter. Nunivak Island, Bering Sea, to the Coronado Islands.

Shell small, plump, often inequilateral; sculpture more or less reticulate but not muricate, teeth small, but all usually present.—Dall, 1901.

#### *Phacoides (Parvilucina) multilineatus* (Tuomey and Holmes) Dall

Plate 13, figures 34-37

1856. *Lucina multilineata* "Conrad". Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 61, pl. 18, figs. 16, 17.  
 1858. *Lucina multilineata* Emmons, North Carolina Geol. Survey Rept., p. 291 (name only).  
 1858. *Lucina multilineata* "Conrad." Holmes, Post-Pleiocene fossils of South Carolina, p. 29, pl. 6, fig. 6.  
 1901. *Phacoides (Parvilucina) crenella* Dall, U. S. Nat. Mus. Proc., vol. 23, pp. 810, 825, pl. 39, fig. 2.  
 1903. *Phacoides (Parvilucina) multilineatus* Tuomey and Holmes. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1384.

1932. *Phacoides* (*Parvilucina*) *multilineata* (Tuomey and Holmes). Mansfield, Florida Geol. Survey Bull. 8, p. 101, pl. 20, figs. 6, 7.

1937. *Parvilucina multilineata* Tuomey and Holmes. Chavan, Jour. conchyliologie, vol. 81, p. 210.

Shell orbicular, concentrically and closely ribbed, radiately striate.

This little fossil has the outline and general characters of *L. crenulata*, from which it can only be distinguished by the radiating lines, which give the shell a cancellated appearance.—Tuomey and Holmes, 1856.

Type locality: Waccamaw, S. C. Waccamaw formation.

A right and a left valve of different individuals (U. S. Nat. Mus. 325537) are figured. They were collected from the Waccamaw formation at Neills Eddy Landing on the Cape Fear River, N. C. The right valve measures 6.5 millimeters in height and 6.6 millimeters in width; the left valve measures 7.5 millimeters in height and 7.3 millimeters in width.

Tuomey and Holmes, by a happy blunder, identified their species with *L. multilineata* of Conrad. Conrad's form was not named "*multilineata*" but "*multistriata*" and it was later relegated to subspecific rank under *P. trisulcatus*.

Shell small, globose. Outline roughly circular, the dorsal margins forming a chord of the circle; lateral margins often a little contracted by the depression of the dorsal areas. Umbones central, moderately inflated; their apices acute and prosogyrate. Lunule small, smooth, cordate, depressed, but not excavated. Anterior and posterior dorsal areas defined by a slight depression of the valve, a very low and obscure, radial fold, and an abrupt disappearance of the radial sculpture. Surface ornamented with sublinear radiations, separated by interradians of scarcely greater width; radials obsolete in the umbonal region; concentric lirae very fine, overriding the radials and minutely cancellating them. Ligament opisthodontic, mounted on a linear nymph. Anterior cardinal of right valve almost obsolete; posterior subumbonal, robust, cuneiform; laterals vigorous; hinge of left valve armed with a moderately strong, anterior cardinal, a simple, compressed, posterior cardinal, and deep grooves for the reception of the strong right laterals. Adductor muscle impressions small, a little above the median horizontal. Inner margins crenulated in harmony with the external radials, much finer on the dorsal areas than on the intermediate disk.

*Parvilucina multilineatus* is larger and more inflated than *Phacoides crenulatus*, the only species with which it might be confused. The radial sculpture is stronger and more uniform than in the latter, and the concentric sculpture is more feeble and more inconstant.

The species does not appear until almost the close of

the Miocene. It is, however, abundant and widely distributed in the *Cancellaria* zone of the Choctawhatchee formation and is present in the *Area* zone.

Distribution: Virginia: Miocene, Yorktown formation, 1½ miles northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, 100 yards below Bells Bridge on the Tar River, Edgecombe County; Tar Ferry on Wiccacon Creek (opposite Harrellsville), Hertford County; Rock Landing on the Neuse River, Craven County. Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County; 2 miles below Lumberton and 4 to 5 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek) and Walkers Bluff (on the Cape Fear River), Bladen County; Lake Waccamaw, Cronly (½ mile east of the factories), and Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin marl, Porters Landing, Effingham County; Brunswick River bed, Brunswick, Ga. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Waccamaw and Tillys Lake, Horry County, S. C. Caloosahatchee marl, Nashua and ½ mile above the Atlantic Coast Line Railroad bridge over the St. Johns River, Putnam County, Fla.; De Leon Springs, Volusia County, Fla.; Sanford, Seminole County, Fla.; Caloosahatchee River, Shell Creek, and Myakka River, Fla. Croatan sand, Croatan beds, Craven County, N. C. Pliocene (?), Charlton formation, Orange Bluff, St. Marys River, Nassau County, Fla. Pleistocene, Simmons Bluff and Wadmalaw Sound, S. C.; Rose Bluff, St. Marys River, Nassau County, Fla.; Orient, Hillsborough County, Fla.; Manatee Station and North Creek near Osprey, Manatee County, Fla.; Kissimmee well (at a depth of 96 feet), Osceola County, Fla.; Eau Gallie, Brevard County, Fla.; Labelle, Hendry County, Fla. Recent, (?) Indian Pass, Fla., to Horn Island, Miss., in less than 50 fathoms.

#### Family DIPLDONTIDAE

#### Genus DIPLDONTA Bronn

1831. *Diplodonta* Bronn, Italiens Tertiär-Gebilde, p. 9.

Type by subsequent designation (Herrmannsen, Indici generum Malacozoorum, vol. 1, p. 392): *Venus lupina* Brocchi. Miocene and Pliocene of the Piedmont of Italy.

Shell equivalve, not gaping, subcircular, the beaks subcentral and not prominent. Lunule and escutcheon not defined. External surface smooth or incrementally sculptured. Ligament chiefly external, supported on marginal nymphs. Hinge of right valve armed with a simple anterior and a bifid posterior cardinal; hinge of left valve armed with a bifid anterior and a simple posterior cardinal, so that in the closed valves the two outer cardinals are simple, the two inner ones bifid. Laterals absent. Adductor impressions oval, the anterior longer and narrower than the posterior. Pallial line entire. Inner margins of valves smooth.

The genus is first noted in the Cretaceous; from that time on it has constituted one of the less conspicuous elements in the bivalve faunas. The forty-odd Recent species have a wide distribution in the warmer waters of the globe.

**Diplodonta caloosaensis** Dall

Plate 14, figures 40, 41

1900. *Diplodonta caloosaensis* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1188, pl. 44, fig. 16.

Shell large, moderately inflated, sculptured with somewhat irregularly prominent incremental lines; beaks low, pointed, inconspicuous; anterior end shorter, smaller, evenly rounded into the evenly arcuate base; posterior end squarish, longer, larger, more inflated; in the young the form is even more inequilateral and sometimes rounded trigonal with the anterior end attenuated; hinge line short, with hardly any hinge plate; ligamentary groove sharp, but the nymph not prominent; teeth and scars normal. Altitude 25, latitude 27, diameter 17 millimeters.

This species is larger and less equilateral than *D. Leana*; specimens of the same size are less inflated. It resembles *D. punctata* Say which is a smaller shell, but has not the microscopic surface sculpture.—Dall, 1900.

Holotype, a left valve: U. S. Nat. Mus. 112865.

Type locality: Caloosahatchee River, Fla. Caloosahatchi marl.

Dimensions of figured specimen: Height 20.6 millimeters, width 22.3 millimeters, convexity 6.5 millimeters.

Figured specimen, a left valve: U. S. Nat. Mus. 325553.

Locality of figured specimen: Neills Eddy Landing, 3 miles north of Cronly, Columbus County, N. C. Waccamaw formation.

The figured shell is decidedly heavier than Dall's holotype, but the differences are probably no more than individual. The Waccamaw species closely resembles the St. Marys form, *D. leana eoleana*, which is larger and less inflated than the Yorktown species *D. leana*. *D. caloosaensis* is less evenly rounded posteriorly than *D. leana eoleana* and more strongly upcurved along the anterior ventral margins, but the shells, if they occurred within the same area and formation, would be difficult to separate.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Neills Eddy Landing on the Cape Fear River, Columbus County.

Outside distribution: Pliocene, Waccamaw formation, Waccamaw River, S. C. Caloosahatchee marl, Caloosahatchee River, Fla.

**Diplodonta leana** Dall

1846. *Psammocola lucinoides* H. C. Lea, Am. Philos. Soc. Trans., new ser., vol. 9, p. 239, pl. 34, fig. 16. Not *Diplodonta lucinoides* Deshayes, 1824.

1863. *Psammocola? lucinoides* H. C. Lea. Conrad. Acad. Nat. Sci. Philadelphia Proc., for 1862, p. 573.

1900. *Diplodonta leana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1187.

*P. testâ* suborbiculari, pene aequilaterali, posticè et anticè rotundatâ convexâ, tenui, striatâ; striis concentricis, minimis; natibus prominentibus, subrectis; valvâ sinistrâ dentibus duobus cardinalibus, quorum unus bifidus, lateralibus nullis.

Shell suborbicular, almost equilateral, rounded anteriorly and posteriorly, convex, thin, striate; striae concentric, very small; beaks prominent, nearly straight; left valve with 2 cardinal teeth, 1 of which is bifid, and no lateral ones.

Diameter 0.15, length 0.31, breadth 0.35 of an inch.

Type locality: Petersburg, Dinwiddie County, Va.—H. C. Lea, 1846.

Dall's *leana* is nothing more than a replacement name for the preoccupied *lucinoides* of H. C. Lea.

*Diplodonta leana* Dall s. s. possesses none of the more striking features that characterize the coexistent *Diplodontas*. It is larger and much less globose than *D. nucleiformis* (Wagner); is smaller, thinner, more circular, and more inflated than *D. acclinis* (Conrad); is smaller, thinner, and less inflated in the umbonal region than *D. caloosaensis* Dall; and lacks the diagnostic shagreened surface of *D. soror* C. B. Adams.

Distribution: Virginia: Miocene, Yorktown formation, Petersburg, Dinwiddie County; Cobham Bay, Surry County; 2½ miles northwest of Suffolk and 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Duplin marl, 1½ miles northeast of Fairmont, Robeson County.

**Diplodonta leana eoleana** Gardner, n. subsp.

Plate 14, figures 37, 38

Shell of moderate dimensions, subcircular and rather strongly inflated for the group. Umbones scarcely interrupting the broad arc of the dorsal margins, the tips acute and turned toward each other, subcentral. Anterior end of shell broadly and obscurely truncate, the posterior portion broadly rounded from the umbones to the base. Incrementals fairly strong and regular. Ligament groove deep. Dentition delicate but normal; two divergent cardinals in each valve, the posterior right and the anterior left cardinals deeply sulcate, the anterior right and posterior left cardinals thin and laminar. Adductor scars elongated, placed well up under the dorsal margins. Margin of mantle attachment ragged. Pallial line simple, fairly close to the base.

Dimensions of holotype: Height 18.0 millimeters, width 19.1 millimeters, convexity 5.5 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325556.

Type locality: Urbanna on the Rappahannock River, Middlesex County, Va. St. Marys formation.

The St. Marys subspecies differs from *Diplodonta leana* from the Yorktown formation in the larger, heavier, and relatively higher and less inflated shell. It closely resembles the Waccamaw and Caloosahatchee species, *D. caloosaensis* Dall, but it is broader and a little less produced anteriorly and more evenly rounded posteriorly.

The subspecies has a fairly good representation at the single locality from which it has been reported.



Section **PHLYCTIDERMA** Dall

1899. *Phlyctiderma* Dall, Jour. conchology, London, vol. 9, p. 244.

Type by original designation: *Diplodonta semiaspera* Philippi. Recent from Hatteras to Rio de Janeiro.

Shell like *Diplodonta* but with the surface more or less punctate or pustulate.—Dall, 1899.

**Diplodonta (Phlyctiderma) soror (C. B. Adams)**

Plate 14, figures 42, 43

1852. *Lucina soror* C. B. Adams, Contr. conchology, No. 12, p. 247.

1858. *Lucina klawahensis* Holmes, Post-Pleocene fossils of South Carolina, p. 29, pl. 6, fig. 5.

1900. *Diplodonta soror* C. B. Adams. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1188.

*L. t. suborbiculari*; margine superiore anticè et posticè declivi, inferiore anticè subarcuatà; cinereo-albidà; microscopicè creberrimè punctulatà; striis concentricis exilissimis creberrimis; umbonibus prominentibus; apicibus subobliquis; lunulà minutissimà; limbo simplici; dentibus lateralibus obsoletis. Long. 19.6 millim., alt. 18 millim., lat. 12.7 millim.—C. B. Adams, 1852.

Type locality: Kingston Harbor, Jamaica. Living.

Shell thin, inflated, suborbicular, and approximately equilateral, but somewhat flattened or obscurely carinate posteriorly. Umbones central, inconspicuous, the tips incurved and prosogyrate. Posterior dorsal margin a little oblique and slightly depressed, broadly rounded or obscurely truncate laterally. Anterior dorsal margin continuous with the convex lateral margin. Base line strongly arcuate. External surface shagreened by microscopic punctae, which are imperfectly radial in arrangement and are largest and most numerous on the posterior slope. Ligament external, opisthodontic. Nymph short, inconspicuous; outer margin delimited by a moderately deep groove. Hinge normal, delicate; posterior cardinal of right valve and anterior cardinal of left valve deeply sulcated; anterior cardinal of right valve and posterior cardinal of left valve simple and laminar; hinge strengthened by the grooving of the dorsal margins. Adductor impressions usually irregular, subequal, submedian in position. Pallial line simple, rather near the ventral margin.

The figured left valve (U. S. Nat. Mus. 325555) from the Duplin marl at the Natural Well, N. C., measures 12.3 millimeters in height and 12.7 millimeters in width.

*Diplodonta soror* is characterized by the more or less pronounced posterior flattening and by the shagreened external surface. The single left valve from the Duplin marls near Magnolia is a little more elevated than the normal form but agrees perfectly in all other characters. The species has also been found in the Waccamaw formation.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well and 1½ mile north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Pleistocene, Ashley River and Simmons Blur, Wadmalaw Sound, S. C. Recent, Tortugas to Texas and south to Jamaica and the Antilles in less than 50 fathoms.

Superfamily **Leptonacea**Family **Leptonidae**Genus **ERYCINA** Lamarck

1805. *Erycina* Lamarck, Mus. histoire nat. Annales, vol. 6, p. 413.

Type by subsequent designation (Stoliczka, Geol. Survey India, Mem., Palaeontologia Indica, Cretaceous fauna of southern India, vol. 3, p. 263, 1871): *Erycina pellucida* Lamarck. Calcaire grossier of the Paris Basin.

The earliest designation was probably that of Anton, Verzeichniss der Conchylien, p. 6, 1839. However, the species designated by Anton, *Erycina elliptica* Deshayes, is a *Diplodonta*; and as the confusion resulting from the acceptance of *E. elliptica* as the type would be very great, a request has been made to set aside the rules so that *E. pellucida* may be retained as the genotype of *Erycina*.

Shell small, thin, elongate-oval, usually subequilateral. Surface usually smooth and sometimes with concentric or still more rarely with a radial sculpture. External ligament feeble; internal ligament lodged in a triangular resilial pit behind the umbones and near the dorsal margin. Cardinals minute, subumbonal, 1 or 2 in each valve; strong laminated laterals developed both in front of and behind each umbo. Adductor impressions small, oval. Pallial line entire or slightly sinuated.

The genus apparently both originates and culminates in the Eocene. In the Paris Basin alone 47 species are known. In North America, although *Erycina* is most abundantly represented in the Gulf Eocene, it also occurs throughout the Tertiary section of the east coast.

**Erycina carolinensis** Dall

Plate 14, figure 9

1900. *Erycina carolinensis* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1145, pl. 44, fig. 3.

Shell large for the genus, inequilateral, somewhat compressed, elongated, the anterior end produced, rounded, the posterior end shorter, downwardly arcuated; base nearly straight, slightly insinuated near the middle, corresponding to a slight mesial constriction of the shell; anterior dorsal margin nearly parallel with the base; posterior declining to a rounded point at its junction with the base; beaks small, low, pointed; surface with rather strong, irregular, concentric incremental lines but very little radial striation; hinge normal, the lamellae rather long, and the hook (or cardinal) small; resilial groove deep and strong, elongated; interior of the valves smooth or faintly radially striated toward the margins; adductor scars high up, the anterior larger, the pallial line rather wide, somewhat irregular. Longitude 13.25, altitude 7, diameter 4 millimeters.

This is the largest and apparently the most common species of *Erycina* in the later Tertiary of the Carolinas. On occasional specimens a little faint radial striation may be observed under the shelter of the concentric sculpture, but many speci-



mens do not show it, and on none does it appear to cover the surface.—Dall, 1900.

The right valve (U. S. Nat. Mus. 115096), from Natural Well, Duplin County, N. C., is here designated the lectotype. The measurements are as follows: Height 5.7 millimeters, width 9.0 millimeters, convexity 1.5 millimeters. The dimensions given by Dall are those of the form from the Waccamaw formation of South Carolina, the type of a subspecies *elongata*.

The species varies rather widely in its relative proportions, in the location of the umbones, and in the configuration of its posterior end. The Duplin shells are generally higher than the Waccamaw forms, the umbones are more nearly central, and the arch of the posterior dorsal and lateral margins is more uniform. The elongation of some of the later and more southern specimens is so pronounced that the differences are recognized by a subspecific division.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Lake Waccamaw, Columbus County.

*Erycina carolinensis elongata* Gardner, n. subsp.

Plate 14, figure 1

1900. *Erycina carolinensis* Dall (part), Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1145, pl. 44, fig. 22.

Shell large for the genus. Outline elongate-ovate, inequilateral. Umbones low, slightly posterior, prosogyrate. Anterior dorsal margin rectilinear and parallel with the horizontal base line; lateral margin broadly rounded; posterior dorsal margin oblique, merging gradually into the posterior lateral, which is obscurely truncated at right angles to the base line. Incremental sculpture uneven, obsolete on the umbones; faint, crowded radials similar to those developed in *Erycina kurtzia* Dall but less distinct.

Dimensions of holotype, a left valve: Height 7.5 millimeters, width 12.7 millimeters, convexity 4.0 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325542.

Type locality: Neills Eddy Landing on the Cape Fear River, Columbus County, N. C. Waccamaw formation.

The subspecies *elongata* is separated from *carolinensis* s. s. because of the relatively greater width, the more posterior umbones, and the more oblique posterior dorsal margin. The subspecies seems to be particularly characteristic of the later and more southern faunas. It has been recognized not only in the Waccamaw of both the Carolinas but in the Caloosahatchee marl of Florida as well.

Distribution: North Carolina: Pliocene, Waccamaw formation, Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Pliocene, Waccamaw formation, Waccamaw River, S. C. Caloosahatchee marl, Caloosahatchee River, Fla.

Genus *BORNIA* Philippi

1836. *Bornia* Philippi, Enumeratio molluscorum Siciliae, vol. 1, p. 13.

Type by subsequent designation (Stoliczka, Geol. Survey India, Mem., Palaeontologia Indica, Cretaceous fauna of southern India, vol. 3, p. 266): *Bornia corbuloides* Philippi. Recent in the Mediterranean.

The shell is moderately compressed, subtrigonal to transversely elliptical and subequilateral. The surface may be smooth or feebly rippled and faintly striate concentrically. There is a feeble external ligament and a subumbonal resilium. The dentition in the right valve includes an anterior and a more produced posterior lamina; in the left, two short anterior lamellae and a much longer posterior lamina. The pallial line is simple.

*Bornia* is recorded from the Eocene of the Paris Basin and from the Tertiary of eastern North America and the Gulf of Mexico. The Recent species are restricted largely to the Mediterranean.

*Bornia triangula* Dall

Plate 14, figures 2, 3, 4, 5, 10

*Kellia triangula* H. C. Lea, Label in coll. Acad. Nat. Sci. Philadelphia.

1900. *Bornia triangula*, n. sp.?, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1151.

1904. *Bornia triangula* Dall. Glenn, Maryland Geol. Survey, Miocene, p. 330, pl. 88, figs. 9a, 9b.

This is the most common fossil species of our Tertiary. It occurs quite plentifully sometimes and is readily distinguished from *B. mactroides*, as a rule, by its shorter, more triangular, and less flexuous shell. The outline is quite uniform as a whole and the shell almost always easily separated from *B. mactroides*, for which reason I have retained Lea's unpublished name, though I do not feel wholly confident that both these forms may not eventually prove to be extremes of a single species.

Type locality: Petersburg, Va.—Dall, 1900.

Dimensions of paratypes, a right and a left valve of different individuals: Height 3.0 millimeters, width 3.3 millimeters.

Paratypes, a right valve and a left valve of different individuals: U. S. Nat. Mus. 325547, from Yorktown, York County, Va. Yorktown formation.

Hinge concentrated; resilial pit moderately deep, subumbonal; anterior lamella of right valve pocketlike, thickening abruptly in front of the umbones, recurved and coalescent with the dorsal margin directly beneath the tips; posterior lamella subspinose medially; lamellae of left valve two, the one in front sharply bent and thickened at its umbonal end (thus simulating a true cardinal), the one behind slightly diverging and reduced to a cardinallike protuberance directly beneath the umbo; posterior lamella of left valve not so heavy as the anterior, obscurely cuneiform, wedging out near the tips of the beaks.

*Bornia triangula* Dall is characterized by an outline that roughly approximates a rather high isosceles triangle, with the umbones at the apex, the ventral margin at the base. The species varies somewhat in general proportions and in the position and prominence of the umbones. The representatives from Yorktown are higher, as a rule, than those collected at either Petersburg, Va., or Natural Well, N. C. The outline of the Yorktown representatives is more inequilateral, the anterior dorsal margin somewhat contracted in front of the umbones, and the anterior slope perceptibly steeper than the posterior. The valve is consequently more narrow in front than behind, and the umbones are more conspicuous than in those forms that are not contracted anteriorly. The young of the species are so unlike the adults that they would certainly be considered distinct were they not found associated in an unbroken series. They are stout, convex, suborbicular little shells with rude, unformed hinges and heavy lamellae.

The representatives of the species in Virginia and North Carolina are not confusable with the broader, more angular *B. mactroides* of the Maryland fauna. *B. rota* of the Duplin and Waccamaw is smaller, more compressed, and more attenuated dorsally.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown and 1¼ miles below Yorktown, York County; Petersburg, Dinwiddie County; Mr. Everet's farm near Benns Church, Isle of Wight County; 1½ miles northeast of Suffolk and ½ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1½ miles below Tar Ferry on Wiccacon Creek, Hertford County; Colerain Landing on the Chowan River, Bertie County; Wilson, Wilson County; Rock Landing on the Neuse River, Craven County. Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County; Lumberton (near the bottling works), Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing (3 miles north of Cronly) and Lake Waccamaw, Columbus County.

Outside distribution: Miocene, Duplin marl, Darlington, S. C. Pliocene, Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla.

***Bornia bladenensis* Gardner, n. sp.**

Plate 14, figures 11, 12

Shell thin, polished, strongly convex, oval, subequilateral. Umbones slightly anterior, inflated, incurved, prosogyrate at the tips, scarcely interrupting the low arch of the similar dorsal margins; lateral margins broadly and regularly curved; ventral margin straight medially, upcurved distally. Surface gently rippled by about a dozen feeble radial folds, strongest near the periphery, evanescent halfway to the umbones; external undulations reflected within. Hinge delicate. Resiliifer sublinear, oblique. Anterior lamella of right valve thickened beneath the umbo into a small but prominent cardinal hook; posterior lamella elongated, subspinose a little behind the middle; left valve not known.

*Bornia bladenensis* is represented by a single right valve that is apparently not full grown. The plication is so diagnostic, however, and so unlike any character exhibited by any of the coexistent species that it seems worth while to announce the form at once.

Dimensions of holotype: Height 3.9 millimeters, width 4.75 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325546.

Type locality: Walkers Bluff, Bladen County, N. C. Waccamaw formation.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County.

**Family SPORTELLIDAE**

**Genus SPORTELLA Deshayes**

1858. *Sportella* Deshayes, Description animaux sans vertèbres Bassin de Paris, vol. 1, p. 593.

Type by original designation: *Psammotea dubia* Deshayes. Calcaire grossier of the Paris Basin.

Shell small, thin, transversely elongate, slightly convex, subequilateral in the majority of species. Umbones low and inconspicuous. Neither lunule nor escutcheon defined. Surface smooth or feebly undulated by incrementals, occasionally sculptured with a submicroscopic radial striation. External ligament seated on elongate nymphs; internal lodged in oblique, subumbonal resilial pit. Dentition of right valve consisting of a strong, often recurved, posterior cardinal and a rudimentary anterior cardinal; hinge of left valve with two unequal, divergent cardinals, the anterior of which is stronger. Adductor impressions oval, subequal. Pallial line entire, often punctate. Inner margins smooth.

This is a genus of small and inconspicuous bivalves that inhabited the near-shore waters of Europe and America during Tertiary and Quaternary times.

***Sportella constricta* (Conrad) Dall**

Plate 14, figures 19, 20

1841. *Amphidesma constricta* Conrad, Am. Jour. Sci., 1st ser., vol. 41, p. 347, pl. 2, fig. 15.

1843. *Amphidesma constricta* Conrad, Am. Assoc. Geologists and Naturalists, vol. 1, p. 110, pl. 5, fig. 15.

1845. *Amphidesma constricta* Conrad, Fossils of the medial Tertiary of the United States, p. 76, pl. 43, fig. 10.

1854. *Syndosmya constricta* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 29.

1863. *Fabella constricta* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, pp. 574, 586. [Monotype of *Fabella*.]

1889. *Lepton (Fabella) constricta* Conrad, Dall, U. S. Nat. Mus. Bull. 37, p. 48.

1898. *Sportella constricta* Conrad, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, pl. 25, figs. 4, 4a.

1900. *Sportella constricta* Conrad, Dall, idem, vol. 3, pt. 5, p. 1128.

1932. *Sportella constricta* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 107, pl. 21, figs. 14, 18.

Oblong, oval, ventricose; basal margin opposite the apex slightly contracted; end margins rounded; beaks nearest the

posterior extremity; fosset profound; cardinal teeth prominent, lateral teeth none.—Conrad, 1841.

Dimensions of figured specimens: Right valve, height 6.0 millimeters, width 9.0 millimeters. Left valve, height 5.7 millimeters, width 9.0 millimeters.

Figured specimens: U. S. Nat. Mus 155730, from the Caloosahatchee River, Fla.

Type locality: Natural Well, Duplin County, N. C. Duplin marl.

Shell heavy, slightly inequilateral, transversely oval to subquadrate. Umbones inconspicuous, prosogyrate, located a little behind the median line. Anterior end slightly contracted in front of the beaks; anterior dorsal margin nearly rectilinear and subparallel to the base; lateral margin broadly rounded. Posterior dorsal margin slightly oblique and reflected; posterior end a little shorter and more narrow than the anterior. Surface irregularly wrinkled by the incrementals. Hinge conspicuously robust. Ligamentary attachment opisthodontic, sublinear. Resilial pit oblique, deeply excavated. Right posterior and left anterior cardinals stout and conical; right anterior and left posterior cardinals rudimentary; cardinal fossets correspondingly deep. Adductor scars obscure, set well up toward the dorsal margin, the anterior a little higher than the posterior. Pallial line entire.

*Sportella constricta* (Conrad) differs from all its congeners by its subquadrate outline and by the vigor of its hinge.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County.

Outside distribution: Miocene, Choctawhatchee marl, northern Florida. Pliocene, Waccamaw formation, Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla.

***Sportella calpix* Gardner, n. sp.**

Plate 14, figures 30, 39

Shell moderately convex in the umbonal region, compressed ventrally, often with a very broad and shallow medial depression. Outline transversely ovate, inequilateral. Umbones a little posterior, prosogyrate. Anterior end slightly contracted in front of the beaks; anterior dorsal margin obliquely truncated, lateral margin evenly rounded. Posterior dorsal slope more steep than the anterior, merging gradually into the broadly rounded lateral margin. Base horizontal. Surface concentrically striated with submicroscopic incrementals, most plainly visible toward the lateral margins; traces of a faint, distant, radial striation discernible on both the exterior and the interior of the valve. Ligament opisthodontic, lodged in a deep groove. Resilial pit oblique, profound. Posterior cardinal of right valve stout, subtriangular; anterior cardinal rudimentary; anterior cardinal of left valve strong, conical;

posterior cardinal rudimentary. Adductor impressions obscure, apparently rather near the ventral margin. Pallial line entire.

Dimensions: Height 10.2 millimeters, width 14.7 millimeters, convexity 3.5 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325543.

Type locality: 1½ miles below Tar Ferry, on Wiccacon Creek, Hertford County, N. C. Yorktown formation.

*Sportella calpix* is most closely allied to *S. pelex* Dall, from the Yorktown of Virginia. The latter is, however, a much smaller, relatively higher shell with a less produced and attenuated anterior end. The obliquity of the anterior dorsal margin separates *S. calpix* at once from *S. constricta* (Conrad) and *S. waccamawensis*, whereas the dissimilarity of the dorsal margins separates it from the more nearly equilateral *S. petropolitana* Dall.

Distribution: North Carolina: Miocene, Yorktown formation, Tar Ferry on Wiccacon Creek (opposite Harrellsville) and 1½ miles below Tar Ferry, Hertford County; ½ to ¾ mile above Edenhouse Point, Bertie County. Duplin marl, 1½ miles north-east of Fairmont, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County.

***Sportella gibberosa* Gardner, n. sp.**

Plate 14, figures 6, 7

Shell small, heavy for its size, moderately inflated, transversely ovate, inequilateral. Umbones subcentral, slightly posterior, prosogyrate. Anterior end contracted in front of the umbones; anterior dorsal slope rather gentle, merging gradually into the rounded lateral margin. Posterior dorsal margin obscurely arched; lateral margin broadly rounded. Base line straight. Incrementals distant and inconspicuous; traces of a radial striation faintly discernible on both the external and the internal surfaces. Hinge delicate. Ligament groove minute, opisthodontic; resilial pit oblique, moderately deep. Only the right posterior and left anterior cardinals developed and these not prominently. Anterior adductor impression elongated; posterior suborbicular, situated a little below the median horizontal. Pallial line entire.

Dimensions of cotypes: Right valve, height 3.2 millimeters, width 4.5 millimeters. Left valve, height 3.3 millimeters, width 4.5 millimeters.

Cotypes, a right and a left valve of different individuals: U. S. Nat. Mus. 325544.

Type locality: Walkers Bluff on the Cape Fear River, Bladen County, N. C. Waccamaw formation.

The slight contraction in the basal margin of the left valve of the type is an individual rather than a specific character. This small form recalls in outline and dimensions *Mactra clathrodon* H. C. Lea. Because of its minute size and the delicacy of the hinge, it was at first considered to be the young of an unreported adult, but the relatively heavy shell and the

crowding of the incrementals toward the ventral margin are evidences to the contrary.

The vaulting of the dorsal margin behind the umbones gives to the species a hunch-backed aspect that is characteristic.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

***Sportella waccamawensis* Gardner, n. sp.**

Plate 14, figures 21, 22

Shell of moderate size, rather compressed, especially toward the ventral margin; outline roughly ovate, rather angular, inequilateral. Umbones moderately inflated, prosogyrate, subcentral, or slightly posterior. Anterior end contracted in front of the umbones; dorsal margin slightly excavated; lateral margin squarely truncated. Posterior dorsal slope rather steep, merging gradually into the evenly rounded, lateral margin. Base horizontal. Surface sculptured with unequal, often exaggerated incrementals and with faint traces of rather distant radiating striations; interior of valve also faintly rayed. External ligament lodged in a groove behind the umbo; resilial pit deep and oblique. Right posterior and left anterior cardinals stout; other cardinals not developed; cardinal sockets moderately deep. Adductor impressions rather obscure, placed about halfway between the umbones and the base; anterior elongated, posterior subcircular. Pallial line entire.

Dimensions of holotype: Height 8.2 millimeters, width 13.5 millimeters, convexity 2.0 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325545.

Type locality: Walkers Bluff on the Cape Fear River, Bladen County, N. C. Waccamaw formation.

*Sportella waccamawensis* differs from all its congeners by the configuration of the anterior part of its shell, outlined by the slightly excavated dorsal margin, the horizontal ventral margin, and the lateral margin truncated at right angles to the base. The young are relatively higher and less angular, and thus approach *S. pelex* Dall and *S. calpix*. The form has been reported from the Waccamaw formation only.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

***Sportella compressa* (H. C. Lea) Dall**

Plate 14, figures 27-29

1846. *Petricola compressa* H. C. Lea, Am. Philos. Soc. Trans., 2d ser., vol. 9, p. 239, pl. 34, fig. 15.

1863. *Petricola compressa* H. C. Lea. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.

1898. *Sportella compressa* H. C. Lea. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, pl. 25, fig. 3a.

1900. *Sportella compressa* H. C. Lea. Dall, idem, vol. 3, pt. 5, p. 1130.

Shell very transverse, very inequilateral, subelliptical, compressed, posteriorly subtruncate, anteriorly rounded, thin, striate posteriorly and anteriorly; striae very small, concentric; basal margin straight; dorsal margin straight; beaks somewhat acute, prominent; teeth 2, small, divergent. Diameter 0.10, length 0.12, breadth 0.25 inch.

The concentric lines of growth are very small. They are visible on the anterior and posterior portions of the shell. On the central part they are obsolete, leaving it smooth. The teeth are small and unusually divergent for a *Petricola*.—H. C. Lea, 1846.

Figured specimen, a left valve: Acad. Nat. Sci. Philadelphia 1596.

Type locality: Petersburg, Va. Yorktown formation.

*Sportella compressa* (H. C. Lea) is separated from *S. protexta* (Conrad) by a heavier shell, by an elongate and oval rather than a subanceolate outline, and by the absence of punctae on the external surface. No other of the coexistent *Sportellas* approaches it in the degree of transverse elongation.

Distribution: Virginia: Miocene, Yorktown formation, Petersburg, Dinwiddie County.

North Carolina: Pliocene, Waccamaw formation, (?) Walkers Bluff, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Pliocene, Waccamaw formation, Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River, Fla. Croatan sand, Slocums Creek, Craven County, N. C. (Dall).

**Family MONTACUTIDAE**

**Genus MYSELLA Angas**

1876 (July 24). *Rocheportia* Vélain, Comptes rendus, p. 285 (nomen nudum).

1877 (Aug. 1, fide Iredale). *MySELLA* Angas, Zool. Soc. London Proc., p. 176.

1878 (not earlier than Nov. 12, fide Iredale). *Rocheportia* Vélain, Archives de zoologie expérimentale et générale, vol. 6, p. 132.

Type by monotypy: *Rocheportia australis*, Vélain. St. Paul Island, South Indian Ocean.

1891. *MySELLA* Angas. E. A. Smith, Annals and Mag. Nat. History, 6th ser., vol. 8, p. 235.

1899. *MySELLA* Dall, U. S. Nat. Mus. Proc., vol. 21, pp. 876, 881.

1900. *Rocheportia* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1157.

1924. *MySELLA* Angas. Iredale, Linnean Soc. New South Wales Proc., vol. 49, p. 207.

Type by monotypy: *MySELLA anomala* Angas. Recent off the southeastern Australian shores.

Dall, 1900, has given a comprehensive discussion of the group. He failed to recognize the nudity of *Rocheportia* Vélain, 1876; and apparently the priority of *MySELLA* Angas has been established by Iredale. Many of the recent species of *Rocheportia* are commensal with crustacea.

***Mysella stantoni* (Dall) Gardner**

Plate 14, figure 8

1900. *Rocheportia stantoni* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1160, pl. 43, fig. 11.

Shell minute, convex, elongate-ovate, quite inequilateral, the anterior end much longer; surface with faint incremental lines, polished; dorsal margin arcuate in front, descending behind the umbo; ends rounded, an oblique nearly straight bit of margin intervenes between the posterior rounded end and the arcuate base as if a little of the edge had been shaved off; beaks low, hinge with small lamellar teeth, the anterior nearly twice as long as the posterior, resiliary notch small; adductor scars high, rather large, and distinct; margin simple, entire. Longitude 3.6, altitude 2.4 [2.2], diameter 1.5 [0.8] millimeters—Dall, 1900.

Holotype, a right valve: U. S. Nat. Mus. 115102.

Type locality: Natural Well, Duplin County, N. C. Duplin marl.

This minute, ovate, inequilateral form is the most individual of any of the east coast Tertiary *Mysellas*. It is characterized by a transversely elliptical outline and a simple laminar dentition.

The species was named in honor of Dr. T. W. Stanton, who retained his interest in and his command of the Lower Cretaceous faunas through many years of duty in high administrative positions.

Distribution: Virginia: Miocene, Yorktown formation, Sycamore on the Nottoway River, Southampton County.

North Carolina: Miocene, Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Neills Eddy Landing, 3 miles north of Cronly, Columbus County; Wilmington, New Hanover County.

***Mysella bladenensis* Gardner, n. sp.**

Plate 14, figures 17, 18

Shell thin, minute, moderately compressed, elongate-oval, slightly contracted anteriorly. Umbones low, almost level with the anterior dorsal margin, incurved, placed about two-thirds of the distance back toward the posterior margin. Anterior dorsal margin rectilinear, parallel with the horizontal base line; lateral margin evenly rounded; posterior end very short, slightly contracted behind the umbones; rounded laterally. Incremental sculpture strong, equally conspicuous on all parts of the external surface. Radial sculpture discernible under high magnification, possibly adventitious as in so many of the species of *Leptonacea*. Resilifer concealed beneath the tip of the umbo. Dental lamellae short, equal, divergent, subspinose near their ventral margins. Adductor impressions and pallial line obscure.

Dimensions of holotype: Height 3.0 millimeters, width 4.5 millimeters, convexity 1.0 millimeter.

Holotype, a right valve: U. S. Nat. Mus. 325550.

Type locality: Walkers Bluff, Bladen County, N. C. Waccamaw formation.

*Mysella bladenensis* is allied to *M. stantoni* (Dall) and to *M. vélaini*. It does not, however, exhibit the peculiar oblique truncation of the posterior ventral margin that characterizes *M. stantoni* (Dall), and it differs furthermore in the similar anterior and posterior dental laminae. *M. vélaini* is a less regular, more elevated species.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County.

***Mysella vélaini* Gardner, n. sp.**

Plate 14, figures 15, 16

Shell minute, moderately compressed, elongate-ovate, inequilateral. Umbones low, inconspicuous, rising only a little above the level of the dorsal margin, located about two-thirds of the distance toward the posterior margin. Posterior end very short, faintly depressed, broadly and evenly rounded; anterior end much produced, the dorsal margin rudely parallel to the base, the lateral margin evenly rounded; base line horizontal medially. Incremental sculpture strong, irregular, most conspicuous anteriorly. Resilifer concealed beneath the tip of the umbones. Dental laminae short, subequal, feeble but distinct, subspinose near their ventral extremities. Adductor impressions and pallial line obscure.

Dimensions of holotype: Height 3.0 millimeters, width 4.2 millimeters, convexity 0.9 millimeter.

Holotype, a right valve: U. S. Nat. Mus. 325548.

Type locality: Walkers Bluff on the Cape Fear River, Bladen County, N. C. Waccamaw formation.

This odd little ovate form is characterized by the obliquely elliptical outline, the relatively strong incremental sculpture, and the feeble dentition. It is more elevated and less regular than *M. bladenensis*, the only form that approaches it in general outline. It is named in honor of M. Vélain, the author of the genus *Rocheportia*.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

***Mysella majorina* Gardner, n. sp.**

Plate 14, figures 13, 14

Shell moderately large for the genus; transversely ovate; moderately compressed, inequilateral. Umbones low and inconspicuous, a little behind the median horizontal, slightly bulbous at their apices. Lunule and escutcheon not defined. Anterior end produced, the dorsal slope very gentle, almost rectilinear; the lateral margin broadly rounded. Posterior end relatively short and narrow; the dorsal margin descending more rapidly posteriorly than anteriorly; the lateral margin obtusely pointed. Base line feebly arcuate. External surface polished, sculptured only with microscopically fine and close concentric striations. Ligament entirely

internal, lodged in a subumbonal resilial pit concealed beneath the apices of the umbones. Hinge lamellae of right valve short, equal, divergent, subspinose distally; margins of left valve on each side of the umbones beveled to fit into the sockets between the lamellae and the dorsal margins of the right valve. Interior of valve faintly radiate. Adductor muscle impressions and pallial line obscure.

Dimensions of cotypes: Right valve, height 2.7 millimeters, width 4.0 millimeters, convexity 0.6 millimeter. Left valve, height 2.7 millimeters, width 4.1 millimeters, convexity 0.5 millimeter.

Cotypes, a right and a left valve of different individuals: U. S. Nat. Mus. 325549.

Type locality: Neills Eddy Landing on the Cape Fear River, N. C. Waccamaw formation.

*Mysella majorina* is conspicuous among its congeners for its narrow, obtusely pointed, posterior extremity. It is known only from the type locality.

Distribution: North Carolina: Pliocene, Waccamaw formation; Neills Eddy Landing (3 miles north of Cronly) on the Cape Fear River, Columbus County.

#### Genus *ALIGENA* H. C. Lea

1846. *Aligena* H. C. Lea, Am. Philos. Soc. Trans., 2d ser., vol. 9, p. 238.

Type by subsequent designation (Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1175): *Aligena striata* H. C. Lea. Miocene (Yorktown) from Petersburg, Va.

Shell equivalve; subequilateral, closed posteriorly and anteriorly; hinge with one cardinal tooth and a long shallow sulcation under the beaks.

The cardinal tooth is, in general, rather small. The sulcus appears to have received the ligament. It commences at the beak and runs obliquely past the dorsal margin into the cavity under the beak. As I possess only odd valves of both the following species, I am unable to determine whether the shell is equivalve or not. \* \* \* I have called the genus *Aligena*, one of the surnames of Venus, from its resemblance to *Erycina*, also an appellation of that goddess.—H. C. Lea, 1846.

*Aligena* is known by its rounded-trigonal convex shell, obliquely elongated resilifer, and single subumbonal cardinal.

The genus has representatives in the Tertiary deposits of the east coast and of the Paris and Vienna Basins and still persists in the cooler waters of the Atlantic.

Two species were cited by Lea in his original description of *Aligena*. The first, designated as the type of the genus, is *A. striata*. The second, *A. laevis* (pl. 14, figs. 24–26), differs from the first in the much more produced and less conical cardinal tooth and in the thickened and modified dorsal margins. Dall suggested that it is “apparently a species of *Fulerella*,” but it is distinct from the American species assigned to that genus. Only the holotype, a right valve, has been recorded.

#### *Aligena chowanensis* Gardner, n. sp.

Plate 14, figures 31, 32

Shell small, moderately convex, elevated, roughly trigonal, inequilateral. Umbones inflated, subcentral, strongly prosogyrate. Dorsal and lateral areas not differentiated. Anterior end contracted and slightly excavated in front of the umbones; rounded and somewhat produced laterally. Posterior end obscurely convex, rounding rather abruptly into the feebly arcuated ventral margin. Surface sculptured with fine, irregular, discontinuous striations; resting stages conspicuous, occurring at fairly regular intervals, 4 in all. Ligament internal; resilifer narrow, obliquely elongated, deeply submerged beneath the umbones. Cardinal broken away; scar, of moderate size, just below the tip of the beak. Adductor impressions and sinus obscure.

Dimensions of holotype: Height 4.7 millimeters, width 4.7 millimeters, convexity 1.5 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325551.

Type locality: The single right valve on which the species is founded was collected in the marls of the Yorktown formation at Colerain Landing, on the Chowan River, Bertie County, N. C.

The peculiar concavo-convex outline of the anterior and posterior ends, the attenuated dorsal region and the strong resting stages are not displayed by any of the coexistent *Aligenas* and vaguely suggest some of the small *Phacoides*, notably *P. trisulcatus* Conrad.

Distribution: North Carolina: Miocene, Yorktown formation, Colerain Landing, Bertie County.

#### *Aligena rhomboidea* Gardner, n. sp.

Plate 14, figure 23

Shell rather large for the genus, strongly convex, slightly depressed posteriorly, inequilateral, roughly rhomboidal. Umbones placed a little behind the median line, inflated, feebly prosogyrate. Anterior dorsal margin rectilinear; subparallel with the base, extending a little beyond it; lateral margin broadly rounded. Posterior end shorter than anterior and much narrower; posterior dorsal slope steep, roughly parallel with the anterior lateral margin. Surface badly worn; sculpture limited to incrementals that were probably rather strong. Ligament internal. Resilifer narrow, elongated, deeply submerged beneath the cardinal margin. Cardinal tooth solitary, a small, rounded protuberance directly below the tip of the umbo. Interior polished. Adductor impressions and pallial line obscure.

Dimensions of holotype: Height 7.8 millimeters, width 8.8 millimeters, convexity 2.3 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325552.

Type locality: Duplin marl at the Natural Well, Duplin County, N. C.

*Aligena rhomboidea* does not seem to be closely related to any of the coexistent *Aligenas*. It is larger than any except the largest of the *A. aequata*; the rhomboidal outline is peculiar to the species, and the cardinal tooth is relatively smaller than in any of its congeners. Only a single left valve was collected.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well, Duplin County.

#### Superfamily CHAMACEA

#### Family CHAMIDAE

The *Chama* group offers one of the best examples of the effect of habitat on the outline of valves and on the development of hinge dentition. True *Chama* is attached by the left valve, *Pseudochama* by the right, but in both genera the resulting form is the same—a heavy, concave, often cornucopia-shaped attached valve and a thinner, flatter free valve. The Mesozoic Ruditids of all the sessile bivalves present the most striking shell modifications, but the same tendency may be observed to a lesser degree in the *Ostreas*.

#### Genus CHAMA Linnaeus

1758. *Chama* Linnaeus (part), *Systema naturae*, 10th ed., p. 691.  
1919. *Chama* Odhner, K. svenska vetensk. akad. Handl., Band 59, Nr. 3, p. 75.

Type by subsequent designation (Schmidt, C. F., *Versuch über die beste Einricht*, etc., pp. 63, 177, 194, Gotha, 1818): *Chama lazarus* Linnaeus. Recent in the Indian Ocean.

The apices are twisted to the right, and the left valve is attached to the substratum.

#### *Chama striata* Emmons

Plate 13, figures 12–15

1858. *Chama striata* Emmons, North Carolina Geol. Survey Rept., p. 288, fig. 211.  
1863. *Chama striata* Emmons. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
1903. *Chama striata* Emmons. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1401.  
1932. *Chama striata* Emmons. Mansfield, Florida Geol. Survey Bull. 8, p. 91, pl. 16, figs. 8, 10.

Shell small, ovate, rather thick for its size; lower valve distinctly striate. Usually found in the hollow or inside of the univalves.—Emmons, 1858.

Habitat, North Carolina.

Right and left valves of different individuals from the Waccamaw formation at Neills Eddy Landing on the Cape Fear River, N. C., have been figured. The right valve (U. S. Nat. Mus. 325541) measures 17.0 millimeters in height and 18.5 millimeters in width. The left valve (also U. S. Nat. Mus. 325541) measures 24.0 millimeters both in height and in width.

Shell inequivalve, inequilateral, small, rather com-

pressed, attached by the lower left valve, which is irregular in outline, moderately deep, and medially depressed; upper right valve flattened except near the apex of the umbo, irregular in outline, obscurely bi- or tri-lobate. Surface of lower valve sculptured with about half a dozen overlapping lamellae, transversely puckered, the free edges occasionally flaring into sub-spinose processes, which occur most commonly along the ridges that outline the medial depression and on the posterior slope; sculpture of upper valve much finer, the laminae sometimes breaking into free spines along the summits of the radial ridges and near the posterior margin, usually gathered into closely proximate and closely appressed tubuli. Ligament groove narrow, moderately deep. Dental socket of left valve narrow, oblique, undercutting the dorsal margin; tooth laminar, slightly crescentic, transversely grooved dorsally; dental process of right valve rather slender, sharp; dorsal margin grooved beneath the umbones to correspond to the sulcations of the tooth of the left valve. Adductor impressions elongate-oblong, sub-medial, the anterior terminating just in front of the dental lamina. Pallial line simple. Inner margins finely and closely crenate.

*Chama striata* Emmons is a smaller and more compressed species than its less frequent congener, *C. congregata* Conrad. The medial depression of *C. striata* is a diagnostic character; the lamellae on the left valve are fewer, and the spines are fewer and stronger than those of *C. congregata*. The right valve is more flattened than in *C. congregata* and the radial sculpture more delicate except for an occasional strongly developed spine. In Florida *C. striata* has been reported only from the *Cancellaria* zone of the Choctawhatchee, whereas *C. congregata* occurs not only in the *Cancellaria* zone but also in the underlying *Ecphora* zone. *C. congregata* has been reported by Olsson from the Gatun of Costa Rica. *C. involuta* Guppy of the upper Miocene mid-American fauna is a smaller shell with a more highly inflated left valve and a more closely plicate sculpture.

Distribution: Virginia: Miocene, Yorktown formation, Benns Church, Isle of Wight County.

North Carolina: Miocene, Yorktown formation, Rock Landing, Craven County. Duplin marl, 2½ miles south of Clinton, 4 miles south of Clinton, Sampson County; 3 miles northeast of Warsaw, Natural Well, 1½ miles north of Magnolia, and Frank Wilson's and W. H. Kornegay's marl pits (near Magnolia), Duplin County; Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, 1½ miles northeast of Fairmont (Ashpole), and at Fairmont, Robeson County. Pliocene, Waccamaw formation, Lake Waccamaw, Neills Eddy Landing, Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla.



Genus **PSEUDOCHEMA** Odhner

1917. *Pseudochama* Odhner, K. svenska vetensk. akad. Handl., Band 52, No. 16, p. 30.

Type by monotypy: *Chama cristella* Lamarck. Recent from the Gulf of Siam to Java, the Moluccas, and Australia.

The apices are twisted to the left, and it is the right valve that is attached to the substratum. The generic value of the sinistral twist is not recognized by Davies.<sup>43</sup>

**Pseudochama corticosa** (Conrad) Gardner

Plate 13, figures 5, 16, 28

1833. *Chama corticosa* Conrad, Am. Jour. Sci., 1st ser., vol. 23, p. 341.  
 1838. *Chama corticosa* Conrad, Fossils of the medial Tertiary of the United States, p. 32, pl. 17, fig. 3.  
 1855. *Chama corticosa* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 22, pl. 7, figs. 1-3.  
 1858. *Chama corticosa* Emmons, North Carolina Geol. Survey Rept., p. 288, fig. 210.  
 1863. *Chama corticosa* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
 1903. *Chama corticosa* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1400.

Shell sinistral, with strong concentric undulated laminae transversely striated; superior valve flat; inner margin crenulated. Found with the preceding species [*Chama congregata* Conrad].—Conrad, 1833.

Type locality: James River near Smithfield, Isle of Wight County, Va.

Illustrations of specimens from the Duplin marl at Darlington, S. C., made by Tuomey and Holmes, have been reproduced.

Shell large, heavy, lamellose, attached by the strongly convex right valve; upper (left) valve flat, disklike; obscure, submedial carina most clearly defined on the umbones, becoming evanescent ventrally; posterior radial fold usually developed. Umbones very high and prominent, twisted toward the left; right umbo performing at least one complete revolution; umbo of left valve less strongly gyrate; outline of interior of valve, exclusive of cardinal area, subcircular. Surface of both valves covered with overlapping concentric lamellae that are attached dorsally, the ventral edges more flaring and more closely overlapping in the upper valve than in the lower; transverse striations irregular, most conspicuous on eroded surfaces and toward the ventral margin of the right valve. Ligament groove inset, crescentic, broader and deeper in the right valve than in the left. Dental socket in right valve broad, transversely elongated, central in position, separated from ligament groove by a shelly ridge and limited ventrally by a rude, horizontal, dental process; dentition in left valve little more than a roughened modification of the dorsal margin and, ventral to the

tooth, an irregular pit for the reception of the corresponding process in the right valve. Muscle impressions much elongated, slightly reniform, the dorsal termination of the anterior adductor subumbonal; posterior adductor less produced dorsally. Pallial line simple. Inner surface finely and irregularly crenate a short distance from the margin of the valve.

*Pseudochama corticosa* (Conrad) is conspicuous among its congeners for its large size and sinistral beaks.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; near mouth of Baileys Creek, Prince George County; 3½ miles north of Smithfield, Isle of Wight County.

North Carolina: Miocene, Yorktown formation, 1½ miles above Murfreesboro, Hertford County; 6 miles west of Goldsboro, Wayne County; Rock Landing, Craven County. Duplin marl, Natural Well, 1½ miles north of Magnolia, Duplin County; Lumberton (near the bottling works), Robeson County.

Outside distribution: Miocene, Duplin marl, Darlington, Darlington County, S. C.

Superfamily **CARDIACEA**Family **CARDIIDAE**Genus **CARDIUM** Linnaeus

1758. *Cardium* Linnaeus, Systema naturae, 10th ed., p. 678.  
 1799. *Cardium* Lamarck, Pródrome d'une nouvelle classification des coquilles: Soc. d'histoire nat. Paris Mém., p. 86.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einricht, etc., pp. 53, 176, Gotha, 1818): *Cardium costatum* Linnaeus. Recent in the Indo-Pacific.

The type of the genus is a thin, gaping, highly inflated, transversely elongate shell, with narrow elevated radials persistent to the margin and interlocking at the margin with the radials of the opposite valve. The cardinals of the right valve are two prominent cusps united at the base and received between the anterior and posterior cardinals of the left valve, one beneath the other rather than side by side. Both the anterior and the posterior laterals are strongly developed in both valves.

*Cardium* s. s. is not recorded in the fossil state.

Genus **CERASTODERMA** Mörch

1853. *Cerastoderma* Mörch, Catalogus conchyliorum quae reliquit D. Alphonso d'Aguirra & Gadea Comes de Yoldi, fasc. 2, p. 34.  
 1930. *Cerastoderma* (Poli) Mörch. Stewart, Acad. Nat. Sci. Philadelphia Special Pub. 3, p. 259.

Type by subsequent designation (Von Martens, Zool. Rec. for 1869, vol. 6, p. 586, 1870): *Cardium edule* Linnaeus. Recent along European shores from the North Atlantic to the Mediterranean.

Valves closed; rotund, transversely or obliquely ovate, cordate in outline. Anterior and posterior areas inconspicuous or not defined. Radial costae numerous, elevated, smooth, granulated, or imbricated. Inter-costal areas simple. Left cardinals anterior when interlocked.

<sup>43</sup> Davies, A. M., Tertiary faunas, vol. 1, p. 150, 1935.

**Cerastoderma laqueatum (Conrad) Conrad**

Plate 16, figure 4

1831. *Cardium laqueatum* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 6, p. 258.  
 1938. *Cardium laqueatum* Conrad, Fossils of the medial Tertiary of the United States, p. 31, pl. 17, fig. 1.  
 1839?. *Cardium ingens* Wagner. Unpublished figure.  
 1863. *Cardium (Cerastoderma) laqueatum* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
 1897. *Cardium ingens* Wagner. Dall, Wagner Free Inst. Sci. Trans., vol. 5, p. 10, pl. 3, fig. 2.  
 1900. *Cardium (Cerastoderma) laqueatum* Conrad. Dall, idem, vol. 3, pt. 5, p. 1092.  
 1904. *Cardium (Cerastoderma) laqueatum* Conrad. Glenn, Maryland Geol. Survey, Miocene, p. 319, pl. 86, fig. 1.

Shell cordate, ventricose, thin, with about 33 subtriangular, transversely wrinkled ribs; umbones prominent; lunule not profoundly impressed and somewhat lanceolate; cardinal tooth subulate.

Cab[inet of the] Academy.

Inhabits—Fossil from Maryland.

Length  $1\frac{1}{2}$  inches; length and height nearly equal. The only determinate fossil species of its genus yet discovered in this country; I found it only in the clay beds at St. Marys River, and always in a state of decomposition, that rendered it impossible to obtain any but mutilated specimens.—Conrad, 1831.

A left valve from the Choptank formation at Jones Wharf on the Patuxent River, St. Marys County, Md., was figured by Glenn, and the illustration is reproduced in this paper. The specimen is in the collection of the Maryland Geological Survey, Johns Hopkins University, Baltimore, Md.

Shell large; the height and width nearly equal; rounded and produced anteriorly, obliquely truncated posteriorly, slightly arcuate ventrally. Umbones inflated. Radial ribs generally rounded, less frequently flat-topped or triangular, slightly wider than the inter-radials, normally 28 to 32 in number, exclusive of the 6 to 9 low, overturned ridges on the posterior area; very faint secondary radial striae sometimes visible on the summits of the primaries; concentric sculpture of undulatory incrementals that are strongest near the posterior margin of the valves; ribs made up of hollow cones, one within the other, laid obliquely on the shell, the apices directed toward the umbones—a very weak structure responsible for the decorticated condition in which the valves of this species are usually found; sculpture best preserved near the ventral margins; scars left by the ribs in the form of pairs of elevated radiating lines, each pair marking the lateral boundaries of a former rib.

*Cerastoderma laqueatum* (Conrad) is a relatively lower, broader form than *C. acutilaqueatum* of the same author. The ribs are slightly fewer and are usually flat or rounded on the top rather than triangular, as in the latter species. *Dinocardium robustum* (Solander) is not quite so broad as *C. laqueatum*, a little more oblique, with a more strongly differentiated

posterior area and with fewer but broader radials. It occupies in the fauna of the Duplin and Waccamaw much the same position that *C. laqueatum* (Conrad) does in the St. Marys.

*C. laqueatum* (Conrad) is represented in the Arca zone of the Choctawhatchee formation by *Cardium (Cerastoderma) laqueatum blountense* Mansfield, 1932. The Floridian species is not so large as that from the middle Atlantic slope, is less oblique, and differs in the details of the sculpture pattern. In these variations it approaches *Cerastoderma waltonianum*, abundant in the Shoal River formation of the Alum Bluff group.

Distribution: Virginia: Miocene, St. Marys formation?, Nomini Cliffs, Westmoreland County. St. Marys formation, half a mile below Bowlers Wharf, Essex County; Claremont Wharf (lower bed), and old Claremont Wharf (lower bed), Surry County.

Outside distribution: Miocene, Hawthorn formation, Porters Landing, Effingham County, Ga. Choptank formation, Greensboro, Caroline County, Md.; Dover Bridge and Sand Hill, Talbot County, Md.; Governor Run, Flag Pond, and St. Leonards Creek, Calvert County, Md.; Jones Wharf, Turner, Pawpaw Point, and Cuckold Creek, St. Marys County, Md. St. Marys formation, Cove Point, Calvert County, Md.; Langleys Bluff and St. Marys River, St. Marys County, Md.

**Cerastoderma acutilaqueatum (Conrad) Conrad**

Plate 16, figure 5

1839. *Cardium acutilaqueatum* Conrad, Fossils of the medial Tertiary of the United States, back cover of No. 1.  
 1840. *Cardium acutilaqueatum* Conrad, idem, p. 34, pl. 18, fig. 2.  
 1863. *Cardium (Cerastoderma) acutilaqueatum* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
 1900. *Cardium (Cerastoderma) acutilaqueatum* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1092.

Shell oblique, ovate, ventricose, rounded at base and posterior extremity; ribs about 36, subtriangular, narrow, prominent; posterior margin very long, oblique, and subrectilinear; umbo narrow, summit very prominent; margin profoundly crenate. Length 4 inches, height  $4\frac{1}{2}$  inches. Locality, Yorktown, Va.—Conrad, 1839.

This species has been confounded with *C. laqueatum*, the ribs of which, in immature specimens, resemble those of the present species in their subtriangular form; but the latter shell is proportionately more elevated, being higher than long, whilst the former is rather more in length than height.—Conrad, 1840.

Conrad's illustration of his holotype, a right valve, has been reproduced.

*Cerastoderma acutilaqueatum* weathers in much the same manner that *Cerastoderma laqueatum* does. It is more widely distributed than the latter species, though the geologic and geographic ranges of both are much the same. The former tends, in a general way, to be the more common and to occur at a slightly higher horizon and in a more southern area. Dall reports the species from the upper bed at Alum Bluff, Liberty County, Fla., an outcrop considered by Mansfield to be typical of the *Ecphora* zone of the Choctawhatchee formation.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; a quarter of a mile south of the Smithfield powerhouse, Isle of Wight County; a quarter to  $\frac{1}{2}$  mile below Sycamore, Southampton County;  $\frac{1}{4}$  mile north of Chuckatuck,  $2\frac{1}{2}$  miles northwest of Suffolk, 1 mile west of Suffolk,  $1\frac{1}{2}$  miles northeast of Suffolk, 1 mile northeast of Suffolk, and  $\frac{1}{2}$  mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 2 miles below Toddy Station, 2 miles southeast of Tugwell (on Jacobs Branch), 3 miles south of Farmville,  $2\frac{1}{2}$  miles north of Standard, 8 to 9 miles west of Greenville (on the east side of Pine-log Branch), 9 to 10 miles south of Greenville, and 1 mile northwest of Galloway Crossroads, Pitt County;  $1\frac{1}{4}$  miles northeast of Chocowinity, Beaufort County,  $\frac{1}{2}$  mile east of Lizzie, Greene County; Rock Landing, Craven County. Duplin marl, Natural Well, Duplin County.

Outside distribution: Miocene, Choctawhatchee formation, Alum Bluff (upper bed) (Dall), Calhoun County, Fla.

### *Cerastoderma virginianum* (Conrad) Conrad

Plate 16, figure 3

- 1839 (April). *Cardium virginianum* Conrad, Fossils of the medial Tertiary of the United States, back cover of No. 1.  
 1839 (December). *Cardium quadrans* Rogers and Rogers, Am. Philos. Soc. Trans., 2d ser., vol. 5, p. 375, pl. 30, fig. 1.  
 1840. *Cardium virginianum* Conrad, Fossils of the medial Tertiary of the United States, p. 33, pl. 18, fig. 1.  
 1840. *Cardium ingens* Wagner. Conrad, idem, p. 33. Not *C. ingens* Wagner, 1839?  
 1863. *Cardium* (*Cerastoderma*) *virginianum* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
 1900. *Cardium* (*Cerastoderma*) *virginianum* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1094.  
 1932. *Cardium* (*Cerastoderma*) *virginianum* Conrad. Mansfield, Florida Geol. Survey Bull. 8, p. 111, pl. 17, fig. 6.

Shell very oblique, convex-depressed; ribs about 26, broad, flat; interstices narrow and very shallow; summit narrow and not very prominent, oblique; anterior margin rectilinear, extremity angular; posterior extremity rounded; basal margin very long, arcuated. Length about 4 inches. Locality, James River, near Smithfield.—Conrad, 1839.

Conrad's illustration of his holotype, a right valve, has been reproduced.

*Cerastoderma virginianum* (Conrad) is an unusually well characterized species. The diagnostic features are the rhomboidal outline; the low, flattened, posterior umbones; the rectilinear anterior margin; the sharply differentiated posterior area; and the very low, broad, flat-topped ribs, often showing faint, secondary striation. The posterior area is unsculptured except for five to seven impressed lines, which become obsolete before reaching the margin. The concentric sculpture is similar to that of the other members of the subgenus. Even the merest fragment may be determined if it includes a bit of the hinge line or of the radial sculpture.

The species is limited in its known distribution to the Yorktown of southern Virginia and northern North Carolina, and to the *Ecphora* zone of the Choctawhatchee formation of Florida (Mansfield, 1932).

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, Bellefield, York County;  $1\frac{1}{2}$  miles west of the mouth of Baileys Creek, Prince George County; Smithfield and Zuni, Isle of Wight County; Sycamore, 3 to 4 miles above the lower Seaboard Railway bridge, and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County.

North Carolina: Miocene, Yorktown formation,  $1\frac{1}{2}$  miles above Branches Bridge, 1 mile above Branches Bridge, and Branches Bridge, Northampton County; Halifax (on Mr. Durham's farm),  $\frac{1}{2}$  mile above the Atlantic Coast Line Railway bridge and at Palmyra Bluff, Halifax County.

Outside distribution: Miocene, Choctawhatchee formation, Alum Bluff (upper bed), Calhoun County, Fla. (?) Miocene, Gay Head, Mass. (Dall).

### Genus *TRACHYCARDIUM* Mörch

1853. *Trachycardium* Mörch, Catalogus conchyliorum quae reliquit D. Alphonso d'Aguirra et Gadea Comes de Yoldi, fasc. 2, p. 34.

Type by subsequent designation (Von Martens, Zool. Rec. for 1869, vol. 6, p. 586, 1870): *Cardium isocardia* Linnaeus. Recent on the east coast from Hatteras to Trinidad; fossil in the later Tertiary and Pleistocene.

Valves closed, rotund, or ovate-cordate in outline; ribs concentrically sculptured or granulose, many of them elaborately imbricated or tuberculate; left cardinals anterior when interlocked.

### *Trachycardium isocardia* (Linnaeus)

Plate 15, figures 19, 20

1758. *Cardium isocardia* Linnaeus, Systema naturae, 10th ed., p. 679.  
 1782. *Cardium isocardia* Linnaeus. Chemnitz, Conchylien cabinet, vol. 6, p. 182, pl. 17, figs. 174-176.  
 1845. *Cardium isocardia* Linnaeus. Reeve, Conchologia iconica, vol. 2, *Cardium*, pl. 17, fig. 84.  
 1856. *Cardium egmontianum* Shuttleworth, Jour. conchylologie, vol. 5, 2d ser., vol. 1, p. 172.  
 1858. *Cardium isocardia* Linnaeus. Holmes, Post-Pleocene fossils of South Carolina, p. 25, pl. 5, fig. 4.  
 1875. ?*Cardium eburniferum* Guppy, Annals and Mag. Nat. History, ser. 4, vol. 15, p. 51, pl. 7, fig. 3.  
 1900. *Cardium* (*Trachycardium*) *isocardia* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1085.

*Cardium testa cordata*; sulcis squamis fornicatis imbricatis.—Linnaeus, 1758.

Paired valves of a Recent individual from the Florida coast (U. S. Nat. Mus. 57147) have been figured. The shell measures 47.5 millimeters in height and 37.5 millimeters in width.

This is the type of the subgenus and has about 27 to 33 ribs, with comparatively low and distant arcuate imbricating scales; the ribs are squarish and the interspaces channeled, the scales tend to be seated on the posterior side of the ribs; on the anterior face of the shell the imbrications are closer, lower, and heavier, but these ornaments change their form very gradually from one end of the shell to the other.

Linné and the earlier writers confounded this shell with a similar form from the East Indies, which was afterwards named *C. squamosum* by Gmelin. A specimen of the West Indian shell was in the Linnaean cabinet and serves to hold

the name, though among the figures cited by him several referred to the Oriental shell.—Dall, 1900.

Shell somewhat inequilateral, obliquely cordate; umbones high, inflated; posterior margin sharply serrated.

*Trachycardium isocardia* (Linnaeus) is relatively lower than its precursor, *T. emmonsii* (Conrad), the umbones are less prominent, and the medial and lateral sculptures are less elaborate and less sharply differentiated. In the latter, furthermore, the medial ribs are decked with high, vaulted imbrications, which on the posterior side of the shell are abruptly flattened and continuous with one another. In the former, the imbrications are lower, more distant, and frequently confined to the posterior half of the rib.

Distribution: North Carolina: Pliocene, Waccamaw formation, Wilmington, New Hanover County (U. S. Nat. Mus. 145291).

Outside distribution: Pliocene, Caloosahatchee River and Myakka River, Fla. Pleistocene, Abbapoola, Folly Island, and Simmons Bluff, S. C.; Orient, Hillsborough County, Fla.; Manatee Station and North Creek near Osprey, Manatee County, Fla.; Eau Gallie, Brevard County, Fla.; 1 mile south of Daytona Beach, Volusia County, Fla.; Labelle, Hendry County, Fla.; Fort Lauderdale, Broward County, Fla.; Big Pine Key and Torch Key, Fla. Recent, Hatteras to Trinidad and east to Bermuda in less than 50 fathoms.

#### *Trachycardium emmonsii* (Conrad) Conrad

1858. *Cardium muricatum* Emmons, North Carolina Geol. Survey Rept., p. 301, figs. 232, 233. Not *C. muricatum* Linnaeus, 1758, nor Tuomey and Holmes, 1856.  
 1863. *Cardium (Trachycardium) muricatum?* Linnaeus. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
 1867. *Cardium (Trachycardium) emmonsii* Conrad, Am. Jour. Conchology, vol. 3, p. 13.  
 1887. *Cardium floridanum* Heilprin, Wagner Free Inst. Sci. Trans., vol. 1, pp. 92, 103, pl. 11, fig. 25.  
 1900. *Cardium (Trachycardium) emmonsii* Conrad. Dall, idem, vol. 3, pt. 5, p. 1084.

The specimen given in the figure resembles the *muricatum*, but it is more elongated, and its crenulations appear to differ. I have obtained only one specimen; and hence cannot speak of the permanence of its characters. It occurs in Walkers Bluff, on the Cape Fear.—Emmons, 1858.

This shell is shorter or comparatively more elevated than *C. muricatum*, with a thicker cardinal plate. In the figure the ribs are also flatter on the back and furnished with broad scales, not small tubercles as in *C. muricatum*.—Conrad, 1867.

This form has 9 ribs on the posterior with hoodlike imbrications; 10 on the disk with high, arching imbrications continuous on the posterior side; and 10 anterior, with cuplike ornaments like strung convolvulus flowers. The nearest recent relative is *C. consors* Broderip of the Pacific coast.—Dall, 1900.

The species is considerably higher than wide, representative individuals measuring 60.6 millimeters, 74.3 millimeters, and 77.0 millimeters in height, and 47.0 millimeters, 57.5 millimeters, and 57.8 millimeters in width, respectively. The valves are somewhat rounded anteriorly, truncate and serrate posteriorly. The umbones are high and narrow. The sculpture is more elaborate than in any other member of the genus within

the area. The ribs vary slightly in number and in the degree of differentiation between the medial and lateral areas.

Conrad's species is referred to *Trachycardium* s.s. The resemblance between *T. emmonsii* and *T. isocardia* seems much closer than that between *T. emmonsii* and *T. muricatum*. The relationship is indicated both in the outline and contour of the shell and in the sculpture pattern. *Dalloccardia* Stewart should probably include, however, *T. oedaliium* Dall from the Caloosahatchee of Florida and *T. bowdenense* Dall from Jamaica. *T. ustrix* Gardner, with 35 ribs, abundant in the Shoal River formation, is an earlier member of the *T. isocardia* group.

This daintily sculptured cockle is fairly common at a single horizon and is represented by a dozen or so perfectly preserved valves. It has not been recognized in strata older than the Pliocene.

Distribution: North Carolina: Pliocene, Waccamaw formation. Walkers Bluff, Bladen County (Emmons); Neills Eddy Landing, Columbus County, N. C.

Outside distribution: Pliocene, Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla.

#### Section DALLOCCARDIA Stewart

1930. *Dalloccardia* Stewart, Acad. Nat. Sci. Philadelphia, Special Pub. 3, p. 264.

Type by original designation: *Cardium quadrigenarium* Conrad. Recent off the California coast near Santa Barbara.

The differences that separate *Dalloccardia* from *Trachycardium* s.s. seem of doubtful subgeneric value. The hinge of *Dalloccardia* is similar to that of *Trachycardium* but not so heavy, and the ornamentation on the crests of the medial ribs are, in *Dalloccardia*, more commonly confined to the posterior portion of the rib. *T. muricatum* is considered by Stewart to exemplify the characteristic features of his subgenus.

#### *Trachycardium muricatum* (Linnaeus) Dall

Plate 15, figure 21

1758. *Cardium muricatum* Linnaeus, Systema naturae, 10th ed., p. 680.  
 1900. *Cardium (Trachycardium) muricatum* Linnaeus. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1089.

*C. testa subcordata sulcata lateribus muricata. Habitat ad sinum Campechiensem.*—Linnaeus, 1758.

Dall has given an extensive discussion of the variations in the sculpture pattern of *muricatum*. Although it is rarely recorded in the Tertiary faunas, the precursal forms are sufficiently close to have been confused with the Recent species in the early check lists and synonymies. The closely related *oedaliium* Dall described from the Caloosahatchee Pliocene of southern Florida, is represented in the Choctawhatchee Miocene of northern Florida by *oedaliium harveyense* Mansfield, 1932. The subspecies is confined to the *Cancellaria* zone, which is the uppermost zone of the Choc-

tawhatchee formation, at the top of the Miocene section of Florida. Mansfield<sup>44</sup> referred in his description to "2 small and eroded valves having 31 or 32 ribs and a fragment of a larger specimen," which may be referable to his *harveyense*. They were collected in the Duplin marl, 1 mile east of Darlington, S. C.

A shell from the Cape Fear River is figured.

#### Genus TRIGONICARDIA Dall

1900. *Trigonicardia* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1075.

1930. *Trigonicardia* Dall. Stewart, Acad. Nat. Sci. Philadelphia, Special Pub. 3, p. 267.

Type by original designation: *Cardium graniferum* Broderip and Sowerby. Recent from the Gulf of California to Panama.

Shell small, few-ribbed, medial ribs very strong; posterior end subtruncate with smaller, closer ribs; channels strongly concentrically sculptured; shell colorless, periostracum smooth.—Dall, 1900.

The genus *Fragum* is not known from American waters and apparently never reached the New World. *Trigonicardia* Dall (1900, p. 1075), which was described as a section of the subgenus *Fragum*, has a different hinge and is to be treated as a distinct genus. These two genera were considered related because of the prominent posterior umbonal slope present on both, but *Fragum* has the posterior laterals crowded toward the cardinals, while *Trigonicardia* has the anterior laterals crowded against the cardinals. \* \* \* The hinge of *Trigonicardia* seems more closely related to that of *Trachycardium* than to that of *Fragum*. The hinge plate is wider than on *Fragum* so that the cardinals do not protrude ventrally where they join the hinge, while the anterior right and posterior left cardinals are less developed than in *Fragum*. This wide hinge plate and unequal cardinals are characteristic of *Trachycardium* s. s. and suggest that *Trigonicardia* is related to it.—Stewart, 1930.

*Trigonicardia* has not been recognized in strata older than the Miocene.

#### Subgenus AMERICARDIA Stewart

1930. *Americardia* Stewart, Acad. Nat. Sci. Philadelphia, Special Pub. 3, p. 267.

Type by original designation: *Cardium medium* Linnaeus, Systema naturae, 10th ed., p. 678, 1758. Recent from Cape Lookout, N. C., to Santa Marta, Brazil; abundant in the West Indies. Miocene and Pliocene of the middle Atlantic and the Gulf Coastal Plain.

The subgenus is characterized by the position of the cardinals, which are symmetrically disposed between the anterior and posterior laterals, and by the absence of costal ornamentation other than an exaggerated incremental sculpture. *Americardia*, as defined by Stewart, includes the Tertiary species formerly referred to *Trigonicardia*. In the symmetry of the dentition, *Americardia* suggests the oriental group of *Ctenocardia* H. and A. Adams.

#### *Trigonicardia (Americardia) media* (Linnaeus) Stewart

1758. *Cardium medium* Linnaeus, Systema naturae, 10th ed., p. 678.

1844. *Cardium medium* Linnaeus. Reeve, Conchologia iconica, vol. 2, *Cardium*, pl. 6, fig. 30.

1861. *Cardium venustum* Dunker, Malakozool. Blätter, vol. 8, p. 37.

1887. *Hemicardium columba* Heilprin, Wagner Free Inst. Sci. Trans., vol. 1, p. 93, pl. 11, figs. 26, 26a.

1900. *Cardium (Fragum) medium* Linné. Dall, idem, vol. 3, pt. 5, p. 1101.

1904. *Cardium (Fragum) medium* Linné. Glenn, Maryland Geol. Survey, Miocene, p. 322, pl. 86, figs. 6a, 6b.

*C. testa subcordata subangulata; valvulis angulatis sulcatis laevibus. Habitat in O. Indico.*—Linnaeus, 1758.

This species is abundant in the West Indies and differs especially in the amount of impression of the posterior area and the elevation of the upper part of the posterior margin projecting from the central part of the depression when the valves are closed. Some specimens have only a slight depression, others have it very marked, and the intermediate stages are so common that it is evident they are of little systematic value.—Dall, 1900.

Shell high, the outline of the interior squarish. Posterior margin truncated and rather sinuous. Anterior margin slightly rounded. Ventral margin nearly straight. Umbones high, narrow, angular, involute. A well-marked angulation extending from the umbo to the posterior basal margin; posterior area feebly undulated and depressed. Radial ribs, 33 to 37, covered with crowded concentric imbrications, which are most prominent on the posterior portion of the shell. These are readily removed by erosion and reveal the polished rectangular ribs without a trace of the original sculpture.

Distribution: North Carolina: Miocene, Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Neills Eddy Landing, Columbus County.

Outside distribution: Miocene, St. Marys formation, St. Marys River, Md.? Pliocene, Caloosahatchee marl, Caloosahatchee River, Shell Creek, and Alligator Creek, Fla. Recent, Cape Lookout, N. C., to Santa Marta, Brazil, in less than 50 fathoms except off the West Indies, where it occurs in both shallow and deep water.

#### Genus LAEVICARDIUM Swainson

1840. *Laevicardium* Swainson, Treatise on malacology, p. 373.

Type by subsequent designation (Bucquoy, Dautzenberg, and Dollfus, Mollusques marins du Roussillon, vol. 2, p. 298, 1892): *Cardium europaeum* Wood = *Cardium norvegicum* Spengler. Recent on the west coast of Europe and in the Mediterranean.

The genus is best known by the absence of strong radial sculpture. The hinge line is arcuate and the dentition more delicate than in many of the *Cardia*. The anterior cardinal of the right valve is rudimentary, but the posterior cardinal is a prominent conical peg received between the two left cardinals. The left pos-

<sup>44</sup> Mansfield, W. C., Florida Geol. Survey Bull. 8, p. 111, 1932.

terior lateral is very feeble. The obscure radial sculpture is most strongly indicated in the crenation of the inner margins.

***Laevicardium sublineatum* (Conrad) Conrad**

Plate 15, figures 11, 12, 15, 16

1841. *Cardium sublineatum* Conrad, Am. Jour. Sci., 1st ser., p. 347, pl. 2, fig. 13.  
 1843. *Cardium sublineatum* Conrad, Assoc. Am. Geologists and Naturalists Proc. and Trans., p. 110, pl. 5, fig. 13.  
 1845. *Cardium sublineatum* Conrad, Fossils of the medial Tertiary of the United States, p. 66, pl. 37, fig. 4.  
 1856. *Cardium sublineatum* Conrad, Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 64, pl. 19, fig. 3.  
 1863. *Cardium (Laevicardium) sublineatum* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576.  
 1900. *Cardium (Laevicardium) sublineatum* Conrad, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1111.  
 1906. *Laevicardium sublineatum* Conrad, Böse, Inst. Geol. México Bol. 22, pp. 25, 28, 79, pl. 2, figs. 1-3; pl. 11, fig. 4.

Obliquely obovate, thin, slightly ventricose, with obsolete radiating lines, most distinct near the ends; submargins of anterior and posterior sides destitute of radiating lines; within striated; margin crenulated.—Conrad, 1841.

Type locality: Wilmington, N. C. Waccamaw formation.

Dimensions of figured specimens: Right valve, height 28.7 millimeters, width 29.0 millimeters, convexity 8.7 millimeters. Left valve, height 26.0 millimeters, width 28.5 millimeters, convexity 8.0 millimeters.

Figured specimens, a right and a left valve of different individuals (U. S. Nat. Mus. 325559) from the Waccamaw formation at Neills Eddy Landing on the Cape Fear River, Columbus County, N. C.

The outer smooth and polished surface is readily removed by erosion and reveals the radially striate, porcellaneous layer beneath.

Distribution: Virginia: Miocene, Yorktown formation,  $\frac{1}{4}$  mile north of Chuckatuck and  $1\frac{1}{2}$  miles northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation,  $\frac{1}{4}$  to  $\frac{1}{2}$  mile above Edenhous Point, Bertie County. Duplin marl, Natural Well and at several neighboring localities, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Lake Waccamaw, Cronly ( $\frac{1}{2}$  mile east of the factories), and Neills Eddy Landing, Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin marl, Darlington, Darlington County, S. C.; Santa Rosa and Santa Maria Tetetla, Vera Cruz, Mexico. Waccamaw formation, Nixons, Tillys Lake, and Todds Ferry, Horry County, S. C.

**Superfamily TELLINACEA**

**Family TELLINIDAE**

**Genus TELLINA (Linnaeus) Lamarck**

1758. Linnaeus, Systema naturae, 10th ed., p. 674.  
 1799. Lamarck, Prodrome d'une nouvelle classification des coquilles, Soc. histoire nat. Paris Mém., p. 84.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einrichtung, etc., pp. 51, 177, Gotha, 1818): *Tellina radiata* Linnaeus. Recent in the West Indies.

Shell transversely ovate to ovate-trigonal in outline, compressed; usually rostrate and flexed to the right posteriorly, and broadly depressed in front of the rostrum. Umbones low, subcentral or posterior, often opisthogyrate. External surface rarely smooth; dominant sculpture concentric, regular, and generally incremental in character; radial ornamentation commonly suggested by the color pattern and by the reinforcing internal rays, rarely by the sculpture; oblique sculpture developed in one group. Ligament external, opisthodontic. Two cardinals, one of them bifid, developed in each valve, interlocking in the closed valves so that the bifid teeth are flanked on either side by a simple laminar tooth. Anterior and posterior laterals developed in some groups in both valves; in others, reduced to a single right anterior lateral. Sinus free or coalescent ventrally with the pallial line, often discrepant in the two valves, the dorsal margin of the sinus commonly uniting the anterior and posterior adductors.

The Tellinas are essentially a modern group, though they have their roots in the Mesozoic.

**Subgenus MOERELLA Fischer**

1887. *Moerella* Fischer, Manuel de conchyliologie et de paléontologie conchyliologique, p. 1147.

Type by monotypy: *Tellina donacina* Linnaeus. Recent off the European coasts from the Hebrides to the Mediterranean. Fossil in the Coralline Crag of England.

Shell rather small for the genus, transversely ovate, obscurely rostrate posteriorly. Sculpture dominantly concentric, the Recent species often rayed with colors. Umbones low, opisthogyrate. Lunule and escutcheon extremely narrow, indicated but not well defined. Ligament external, opisthodontic. Two cardinal teeth in each valve, the anterior right and the posterior left simple and laminar, the posterior right and the anterior left stouter and bifid. True laterals not developed in the left valve, though the edges are beveled to function as laterals and are received within the lateral sockets on the right valve; the anterior lateral more elevated and closer to the umbo than the posterior. Pallial sinus confluent ventrally with the pallial line throughout the greater part of its extent.

Most of the east coast Tertiary Tellinas, referred in earlier publications to *Angulus*, seem more closely allied to *Moerella*. *Angulus* is an Indo-Pacific group in which only a single lateral—the right anterior—is developed; it has not been recognized in the Miocene and lower Pliocene faunas of the east coast.

***Tellina (Moerella) declivis* Conrad**

1834. *Tellina declivis* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 131.

1840. *Tellina declivis* Conrad, Fossils of the medial Tertiary of the United States, p. 35, pl. 19, fig. 1.  
 1863. *Tellina (Angulus) declivis* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 573.  
 1894. *Tellina (Angulus) declivis* Say. Whitfield, U. S. Geol. Survey Mon. 24, p. 77, pl. 14, figs. 4-6.  
 1900. *Tellina (Angulus) declivis* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1029.  
 1904. *Tellina (Angulus) declivis* Conrad. Glenn, Maryland Geol. Survey, Miocene, p. 298, pl. 72, fig. 14.  
 1909. *Tellina declivis* Conrad. Grabau and Shimer, North American index fossils, vol. 1, p. 567, fig. 777a.

Shell somewhat elliptical, with the anterior [posterior] side short, and the margin obliquely truncated; posterior [anterior] end regularly rounded; beaks hardly prominent; lateral teeth distinct.

Locality: Yorktown, Va.

It resembles in outline the *Amphidesma subreflexa nobis*; and might, viewing the exterior only, be mistaken for that shell.—Conrad, 1834.

Shell thin, fragile, compressed, inequilateral. Outline ovate-elongate. Umbones low, inconspicuous, opisthogyrate, situated about two-thirds of the distance toward the posterior margin. Anterior dorsal margin produced, gently sloping into the rounded anterior end; posterior slightly contracted at the nymph, the contraction most noticeable in the right valve; obscurely truncate from the umbones to the base; ventral margin straight, usually at a low angle to the anterior dorsal margin. Surface feebly sculptured with concentric groovings that are least faint anteriorly and near the base, though obsolete on the umbones. Cardinals normal in both valves, but rather small and rude. Anterior lateral of right valve strong, not in line with the anterior cardinal, but a little dorsal to it; posterior lateral short, low, and inconspicuous, located near the ventral terminal of the nymph; margin of valve slightly contracted at this point, thus making a little V-shaped groove for the reception of the feeble prominence on the dorsal margin of the left valve. No true laterals developed in left valve but dorsal margins modified to function as laterals. Slightly thickened anterior ray often visible internally. Muscle scars and pallial line and sinus usually obliterated. Anterior scar somewhat elongated and very irregular; posterior semi-elliptic. Sinus, a wavy line rising a little higher in the right valve than in the left and reaching its maximum at a point on a vertical with the umbones, then more gradually descending and falling only a little short of the anterior scar.

*Tellina declivis* Conrad is one of the most abundant representatives of the genus in the Tertiary of North Carolina and, more particularly, of Virginia along the York River and in the vicinity of Suffolk, Nansemond County. Though inconstant in outline, the species has an individuality that makes it readily recognizable—a generally untidy appearance owing to the irregularity of outline and to the nicked and ragged margins of the thin and fragile valves. It is less elongated anteriorly

than *T. producta* Conrad, and the anterior dorsal margin is generally at a low angle to the base instead of parallel with it, as in the latter. It is more elongated, however, than *T. calpia*, from the Yorktown of North Carolina, an oval form with subcentral umbones and rounded dorsal margins nearly similar to one another. *T. macilenta* Dall, of the Duplin fauna, is relatively higher, with a much higher umbonal angle. *T. sayi* Deshayes, of the Pliocene and Recent, is closely allied and is its possible descendant. *T. sayi*, however, averages a little smaller, is the more regular in outline, and is obliquely produced and truncated along its posterior margin. In *T. declivis*, there is a small contraction at the nymph; below it, the slightly flaring margin may be very gently arched or rather obscurely truncated. The angle of the margin with the base is decidedly higher than in *T. sayi* and often approaches a right angle. The dentition of *T. sayi* is usually a little stronger, and the dorsal margin of the pallial sinus seems a trifle higher. The two forms rarely occur together, *T. declivis* being essentially a Miocene species north of the Hatteras, whereas *T. sayi* is a post-Miocene shell south of the Hatteras. The former, however, persists in much reduced numbers in the Caloosahatchee fauna.

Distribution: Virginia: Miocene, St. Marys formation, 1 to 2 miles below Bowlers Wharf, Essex County; Union Mills, 2½ miles south of Farnham, Richmond County; Urbanna, Middlesex County; Sunken Marsh Creek (lower bed), James River, Surry County. Yorktown formation, Yorktown, York County; Petersburg, Dinwiddie County; 2 miles northwest of Smithfield; 6½ miles below Zuni, Isle of Wight County; ¼ mile north of Chuckatuck, ½ mile east of Everets Post Office, 5½ miles northwest of Suffolk, 2½ miles northwest of Suffolk, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, half a mile below the Suffolk waterworks dam, and 1 mile south of Deep Creek, Nansemond County.

North Carolina: Miocene, Yorktown formation, Palmyra Bluff, Halifax County; half a mile above Bells Bridge, Tar River, Edgecombe County; Tar Ferry on Wicacoan Creek (opposite Harrellsville), 1½ miles below Tar Ferry, and Mount Pleasant Landing, Hertford County; ½ to ¾ mile above Edenhouse Point, Bertie County.

Outside distribution: Miocene, Calvert formation, Shiloh, Cumberland County, N. J.; Plum Point, Calvert County, Md. Choptank formation, Jones Wharf, St. Marys County, Md. Pliocene, Caloosahatchee marl, Shell Creek, Fla.

#### *Tellina (Moerella) sayi* (Deshayes ms.) Dall

Plate 17, figure 4

1822. *Tellina polita* Say, Acad. Nat. Sci. Philadelphia, 1st ser., vol. 2, p. 276. Not *T. polita* Poli, 1795, *T. polita* Spengler, 1798, *T. polita* Pulteny, 1813, or *T. polita* Sowerby, 1825.  
 1834. *Tellina polita* Say, Am. conchology, pt. 7, pl. 65, fig. 2.  
 1846. *Tellina polita* Say. Hanley, Thesaurus conchyliorum, vol. 1, pt. 6, p. 282, pl. 57, fig. 60.  
 1856. *Tellina polita* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 91, pl. 22, fig. 6.



1856. *Tellina (Angulus) polita* Say. H. and A. Adams, Genera Recent Mollusca, vol. 2, p. 398.  
 1858. *Angulus polita* Say. Holmes, Post-Pleocene fossils of South Carolina, p. 45, pl. 8, fig. 2.  
 1900. *Tellina sayi* Deshayes, ms., fide Dall.  
 1900. *Tellina (Angulus) sayi* Deshayes. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1034.

Shell transversely subtriangular, minutely wrinkled concentrically, white, immaculate; anterior [posterior] margin rather shorter than the posterior [anterior] one, the hinge slope declining, in a very slightly arquated line to a subacute termination; basal margin nearly rectilinear from behind the middle to the anterior [posterior] termination; a lateral tooth behind [in front of] the primary teeth.

Length two-fifths of an inch, breadth thirteen-twentieths of an inch.

Inhabits the southern coast.

Cabinet of the Academy and Philadelphia Museum.

Not unfrequent on the beach of South Carolina and east Florida.—Say, 1822.

The well-known name of this species must be changed, as it had been used for a *Tellina* 3 or 4 times before Say so applied it, and one of the prior attempts at least was made on a species of *Angulus*. The name of Deshayes is suggested in one of his manuscripts in my possession.—Dall, 1900.

A Recent left valve (U. S. Nat. Mus. 128444) from off the coast of South Carolina has been figured. It measures 10.0 millimeters in height and 17.4 millimeters in width.

Shell rather thin but solid, moderately compressed, often slightly flexuous in front of the posterior fold. Posterior end cuneate, the anterior rounded, the anterior dorsal margin gently sloping, as a rule, though approaching a parallel with the straight base line. Umbones low, inconspicuous, opisthogyrate, placed between half and two-thirds of the distance toward the posterior margin. Posterior flexure feeble. Faint concentric groovings visible near the ventral margin, obsolete in the umbonal region. Ligament external, opisthodontic; nymphs elongate. Dentition similar to but slightly stronger than that of *Tellina declivis*—a simple and a bifid cardinal in both right and left valves, and a strong anterior and an inconspicuous posterior lateral in the right valve only. Faint internal radiations but no thickened fold. Muscle scars and pallial sinus obliterated in the majority of individuals. Anterior muscle impression irregular and somewhat elongated; posterior semielliptical. Dorsal margin of pallial sinus marked by wavy line, which reaches its maximum elevation beneath the umbones, then descends more gradually, almost but not quite reaching the anterior scar.

*T. sayi* Deshayes is identified with the Recent fauna and has only a meager representation in the North Carolina Pliocene. It is well characterized among its Tertiary congeners by the moderately low height and the obliquely produced and truncated posterior end.

*T. (Moerella) piesa* Gardner, abundant and widespread in the Shoal River formation of northern Florida, is perhaps a precursal form. Mansfield, 1932, has

noted the similarity of *piesa* to his subspecies, *T. sayi deadenensis* from the *Arca* and *Cancellaria* zones of the Choctawhatchee formation. The Recent species is a little higher relatively than either of the fossil forms.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Pliocene, Waccamaw formation, Waccamaw River, S. C. Caloosahatchee marl, Caloosahatchee River, Fla. Croatan sand, Slocums Creek, Craven County, N. C. Pleistocene, Simmons Bluff, S. C.; Rose Bluff, St. Marys River, Nassau County, Fla. Recent, North Carolina to Yucatan.

#### *Tellina (Moerella) dupliniana* Dall

1900. *Tellina (Angulus) dupliniana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1032, pl. 46, fig. 17.  
 1900. *Tellina (Angulus) propetenella* Dall, idem, vol. 3, pt. 5, p. 1033, pl. 46, fig. 6.  
 1904. *Tellina (Angulus) dupliniana* Dall. Glenn, Maryland Geol. Survey, Miocene, p. 299, pl. 73, fig. 1.

Shell small, solid, rather convex, inequilateral, dorsal margins rectilinear, diverging at an angle of about 108°, anterior end longer, rounded evenly into the base, which is nearly parallel with the anterior dorsal margin; posterior end much shorter, pointed, the terminal angle slightly decumbent and the basal margin in front of it slightly incurved; beaks inconspicuous, hinge normal, the right adjacent lateral short and the anterior hinge margin in front of it grooved for the edge of the opposite valve; middle of the disk smooth—the beaks, posterior dorsal area, and the portions of the disk near the basal margin more or less concentrically striated; interior with the pallial sinus rising to a small angle under the umbo, then descending in a somewhat wavy line to a point on the pallial line considerably short of the anterior adductor scar; in the left valve the sinus is not angulated above and extends somewhat nearer the adductor; the interior is marked with some faint radiations near the adductors, but no thickened ray appears. Longitude 12.5, altitude 8, diameter 4 millimeters.

There is some little difference in the proportional height in different individuals, in the amount of inflation, and in the arcuation of the posterior dorsal margin; the posterior fold, or ridge bounding the posterior dorsal area, is not strongly marked. Compared with *T. tenella* Verrill, this species is a heavier and higher shell, with the posterior end more pointed and decurved. The dorsal margin of the right valve is not grooved in *T. tenella*, and the adjacent lateral is longer than in *T. dupliniana* of the same size.—Dall, 1900.

Holotype: U. S. Nat. Mus. 115040.

Type locality: Magnolia, Duplin County, N. C. Duplin marl.

*T. dupliniana* Dall is a compact and solid little species that displays a rather remarkable series of variations in the degree of convexity, posterior flexure, and general form—particularly in respect to the inclination of the anterior and dorsal margins to the base and the outline of the posterior margin—and, to a limited extent, even in the dentition, notably in the prominence of the anterior right lateral.

A constant peculiarity of the hinge separates the form from all the coexistent *Tellina* with which in some of its various manifestations it might easily be confused. This is the position of the anterior right lat-

eral, which instead of being a little dorsal to the cardinal, as in the majority of *Moerella*, is in a direct line with it.

*T. propetenella* Dall (U. S. Nat. Mus. 144856) is synonymous with *T. dupliniana*. The forms separated under that name are slightly smaller than the average *dupliniana* and are more uniform in outline, but they have no characters by which they can be distinguished even subspecifically. Much more worthy of separation are forms from Robeson County, most of which are unusually high and heavy individuals, strongly flexed posteriorly, with the posterior margin somewhat produced and with remarkably strong and prominent teeth. As these characters are exhibited in a greater or less degree, both individually and collectively, at a number of widely separated localities, it has seemed unnecessary and undesirable to subdivide the species.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, and 1 mile below Yorktown, York County; 5½ miles northwest of Smithfield, and ¼ mile northeast of Smithfield, Isle of Wight County; Sycamore, Southampton County; 1½ miles southeast of Reid's Ferry, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, and ½ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, Palmyra Bluff, Halifax County; 2 miles west of Rocky Mount, 5 miles below New Bridge on the Tar River, Edgecombe County; Jacobs Branch (2 miles southeast of Tugwell), 3 miles south of Farmville, 8 to 9 miles south of Greenville, 9 to 10 miles south of Greenville, and 2 miles east of Grifton (on J. F. Brooks' land), Pitt County; 1 mile west of Wilson (in Hominy Swamp, on Frank Barnes' land), Wilson County; 1½ miles below Tar Ferry, Wicaco Creek, and 3 to 4 miles below Tar Ferry, Hertford County; Colerain Landing and ½ to ¾ mile above Edenhouse Point, Bertie County; Rock Landing, Craven County. Duplin marl, 4 miles south of Clinton (on J. L. Mathis' farm), Sampson County; Natural Well, 1½ miles north of Magnolia, and the marl pit of W. H. Kornegay near Magnolia, Duplin County; 1 mile west of Lumberton (on the farm of Charles Rowland), Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, 4 miles northeast of Fairmont (on the farm of D. E. Lewis), and 1½ miles northeast of Fairmont (on the farm of Andrew Jones), Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown on Hammond Creek (on the land of Mrs. Clark), and Walkers Bluff, Bladen County; Lake Waccamaw, Cronly (½ mile east of the factories), and Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Calvert formation, Plum Point, Calvert County, Md. (Dall). Pliocene, Waccamaw formation, Tillys Lake, Waccamaw River, S. C. Caloosahatchee marl, Caloosahatchee River, Fla.

*Tellina (Moerella) macilenta* Dall

Plate 17, figure 5

1900. *Tellina (Angulus) macilenta* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1034, pl. 46, fig. 20.

1919. *Tellina (Angulus) macilenta* Dall. Gardner and Aldrich, Acad. Nat. Sci. Philadelphia Proc., vol. 71, p. 19. (Check list of fossils from Muldrow Place, S. C.)

1932. *Tellina (Moerella) macilenta* Dall. Mansfield, Florida Geol. Survey Bull. 8, p. 137, pl. 27, figs. 10-12.

Shell solid, subtrigonal, moderately convex. equivalve; inequilateral; anterior end longer, rounded, posterior roundly pointed near the base; beaks pointed, dorsal margins slightly arched; surface polished, faintly distantly concentrically striated; near the basal margin the striae become regular and more sharp and conspicuous; posterior dorsal area nearly smooth, posterior end not folded, but slightly flexed; hinge normal, adjacent lateral short, strong and prominent; pallial sinus somewhat arched above, long, wholly confluent below; interior more or less radially striate; in the left valve the thickened rays inside the adductor scars are obvious. Longitude 16.5, altitude 10.5 [10.8], diameter 5.5 millimeters.

This form is not intimately related to any of the recent species and is easily discriminated by its solid subtrigonal valves, size, and shortness from any of the Miocene species.—Dall, 1900.

Holotype, a right valve: U. S. Nat. Mus. 115045.

Type locality: Natural Well, Duplin County, N. C. Duplin marl.

Mansfield records the species from the *Cancellaria* zone of the Choctawhatchee formation.

Distribution: North Carolina: Miocene, Yorktown formation, 2½ miles northwest of Williamston (on Joseph Cherry's farm), Martin County; 1 mile east of Lizzie (on T. N. Lassiter's farm), Greene County. Duplin marl, Natural Well, 1½ miles north of Magnolia, Duplin County; 2 miles below Lumberton and 1½ miles northeast of Fairmont (on Andrew Jones' farm), Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County.

*Tellina (Moerella?) verdevilla* Gardner, n. sp.

Plate 17, figures 6, 7

Shell thin, ovate, subcuneate posteriorly, flexuous. Posterior fold indistinct, emphasized by depression in front of it. Umbones low, inconspicuous, slightly opisthogyrate, posterior. Lunule narrow, elongated, clearly delimited. Anterior dorsal margin gently sloping; lateral margin broad, evenly rounded. Posterior end obliquely truncated. Dorsal slope steep, margin expanding slightly below the nymph. Base arcuate, somewhat contracted posteriorly. Surface sculptured with microscopic concentric striations and stronger incrementals. Hinge characters of only the right valve known. Ligament external, opisthodontic; nymph sublinear, a deep groove at its ventral margin. Anterior cardinal short, laminar; posterior cardinal deeply sulcated; both the anterior and posterior laterals prominent, subspinose, separated from the margins by deep grooves. Traces of an inner posterior ray faintly visible in one of the two valves. Adductor impressions very feeble. Pallial line indistinct. Sinus moderately broad, the dorsal margin slightly bowed beneath the umbones, the ventral margin confluent with the pallial line, rather shallow for the genus, extending only about two-thirds of the distance toward the anterior margin.

Dimensions of holotype: Height 13.8 millimeters, width 20.0 millimeters, convexity 3.6 millimeters. Par-

atype: Height 15.0 millimeters, width 21.0 millimeters.

Holotype and paratype, both right valves: U. S. Nat. Mus. 325596.

Type locality: 6 miles below Greenville, Pitt County, N. C. Yorktown formation.

*Tellina verdevilla*, n. sp., is sharply separated from all members of the *Moerella* group, which it most closely resembles in the external characters, by the strong posterior lateral in the right valve. The outline recalls *Moerella macilenta* Dall, but the hinge is less concentrated and the anterior lateral more isolated. In most of the *Moerellae* the groove separating the anterior cardinal and the dorsal margin is continuous with the lateral socket. In *verdevilla* the groove is extremely shallow medially.

Distribution: North Carolina: Miocene, Yorktown formation, 6 miles below Greenville, Pitt County.

***Tellina* (*Moerella*?) *calpix* Gardner, n. sp.**

Plate 17, figures 2, 3

Shell thin, oval, rather compressed, slightly contracted posteriorly, almost but not altogether equilateral. Umbones low, flattened, opisthogyrate, situated a little behind the median line. Both anterior and posterior dorsal and distal margins rounded; the anterior end slightly broader, higher, and more evenly arched; the posterior with a tendency toward an obscure truncation. Base line gently arched. Posterior flexure indistinct. Concentric groovings discernible only on the anterior end and near the ventral margin. Valves faintly radiate within, but not noticeably thickened. Ligament external, attached to narrow, elongated nymphs. Dentition of right valve only known, similar to that of *Tellina declivis* Conrad; posterior bifid and anterior simple cardinals rather slender. Anterior lateral of moderate strength, situated a little dorsal to the anterior cardinal; posterior lateral low and small; lateral grooves extending for some distance toward the base before becoming entirely obsolete. Posterior muscle impression subcircular; anterior irregular, longer than broad. Pallial sinus very indistinct, more regular than in most of the group, ascending from a point about halfway down the anterior side of the posterior adductor impression to a point underneath the umbones and level with the dorsal boundary of the posterior scar, then descending gradually in a regular line and just clearing the anterior adductor.

Dimensions of holotype: Height, 8.0 millimeters, width 11.5 millimeters, convexity 2.0 millimeters.

Holotype a right valve: U. S. Nat. Mus. 325595.

Type locality: Eight to 9 miles south of Greenville, Pitt County, N. C. Yorktown formation.

The shell is remarkable for its regularly rounded, oval form, its subcentral umbones, and the absence of the posterior angulation. It is apparently most closely related to *T. declivis* Conrad, from which it differs in

being more nearly equilateral and more rounded, both anteriorly and posteriorly. The outline suggests a miniature *Macoma*, but the development of laterals in the right valve throws it out of that genus. A knowledge of the left valve is necessary for the assured placement of the species within the proper subgeneric group.

Distribution: North Carolina: Miocene, Yorktown formation, 3½ miles below Palmyra Bluff, Halifax County; 8 to 9 miles south of Greenville and 9 to 10 miles south of Greenville, Pitt County.

***Tellina* (Subgenus uncertain) *egena* Conrad**

Plate 17, figure 1

1834. *Tellina egena* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 131.

1840. *Tellina egena* Conrad, Fossils of the medial Tertiary of the United States, p. 35, pl. 19, fig. 2.

1900. *Tellina* (*Peronidia*?) *egena* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1029.

Shell subtriangular, convex, with fine, crowded, concentric lines and obscure, radiating striae; anterior margin oblique, rectilinear; extremity subangulated; dorsal margin but little arcuated; lateral teeth none. Length, 2½ inches.

Locality, James River, Va.—Conrad, 1834.

It is strange that a form so conspicuously large should not have been recorded from some of the later collections.

Dall referred *T. egena* to *Peronidia*, a group characterized by the absence of laterals. The type has not been examined.

**Genus *MACOMA* Leach**

1819. *Macoma* Leach. Ross, John, A voyage of discovery made under the orders of the Admiralty in His Majesty's ships *Isabella* and *Alexander* for the purpose of exploring Baffin's Bay and inquiring into the probability of a northwest passage, App. 2, p. 62.

1819. *Macoma* Leach, Jour. physique, vol. 88, p. 465.

Type by monotypy: *Macoma tencra* Leach = *Tellina calcarea* Gmelin. Recent in the North Atlantic and Arctic Oceans.

Outline transversely ovate or subtrigonal, strongly flexuous, as a rule, posteriorly. External surface smooth or feebly sculptured concentrically. Two divergent cardinals in each valve. Laterals absent. Pallial sinus often discrepant in the two valves, varying widely within the limits of the genus.

The genus is fairly common from the Miocene on and is represented in the Recent seas by about 100 species. Though not restricted to the cooler waters, the typical members are characteristic of the higher latitudes.

***Macoma virginiana* (Conrad) Dall**

Plate 17, figures 9, 10

1840. *Tellina lusoria* Conrad, Fossils of the medial Tertiary of the United States, p. 35, pl. 19, fig. 3. Not *Psammobia*? *lusoria* Say, 1822.

1856. *Tellina lusoria* Conrad. Tuomey and Holmes, Pleistocene fossils of South Carolina, p. 89, pl. 22, fig. 5.  
 1858. *Tellina lusoria* Emmons?, North Carolina Geol. Survey Rept., p. 297, fig. 225a.  
 1863. *Tellina* (*Peronacderma*) *lusoria*? Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 573.  
 1866. *Macoma virginiana* Conrad, Am. Jour. Conchology, vol. 2, p. 76.  
 1900. *Macoma virginiana* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1048.

Shell elliptical, with a distinct fold near the posterior extremity; posterior end reflected; posterior dorsal margin straight, oblique, extremity truncated and much above the line of the base; beaks nearest the posterior end; basal margin very regularly arched; lateral teeth none.

Locality, Yorktown, Va.—Conrad, 1840.

This species is extinct and may be distinguished from *M. lusoria* by being proportionally more elevated, rounded at base, and less compressed and reflexed anteriorly.—Conrad, 1866.

After repeated studies of the subject I have come to the conclusion that Say's *Psammobia lusoria* was probably based on a large specimen of the shell, which he afterwards described under the name of *Tellina tenta*. From that species the present shell differs, as Conrad states it does from *lusoria*, by being higher, more arcuate below, and less compressed and flexuous behind; it also averages considerably larger. The pallial sinus is low, rather short, rounded in front, and about half confluent with the pallial line below. There is some doubt as to whether the shell figured by Emmons is the same, as he speaks especially of sharp, elevated lines on the surface, which I have not observed on any of the Virginia shells.—Dall, 1900.

Shell thin, inflated, slightly inequivalve, the right valve a trifle higher than the left, inequilateral, the anterior end semielliptical, its dorsal margin subparallel to the base, and the lateral margin broadly and regularly rounded. Posterior end shorter, attenuated, the dorsal margin slightly contracted beneath the umbones, and the dorsal and ventral margins converging at a low angle, obscurely truncated distally. Umbones posterior, opisthogyrate. Surface feebly sculptured with incrementals. Ligament external, opisthodontic, seated on a very narrow and rather elongated nymph. Hinge armature of right valve a rather stout, simple, anterior cardinal and a rather slender, bifid, posterior cardinal. Left valve with a bifid anterior and a very slender, almost laminar, posterior cardinal. No laterals developed in either valve. Interior faintly striated radially. Anterior adductor scar irregularly elongated; the posterior, semielliptical. Pallial sinus broad, rounded, often slightly arched just beneath the umbones, extending about two-thirds of the distance across from the posterior to the anterior margin.

Dimensions of figured specimen: Height 12.3 millimeters, width 19.8 millimeters.

Figured specimen, a right valve: U. S. Nat. Mus. 325594, from 1 mile northeast of Suffolk, Va. Yorktown formation.

Though the inequality of the valves is very slight, it is sufficient to make a noticeable difference in their

general aspect; in the right valve there is a tendency toward a perceptible flare in the anterior dorsal margin; in the left valve the anterior dorsal and ventral margins are more nearly parallel. The species is well characterized by the nasute aspect of the posterior portion of the shell. This feature is absent in *M. carolinensis* Gardner and Aldrich, the closely related form south of the Hatteras axis, for in the latter the posterior dorsal margin declines at a uniform and rather steep angle, and the lateral margin is evenly rounded and merges gradually into the base line.

*Macoma virginiana* Conrad is fairly common, particularly in the Yorktown formation of the State from which it takes its name. Mansfield has described a subspecies *coensis* from the *Cancellaria* zone of the Choctawhatchee formation, which differs both from *M. virginiana* and from the subspecies *conradi* by the more tapering posterior extremity.

Distribution: Virginia: Miocene, St. Marys formation, 1 to 2 miles below Bowers Wharf, Essex County. Yorktown formation, Yorktown, 1 mile below Yorktown, and 1¼ miles below Yorktown, York County; mouth of Baileys Creek, Prince George County; 7 to 7½ miles below Zuni, 1½ miles northeast of Smithfield, and ¾ mile northeast of Smithfield, Isle of Wight County; 1½ miles southeast of Reids Ferry, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, 1 mile east of Suffolk, and ½ mile below the Suffolk waterworks dam, Nansemond County.

#### *Macoma virginiana conradi* Dall

Plate 17, figure 22

1900. *Macoma conradi* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1048, pl. 47, fig. 3.

Shell thin, inflated, ovate, broad and rounded in front, rapidly attenuated, roundly pointed and somewhat flexuous behind; beaks low, pointed, near the posterior third; surface smooth or marked only with fine incremental lines; hinge normal, feeble, teeth small; adductor scars large, pallial sinus short, rounded, and curved (in the right valve) well backward below before coalescing with the pallial line. Longitude 22 [21.7] altitude 14, diameter 7 millimeters.

This is a shorter and broader and less flexuous shell than *M. virginiana* Conrad, some of the varieties of which somewhat approach it.—Dall, 1900.

Holotype, a right valve: U. S. Nat. Mus. 144475.

Type locality: Yorktown, Va. Yorktown formation.

The characters that separate the type of *conradi* from *M. virginiana* s. s. are of degree rather than kind, and an unbroken series connecting the two forms can be established. The individuals from the Carolinas that have been referred to this species are, however, distinct, and the same diagnostics that are used to separate *virginiana* s. s. and *carolinensis*—that is, the nasute posterior end and the broader but more shallow pallial sinus of the former—are shared by the subspecies as well.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Exit, 1½ miles northwest of Suffolk, and 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, Colerain Landing on the Chowan River, Bertie County.

***Macoma carolinensis* Gardner and Aldrich**

1919. *Macoma carolinensis* Gardner and Aldrich, Acad. Nat. Sci. Philadelphia Proc., p. 50, pl. 3, figs. 5-7.

Right valve, altitude 12.3 millimeters, latitude 18.2 millimeters, semidiameter 4.3 millimeters. Left valve of another individual, altitude 12.5 millimeters, latitude 19.5 millimeters, semidiameter 3.3 millimeters.

Type locality: Darlington, S. C. Duplin Formation.

*Macoma carolinensis* is the analogue in the Neogene south of the Hatteras axis of *M. virginiana* and its subspecies *conradi* north of the axis. It is rather higher, less flexuous, and more nearly equilateral than either of the former, both by reason of the more nearly central umbones and the greater similarity of the anterior and posterior extremities. The posterior dorsal margin of *M. carolinensis* has a uniform, fairly steep slope, while that of *M. virginiana* is slightly contracted directly behind the umbones, then obliquely produced at a very low angle. The posterior lateral margin of the former is rounded into the slightly upturned base; that of the latter, obscurely truncated and its ventral margin more strongly recurved. The pallial sinus in both species varies quite widely but that of *carolinensis* is, on the average, more profound and more strongly arched beneath the umbones.

The species is rare in the Duplin and Waccamaw formations of North and South Carolina.—Gardner and Aldrich, 1919.

Distribution: North Carolina: Miocene, Duplin marl, 2 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Mrs. Guion's marl pit, Cape Fear River, Bladen County.

Outside distribution: Pliocene, Caloosahatchee marl, Caloosahatchee River, Fla.

***Macoma cookei* Gardner, n. sp.**

Plate 17, figures 8, 11

Shell relatively large, irregular in outline; rather thin, flexuous; anterior half of shell moderately inflated, posterior somewhat depressed. Posterior fold obscure, evanescent toward the ventral margin. Umbones set a little in front of the median line, rather low and inconspicuous, their tips acute. Anterior end somewhat eccentric, slightly flaring dorsally, obscurely and obliquely truncated medially; strongly arcuate toward the ventral margin; posterior end somewhat produced and attenuated. Surface sculptured with fine, irregular concentric striations. Ligament opisthodontic; nymph narrow elongated, rather surprisingly robust. Hinge armature of right valve reduced to a couple of short, feeble cardinals, divergent beneath the umbones. Muscle impressions irregular, distinct, the anterior submedial and rudely elongated, the posterior roughly quadrate. Pallial sinus of right valve coalescent ventrally with pallial line, upcurved dorsally, its maximum elevation a little above the median horizontal and directly beneath the umbones, its frontal margin overreaching the median vertical but falling short of the anterior adductor. Pallial line moderately distinct.

Dimensions of holotype: Height 28.0 millimeters, width 34.3 millimeters, convexity 7.1 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325592.

Type locality: Yorktown, York River, Va. Yorktown formation.

*Macoma cookei* is described from a single valve collected at the type locality of the Yorktown formation. This relatively large and elevated shell has, however, little but the generic characters in common with its small and transversely elongated congeners. In outline and general aspect it most closely resembles *M. balthica* Linnaeus of the Pleistocene and Recent faunas. The Yorktown species is larger, however, and has a much stronger dentition.

I have the pleasure of naming the form in honor of Dr. Wythe Cooke, whose name has long been associated with the Lower Tertiary faunas of the Gulf region.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County.

**Family SEMELIDAE Dall**

The family is most readily separable from the *Tellinidae* by the presence of an internal resilium.

**Genus SEMELE Schumacher**

1817. *Semele* Schumacher, Essai d'un nouveau système des habitations des vers testacés, p. 165.

Type by monotypy: *Tellina reticulata* Spengler=*Tellina proficua* Pulteney. Pliocene of South Carolina and Florida and living from Virginia to Fernando de Moronha and east to Bermuda in less than 50 fathoms.

Shell oval or suborbicular, slightly inequivalve, usually more or less rostrate posteriorly. Umbones subcentral, low, proximate, prosogyrate. Ligament short, external; resilium strong, internal. Hinge armature consisting of 2 cardinals and 2 laterals in each valve, the laterals of the right valve usually stronger. Adductor impressions large, semielliptical. Pallial sinus profound.

The genus is represented in the Tertiary formations by some 30 species, many of them very attractive, and in the Recent waters by about 60 species, most of them tropical.

**Section SEMELE s. s.**

*Semele* s. s. includes the relatively large members of the genus. The sculpture may be radial and concentric, reticulate, or undeveloped. The chondrophore is obliquely elongated, the laterals of the left valve are feeble but present, and the left posterior cardinal is slender and laminar.

***Semele subovata* (Say) Dall**

1824. *Amphidesma subovata* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 152, pl. 10, fig. 10.

1840. *Amphidesma subovata* Say. Conrad, Fossils of the medial Tertiary of the United States, p. 36.

1854. *Syndosmya subobliqua* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 29 (lapsus for *subovata*).
1862. *Abra ovalis* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 288.
1863. *Abra (Amphidesma) subovata* Say. Conrad, idem, p. 574.
1900. *Semele subovata* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 990.
1900. *Semele bella* Conrad. Dall, idem, vol. 3, pt. 5, p. 990. Not *Semele bella* Conrad, 1875.
1904. *Semele subovata* (Say). Glenn, Maryland Geol. Survey, Miocene, p. 295, pl. 72, figs. 6, 8.
1909. *Semele subovata* (Say). Grabau and Shimer, North American index fossils, vol. 1, p. 568, fig. 780a.

Shell transversely ovate-oval, with somewhat prominent and regular concentric striae.

Shell compressed; beaks rather before the middle, but little prominent; anterior submargin with an obsolete, obtuse undulation; lunule lanceolate; cardinal and lateral teeth prominent.

Length seven-tenths of an inch, breadth less than 1 inch.—Say, 1824.

#### Type locality: Maryland.

This is a common species of the Virginia Miocene, separable from the *S. carinata*—which is almost equally common—by its more oval and thinner shell and finer, sharper, and closer concentric sculpture. The posterior dorsal area is usually conspicuously sculptured, whereas in *S. carinata* the tendency of the sculpture on this area is to become obsolete.—Dall, 1900.

Say has confused the anterior and posterior portions of the valve. The beaks are subcentral or slightly posterior, and the obtuse undulation is on the posterior and not the anterior area.

The examination of a long series of individuals from a number of localities in the Virginia and North Carolina Miocene indicates that all the elongate-oval to subtriangular *Semeles* ornamented solely with close concentric laminae of approximately equal strength are referable to this single species.

The three subspecies are based on variations in the outline and in the number and character of the concentric laminae and on the persistence or nonpersistence of the sculpture across the posterior keel.

*Semele subovata* (Say) is separated from *S. carinata* (Conrad) by the absence of secondary concentric ornamentation; from *S. bellastriata* (Conrad) by the absence of radial ornamentation. In weathered individuals erosion has often acted on the striae differently, partly obliterating some; whereas others retain their original prominence and thus give to the form the aspect of a more distantly sculptured species.

The resemblance to *S. carinata* (Conrad) is embarrassingly close where faint traces of the lost lirations still persist. The original sculpture usually may be caught on the lateral margins, however, even though it is removed from the disk.

Distribution: Virginia: Miocene, St. Marys formation, Union Mill, 2½ miles south of Farnham, Richmond County; Urbanna, Middlesex County. Yorktown formation, Yorktown, Bellefield, York County; Petersburg, Dinwiddie County; Claremont Wharf

(upper bed), Surry County; Fergusons Wharf, ¾ mile northeast of Smithfield, Bennis Church; ¼ mile north of Chuckatuck, 1½ miles southeast of Reids Ferry, 6½ miles below Zuni and 12 to 14 miles below Zuni, Isle of Wight County; Sycamore, ¼ to ½ mile below Sycamore, Maddelys Bluff, and ½ to ¾ mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County; 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, 1 mile west of Suffolk, ½ mile below the Suffolk waterworks dam, and the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1 mile above Murfreesboro, Hertford County; ½ mile above Bells Bridge over the Tar River, and Swift Creek, Edgecombe County; 2 miles southeast of Tugwell, 9 to 10 miles south of Greenville, Hardees Creek (3½ miles from confluence with Tar River), and 1 mile northwest of Galloway Crossroads, Pitt County; 2 miles north of Lizzie and 4 miles east of Lizzie, Greene County; Colerain Landing, Bertie County. Duplin marl, 1½ miles northeast of Fairmont, Robeson County.

Outside distribution: Miocene, Galveston well (at 2,552 to 2,600 feet), Texas. Calvert formation, Centerville and Church Hill, Queen Annes County, Md.; Fairhaven, Anne Arundel County, Md. Choptank formation, Governor Run, Calvert County, Md.; Greensboro, Caroline County, Md.; Cordova, Peach Blossom Creek, and Dover Bridge, Talbot County, Md.; Jones Wharf, St. Marys County, Md.

#### *Semele subovata alta* Gardner, n. subsp.

Plate 17, figures 16, 17

Shell high, ovate to subtrigonal. Somewhat compressed posteriorly. Produced, rounded, and slightly inflated anteriorly. Umbones placed a little behind the median line. Anterior dorsal slope gentle, posterior more pronounced, in certain individuals gently arched; anterior lateral margin evenly rounded. Base line arcuate, posterior sinus shallow, often obsolete. Concentric sculpture fine, close, and lirate, or lamellar.

The other characters are shared by all members of the species.

Dimensions of holotype: Height 21.0 millimeters, width 26.3 millimeters, diameter 11.3 millimeters.

Holotype (double valves): U. S. Nat. Mus. 325582.

Type locality: 2 miles northeast of Lizzie, Greene County, N. C. Yorktown formation.

The subspecies is relatively higher than other members of the species, and its sculpture is finer, closer, and less commonly lirate. It has a tendency, furthermore, toward a larger size and a more pronounced inflation of the anterior portion of the valves.

Distribution: Virginia: Miocene, St. Marys formation, Urbanna, Middlesex County. Yorktown formation, Yorktown, York County; Zuni (near the pumping station) and 6½ to 7 miles below Zuni, Isle of Wight County; 1½ miles north of Suffolk, 1½ miles northeast of Suffolk, and 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, Palmyra Bluff, Halifax County; 1 mile northwest of Galloway Crossroads, Pitt County; 2 miles northeast of Lizzie, Greene County; Colerain Landing, Bertie County. Pliocene, Waccamaw formation, Wilmington, New Hanover County.



*Semele bellastrata* (Conrad) Dall

Plate 17, figures 27, 28, 32, 33

1837. *Amphidesma bellastrata* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol 7, p. 239, pl. 20, fig. 4.  
 1845. *Amphidesma cancellata* D'Orbigny. Sagra, Historia fisica politica y natural de la Isla de Cuba, pt. 2, vol. 5, p. 297, pl. 25, figs. 42-44.  
 1847. *Amphidesma cancellata* D'Orbigny. Sagra (French ed.), Histore Physique, Politique et Naturelle de L'Ile de Cuba, Mollusques, vol. 2, p. 241; Atlas, pl. 25, figs. 42-44.  
 1862. *Semele nexilis* Gould, Boston Soc. Nat. History Proc., vol. 8, p. 281.  
 1862. *Semele nexilis* Gould, Otia conchologica, p. 238.  
 1873. *Semele nexilis* Gould. Tryon, American marine conchology, p. 155.  
 1875. *Abra bella* Conrad. In Kerr, Geol. Survey North Carolina, Rept., App. A., p. 19, pl. 3, fig. 4.  
 1883. *Semele nexilis* Gould. Dall, U. S. Nat. Mus. Proc., vol 6, p. 338.  
 1885. *Semele lata* C. B. Adams. Bush, Connecticut Acad. Arts and Sci. Trans., vol. 6, pt. 2, p. 476.  
 1889. *Semele cancellata* D'Orbigny. U. S. Nat. Mus. Bull. 37, p. 62.  
 1900. *Semele bellastrata* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 993.  
 1932. *Semele bellastrata* (Conrad)? Mansfield, Florida Geol. Survey Bull. 8, p. 145, pl. 32, fig. 3.

Shell elliptical, compressed; anterior margin very regularly rounded; posterior side with a slight fold; disk with numerous prominent, not very regular, concentric striae and obscure radiating lines, which are profound near the anterior and posterior extremities; beaks rather nearer the posterior extremity; lateral teeth prominent, distinct in both valves; margin entire.

Inhabits Mobile Point, Ala. Occurs sparingly in the Newer Pliocene marl, near Newbern, N. C.—Conrad, 1837.

Mansfield reports the doubtful occurrence of the species in the *Ecephora* zone of the Choctawhatchee formation.

The figured specimens are U. S. Nat. Mus. 325583, from the Waccamaw formation at Neills Eddy Landing on the Cape Fear River, Columbus County, N. C. The dimensions of the right valve are height 13.2 millimeters, width 18.3 millimeters; of the left valve, height 14.5 millimeters, width 19.0 millimeters.

*Abra bella* of Conrad is a reticulately sculptured form synonymous with his *Amphidesma bellastrata* of 1837. The two varieties of Dall, *duplinensis* and *appresa*, were founded on individuals from the North Carolina Duplin marl that exhibit no radial sculpture but show peculiarities in the concentric sculpture. These same features are developed, though less commonly, in the *subovata* of Virginia, and complete gradations to the normal form occur in both States.

Distribution: North Carolina: Pliocene, New Bern, Craven County? (Conrad). Waccamaw formation, Walkers Bluff, Bladen County; Cronly and Neills Eddy Landing (3 miles north of Cronly), Columbus County.

Outside distribution: Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla. Recent, Cape Hatteras to Cape St. Roque and east to Bermuda in less than 50

fathoms except off Hatteras, where it occurs in both shallow and deep water.

## Section SEMELINA Dall

1900. *Semelina* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 986.

Type by original designation: *Semelina nuculoides* Conrad. Upper Miocene of Virginia and North Carolina, Pliocene (Caloosahatchee) of Florida, Recent from Hatteras to the West Indies.

Shell small, nuculiform; sculpture uniform, close, concentric; chondrophore short; left valve without distinct laterals, the dorsal margins fitting above the laterals of the right valve; left posterior cardinal absent or obsolete, the anterior cardinal bifid; otherwise as in *Semele* s. s.

The species of this section are very similar to one another and have extended from the Oligocene through all the Tertiary horizons to the present fauna. For this reason it seems worthy of sectional rank. The characters by which the shell differs from *Semele* proper are only such as are usually correlated with diminished size.—Dall, 1900.

An exceedingly thin and laminar left posterior cardinal is developed in both the Alum Bluff species. In most individuals it is broken, but in a few it is preserved entire.

*Semele* (*Semelina*) *nuculoides* (Conrad) Dall

Plate 17, figures 18, 19, 20, 21

1841. *Amphidesma nuculoides* Conrad, Am. Jour. Sci., 1st ser., vol. 41, p. 347.  
 1845. *Amphidesma nuculoides* Conrad, Fossils of the medial Tertiary of the United States, p. 73, pl. 41, fig. 6.  
 1863. *Abra nuculoides* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 574.  
 1889. *Semele nuculoides* Conrad. Dall, U. S. Nat. Mus., Bull. No. 37, p. 62.  
 1900. *Semele nuculoidea* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 994.  
 1932. *Semele* (*Semelina*) *nuculoides* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 146, pl. 30, fig. 9.

Ovate, convex, with very regular minute concentric lines; anterior extremity acutely rounded; beaks near the posterior extremity; basal margin arcuate; lateral teeth obsolete.—Conrad, 1841.

Type locality: Wilmington, N. C.

The figured specimens are U. S. Nat. Mus. 325581, from the Waccamaw formation at Neills Eddy Landing on the Cape Fear River, Columbus County, N. C. The height of the right valve is 3.8 millimeters, the width 5.6 millimeters; the height of the left valve is 4.0 millimeters, the width 5.6 millimeters.

Three valves of *Semelina nuculoides* are reported by Mansfield from the *Cancellaria* zone of the Choctawhatchee formation.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Duplin marl, 4 miles south of Clinton (on the farm of J. L. Mathis), Sampson County; Natural Well, drainage ditch just east of railroad 1½ miles north of



Magnolia, and W. H. Kornegay's marl pit near Magnolia, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Lake Waccamaw, Cronly, Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington, New Hanover County.

Outside distribution: Pliocene, Caloosahatchee marl, Caloosahatchee River, Fla. Recent, Cape Hatteras south to the West Indies in both deep and shallow water.

**Genus ABRA (Leach ms.) Lamarck**

1818. *Abra* (Leach ms.) Lamarck, *Histoire naturelle des animaux sans vertèbres*, vol. 5, p. 492.

Type by subsequent designation (Herrmannsen, *Indicis generum Malacozoorum*, vol. 1, p. 1, 1846: *Mastra tenuis* Montagu. Recent off the English and Irish coasts.

Most of the European conchologists, including Forbes, Hanley, Stoliczka, and Lamy, reject *Abra* in favor of *Syndosmya* Recluz, 1843. Lamarck, in listing Leach's manuscript name, did not, to be sure, characterize the genus, but he gave a new name to a known and recognizable shell, and, as Cossmann<sup>45</sup> pointed out, the genotype is beyond question. Whether or not Lamarck had it in his mind to create a new genus is not the concern of nomenclature.

Shell small, ovate to trigonal, or rudely quadrate in outline; rather compressed, flexuous posteriorly. Umbones low, subcentral to posterior, prosogyrate. Outer surface smooth or finely sculptured concentrically. Internal ligament stronger than the external, the chondrophore narrow but produced and deeply inset beneath the umbones. Dentition delicate; normally two short simple cardinals developed in each valve and the modified dorsal margins of the left valve received in the lateral sockets of the right; laterals commonly obsolete in the species of trigonal outline. Pallial sinus deep, confluent ventrally with the pallial line.

The Recent forms are relatively few but have a wide geographic and bathymetric range.

***Abra subreflexa* (Conrad) Conrad**

Plate 17, figures 23, 24, 30, 31

1834. *Amphidesma subreflexa* Conrad, *Acad. Nat. Sci. Philadelphia Jour.*, 1st ser., vol. 7, p. 133.

1840. *Amphidesma subreflexa* Conrad, *Fossils of the medial Tertiary of the United States*, p. 37, pl. 19 (1st ed.), fig. 6; (2d ed.), fig. 12.

1863. *Abra subreflexa* Conrad, *Acad. Nat. Sci. Philadelphia Proc.* for 1862, p. 574.

1900. *Abra subreflexa* Conrad, *Dall, Wagner Free Inst. Sci. Trans.*, vol. 3, pt. 5, 997.

Shell somewhat elliptical, convex, anterior margin descending very obliquely and nearly rectilinearly from the beak; extremity subreflected, obtusely pointed; posterior side elongated, margin rounded; anterior basal margin oblique and

nearly parallel with the dorsal margin. Length half an inch.

Locality, Suffolk, Va.—Conrad, 1834.

Shell elliptical; anterior side narrowed, produced, rounded at tip, the dorsal line rectilinear; posterior side very short, with a rather acute fold, the extremity narrow, but obtuse; lateral teeth in the right valve; in the left, none.

Locality, Yorktown, Va.—Conrad, 1840.

Dimensions of figured specimens: Right valve, height 5.6 millimeters, width 10.4 millimeters, convexity 1.8 millimeters; left valve, height 9.0 millimeters, width 15.6 millimeters, convexity 2.7 millimeters.

Figured specimens: U. S. Nat. Mus. 325584, the right and left valves of different individuals.

Locality of figured specimens: Yorktown formation at Colerain Landing, Chowan River, Bertie County, N. C.

Mansfield<sup>46</sup> described a subspecies *jacksonensis* from the *Ecphora* zone of the Choctawhatchee formation. In his discussion of the subspecies he noted that Conrad in the first description of *Amphidesma subreflexa*, 1834, cited Suffolk, Va., as the type locality. In 1840 he cited Yorktown. Mansfield remarked that he had never found the species at Suffolk and never below the lower part of zone 2 of the Yorktown formation.

Shell transversely elongate, strongly inequilateral, angulated posteriorly. Umbones low, flattened, opisthogyrate, located about two-thirds of the distance back from the anterior end. Anterior portion of shell horizontally produced, rounded laterally; posterior dorsal margin strongly oblique, rounding distally into a base line that is usually straight and subparallel to the anterior dorsal margin, though occasionally slightly sinuous behind. Surface smooth, polished. Resilial pit deep, oblique, elongated, subparallel to the posterior dorsal margin. Lateral margins of right valve grooved to receive the modified dorsal margins of the left. Pallial sinus evenly rounded, extending forward at least two-thirds of the distance toward the anterior margin.

The species varies rather widely in relative proportions and in the configuration of the posterior margins. Its transversely elongate outline, however, sharply separates it from the associated *Abra*.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Petersburg, Dinwiddie County; mouth of Baileys Creek, Prince George County; Claremont Wharf (upper bed), and Sunken Marsh Creek (upper bed), Surry County;  $\frac{3}{4}$  mile northeast of Smithfield, Benns Church, and 12 to 14 miles below Zuni, Isle of Wight County; Sycamore, and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above the lower Seaboard Railway bridge, Southampton County;  $1\frac{1}{2}$  miles southeast of Reids Ferry,  $2\frac{1}{2}$  miles northwest of Suffolk,  $1\frac{1}{2}$  miles north of Suffolk,  $1\frac{1}{2}$  miles northeast of Suffolk, 1 mile northeast of Suffolk, and the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

<sup>45</sup> Cossmann, A. E. M., and Peyrot, A., *Conchologie néogénique de l'Aquitaine*, vol. 1, 215, 1909.

<sup>46</sup> Mansfield, W. C., *Miocene pelecypods of the Choctawhatchee formation of Florida*: Florida Geol. Survey Bull. 8, p. 148, pl. 32, figs. 11, 14, 15, 1932.

North Carolina: Miocene, Yorktown formation, near Murfreesboro, Tar Ferry on Wiccacon Creek (opposite Harrellsville), 1½ miles below Tar Ferry, 3 to 4 miles below Tar Ferry, Dogwood Landing (on the Chowan River) and Mount Pleasant Landing, Hertford County; Colerain Landing, Mount Gould Landing, and ½ to ¾ mile above Edenhous Point, Bertie County; Halifax on Quankey Creek (just below the county bridge) and Palmyra Bluff, Halifax County; 3 miles west of Williamston and 2½ miles northwest of Williamston (on Joseph Cherry's farm), Martin County; ½ mile above Bells Bridge, Shiloh Mills, and Tarboro (on L. E. Fountain's farm), Edgecombe County; 8 to 9 miles southeast of Greenville and 9 to 10 miles south of Greenville, Pitt County. The species is particularly abundant in the Yorktown of North Carolina.

*Abra aequalis* (Say) Holmes

Plate 17, figures 12-15

1822. *Amphidesma aequalis* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 307.  
 1830. *Amphidesma aequalis* Say, Am. conchology, facing pl. 28, pl. 28 unnumbered lateral figures.  
 1845. *Amphidesma equalis* Say. Conrad, Fossils of the medial Tertiary of the United States, p. 76, pl. 43, fig. 9.  
 1856. *Amphidesma equalis* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 93, pl. 23, fig. 3.  
 1858. *Abra aequalis* Say. Holmes, Post-Pleiocene fossils of South Carolina, p. 50, pl. 8, fig. 7. Not *Abra aequalis* Whitfield, U. S. Geol. Survey Mon. 24, p. '80, pl. 14, figs. 11-15, 1894.  
 1863. *Abra equalis* Say. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 574.  
 1867. *Abra nuculiformis* Conrad, Am. Jour. Conchology, vol. 3, p. 14.  
 1900. *Abra aequalis* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 998.  
 1932. *Abra aequalis* (Say)? Mansfield, Florida Geol. Survey Bull. 8, p. 148.

Shell orbicular, slightly oblique, polished, white, with very minute and numerous concentric wrinkles near the margin, which are obsolete, on the disk and umbo; lateral teeth none; primary teeth two in the left valve and one in the other; interior ligament cavity subfusiform, as long as the exterior ligament.

Length two-fifths of an inch. Inhabits the southern coast.—Say, 1822.

This species varies a good deal in outline in the same locality, but southern specimens of the recent shell, especially those from Florida, have the anterior dorsal slope less rounded and the umbonal angle smaller than those from more northern localities. The fossils are generally of this type rather than like the more rounded northern recent specimens.—Dall, 1900.

The figured specimens (U. S. Nat. Mus. 325585) are from the Yorktown formation on the Chowan River, one-half to three-fourths of a mile above Edenhous Point, Bertie County, N. C. The right valve measures 10.6 millimeters in height and 12.0 millimeters in width. The left valve of another individual measures 10.5 millimeters in height and 12.0 millimeters in width.

The shell is subtriangular to obliquely orbicular in outline and is, as a rule, somewhat warped posteriorly. The umbones are central or slightly posterior. The dentition in the right valve consists of 2 cardinals (the

anterior of which is slightly the stronger), and feebly developed lateral grooves. In the left valve the anterior cardinal is fairly strong, but the posterior is almost obsolete; there are no distinct laterals, although the dorsal margins are somewhat modified. The palial sinus is deep and broad and evenly rounded.

The species is rare in Virginia but quite abundant in the post-Chesapeake formations of North Carolina. Mansfield reports a few young or fragmentary specimens from the *Cancellaria* zone of the Choctawhatchee formation.

Distribution: Virginia: Miocene, Yorktown formation, 1½ miles northeast of Suffolk and 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, Tar Ferry on Wiccacon Creek (opposite Harrellsville) and Mount Pleasant Landing, Hertford County; Colerain Landing and ¼ to ½ mile above Edenhous Point, Bertie County; 2½ miles northwest of Williamston (on Joseph Cherry's farm), Martin County; 3 miles southwest of Frog Level (on J. A. Noble's branch), 8 to 9 miles southeast of Greenville, and 9 to 10 miles south of Greenville, Pitt County; 1 mile west of Wilson, Wilson County; 1 mile north of Castoria and 1 mile east of Lizzie (on the farm of T. N. Lassiter), Greene County; Rock Landing, Craven County. Duplin marl, drainage ditch just east of railroad 1½ miles north of Magnolia, Duplin County; 2 miles below Lumberton, 4 to 5 miles below Lumberton, and 1½ miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Lake Waccamaw, Cronly (½ mile east of the factories), and Neills Eddy Landing (3 miles north of Cronly), Columbus County.

Outside distribution: Miocene, Duplin marl, Darlington County, S. C. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River, Fla. Croatan sand, Slocums Creek and Mallisons, Craven County, N. C. Pleistocene, Dismal Swamp canal between posts 15 and 16, Virginia; Simmons Bluff, S. C.; Kissimmee well (at a depth of 96 feet), Osceola County, Fla. Recent, Connecticut to the Gulf of Mexico in 13 to 233 fathoms; occurs in both shallow and deep water off Hatteras, elsewhere in shallow water only.

*Abra aequalis deltoidea* Gardner, n. subsp.

Plate 17, figures 25, 26

Shell convex, triangular; the three sides subequal, suggesting the Greek delta; truncate posteriorly, subtruncate anteriorly, evenly rounded toward the ventral margin, which is straight or slightly arched. Sculpture limited to incrementals as in the typical *Abra aequalis* of Say. Hinge normal in the number and disposition of the teeth but with the laterals of the right valve more strongly developed.

Dimensions of cotypes: Right valve, height 11.2 millimeters, width 11.4 millimeters, convexity 3.0 millimeters; left valve, height 11.1 millimeters, width 11.9 millimeters, convexity 3.2 millimeters.

Cotypes, a right and a left valve of different individuals: U. S. Nat. Mus. 325586.

Type locality: Two miles below Lumberton, Robeson County, N. C. Duplin marl.

The extremes of the subspecies seem quite distinct from *Abra aequalis* s. s., but the connecting series determines the true relation. *A. aequalis deltoidea* is characterized by the approximately equilateral outline and relatively strong dentition, which is doubtless the corollary of the heavier valves. The subspecies is best developed in the Duplin marl of Robeson County in the vicinity of Lumberton, though it is known also from the Waccamaw.

Distribution: North Carolina: Miocene, Yorktown formation, 1 mile west of Wilson, Wilson County. Duplin marl, 2 miles below Lumberton and 4 to 5 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Neills Eddy Landing, Columbus County.

#### Family DONACIDAE Deshayes

#### Genus DONAX (Linnaeus) Lamarck

1758. *Donax* Linnaeus, Systema naturae, 10th ed., p. 682.

1799. *Donax* Lamarck, Prodrome d'une nouvelle classification des coquilles: Soc. histoire nat. Paris Mém., p. 85.

1847. *Donax* Gray, Zool. Soc. London Proc., pt. 15, p. 187.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einrichtung, etc., pp. 55, 176, Gotha, 1818): *Donax rugosa* Linnaeus. Recent in the West Indies.

Shell rather solid, moderately inflated, of varying dimensions, elongate-cuneate to trigonal to subcylindrical in outline. Umbones subcentral to posterior, opisthogyrate. Sculpture finely radial, often subcutaneous, sometimes punctate. Ligament both external and internal; external ligament short, heavy, inset; the resilium seated on short, usually excavated nymphs. Dentition rather rude; normally two cardinals in each valve, one of them commonly bifid; laterals varying widely in strength and relative position within the genus. Pallial sinus deep, partly confluent ventrally with the pallial line. Inner margins serrate.

The genus is remarkably uniform and well characterized by its solid, rather pronounced cuneate and flexuous valves, opisthogyrate and usually posterior umbones, and serrated inner margins. The earliest known occurrence of the form in American waters is in the Oligocene. The approximately 100 living species inhabit the sandy beaches of warm and tropical seas. They are lovely little bivalves, ornamented with varicolored rays on a dull gray or dun background. The "pampalone shells," as they are called along the Florida coast, where they are particularly abundant, are used to a considerable extent for food.

#### *Donax emmonsii* Dall

Plate 23, figure 5

1858. *Donax* Emmons, North Carolina Geol. Survey Rept., p. 298, fig. 227 (cited by error as 226).

1863. *Donax* Emmons. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 574.

1892. *Donax emmonsii* Dall, Nautilus, vol. 5, p. 126.

1898. *Donax emmonsii* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, pl. 28, fig. 16.

1900. *Donax emmonsii* Dall, idem, vol. 3, pt. 5, p. 967.

Shell triangular, rather abruptly truncate behind, and traversed by a ridge from the umbo to the base; surface marked by obscure radiating lines; base crenulated. This small shell differs from the *variabilis* in its proportion; it is more triangular and is not produced so much in front.—Emmons, 1858.

This species is more triangular than any of the recent forms of the coast, faintly radially striate, ventrally somewhat flexuous, and with a sharply serrate margin. The teeth are normal and strong, especially the sockets for the laterals. Longitude 10 [10.2], altitude 7 [6.7], diameter 4 millimeters.—Dall, 1900.

Holotype, a right valve: U. S. Nat. Mus. 108447.

Type locality: Cape Fear River, near Cronly, N. C. Waccamaw formation.

It is strange that, though Emmons described and figured this species, he suggested no name by which it should be called.

*Donax emmonsii* Dall is separated from *D. fossor* Say by the relatively higher outline, the more ventricose valves, the longer, more oblique, posterior dorsal margin, and the anterostral depression with the resulting contraction of the ventral margin. The species, exclusive of varietal forms, is rare and rather limited in distribution.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; 1½ miles south of Reids Ferry, Nansemond County.

North Carolina: Miocene, Yorktown formation, Dogwood Landing, Hertford County; 2½ miles northwest of Williamston (on the farm of Joseph Cherry), Martin County; 9 to 10 miles south of Greenville, Pitt County. Duplin marl, Natural Well, Duplin County; 4 to 5 miles below Lumberton, Fairmont, 1½ miles northeast of Fairmont, and 4 miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek) and at Walkers Bluff, Bladen County; Neills Eddy Landing on the Cape Fear River (3 miles north of Cronly), Columbus County.

#### *Donax emmonsii preaequilibrata* Gardner, n. subsp.

Plate 23, figures 3, 4

Valves tumid, elongate-trigonal, rostrate posteriorly, depressed in front of the rostrum; umbones posterior to subcentral; anterior dorsal margin oblique, posterior oblique or slightly hunched; base line feebly sinuated by the anterostral depression; basal serration sharp; hinge characters normal, varying somewhat with the outline of the valves.

The subspecies includes a series of forms gradational between the inequilateral, cuneate, rather strongly rostrate, and sinuous *Donax emmonsii* Dall s.s. and the more nearly equilateral and elongated *D. aequilibrata* Dall, in which the posterior carination is feeble and ill defined and the ventral margin almost, or altogether, straight.

*D. emmonsii preaequilibrata* is mostly limited to the Duplin marl of Robeson County. Its development in the environs of Lumberton and Fairmont suggests the

immediate vicinity as the site of the evolution of the Pliocene *D. aequilibrata* from the earlier *D. emmonsii*. One rarely finds a connecting series so complete between extremes so widely separated.

Dimensions of holotype: Height 8.0 millimeters, width 14.4 millimeters, diameter of double valves 6.5 millimeters.

Holotype (double valves): U. S. Nat. Mus. 325590.

Type locality: 2 miles below Lumberton, Robeson County, N. C. Duplin marl.

Distribution: Virginia: Miocene, Yorktown formation, 1½ miles north of Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, Rock Landing, Craven County. Duplin marl, Lumberton, 2 miles below Lumberton, 4 to 5 miles below Lumberton, and 4 miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Cronly, Columbus County.

### *Donax aequilibrata* Dall

Plate 17, figure 29

1892. *Donax aequilibrata* Dall, Nautilus, vol. 5, p. 126.

1898. *Donax aequilibrata* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, pl. 28, fig. 17.

1900. *Donax aequilibrata* Dall, idem, vol. 3, pt. 5, p. 968.

Shell longer in proportion to its height than in any of our Recent species, rounded in front, the posterior end rostrate and pointed; truncated area impressed, its borders not carinated and ill defined, rostrum faintly grooved, the rest of the shell polished, with obsolete, impressed lines; inner margin denticulate; hinge teeth well developed, laterals strong and near the cardinals; pallial sinus rounded and extending a little in front of the beaks; the latter are well defined, not prominent, and nearly central. Longitude of shell 17 [17.9], altitude 8.9 [8.5], diameter 6 millimeters.—Dall, 1892.

Holotype, a right valve: U. S. Nat. Mus. 108450.

Type locality: Mrs. Guion's marl bed, Cape Fear River, Columbus County, N. C. Waccamaw formation.

Distribution: North Carolina: Pliocene, Waccamaw formation, Mrs. Guion's marl pit and Neills Eddy Landing, Columbus County.

### *Donax chuckatuckensis* Gardner, n. sp.

Plate 23, figure 6, 7

Shell small, remarkably compressed, cuneate. Umbones acute, flattened, opisthogyrate, placed about two-thirds of the way back toward the posterior extremity. Anterior dorsal margin produced and oblique; posterior short and slightly rounded near the ventral margin. Posterior keel rounded off. Base line feebly arcuate, finely serrate within. Surface highly polished with a microscopic, subsurficial, radial lineation; hinge armature compact. Two strong diverging cardinals in the left valve, separated by a subumbonal, triangular pit; on either side of the cardinals is a less prominent lateral, the posterior the stronger. Pallial sinus deep, indistinct.

Dimensions of holotype: Height 3.6 millimeters, width 5.2 millimeters, convexity 1.0 millimeter.

Holotype, a left valve: U. S. Nat. Mus. 325589.

Type locality: A quarter of a mile north of Chuckatuck, Nansemond County, Va. Yorktown formation.

Although the species is described from a single left valve, there should be no doubt about its determination, as it is well characterized by the compressed shell; by the sharp, flattened, almost subterminal umbones; by the absence of an acute posterior keel; the anterior truncation extending almost to the ventral margin; and by the smooth, highly polished external surface. *Donax chuckatuckensis* is perhaps most nearly related to *D. fossor* Say. The want of a sharp rostrum and the degree of truncation of the anterior margin will, however, preclude any confusion of the two forms.

Distribution: Virginia: Miocene, Yorktown formation, a quarter of a mile north of Chuckatuck, Nansemond County.

### *Donax fossor* Say

Plate 23, figures 1, 2, 10, 11

1822. *Donax fossor* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 306.

1849. *Donax protracta* Conrad, idem, 2d ser., vol. 1, p. 208, pl. 39, fig. 8. (Senile stage.)

1856. *Donax variabilis* Tuomey and Holmes (not Say), Pleiocene fossils of South Carolina, p. 95, pl. 23, fig. 6.

1863. *Donax variabilis* Tuomey and Holmes? Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 573.

1873. *Donax fossor* Say. Tryon, American marine conchology, p. 153, pl. 27, figs. 376, 377.

1900. *Donax fossor* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 967.

1932. *Donax fossor* Say. Mansfield, Florida Geol. Survey Bull. 8, p. 151, pl. 31, figs. 6, 7.

Shell subtriangular; anterior margin short and rounded; posterior hinge slope rectilinear; base very slightly prominent beyond a regular curve at the middle; valves longitudinally striated with numerous, equal, parallel, regular impressed lines, not visible to the unassisted eye, and obsolete on the posterior margin; basal edge within crenate; color pale livid, with two longitudinal whitish rays before the middle, both within and without. Breadth from half an inch to three-fifths. Inhabits the coasts of New Jersey and Maryland.—Say, 1822.

The figured specimens (U. S. Nat. Mus. 325587) are from the Waccamaw formation 4 miles south of Elizabethtown, N. C. The right valve measures 3.3 millimeters in height and 5.0 millimeters in width; the left valve of another individual measures 4.9 millimeters in height and 9.0 millimeters in width.

Say, in his description, has confused the anterior and posterior portions of the shell. The species is characterized by the posterior umbones; the rounded posterior margin, the long, only slightly oblique, anterior dorsal margin; and the straight base line. The form is much less conspicuously cuneate than *Donax emmonsii* Dall, the umbones are set farther back, the posterior dorsal margin is rounded instead of angular,

and the prerostral area is not depressed sufficiently to sinuate the base.

The Recent representatives range from the West Indies north to New Jersey, the only east coast species of *Donax* to venture into the temperate seas.

Mansfield reports eight valves from one locality in the *Cancellaria* zone of the Choctawhatchee formation, which "appear closely related to if not the same as the Recent species *Donax fossor* Say."

*D. fossor* is strikingly similar in outline and ornamentation to *D. transversa* Deshayes, the type of *Paradonax* from the Miocene of southern France, and to *D. (Paradonax) aldrichi* Gardner from the Oak Grove; but *Paradonax* has no trace of an isolated anterior lateral such as that developed in *D. fossor* Say.

Distribution: North Carolina: Miocene, Yorktown formation,  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhouse Point, Craven County. Duplin marl,  $1\frac{1}{2}$  miles north of Magnolia, Duplin County; 4 miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek) and Walkers Bluff (on the Cape Fear River), Bladen County; Lake Waccamaw and Neills Eddy Landing (3 miles north of Cronly), Columbus County.

Outside distribution: Miocene, Duplin marl, Sumter district, S. C. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Tillys Lake, Horry County, and Goose Creek, Berkeley County, S. C. Caloosahatchee marl, Caloosahatchee River, Fla. Croatan sand, Slocums Creek, Craven County, N. C. Pleistocene, Simmons Bluff, S. C.; Rose Bluff on the St. Marys River, Nassau County, Fla. Recent, Far Rockaway, Long Island, to the Florida Keys in less than 50 fathoms.

#### Family GARIIDAE

#### Genus TAGELUS Gray

1817. *Siliquaria* Schumacher, Essai d'un nouveau système des habitations des vers testacés, p. 129. Not *Siliquaria* Bruguière, 1789, Encyclopédie méthodique (Vers), vol. 1, p. xv.

1847. *Tagelus* Gray, Zool. Soc. London Proc., pt. 15, p. 189.

Type by original designation: *Solen guineensis* [guinensis] Chemnitz=*Solen gibbus* Spengler. Fossil from the late Miocene to Recent from Cape Cod to Brazil and on the west coast of Africa.

The shell is elliptical to subquadrate, about three times as wide as it is high, feebly inflated, warped by an obscure medial constriction and a broadly rounded posterior keel, and gaping behind. The umbones are medial or slightly posterior and without tips. The shell is constricted slightly behind the umbones, but both the posterior and the anterior dorsal margins are rudely parallel to the base and the lateral margins slightly oblique to the base but roughly parallel to each other. The only sculpture developed is incremental in character. The ligament is attached to short but heavy nymphs, and two slender pedunculate cardinals spring from the slightly thickened area beneath the umbones that passes for a hinge plate. The posterior muscle scar is rounded—the anterior ragged and

elongated parallel to the dorsal margin. The pallial sinus is deep and its axis nearly horizontal.

#### *Tagelus gibbus* (Spengler) Dall

Plate 22, figures 1-4

1685. *Chama angustior*, etc., Lister, Historiae conchyliorum, fig. 265.

1794. *Solen gibbus* Spengler, Skr. Naturhistorie-Selsk. Kiøbenhavn, vol. 3, pt. 2, p. 104.

1795. *Solen guineensis* Chemnitz, Conchylien cabinet, vol. 11, p. 202, pl. 198, fig. 1937.

1818. *Solen cariboeus* Lamarck, Histoire naturelle des animaux sans vertèbres, vol. 5, p. 454.

1827. *Solecurtus cariboeus* Lamarck. Blainville, Dictionnaire des sciences naturelles, vol. 49, p. 420.

1831. *Solecurtus cariboeus* Blainville. Conrad, American marine conchology, p. 22, pl. 4, fig. 3.

1841. *Solecurtus caribaeus* Lamarck. Gould, Invertebrata of Massachusetts, p. 30.

1843. *Solecurtus cariboeus* Lamarck. Mighels, Boston Jour. Nat. History, vol. 4, p. 312.

1846. *Cultellus cariboeus* Conrad, Am. Jour. Sci., 2d ser., vol. 1, p. 404. Not of Conrad, 1845, Fossils of the medial Tertiary of the United States, p. 75, pl. 43, fig. 1. =*Tagelus gibbus carolinensis* (Conrad).

1858. *P. [anopaea.] cariboeus* Emmons, North Carolina Geol. Survey Rept., p. 299, fig. 228a.

1858. *Siliquaria cariboea* Blainville. Holmes, Post-Pleocene fossils of South Carolina, p. 54, pl. 8, fig. 14.

1863. *Siliquaria carolinensis* Conrad (part), Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 571.

1900. *Tagelus gibbus* Spengler. Dall, Wagner Free Inst. Trans., vol. 3, pt. 5, p. 983.

1906. *Tagelus gibbus* (Spengler). Clark, Maryland Geol. Survey, Pliocene and Pleistocene, p. 200, pl. 57, figs. 1-4.

1906. *Solecurtus (Tagelus) gibbus* Spengler. Böse, Inst. geol. México Bol. 22, p. 83, lám. 12, fig. 2.

*Solen gibbus*, testa lineari, valvula antice et postice gibbos-lineari obliqua.—Spengler, 1794.

Type locality not known.

Valves thin, gaping, inequilateral, transversely elliptical. Umbones flattened, slightly posterior. Postumbonal portion of shell narrower than preumbonal, by reason of the abrupt though slight contraction behind the beaks. Both anterior and posterior dorsal margins approximately parallel to the base. Anterior and posterior lateral margin obtusely truncated, approximately parallel to each other. Base line feebly contracted by a broad but very shallow medial depression of the valves. Posterior area faintly delimited by an obscure keel that extends from the umbone to the posterior ventral margin. Surface sculptured with irregular concentric growth lines. Ligament external, short, strong, attached to unusually stout nymphs. Cardinals proximate, long, slender, recurved at the pointed tips, 2 in each valve. Anterior adductor muscle impression elongated, parallel to the dorsal margin, tapering behind; posterior impression semi-elliptical. Pallial line distant from the ventral margin. Pallial sinus deep, extending beyond the median line of the shell.

The type of this genus is rather widely distributed in the late Miocene and Pliocene of the east coast. It is quite common in the Miocene cliffs below Yorktown, and in the waters at the base of the cliffs the Recent representatives are flourishing.

The figured specimens are from Wailes Bluff near Cornfield Harbor, St. Marys County, Md. They are taken from Clark, 1906, who reproduced them natural size.

The Recent species, which may be estuarine or marine, are separated from certain members of the Solenidae, which they closely resemble, by the hinge characters and the very much longer siphons. The genus has been recognized in rocks as old as the Cretaceous.

Though the number of species referable to *Tagelus* is very small, yet this genus includes two species of remarkable longevity—one the type of *Tagelus* s. s., the other of the subgenus *Mesopleura*. *T. gibbus* (Spengler) has not been found in strata older than the Yorktown formation, but the ancestors of *T. divisus* (Spengler) were flourishing certainly as early as Chipola time.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County.

North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, Columbus County.

Outside distributions: Miocene, Santa Maria Tetetla, Vera Cruz, Mexico. Pliocene, Waccamaw formation, Todds Ferry, Waccamaw River, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River, Fla. Pleistocene, New Bedford, Mass. (Dall); Wailes Bluff and Langleys Bluff, St. Marys County, Md.; Charleston, Simmons Bluff, and Abbapoola, S. C. Recent, Cape Cod to Rio Grande del Sul, east to (?) Europe and (?) Africa, and possibly on the west coast of North America; restricted largely to 5 fathoms and less on mud or sandy mud bottom.

#### *Tagelus gibbus carolinensis* (Conrad) Dall

Plate 22, figure 5

1845. *Cultellus cariboeus* Conrad (part), Fossils of the medial Tertiary of the United States, p. 75, pl. 43, fig. 1. Not *Solen cariboeus* Lamarck, 1818.

1863. *Siliquaria carolinensis* Conrad (part), Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 571.

1900. *Tagelus gibbus* var. *carolinensis* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 983.

This form differs from the typical *gibbus* in being somewhat shorter and stouter and with a shorter pallial sinus. The differences are, however, little greater than appear between specimens of the recent shell from different localities.—Dall, 1900.

Dimensions of holotype: Height 23 millimeters, width 69 millimeters.

Holotype: U. S. Nat. Mus. 145293.

Type locality: Wilmington, New Hanover County, N. C. Waccamaw formation.

Distribution: North Carolina: Pliocene, Waccamaw formation, Wilmington, New Hanover County.

### Superfamily SOLENACEA

#### Family SOLENIDAE

##### Genus SOLEN Linnaeus

1758. *Solen* Linnaeus, Systema naturae, 10th ed., p. 672.

1777. *Solen* Scopoli, Introductio ad historiam naturalem sistens genera lapidum, plantarum et animalium hactenus detecta characteribus essentialibus donata in tribus divisa subinde ad legas naturae, Prague. (No type selected.)

1799. *Solen* Lamarck, Prodrome d'une nouvelle classification des coquilles: Soc. histoire nat. Paris Mém., p. 83.

1930. *Solen* Linnaeus, Stewart, Acad. Nat. Sci. Philadelphia Special Pub. 3, p. 289.

Type by subsequent designation (Schumacher, Essai d'un nouveau système des habitations des vers testacés, pp. 42, 124, 1817): *Solen vagina* Linnaeus. East Indies?

Shell long, narrow, generally straight, scabbard-shaped. Umbones anterior, subterminal. External surface polished, smooth, or feebly sculptured. Ligament external, elongated. Hinge armature limited to a single cardinal in each valve. Anterior adductor muscle impression very long and narrow, near and parallel to the dorsal margin; posterior impression semielliptical. Pallial line distinct, sinus shallow.

*Ensis* resembles *Solen* externally, but internally it differs in the possession of 2 vertical cardinals in the left valve instead of a single one, as in *Solen*.

The Recent species number about 50 and are world-wide in distribution. The majority are littoral. At the approach of danger they burrow rapidly downward by means of the alternate extension and contraction of the foot, which serves first as a blade to cut through the sand and then as an anchor by which they may hold until the valves can be pulled down.

The genus has been recognized as edible since the days of Aristotle, and the clam fishers along the French coasts use the same type of tackle today as that employed by ancient Greek fishermen.

#### *Solen viridis* Say

Plate 23, figure 40

1822. *Solen viridis* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 316.

1831. *Solen viridis* Say. Conrad, American marine conchology, p. 28, pl. 5, fig. 2.

1900. *Solen viridis* Say. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 952.

Shell fragile, elongated, compressed, a little narrowed before, slightly wrinkled concentrically, the wrinkles regularly rounded toward the extremity; hinge margin nearly rectilinear; basal margin a little arquated; anterior tip rounded; posterior tip obliquely truncated, a little reflected and rounded near the base; hinge terminal; teeth one in each valve, each having a flattened vertical surface, which turns upon that of the opposite tooth; epidermis pale green.

Length  $\frac{9}{20}$  of an inch, nearly; breadth  $2\frac{3}{20}$  inches.

Inhabits the southern coast.

Cabinet of the Academy and Philadelphia Museum.—Say, 1822.

A recent shell (U. S. Nat. Mus. 153356) from Smiths Island, Va., has been figured. The height is 7.5 millimeters, the width 35.5 millimeters.

Fragments of this species, showing the diagnostic terminal cardinal and the narrow, elongated, adductor muscle impression, have been found at a single locality in the Waccamaw formation. Hitherto the form has been known only from the Pleistocene of Simmons Bluff and from the Recent east coast faunas from Rhode Island to Georgia.

The more anterior vertical cardinal, the absence of the horizontal cardinal, and the position of the anterior adductor impression—parallel rather than oblique to the dorsal margin—will serve to separate this species from the coexistent *Ensis*, which it closely resembles in general aspect.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County.

Outside distribution: Pleistocene, Simmons Bluff, S. C. Recent, Rhode Island to Sarasota Bay, west Florida, and west to Texas in less than 50 fathoms.

#### Superfamily MACTRACEA

#### Family MACTRIDAE

1917. Lamy, Révision des Mactridae vivants du Muséum d'Histoire Naturelle de Paris, Jour. conchyliologie, vol. 63, pp. 173-275.

1918. Lamy, idem, pp. 291-411.

#### Genus MACTRA Linnaeus

1766. *Mactra* Linnaeus, Systema naturae, 12th ed., p. 1125.

1799. *Mactra* Lamarck, Prodrome d'une nouvelle classification des coquilles: Soc. histoire nat. Paris Mém., p. 85.

1898. *Mactra* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 874.

Type by subsequent designation (Anton, Verzeichniss der Conchylien, p. 2, 1839): *Mactra stultorum* Linnaeus. Recent on west European shores from Norway southward to the Mediterranean and possibly to the Red Sea. Fossil in the Crag.

Within the family the best diagnostic of the genus is the small shelly plate that separates the area of attachment of the internal ligament from that of the marginal external ligament. The plate is so thin and so short that it is frequently lost in the fossil forms, and traces of its former existence are hard to find.

*Labiosa*, a large thin shell reinforced by a concentric rippling, resembles *Mactra* in that the marginal and internal ligaments are separated by a thin lamella. The laterals of *Labiosa*, however, are rudimentary. The hinge of *L. (Raëta) alta* (Conrad), from the Miocene of North Carolina, is figured (pl. 18, fig. 6) for comparison with *Mactra*.

#### Subgenus MACTROTOMA Dall

1894. *Mactrotoma* Dall, Nautilus, vol. 8, p. 26.

1898. *Mactrotoma* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 876.

Type by original designation: *Mactra fragilis* Gmelin. Recent on the east coast from Hatteras to Brazil.

Anterior left lateral tooth bidentate, right ventral tooth tridentate.—Dall, 1894.

Shell subequilateral, elongate; with a thin, silky epidermis, posterior dorsal areas bordered by an impressed fasciole, over which the epidermis is darker colored and differently wrinkled; beaks adjacent; pallial sinus large; valves convex, gaping markedly; ligament lanceolate; chondrophore large, shallow, apically roofed; anterior laminae issuing from the dorsal sinus; cardinals prominent, thin, their posterior arms projecting over the chondrophore; each anterior arm attended by a high accessory lamella in nearly the same plane, closely appressed in the right valve to the ventral lamina and in the left valve to the anterior lateral, so that, to a cursory inspection, the lamina appears tridentate and the tooth bidentate.—Dall, 1898.

#### *Mactra (Mactrotoma) fragilis* Gmelin

Plate 18, figures 9-11, 13

1790. *Mactra fragilis* Gmelin, Systema naturae, vol. I, pt. 6, p. 3261.

1898. *Mactra (Mactrotoma) fragilis* Gmelin. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 894, pl. 27, figs. 1, 4, 8, 18.

*M. testa ovata tenui laevi pellucida planiuscula, vulva transversim striata rugosaque*, Chem. Conch. 6, t. 24, f. 235.—Gmelin, 1790.

This species, the type of the subgenus, is widely distributed and represented in eastern seas by very similar though generally smaller species. It was erroneously referred to the Nicobar Islands by Chemnitz, but his figure enables us to correctly identify his species with the American shell.—Dall, 1898.

*Mactra fragilis* s.s. has not been reported from beds older than the Caloosahatchee. The Recent species ranges from Cape Hatteras, N. C., to Rio de Janeiro. It is cited for comparison with a possibly ancestral subspecies and Dall's excellent figures of the hinge plates have been reproduced.

#### *Mactra (Mactrotoma) fragilis precursor* Gardner, n. subsp.

Plate 18, figure 14

Shell oblong, oval, compressed; dorsal margins gently sloping, anterior lateral margin rounded, posterior obliquely truncated. Base line arcuate. Posterior area clearly differentiated, sculptured with 2 narrow acute ribs, of which the dorsal is the stronger; obscure medial rib also present. Surface sculpture of very fine, irregular, discontinuous concentric striae, which are more numerous on the anterior portion of the shell and terminate abruptly at the posterior keel. Hinge and pallial characters as in *M. fragilis* Gmelin, the type of the genus.



Dimensions of holotype: Height 79.0 millimeters, width 121.0 millimeters, convexity 20.0 millimeters.

Holotype, a left valve: U. S. Nat. Mus. 325593.

Type locality: Neills Eddy Landing, Columbus County, N. C. Waccamaw formation.

A complete series might prove the distinguishing characters of this *Mactra* to be only individual variations from *M. fragilis*. As the species has never before been reported from so early a horizon, it seems better to regard the relatively lower, more oblong outline and the more gently sloping dorsal margins of this single, finely preserved, left valve as subspecific rather than individual differences.

*M. (Mactrotoma) profragilis* Gardner, from the Oak Grove sand of Florida, is a smaller shell with more pointed umbones and a more decided concentric striation. The three forms in question are, however, closely related.

Distribution: North Carolina: Pliocene, Waccamaw formation, Neills Eddy Landing, Columbus County.

#### Genus *SPISULA* Gray

1837. *Spisula* Gray, Mag. Nat. History, new ser., vol. 1, p. 372.

1898. *Spisula* Gray. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 878.

1918. *Spisula* Gray. Lamy, Jour. conchyliologie, vol. 63, p. 291.

Type by subsequent designation (Gray, Zool. Soc. London Proc., pt. 15, p. 185, 1847); *Mactra solida* Linnaeus. Recent on the west coast of Europe. Fossil in the Crag.

Shell often large and rather heavy, moderately inflated, subequilateral, ovate-trigonal in outline, slightly produced and obscurely rostrate posteriorly. Umbones prominent, subcentral. Surface smooth or incrementally sculptured. Ligament inset, not cut off from the resilium by a shelly ridge. Hinge armature strong. Right anterior and posterior cardinals coalescent under the umbones, the anterior arm near the dorsal margin, the posterior bordering the chondophore and partly separating it from the socket in which the small, inverted V-shaped cardinal of the left valve is lodged. Strong lateral teeth, developed within the dorsal margins of the left valve, received in the double sockets of the right; teeth and sockets both transversely striated in most of the groups. Muscle scars large and sunken in the heavier shells. Pallial sinus distinct, short, broadly U-shaped, nearly horizontal.

The absence of a shelly lamina between the chondrophore and the ligament separates *Spisula* from *Mactra*. Furthermore, the laterals of *Mactra* are smooth or finely granular, but those of *Spisula* are as a rule transversely striated.

The genus extends well back into the Cretaceous, and, though not abundantly represented in Recent seas, it is of almost universal occurrence.

For the half dozen Miocene *Spisulas* considered in this report, the superspecific groupings are far from

satisfactory. Three of the species and one subspecies are small, heavy forms allied to similar Miocene species and possibly sufficiently removed from the subgenotype to receive a new sectional name. The other two Miocene forms that are referred to *Mactromeris* are relatively large and thin, and seemingly they differ more from the type of *Hemimactra* than *Hemimactra* differs from *Spisula*.

#### Subgenus *HEMIMACTRA* Swainson

1840. *Hemimactra* Swainson, Treatise on malacology, p. 369.

Type by monotypy: *Mactra gigantea* Lamarck = *Mactra solidissima* Chemnitz. Recent seas from Labrador to North Carolina.

Swainson, in his original description of *Hemimactra* cited a second species, "*Hemimactra grandis* Swainson, sp. nov.," but as his species was neither described nor figured the name seems to be nude.

Many of the large, transversely elongated, and relatively thin species of *Spisula* are included under the subgenus *Hemimactra*.

#### Section *HEMIMACTRA* s. s.

Laterals grooved; cardinals compressed; anterior arm of right cardinal confluent with ventral lamina.

*Spisula (Hemimactra) rappahannockensis* Gardner, n. sp.

Plate 18, figure 2-4, 7

Shell elongate-trigonal. Umbones inflated, subcentral, prosogyrate at their tips. Anterior dorsal margin oblique, the lateral margin rounded. Posterior dorsal margin more steeply sloping than the anterior, the lateral extremity rounded or vaguely truncated. Base line straight or slightly sinuous toward the posterior margin. Surface smooth except for incrementals. Concentric furrows often developed by weathering as in *Spisula confragosa* Conrad. Chondrophore obliquely triangular, cardinal teeth compressed. Laterals not very heavy, straight, transversely grooved, lateral furrows of right valve also grooved. Muscle impressions and pallial line distinct. Pallial sinus rounded, extending about two-thirds of the distance from the posterior margin to the medial line of the shell.

Dimensions: Holotype, height 21.0 millimeters, width 31.5 millimeters, convexity 7.3 millimeters; paratype, height 15.0 millimeters, width 23.0 millimeters, convexity 5.3 millimeters. Two other valves: Height 19.2 and 20.4 millimeters, width 27.1 and 28.8 millimeters, convexity 6.8 and 6.5 millimeters.

Types: Holotype, a right valve, and left figured hinge. U. S. Nat. Mus. 325601; paratype, a left valve, U. S. Nat. Mus. 325600.

Type locality: Holotype, and left hinge, 1 to 2 miles below Bowlers Wharf on the Rappahannock River, Essex County, Va. St. Marys formation.

Paratype, Union Mills, 2½ miles south of Farnham, Richmond County, Va.

The young of *S. rappahannockensis* are higher and more triangular than the adults. There is, in many of the individuals, an ill-defined ridge extending from the umbo to the posterior end of the basal margin, a ridge that becomes obsolete in the adults. The new species is separated from *S. confragosa* Conrad and *S. subparilis* Conrad by the more gibbous umbones, the more gently sloping dorsal margins, and the tendency toward a posterior truncation and sinuous base line.

The species is exceedingly abundant at certain localities along the Rappahannock River and the surrounding territory, notably near Bowlers Wharf and at Union Mill, 2½ miles south of Farnham. The individuals developed at the latter locality exhibit a decidedly more elongated outline than do those along the river.

Distribution: Virginia: Miocene, St. Marys formation?, Nomin-Cliffs, Westmoreland County. St. Marys formation; 2½ miles south of Farnham, Richmond County; 1 to 2 miles below Bowlers Wharf, Essex County; Urbanna Bluff, Middlesex County.

#### *Spisula (Hemimactra) modicella* (Conrad) Meek

Plate 23, figures 8, 9, 18, 19

1833. *Mactra modicella* Conrad, Am. Jour. Sci., 1st ser., vol. 23, p. 340.

1838. *Mactra modicella* Conrad, Fossils of the medial Tertiary of the United States, p. 25, pl. 13, fig. 3.

1863. *Hemimactra modicella* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 572.

1898. *Spisula modicella* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 900.

Shell subtriangular, compressed; posterior side shortest and abrupt or truncated at the extremity; fosset a little oblique, triangular; lateral teeth strong. Length, three-fourths of an inch.

Locality, Yorktown, Va.—Conrad, 1833.

A small, heavy species, characterized by the flattened inequilateral valves, the produced anterior extremity, the strongly grooved laterals, the conspicuous muscle impressions and pallial line. The form seems to be peculiarly susceptible to weathering forces, for all the individuals have a very much worn and battered aspect. It varies quite widely in relative proportions—so widely, indeed, that it has been thought wise to give the higher forms subspecific rank.

Dimensions of figured specimens: Right valve, height 11.2 millimeters, width 15.0 millimeters, convexity 3.9 millimeters. Immature left valve, height 7.9 millimeters, width 11.7 millimeters, convexity 2.3 millimeters.

Figured specimens: U. S. Nat. Mus. 325598.

Locality of figured specimens: One mile northeast of

Suffolk, Nansemond County, Va. Yorktown formation.

These weather-beaten little forms are among the most abundant of the smaller bivalves in the vicinity of Yorktown.

Distribution: Virginia: Miocene, St. Marys formation, Union Mill, 2½ miles south of Farnham, Richmond County. Yorktown formation, Yorktown, York County; ¼ mile northeast of Smithfield, Isle of Wight County; ¼ mile north of Chuckatuck, 1½ miles southeast of Reids Ferry, 1 mile northeast of Suffolk, 1 mile west of Suffolk, and ½ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 6 miles below Greenville, 8 to 9 miles south of Greenville, and 9 to 10 miles south of Greenville, Pitt County.

#### *Spisula (Hemimactra) modicella alta* Gardner, n. subsp.

Plate 23, figures 16, 17

The subspecies resembles *Spisula (Hemimactra) modicella* s. s. except in the notably greater height; concomitant with this are the more oblique anterior and posterior dorsal margins. The general aspects of the normal and of the varietal forms are therefore quite dissimilar.

The subspecies is best developed at Rock Landing, on the Neuse River. At this locality it is one of the most conspicuous of the smaller bivalves and occupies a position in the fauna similar to that of *S. modicella* s. s. in the Yorktown of Virginia.

Dimensions of holotype: Height 13.2 millimeters, width 18.0 millimeters, convexity 4.1 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325599.

Type locality: Rock Landing, Craven County, N. C. Yorktown formation. *S. (Hemimactra) modicella alta* is a higher, cruder shell than *S. (Hemimactra) craspedota*, an abundant species in the Shoal River formation. It is much less elongated transversely than the St. Marys form, *S. rappahannockensis*.

Distribution: Virginia: Miocene, Yorktown formation, 1½ miles northeast of Smithfield, Isle of Wight County; ¼ mile north of Chuckatuck, Nansemond County.

North Carolina: Miocene, Yorktown formation, 3 miles south of Farmville, Pitt County; Colerain Landing, Bertie County; Rock Landing and 2 miles southwest of Maple Cypress, Craven County. Duplin marl, 4 miles northeast of Fairmont, Robeson County.

#### *Spisula (Hemimactra) similis* (Say) Gardner

Plate 22, figures 6, 7

1822. *Mactra similis* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 309.

1856. *Mactra similis* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 97, pl. 23, fig. 8.

1856. *Mactra similis* Say. Holmes, Post-Pleiocene fossils of South Carolina, p. 39, pl. 7, fig. 8.

Shell subtrigonal, smooth, or very slightly wrinkled, white on the disk or upon the umbones, and dirty light brownish colour on the margin; umbones nearly central; lateral teeth strongly and regularly crenated on the side next the recipient cavity.

Length  $1\frac{3}{20}$  inches, nearly; width  $1\frac{1}{2}$  inches.  
Inhabits the coast of the United States.  
Cabinet of the Academy.—Say, 1822.

The young of this species are very close to adult *Spisula subparilis* of Conrad. In the former, however, the shell is sub-ovate and rounded posteriorly; in the latter, subtriangular and obliquely truncated posteriorly.

Distribution: North Carolina: Miocene, Duplin marl, 2 miles below Lumberton and  $1\frac{1}{2}$  miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Cronly,  $\frac{1}{2}$  mile east of the factories, Columbus County.

Outside distribution: Pliocene, Waccamaw formation, Nixons and Tilly Lake, Horry County, and Goose Creek, Berkeley County, S. C. Pleistocene, Simmons Bluff, Abbapool, and St. Andrews, S. C.; Orient, Hillsborough County, Fla.; Kissimee well (at a depth of 96 feet), Osceola County, Fla. Recent, Massachusetts to Florida and the Gulf of Mexico.

#### Section *MACTROMERIS* Conrad

1868 (January). *Mactromeris* Conrad, Am. Jour. Conchology for 1867, vol. 3, app., p. 45.

Type by subsequent designation (Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 878, 1898): *Spisula ovalis* Gould = *Mactra polynyma* Stimpson. Recent from Hudson Bay to Cape Ann, Mass.

The section is characterized by smooth or feebly granular laterals, noncompressed cardinals, and the isolation of the anterior arm of the right cardinal from the ventral lamina.

#### *Spisula (Mactromeris) bowlerensis* Gardner, n. sp.

Plate 18, figures 1, 5

Shell rather large, thin, moderately inflated, rudely trigonal, equivalve, inequilateral. Anterior end slightly excavated dorsally, rounded laterally. Posterior end gently sloping, very slightly arched dorsally, obscurely truncated laterally. Ventral margin straight medially, upturned before and behind. Anterior dorsal area slightly impressed, not clearly delimited. Posterior area including a smooth, somewhat depressed region next to the margins and in front of them, a narrow roughened wedge-shaped surface, the anterior boundary of which is marked by an irregular pitted line extending from the umbo to the posterior ventral margin. Umbones rather low and inconspicuous, proximate, slightly prosogyrate. Surface irregularly furrowed with growth lines and with a peculiar reticulate wrinkling. Hinge armature strong and clean-cut. Chondrophore cuneate, expanding posteriorly. Anterior arm of right cardinal coalescent with ventral lamina. Inverted V-shaped cardinal of left valve compressed. Laterals short but prominent, their inner surfaces granular. Muscle impressions distinct but not conspicuous. Pallial sinus of equal breadth throughout its length, rounded in front, not ascending

appreciably, projected almost but not quite halfway to the anterior margin.

Dimensions of holotype: Height 53.0 millimeters, width 70.0 millimeters, diameter 28.0 millimeters.

Holotype, paired valves: U. S. Nat. Mus. 498201.

Type locality:  $1\frac{1}{2}$  miles below Bowlers Wharf, Rappahannock River, Va. St. Marys formation.

*Spisula (Mactromeris) bowlerensis* is most nearly related to *S. (M.) duplinensis* Dall. It is readily separable from the latter, however, by the higher and somewhat less inflated valves; by the more inequilateral outline, which is consequent on the more pronounced excavation of the anterior dorsal slope of *bowlerensis* and its slightly convex posterior dorsal margin; by the less smooth and polished external surface; and by the broader, nontapering pallial sinus. The new species is smaller and less inequilateral than *S. delumbis* Conrad, less strongly concave anteriorly, more gently sloping and less strongly angulated posteriorly, and with a deeper and less sharply ascending pallial sinus. *S. valhosierr* Gardner, from the Shoal River, is closely related, but the beaks and hinge plate of the older species are not so high and the posterior area is less clearly defined.

This interesting form, which seems to be intermediate between *S. delumbis* and *S. duplinensis* and yet distinct from both of them, is fairly abundant in the single area where it has been found—Bowlers Wharf, on the Rappahannock River.

Distribution: Virginia: Miocene, St. Marys formation, Bowlers Wharf and 1 to  $\frac{1}{2}$  miles below Bowlers Wharf, Essex County.

#### *Spisula (Mactromeris) duplinensis* Dall

Plate 22, figure 10

1898. *Spisula (Hemimactra) duplinensis* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 898, pl. 30, fig. 1.

Shell subovate, thin, moderately inflated; beaks subcentral, not prominent, adjacent; surface smooth except for incremental lines, which are most prominent toward the ends; the middle of the valve is more or less polished, anterior end somewhat shorter than the posterior, both moderately rounded; dorsal slope nearly equal on both sides of the beak; dorsal areas obscure, the posterior smoother and more impressed; hinge much as in *S. marylandica*, but the pit larger and with a more projecting ventral margin; pallial sinus reaching forward more than half the length of the shell, pointed in front; basal margin curved but not arcuate. Longitude 58, altitude 42, diameter 22 millimeters.

This species at first sight looks very close to *S. marylandica* but has a longer pallial sinus, less prominent beaks, more equal dorsal slopes, and less arcuate basal margin. The lateral laminae are finely granulated and not striated—which separates it at once from the *similis* group—and the proportions are quite different from those of the young *S. polynyma* Stimpson of the same size. It is probably the shell referred to *S. similis* Say by Tuomey and Holmes<sup>47</sup> and Emmons.<sup>48</sup>—Dall, 1898.

<sup>47</sup> Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 97, pl. 23, fig. 8, 1856.

<sup>48</sup> Emmons, E., North Carolina Geol. Survey Rept., p. 298, 1858.

Holotype, a right valve: U. S. Nat. Mus. 153784.

Type locality: Natural Well, Duplin County, N. C. Duplin marl.

Though the figure of Tuomey and Holmes is not conclusive, the finding of indubitable specimens of *S. similis* in the Duplin of Robeson County makes the correctness of their determination plausible.

Distribution: North Carolina "Chesapeake Miocene of Duplin County, Willcox."

#### Genus MULINIA Gray

1837. *Mulinia* Gray, Mag. Nat. History, new ser., vol. 1, p. 375.

1898. *Mulinia* Dall. Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 880.

Type by subsequent designation (Herrmannsen, Indicis generum Malacozoorum, vol. 2, p. 61, July 1847): *Mactra lateralis* Say. Recent from New Brunswick to Texas and the West Indies. Late Tertiary and Pleistocene.

Shell with the ligament and resilium both enclosed in a single pit and invisible externally. Laterals subequal, moderately distant; teeth normal; valves closing almost hermetically; pallial sinus short and small; siphons short; foot narrow, pointed.

Widely distributed in estuaries of the tropics and temperate seas over most of the world. The most conspicuous species are from South America.—Dall, 1898.

#### *Mulinia congesta* (Conrad) Dall

Plate 23, figures 12–15, 21–24

1833. *Mactra congesta* Conrad, Am. Jour. Sci., 1st ser., vol. 23, p. 340.

1838. *Mactra congesta* Conrad, Fossils of the medial Tertiary of the United States, p. 27, pl. 15, fig. 2.

1841. *Mactra crassidens* Conrad, Am. Jour. Sci., 1st ser., vol. 41, p. 346, pl. 2, fig. 11.

1843. *Mactra triquetra* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 324.

1845. *Mactra triquetra* Conrad, Fossils of the medial Tertiary of the United States, p. 69, pl. 39, fig. 3.

1845. *Mactra crassidens* Conrad, idem, p. 69, pl. 39, fig. 5.

1856. *Mactra congesta* Conrad. Tuomey and Holmes, Miocene fossils of South Carolina, p. 98, pl. 23, fig. 10.

1863. *Hemimactra congesta* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 572.

1863. *Mulinia crassidens* Conrad, idem, p. 573.

1863. *Mulinia triquetra* Conrad, idem, p. 573.

1863. *Standella congesta* Conrad, idem, p. 573.

1894. *Mactra* (*Mulinia*?) *lateralis* "Say". Whitfield, U. S. Geol. Survey Mon. 24, p. 82, pl. 15, figs. 1–3. Not *Mactra lateralis* Say, 1821.

1898. *Mulinia congesta* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 900.

1932. *Mulinia congesta* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 154, pl. 32, figs. 1, 2, 5, 6.

Shell triangular, convex, thick; posterior side cuneate, beaks nearly central; lunule none; fosset small, circular, profound; lateral teeth thick. Length, 1 inch.

Locality: Suffolk, Va., where it is extremely abundant. A much smaller variety occurs at James River—generally shorter in proportion to the height, and with central beaks. Upper marine formation.—Conrad, 1833.

This well-known and variable species is of wide distribution. Short, high specimens form the variety *triquetra*, of

which *crassidens* is a young shell. Conrad, by the extraordinary carelessness which was normal to him, placed the two latter names under *Mulinia*, while *congesta* appears both as *Hemimactra* and as *Standella* in different places in the same list of Miocene fossils printed in 1863!—Dall, 1898.

Dimensions of figured specimens: U. S. Nat. Mus. 325602, right valve, height 15.5 millimeters, width 21.0 millimeters, convexity 5.6 millimeters; left valve of another individual, height 15.3 millimeters, width 22.0 millimeters, convexity 5.5 millimeters. U. S. Nat. Mus. 325603, right valve, height 23.0 millimeters, width 25.5 millimeters, convexity 9.5 millimeters; left valve of another individual, height 24.5 millimeters, width 26.5 millimeters, convexity 10.0 millimeters.

Locality of figured specimens: U. S. Nat. Mus. 325602, Yorktown formation, 1 mile northeast of Suffolk, Nansemond County, Va.; U. S. Nat. Mus. 325603, Yorktown formation, 1½ miles west of Smithfield, Isle of Wight County, Va.

*Mulinia congesta* (Conrad) is one of the most easily recognized representatives of the pelecypod fauna of the east coast Miocene. It has been reported from the majority of North Carolina and Virginia localities at which the fossiliferous Miocene occurs, and in number of individuals it generally exceeds all other bivalves. At some of the exposures in southern Virginia and northern North Carolina, on the Meherrin River in Southampton County, Va., for example, and in the vicinity of Murfreesboro, Hertford County, N. C., the marls are literally packed with this shell. The form varies rather widely in size and outline, though the characters are usually fairly constant at a single locality. The majority of the forms from the Meherrin River outcrops correspond closely to the type of Conrad's *M. congesta*. They are commonly smaller than those at Yorktown and are relatively lower with a more produced posterior margin and more proximate umbones. In the later Yorktown fauna, on the other hand, the species is of the larger, heavier, subequilateral, triangular type, and thus follows the line of variation represented by *M. triquetra* Conrad. This variant is particularly abundant in the environs of Suffolk, Nansemond County, Va. Near Exit, in the same county, the shells are remarkable for the preservation of the concentric color markings. *M. congesta* of the Duplin fauna is inconstant. Though often of medium size, individuals from the vicinity of Clinton, Sampson County N. C., reach a height of 26.5 millimeters and a width of 35.0 millimeters, and near Lumberton, in Robeson County, N. C., they commonly measure 24 to 26 millimeters in height, with a corresponding width of 34 to 34.5 millimeters. These large Duplin forms differ, however, from those of the Yorktown fauna in the produced posterior margin. The oval, elongate forms were set aside by Dall under the manuscript name *elongata*. They have been given subspecific rank, for they are distinct and readily separable; though, on

the other hand, they are connected with the normal representatives of the species by an unbroken gradational series.

*Mulinia congesta* (Conrad) is distinguished from the later and much less abundant *M. lateralis* (Say) by the heavier, usually larger shell and the more robust hinge. Both species vary widely in outline, but the former is, for the most part, less triangular and more equilateral.

Mansfield records *M. congesta* from each of the three zones of the Choctawhatchee formation of Florida but "only one small valve has been collected from the *Arca* zone." He reported it to be one of the most common species in the *Ecphora* zone and observed that "the shells are larger, thicker, and have stronger laterals in the *Ecphora* zone than in the *Cancellaria* zone."

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Lanexa (upper bed), New Kent County; Petersburg, Dinwiddie County; 5 miles northeast of Smithfield, 1½ miles northeast of Smithfield, 2 miles west of Smithfield, 1½ miles west of Smithfield, and Bennis Church, Isle of Wight County; 2½ to 3 miles northwest of Zuni, 2 miles northwest of Zuni, 1½ miles above Zuni, 1 mile north of Zuni, ¾ mile north of Zuni, Zuni (near the pumping station), 6½ to 7 miles below Zuni, 7 to 7½ miles below Zuni, and 8 to 8½ miles below Zuni, Isle of Wight County; Hitchcock, Greensville County; Sycamore, Harcum's store, ¼ to ½ mile below Sycamore, the lower Seaboard Railway bridge, and Maddelys Bluff, Southampton County; 2 miles below South Quay; ¼ mile north of Chuckatuck, Chuckatuck mill dam, Everets, Exit, 1½ miles southeast of Reids Ferry, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 5½ miles northwest of Suffolk, 2½ miles northwest of Suffolk, 1½ miles northwest of Suffolk, 1 mile west of Suffolk, 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, ½ mile below the Suffolk waterworks dam, and the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, 3 to 4 miles below the lower Seaboard Railway bridge over the Meherrin River, 1½ miles above Branches Bridge, 1 mile above Branches Bridge, Branches Bridge, and 1½ miles below Branches Bridge, Northampton County; 2½ miles northwest of Murfreesboro (at Watsons Mill on Kirbys Creek), 1½ miles above Murfreesboro, 1 mile above Murfreesboro, and near Murfreesboro, Hertford County; Tar Ferry on Wicacoa Creek (opposite Harrellsville), 1½ miles below Tar Ferry, 3 to 4 miles below Tar Ferry, Dogwood Landing, and Mount Pleasant Landing on the Chowan River, Hertford County; Colerain Landing, Bertie County; 1 to 2 miles above the Atlantic Coast Line Railroad bridge, Halifax (at Quankey Creek, just below the county bridge), 1¼ miles northeast of Enfield, ½ mile west of Enfield, Palmyra Bluff, and 3½ miles below Palmyra Bluff, Halifax County; 1¼ miles east of Battleboro, 3 miles south of Battleboro, and 2 miles southeast of Sharpsburg, Nash County; 3½ miles northwest of Rocky Mount, 2 miles west of Rocky Mount, ¾ mile northwest of the Rocky Mount waterworks, ¼ mile north of the Rocky Mount waterworks, 6 to 7 miles below Rocky Mount (at Capt. Turner Battle's), Compass Creek (at a point 1 mile from the confluence with the Tar), ¾ mile north of New Bridge, 5 miles below New Bridge, Swift Creek, 15½ miles above Bells Bridge, ½ mile above Bells Bridge, 100 yards below Bells Bridge, ¼ mile below Bells Bridge, 1 mile below Bells Bridge, Shiloh Mills, and 1 mile below old Sparta Bridge, Edgecombe County; Hamilton Bluff, ½ mile below Hamilton

Landing, 2 miles southeast of Hamilton Bluff (at old fort), and 2½ miles northwest of Williamston (on Joseph Cherry's farm), Martin County; 2 miles below Toddy Station, 2 miles southeast of Tugwell (on Jacobs Branch), 1¼ miles northeast of Farmville, 3 miles south of Farmville, 2½ miles north of Standard, near Standard, 5 miles southwest of Frog Level (on J. A. Nobles branch), 8 to 9 miles west of Greenville (on the east side of Pinelogs Branch), 3 miles west of Greenville (on Schoolhouse Branch), Greenville (just east of the county bridge), 6¾ miles below Greenville (at Tafts Landing), 8 to 9 miles southeast of Greenville, 1½ miles west of Galloway Crossroads, and 9 to 10 miles south of Greenville, Pitt County; 2½ miles northwest of Chocowinity, and 1¼ miles northeast of Chocowinity, Beaufort County; 2 miles southwest of Maple Cypress, Rock Landing, Craven County; 1 mile west of Wilson (in Hominy Swamp), 3 miles east-southeast of Wilson, 5 miles south of Wilson, and 7 miles southeast of Wilson, Wilson County; 6 miles west of Goldsboro, Wayne County; 1 mile north of Castoria, ½ mile east of Lizzie, 1 mile east of Lizzie, 4 miles east of Lizzie (on Dog Swamp), and 1½ miles east of Ormondsville, Greene County. Duplin marl, 3 miles south of Clinton (on Gum Chimney Branch), 4 miles south of Clinton, and 10 miles south of Clinton, Sampson County; 2 miles northeast of Warsaw, Natural Well, drainage ditch just east of railroad, 1½ miles north of Magnolia, and Magnolia (at Frank Wilson's marl pit), Duplin County; 4 miles north of Lumberton (on Berry Godwin's plantation), 1 mile west of Lumberton, Lumberton (near the bottling works), 2 miles below Lumberton, 4 to 5 miles below Lumberton, Fairmont, 1½ miles northeast of Fairmont, 4 miles northeast of Fairmont, and 2 miles northwest of Barnesville, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Cape Fear River, Bladen County; Lake Waccamaw, Columbus County; Wilmington (at the city rock quarry), New Hanover County.

Outside distribution: Miocene, Choctawhatchee formation, northern Florida. Choptank formation, (?) Atlantic City (well bore), N. J. Duplin marl, Muldrow Place, Sumter County, S. C.; Porters Landing on the Savannah River, Effingham County; Brunswick River bed, Brunswick, Glynn County, Ga. Pliocene, Caloosahatchee marl, Nashua, Putnam County, Fla.; De Leon Springs, Volusia County, Fla. Croatan sand, Slocums Creek and Mallisons, Craven County, N. C.

#### *Mulinia congesta magnoliana* (Dall) Gardner

1898. *Spisula* (*Hemimactra*?) *magnoliana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 899, pl. 27, fig. 29.

Shell small, equilateral, somewhat compressed, with small, little-elevated, pointed, adjacent beaks; surface smooth except for lines of growth and a feeble angulation extending backward from the umbo to the lower posterior margin; ends nearly equally rounded, the posterior slightly more pointed, the base moderately and evenly curved; pallial sinus small, angular, very short; hinge normal, feeble, with short granulate laterals. Longitude 17, altitude 10, diameter 7 millimeters.—Dall, 1898.

Holotype, a left valve: U. S. Nat. Mus. 115080.

Type locality: Magnolia, Duplin County, N. C.

In the unique valve that was taken as the type of *Spisula magnoliana* Dall, the cardinal margin is broken away and the edges are so perfectly rounded by erosion that all trace of the characteristic ligamentary attachment of *Mulinia* has been obliterated and replaced by a pseudospisuloid attachment. This fact was brought out by the examination of fresh individuals in which the septum had been recently shipped away.

The subspecies is separated from *M. congesta* s. s. by the lower, more regularly oval and elongate valves, the less prominent umbones, and the short, rather heavy laterals.

Distribution: Virginia: Miocene, Yorktown formation, South Quay, Nansemond County.

North Carolina: Miocene, Yorktown formation, 3½ miles below Palmyra Bluff, Halifax County; 8 to 9 miles south of Greenville, Pitt County; 1 mile north of Castoria, Greene County; Rock Landing, Craven County. Duplin marl, 10 miles south of Clinton, Sampson County; Natural Well, Duplin County; 2 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, Columbus County.

Outside distribution: Miocene, Duplin marl, Brunswick River bed, Brunswick, Glynn County, Ga.

#### Family MESODESMATIDAE

##### Genus MESODESMA Deshayes

1831. *Mesodesma* Deshayes, Encyclopédie méthodique, vers. vol. 2, p. 442.

Type by subsequent designation (Anton, Verzeichniss der Conchylien, p. 3, Halle, 1839): *Mastra donacia* Lamarck. Recent off the coast of Chile.

Shell heavy, compressed, donaciform or subtrigonal, inequilateral. Umbones posterior. Ligament short, mostly internal. Hinge strong. Resilial pit deep. A single cardinal in each valve, that of the left usually stronger and often bifid. Anterior and posterior sulcated laterals in the left valve received between the sulcated laminae of the right. Inner margin of valves smooth. Muscle impressions deep. Pallial sinus well defined, variable.

The genus is first recognized in the Eocene. The Recent species are relatively few, but they are worldwide in distribution.

##### *Mesodesma spatha* Gardner, n. sp.

Plate 18, figures 8, 12

Shell small, compressed, ovate-oblong, strongly inequilateral. Umbones very low and flattened, located about two-thirds of the distance back. Anterior portion of shell slightly contracted, much produced, gently sloping dorsally, evenly rounded distally. Posterior dorsal margin slightly hunched. Lateral margin subtruncate. Base line nearly straight. Surface smooth or marked with feeble incrementals. Hinge known from right valve only; hinge plate heavy. Resilial pit large and deep, slightly oblique; limiting margins raised. Lateral furrows narrow, deep, transversely grooved, the posterior decidedly shorter. Anterior arm of cardinal in line with the anterior ventral lamina but not confluent with it; posterior arm projecting almost horizontally over the chondrophore. Lateral sockets deep. Muscle impressions and pallial characters distinct. Anterior adductor scar pyriform; posterior semielliptical. Pallial line rather distant from

the hinge margin. Sinus evenly rounded, projected forward as far as the umbones.

Dimensions of holotype: Height 6.4 millimeters, width 10.3 millimeters, convexity 1.7 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325591.

Type locality: 1 mile northeast of Suffolk, Nansemond County, Va. Yorktown formation.

This single valve, the only one of the genus thus far reported from the east coast Miocene, has many characters in common with *Mesodesma deauratum* Turton of the Pleistocene faunas of the North Atlantic coast and may be the precursor of that species. The umbones are more posterior than in the majority of the Recent individuals; the hinge plate is set in the plane of the dorsal margins rather than slightly oblique to it, as in the *M. deauratum* of Turton; and the ventral laminae of the laterals and the anterior arm of the cardinals are less elevated. The species also suggests at first glance *Spisula modicella* Conrad. It is, however, relatively lower, more inequilateral, with a much more deeply excavated resilial pit and shorter and more narrow lateral grooves.

Distribution: Virginia: Miocene, Yorktown formation, 1 mile northeast of Suffolk, Nansemond County.

##### Genus ERVILIA Turton

1822. *Ervillea* Turton, Conchyliæ insularum britannicarum: Dithyra, p. 55.

Type by monotypy: *Mya nitens* Montagu. Recent from the Tortugas to the northern coast of South America.

Shell small, oval to triangular. Umbones low, subcentral, slightly opisthogyrate. External ligament obsolete; internal, lodged in a small resilifer, situated between the anterior and posterior cardinals. Lateral armature feeble; grooves developed in right valve; lateral teeth of left usually replaced by modifications of the dorsal margins. Pallial sinus well defined.

These lentil-shaped bivalves form an inconspicuous factor in the marine faunas of the Tertiary and post-Tertiary seas. The Recent forms are mostly tropical.

##### *Ervillea lata* Dall

Plate 23, figure 20

1898. *Ervillea lata* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 915, pl. 33, fig. 20.

1932. *Ervillea lata* Dall. Mansfield, Florida Geol. Survey Bull. 8, p. 155, pl. 32, figs. 4, 7, 10.

Small, very similar to *E. concentrica*, from which it differs by being broader between the beak and the basal margin, with the beaks slightly more equilateral and the dorsal margin behind the umbo usually more impressed; the surface is usually covered with concentric ridges, which are flattened and coarser and less regular than those of *E. concentrica*; the hinge teeth also are less strong than the latter species. Longitude 4.5 [5.2], altitude 3.5 [3.6], diameter 2.2 millimeters.

This form on casual inspection would be referred to *E. concentrica* as a mere variety, but when a large number of specimens are examined and the characters above-mentioned seem



to be fairly constant, I believe it is best to recognize the average differences by a name than to overlook them by consolidation with what I regard as probably a distinct species.—Dall, 1898.

Holotype, a right valve: U. S. Nat. Mus. 115054.

Type locality: Natural Well, Duplin County, N. C. Duplin marl.

Distribution: North Carolina: Miocene, Duplin marl, 1½ miles north of Magnolia and at Frank Wilson's marl pit near Magnolia, Duplin County. Pliocene, Waccamaw formation, Cronly and Neills Eddy Landing 3 miles north of Cronly on the Cape Fear River, Columbus County.

***Ervilia lata radiata* Gardner, n. subsp.**

Plate 23, figures 25, 29

Shell minute, oblong to subtriangular, slightly inequilateral. Umbones subcentral or a little in front of the medial line, opisthogyrate. Dorsal margins fairly steep; anterior lateral margin evenly rounded, posterior slightly produced and rounded. Base line strongly arcuate, often slightly contracted posteriorly. Surface sculptured with crowded concentric lirae, which vary rather widely in strength in different individuals, and on the posterior slope, with distinct though submicroscopic radial striations. Ligament pit moderately large. Anterior cardinal of right valve strong, the posterior obsolete. Anterior lateral groove ill defined, posterior less feeble; dorsal edges of left valve modified to function as laterals. Pallial sinus rather deep, well rounded.

Dimensions of holotype: Height 2.6 millimeters, width 4.0 millimeters, convexity 0.8 millimeter. Paratype: Height 2.6 millimeters, width 4.2 millimeters.

Holotype, a right valve, and paratype, a left valve: U. S. Nat. Mus. 325597.

Type locality: Neills Eddy Landing on the Cape Fear River, Columbus County, N. C. Waccamaw formation.

*Ervilia lata radiata* differs from *E. lata* s.s. by the lower, less triangular outline, by the tendency toward a less regular and less clearly defined concentric sculpture, and preeminently by the radial striations of the posterior keel. The subspecies is best developed at the type locality, Neills Eddy Landing, in the Waccamaw, though it is present in the Yorktown and is associated with *E. lata* Dall in the Duplin. The concentric and radial sculpture serve also to separate the subspecies *radiata* from the coexistent *E. polita* Dall.

Less than half a dozen valves of this small species were recovered by Mansfield from the *Cancellaria* zone of the Choctawhatchee formation in Florida.

A closely related species, *E. gabbi* Woodring, is described by Woodring, 1925, from the Bowden of Jamaica. He differentiated it from the southeastern American species because it is less compressed and less inequilateral.

Distribution: Virginia: Miocene, Yorktown formation, 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Duplin marl, Frank Wilson's marl pit near Magnolia, Duplin County. Pliocene, Waccamaw formation, Neills Eddy Landing, Columbus County.

Superfamily VENERACEA Menke

Family PETRICOLIDAE D'Orbigny

Genus PETRICOLA Lamarck

1801. *Petricola* Lamarck, *Système des animaux sans vertèbres*, p. 121.

Type by subsequent designation (Schmidt, C. F., *Versuch über die beste Einricht*, etc., pp. 55, 176., Gotha, 1818); *Venus lapicida* Chemnitz. Found by Chemnitz in ballast of coral rock from the West Indies.

Shell thin, oval or elongate, often irregular, gaping. Umbones anterior but not terminal. Lunule ill defined. Sculpture dominantly radial and in the genotype divaricate or zigzag. Inner margins smooth. Ligament external, attached to nymphs. Armature of right valve usually consisting of two cardinals, the posterior of which is grooved or bifid; third rudimentary cardinal rarely present; left valve furnished either with three divergent cardinals (the middle one bifid, the remaining two simple) or with two divergent cardinals (a simple posterior and a bifid anterior); laterals absent in the normal adult. Pallial sinus narrow, as a rule, and ascending, with considerable variation in depth.

This is a nestling or burrowing genus, which exhibits the variability characteristic of dwellers in such a habitat.

The group has been recognized from strata as early as the Cretaceous; the Recent species, though numbering only about 25, are, owing in part to their habitat, widely distributed in the temperate and warm waters.

*Petricola* s.s. has not been recognized in the Miocene or in the pre-Caloosahatchee Pliocene. Dall reports the genotype from the Caloosahatchee marl. Possibly the temperature of the water may have been the controlling factor that excluded it from the early Pliocene of the Carolinas, although it is recorded in the Recent faunas from the coast of South Carolina.

Subgenus RUPELLARIA Fleuriau-Bellevue

1802. *Rupellaria*, Fleuriau-Bellevue, *Jour. physique*, vol. 54, p. 347; *Soc. Philom. (Paris) Bull. des Sciences*, 62, p. 106.

1900. *Rupellaria* Dall, *Wagner Free Inst. Sci. Trans.*, vol. 3, pt. 5, p. 1058.

Type by elimination: *Venus lithophaga* Retzius. Widely reported but most common off the Atlantic coasts of France and Spain and in the western Mediterranean.

Fleuriau-Bellevue cited two species under his newly described genus: the first a *Venerupis*, the second *Venus lithophaga* Retzius, which becomes by elimination the type of the subgenus.

*Rupellaria* is short and inflated in front, less inflated and attenuated behind. A radial sculpture is usually



developed over the entire shell but is stronger anteriorly. The pallial sinus is broad and broadly rounded.

*Petricola (Rupellaria) grinnelli* Olsson

Plate 15, figures 13, 14, 18

1914. *Petricola (Claudiconcha) grinnelli* Olsson, Bull. Am. Paleontology, vol. 5, No. 24, p. 16, pl. 4, figs. 7-10.

Shell elongated, solid, often distorted; anterior end rounded; posterior end elongated, pointed; right valve slightly larger and overlapping the left, especially on the posterior dorsal margin; surface sculpture of irregular radial striae, which as a rule are slightly larger and separated by wider interspaces on the anterior portion of the shell; striae more or less granulated by concentric lines; hinge weak, with slender teeth, those in the specimens broken off but, judging from the stumps remaining, consisting of three cardinal teeth in each valve.

Type specimen: Length 22, height 13, thickness 12 millimeters.

A large valve: Length 25, height 16, thickness 7 millimeters.

The subgenus *Claudiconcha* Fischer, as exemplified by *P. monstrosa* Gmelin, contains shells which have the right valve slightly larger and overlapping on the left. This species probably burrowed in the sand. The Miocene shell compares well with the type form of this subgenus but possesses a much more degenerate hinge.

Yorktown formation, James River, 5 miles north of Smithfield; Bellefield.—Olsson, 1914.

The Chemnitz figures to which Gmelin refers in his citation of *monstrosa* indicate a shell unlike *grinnelli*. Olsson's species seems more properly referable to *Rupellaria*.

The shell is built up of concentric layers, and the successive laminae are often visible in cross section at the inner margins of the valves. The outline is strongly convex, oval, cylindrical, or trapezoidal. The dorsal margins are usually rectilinear, the anterior sometimes flaring widely, the posterior parallel with the base. The lateral margins are evenly and similarly rounded or obscurely truncated at approximately the same angle to the base. The umbones are inflated, incurved to the dorsal margins, their tips proximate and prosogyrate, and located about one-third of the distance back from the anterior margin. The surface is sculptured with some 40 irregular radials, mostly equisize and equispaced but slightly more crowded posteriorly. The free edges of the concentric lamellae are ruffled at the intersection with the ribs. The lunule is not defined. The ligament is external and seated on a very narrow nymph. The 2 right cardinals are proximate, slender, conical, recurved, issuing from beneath the umbo. The dentition of the left valve is imperfectly known. The anterior adductor impression is oval, the posterior suborbicular, and both of them are set well up toward the dorsal margin. The pallial line and sinus are strongly marked. The sinus is very broad and somewhat oblique, the frontal margin rounded and not far from the median vertical; the ventral margin parallel to but not coalescent with the pallial line.

Dimensions of figured specimens: Right valve (U. S. Nat. Mus. 325562, from Palmyra Bluff on the Roanoke River, Halifax County, N. C.), height 13.5 millimeters, width 23.5 millimeters, convexity 5.5 millimeters. Left valve (U. S. Nat. Mus. 325561, from Wilmington, N. C.), height,  $16.0 \pm$  millimeters, width 24.8 millimeters, convexity 5.8 millimeters.

*P. grinnelli* Olsson is characterized by the laminar texture, the irregular *Pleiorytis*-like radials, distributed with approximate uniformity over the entire external surface, and the bizarre outline of the pallial line and sinus, which is due to the elevated position of the adductors. Almost any of these characters alone would suffice to differentiate the species.

Distribution: Virginia: Miocene, Yorktown formation, Bellefield on the York River, York County; Petersburg, Dinwiddie County; 5 miles north of Smithfield on the James River, Isle of Wight County; Suffolk, Nansemond County.

North Carolina: Miocene, Yorktown formation, Palmyra Bluff, Halifax County;  $1\frac{1}{4}$  miles below Bells Bridge, Tar River, Edgecombe County. Pliocene, Waccamaw formation, Walkers Bluff(?), Bladen County; Wilmington(?), New Hanover County.

Subgenus *PETRICOLARIA* Stoliczka

1871. *Petricolaria* Stoliczka, India Geol. Survey Mem., Palaeontologia Indica, Cretaceous fauna of southern India, vol. 3, p. 139.

Type by original designation: *Petricola pholadiformis* Lamarck. Recent from Prince Edward Island to the West Indies and the Gulf of Mexico.

In this the shell is very much elongated, subcylindrical, the sinus narrow and very deep; the hinge has 2 teeth in each valve, attached below the hinge area and curving upward; in the right valve the anterior tooth is hooklike, the posterior much larger, broadly laminar and bipartite; in the left the anterior is very large and bipartite, its anterior portion almost representing a separate hooklike tooth corresponding to the anterior tooth of the right valve; the posterior portion is thick and prominent and longitudinally grooved; besides this there is a small, sometimes obsolete, posterior cardinal tooth.—Stoliczka, 1870.

*Petricola (Petricolaria) pholadiformis* Lamarck

1818. *Petricola pholadiformis* Lamarck, Histoire naturelle des animaux sans vertèbres, vol. 5, p. 505.

1822. *Petricola fornicata* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 319.

1832. *Petricola pholadiformis* Lamarck. Conrad, American marine conchology, p. 37, pl. 7, fig. 3.

1834. *Petricola pholadiformis* Lamarck. Say, American conchology, pt. 6, pl. 60 (upper and lower figs.).

1841. *Petricola pholadiformis* Lamarck. Gould, Invertebrata of Massachusetts, p. 63.

1854. *Petricola pholadiformis* Lamarck. Sowerby, Thesaurus conchyliorum, pt. 15, p. 771, pl. 166, fig. 1.

1858. *Petricola pholadiformis* Lamarck. Holmes, Post-Pleocene fossils of South Carolina, p. 38, pl. 7, fig. 6.

1889. *Petricola pholadiformis* Lamarck. Dall, U. S. Nat. Mus. Bull. 37, p. 58, pl. 59, fig. 15; pl. 64, fig. 140a.

1900. *Petricola (Petricolaria) pholadiformis* Lamarck. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1061.

1906. *Petricola pholadiformis* Lamarck. Clarke, Maryland Geol. Survey, Pliocene and Pleistocene, p. 201.

*P. testâ transversim elongatâ; latere postico brevissimo, sulcis longitudinalibus lamelloso-dentatis utrinque radiato; antico subglabro . . . Largeur, 46 millim.—Lamarck, 1818.*

The species is characterized by a cylindrical outline, by a strong differentiation of the sculpture on the anterior and posterior portions of the shell, and by the relatively few but prominent denticulated radials on the anterior end. There are 3 cardinals in the left valve—the middle one sulcated, the anterior and posterior ones simple.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County.

North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Pleistocene, Sankaty Head (early fauna), Mass.; Walles Bluff near Cornfield Harbor, St. Marys County, Md.; Eau Gallie, Brevard County, Fla. Recent, Prince Edward Island to Greytown, Nicaragua, in less than 50 fathoms; most abundant on sandy and muddy bottoms.

#### *Petricola* (*Petricolaria*) *carolinensis* Conrad

1856. *Petricola pholadiformis* Tuomey and Holmes, Pleistocene fossils of South Carolina, p. 87, pl. 21, fig. 5. Not *P. pholadiformis* Lamarck, 1818.

1863. *Petricola carolinensis* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 576. (New name for *P. pholadiformis* Tuomey and Holmes.)

1900. *Petricola* (*Petricolaria*) *carolinensis* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1060.

Shell elongated, cylindrical, buccal side very short, radiately [costate] and striate; ribs lamellar; anal side much elongated, radiately striate; lunule ovate. . . . The shell is ovate-cylindrical, equivalve, but very unequilateral; the buccal side is rounded and covered with irregular lamellar and somewhat toothed ribs; anal side covered with radiating irregular raised lines. The lunule is defined by the termination of the lines of growth.—Tuomey and Holmes, 1856.

Locality: Pee Dee and Smiths, Goose Creek, S. C.

Valves gaping, strongly convex, elongate-ovate, very inequilateral. Anterior end short and evenly rounded; posterior, alar, produced, tapering gradually to the acutely rounded extremity. Umbones tumid, proximate, prosogyrate, located about one-fifth of the distance back from the anterior margin. Radial sculpture on the anterior part of the shell coarse and distant, the posterior of the primary radials originating at the umbones and reaching the ventral margin a little in front of the median line; remainder of shell covered with fine and uniform radiating striae, some 50 to 70 in number. Concentric lines inconsequential except on the anterior end, where they tend to become scabrous at the intersection with the prominent radials. Lunule delimited by the anterior radial. Escutcheon not defined. Ligament external; nymphs elongated, lenticular in the closed valves, with a deep groove at their ventral margins. Armature in right valve consisting

of a stout, projecting, slightly recurved, anterior cardinal, and a laminar, sulcated, posterior cardinal; in the left valve 3 divergent teeth—the anterior cardinal simple, the middle cardinal feebly sulcated on the ventral surface, and the posterior cardinal simple and laminar. Anterior adductor muscle impressions sub-circular; the posterior semielliptical. Sinus free, extending about half the distance toward the anterior margin, rounded in front, its dorsal and ventral boundaries parallel. Pallial line usually indistinct. Inner margins of valve often crenate, particularly in front.

*Petricola carolinensis* Conrad is separated from *P. pholadiformis* Lamarck by the less strongly differentiated sculpture of the anterior and posterior areas. The radials as a whole are more numerous and consequently less prominent and distant. The concentric sculpture is laminar at its intersection with the radial, but the edges are rarely free and vaulted as in *P. pholadiformis*. *P. carolinensis* is most closely allied to the Recent *P. dactylus* Sowerby, from which it differs in being constantly more elongated and cylindrical. The general characters of the sculpture are very similar. The Tertiary species is on the whole rather rare, though in the Duplin marl, in Robeson County, well preserved individuals have been collected in considerable numbers.

Distribution: North Carolina: Miocene, Yorktown formation, 2½ miles northwest of Williamston (on the farm of Joseph Cherry), Martin County. Duplin marl, 2 miles below Lumberton, 1½ miles northeast of Fairmont (on the farm of Andrew Jones), and at Fairmont, Robeson County.

Outside distribution: Pliocene, Waccamaw formation, Goose Creek and Pee Dee River, S. C.

#### Genus *PLEIORYTIS* Conrad

1862. *Pleiorytis*, Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 286.

1936. *Pleiorytis* Conrad. Gardner, Florida Dept. Cons. Geol. Bull. 14, p. 39.

Type by monotypy: *Pleiorytis ovata* Conrad (Days Point, James River, Va.) = *Petricola centenaria* Conrad, 1833. Middle and upper Miocene of the middle and south Atlantic Coastal Plain.

Equivalve, ovate or oval, with radiating striae, gaping posteriorly; hinge of right valve with 2 widely diverging teeth; left valve with 1 direct, thick, triangular, bifid tooth under the apex, and an oblique compressed tooth posteriorly; sinus of pallial impression extending beyond the middle of the valves; muscular impressions large. (Miocene.)—Conrad, 1862.

Conrad placed this genus under the family Petricolidae.

The group of *Pleiorytis centenaria* Conrad has a limited geographic and stratigraphic range, and perhaps for that reason its dissimilarity to the type of *Asaphis* (*Venus deflorata* Linnaeus from the Bahamas) was not noted by Dall and others in assigning *centenaria* to *Asaphis*. In *Asaphis*, as in many of the

tellinids, the tips of the umbones are bent inward and very slightly backward, and no trace of a lunular spur appears across the cardinals. In *Pleiorbytis*, as in *Petricola* and other venerids, the umbones are decidedly prosogyrate, and the lunular spur is more or less developed. In *Asaphis* the bifid cardinal of the right valve is produced and oblique; in *Pleiorbytis* it is short and nearly vertical. In *Asaphis*, in the left valve, the dorsal margin is tabulated in front of the bifid cardinal; in *Pleiorbytis* there is a well-developed laminar, left anterior cardinal.

The general relations of *Pleiorbytis* were properly indicated by Conrad, and though possibly it should be given only subgeneric rank under *Petricola*, the habits of the animal are not those of typical *Petricola*, the shell is not adjusted to a boring habitat, and the consequent differences may be recognized generically. The genus may then be described as follows:

Shell of moderate dimensions, rather thin, slightly gaping; transversely elongate, moderately inflated. Umbones anterior, not conspicuously prominent, the tips proximate and prosogyrate. Lunule and es-cutcheon not developed. Posterior area flattened but not rostrate. Ligament strong, external. A slender spur from the lunular region carried across the cardinals. Teeth short, built up from a narrow hinge plate; a laminar anterior and bifid medial cardinal in the right valve, the posterior cardinal almost or entirely obsolete; a laminar anterior, bifid medial, and laminar posterior cardinal in the left valve. Laterals not developed. Adductor scars large, the pallial sinus broad and deep, not confluent ventrally with the pallial line. Inner edges of the valves simple or faintly rayed but not crenate.

The group is particularly characteristic of the middle and upper Miocene of the eastern seaboard of the United States.

*Petricola (Rupellaria) harrisii* Dall has a hinge identical with that of *Pleiorbytis centenaria* and may, as indicated by Mansfield,<sup>49</sup> be nothing more than a much-warped individual of that species. Warping is not common in the group, but it is present to a considerable degree in a few individuals. *Petricola (Petricolaria) calvertensis* Dall is similar in sculpture but it more cylindrical and, though the hinge is rather badly broken, does not seem to have the hinge plate so well developed as that of *Pleiorbytis*.

#### *Pleiorbytis centenaria* (Conrad) Conrad?

Plate 15, figure 17

1833. *Petricola centenaria* Conrad?, Am. Jour. Sci., 1st ser., vol. 23, p. 341.

1863. *Pleiorbytis centenaria* Conrad?, Acad. Nat. Sci. Philadelphia Proc. for 1862, vol. 14, p. 576.

1900. *Petricola (Rupellaria) harrisii* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1060, pl. 43, fig. 1.

<sup>49</sup> Mansfield, W. C., Florida Geol. Survey Bull. 8, p. 149, 1932.

1932. *Asaphis centenaria* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 149, pl. 31, fig. 4.

Shell solid, ovate, distorted more or less by the irregularities of its situs; posterior end blunt, longer; anterior end shorter, rounded; sculpture of fine, nearly uniform, radial, rounded threads with wider interspaces, crossed by fine, rounded, slightly elevated incremental lines; beak moderately elevated; hinge short, with (in the left valve) 1 strong, apically grooved cardinal between 2 simple narrow diverging teeth; ligamentary nymph short, strong, deeply grooved; basal margin feebly crenulated by the external sculpture; pallial sinus wide, shallow; altitude 20 [20.5], latitude 23 [22.5]; semidiameter 7 millimeters.

Only 1 valve of this species was obtained by Professor Harris, in whose honor it is named.—Dall, 1900.

Holotype of *P. harrisii* Dall, a left valve: U. S. Nat. Mus. 145020.

Type locality: Bellefield Bluff, 4½ miles above Yorktown, Va. Yorktown formation.

Mansfield was the first to suggest that *Petricola harrisii* Dall should fall into the synonymy of "*Asaphis*" *centenaria* Conrad.

#### Family COOPERELLIDAE

##### Genus COOPERELLA Carpenter

1864. *Cooperella* Carpenter, British Assoc. Advancement Sci. Rept. for 1863, p. 639.

1900. *Cooperella* Carpenter. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1061.

Type by monotypy: *Cooperella scintilloeformis* Carpenter = *Oedalia subdiaphana* Carpenter. Recent on the Pacific coast between Vancouver and Todos Santos Bay.

New subgenus of *Oedalia*. Cartilage semi-internal; only 1 tooth bifid.—Carpenter, 1864.

Shell small, thin, smooth, or concentrically striate or undulate, equivalve, nearly equilateral, with entire margins; ligament long, feeble, profuse, amphidetic; resillum short, stout, opisthodontic, immersed behind the cardinals on an oblique thickening of the hingeplate, not excavated to form a pit or produced into a chondrophore; hingeplate narrow, carrying two right and three left subumbonal, divaricating, short, cardinal teeth, of which the left central tooth is always, and the others frequently, bifid; laterals none; muscular impressions small, oval; pallial line narrow with an ample sinus.—Dall, 1900.

This small genus has a very interesting distribution. Only a few species of *Cooperella* s. s. have been recognized—a single species from the east coast Tertiary; the others, including the genotype, from the Pleistocene and Recent of the west coast. Woodring, 1925, described a species from the Bowden, but he referred it to a new subgenus *Cooperellopsis*.

#### *Cooperella carpenteri* Dall

Plate 14, figures 44, 47

1900. *Cooperella carpenteri* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1063.

1900. *Diplodonta yorkensis* Dall, idem, vol. 3, pt. 5, p. 1185, pl. 43, fig. 5.

1903. *Cooperella carpenteri* Dall, idem, vol. 3, pt. 6, pl. 49, fig. 8.

Shell smooth or slightly concentrically undulate, and with faint incremental lines; oval, nearly equilateral, the beaks mod-

erately elevated; hinge delicate, hingeplate narrow, excavated; pallial sinus deep but only moderately high; base arcuate, ends rounded. Longitude 14 [12.5], altitude 11.5 [10.0], diameter 7.50 millimeters.—Dall, 1900.

Holotype, a right valve: U. S. Nat. Mus. 155714.

Type locality: Petersburg, Va. Yorktown formation.

Both the cardinals in the right valve show a tendency toward a sulcated ventral margin. In the left valve the middle cardinal is strongly bifid, the posterior one simple and laminar, and the anterior cardinal usually simple but sometimes feebly sulcated in the adult. The regularly transverse-oval and convex valves, the peculiar depression of the hinge behind the umbones, and the dentition characterize this small form, which in outward semblance recalls some of the smaller and more convex of the *Diplodontas*.

Dall described, under the name of *Diplodonta yorkensis*, a shell apparently identical with his *Cooperella carpenteri*.

The species has been reported from a number of localities and is particularly abundant in the Yorktown formation in the vicinity of Suffolk.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Petersburg, Dinwiddie County; Cobham Wharf (upper bed) on the James River, Surry County; 12 to 14 miles below Zuni, Blackwater River, Benms Church, Isle of Wight County; Sycamore on the Nottoway River and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County;  $5\frac{1}{2}$  miles northwest of Suffolk,  $2\frac{1}{2}$  miles northwest of Suffolk,  $1\frac{1}{2}$  miles north of Suffolk,  $1\frac{1}{2}$  miles northeast of Suffolk, 1 mile northeast of Suffolk, and  $\frac{1}{2}$  mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation,  $\frac{1}{2}$  mile above Bells Bridge, Tar River, Edgecombe County; Dogwood Landing, Hertford County. Duplin marl, Natural Well, Duplin County (Dall).

#### Family VENERIDAE

#### Subfamily DOSINIINAE

#### Genus DOSINIA Scopoli

1777. *Dosinia* Scopoli, Introductio ad Historiam naturalem, sistens genera Lapidum, Plantarum et Animalium, hactenus detecta, caracteribus essentialibus donata, in tribus divisa, subinde ad leges Naturae, p. 399.

Type by tautonomy: *Chama dosin* Adanson = *Dosinia africana* Hanley. Recent off the coast of Senegal and adjacent waters.

The outline of the paired valves of *Dosinia* recalls that of some of the discoidal lucinoids. The beaks are prominent and the prodissococonch is, in many species, unusually conspicuous. The lunule is small, sunken, and outlined by a deeply impressed line. In the type section, the escutcheon is clearly indicated both by the contour and by the sculpture, and it extends the length of the posterior dorsal margin. The usual sculpture

is a flat concentric lamination, least feeble toward the lateral margins. The ligament is deeply inset and produced about half the length of the dorsal margin. The anterior and middle cardinals of the right valve are short and laminar with parallel proximate faces. The posterior cardinal is produced and bifid. In the left valve the anterior cardinal is short and laminar to fit between the opposing faces of the anterior and middle cardinals of the right valve, the middle left cardinal is relatively heavy, and the posterior cardinal is thin and not very prominent. There is a short dental process by way of an anterior lateral in the left valve and, in the right valve, a corresponding socket placed near the ventral extremity of the lunule. The pallial line is rather distant from the smooth inner margins, and the sinus is almost horizontally directed and acutely rounded at the extremity.

The genus has been reported from the Wangaloa beds, Palaeocene of New Zealand, but some doubt has been cast by Stewart, 1930, on its occurrence at so early a time. In Europe the earliest records of the genus, according to Cossmann and Peyrot, are in the Aquitanian, and in the Coastal Plain deposits of this country the Miocene marks the first recorded appearance of the group. Marwick<sup>50</sup> noted that the left anterior lateral is merely the isolated extension of the anterior cardinal and does not arise independently of the cardinal, as in *Macrocallista* and *Callocardia*.

#### Subgenus DOSINIDIA Dall

1902. *Dosinidia* Dall, U. S. Nat. Mus. Proc., vol. 26, p. 347.

Type by original designation: *Venus concentrica* Born. Recent from the Florida Keys to Rio de Janeiro.

Valves suborbicular, subcompressed, white, with a sculpture of concentric grooving, never lamellose; furnished with an obvious periostracum; lunule small, impressed; escutcheon absent; pallial sinus ample, ascending, angular in front; posterior cardinals serrate or corrugated in the nepionic young, smooth in the adult.

This group is confined to the tropical and warmer temperate seas of America.—Dall, 1902.

#### *Dosinia* (*Dosinidia*) *acetabulum* (Conrad) Conrad

Plate 11, figure 4

1832. *Artemis acetabulum* Conrad, Fossil shells of the Tertiary formations of North America, p. 20, pl. 6, fig. 1.

1834. *Cytherea obovata* Conrad, Acad. Nat. Sci. Philadelphia Jour., vol. 7, p. 132 (young shell).

1838. *Cytherea obovata* Conrad, Fossils of the medial Tertiary of the United States, p. 14, pl. 8, fig. 4.

1838. *Artemis acetabulum* Conrad, idem, p. 29, pl. 16, fig. 1.

1863. *Dosinia acetabulum* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 575.

1863. *Dione obovata* Conrad, idem, p. 575.

1870. *Dosinia obovata* Conrad, Am. Jour. Conchology, vol. 6, p. 77. Not *D. obovata* Conrad. Bush, Connecticut Acad. Sci. Trans., vol. 6, pt. 2, p. 477, 1885.

<sup>50</sup> Marwick, J., New Zealand Inst. Trans., vol. 57, p. 580, 1927.

1894. *Dosinia acetabulum* Conrad. Whitfield, U. S. Geol. Survey Mon. 24, p. 73, pl. 13, fig. 2.
1903. *Dosinia* (*Dosinidia*) *acetabulum* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1230.
1904. *Dosinia acetabulum* Conrad. Glenn, Maryland Geol. Survey, Miocene, p. 315, pl. 83, fig. 1; pl. 84, fig. 1.
1906. *Dosinia acetabulum* Conrad? Böse, Inst. geol. México Bol. 22, p. 81, pl. 11, figs. 7, 12.
1922. *Dosinia acetabulum* Conrad. Olsson, Bull. Am. Paleontology, vol. 9, No. 39, p. 231, pl. 31, fig. 1.
1926. *Dosinia* (*Dosinidia*) *acetabulum* (Conrad). Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 63, pl. 19, figs. 1-3, 6-7, 9.
1932. *Dosinia* (*Dosinidia*) *acetabulum* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 116, pl. 24, fig. 1.

Lentiform, with numerous concentric striae, which are rather sharp and elevated on the anterior and posterior sides; cardinal fosset large, oblong, profound; with age, almost obliterating the posterior tooth; right valve with 3 teeth, the posterior one long and sulcated longitudinally; 2 anterior teeth approximate; left valve with 4 teeth, 3 of them distant; the anterior tooth somewhat pyramidal and entering a groove formed by 2 slight elevations in the opposite valve.

Type localities: St. Marys River and Easton, Md.; James River, near Smithfield, and Suffolk, Va. Upper Tertiary.—Conrad, 1832.

Conrad's original figures are reproduced.

Shell large, heavy, crumbly, moderately compressed, prolately discoidal. Umbones subcentral, flattened, oblique, strongly prosogyrate. Lunule impressed, cordate in the double valves, clearly delimited by an incised line. Escutcheon absent. Surface covered with a dark brown or rufous periostracum, which is sometimes well preserved even in the Chesapeake Miocene forms; surface beneath concentrically sulcated with somewhat irregular grooves, which are strongest and most regular near the dorsal margins and tend to become obsolete on the central portion of the disk. Ligament very strong; nymph elongated, roughly sickle-shaped, limited dorsally by a very sharp and deep groove; resilial pit deep, oblong, subumbonal, often enlarged by decay in senile individuals so that it encroaches to a considerable extent on the posterior cardinal. Hinge plate broad and heavy; armature of right valve consisting of a simple anterior and a medial cardinal, their inner surfaces flattened and proximate; and of a single obliquely elongated, rather distant, bifid, posterior cardinal; groove for reception of anterior lateral of left valve shallow; posterior lateral absent; hinge margin just behind posterior cardinal sharply pinched; armature of left valve consisting of three divergent cardinals, the anterior and the posterior cardinal simple and moderately elongated, the middle tooth broader and somewhat undulated or grooved; anterior lateral a small, rounded prominence placed near the ventral margin of the lunule. Adductor impressions and pallial line distinct, the area of the adherent mantle usually somewhat roughened, the rest of the interior often polished. Anterior muscle scar rudely

lenticular, the upper end, at the ventral extremity of the lunule, the lower at, or a trifle above, the median horizontal; posterior adductor scar relatively wider and submedial in position. Pallial line moderately distant from the base. Sinus sharply ascending, pointed in front. Young relatively higher than the adults, the umbones more prominent; the concentric sculpture stronger and more regular, and the posterior cardinal transversely grooved.

*Dosinia acetabulum* is one of the most widely distributed, abundant, and conspicuous bivalves in the east coast Miocene. The shell substance crumbles readily so that the external surface is often badly decorticated. The characters are so distinctive, however, that the species may be confidently determined even from fragments. The only coexistent representative of the genus—*D. elegans* Conrad—is a somewhat smaller, thinner, more compressed shell with a more pronounced and regular concentric sculpture.

Mrs. K. V. W. Palmer has noted an increase in the size of the specimens in the later formations. The prominence of the beaks and the strength and regularity of the concentric sculpture in juvenile specimens is so marked that it is not surprising they were described by Conrad as a distinct species. Mansfield reports the rare occurrence of *D. acetabulum* s. s. from both the *Ecphora* and the *Cancellaria* zones of the Choctawhatchee formation, and a variety, *D. acetabulum blountana*, from the *Arca* zone. The mid-American shells described by Böse, 1906, and by Toulas, 1909, may be referable to *D. delicatissima* Brown and Pilsbry, 1913, from the Gatun formation.

Distribution: Virginia: Miocene, St. Marys formation?, Nomini Cliffs, Westmoreland County. St. Marys formation, 1 to 2 miles below Bowlers Wharf, Essex County; 2½ miles south of Farnham, Richmond County; a quarter of a mile below Jones Point and Urbanna, Middlesex County. Yorktown formation, 3 miles northeast of Walkerton, King and Queen County; Lanexa (upper bed), New Kent County; Yorktown, York County; mouth of Baileys Creek, Prince George County; Lieutenant Run, Petersburg, Dinwiddie County; Sunken Marsh Creek (upper bed), Surry County; 5 miles northeast of Smithfield, 2 miles northwest of Smithfield, 1½ miles northwest of Smithfield, 1½ miles west of Smithfield, Zuni (near the pumping station), 6½ to 7 miles below Zuni, and 12 to 14 miles below Zuni, Isle of Wight County; Hitchcock, Greensville County; 3 to 4 miles above the lower Seaboard Railway bridge, and ½ to ¾ mile above the lower Seaboard Railway bridge, Southampton County; 1 mile east of Everetts Post Office, Exit, 5½ miles northwest of Suffolk, 2½ miles northwest of Suffolk, 1½ miles north of Suffolk, 1¼ miles north of Suffolk, 1 mile west of Suffolk, 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, and half a mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1½ to 2 miles above Branches Bridge over the Meherrin River, 1 mile above Branches Bridge, Branches Bridge, and 1½ mile below Branches Bridge, Northampton County; 2½ miles northwest of Murfreesboro, 1½ miles above Murfreesboro, and near Murfreesboro, Hertford County; Halifax (at Quankey

Creek, just below the county bridge) and at Palmyra Bluff, Halifax County; 2 miles west of Rocky Mount,  $\frac{1}{2}$  mile above Bells Bridge over the Tar River,  $\frac{1}{8}$  mile below Bells Bridge, 1 mile below Bells Bridge,  $1\frac{1}{4}$  miles below Bells Bridge, Shiloh Mills, and 1 mile below old Sparta Bridge, Edgecombe County, 2 miles southeast of Tugwell (on Jacobs Branch), 3 miles south of Farmville, 3 miles southwest of Frog Level (on J. A. Noble's branch), 8 to 9 miles west of Greenville (on the east side of Pinelog Branch),  $1\frac{1}{2}$  miles west of Greenville (on Schoolhouse Branch), Greenville (just east of the county bridge), 6 miles below Greenville,  $6\frac{3}{4}$  miles below Greenville (at Tafts Landing), 8 to 9 miles southeast of Greenville,  $1\frac{1}{2}$  miles west of Galloway Crossroads, 9 to 10 miles south of Greenville (on Fred Haddock's farm), 1 mile northwest of Galloway Crossroads, and  $\frac{3}{4}$  mile north of Grimesland, Pitt County;  $2\frac{1}{2}$  miles northwest of Chocowinity, Beaufort County; half a mile east of Lizzie (on David Summeril's farm), Greene County.

Outside distribution: Miocene, Santa Maria Tetetla, Vera Cruz, Mexico. Calvert formation, Atlantic City (well bore), N. J.; Reeds, Queen Annes County, Md.; Lyons Creek, Anne Arundel County, Md.; Whites Landing, Prince Georges County, Md.; Plum Point and Chesapeake Beach, Calvert County, Md. Choptank formation, Greensboro, Caroline County, Md.; Cordova, Peach Blossom Creek, Dover Bridge, and Trappe Landing, Talbot County, Md.; Sand Hill, Dorchester County, Md.; Governor Run, Flag Pond, and St. Leonard Creek, Calvert County, Md.; Turner, Jones Wharf, and Pawpaw Point, St. Marys County, Md. St. Marys formation, Cove Point, Calvert County, Md.; St. Marys River and Langleys Bluff, St. Marys County, Md.

#### *Dosinia (Dosinidia) elegans* (Conrad) Conrad

Plate 11, figure 1

1685. *Pectunculus albidus*, etc., Lister, pl. 238, fig. 124.  
 1838. *Artemis elegans* Conrad, Fossils of the medial Tertiary of the United States, p. 30.  
 1844. *Artemis elegans* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 325.  
 1846. *Artemis elegans* Conrad, Am. Jour. Sci., 2d ser., vol. 2, p. 393.  
 1850. *Artemis concentrica* Reeve, Conchologia iconica, vol. 6, pl. 2, fig. 8. Not *Venus concentrica* Born, 1780.  
 1856. *Venus concentrica* Gmelin. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 82, pl. 21, fig. 7.  
 1858. *Artemes transversus* Emmons, North Carolina Geol. Survey Rept., p. 295, figs. 223, 224.  
 1863. *Dosinia elegans* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 575.  
 1863. *Dosinia intermedia* Conrad, idem, p. 575.  
 1889. *Dosinia elegans* Conrad. Dall, U. S. Nat. Mus. Bull. 37, p. 56.  
 1903. *Dosinia (Dosinidia) elegans* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1231.  
 1906. *Dosinia elegans* Conrad? Böse, Inst. geol. México Bol. 22, p. 80, pl. 11, fig. 6.  
 1926. *Dosinia (Dosinidia) elegans* (Conrad). Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 62, pl. 18, figs. 3, 4, 8, 9; pl. 20, fig. 2.

This shell is nearly related to *A. concentrica* but is much larger and has the concentric lines more remote and deeply impressed.—Conrad, 1838.

Lentiform, regularly convex, with strongly marked, rather distant, impressed, concentric lines; on the posterior side these are closely arranged and profound, forming prominent recurved lines, which become acute or lamelliform toward the posterior

margin; posterior hinge margin elongated, slightly convex, oblique; lunule cordate, deeply impressed. Height  $2\frac{1}{2}$  inches, length  $2\frac{7}{8}$  inches.

Locality, Neuse River, below New Bern, N. C. Miocene.

This beautiful shell is allied to *A. concentrica* but is readily distinguished by its stronger, remoter stria, by its convexity of disk and its more robust anterior cardinal teeth; the posterior teeth are less oblique, forming a wider space between them and the anterior teeth. The posterior hinge margin is not so elongated, in proportion as in the *concentrica*.—Conrad, 1844.

The figured right valve, U. S. Nat. Mus. 497065 from the Caloosahatchee Pliocene at Shell Creek, DeSoto County, Fla., measures 61 millimeters in height and 68 millimeters in width.

*Dosinia elegans* Conrad resembles his *D. acetabulum* in the major features. It runs a little smaller than the latter, is somewhat more compressed and more uniformly rotund; the valves are thinner and less friable, the concentric sculpture is stronger and much more regular, and, though more elevated near the dorsal margins, it is always persistent and moderately prominent over the entire surface. The hinge is less heavy and rude than in *D. acetabulum*, and the teeth, though similar and similarly arranged, are more sharply cut. *D. discus* Reeve, of the post-Miocene faunas, is even smaller, thinner, and more compressed than *D. elegans*, and it has a finer, closer, less conspicuous concentric sculpture.

In all the young of this section the outline is more elevated, and the umbones are more prominent than in the adults.

*D. elegans* Conrad, though never so abundant, occupies in the Tertiary faunas south of the Hatteras axis a position analogous to that of *D. acetabulum* north of the axis.

Distribution: North Carolina: Miocene, Duplin marl, 4 miles north of Lumberton (on the land of Charles Rowland), Lumberton (near the bottling works), 2 miles below Lumberton, and 4 to 5 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

Outside distribution: Miocene, Santa Maria Tetetla, Vera Cruz, Mexico. Duplin marl, Sumter district, S. C. Pliocene, Waccamaw formation, Tillys Lake and Todds Ferry, Horry County, S. C. Caloosahatchee marl, half a mile above the Atlantic Coast Line Railroad bridge, Putnam County, Fla. Caloosahatchee River, Snell Creek, and Alligator Creek, Fla. Pleistocene, North Creek near Osprey, Manatee County, Fla.; Labelle, Hendry County, Fla.; Fort Lauderdale, Broward County, Fla.; Torch Key, Fla. Recent, Hatteras to Aspinwall in less than 50 fathoms.

#### Subfamily MERETRICINAE

#### Genus MACROCALLISTA Meek

1876. *Macrocallista* Meek, Rept. U. S. Geol. Survey of the Territories, vol. 9, p. 179.

Type by monotypy: *Venus gigantea* Gmelin=*Venus nimbose* Solander, Pliocene and Pleistocene of the Carolinas and Florida.



Recent from North Carolina to the Gulf of Mexico.

The group was isolated by Meek as a subgenus of *Callista*.

The solid shell, transversely ovate outline, and highly polished surface characterize the genus. The well-defined lunule, indistinct escutcheon, and distinct pallial sinus are group characters. The dental formula is similar to that of *Callocardia*. There are three cardinals in each valve—the anterior and middle cardinals short and not very heavy, the posterior cardinal laminar and produced. The anterior left lateral is slightly elongated and prominent and received in a deep double socket of the right valve. The Recent species has a periostracum and a radial color pattern similar to that common among the Tellinas.

The group is distinguished among the venerids by the sleek outline, the highly polished shell, the broad and broadly rounded sinus almost horizontally directed. *Callocardia* is more chalky, higher and more inflated, and has a less broad, obliquely directed sinus.

*Macrocallista* is known from the earliest Tertiary. It includes a considerable number of large and attractive Tertiary and Quaternary species, inhabitants chiefly of the warmer seas.

#### *Macrocallista reposta* (Conrad) Dall

Plate 19, figures 1-3, 5

1834. *Cytherea reposta* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 7, p. 132.  
 1834. *Cytherea pandata* Conrad?, idem, 1st ser., vol. 7, p. 132 (young shell).  
 1858. *Cytherea reposta* Emmons, North Carolina Geol. Survey Rept., p. 294, fig. 223a. Not *C. reposta* Emmons, 1858.  
 1863. *Dione reposta* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 575.  
 1903. *Macrocallista reposta* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1252.  
 1926. *Callista (Callista) reposta* (Conrad). Palmer, Palaeontographica Americana, vol. 1, no. 5, p. 82, pl. 13, figs. 5, 10.

Shell large, ovate, moderately thick, and convex; beaks prominent; dorsal margin depressed, slightly arcuated; posterior extremity obtusely rounded; lunule large, lanceolate, defined by a slightly impressed line; 2 anterior cardinal teeth united above; posterior cardinal tooth laminar, slightly prominent; anterior tooth thick, subpyramidal. Length 5 inches, height  $3\frac{3}{4}$  inches.

Locality, Suffolk, Va.—Conrad, 1834.

Dimensions of figured specimens: Right valve (U. S. Nat. Mus. 325577), height 42.5 millimeters, width 62.8 millimeters; left valve (U. S. Nat. Mus. 325575), height 50.0 millimeters, width  $85.0 \pm$  millimeters.

Locality of figured specimens: Right valve, 4 to 5 miles below Lumberton, Robeson County, N. C.; left valve, 2 miles below Lumberton, Robeson County, N. C. Duplin marl.

*Macrocallista reposta* (Conrad) is intermediate in its characters between *M. albaria* (Say) and *M. nimbosa* (Solander). It is relatively lower than the

former and higher than the latter; the umbones are between a quarter and a third of the length behind the anterior margin; the posterior dorsal margin is less oblique than in *M. albaria* but never so nearly rectilinear as in *M. nimbosa* (Solander); the ligamentary nymph is between a third and half the length of the dorsal margin; the hinge armature is less rude than that of *M. albaria*, and less sharp than that of *M. nimbosa*. The shell is never conspicuously thickened within, though it is rarely so delicate as in the Recent form. The distribution in time and space, as well as the shell characters of *M. reposta*, are intermediate. *M. albaria* is most closely identified with the Chesapeake Miocene faunas north of the Hatteras axis; *M. nimbosa*, with the Caloosahatchee and Recent faunas south of the Hatteras axis; *M. reposta*, with the Duplin fauna of southern North Carolina. The species is abundant only along the Lumber River in Robeson County.

A closely related form is cited by Mansfield, 1932, from the *Cancellaria* zone of the Choctawhatchee formation of Florida.

Distribution: Virginia: Miocene, Yorktown formation, Suffolk, Nansemond County (Conrad).

North Carolina: Miocene, Yorktown formation, Colerain Landing (?) and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhouse Point (?), Bertie County. The young forms obtained at these two Yorktown localities are probably, though not certainly, referable to *Macrocallista reposta*. Duplin marl,  $2\frac{1}{2}$  miles south of Clinton and 4 miles south of Clinton, Sampson County; Natural Well,  $1\frac{1}{2}$  miles north of Magnolia, and the marl pits of Frank Wilson and W. H. Kornegay, Duplin County; 4 miles north of Lumberton, 2 miles below Lumberton, 4 to 5 miles below Lumberton, and  $1\frac{1}{2}$  miles northeast of Fairmont (on the land of Andrew Jones). Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek) and Walkers Bluff (on the Cape Fear River), Bladen County; Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington, New Hanover County.

#### Subgenus *COSTACALLISTA* Palmer

1926. *Costacallista* Palmer, Palaeontographica Americana, vol. 1, No. 5, pp. 73, 84.

Type by original designation: *Venus erycina* Linnaeus. Recent in the Indo-Pacific.

The subgenus is characterized by strong, flat, concentric ribbing. The outline of the shell is higher in proportion to its width than that of most of the *Macrocallistas*.

#### *Macrocallista (Costacallista) emmonsi* Gardner, n. sp.

Plate 19, figures 6, 9

Shell rather heavy, of moderate size and moderately compressed, transversely ovate in outline. Umbones rather low, not very conspicuous, prosogyrate, placed within the anterior third. Lunule narrow, lanceolate, outlined by an impressed line. Escutcheon suggested but not defined by the evanescence of the sculpture to-



ward the posterior margin. Anterior lateral margin broadly rounded. Posterior lateral margin rounded above into the gently convex dorsal margin and below into the ventral. Base arcuate. Surface sculptured with 35 to 40 deep concentric furrows, linear in the umbonal region, much wider toward the ventral margin. Ligament marginal, opisthodetic, lodged in a moderately deep groove, extending almost halfway down the dorsal slope. Hinge plate heavy; hinge of only right valve known. Cardinal teeth 3 in number—the anterior and middle cardinals moderately heavy, simple, cuneate, convergent beneath the tips of the umbones; posterior cardinal laminar, much elongated; anterior lateral short, conical, not far removed from the umbones. Adductor scars quite large and distinct, the anterior placed a little higher than the posterior. Pallial sinus very broad, obtuse, only slightly ascending, produced almost to the median vertical. Inner margins smooth.

Dimensions of holotype: Height 43.0 millimeters, width 56.5 millimeters, convexity 12.5 millimeters.

Holotype: U. S. Nat. Mus. 107834.

Type locality: Natural Well (?), Duplin County, N. C.

A single valve of this large and conspicuous species was found among Emmons' duplicates. As nothing of the kind has been reported from any of the other numerous collections made from the Duplin County marls, Dall suggested that it might be a European shell that was, through some error, passing for an east coast Tertiary fossil. Curiously enough, 2 immature left valves have been found in the Yorktown materials, and, though quite young, they are apparently identical with the form in Emmons' collection. Further evidence of the American origin of the valve in question is offered by the character of the iron stains and of the matrix still clinging to the shell.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County (young shells).

North Carolina: Miocene, Duplin marl, Natural Well(?), Duplin County.

#### Genus CALLOCARDIA A. Adams

1864. *Callocardia* A. Adams, Annals and Mag. Nat. History, 3d ser., vol. 13, p. 307.

Type by monotypy: *Callocardia guttata* A. Adams. Recent in the China Sea.

Shell ovate to subtriangular. Umbones anterior, involute. Lunule circumscribed by a faintly incised line. Escutcheon not delimited. Ligament external, lodged in a deep groove. Nymphs prominent. Exterior sculpture concentric. Three rather discrepant cardinals in each valve, commonly bifid or cuspid. Two lateral lamellae in right valve, which receive between them the anterior lateral tooth of the left valve. Pallial sinus varying widely within the limits of

the genus; angular and sharply defined to almost obsolete. Inner margins of valves entire.

The group is first recognized in the Eocene, since when it has formed a fairly conspicuous and widely distributed factor in the molluscan faunas of the warmer seas.

#### Subgenus AGRIOPOMA Dall

1902. *Agriopoma* Dall, U. S. Nat. Mus. Proc., vol. 24, p. 509.

Type by monotypy: *Cytherea texasiana* Dall. Recent in the Gulf of Mexico.

The subgenus as separated by Dall is characterized by the heavy chalky shell, the less involute umbones, and especially by the deep and angular pallial sinus.

#### *Callocardia (Agriopoma) sayana* (Conrad) Dall

Plate 19, figure 33

1824. *Cytherea convexa* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 149, pl. 12, fig. 3. Not *C. convexa* Brongniart, 1822.

1833. *Cytherea sayana* Conrad, Am. Jour. Sci., 1st ser., vol. 23, p. 345.

1838. *Cytherea sayana* Conrad, Fossils of the medial Tertiary of the United States, p. 13, pl. 7, fig. 3.

1852. *Venus sayana* Conrad, D'Orbigny, Prodrôme paléontologie, vol. 3, p. 108, No. 2011.

1854. *Meretrix sayana* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 7, p. 30.

1856. *Venus sayana* D'Orbigny. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 83, pl. 21, fig. 9.

1858. *Cytherea* (misprint for *Cytherea*) *sayana* Emmons, North Carolina Geol. Survey Rept., p. 294, fig. 221.

1863. *Dione sayana* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 575.

1869. *Caryatis plionema* Conrad, Am. Jour. Conchology, vol. 4, p. 278, pl. 20, fig. 3.

1873. *Callista convexa* Say. Tryon, American marine conchology, p. 161.

1894. *Dione sayana* Conrad. Whitfield, U. S. Geol. Survey Mon. 24, p. 75, pl. 12, fig. 1.

1903. *Callocardia (Agriopoma) sayana* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1261, pl. 54, fig. 16.

1904. *Callocardia (Agriopoma) sayana* (Conrad). Glenn, Maryland Geol. Survey, Miocene, p. 313, pl. 73, figs. 13, 14.

1926. *Pitaria (Pitaria) sayana* (Conrad). Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 20, pl. 4, figs. 2, 5, 12, 14, 15, 18; pl. 5, figs. 11, 15, 19, 27, 28.

Shell subcordate; elevated convex, concentrically wrinkled, inequilateral; posterior tooth and fosset not striated; edge not crenated; umbo rather prominent; lunule dilated, cordate, marked by a simple line.

Length  $1\frac{1}{8}$  inch[es], breadth more than  $1\frac{1}{8}$  inch[es].—Say, 1824.

Type locality: Maryland.

Shell porcellaneous, thin in the young, moderately heavy in adults, massive in the senile forms. Outline subtrigonal to ovate, inequilateral, strongly inflated in the umbonal region. Umbones gibbose, rather prominent, incurved, strongly prosogyrate, placed about two-thirds of the way over toward the anterior margin. Lunule cordate, defined by an incised line. Escutcheon

absent. In the young, anterior end oblique in the lunular region; in the adult, somewhat produced and convex in front of the lunule; in senile individuals, inclined toward a uniformly steep slope from the umbones to the ventral margin. Posterior dorsal and lateral margins not differentiated, gently arcuate from the umbones to the base. Ventral margin much more strongly arched in the young than in the adult. Surface concentrically wrinkled with fine, close, discontinuous striae. Ligament marginal, opisthodontic; nymph sublinear, extending a little more than a third of the way to the base; groove behind it deep. Hinge plate heavy. Three cardinals developed in each valve. In the right valve the anterior and posterior cardinals are united beneath the tips of the beaks—the former simple and laminar, the latter obliquely produced and longitudinally sulcated—and the middle cardinal is an isolated denticle within the  $\Lambda$  formed by the union of the two distal teeth. Pit for reception of anterior lateral of left valve deep. Anterior and middle cardinals of left valve united to form a  $\Lambda$ -shaped tooth, the anterior arm being the thinner and more laminar; posterior cardinal slender, obliquely produced; anterior lateral strong, subconical. Adductor muscle impressions subequal, roughly semielliptical. Pallial line distinct, sinus short, moderately broad, both the dorsal and ventral margins usually ascending rather steeply.

Dimensions of figured specimen: Height 40.0 millimeters, width 45.0 millimeters.

Figured specimen: U. S. Nat. Mus. 143732.

Locality of figured specimen: Choptank River, a quarter to half a mile below Barkers Landing, Talbot County, Md. Choptank formation.

*Callocardia sayana* exhibits the amount of mutation to be expected of a widely distributed species, but the confusion in the literature and collections is due to differences in age characters rather than in latitude. The species, though strongly inflated in the umbonal region, is distinctly flattened toward the ventral margin so that in the young the shell is relatively more convex and rotund than in the adult, the umbones are relatively higher and more prominent, and the base is more strongly arcuate. *Caryatis plionema* Conrad is described from a senile individual. Many forms determined as *Callocardia subnasuta* (Conrad) are young *sayana* in which the anterior margin is more produced than in the adults. They are not, however, rostrate as in the true *C. subnasuta*, and the valves are less elongated transversely and the umbones higher and more inflated. The young of the species have also been confused in both the reference collections and the check lists with the Recent *Callocardia morrhuana* (Linsley), a relatively lower, less trigonal species most readily separable from *C. sayana* by the deeper pallial sinus in which the dorsal margin is approximately horizontal rather than obliquely ascending. The outline of the shell is not

established in the young forms, and even the sinus varies within narrow limits. Linsley's species is certainly not present in the adult state in the material at hand or in any of the available reference collections. The only young *Callocardia* not readily reconcilable with *C. sayana* (Conrad) is a single half-grown rotund valve from the Yorktown formation, 1 mile east of Lizzie, in Greene County, N. C. It is probable, however, that this is the young of an undescribed form or of *C. castoriana* rather than of *C. morrhuana* (Linsley).

Distribution: Virginia: Miocene, St. Marys formation, 1 to 2 miles below Bowers Wharf,  $\frac{1}{4}$  mile below Jones Point, Essex County. Yorktown formation, 3 miles northeast of Walkerton, King and Queen County. Yorktown and Bellefield, York County; Petersburg, Dinwiddie County; 5 miles northeast of Smithfield, 2 miles northwest of Smithfield,  $1\frac{1}{2}$  miles west of Smithfield, Zuni (near the pumping station), Isle of Wight County;  $\frac{1}{4}$  mile north of Chuckatuck,  $\frac{1}{4}$  mile east of Everets Post Office,  $5\frac{1}{2}$  miles northwest of Suffolk,  $2\frac{1}{2}$  miles northwest of Suffolk, 1 mile west of Suffolk,  $1\frac{1}{2}$  miles north of Suffolk,  $1\frac{1}{4}$  miles north of Suffolk,  $1\frac{1}{2}$  miles east of Suffolk, 1 mile northeast of Suffolk, and  $\frac{1}{2}$  mile below the Suffolk waterworks dam, Nansemond County. The species is exceedingly abundant in the environs of Suffolk.

North Carolina: Miocene, Yorktown formation, Halifax (on Quankey Creek, just below the county bridge) and Palmyra Bluff, Roanoke River, Halifax County;  $2\frac{1}{2}$  miles northwest of Williamston (on Joseph Cherry's farm) and 3 miles west of Williamston, Martin County;  $15\frac{1}{2}$  miles above Bells Bridge,  $\frac{1}{2}$  mile above Bells Bridge, Tar River, and Shiloh Mills, Edgecombe County; 2 miles southeast of Tugwell (on Jacobs Branch),  $2\frac{1}{2}$  miles north of Standard, 3 miles southwest of Frog Level (on J. A. Noble's branch), 8 to 9 miles west of Greenville (on the east side of Pinelog Branch), 2 miles west of Greenville,  $1\frac{1}{2}$  miles west of Greenville (on Schoolhouse Branch),  $6\frac{3}{4}$  miles below Greenville (at Tafts Landing), 8 to 9 miles southeast of Greenville,  $1\frac{1}{2}$  miles west of Galloway Crossroads, Hardees Creek ( $3\frac{1}{2}$  miles from its confluence with the Tar River), 1 mile northwest of Galloway Crossroads,  $\frac{3}{4}$  mile north of Grimesland, Pitt County;  $2\frac{1}{2}$  miles northwest of Chocowinity, Beaufort County; 1 mile west of Wilson (at Hominy Swamp, on the land of Frank Barnes), Wilson County;  $\frac{1}{2}$  mile east of Lizzie (on the land of David Summeril), Greene County; Tar Ferry,  $1\frac{1}{2}$  miles below Tar Ferry, Wiccacon Creek (opposite Harrellsville), and Mount Pleasant Landing, Hertford County; Colerain Landing and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhouse Point, Bertie County. Duplin marl, 2 miles below Lumberton, Fairmont (Ashpole), and  $1\frac{1}{2}$  miles northeast of Fairmont (on the property of Andrew Jones), Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek) and Walkers Bluff (on the Cape Fear River), Bladen County; Neills Eddy Landing (3 miles north of Cronly), Columbus County; and Wilmington, New Hanover County.

Outside distribution: Miocene, Calvert formation, Atlantic City (well bore), N. J. Choptank formation, Peach Blossom Creek, and Choptank River, one-fourth to one-half mile below Barkers Landing, Talbot County, Md.; Jones Wharf, Patuxent River, St. Marys County, Md. St. Marys formation, Cove Point, Calvert County, Md.; St. Marys River, St. Marys County, Md. Duplin marl, Darlington, Darlington County, S. C. Pliocene, Waccamaw formation. Nixons and Tillys Lake, Horry County, S. C. Caloosahatchee marl. Kissimmee well (at a depth of 150 feet), Osceola County, Fla.; Caloosahatchee River and Alligator Creek, Fla. Croatan sand, Slocums Creek, Craven County,

N. C. Pleistocene, Wailes Bluff near Cornfield Harbor, St. Marys County, Md. (Dall); Orient, Hillsborough County, Fla.; Kissimmee well (at a depth of 96 feet), Osceola County, Fla.; Labelle, Hendry County, Fla.

***Callocardia (Agriopoma) castoriana* Gardner, n. sp.**

Plate 19, figures 28, 29

Shell rather large for the genus, moderately inflated, transversely oblong to subquadrate, inequilateral. Umbones not prominent, anterior, between two-thirds and three-fourths of the distance over toward the anterior margin; tips incurved, prosogyrate. Lunule rather narrow, much elongated, about three-fourths the length of the anterior end. Escutcheon absent; posterior submargin obscurely carinated. Anterior slope very steep, uniform, the dorsal and lateral margins not differentiated; posterior dorsal margin gently arcuate, lateral margin squarely truncate. Base line straight medially, strongly upcurved distally. Surface sculptured with crowded, discontinuous, concentric wrinkles. Ligament external, opisthodetic; nymph about half as long as the dorsal margin, slender, sickle-shaped, limited on the outer margin by a deep groove. Hinge plate wide and heavy. Three discrete cardinals in the right valve, the anterior cardinal thin and laminar, the posterior one heavy, longitudinally sulcate, the middle one a simple ridge with a flattened anterior surface, a little ventral to the other two cardinals; pit for reception of lateral of left valve small but profound; armature of left valve not definitely known. Adductor impressions subequal, semielliptical, submedial in position. Sinus short, broad, pointed in front, its dorsal margin approximately horizontal.

Dimensions of holotype: Height 39.0 millimeters, width 49.0 millimeters, convexity 14.2 millimeters.

Holotype, a right valve: U. S. Nat. Mus. 325563.

Type locality: 1 mile north of Castoria, Greene County, N. C. Yorktown formation.

The species is more regularly oblong or quadrate than any of the closely related forms. The young of *C. morrhuana* (Linsley) sometimes approach it closely in outline, though the adults are constantly more trigonal. Both Linsley's species and the *C. sayana* of Conrad have a cordate rather than a lanceolate lunule and both have the umbonal ends of the anterior and posterior right cardinals united to form a rather distinct **U**; in *C. castoriana* they are discrete. The hinge plate of the new species is more strongly angulated and wider anteriorly, and the space between the margin of the anterior lateral pit and the margin of the hinge plate is broader and flatter than in any of the coexistent species. The sinus is similar to that of *C. morrhuana*, probably its nearest of kin.

It is always unsatisfactory to describe a new species of a variable genus from a single valve, but in this case the diagnostic characters are so distinctive that

the danger of its later proving to be identical with an earlier species seems negligible. The single right valve was collected by Dr. Harvey Bassler from the vicinity of Castoria, in Greene County.

Distribution: North Carolina: Miocene, Yorktown formation, 1 mile north of Castoria, Greene County.

***Callocardia (Agriopoma) chioneformis* Gardner, n. sp.**

Plate 19, figures 7, 8

Shell heavy, moderately inflated. Outline chioneform, trigonal, inequilateral, a shallow depression in front of the obscure posterior carina. Umbones not very prominent, their tips flattened, rather strongly incurved and prosogyrate. Lunule wide, cordate, defined by an incised line. Escutcheon absent. Anterior end oblique in the lunular area, bowed outward in front of the lunule; posterior end a gentle and uniform arch from the umbones to the basal margin. Base line straight posteriorly or slightly sinuated by the posterior fold, strongly upcurved anteriorly. Surface closely and strongly wrinkled concentrically. Ligament external, nymph elongated, sublinear, narrower than the groove behind it. Hinge armature complex. Three cardinals in the right valve, the anterior and posterior uniting to form an open **U**, the anterior simple and laminar, the posterior obliquely elongated, slender, and sulcate longitudinally; the middle cardinal isolated, flattened on its anterior surface; pit for reception of lateral of left valve deep. Anterior and middle cardinals of left valve united beneath the tips of the umbones to form a **A**, the anterior arm the more laminar; posterior cardinal oblique, very slender and longitudinally sulcate; anterior lateral subconical, prominent. Adductor impressions rather small, subequal, the anterior somewhat more elongated, median in position, broadly lenticular and placed not far from the ventral margin. Pallial line rather near the base. Sinus broad, obtusely pointed in front, gently ascending, but falling short of both the median horizontal and the vertical.

Dimensions of holotype, a left valve: Height 26.5 millimeters, width 31.0 millimeters, convexity 9.4 millimeters.

Dimensions of paratype, a right valve: Height 17.5 millimeters, width 20.5 millimeters, convexity 6.2 millimeters.

Holotype and paratype, U. S. Nat. Mus. 325564.

Locality for both holotype and paratype: Wilmington, N. C. Waccamaw formation.

Three valves of this well-characterized species were collected by Dr. T. W. Stanton at Wilmington. It stands apart from all the coexistent *Callocardia* by reason of its chionelike outline and the posterior depression which, though shallow, persists from the umbones to the base. The lunule is wider and less elongated than that of *C. sayana* (Conrad), and the

concentric wrinkling of the external surface somewhat stronger.

Distribution: North Carolina: Pliocene, Waccamaw formation, Wilmington, New Hanover County.

#### Subfamily VENERINAE

#### Genus CHIONE Von Mühlfeld

1811. *Chione* Megerle von Mühlfeld, Entwurf eines neuen System der Schalthiergehatise, Magazin der Gesellschaft naturforschender Freunde zu Berlin, 5ter Jahrg., p. 51.

Type by subsequent designation (Gray, Zool. Soc. London Proc., pt. 15, p. 183, 1847): *Venus dysera* Chemnitz=*Venus cancellata* Linnaeus. Recent from North Carolina to Brazil.

*Chione* includes the solid trigonal venerids of medium size and convexity characterized most obviously by strong, often crude, concentric ribs or lamellae, with or without free upturned margins. A radial sculpture is indicated in the flutting of the free edges of the concentric lamellae and in a radial grooving, in some groups restricted to the ventral surfaces of the concentric ribs or, in some concentrically laminated groups, cancellating the disk. The lunule and escutcheon are sharply set off by both the sculpture and the contour of the shell. The ligament is marginal and deeply inset behind the beaks. There are three cardinals radiating fanlike in each valve, the medial and posterior cardinals in many groups grooved or bifid. True laterals are not developed. The muscle scars and the pallial line are distinct; the sinus is shallow and trigonal. The inner anterior and ventral margins are strongly crenate.

True *Chione* has not been certainly recognized in the southeastern United States below the Chickasawhay formation. Since the time of that formation *Chione* rapidly increased in prominence, and in the upper lower and in the middle Miocene of the mid-Americas it was ubiquitous and exceedingly abundant.

#### Subgenus CHIONE s. s.

Type by subsequent designation (Gray, Zool. Soc. London, Proc., pt. 15, p. 183, 1847): *Venus dysera* Chemnitz=*Venus cancellata* Linnaeus. Recent from North Carolina to Brazil.

*Chione* (*Chione*) is characterized by a sculpture of regularly spaced, free-edged, concentric lamellae superimposed upon a radially lirated surface. The lamellae are commonly frilled in harmony with the radial lirations, and the inner margins of the valves are crenate.

#### *Chione* (*Chione*) *cortinaria* (Rogers and Rogers) Dall

Plate 19, figure 4

1837. *Venus cortinaria* W. B. and H. D. Rogers, Am. Philos. Soc. Trans., new ser., vol. 5, p. 333.

1838. *Venus cortinaria* Rogers. Conrad, Fossils of the medial Tertiary of the United States, p. 11, pl. 8, fig. 1.

1839. *Venus cortinaria* W. B. Rogers and H. D. Rogers, Am. Philos. Soc. Trans., new ser., vol. 6, pl. 26, fig. 7.

1863. *Dione* (*Chamelea*) *cortinaria* Rogers. Conrad, Acad. Nat. Sci. Philadelphia for 1862, p. 575.

1903. *Chione cortinaria* Rogers. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1292.

1926. *Chione* (*Chione*) *cortinaria* (Rogers). Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 142, pl. 38, figs. 4, 11, 13; pl. 40, figs. 8, 37.

1932. *Chione* (*Chione*) *cortinaria* (Rogers). Mansfield, Florida Geol. Survey Bull. 8, p. 125, pl. 23, fig. 8.

Shell subcordate, inflated, with very regular, concentric, closely approximate, and very prominent imbricated ridges, which incline toward the beak, except the portion opposite the anterior, basal, and posterior margins, where they decline outward toward the margin; beaks moderately prominent, about twice as far from the anterior as the posterior end; two anterior cardinal teeth, closely approximate above, second one of the left valve thick and subbifid; lunule wide, cordate; basal margin crenate within; posterior margin short, straight, and especially at the lunule finely crenate. Length 1 inch, height 0.9 inch.

Locality, Williamsburg. Miocene. This beautiful shell rarely shows the concentric ridges perfect, from their prominence and thinness.—W. B. and H. D. Rogers, 1837.

Dimensions of figured specimen, a left valve (U. S. Nat. Mus. 146126) from the Yorktown formation at Grove Wharf, James River, Va.: Height 23.5 millimeters, width 26.5 millimeters.

Three discrete, divergent cardinals in each valve; the anterior cardinal of the right valve simple and laminar; the medial cardinal short, rather slender and feebly bifid; the posterior cardinal elongated parallel to the dorsal margin and longitudinally sulcated. The anterior cardinal of the left valve is simple and laminar; the central cardinal stout and bifid; the posterior cardinal laminar and elongated parallel to the dorsal margin.

*Chione cortinaria* has been confused with *C. cribraria* (Conrad), though the two species are distinct when seen together. *C. cribraria* is the heavier, more convex shell; the concentric lamellae in *C. cribraria* seldom exceed 30, whereas in *C. cortinaria* they usually number between 40 and 45; the lamellae of *C. cortinaria* are lower, the flutings less conspicuous and abruptly evanescent near the free edge, and ordinarily they are so closely appressed dorsally that the interlamellar spaces are not visible as in *C. cribraria*; as might be surmised, the dentition of the inner margins of *C. cribraria* is more coarse and obvious than in the more finely laminated *cortinaria*.

*Chione cortinaria* (Rogers and Rogers) seems to have a limited distribution, though its near relative is both widespread and abundant.

Mansfield regarded *cortinaria* as one of the diagnostic fossils of zone 1 of the Yorktown formation and as a precursal form of *cribraria*. He reports *cortinaria* from Florida, in the *Ecphora* zone of the Choctawhatchee formation.

Distribution: Virginia: Miocene, Yorktown formation, Grove Wharf on the James River, Surry County; Williamsburg, James City County (Rogers and Rogers).

Outside distribution: Miocene, Choctawhatchee formation, Jackson Bluff (southeast of Tallahassee), Leon County, Fla.

### *Chione (Chione) cribraria* (Conrad) Dall

1843. *Venus cribraria* Conrad, Acad. Nat. Sci. Philadelphia Proc., vol. 1, p. 310.  
 1845. *Venus cribraria* Conrad, Fossils of the medial Tertiary of the United States, p. 67, pl. 38, fig. 2.  
 1858. *Venus cribraria*[a] Conrad. Emmons, North Carolina Geol. Survey Rept., p. 293, fig. 218.  
 1863. *Dione (Chamelea) cribraria* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 575.  
 1903. *Chione cribraria* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1292.  
 1926. *Chione (Chione) cribraria* (Conrad). Palmer, Palaeontographica Americana, vol. 1, no. 5, p. 142, pl. 38, figs. 1, 8, 9; pl. 39, figs. 3, 24.

Subtrigonal, slightly ventricose, with about 25 concentric elevated recurved lamelliform ribs, on the inferior side of which are elevated transverse lines; lunule cordate, laminated, suture profound; inner margin profoundly creunulated. Length  $1\frac{1}{4}$  inch[es], height  $1\frac{1}{8}$  [inches] nearly.

Locality: Wilmington, N. C.; Neuse River below New Bern, N. C.—Conrad, 1843.

Shell rather large, heavy, and convex for the genus. Outline subtrigonal, inequilateral. Umbones moderately prominent, prosogyrate, about twice as far from the posterior as from the anterior end. Lunule short, cordate, defined by a deeply incised line which dissects the concentric lamellae. Escutcheon indicated by the abrupt cessation of the concentric sculpture. Anterior end bowed outward in front of the lunule. Posterior dorsal margin oblique or slightly gibbous; posterior lateral margin obscurely truncate. Base line strongly upturned anteriorly. Concentric lamellae on external surface 25 to 30 or even more in unusually large forms, elevated, rising 1 to  $1\frac{1}{2}$  millimeters above the surface of the valve and approximately at right angles to it except near the escutcheon, where they flare rather widely and are often slightly inclined toward the base; transverse flutings strong, sometimes evanescent just at the free margin, altogether absent on the lunular lamellae. Ligament inset; nymph linear. Hinge plate sinuous ventrally. Three divergent cardinals in each valve; the anterior and central cardinals of the right valve slender, simple, proximate; the posterior cardinal longitudinally sulcate, obliquely elongated parallel to the dorsal margin. Anterior cardinal of left valve simple, slender, and laminar, the middle cardinal stout and bifid, the posterior laminar, parallel to the dorsal margin. Adductor impressions obscure, subequal, the posterior slightly more rotund. Pallial sinus short, linguiform, the dorsal margin almost horizontal. Inner margins crenate.

*Chione cribraria* (Conrad) is heavier than *C. cortinaria*, and the crenulations of the inner margins of the valves are coarser and deeper; the concentric lamellae of the former are fewer and consequently less crowded; they are more strongly fluted transversely

and their free edges much less strongly recurved and less dorsally appressed. Unlike the slightly earlier *C. cortinaria*, *C. cribraria* is a widely distributed, abundantly represented species at many localities in the east coast Tertiary deposits.

Distribution: Virginia: Miocene, Yorktown formation 12 to 14 miles below Zuni, Isle of Wight County;  $\frac{1}{4}$  mile north of Chuckatuck, Nansemond County.

North Carolina: Miocene, Yorktown formation, Wilson, Wilson County; Colerain Landing and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhouse Point, Bertie County; Rock Landing, Craven County. Duplin marl, Natural Well,  $1\frac{1}{2}$  miles north of Magnolia, and the marl pits of Frank Wilson and W. H. Kornegay, Duplin County; 2 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Lake Waccamaw, Cronly ( $\frac{1}{2}$  mile east of the factories), and Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington, New Hanover County.

Outside distribution: Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C.

### Section *TIMOCLEA* Brown

1827. *Timoclea* Thomas Brown, Illustrations of the conchology of Great Britain and Ireland, pl. 19, fig. 11.

Type by monotypy: *Venus ovata* Pennant. Recent along the western shores of Europe from Scandinavia southward and in the Mediterranean.

The section is characterized by relatively strong radial and relatively weak concentric sculpture.

### *Chione (Chione) grus* (Holmes) Dall

Plate 19, figures 12, 13, 20, 21

1854. *Venus parva* G. B. Sowerby, Thesaurus conchyliorum, pt. 14, p. 787, pl. 168, figs. 227, 228. Not *V. parva* James Sowerby, 1829.  
 1858. *Tapes grus* Holmes, Post-Pliocene fossils of South Carolina, p. 37, pl. 7, fig. 5.  
 1860. *Venus trapezoidalis* Kurtz, Catalogue of Recent marine shells of North and South Carolina, p. 5.  
 1867. *Chione parva* G. B. Sowerby. Römer, Malakozool. Blätter, vol. 14, p. 60.  
 1889. *Venus pygmaea* Lamarck (part). Dall, U. S. Nat. Mus. Bull. 37, p. 54.  
 1903. *Chione (Timoclea) grus* Holmes. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1299.  
 1926. *Chione (Chione) grus* (Holmes). Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 156, pl. 40, figs. 13, 18, 21.  
 1932. *Chione (Timoclea) grus* (Holmes). Mansfield, Florida Geol. Survey Bull. 8, p. 131, pl. 26, fig. 2.

Shell small, convex, transversely oblong, subrhomboidal, inequilateral, with 25 or 26 ribs; ribs radiating and interrupted by distinct overlapping zones of increase, which give the shell a laminated, or squamose appearance; umbones anterior; dorsal margin thick, rectilinear, or very slightly curved, without ribs, squamose; posterior margin subtruncated, anterior margin shorter, regularly rounded; pallial margin crenated; pallial sinus deep; muscular impressions large.—Holmes, 1858.

Type locality: Simmons Bluff. Pleistocene.

Dimensions of figured specimens, a right and a left valve, U. S. Nat. Mus. 325565, from the Waccamaw

formation at Neills Eddy Landing on the Cape Fear River, N. C.: Right valve, height 6.8 millimeters, width 9.5 millimeters, convexity 2.6 meters. Left valve, height 5.0 millimeters, width 7.5 millimeters, convexity 2.2 millimeters.

The species varies in relative proportions and the outline may be rhomboidal, trapezoidal, or transversely oblong. The lunule is short, cordate, clearly defined and sculptured with microscopic radials; the escutcheon is smooth or laminated by the concentric sculpture. The number of riblets usually exceeds 26 and those on the anterior half of the shell are medially bifurcated. The relative prominence of the concentric sculpture is a variable factor. The overlapping laminae number about 30 in a normal individual and are strongest on the posterior slope, where the edges are usually free and minutely ruffled on overriding the radials. The nymph is short and not very prominent; the dentition normal, concentrated; 3 simple, discrete cardinals are arranged fanlike under the umbo of each valve.

This small reticulate species has a meager representation in the Yorktown and Duplin formations but, in the Waccamaw formation particularly at Neills Eddy Landing, it is abundant.

Mansfield reports the species from a number of localities in his *Cancellaria* zone at the top of the Choctawhatchee formation in Florida. Olsson, 1922, reports a varietal form from the Gatun stage in Costa Rica. It is common in the Floridian Pliocene and occurs in the Recent shallow-water faunas from North Carolina to Yucatan.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, and ½ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, Rock Landing, Neuse River, Craven County. Duplin marl, Natural Well and 1½ miles north of Magnolia, Duplin County; 2 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Choctawhatchee formation, Jackson Bluff, Ochlockonee River, Leon County, Fla. Pliocene, Waccamaw formation, Tillys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla. Pleistocene, Simmons Bluff, S. C.; Kissimmee well (at a depth of 96 feet), Osceola County, Fla.; Eau Gallie, Brevard County, Fla.; 1 mile southwest of Daytona, Volusia County, Fla. Recent, Hatteras to Yucatan in 12 to 63 fathoms.

#### Section CHAMELEA Mörch

1853. *Chamelea* Mörch, *Catalogus conchyliorum, quae reliquit D. Alphonso d'Aguirra & Gadea Comes de Yoldi*, fasc. 2, p. 23.

Type by subsequent designation (Bucquoy, Dautzenberg, and Dollfus, *Mollusques marins du Roussillon*, vol. 2, p. 355, 1893): *Venus gallina* Linnaeus. Recent in the Mediterranean.

*Chamelea* is characterized by the narrow, close, concentric lamellae and the absence of radial sculpture. The cardinals are entire.

#### *Chione* (*Chamelea*) *dalli* Olsson

Plate 19, figures 10, 11

1914. *Chione dalli* Olsson, *Bull. Am. Paleontology*, vol. 5, No. 24, p. 19, pl. 3, figs. 7-9.

1926. *Chione* (*Chione*) *dalli* Olsson. Palmer, *Paleontographica Americana*, vol. 1, No. 5, p. 162, pl. 41, figs. 1, 2, 6.

Shell ovate to triangular, slightly convex, very solid; beaks prominent, approximate, subacute; lunule lanceolate, defined by an impressed line, smooth or with lines of growth; escutcheon long and narrow, smooth; surface of shell with thick, flattened, concentric lamellae, fairly regularly arranged on the umbo, later becoming irregular and coalescing toward the basal margin; no radial sculpture present; hinge fairly heavy, with 3 cardinal teeth in each valve; pallial sinus merely a small notch; margin minutely crenulated.

Type: Length 23, height 20, thickness 6 millimeters.

Larger shell: Length 25, height 21, thickness 6 millimeters.

On page 1290 Dall, in his Tertiary geology of Florida, volume 3, part 6, briefly describes without naming a *Chione* from Petersburg, Va., which appears to belong to this species. This species bears some resemblance to *C. cortinaria* Wagner [Rogers] but may be distinguished by its irregular concentric lamellae and the entire absence of the radial sculpture. At Claremont Wharf the species occurs in blue clays of the St. Marys formation, accompanied by several unusual species. *Arca virginiae* Wagner is very common here, and a small triangular *Glycymeris* like *Pectunculus virginiae* Wagner showing relationship with *G. subovata* Say, of which it is probably a mutation.

St. Marys formation; James River at Claremont Wharf, Va.—Olsson, 1914.

Shell rather small, heavy, rounded-trigonal, moderately compressed, inequilateral. Umbones low, placed near the anterior third, the apices acute and prosogyrate. Lunule rather small, smooth, narrow cordate, defined by a strongly incised line. Escutcheon moderately broad, sharply delimited by the angulation of the valve and the abrupt discontinuance of the concentric sculpture. Anterior end somewhat expanded in front of the lunule, rounding broadly and evenly into the base line. Posterior dorsal margin obliquely produced with a suggestion of gibbosity near the umbones. Posterior lateral margin obscurely truncate. Base line gently arched. Sculpture of many unequal irregular lamellae attached ventrally, and their dorsal margins somewhat fused with the surface or with each other posteriorly, usually free and overlapping anteriorly; no trace of radial sculpture discernible. Ligament external, inserted on a linear nymph. Hinge plate slightly sinuous. Right valve furnished with 3 discrete cardinals, the anterior cardinal simple and laminar, the middle cardinal moderately compressed, grooved longitudinally with a shallow sulcus; posterior cardinal slender, obliquely elongate, longitudinally sulcate. Cardinals of left valve also 3 in number, the anterior simple and slender, the middle cardinal cuneiform, the



posterior sublamina, slightly convex. Adductor muscle impressions clearly defined, submedial, the anterior roughly semielliptical, the posterior subrotund. Pedal muscle impression a small dent just dorsal to the anterior adductor and concealed by the hinge plate. Inner margins very finely crenate.

Dimensions of figured topotypes (U. S. Nat. Mus. 325529): Right valve, height 20.0 millimeters, width 22.3 millimeters, convexity 5.8 millimeters. Left valve, height 19.5 millimeters, width 21.0 millimeters, convexity 6.4 millimeters.

Type locality: Claremont Wharf, Surry County, Va.

*Chione dalli* is separated from *C. latilirata* (Conrad)—the only other species exhibiting low, dorsally appressed, concentric ribs—by the thinner shell, usually smaller size, and the much more numerous and less prominent costals; in Conrad's form, the ribs may number as few as 5 but never higher than 12; in *C. dalli* they may number as high as 25 and never fewer than 15, and they have, naturally, a concomitant difference in breadth and spacing.

Distribution: Virginia: Miocene, St. Marys formation, Claremont Wharf (lower bed) on the James River, Surry County.

#### Genus *VENUS* Linnaeus

1758. *Venus* Linnaeus, *Systema naturae*, 10th ed., p. 684.

Type by subsequent designation (Gray, Zool. Soc. London Proc., pt. 15, p. 183, 1847): *Venus verrucosa* Linnaeus. Recent along European shores from southern England to northern Africa and the Mediterranean.

*Venus* (*Venus*) is not represented in the Tertiary or Recent east coast faunas.

#### Subgenus *MERCENARIA* Schumacher

1817. *Mercenaria* Schumacher, *Essai d'un nouveau système des habitations des vers testacés*, p. 135.

Type by monotypy: *Venus violacea* Schumacher = *Venus mercenaria* Linnaeus. Gulf of St. Lawrence to Florida and the Gulf of Mexico.

#### *Venus* (*Mercenaria*) *mercenaria notata* Say

Plate 21, figure 10

1822. *Venus notata* Say, *Acad. Nat. Sci. Philadelphia Jour.*, 1st ser., vol. 2, p. 271.

1858. *Mercenaria notata* Say. Holmes, *Post-Pleocene fossils of South Carolina*, p. 34, pl. 6, fig. 13.

1870. *Venus notata* Say. Gould, *Invertebrata of Massachusetts*, p. 135, fig. 446.

1903. *Venus mercenaria* var. *notata* Say. Dall, *Wagner Free Inst. Sci. Trans.*, vol. 3, pt. 6, p. 1312.

1926. *Venus mercenaria notata* Say. Palmer, *Palaeontographica Americana*, vol. 1, No. 5, p. 186, pl. 32, fig. 5.

Shell obtusely rounded before, and with a slight undulation on the anterior margin; disk nearly destitute of the elevated concentric striae, which mark the borders of the shell, and distinguished by rufous zigzag transverse lines; within yellowish white.

Breadth about 3 inches.

Inhabits the coast of the United States.

Cabinet of the Academy and Philadelphia Museum, and Mr. Wm. Hyde's collection.—Say, 1822.

A Recent shell, U. S. Nat. Mus. 46867, from the east coast of Florida, has been figured. The height is 60.0 millimeters, the width 76.0 millimeters.

The shell is less heavy and oblique than in the subgenotype, *V. mercenaria* s. s., the posterior dorsal slope is less steep, and the posterior end is consequently broader. The zigzag color pattern is, however, the only sure diagnostic, and as this is rarely preserved in the fossil forms the subspecific determinations are exceedingly dubious.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Claremont Wharf (upper bed) on the James River, Surry County.

Outside distribution: Pleistocene, Simmons Bluff, S. C. Recent, Massachusetts to Georgia in less than 50 fathoms.

#### *Venus* (*Mercenaria*) *campechiensis rileyi* Conrad

1838. *Venus rileyi* Conrad, *Fossils of the medial Tertiary of the United States*, p. 9, pl. 6, fig. 1.

1856. *Venus rileyi* Conrad. Tuomey and Holmes, *Pleocene fossils of South Carolina*, p. 78, pl. 21, fig. 8.

1858. *Venus rileyi* Emmons, *North Carolina Geol. Survey Rept.*, p. 292.

1863. *Mercenaria rileyi* Conrad, *Acad. Nat. Sci. Philadelphia Proc. for 1862*, vol. 14, p. 574.

1903. *Venus tridacnoides* var. *rileyi* Conrad. Dall, *Wagner Free Inst. Sci. Trans.*, vol. 3, pt. 6, p. 1311.

1904. *Venus rileyi* Conrad. Glenn, *Maryland Geol. Survey, Miocene*, p. 304, pl. 76, figs. 4, 5.

1926. *Venus tridacnoides* (Lamarck) (part). Palmer, *Palaeontographica Americana*, vol. 1, No. 5, p. 191, pl. 33, figs. 1, 3.

1932. *Venus tridacnoides rileyi* Conrad. Mansfield, *Florida Geol. Survey Bull.* 8, p. 133, pl. 28, fig. 3.

Shell obliquely ovate, slightly ventricose, thick, very inequilateral; disks with small, crowded, reflected, concentric ribs; anterior side narrowed; umbo very oblique, prominent; posterior margin arcuate; inner margin deeply crenulated.

Locality, Yorktown, Va.

This shell has probably been confounded with *V. tridacnoides*, but it is much thinner, not undulate on the disk, and the cardinal teeth are much less robust. Its narrowed and compressed anterior side will distinguish it from the other fossil species, and its ribs from the recent *V. mercenaria*. Young shells are compressed or plano-convex. The disks are generally worn, showing the radiating striae common to all these large fossil species when the surface becomes decomposed. It is named in compliment to my scientific friend, Dr. William Riley, of Baltimore.—Conrad, 1838.

Shell only moderately heavy, transversely oval or ovate to subquadrate in outline. Umbones rather low and not very prominent, their tips acute and prosogyrate, situated as a rule within the anterior third. Lunule narrow, cordate, varying with the outline of the shell, delimited posteriorly by a sharply incised line which dissects the concentric lamellae; lunular sculpture similar to that of the disk. Escutcheon slightly narrower and more laminar in the right valve



than in the left valve, elongate-cuneate or scimitar-shaped; defined by both the angulation of the valve and the partial obsolescence of the surface sculpture, which, however, is manifested at least by vigorous incrementals. Anterior end bowed out in front of the lunule, rounding broadly and evenly into the base; posterior dorsal margin subrectilinear, oblique, or slightly gibbous. Posterior lateral margin broadly rounded, obtusely pointed or obscurely truncated. Base line approximately horizontal or gently arcuate. Sculpture of thin, sharp, concentric lamellae, erect or with a dorsal inclination, so crowded in perfect individuals that the surface of the shell is visible only near the umbones, uniform in strength from the lunule to the anterior margin of the escutcheon; concentric lamellae eroded in the great majority of individuals, revealing a pronounced subsurficial radial sculpture. Ligament powerful, opisthodontic, seated on a correspondingly heavy nymph. Dentition normal in pattern but heavy. Adductor muscle scars very large, deeply impressed. Pedal scar, a dent beneath the anterior cardinal. Pallial line distinct, the sinus short, acutely angular. Inner surface thickened over the area of the adherent mantel. Inner margins finely crenate.

*Venus (Mercenaria) campechiensis rileyi* is instant in sculpture, the outline of the lunule and escutcheon, and the outline and equipment of the hinge plate. These characters vary not only concomitantly but independently as well. The group in each formation, however, presents a similar general effect. This is most strikingly exemplified in the Waccamaw where it is so distinctive that, given an intergrading series of some twenty-odd forms with typical end members, one can place the group vertically, and often horizontally, with a fair degree of assurance.

The most serviceable characters in isolating the subspecies *rileyi* have proved to be the oval, ovate, or subquadrate outline, which is never conspicuously trigonal or circular; the moderately light shells; the rather compressed valves; and the low, anterior umbones.

In the Yorktown formation, from which Conrad's type was derived, the subspecies *rileyi* is relatively small and heavy and is ovate to subquadrate in outline. Along the Nansemond River, in the environs of Suffolk, a larger, lighter, often posteriorly produced form is very common. Measurements of valves typical of this locality are as follows: Height 107.0 millimeters, 86.5 millimeters; width 144.0 millimeters, 116.5 millimeters; convexity 28.5 millimeters, 27.0 millimeters. The subspecies *rileyi* is exceedingly abundant on the Chowan River, and pairs of valves with the crowded, concentric, lamellar sculpture perfectly preserved are far from rare. Dimensions of typical individuals are as follows: Height 67.0 millimeters, 68.5 millimeters; width

95.0 millimeters, 83.5 millimeters; convexity 24.0 millimeters, 24.5 millimeters.

The James River race as a whole, and particularly the Smithfield forms, are small, relatively thin, and ovate in outline, with the concentric lamellae usually eroded except toward the basal margin. Measurements of typical individuals from the James River are as follows: Height 65.0 millimeters, 60.0 millimeters; width 90.0 millimeters, 73.0 millimeters; convexity 22.0 millimeters, 18.0 millimeters. Along the Meherrin and Nottoway Rivers the subspecies is characteristically represented by large, notably thin, and elevated shells, often posteriorly produced and obtusely pointed. The dimensions of two perfect individuals are as follows: Height 91.0 millimeters, 93.0 millimeters; width 127.0 millimeters, 123.0 millimeters; diameter 53.0 millimeters, 51.5 millimeters. These dimensions suggest the Suffolk race, but the shells are larger and relatively higher, with a more oblique posterior dorsal margin and a lateral margin more often bluntly pointed rather than subtruncate. There is a tendency toward a similar, though less extreme development in the representatives from the Roanoke and Tar Rivers in Edgecombe County, although along the lower course of the Tar River in Pitt County, where the form is unusually abundant, the valves are, generally, smaller and relatively heavier, with a more persistent sculpture. In all the Yorktown localities in southern Virginia and north of the Hatteras axis in North Carolina the transition to the moderately large and moderately heavy, subtrigonal *V. campechiensis* s. s. is very easy and frequently accomplished. South of the Hatteras axis, however, the group assumes quite a different aspect. *V. campechiensis* is represented in the Waccamaw by the ponderous subspecies *carolinensis* Conrad, but even in the Duplin the representatives of the subspecies *rileyi* have taken on the peculiarities of the group, and the small, thin, transversely oval, peripheral forms exhibit the close, crowded, often dorsally inclined concentric lamellae, which is characteristic of their massive kindred, a significant fact in the consideration of the probable line of descent of *carolinensis*.

Mansfield records the species from the *Ecphora* zone of the Choctawhatchee formation.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; mouth of Baileys Creek, Prince George County; Lieutenant Run near Petersburg, Dinwiddie County; Grove Wharf and Schmidts Bluff (8½ miles below Claremont Wharf), Surry County; 1½ miles northeast of Smithfield, ¾ mile northeast of Smithfield, Fergusons Wharf, Benns Church, 1½ miles above Zuni, and 8 to 8½ miles below Zuni on the Blackwater River, Isle of Wight County; Hitchcock, Greenville County; Sycamore on the Nottoway River, ¼ to ½ mile below Sycamore, 3 to 4 miles above the lower Seaboard Railway bridge, ½ to ¾ mile above the lower Seaboard Railway bridge, and Maddelys Bluff on the Meherrin River, Southampton County; Exit, 5 miles northeast of Suffolk, 1½ miles northwest of Suffolk, 1½ miles north of Suffolk, 1½ miles northeast of

Suffolk, 1 mile northeast of Suffolk,  $\frac{1}{2}$  mile below the Suffolk waterworks dam, and the drainage ditch just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation,  $2\frac{1}{2}$  miles northwest of Murfreesboro (at Watsons Mill on Kirbys Creek), Tar Ferry on Wiccacon Creek (opposite Harrellsville),  $1\frac{1}{2}$  miles below Tar Ferry, 3 to 4 miles below Tar Ferry, and Dogwood Landing on the Chowan River, Hertford County; Cole-rain Landing, Mount Gould Landing, and  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhouse Point on the Chowan River, Bertie County; Halifax (on Mr. Durham's property),  $\frac{1}{2}$  mile above the Atlantic Coast Line Railroad bridge, and at Palmyra Bluff, Halifax County; Hamilton Bluff, 2 miles southeast of Hamilton Bluff, 4 miles northwest of Williamston, and  $2\frac{1}{2}$  miles northwest of Williamston (on Joseph Cherry's property), Martin County; 1 mile below Bells Bridge, Shiloh Mills, Tarboro (at L. E. Fountain's farm), and 1 mile below old Sparta Bridge over the Tar River, Edgecombe County; 2 miles below Toddy Station, 4 miles east of Farmville (on the east side of Pinelog Branch),  $2\frac{1}{4}$  miles north of Standard, 8 to 9 miles west of Greenville, 2 miles west of Greenville,  $1\frac{1}{2}$  miles west of Greenville (on Schoolhouse Branch), Pitt County; Greenville (just east of the county bridge), 6 miles below Greenville,  $6\frac{1}{4}$  miles below Greenville (at Tafts Landing), 9 to 10 miles south of Greenville, 1 mile northwest of Galloway Crossroads, and  $\frac{3}{4}$  mile north of Grimesland, Pitt County;  $2\frac{1}{2}$  miles northwest of Chocowinity and  $1\frac{1}{4}$  miles northeast of Chocowinity, Beaufort County; 1 mile north of Castoria,  $\frac{1}{2}$  mile east of Lizzie (on David Summeril's property), and 4 miles east of Lizzie (in Dog Swamp, on the property of O. W. Frizzelle), Greene County; Rock Landing on the Neuse River, Craven County. Duplin marl, 3 miles south of Clinton (on Gum Chimney Branch, on the property of Hugh Moore), Sampson County; Natural Well and  $1\frac{1}{2}$  miles north of Magnolia, Duplin County; Lumberton (near the bottling works) and  $1\frac{1}{2}$  miles northeast of Fairmont (on the property of Andrew Jones), Robeson County. Pliocene, Waccamaw formation, 4 miles south of Clarkton, Bladen County; Donahues Landing, 48 miles above Wilmington, 4 miles south of Elizabethtown (on Hammond Creek, on the property of Mrs. Clark), Bladen County; Walkers Bluff on the Cape Fear River, Bladen County; Lake Waccamaw and Neills Eddy Landing (3 miles north of Cronly), Columbus County; Wilmington (at the city rock quarry), New Hanover County.

***Venus (Mercenaria) campechiensis carolinensis* Conrad**

Plate 20, figures 1, 2

1875. *Mercenaria carolinensis* Conrad. Kerr, North Carolina Geol. Survey Rept., vol. 1, App. A, p. 20.  
 1903. *Venus campechiensis* Gmelin (part). Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1315.  
 1926. *Venus campechiensis carolinensis* (Conrad). Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 190.  
 1932. *Venus campechiensis carolinensis* (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 132, pl. 28, fig. 4.

Shell subtriangular, elongated, very inequilateral, slightly ventricose, disk with coarse, flattened, uneven, imbricated ridges on the middle and posterior side, the lines disposed to be ramose; on the anterior side and posterior slope they are sharp, prominent, rugose, imbricated lines; lunule large, cordate. Length 5 inches, height 4 inches.

Locality, Cape Fear River.—Conrad, 1875. Waccamaw formation.

Dimensions of figured specimen, a left valve, U. S. Nat. Mus. 325573, from the Waccamaw formation at Walkers Bluff on the Cape Fear River, N. C.: Height

119.0 millimeters, width 153.0 millimeters, convexity 45.0 millimeters.

Shell ovate to subtriangular, very large, and ponderous. Posterior dorsal margin often slightly gibbous. Lunule cordate, delimited by a deep linear groove, laminated. Escutcheon less sharply defined, narrower and more strongly laminated in the right valve than in the left. Surface sculptured with thin, sharp lamellae that number 2 or 3 to the millimeter, except on the umbones; often dorsally appressed on the disk, most elevated near the lunule. Ligamental and hinge areas extremely heavy but otherwise normal for the species. Adductor scars indicative of the powerful muscles necessary to control so weighty a shell. Pallial line and sinus distinct, often thrown into prominence by the thickening of the interior of the shell over the area of the adherent mantle.

The measurements of 3 characteristic valves are as follows: Height 140.0 millimeters, 120.0 millimeters, 130.0 millimeters; width 182.0 millimeters, 150.0 millimeters, 160.0 millimeters; and convexity 50.0 millimeters, 43.0 millimeters, 41.0 millimeters.

*Venus (Mercenaria) campechiensis carolinensis* Conrad is second in bulk only to *V. campechiensis tridacnoides* Lamarck. Although not approaching the latter in the degree of deformity, some individuals in the collection exhibit not only a decided interior thickening but the base line is rippled by a radial undulation similar to that of *tridacnoides*. By a decrease in size, weight, relative altitude, and prominence of the umbones *V. carolinensis* merges gradually into the ubiquitous *V. rileyi*, its probable ancestor.

Mansfield reports the species from the *Cancellaria* zone of the Choctawhatchee formation.

Distribution: North Carolina: Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek) and at Walkers Bluff (on the Cape Fear River), Bladen County; Neills Eddy Landing (3 miles north of Cronly), Columbus County.

***Venus (Mercenaria) campechiensis tridacnoides* (Lamarck) Conrad**

Plate 21, figure 11

1685. — Lister, Historiae sive Synopsis Methodicae Conchyliorum, pl. 499, fig. 53.  
 1818. *Cyprina tridacnoides* Lamarck, Histoire naturelle des animaux sans vertèbres, vol. 5, p. 558.  
 1824. *Venus deformis* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 4, p. 148, pl. 12, figs. 2, 2a.  
 1838. *Venus tridacnoides* Conrad, Fossils of the medial Tertiary of the United States, p. 10, pl. 7, fig. 2.  
 1856. *Venus tridacnoides* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 85, pl. 22, fig. 1.  
 1858. *Venus tridacnoides* Conrad. Emmons, North Carolina Geol. Survey Rept., p. 292.  
 1858. *Venus difformis* Say. Emmons, idem.  
 1863. *Mercenaria tridacnoides* Lamarck. Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 574.  
 1867. *Mercenaria percrassa* Conrad, Am. Jour. Conchology, vol. 3, p. 13.

1869. *Mercenaria percrassa* Conrad, idem, vol. 4, p. 278, pl. 19, fig. 1.

1903. *Venus tridacnoides* Lamarck. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1310.

1926. *Venus tridacnoides* (Lamarck) (part). Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 191, pl. 33, fig. 6.

*C. testâ transversim ovatâ, corrugatâ; striis verticalibus; limbo superiore undatim plicato.*

Mon cabinet. List. Conch. t. 499. f. 53.

Habite . . . Fossile d'Italie. Largeur, 11 centimètres. Coquille singulière; grande, plissée, en son limbe, comme dans les tridacnes, ayant dans les interstices de ses sillons des stries verticales.—Lamarck, 1818.

Type locality not known but certainly not "Italie."

Shell subcordate, with transverse wrinkles, which are distant and regular on the umbones, and much crowded on the basal half; several very obtuse longitudinal undulations, of which that on the middle is more profound; basal margin deeply undulated in compliance with the undulations of the disk; within crenate on the edge; anterior margin flattened and simply wrinkled.

Length nearly 5, breadth 6 inches. Smallest specimen, 3.7 inches long and 4½ inches wide.

This extraordinary shell has so unusual an appearance, that I should almost have been disposed to regard a single specimen as a monstrosity. The examination of several individuals proves that the species varies somewhat in form and in the locality of the undulations.—Say, 1824.

The deformity of this shell is sometimes so great that a valve 107.5 millimeters in width will have a maximum thickness of 33.70 millimeters. The outline is variable, as Say has noted, and the undulations are inconstant in both their strength and their position. The lunule varies with the outline; the escutcheon is moderately broad; the nymph is heavy and the groove deep enough to seat a ligament adequate to hold the massive valves; the rugose area is broadly lenticular and strongly marked. The hinge plate and dentition are robust; the anterior cardinal of the right valve is simple, the middle and posterior cardinals are bifid; the anterior and middle cardinals of the left valve are bifid, the posterior is simple and somewhat laminar. The muscle impressions and pallial characters are thrown into prominence by the thickening of the shell over the area of the adherent mantle. The adductor scars are very large, the anterior adductor semielliptical, the posterior, subcircular. The pallial line is moderately distant from the hinge margin; the sinus is short and triangular. The crenulations of the inner margins are rather finer than one might expect in such ponderous valves.

Neither the abnormal thickening nor the undulations are developed in the young forms, which are indistinguishable from the young of *Venus campechiensis rileyi*, and the adults exhibit varying degree of thickness and undulation from the normal subspecific form to the incongruously ponderous individuals that have attracted the attention of conchologists since the time of the prebinomial Lister. The fact that the normal

and abnormal types are coexistent at many localities would suggest a pathologic state that is due to some organism. A general condition such as the mechanical or chemical constitution of the sea water or the features of the food supply would be fairly constant at a given locality and would probably affect all individuals alike.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; mouth of Baileys Creek, Prince George County; Petersburg, Dinwiddie County; Fergusons Wharf, Grove Wharf on the James River, Surry County; Benns Church, 1½ miles above Zuni and 12 to 14 miles above Zuni on the Blackwater River, Isle of Wight County; Sycamore, ¼ to ½ mile below Sycamore on the Nottoway River, ½ to ¾ mile above the lower Seaboard Railway bridge, and at Maddelys Bluff on the Meherrin River, Southampton County.

North Carolina: Miocene, Yorktown formation, 1½ to 2 miles above Branches Bridge, Northampton County; 1½ miles above Murfreesboro on the Meherrin River, Hertford County; Halifax (on Mr. Durham's farm ½ mile above the Atlantic Coast Line Railroad bridge), Halifax County; 4 miles northwest of Williamston, Martin County; 15½ miles above Bells Bridge, and ½ mile above Bells Bridge over the Tar River, Edgecombe County; 3 miles west of Greenville, Pitt County.

#### *Venus (Mercenaria) berryi* Gardner, n. sp.

Plate 21, figures 1-6

Shell small, rather light, moderately inflated, ovate to subtrigonal externally, ovate to subquadrate internally. Umbones rather plump but not very prominent; the apices acute and prosogyrate, a distance of about one-third the width back from the anterior margin. Lunule rather narrow, conspicuously cordate, outlined posteriorly by a deeply impressed groove that dissects the sculpture. Escutcheon lanceolate, wider, and less strongly laminated in the left valve than in the right. Anterior margin bowed out in front of the lunule. Posterior dorsal margin gently declining or slightly gibbous. Lateral margin broadly rounded, as a rule. Ventral margin gently arcuate, more strongly upcurved in front than behind. Sculpture unusually variable in detail but uniform in general aspect; concentric lamellae 45 to 65 in number, erect on the posterior and, particularly, on the anterior margin, the free edges frequently crenulated; laminae closely appressed dorsally on the medial portion of the disk, and often fused either with the surface or with one another; sculpture on the disk thus developed into low, flat, unequal areas, formed by the fusion of 2 to 8 lamellae, separated from one another by narrow channels that occasionally bear 1 to 2 linear lirations. Radial sculpture discernible only on eroded surfaces. Ligament area moderately wide, approximately half the posterior dorsal margin in length; ligament mounted on rather vigorous nymphs, the outer margin inset in a deep groove that obliquely undercuts the dorsal margin of the valve. Rugose area narrow, elongate. Three discrete cardinals in each valve, spreading fanlike from beneath the tips of the umbones. An-

terior cardinal of right valve compressed; middle cardinal robust, feebly bifid; posterior cardinal more compressed and elongate and more deeply sulcate longitudinally. Anterior cardinal of left valve moderately compressed-cuneiform but more elevated than either of the other 2, feebly depressed medially; middle cardinal robust, rudely sulcate, but distinctly less elevated than the tooth in front of it; posterior cardinal exceedingly thin and elongate, partially fused with the rugose area behind it; lateral margin in right valve grooved for the reception of the beveled edge of the escutcheon of the left valve. Adductor muscle scars of moderate size, submedial in position, distinct but not strikingly prominent. Pallial line moderately distant from the ventral margin. Pallial sinus short, not attaining the median vertical, its dorsal margin approximately horizontal, the terminal angle not far from 45°. Inner margins finely and evenly crenate.

Dimensions of holotype (paired valves): Height 57.0 millimeters, width 62.5 millimeters, diameter 37.6 millimeters. Dimensions of adult paratype, a right valve: Height 46.5 millimeters, width 54.0 millimeters, convexity 10.6 millimeters. Dimensions of adolescent paratype, height 8.0 millimeters, width 8.5 millimeters.

Holotype (paired valves) and adult paratype, a right valve: U. S. Nat. Mus. 325574.

Adolescent paratype, a right valve: U. S. Nat. Mus. 325576.

Locality of types: Holotype and adult paratype, 2½ to 3 miles below Bowlers Wharf, Essex County, Va. St. Marys formation. Adolescent paratype, 1 to 2 miles below Bowlers Wharf, Essex County, Va. St. Marys formation.

*Venus (Mercenaria) berryi* stands so far apart from the described Tertiary species of the middle Atlantic coast that its affinities are somewhat in doubt. The more regularly sculptured forms suggest a subdued type of *V. ducatelli* Conrad, on which the concentric lamellae are developed in greater numbers and less conspicuously than in the normal form. The phenomenon of the fusion of the lamellae, is however, quite unknown in Conrad's form, and when the fusion tends toward the somewhat strongly marked obsolescence of the entire surface sculpture on the disk, the species approaches some of the manifestations of *V. mercenaria* Linnaeus. The general contour of the shell, however, and the distribution are much more suggestive of *V. ducatelli* Conrad than of *V. mercenaria*.

The young shells are rotund little valves sculptured with equisize, equispaced, relatively distant, concentric lamellae, which are uniform in strength and character over the entire surface of the shell. So individual is the species in the young stage that it recalls on first examination an unusually rotund *Chione*.

I have the pleasure of naming the species in honor of Dr. E. W. Berry, the former dean of the Undergrad-

uate School, Johns Hopkins University, who, though best known as an administrator and as a notable contributor to knowledge of the Tertiary floras, has done much to advance the knowledge of the faunas as well.

Distribution: Virginia: Miocene, St. Marys formation, 1 to 2 miles below Bowlers Wharf and 2½ to 3 miles below Bowlers Wharf on the Rappahannock River, Essex County.

#### *Venus (Mercenaria) plena inflata* Dall

Plate 21, figure 9

1903. *Venus plena* var. *inflata* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1310.

A variety which may be called *inflata* is more trigonal and measures 60 millimeters long, 55 [51.0] millimeters high, and 36 [20.5] millimeters in diameter [convexity of single valve]. It is from Bellefield, York River, Va.—Dall, 1903.

Holotype, a right valve: U. S. Nat. Mus. No. 163419.

Type locality: Bellefield, York River, Va. Yorktown formation.

Shell heavy, elevated, trigonal, inflated in the umbonal region. Umbones gibbous, involute, prosogyrate, fully three-fourths of the way over toward the anterior margin. Lunule broadly cordate, laminated, bounded by a deeply incised line that dissects the concentric sculpture. Escutcheon rather obscure, feebly laminar. Anterior margin convex in front of the lunule. Posterior dorsal margin obliquely produced or somewhat gibbous; posterior lateral margin subtruncate. Base line straight, upcurved anteriorly. Surface covered with thick, heavy lamellae, closely crowded together. Ligamentary nymph rather slender; groove behind it deep. Dentition normal, three discrete cardinals in each valve, fanlike in their arrangement; anterior cardinal in both valves simple; middle cardinal in both valves bifid; posterior cardinal bifid in the right, simple in the left; rugose area rather narrow. Adductor impressions distinct; semielliptical. Pallial line rather distant from the margin. Sinus short, triangular.

The subspecies is heterodox only in the outline.

Distribution: Virginia: Miocene, Yorktown formation, Bellefield, York County.

#### *Venus (Mercenaria) plena nucea* Dall

Plate 21, figures 7, 8

1903. *Venus plena* var. *nucea* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1310.

Another form which I found mixed with the type at the same locality [Bellefield, York River, Va.] and at first thought might be distinct, is rounded, subtruncate behind, very thick for its size, the surface slightly undulate and with the lamellation obsolete. It may take the name of variety *nucea*. It measures: Length [width] 33, height 29 [30.0], and diameter 16 millimeters [convexity 11.0 millimeters].—Dall, 1903.

Holotype, a right valve: U. S. Nat. Mus. 163418.

Shell heavy, rude, rounded, roughly quadrate or trigonal, inflated in the umbonal region, often flattening

rather abruptly toward the umbones. Umbones strongly anterior, sometimes not more than a fifth of the way back from the anterior margin, involute, prosogyrate. Lunule cordate or oblong, sharply defined, laminated. Escutcheon lanceolate, laminar, rather obscure. Anterior end very short; slightly arcuate in front of the lunule, in some individuals sloping uniformly from the umbones to the base at an angle not exceeding  $10^{\circ}$  or  $12^{\circ}$  off the vertical. Posterior dorsal margin oblique or somewhat gibbous, broadly truncated laterally. Base line straight or gently arcuate. Hinge characters normal for the species. Muscle impressions and pallial line emphasized by a thickening of the shell over the surface of attachment of the mantle.

The subspecies is remarkable for its small, rude, stunted valves, which strongly suggest a pathologic condition.

Distribution: Virginia: Miocene, Yorktown formation, Bellefield, York County.

#### Subfamily GEMMINAE

This group includes small species of Veneridae, which are characterized by viviparity and carry the young for a considerable period, like *Sphaerium*, within the perivisceral chamber. They have, as a rule, purple and white coloration, if any, and a smooth or concentrically striated surface. They live in sand or mud in moderate depths of water on both coasts of North America and have not been identified from any other region.—Dall,<sup>51</sup> 1903.

#### Genus GEMMA Deshayes

1853. *Gemma* Deshayes, Catalogue of the Conchifera of the British Museum, pt. 1, p. 112.

Type by tautonomy and monotypy: *Venus gemma* Totten. Recent from Labrador to North Carolina.

*Gemma* includes a group of small venerids roughly resembling in outline a  $60^{\circ}$  segment of a circle. A large, rather obscurely defined lunule is developed but no escutcheon. The surface is concentrically wrinkled, and the inner margins of the valves are radially crenate. The hinge armature is restricted to three cardinals in each valve, unequal in size and diverging fanlike from beneath the tips of the umbones. The pallial sinus is short and steeply ascending.

The genus has been an inconspicuous element in the faunas of the east coast and Gulf since the middle Eocene. There is no record of it in either the Tertiary or the Recent European seas.

#### *Gemma magna* Dall

1903. *Gemma magna* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1330, pl. 57, fig. 4.

1926. *Gemma magna* Dall. Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 206, pl. 43, fig. 22.

1932. *Gemma magna* Dall. Mansfield, Florida State Geol. Survey Bull. 8, p. 134, pl. 27, figs. 1, 2.

Shell trigonal, moderately convex, the anterior end slightly shorter, rounded; the posterior end longer, more pointed; beaks high, pointed; lunule [s]lightly flattened, bounded by an incised line often feeble, lanceolate, about half as long as the anterior dorsal slope; escutcheon not defined; surface sculptured with numerous regular, even, concentric sulci, with wider smooth interspaces; hinge normal, well developed, especially the long lateral laminae, the cardinals entire; basal margin crenulate, pallial sinus small, angular. Length 7, height 6, diameter 4 millimeters.

*G. magna* attains a larger size than any of the later representatives of the genus. It resembles *G. var. purpurea* of the recent fauna in its sculpture, but relatively is much less inflated.—Dall, 1903.

The measured and figured specimen, which may be considered the lectotype, is U. S. Nat. Mus. 115174. It is a right valve. Mounted on the same card with it and bearing the same Museum number is a second right valve and two left valves.

Type locality: Natural Well, Duplin County, N. C. Duplin formation.

*Gemma magna* Dall in the broader sense is a protean species and one of the most prolific of the smaller bivalves. Were it not for the wealth of material, the differences between the peripheral members would be regarded as specific; but with a complete series of intergrading individuals it is impossible to establish anything more than subspecific variations. The Yorktown formation has two common subspecies, one notably small, high, and moderately heavy, with a rather delicate hinge (subspecies *virginiana*); the other characterized by a relatively large, rather thin, compressed, and rounded, but usually inequilateral shell with umbones of little prominence and a moderately robust hinge (subspecies *majorina*). In the Duplin, the species is fairly large, though smaller, relatively more strongly inflated, higher and more angular than the subspecies *majorina*, but lower, more inequilateral, and decidedly larger than the subspecies *virginiana*. *Gemma magna* is, however, more unstable in the Duplin than in any of the other formations, and it exhibits, even at the type locality (the Natural Well), a bewildering range in outline, degree of compression, and sculpture. The individual selected as the type is high, trigonal, approximately equilateral, and closely and regularly sulcated concentrically. From this characteristic type, the form may merge into a lower, less angular, more compressed, and more inequilateral phase. Variations in the strength of the sculpture bear no relation, apparently, to the variations in outline. The prodissoconch and frequently the entire umbonal region are destitute of sculpture, and occasionally, though more rarely than in the succeeding Waccamaw, the entire valve is smooth (subspecies *insulcata*); *G. magna* s.s. reaches distinctly greater dimensions in Robeson County than in Duplin County and is usually

<sup>51</sup> Dall, W. H., Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 1329, 1903.

more inequilateral in the former. The Waccamaw race is less differentiated than the Yorktown race and is hardly more than a collection of miniatures of Duplin forms. Both the high trigonal, inflated, equilateral type and the lower, ovate, more compressed, inequilateral type are present together with the intergrading individuals. The tendency toward a smooth surface is much stronger than in Miocene forms, a rather perverse phase in the development of the species, since the juvenile valve is smooth, and, with the rise in the stratigraphic column, one might reasonably expect an evolution toward a constantly and regularly sulcated type rather than away from it.

Distribution: North Carolina: Miocene, Yorktown formation, 3 miles south of Farmville, Pitt County; Colerain Landing on the Chowan River, Bertie County. Duplin marl, Natural Well, 1½ miles north of Magnolia, and W. H. Kornegay's marl pit, Duplin County; 4 miles north of Lumberton (on the Berry Godwin plantation), 2 miles below Lumberton, 4 to 5 miles below Lumberton, and 1½ miles northeast of Fairmont (on the property of Andrew Jones), Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek, on the property of Mrs. Clark) and Walkers Bluff (on the Cape Fear River), Bladen County; Neills Eddy Landing (3 miles north of Cronly), and Lake Waccamaw, Columbus County; Wilmington (at the city rock quarry), New Hanover County.

Outside distribution: Pliocene, Waccamaw formation, Todds Ferry on the Waccamaw River, Horry County, S. C. Caloosahatchee marl, Nashua, Putnam County, Fla.; Caloosahatchee River, Alligator Creek, and Shell Creek, Fla.

#### *Gemma magna virginiana* Dall

Plate 19, figures 15-18, 25, 26

1903. *Gemma magna* var. *virginiana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1330.

1926. *Gemma magna virginiana* Dall. Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 206.

Shell smaller, shorter, more delicate. Length 3.8, height 3.6, diameter 1.6 millimeters.

From the Miocene of Yorktown, Va., in the middle portion of the series; Harris.

This form is the earliest *Gemma* now known, and if I felt sure that it was adult I should separate it specifically from *G. magna*, which appears in the uppermost Miocene just before the opening of the Pliocene epoch. It closely resembles the young of the *G. magna*, and perhaps larger specimens may hereafter turn up.—Dall, 1903.

Dimensions of figured cotypes: Right valves, height 3.4 millimeters, width 3.5 millimeters; height 3.2 millimeters, width 3.3 millimeters. Left valves, height 3.7 millimeters, width 4.1 millimeters; height 3.0 millimeters, width 3.2 millimeters.

Dimensions of figured topotype, a left valve: Height 3.3 millimeters, width 3.6 millimeters.

Cotypes, 2 right and 3 left valves: U. S. Nat. Mus. 144633.

Topotypes, a right and a left valve: U. S. Nat. Mus. 325571.

Type locality: Yorktown, Va. Yorktown formation.

The most constant difference between the subspecies and *G. magna* s.s. is the smaller size and less robust hinge of the former. The greater degree of inflation and the higher and more nearly equilateral outline separate *virginiana* from the coexistent subspecies *majorina*. *G. magna virginiana* follows the tendency that seems to be general among the Tertiary Gemmas of presenting an unsculptured as well as a sculptured phase. All the other characters remain constant, however, and the transition between the smooth form and the evenly sulcated type is freely demonstrated in the material at hand.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County (both smooth and sulcate races); 1½ miles southeast of Reids Ferry (both smooth and sulcate races); 1 mile north of Suffolk (sulcate race only), Nansemond County.

North Carolina: Miocene, Yorktown formation, half a mile above Bells Bridge over the Tar River, Edgecombe County; Tar Ferry on Wicacoon Creek (opposite Harrellsville), Hertford County; Colerain Landing (smooth type only) and ½ to ¾ mile above Edenhouse Point on the Chowan River (smooth type only), Bertie County; Rock Landing on the Neuse River (both smooth and sulcate types), Craven County.

#### *Gemma magna majorina* Gardner, n. subsp.

Plate 19, figures 19, 27

Shell large for both the genus and the species; moderately compressed. Outline ovate to subtrigonal, inequilateral. Umbones flattened, inconspicuous, erect or slightly prosogyrate, often rather bulbous at their tips, placed a little in front of the median horizontal. Lunule indicated merely by the cessation of the concentric sculpture. Escutcheon not defined. Dorsal and lateral margins not differentiated; anterior slope shorter and consequently steeper than the posterior. Base line evenly and rather strongly arched. Surface normally sculptured with 30 to 40 fine, regular, continuous, concentric striae; occasional resting stages present. Ligament external, opisthodontic; nymph short, sublinear; groove behind it narrow. Hinge concentrated; middle cardinal of right valve stout, triangular; cardinal behind it more slender; that in front of it a thin lamina often worn or broken away; anterior and middle cardinals in left valve cuneate, the anterior, the more slender and produced, separated from the medial cardinal by a deep, triangular, subumbonal socket; posterior cardinal of left valve thin and laminar; posterior dorsal margin of right valve and anterior dorsal margin of left valve sulcated to receive the slightly modified corresponding margins of the opposite valves. Adductor impressions small, the anterior impression somewhat oblong and submedial, the posterior relatively broader and a little lower. Pallial line obscure, rather distant. Pallial sinus short, linguiform, and sharply ascending; inner margins usually crenate.

Dimensions of cotypes: Right valve, height 5.6 millimeters, width 6.6 millimeters, convexity 1.4 millimeters.



Left valve, height 6.6 millimeters, width 7.3 millimeters, convexity 1.5 millimeters.

Cotypes, the right and left valves of different individuals: U. S. Nat. Mus. 325566.

Type locality: One mile east of Lizzie, Greene County, N. C. Yorktown formation.

*Gemma magna majorina* is notably larger than *G. magna* s. s., more compressed, less trigonal, with more rounded margins, a relatively thinner shell, and a less robust hinge.

Distribution: Virginia: Miocene, Yorktown formation, 1 mile northeast of Suffolk, and  $\frac{1}{2}$  mile below the Suffolk waterworks, Nansemond County.

North Carolina: Miocene, Yorktown formation, Halifax and Palmyra Bluff on the Roanoke River, Halifax County; Hamilton Bluff, a  $\frac{1}{4}$  mile below Hamilton Landing, 3 miles west of Williamston, and  $2\frac{1}{2}$  miles northwest of Williamston (on the property of Joseph Cherry), Martin County; 3 miles west of Rocky Mount, Edgecombe County; 2 miles below Toddy Station, 2 miles southeast of Tugwell (on Jacobs Branch), 3 miles southwest of Frog Level (on J. A. Noble's branch), 8 to 9 miles southeast of Greenville, 9 to 10 miles south of Greenville, and 2 miles east of Grifton (on J. F. Brooks' property), Pitt County;  $2\frac{1}{2}$  miles northwest of Chocowinity, Beaufort County; 2 miles southwest of Maple Cypress (on the Neuse River), Craven County; 1 mile west of Wilson (in Hominy Swamp, on the property of Frank Barnes) (smooth race as well as sulcated), Wilson County; 1 mile north of Castoria and 1 mile east of Lizzie (both smooth and sulcate races), Greene County; Tar Ferry and  $1\frac{1}{2}$  miles below Tar Ferry on Wiccacon Creek (opposite Harrellsville), Hertford County;  $\frac{1}{2}$  to  $\frac{3}{4}$  mile above Edenhouse Point on the Chowan River, Bertie County.

*Gemma magna insulcata* Gardner, n. subsp.

Plate 19, figures 14, 22

Shell trigonal or approximately so. Valves evenly inflated. Apical angle not far from  $60^\circ$ ; posterior margin often a little more produced and pointed than the anterior; base line arcuate, more strongly upcurved, as a rule, before than behind. Umbones inconspicuous, the apices obtuse, directed toward one another. Lunule and escutcheon not differentiated. Surface smooth except for incrementals, which may assume a certain regularity toward the ventral margin. Ligament opisthodetic, mounted upon a sublinear nymph. Three cardinals in the right valve but only one of them at all obvious; anterior cardinal very thin and laminar, often broken away; posterior cardinal only a little less slender but decidedly more elongate; middle cardinal stout and trigonal; three cardinals of left valve less discrepant in strength than those of right; anterior cardinal much compressed and rather short; middle cardinal narrowly cuneiform, posteriorly directed; posterior cardinal merely a thin lamina, which is rarely preserved in perfection; posterior dorsal margin of right valve and anterior dorsal margin of left valve sulcated to receive the slightly modified corresponding margins of the opposite valve. Adductor im-

pressions obscure but apparently normal for the species. Pallial sinus short, very sharply ascending, somewhat linguiform. Inner margins finely crenate.

Dimensions: Holotype, height 4.5 millimeters, width 5.2 millimeters, convexity 1.5 millimeters; paratype, height 3.4 millimeters, width 4.1 millimeters.

Holotype, a right valve, U. S. Nat. Mus. 325567; paratype, a left valve, U. S. Nat. Mus. 325570.

Type localities: Holotype, Neills Eddy Landing, Columbus County, N. C.; paratype, Walkers Bluff, Bladen County, N. C. Waccamaw formation.

The diagnostic character for the separation of *G. magna insulcata* from the *G. magna* s. s. is the absence of a well-defined concentric sculpture. In many of the forms the sculpture is not assumed until the individual has attained a width of three millimeters, so that adults with smooth umbonal areas are quite common. It is rather unexpected that the tendency toward a smooth shell, apparently a reversion to type, should be most strongly marked in the Waccamaw (Pliocene).

Distribution: North Carolina: Miocene, Duplin marl, 2 miles below Lumberton and 4 to 5 miles below Lumberton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Cronly ( $\frac{1}{2}$  mile east of the factories) and Neills Eddy Landing (3 miles of Cronly). Columbus County.

*Gemma cravenensis* Gardner, n. sp.

Plate 19, figures 23, 24

Shell rather large for the genus, thin, compressed, suboval in outline, slightly inequilateral. Anterior dorsal margin a little shorter than the posterior, and consequently a little less gently sloping; lateral margins broadly and evenly rounded; base line straight medially, upcurved distally. Umbones low, rather flat, and not at all conspicuous; apices obtuse and turned toward each other. Lunule merely suggested, not defined. Escutcheon absent. Surface smooth or feebly sulcated toward the margins by the growth lines. Ligament external, opisthodetic, seated on a very narrow, but rather robust nymph. Hinge normal but expanding with the dorsal margins, and less concentrated than in the more trigonal races. Armature in the right valve consisting of a very thin laminar anterior cardinal, a sturdy, triangular, subumbonal middle cardinal, and a compressed and obliquely produced posterior cardinal. Three cardinals present in the left valve as well, the anterior cardinal only a little less robust and a little more compressed than the middle, and separated from it by the deep, subumbonal socket; the posterior cardinal thin, laminar, oblique, but not produced; right anterior and left posterior dorsal margins feebly sulcated and the opposing margins beveled. Muscle impressions small, slightly below the median horizontal, the anterior reniform, and more regular in outline than the posterior. Pallial line rather distant. Pallial



sinus broad and shallow. Inner margins faintly crenate.

Dimensions of holotype: Height 3.7 millimeters, width 4.6 millimeters, convexity 0.9 millimeters.

Holotype, the right and left valves of a single individual: U. S. Nat. Mus. 325569.

Type locality: Rock Landing on the Neuse River, Craven County. Yorktown formation.

*Gemma cravenensis* is most closely allied to *G. magna majorina*. It is, however, much thinner, more compressed, and more oval, with a fanlike divergence of the cardinals that isolates it readily even among the protean representatives of *G. magna*.

Distribution: North Carolina: Miocene, Yorktown formation, Rock Landing on the Neuse River, Craven County.

*Gemma verdevilla* Gardner, n. sp.

Plate 19, figures 31, 32

Shell minute, but rather heavy, subcircular, subequilateral. Posterior end more evenly arcuate than the anterior, which is obscurely truncate dorsally. Base line evenly rounded. Umbones rather inflated but not conspicuous. Apices obtuse, facing one another. Lunule faintly suggested but not defined. Escutcheon absent. Surface very feebly and somewhat irregularly sculptured by the incrementals. Ligament external, opisthodetic, seated on linear nymphs. Hinge delicate, concentrated. Right valve armed with a very thin, laminar, anterior cardinal; a robust, cuneiform, middle cardinal; and a compressed, obliquely produced, posterior cardinal. Left valve with subequal anterior and middle cardinals, the anterior a little the more compressed, the two separated by a deep, triangular, subumbonal socket; posterior cardinal imperfect in the type but oblique and probably much compressed. Feeble lateral ridges developed on the anterior margin of the right valve and the posterior margin of the left, with corresponding grooves in the posterior margin of the right valve and the anterior margin of the left. Muscle impressions small, a little below the median horizontal, the anterior minutely reinform and more regular in outline than the posterior. Pallial line rather distant. Sinus broad and very shallow. Inner margins faintly radiate but not crenate.

Dimensions of holotype: Height 2.6 millimeters, width 2.6 millimeters, diameter 1.3 millimeters.

Holotype, the right and left valves of a single individual: U. S. Nat. Mus. 325568.

Type locality: Eight to 9 miles southeast of Greenville, Pitt County, N. C. Yorktown formation.

*Gemma verdevilla* is smaller than any of the associated Gemmas, is more inflated, and is more rotund in outline, with less angular umbones and a broader, more shallow, pallial sinus. The species is known only from the two valves, which belong apparently to the same individual.

Distribution: North Carolina: Miocene, Yorktown formation, 8 to 9 miles southeast of Greenville, Pitt County.

Superfamily MYACEA

Family MYACIDAE

Genus MYA Linnaeus

1758. *Mya* Linnaeus, Systema naturae, 10th ed., p. 670.

Type by subsequent designation (Schumacher, Essai d'un nouveau système des habitations des vers testacés, p. 116): *Mya truncata* Linnaeus. Recent in the estuaries and coastal waters of the British Isles. Found in the fossil state as early as the Coralline Crag.

Shell oblong or rhomboidal, only slightly inequivalve, gaping at both extremities. Outer surface incrementally wrinkled. Umbones low, proximate. Ligament attached to a projecting chondrophore in the left valve and, in the right valve, to an inverted ligament pit directly beneath the umbo. No development of either a cardinal or a lateral dentition. Adductor scars subequal. Pallial sinus deep.

Davies<sup>52</sup> has given an interesting series of diagrammatic sections showing the change in the position of the resilium and resilifer from the strongly inequivalve Corbulas, in which the attachment areas of the right and left valves are diagonally opposed, to that of *Mya*, in which the valves are approximately equal in size but the chondrophore of the left valve projects beneath the resilial pit of the right, so that the opposing attachment faces are almost directly one above the other.

The genus is known from the Tertiary to the present day. The Recent species are largely confined to the northern hemisphere and, though few in number, are prolific in individuals.

*Mya arenaria* Linnaeus

Plate 22, figure 8

1758. *Mya arenaria* Linnaeus, Systema naturae, 10th ed., p. 670.

1822. *Mya acuta* Say, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 2, p. 313.

1822. *Mya mercenaria* Say, idem.

1841. *Mya arenaria* Linnaeus. Gould, Invertebrata of Massachusetts, p. 40.

1845. *Mya corpulenta* Conrad, Fossils of the medial Tertiary of the United States, p. 68, pl. 39, fig. 1.

1858. *Mya arenaria* Linnaeus. Holmes, Post-Pliocene fossils of South Carolina, p. 55, pl. 8, fig. 15.

1863. *Mya corpulenta* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 572.

1889. *Mya arenaria* Linnaeus. Dall, U. S. Nat. Mus. Bull. 37, p. 70, pl. 49, fig. 9; pl. 55, fig. 2; pl. 69, fig. 2.

1898. *Mya arenaria* Linnaeus. Dall, Wagner Free Inst. Sci. Trans. vol. 3, pt. 4, p. 857.

1906. *Mya arenaria* Linnaeus. Clark, Maryland Geol. Survey, Pliocene and Pleistocene, p. 194, pl. 53, figs. 5, 6; pl. 54, figs. 1-4.

<sup>52</sup> Davies, A. M., Tertiary faunas, vol. 1, p. 203, fig. 282, 1935.

1908. *Mya arenaria* Linnaeus. Rogers, Shell book, p. 324, pl. facing 323, fig. 7.

*M. testa ovata postice rotundata, cardinis dente antrorsum porrecto rotundato denticuloque laterali.*

Habitat in O. Europae septentrionalis sub arena, foraminibus duobus detegenda.—Linnaeus, 1758.

*Mya arenaria* varies in the outline of the posterior portion of the valves from the evenly rounded forms to the distinctly angular. This, the soft-shell or sand clam of the fish market, is a common inhabitant of the northern Atlantic and Arctic waters on both American and European shores. Though most abundant on the gravelly mud flats of the New England coast, it is found as far south as South Carolina and as far north as Greenland, and though originally introduced accidentally with seed oysters, it is now well established in the waters of San Francisco Bay.

Clark's figure of a left valve from the Pleistocene at Wailes Bluff, Md., is reproduced. The species, though not abundant, may be found frequently in the red Miocene cliffs along the York River, while the waters at the base of the cliffs serve as a home for its living representatives.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County.

North Carolina: Pliocene, Waccamaw formation, Lake Waccamaw and Neills Eddy Landing, Columbus County.

Outside distribution: Pleistocene, Point Shirley and Sankaty Head, Mass.; Wailes Bluff and Cornfield Harbor, St. Marys County, Md.; Simmons Bluff and Abbapoola, S. C. Recent, Arctic Ocean to North Carolina and possibly to Miami, Fla., in water up to 40 fathoms; also on Scandinavian coasts in the low-tide area.

#### Family CORBULIDAE

##### Genus CORBULA Bruguière

1797. *Corbula* Bruguière, Tableau encyclopédique et méthodique des trois règnes de la nature, vers, coquilles, mollusques, et polipiers, pl. 230, figs. 1a-c; 3a-c; 4a-d; 5a-c; 6a-b. (Figures only, no text.)

1799. *Corbula* Lamarck, Prodrome d'une nouvelle classification des coquilles, Soc. histoire nat. Paris mém., p. 89. (No species cited.)

1801. *Corbula* Lamarck, Système des animaux sans vertèbres, p. 137.

1811. *Aloidis* Megerle von Mühlfeld, Entwurf eines neuen System der Schalthiergehäuse, Magazin der Gesellschaft naturforschende Freunde, 5ter Jahrg., p. 67.

Type by monotypy: *Corbula guineensis* Von Mühlfeld=*Corbula sulcata* Lamarck.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einricht, etc., pp. 57, 177, Gotha, 1818: *Corbula sulcata* Lamarck. Recent off the coast of Senegal.

In the earlier reports, I have followed the type designation of Children, 1822, *Corbula nucleus* Lamarck=*C. gibba* (Olivi). *C. sulcata* Lamarck served as the type of the subgenus *Aloidis*. If Schmidt's designation be accepted, and there seems to be no adequate

reason for rejecting it, *Aloidis* Von Mühlfeld becomes an exact synonym of *Corbula* s. s.

Topotypes in the Academy of Natural Sciences, Philadelphia, are between 15 and 20 millimeters high and 25 millimeters wide. The posterior keel is very sharp and is defined anteriorly by a deep sulcus, which persists from the nepionic shell to the margin. Both valves are coarsely rugose, the sculpture on the right valve being heavier than on the left. Radial sculpture is absent on the conch. The tips of the umbones are conspicuously capped by the nepionic valves, which differ from the adult to a remarkable degree. They are nearly equivalve, compressed, acutely rostrate, posteriorly, and similarly sculptured with concentric rugae, which strengthen toward the ventral margin. There are no east American shells sufficiently close to the large coarse Senegalese shell to suggest the representation of the *C. sulcata* group in east American waters either in Tertiary or in Recent times.

##### Subgenus CARYOCORBULA Gardner

1926. *Caryocorbula* Gardner, Nautilus, vol. 40, p. 46.

*Cuneocorbula* Dall and authors, not *Cuneocorbula* Cossmann, 1886.

Type by original designation: *Corbula alabamiensis* Isaac Lea. Claiborne (Eocene) of the east coast and Gulf region from South Carolina to the Rio Grande.

Shell small or of moderate dimensions; acutely keeled posteriorly. Slightly inequivalve; right valve a little larger and a little higher relatively than the left. Both valves concentrically rugose, the sculpture on the right valve in some species stronger and more regular than on the left; a microscopically fine radial lineation developed in some of the later species, particularly on the posterior keel. Ligament, dental, muscle, and sinal characters similar to those of *Corbula*, s.s.

*Caryocorbula* includes most of the American species formerly assigned to *Cuneocorbula*. *Caryocorbula* differs from the Paris Basin group in that the shell is less trigonal, not so produced posteriorly, usually heavier, unirostrate rather than birostrate, and more strongly sculptured. *Caryocorbula* is abundantly represented in the Tertiary and Pleistocene deposits of the east coast and Gulf and in the Recent east American waters.

##### *Corbula* (*Caryocorbula*) *conradi* Gardner, n. sp.

Plate 23, figures 27, 28

Shell inequivalve, right valve commonly overlapping the left, inequilateral, moderately heavy and convex, strongly rostrate. Umbones low, the left umbo a little the higher. Base line of right valve arcuate, slightly sinuous posteriorly; that of the left slightly oblique, ascending a little in front of the rostrum. Sculpture of fine, mostly continuous and equidistant, concentric

lirae, which persist across the keel with little change in character; submicroscopic, radial striations also visible in well-preserved specimens, more distinct as a rule on the left valve. Ligament internal, seated on a process of the posterior dorsal margin of the left valve. Cardinal socket deep. Cardinal tooth stout, recurved, placed beneath the right umbo; resilial pit behind it moderately excavated. Muscle impressions and pallial line indistinct.

Dimensions of holotype (paired valves): Height 6.7 millimeters, width 11.0 millimeters, diameter 4.7 millimeters.

Holotype, paired valves: U. S. Nat. Mus. 325605.

Type locality: 15½ miles above Bells Bridge on the Tar River, Edgecombe County, S. C. Yorktown formation.

The species suggests *Corbula inaequalis* Say in the general outline of the valves. It is not, however, so large or so heavy as the latter. The most conspicuous difference is in the concentric sculpture, which is closer, finer, and more regular than that of *C. inaequalis* and approaches that of *C. cuneata* Say, a relatively low species that is characterized by the straight base line of the right valve. The new species differs, furthermore, from both *C. inaequalis* Say and *C. cuneata* Say in the possession of a delicate radial sculpture that is less pronounced than, but similar in character to, that exhibited by *C. barrattiana* C. B. Adams and *C. swiftiana* C. B. Adams. *C. dominicensis* Gabb is not relatively so high and is larger.

*C. conradi* is quite widely distributed and fairly abundant in the Miocene and Pliocene of Virginia and North Carolina, where it has doubtless been confused with its notoriously variable congener, *C. inaequalis*, and possibly with the much less common *C. cuneata*.

Distribution: Virginia: Miocene, St. Marys formation?, Nomin Cliffs, Westmoreland County. St. Marys formation, 2½ miles south of Farnham, Richmond County; Urbanna, Middlesex County. Yorktown formation, 4 miles northwest of Walkerton and 3 miles northeast of Walkerton, King and Queen County; Yorktown, York County; Petersburg, Dinwiddie County; ¾ mile northeast of Smithfield, 12 to 14 miles below Zuni, Isle of Wight County; Sycamore, and ¼ to ½ mile below Sycamore, Southampton County; 1½ miles southeast of Reids Ferry, 1½ miles north of Suffolk, 1 mile northeast of Suffolk, 1 mile west of Suffolk, and ½ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, Watsons Mill on Kirbys Creek, 2½ miles northwest of Murfreesboro, Tar Ferry, and 3 to 4 miles below Tar Ferry, Wiccacon Creek (opposite Harrellsville), Hertford County; Halifax, Halifax County; 2½ miles northwest of Williamston (on Joseph Cherry's farm), Martin County; Swift Creek, 15½ miles above Bells Bridge, ½ mile above Bells Bridge, Tar River, and at Shiloh Mills, Edgecombe County; 7 miles southeast of Wilson, Wilson County; 1 mile north of Castoria, ½ mile east of Lizzie (on David Summeril's farm), and 4 miles east of Lizzie (in Dog Swamp, on O. W. Frizzelle's farm), Greene County; 1½ miles northeast of Farmville, 3 miles south of Farmville,

2 miles west of Greenville, and 6¾ miles below Greenville (at Tafts Landing), Pitt County; Rock Landing, Craven County.

***Corbula (Caryocorbula) conradi retusa* Gardner, n. subsp.**

Plate 23, figures 33, 34

Shell rather small, subtrigonal, inequivalve. Inequilateral, rostrate posteriorly. Umbones flattened, incurved, prosogyrate. Base line of right valve strongly arcuate; that of left slightly oblique. Concentric sculpture of rather coarse lirae, 20 to 25 in the type; approximately equisize and equidistant; on the anterior slope becoming discontinuous toward the medial portion of the valve, and on the posterior portion and keel often obsolete; radial striae faintly visible over the entire shell. Hinge normal.

Dimensions of holotype: Height 5.0 millimeters, width 7.7 millimeters, diameter 3.3 millimeters.

Holotype, paired valves: U. S. Nat. Mus. 325604.

Type locality: Half to three-quarters of a mile below Edenhouse Point, Bertie County, N. C. Yorktown formation.

The subspecies *retusa* is a little smaller and noticeably higher than *Corbula conradi* s. s. The most constant difference, however, is in the concentric sculpture, which, instead of being approximately uniform over the entire valve as in *C. conradi* s. s., becomes irregular medially and evanescent posteriorly. These characters are shared by *C. inaequalis* Say, and the resemblance between the subspecies *retusa* and the young of the coexistent *inaequalis* is often disconcerting. The delicate radial sculpture will serve to determine the form, if the individuals are fresh. If this diagnostic feature has been lost through erosion, there is an aspect of regularity and clean definition of sculpture on the anterior part of the shell that will serve to separate a series, though it may be of little value in the determination of single individuals. The type was taken from the Yorktown sands of the Chowan River, half to three-quarters of a mile above Edenhouse Point. The subspecies is quite common at a number of localities along the Chowan, but it is rare in the Duplin.

Distribution: Virginia: Miocene, Yorktown formation, Exit, Nansemond County.

North Carolina: Miocene, Yorktown formation, 7 miles southeast of Wilson, Wilson County; 6¾ miles below Greenville (at Tafts Landing), Pitt County; 2 miles southwest of Maple Cypress, Craven County; Dogwood Landing and Mount Pleasant Landing, Hertford County; Colerain Landing and half to three-quarters of a mile above Edenhouse Point, Bertie County. Duplin marl, Natural Well and 1½ miles above Magnolia, Duplin County.

***Corbula (Caryocorbula?) scutata* Gardner, n. sp.**

Plate 23, figures 26, 30-32

Shell heavy, subtriangular to subtrapezoidal; both right and left valves strongly convex, the former a

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## PLATES 1-23

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## PLATE 1

FIGURES 1-2. *Nucula proxima* Say (p. 19).

1. Exterior of right valve; height 4.0 millimeters; width 4.5 millimeters. (After Clark.)

2. Interior of same valve. (After Clark.)

FIGURE 3. *Nucula diaphana* H. C. Lea (p. 20). Interior of left valve (Acad. Nat. Sci. Philadelphia 1591); height 2.5 millimeters; width 3.1 millimeters.

FIGURES 4-5. *Nucula proxima* Say (p. 19).

4. Interior of left valve; height 3.9 millimeters; width 4.7 millimeters. (After Clark.)

5. Exterior of same valve. (After Clark.)

FIGURE 6. *Glycymeris tumulus* (Conrad) (p. 27). Interior of left valve (U. S. Nat. Mus. 325483) from Nomini Cliffs, Westmoreland County, Va.; height 44.5 millimeters; width 44.7 millimeters.

FIGURES 7-8. *Brachidontes* (*Ischadium*) *recurvus* (Rafinesque) (p. 29).

7. Exterior of right valve; height 18.0 millimeters; width 30.0 millimeters. (After Clark.)

8. Interior of left valve; height 13.3 millimeters; width 22.5 millimeters. (After Clark.)

FIGURE 9. *Nucula diaphana* H. C. Lea (p. 20). Exterior of left valve (Acad. Nat. Sci. Philadelphia 1591); height 2.1 millimeters; width 2.7 millimeters.

FIGURE 10. *Yoldia laevis* (Say) (p. 21). Exterior of right valve and interior of left valve; height 13.0  $\pm$  millimeters width 26.0  $\pm$  millimeters. (After Say.)

FIGURE 11. *Glycymeris laevis* (Tuomey and Holmes) (p. 26). Exterior of left, and interior, hinge and teeth of right valve; height 30.0  $\pm$  millimeters; width 31.0  $\pm$  millimeters. (After Tuomey and Holmes.)

FIGURES 12-15. *Glycymeris tumulus* (Conrad) (p. 27).

12. Exterior of left valve (U. S. Nat. Mus. 325483) from Nomini Cliffs, Westmoreland County, Va.; height 44.5 millimeters; width 44.7 millimeters.

13. Exterior of juvenile (U. S. Nat. Mus. 325483); height 7.8 millimeters; width 7.3 millimeters.

14. Interior of same valve figured to show early dentition.

15. Profile of closed valves from front (U. S. Nat. Mus. 325483); greatest convexity 27.0 millimeters.

FIGURES 16-21. *Glycymeris americana* (Defrance) (p. 27).

16. Hinge of left valve (U. S. Nat. Mus. 325482), Neills Eddy Landing, Cape Fear River, N. C.; natural size, figured to show partial encroachment of ligament area on dental series.

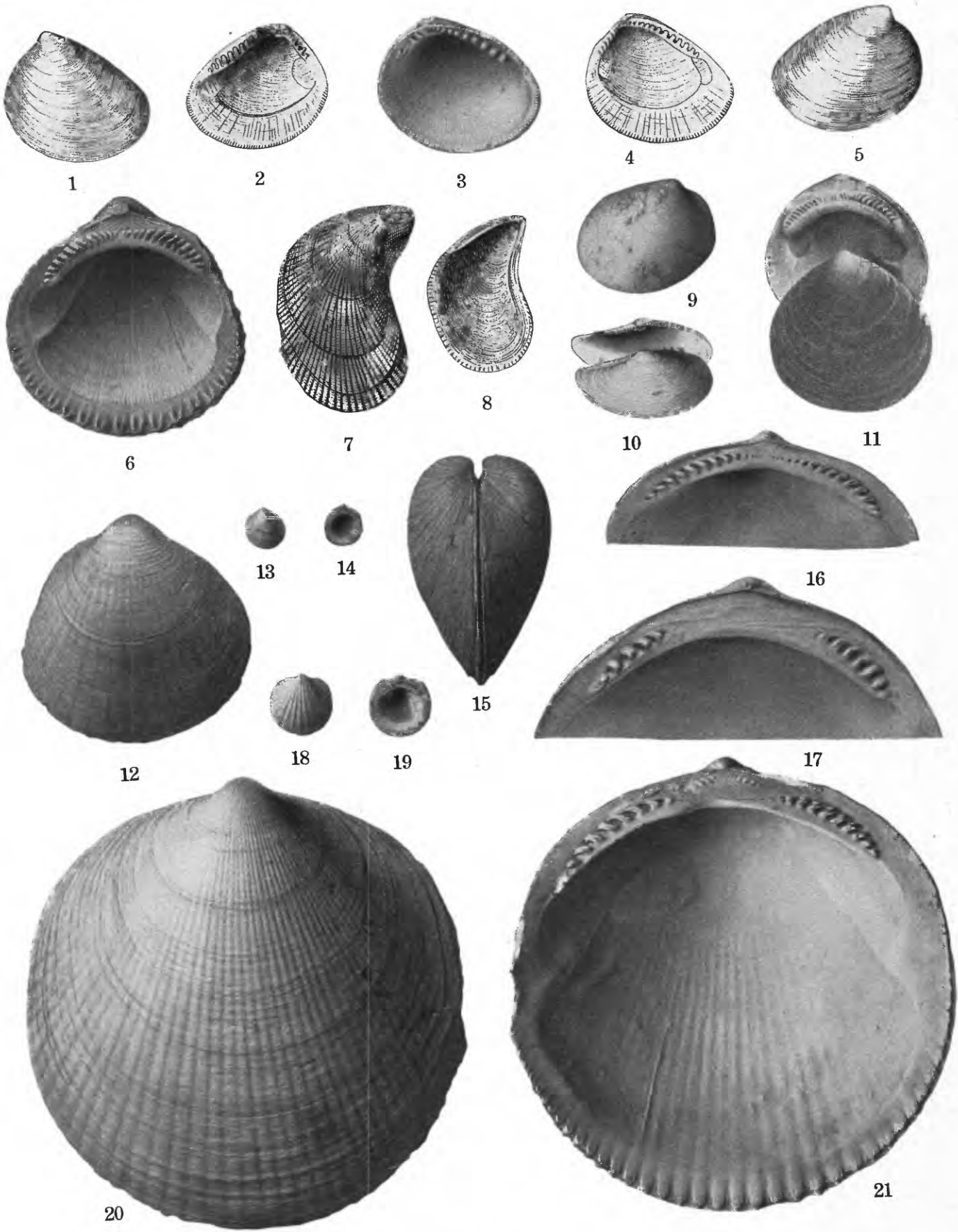
17. Hinge of left valve (U. S. Nat. Mus. 325482); natural size, figured to show further encroachment of ligament area on dental series.

18. Exterior of juvenile (U. S. Nat. Mus. 325482); height 11.5 millimeters; width 11.7 millimeters.

19. Interior of same juvenile figured to show dentition.

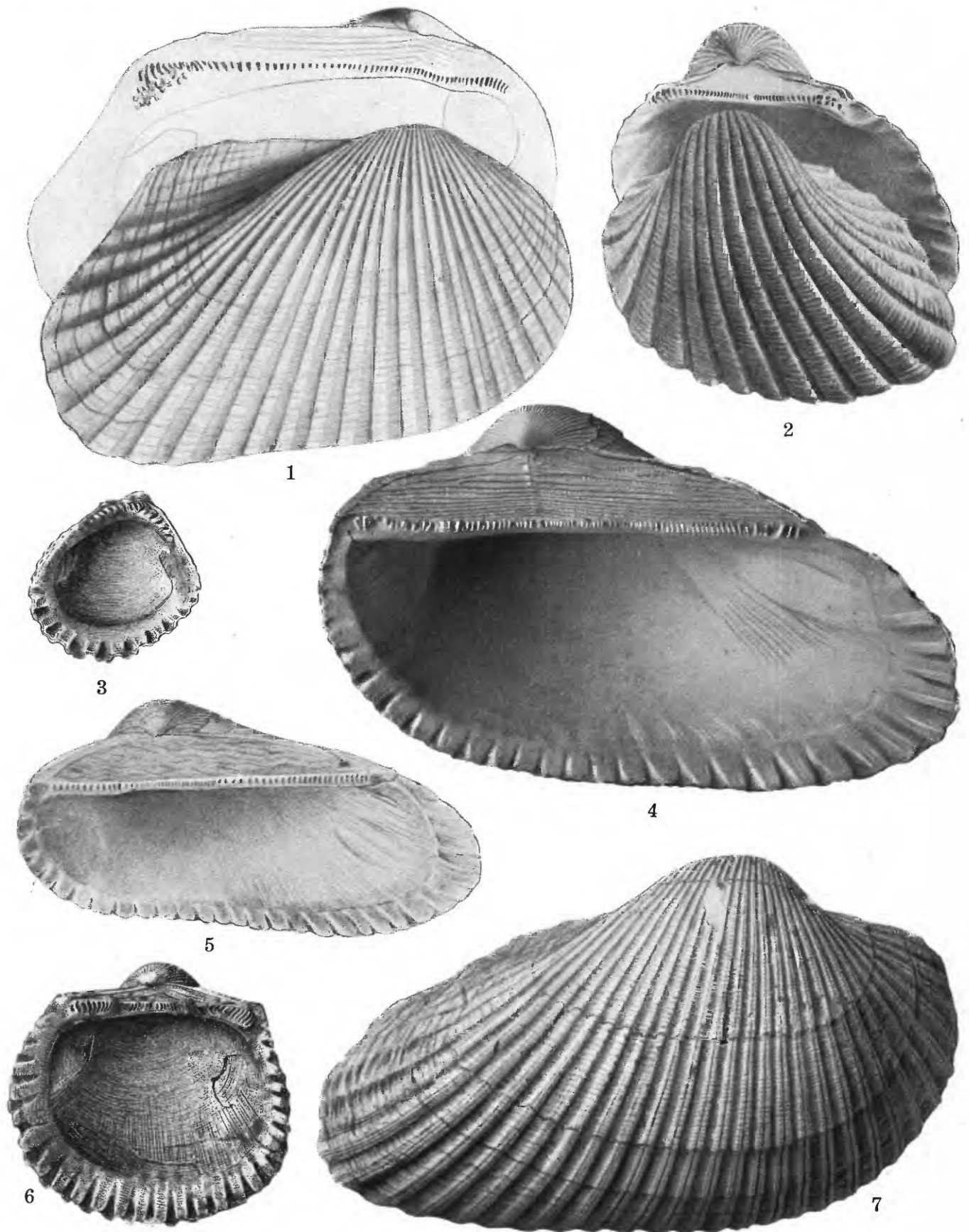
20. Exterior of left valve (U. S. Nat. Mus. 325482); height 85.5 millimeters; width 84.0 millimeters.

21. Interior of same valve.



PELECYPODS.





PELECYPODS.



## PLATE 2

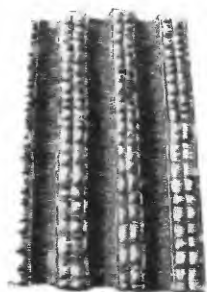
- FIGURE 1. *Barbatia (Granoarca) propatula* (Conrad) (p. 22). Exterior of right valve and hinge of left valve; height 57.0  $\pm$  millimeter; width 100.0  $\pm$  millimeter. (After Conrad.)
- FIGURE 2. *Anadara (Cunearca) scalaris* (Conrad) (p. 26). Exterior of left valve and hinge of right valve; height 54.0  $\pm$  millimeter; width 64.0  $\pm$  millimeter. (After Tuomey and Holmes.)
- FIGURE 3. *Glycymeris duplinensis* Dall (p. 27). Interior of holotype, a left valve (U. S. Nat. Mus. 114941); height 10.0 millimeters; width 9.0 millimeters. (After Dall.)
- FIGURE 4. *Anadara lienosa* (Say) (p. 23). Interior of right valve (U. S. Nat. Mus. 325428); height 69.0 millimeters; width 117.0 millimeters.
- FIGURE 5. *Anadara protracta* (Rogers and Rogers) (p. 24). Interior of right valve; height 40.0  $\pm$  millimeters; width 86.0  $\pm$  millimeters. (After Rogers and Rogers.)
- FIGURE 6. *Anadara carolinensis* (Wagner) (p. 25). Interior of right valve (Wagner Free Inst. Sci. Philadelphia); height 55.0 millimeters; width 56.0 millimeters. (After Dall.)
- FIGURE 7. *Anadara lienosa* (Say) (p. 23). Exterior of right valve (U. S. Nat. Mus. 325428), from Wilmington, N. C.; height 69.0 millimeters; width 117.0 millimeters.

### PLATE 3

- FIGURE 1. *Anadara magnoliana* Gardner, n. sp. (p. 25). Exterior of holotype, a right valve (U. S. Nat. Mus. 325486), from Natural Well, Duplin County, N. C.; height 34.3 millimeters; width 46.7 millimeters.
- FIGURE 2. *Anadara callicestosa* (Dall) (p. 24). Detail of sculpture of holotype. (After Dall.)
- FIGURE 3. *Anadara protracta* (Rogers and Rogers) (p. 24). Exterior of right valve; height  $40.0 \pm$  millimeters; width  $86.0 \pm$  millimeters. (After Rogers and Rogers.)
- FIGURE 4. *Anadara magnoliana* Gardner, n. sp. (p. 25). Interior of holotype.
- FIGURE 5. *Anadara magnoliana* Gardner, n. sp. (p. 25). Detail of sculpture of holotype.
- FIGURE 6. *Anadara callicestosa* (Dall) (p. 24). Exterior of holotype, a left valve (U. S. Nat. Mus. 146264); height 27.0 millimeters; width 32.0 millimeters. (After Dall.)
- FIGURE 7. *Anadara magnoliana* Gardner, n. sp. (p. 25). Interior of right valve (U. S. Nat. Mus. 325487); height 31.0 millimeters; width 39.0 millimeters.
- FIGURE 8. *Anadara callicestosa wilsoni* Gardner, n. subsp. (p. 24). Detail of sculpture of holotype.
- FIGURE 9. *Anadara callicestosa wilsoni* Gardner, n. subsp. (p. 24). Exterior of holotype, a left valve (U. S. Nat. Mus. 325488); height 30.6 millimeters; width 34.3 millimeters.
- FIGURES 10–11. *Pododesmus (Monia?) philippi* Gardner, n. sp. (p. 41).
10. Interior of holotype, a left valve (U. S. Nat. Mus. 325497); height 35.7 millimeters; width 36.0 millimeters.
11. Detail of sculpture of holotype.
- FIGURE 12. *Anadara callicestosa wilsoni* Gardner, n. subsp. (p. 24). Interior of holotype.
- FIGURE 13. *Pododesmus (Monia?) philippi* Gardner, n. sp. (p. 41). Exterior of holotype.
- FIGURES 14–16. *Crenella precursor* Gardner, n. sp. (p. 30).
14. Hinge of holotype,  $\times 6$ .
15. Exterior of holotype, a right valve (U. S. Nat. Mus. 325498); height 7.6 millimeters; width 6.4 millimeters.
16. Interior of holotype.
- FIGURE 17. *Ostrea waccamawensis* Gardner, n. sp. (p. 41). Exterior of holotype, a left valve (U. S. Nat. Mus. 497063); height 68.0 millimeters; width 57.0 millimeters.



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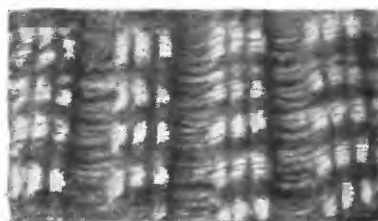
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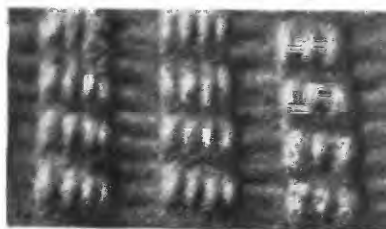
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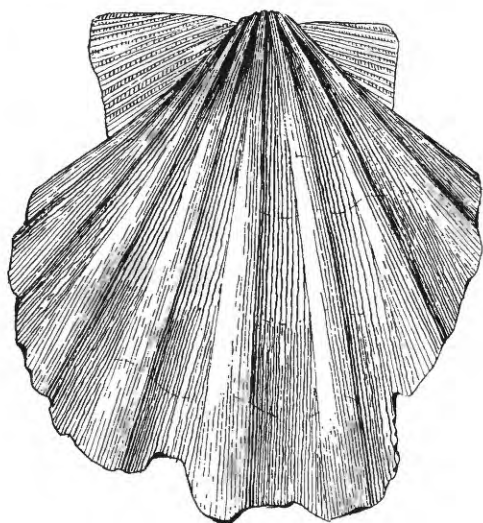
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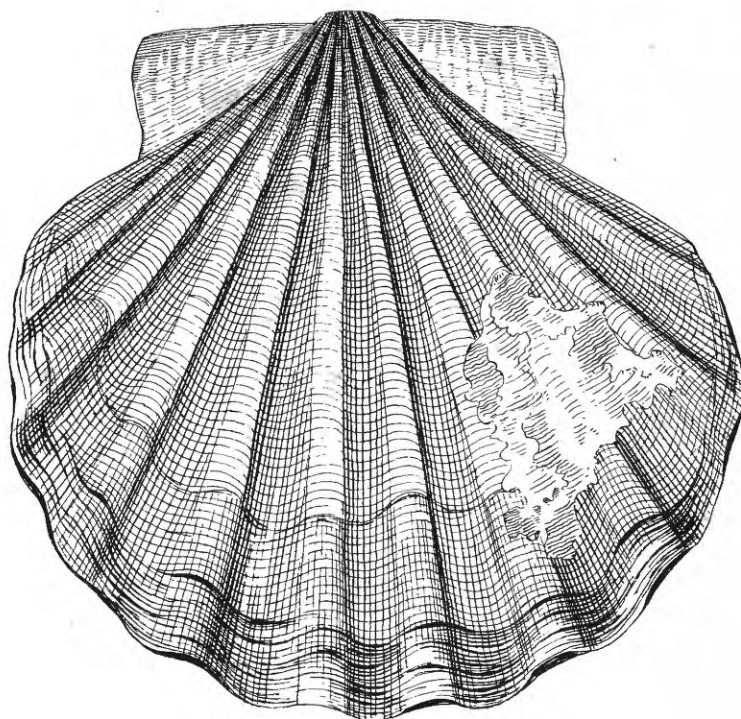
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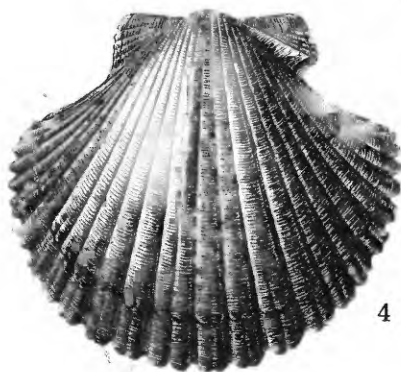
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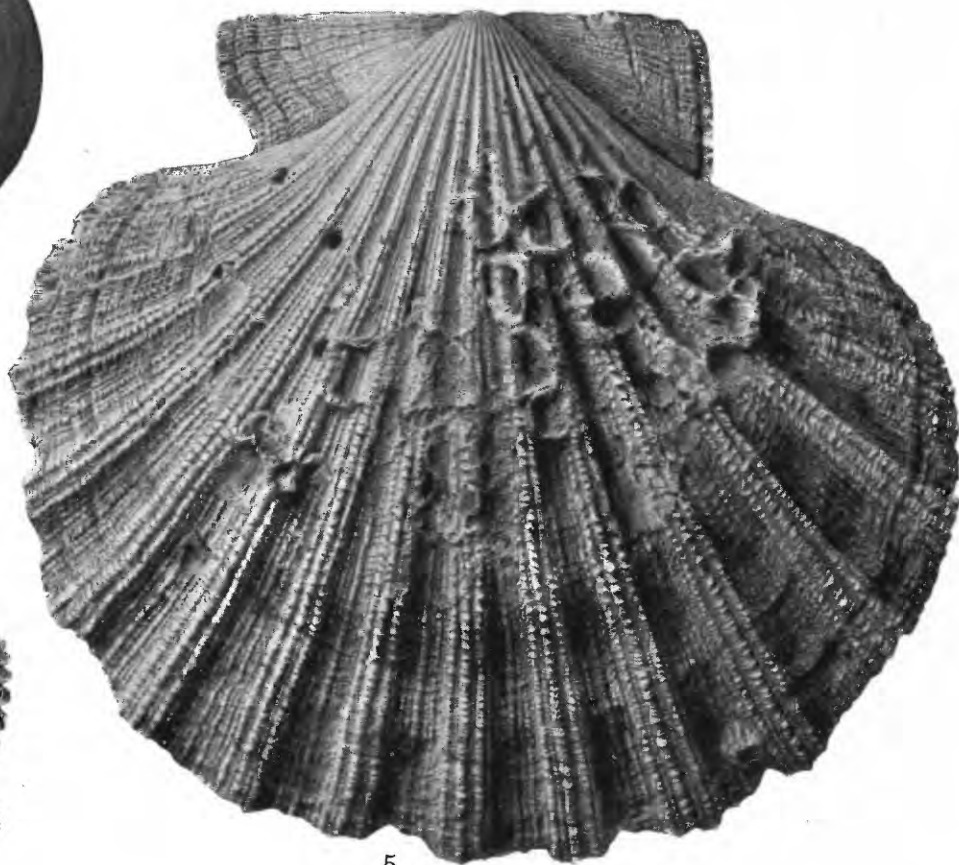
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PELECYPODS.

#### PLATE 4

- FIGURE 1. *Chlamys (Lyropecten) jeffersonia septenaria* (Say) (p. 34). Exterior of left valve; height 70.0 millimeters; width 70.0 millimeters. (After Say.)
- FIGURE 2. *Chlamys (Lyropecten) jeffersonia* (Say) (p. 32). Exterior of left valve; "length 5.3 inches; breadth 5.7 inches." (After Say.)
- FIGURE 3. *Chlamys (Placopecten) virginiana* (Conrad) (p. 38). Exterior of holotype, a right valve (Acad. Nat. Sci. Philadelphia 1620); height 57.8 millimeters; width 58.8 millimeters.
- FIGURE 4. *Pecten (Euvola) raveneli* Dall (p. 30). Exterior of holotype, a right valve (U. S. Nat. Mus. 107750); height 42.0 millimeters; width 47.0 millimeters. (After Dall.)
- FIGURE 5. *Chlamys (Lyropecten) madisonia* (Say) (p. 32). Exterior of left valve (U. S. Nat. Mus. 325490); height 117.0 millimeters; width 126.0 millimeters.

## PLATE 5

FIGURES 1-2. *Chlamys decemnaria* (Conrad) (p. 31).

1. Exterior of left valve (U. S. Nat. Mus. 325496); height 18.0 millimeters; width 15.7 millimeters.

2. Exterior of left valve (U. S. Nat. Mus. 325495); height 27.3 millimeters; width 25.0 millimeters.

FIGURE 3. *Pecten* sp. cf. *P. (Plagioctenium) gibbus* (Linnaeus), s. l. (p. 31). Exterior of right valve (U. S. Nat. Mus. 146256); height 43.0 millimeters; width 44.0 millimeters.

FIGURE 4. *Chlamys (Placopecten) marylandica* (Wagner) (p. 38). Exterior of left valve (U. S. Nat. Mus. 145991); height 67.5 millimeters; width 66.0 millimeters.

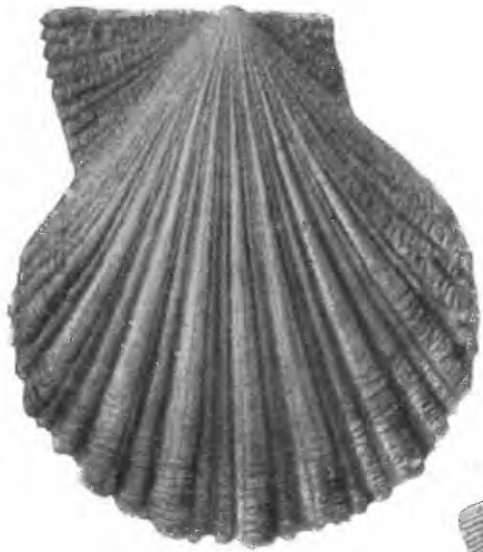
FIGURE 5. *Glycymeris duplinensis* Dall (p. 27). Exterior of holotype, a left valve (U. S. Nat. Mus. 114941); height 10.0 millimeters; width 9.0 millimeters. (After Dall.)

FIGURES 6-7. *Chlamys decemnaria* (Conrad) (p. 31).

6. Exterior of right valve (U. S. Nat. Mus. 325495); height 27.3 millimeters; width 25.0 millimeters.

7. Exterior of right valve (U. S. Nat. Mus. 325494); height 43.0 millimeters; width 42.0 millimeters.





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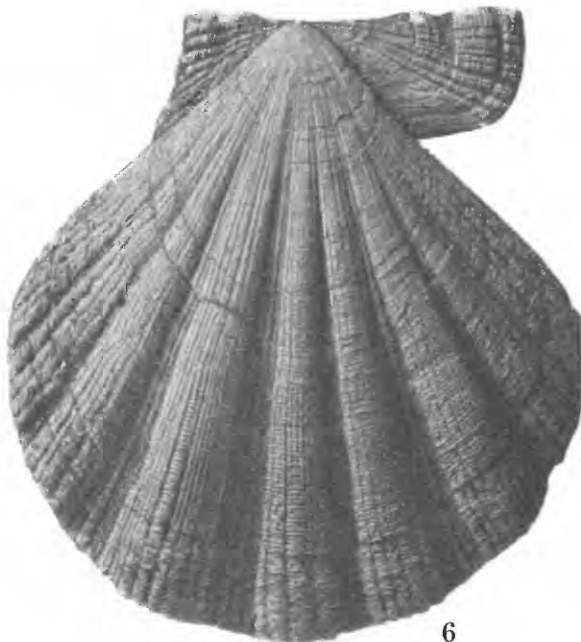
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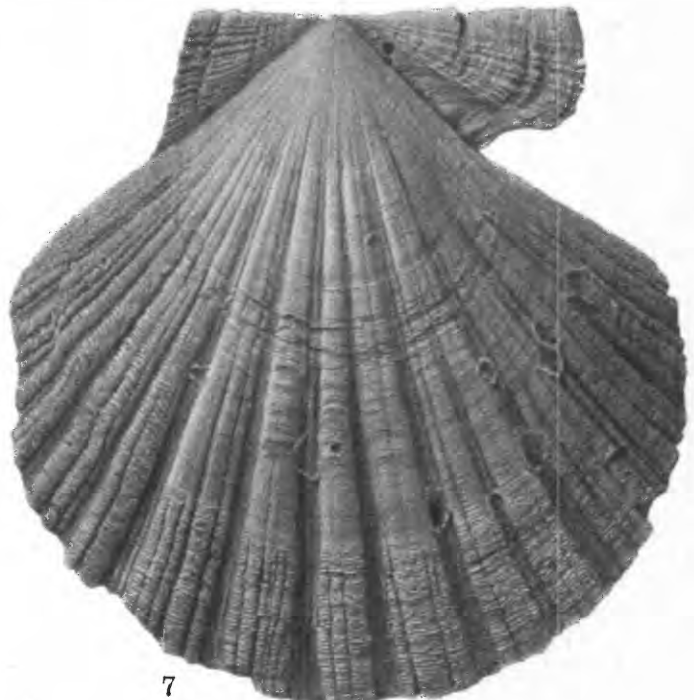
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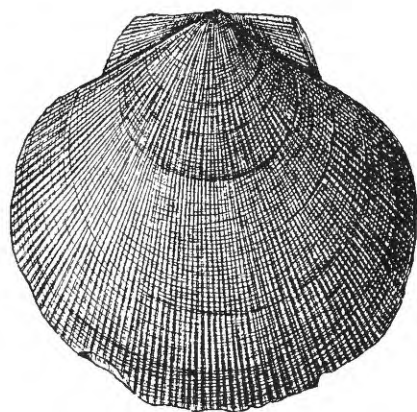


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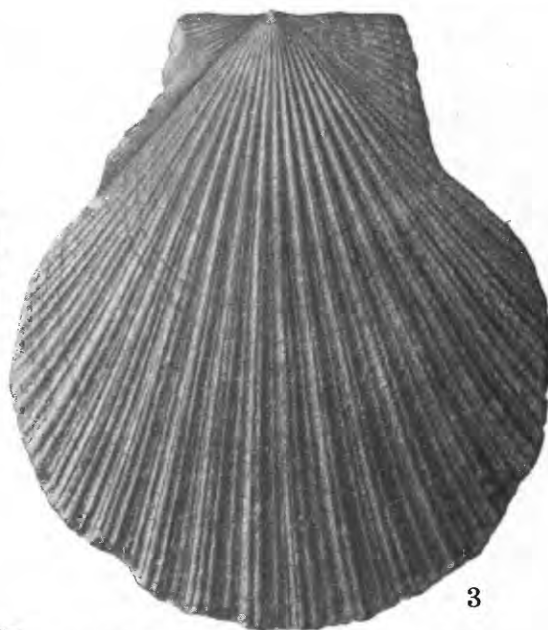




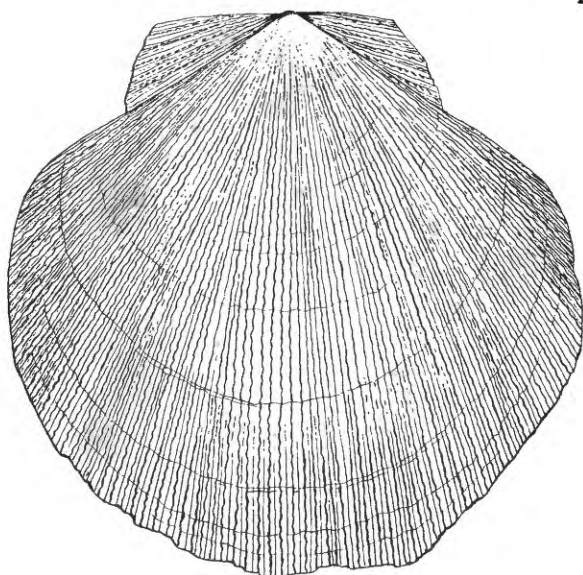
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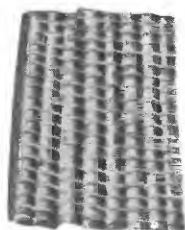
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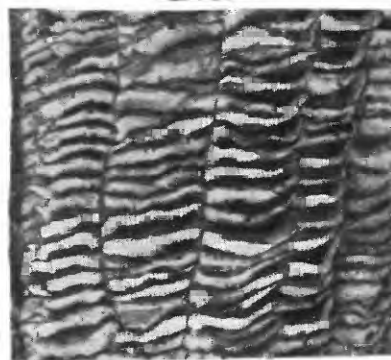
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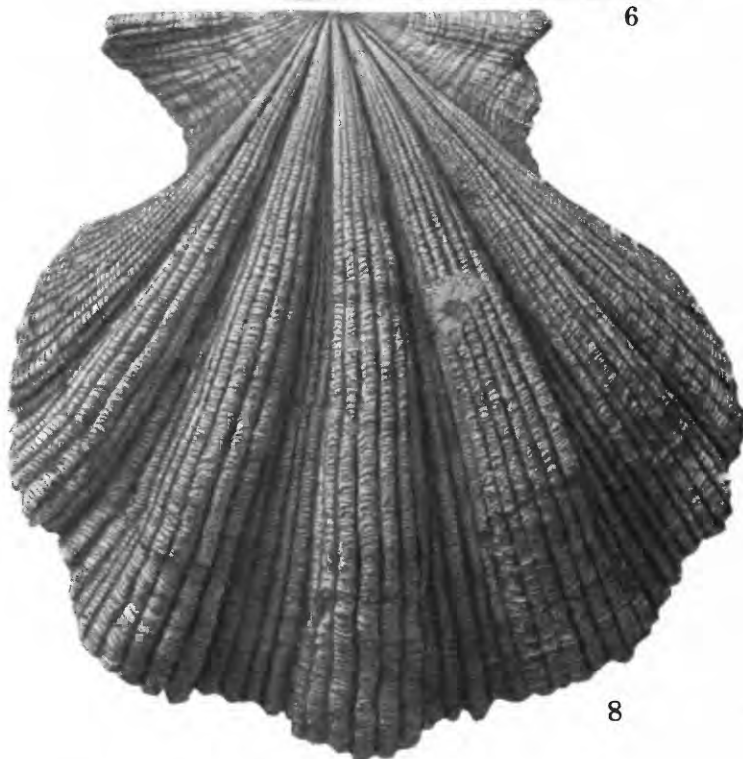
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## PLATE 6

FIGURE 1. *Chlamys (Placopecten) clintonia* (Say) (p. 37). Exterior of left valve; height 100.0+ millimeters; width 104.0 millimeters (After Glenn.)

FIGURES 2-3. *Chlamys (Placopecten) marylandica* (Wagner) (p. 38).

2. Exterior of right valve (U. S. Nat. Mus. 143966); height 53.5 millimeters; width 47.0+ millimeters.

3. Exterior of left valve (U. S. Nat. Mus. 145991); height 81 millimeters; width 70 millimeters.

FIGURE 4. *Chlamys (Placopecten) clintonia* (Say) (p. 37). Exterior of left valve; "length 4 inches; breadth rather more." (After Say.)

FIGURE 5. *Chlamys (Lyropecten) peedeensis* (Tuomey and Holmes) (p. 35). Detail of sculpture. (After Tuomey and Holmes.)

FIGURES 6-8. *Chlamys (Lyropecten) ernestsmithi* (Tucker) (p. 34).

6. Detail of sculpture.

7. Exterior of right valve (U. S. Nat. Mus. 325492); height 70.0 millimeters; width 67.0 millimeters.

8. Exterior of left valve (U. S. Nat. Mus. 325492); height 101.5 millimeters; width 100.0 millimeters.

## PLATE 7

FIGURE 1. *Chlamys (Aequipecten) eborea* (Conrad) (p. 36). Exterior of right valve (double valves); height  $83.0 \pm$  millimeters; width  $90.0 \pm$  millimeters. (After Tuomey and Holmes.)

FIGURES 2-4. *Chlamys (Aequipecten) comparilis* (Tuomey and Holmes) (p. 37).

2. Exterior of right valve of holotype (double valves); height  $65.0 \pm$  millimeters; width  $65.0 \pm$  millimeters. (After Tuomey and Holmes.)

3. Detail of sculpture and of ventral margin of holotype. (After Tuomey and Holmes.)

4. Profile of double valves of holotype; convexity  $29.0 \pm$  millimeters. (After Tuomey and Holmes.)

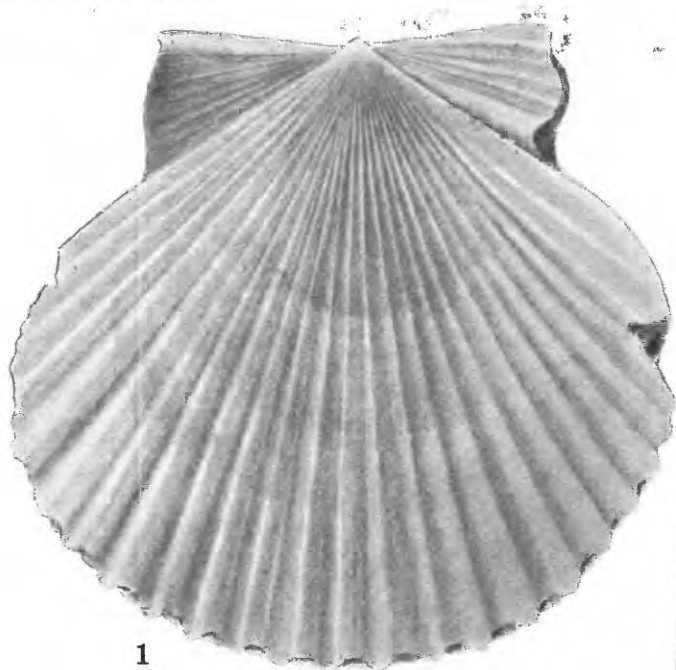
FIGURES 5-6. *Chlamys (Aequipecten) eborea* (Conrad) (p. 36).

5. Profile of double valves; convexity  $23.0 \pm$  millimeters. (After Tuomey and Holmes.)

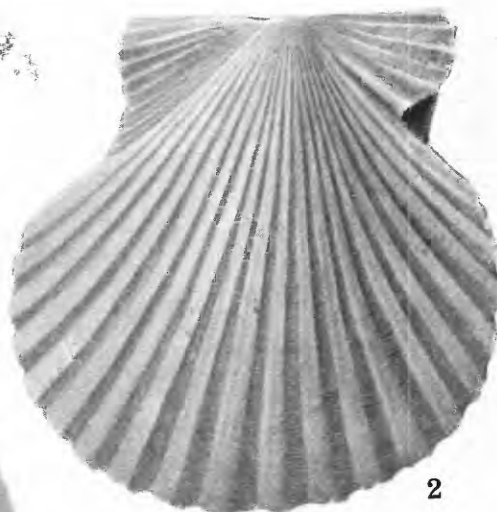
6. Detail of sculpture and of ventral margin. (After Tuomey and Holmes.)

FIGURE 7. *Chlamys (Aequipecten) comparilis* (Tuomey and Holmes) (p. 37). Exterior of left valve of holotype(?). (After Tuomey and Holmes.)

FIGURE 8. *Chlamys (Aequipecten) eborea* (Conrad) (p. 36). Exterior of left valve. (After Tuomey and Holmes.)



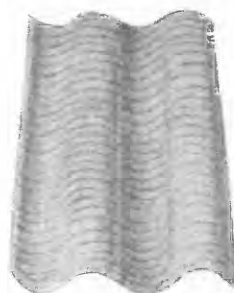
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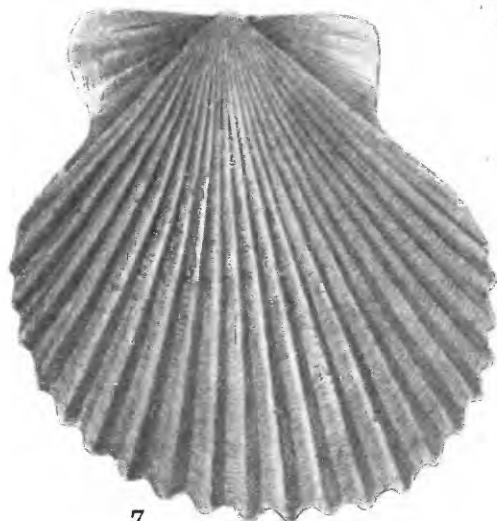
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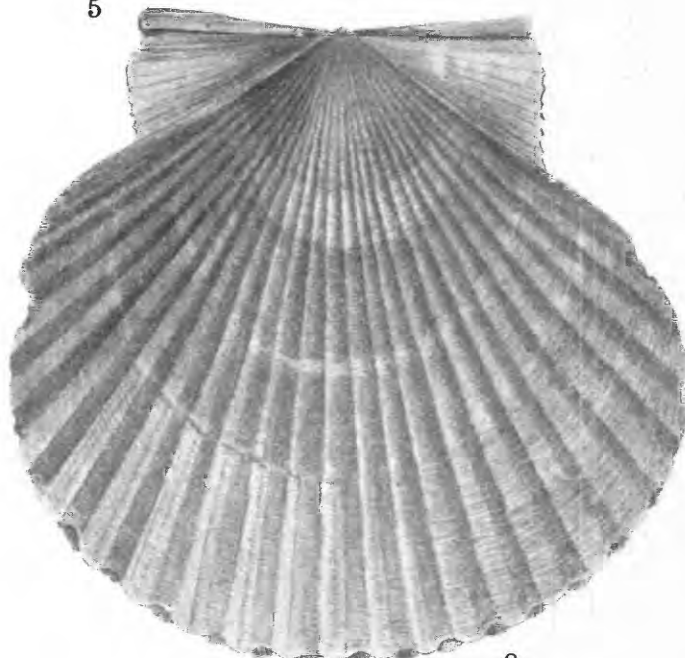
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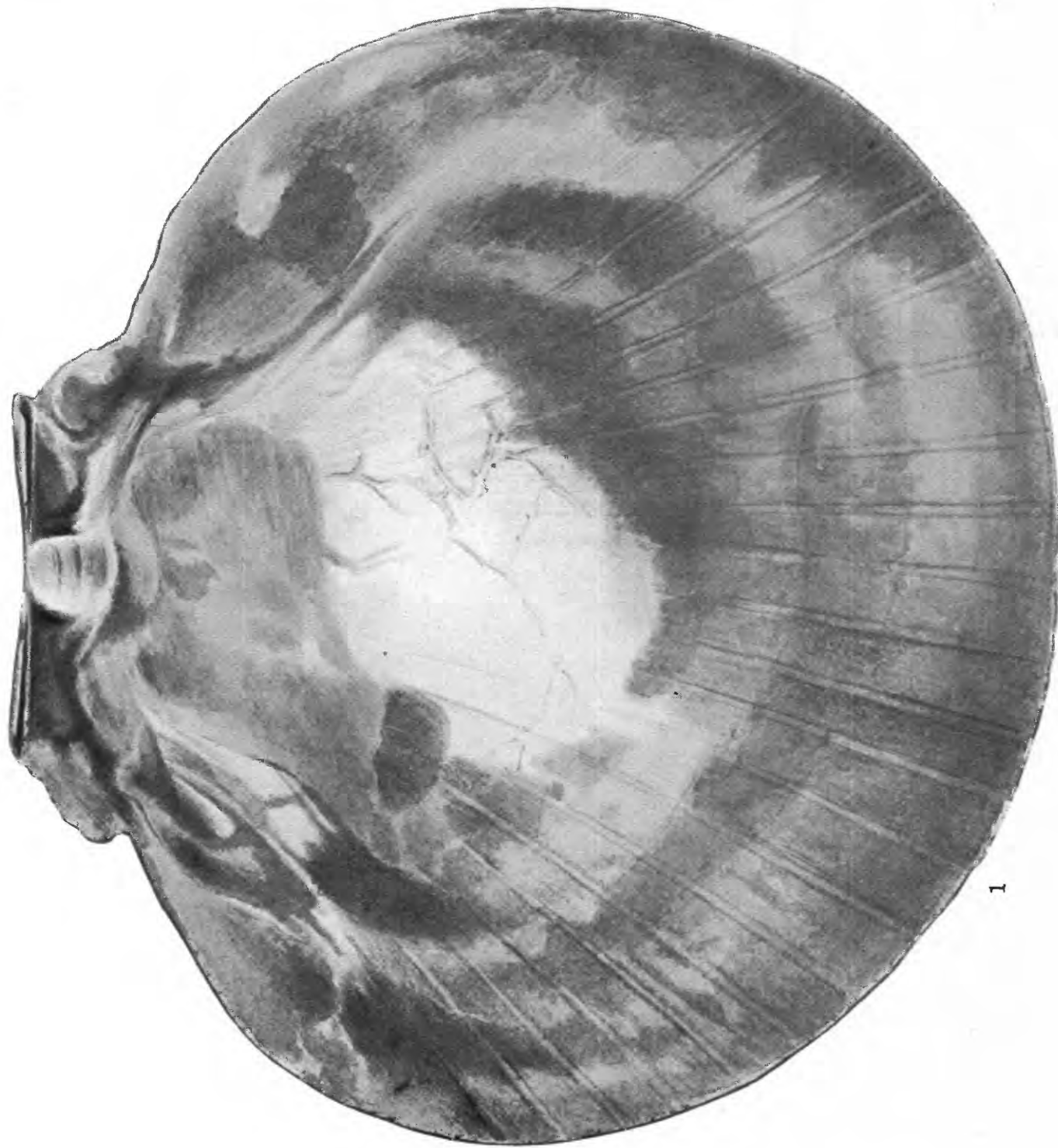
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## PLATE 8

FIGURES 1-2. *Amusium mortoni* (Ravenel) (p. 39).

1. Interior of right valve; height 178 millimeters; width 195 millimeters. (After Tuomey and Holmes.)
2. Profile of double valves; convexity 31 millimeters. (After Tuomey and Holmes.)

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## PLATE 9

FIGURE 1. *Chlamys (Lyropecten) planicosta* Gardner, n. sp. (p. 34). Exterior of right valve (U. S. Nat. Mus. 325493); height 111.0 millimeters; width 118.0±millimeters.

FIGURES 2-6. *Coralliophaga? microreticulata* Gardner (p. 66). Cotypes (U. S. Nat. Mus. 325560).

2. Cluster of burrows showing openings at smaller ends, ×3.

3. Fragment of ventral portion of shell, ×2.

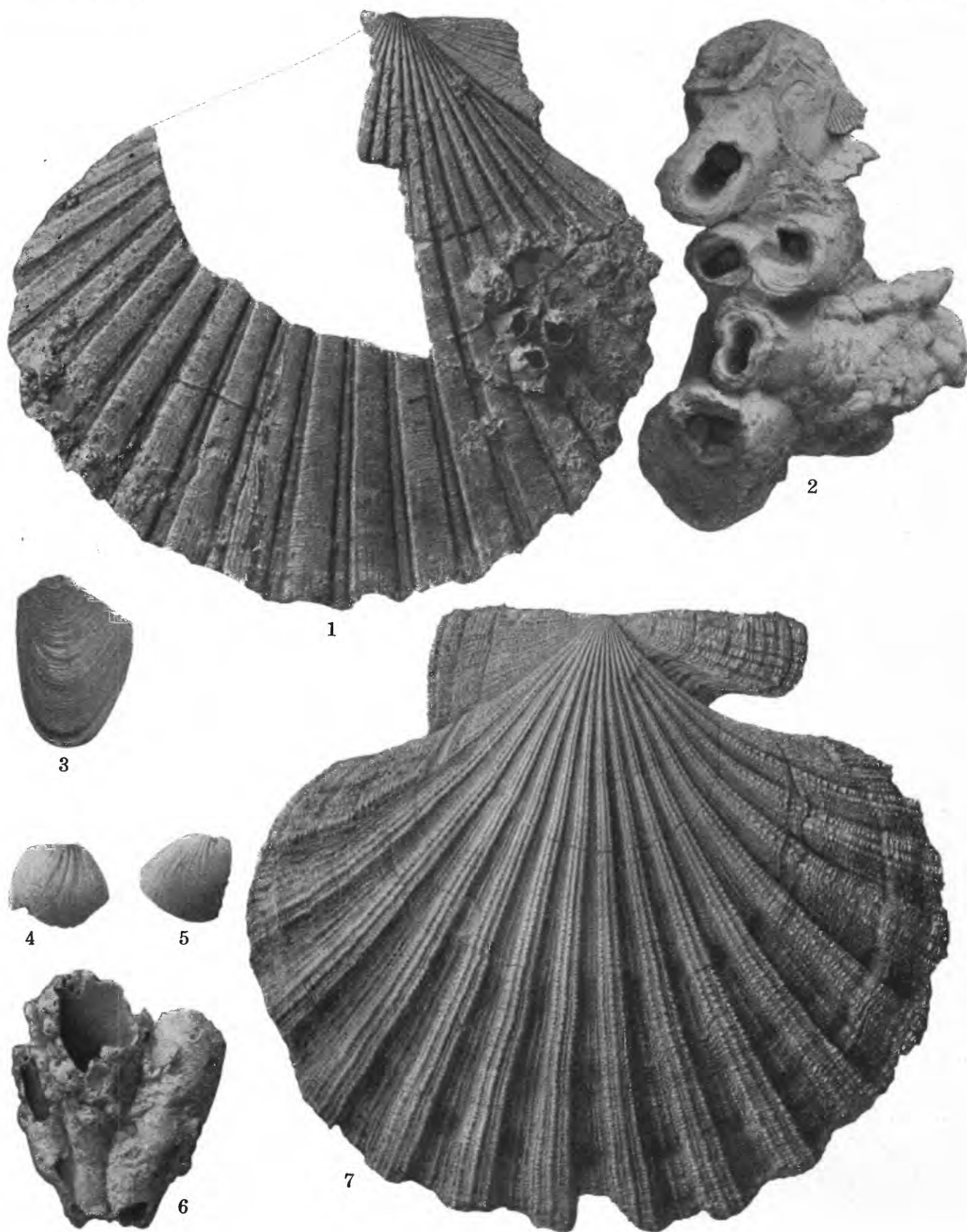
4. Fragment of anterior portion of right valve, ×2.

5. Fragment of anterior portion of left valve, ×2.

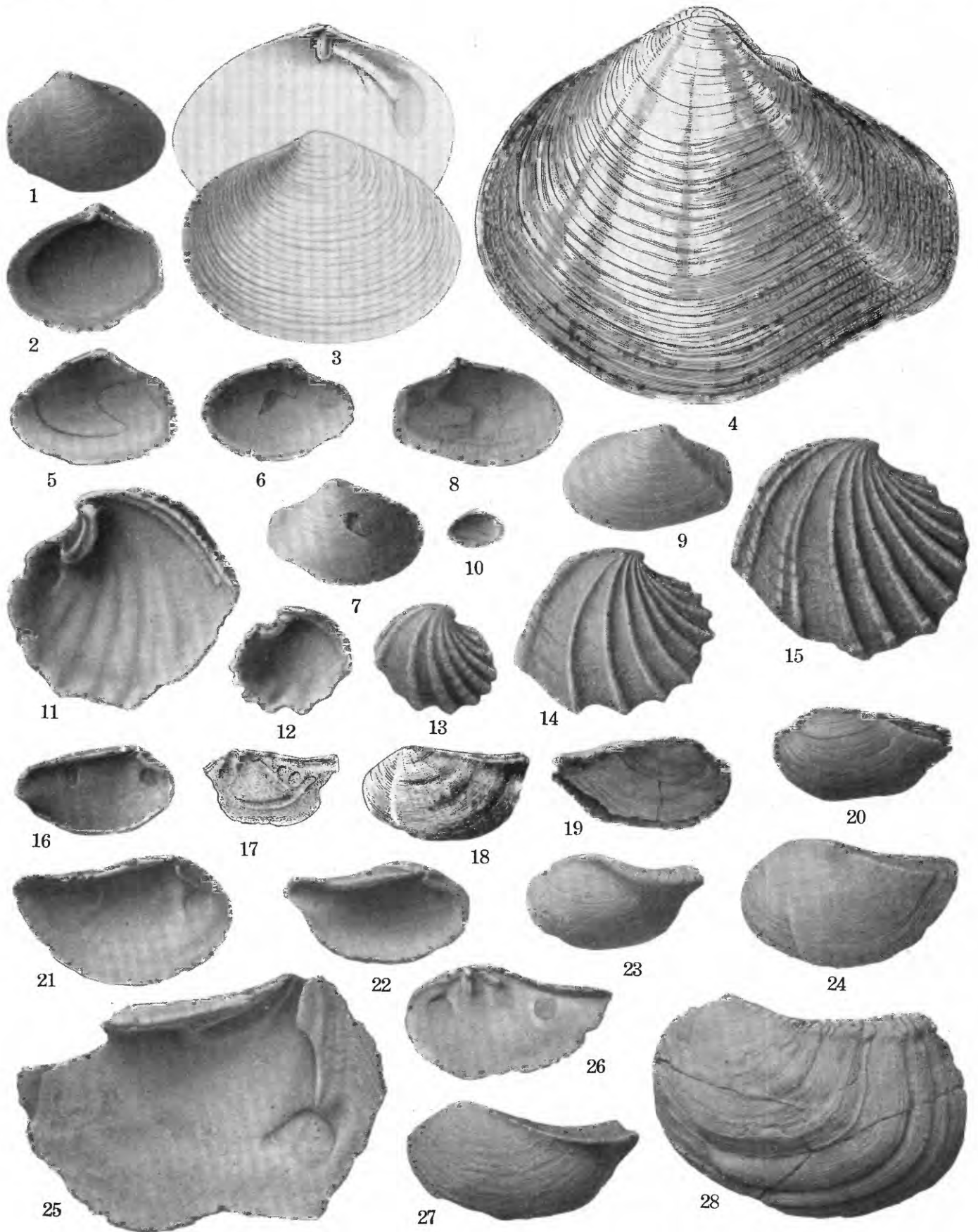
6. Cluster of burrows, natural size.

FIGURE 7. *Chlamys (Lyropecten) madisonia* (Say) (p. 32). Exterior of right valve (U. S. Nat. Mus. 325490); height 117.0 millimeters; width 131.0 millimeters.





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## PLATE 10

FIGURES 1-2. *Thracia maddelysensis* Gardner, n. sp. (p. 44).

1. Exterior of holotype, a right valve (U. S. Nat. Mus. 325508); height 4.0 millimeters; width 5.0 millimeters.

2. Interior of holotype.

FIGURE 3. *Periploma (Cochlodesma) antiqua* Conrad (p. 42). Interior of right valve of holotype and exterior of left valve; height  $39.0 \pm$  millimeters; width  $52.5 \pm$  millimeters. (After Conrad.)

FIGURE 4. *Thracia conradi* Couthouy (p. 43). Exterior of left valve and overtopping margin of right; height 74.0 millimeters; width  $90.0 \pm$  millimeters. (After Gould, 1870, and Dall, 1889.)

FIGURES 5-10. *Thracia transversa* H. C. Lea (p. 43).

5. Interior of right valve (Acad. Nat. Sci. Philadelphia 1585); height  $1.8 \pm$  millimeters; width  $2.6 \pm$  millimeters.

6. Interior of right valve (U. S. Nat. Mus. 325509); height  $4.8 \pm$  millimeters; width 7.3 millimeters.

7. Exterior of same right valve.

8. Interior of left valve (U. S. Nat. Mus. 325509); height  $5.1 \pm$  millimeters; width 7.9 millimeters.

9. Exterior of same left valve.

10. Interior of right valve (Acad. Nat. Sci. Philadelphia 1585); height  $1.8 \pm$  millimeters; width  $2.6 \pm$  millimeters.

FIGURE 11. *Verticordia (Trigonulina) chowanensis* Gardner, n. sp. (p. 51). Interior of holotype, a right valve (U. S. Nat. Mus. 325507); height 5.1 millimeters; width 5.6 millimeters.

FIGURES 12-13. *Verticordia (Trigonulina) rogersi* Gardner, n. sp. (p. 50).

12. Interior of holotype, a right valve (U. S. Nat. Mus. 325506); height 2.5 millimeters; width 2.8 millimeters.

13. Exterior of right valve of holotype.

FIGURE 14. *Verticordia (Trigonulina) emmonsii* Conrad (p. 50). Exterior of right valve (U. S. Nat. Mus. 145332); height 6.0 millimeters; width 6.8 millimeters.

FIGURE 15. *Verticordia (Trigonulina) chowanensis* Gardner, n. sp. (p. 51). Exterior of holotype shown in figure 11.

FIGURE 16. *Pandora (Kennerlia) arenosa* Conrad (p. 45). Interior of left valve of topotype (U. S. Nat. Mus. 325505); height 8.0 millimeters; width 14.5 millimeters.

FIGURES 17-18. *Pandora (Clidiophora) crassidens* Conrad (p. 46).

17. Interior of right valve from Cove Point, St. Marys River, Md., slightly enlarged. (After Glenn.)

18. Exterior of left valve from Cove Point, St. Marys River, Md., slightly enlarged. (After Glenn.)

FIGURES 19-20. *Pandora (Kennerlia) arenosa* Conrad (p. 45).

19. Exterior of topotype (U. S. Nat. Mus. 325505), a right valve, the margin of the slightly larger left valve visible dorsally and ventrally; height of double valves 8.5 millimeters; width 16.6 millimeters.

20. Exterior of double valves from left.

FIGURE 21. *Pandora (Kennerlia) dalli* Gardner, n. sp. (p. 45). Interior of holotype, a left valve (U. S. Nat. Mus. 325503); height 11.1 millimeters; width 19.8 millimeters.

FIGURES 22-23. *Pandora (Kennerlia) naviculoides* Gardner, n. sp. (p. 46).

22. Interior of holotype, a left valve (U. S. Nat. Mus. 325504); height 8.9 millimeters; width 16.6 millimeters.

23. Exterior of holotype.

FIGURE 24. *Pandora (Kennerlia) dalli* Gardner, n. sp. (p. 45). Exterior of holotype.

FIGURE 25. *Pandora (Clidiophora) crassidens majorina* Gardner, n. subsp. (p. 47). Interior of paratype, a left valve (U. S. Nat. Mus. 325500); height  $25.0 \pm$  millimeters; width  $35.0 \pm$  millimeters.

FIGURE 26. *Pandora (Kennerlia) dalli* Gardner, n. sp. (p. 45). Interior of paratype (U. S. Nat. Mus. 325503); height 10.2 millimeters; width 18.8 millimeters.

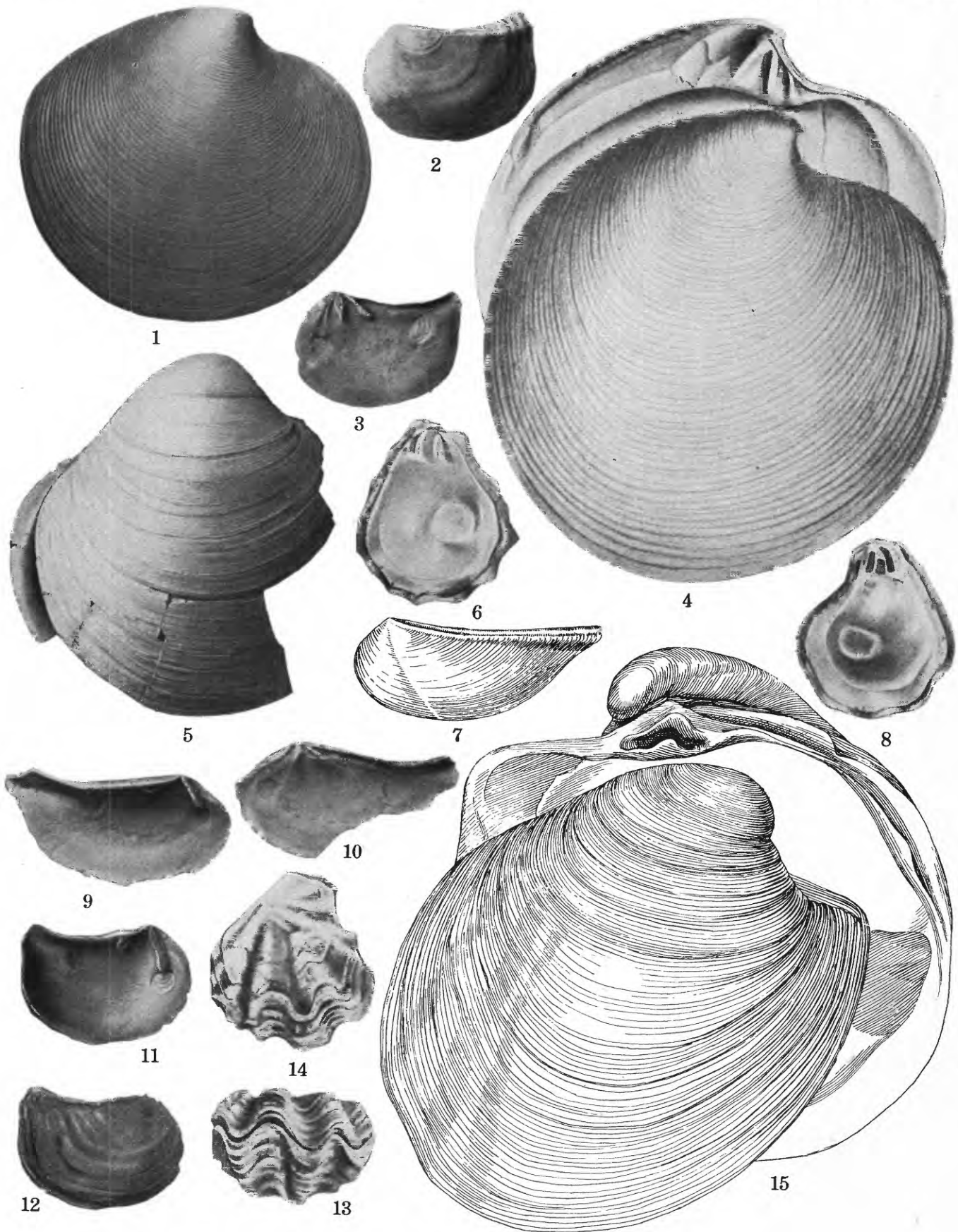
FIGURE 27. *Pandora (Clidiophora) tuomeyi* Gardner and Aldrich (p. 48). Exterior of holotype, a left valve (U. S. Nat. Mus. 325502); height 9.5 millimeters; width 21.0 millimeters; convexity 2.0 millimeters.

FIGURE 28. *Pandora (Clidiophora) crassidens majorina* Gardner, n. subsp. (p. 47). Exterior of holotype, a left valve (U. S. Nat. Mus. 325501); height 37.8 millimeters; width 59.6 millimeters.

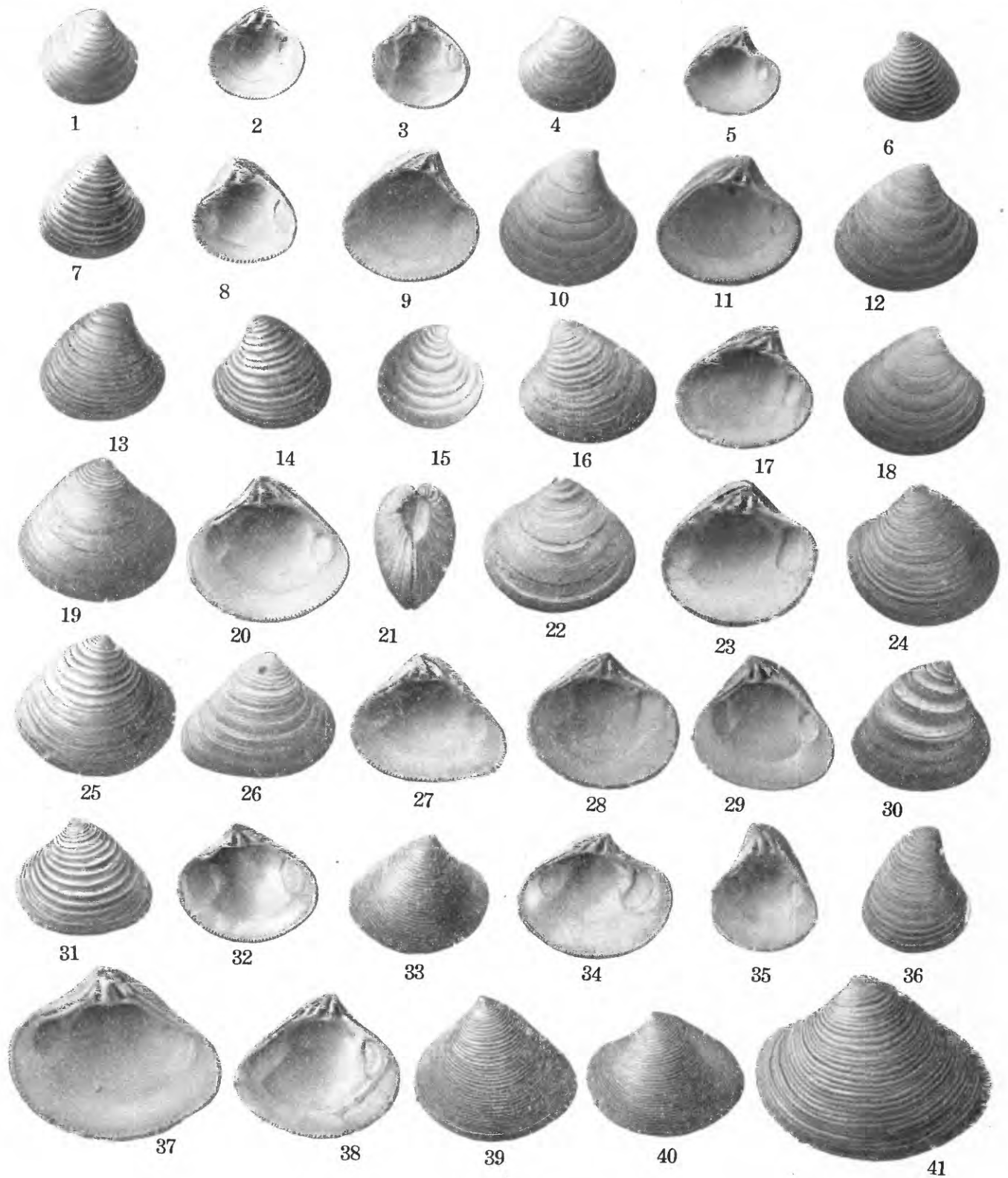
## PLATE 11

- FIGURE 1. *Dosinia (Dosinidia) elegans* Conrad (p. 122). Exterior of right valve (U. S. Nat. Mus. 497065) from Shell Creek, De Soto County, Fla.; height 61.0 millimeters; width 68.0 millimeters.
- FIGURES 2-3. *Pandora (Clidiophora) prodromos* Gardner and Aldrich (p. 48). Holotype, the two valves of a single individual (U. S. Nat. Mus. 325499) from Yorktown, Va.; height 21.0 millimeters; width 33.0 millimeters.
2. Exterior of left valve. (After Gardner and Aldrich.)
  3. Interior of right valve. (After Gardner and Aldrich.)
- FIGURE 4. *Dosinia (Dosinidia) acetabulum* Conrad (p. 120). Exterior of right valve and hinge of left valve of holotype. (After Conrad.)
- FIGURE 5. *Isocardia fraterna carolina* Dall (p. 67). Exterior of specimen, a right valve (U. S. Nat. Mus. 325558) from Delaware, Nottoway River, Va.; height 71.0 millimeters; width 73.0 millimeters; semidiameter 25.0 millimeters.
- FIGURE 6. *Plicatula marginata* Say (p. 40). Interior of right valve from the Darlington district, S. C.; height  $34.0 \pm$  millimeters; width  $30.0 \pm$  millimeters. (After Tuomey and Holmes.)
- FIGURE 7. *Pandora (Clidiophora) trilineata* Say (p. 49). Exterior of left valve (U. S. Nat. Mus. 61028), Recent in Tampa Bay, Fla.; height 8.0 millimeters; width 20.0 millimeters; diameter 2.0 millimeters. (After Dall.)
- FIGURE 8. *Plicatula marginata* Say (p. 40). Interior of left valve from the Darlington district, S. C.; height  $34.0 \pm$  millimeters; width 30.0 millimeters. (After Tuomey and Holmes.)
- FIGURES 9-10. *Pandora (Clidiophora) tuomeyi* Gardner and Aldrich (p. 48).
9. Interior of holotype, a left valve (U. S. Nat. Mus. 325502) from Walkers Bluff, Bladen County, N. C.; height 9.5 millimeters; width 21.0 millimeters. (After Gardner and Aldrich.)
  10. Interior of paratype, a right valve (U. S. Nat. Mus. 325502) from Walkers Bluff, Bladen County, N. C.; height 11.0 millimeters. (After Gardner and Aldrich.)
- FIGURES 11-12. *Pandora (Clidiophora) prodromos* Gardner and Aldrich (p. 48).
11. Interior of left valve of holotype shown in figure 2. (After Gardner and Aldrich.)
  12. Exterior of right valve of holotype shown in figure 3. (After Gardner and Aldrich.)
- FIGURES 13-14. *Plicatula marginata* Say (p. 40).
13. Ventral margin of paired valves from Darlington district, S. C. (After Tuomey and Holmes.)
  14. Exterior of left(?) valve from the Darlington district, S. C.; height  $29.0 \pm$  millimeters; width  $33.0 \pm$  millimeters. (After Tuomey and Holmes.)
- FIGURE 15. *Isocardia fraterna* Say (p. 67). Exterior of right valve and hinge of right valve. (After Say.)





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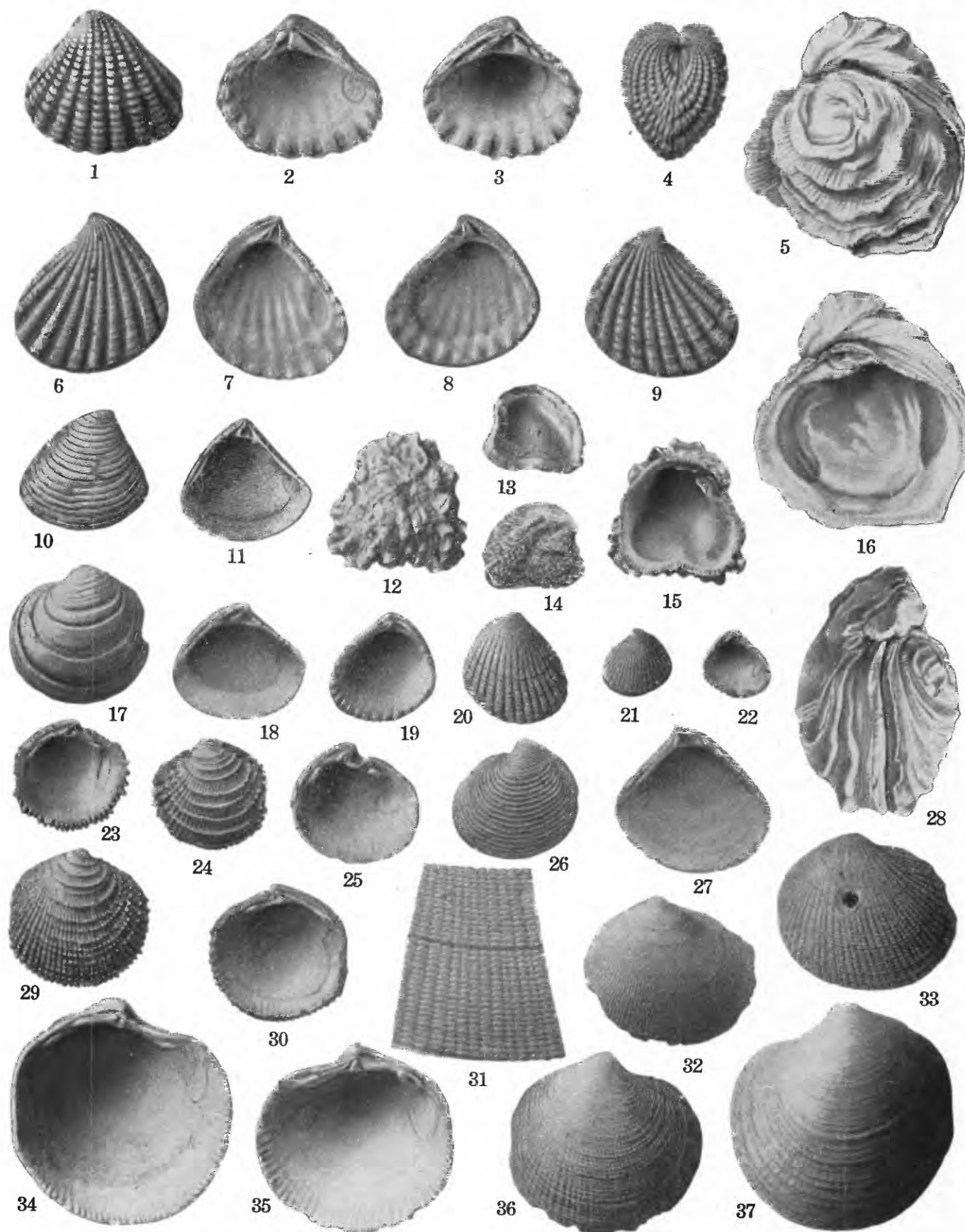
## PLATE 12

- FIGURES 1-4. *Astarte symmetrica* Conrad (p. 51). Topotypes, a right and a left valve of different individuals (U. S. Nat. Mus. 325516) from Yorktown, Va.
1. Exterior of right valve; height 16.9 millimeters; width 17.7 millimeters.
  2. Interior of left valve; height 17.0 millimeters; width 17.5 millimeters.
  3. Interior of right valve shown in figure 1.
  4. Exterior of left valve shown in figure 2.
- FIGURES 5-8. *Astarte exaltata* Conrad (p. 52). A right and a left valve of different individuals (U. S. Nat. Mus. 325519) from the mouth of Baileys Creek, James River, Va.
5. Interior of left valve; height 16.0 millimeters; width 17.0 millimeters.
  6. Exterior of left valve shown in figure 5.
  7. Exterior of right valve; height 19.0 millimeters; width 18.8 millimeters.
  8. Interior of right valve shown in figure 7.
- FIGURES 9-10. *Astarte roanokensis* Gardner, n. sp. (p. 53). Two cotypes, a right and a left valve of different individuals (U. S. Nat. Mus. 325523) from Halifax, N. C.
9. Interior of left cotype; height 24.2 millimeters; width 23.9 millimeters.
  10. Exterior of right cotype; height 24.4 millimeters; width 23.9 millimeters.
- FIGURES 11-12. *Astarte hertfordensis* Gardner, n. sp. (p. 53). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325526) from Murfreesboro, Hertford County, N. C.
11. Interior of left valve of holotype; height 23.0 millimeters; width 25.7 millimeters.
  12. Exterior of right valve of holotype.
- FIGURES 13-14. *Astarte arata* Conrad (p. 55).
13. Exterior of right valve (U. S. Nat. Mus. 325517) from Halifax, N. C.; height 21.5 millimeters; width 21.0 millimeters.
  14. Exterior of left valve (U. S. Nat. Mus. 325517) from Halifax, N. C.; height 20.0 millimeters; width 21.0 millimeters.
- FIGURE 15. *Astarte coheni* Conrad (p. 53). Exterior of right valve; height  $18.0 \pm$  millimeters; width  $18.5 \pm$  millimeters. (After Conrad.)
- FIGURES 16-17. *Astarte stephensoni* Gardner, n. sp. (p. 54). Holotype, a left valve (U. S. Nat. Mus. 325528) from Halifax, N. C.; height 22.7 millimeters; width 24.2 millimeters; convexity 6.3 millimeters.
16. Exterior of holotype.
  17. Interior of holotype.
- FIGURE 18. *Astarte hertfordensis meherrinensis* Gardner, n. subsp. (p. 54). Exterior of holotype, a right valve (U. S. Nat. Mus. 325531); height 23.0 millimeters; width 24.8 millimeters.
- FIGURES 19-20. *Astarte (Ashtarotha) rappahannockensis* Gardner, n. p. (p. 56). Holotype, a right valve (U. S. Nat. Mus. 325527) from Urbanna, Va.; height 25.8 millimeters; width 28.6 millimeters.
19. Exterior of holotype.
  20. Interior of holotype.
- FIGURE 21. *Astarte hertfordensis* Gardner, n. sp. (p. 53). Holotype (U. S. Nat. Mus. 325526) from Murfreesboro, N. C. Double valves viewed from the front; diameter 14.4 millimeters.
- FIGURE 22. *Astarte (Ashtarotha) griftonensis* Gardner, n. sp. (p. 57). Exterior of holotype, a left valve (U. S. Nat. Mus. 325524) from 2 miles east of Grifton, Pitt County, N. C.; height 23.8 millimeters; width 27.0 millimeters.
- FIGURES 23-24. *Astarte berryi* Gardner, n. sp. (p. 56). Holotype, a left valve (U. S. Nat. Mus. 325533) from  $2\frac{1}{2}$  miles northwest of Chocowinity, Beaufort County, N. C.; height 25.0 millimeters; width 27.2 millimeters.
23. Interior of holotype.
  24. Exterior of holotype.
- FIGURE 25. *Astarte (Ashtarotha) undulata* Say (p. 57). Exterior of right valve (U. S. Nat. Mus. 325521) from  $1\frac{1}{4}$  miles northeast of Chocowinity, N. C.; height 25.0 millimeters; width 28.5 millimeters.
- FIGURES 26-27. *Astarte (Ashtarotha) undulata vaginulata* Dall (p. 58). Lectotype, a right valve (U. S. Nat. Mus. 146121) from Grove Wharf, James River, Va.; height 22.4 millimeters; width 27.5 millimeters.
26. Exterior of lectotype.
  27. Interior of lectotype.
- FIGURE 28. *Astarte (Ashtarotha) griftonensis* Gardner, n. sp. (p. 57). Interior of holotype shown in figure 22.
- FIGURES 29-30. *Astarte (Ashtarotha) undulata deltoidea* Gardner, n. subsp. (p. 59). Holotype, a right valve (U. S. Nat. Mus. 325525) from 7 to  $7\frac{1}{2}$  miles below Zuni, Isle of Wight County, Va.; height 23.5 millimeters; width 24.7 millimeters.
29. Interior of holotype.
  30. Exterior of holotype.
- FIGURE 31. *Astarte (Ashtarotha) undulata* Say (p. 57). Exterior of left valve (U. S. Nat. Mus. 325520) from Murfreesboro, N. C.; height 20.8 millimeters; width 24.0 millimeters.
- FIGURES 32-34. *Astarte (Ashtarotha) concentrica* Conrad (p. 59). Figured specimens (U. S. Nat. Mus. 325518) from Colerain Landing, Chowan River, N. C.
32. Interior of right valve; height 21.2 millimeters; width 25.0 millimeters.
  33. Exterior of right valve shown in figure 32.
  34. Interior of left valve; height 22.3 millimeters; width 28.0 millimeters.
- FIGURES 35-36. *Astarte (Ashtarotha) undulata deltoidea* Gardner, n. subsp. (p. 59). Paratype, a right valve (U. S. Nat. Mus. 325532) from Zuni, Isle of Wight County, Va.; height 22.5 millimeters; width  $19.0 \pm$  millimeters.
35. Interior of paratype.
  36. Exterior of paratype.
- FIGURE 37. *Astarte (Ashtarotha) concentrica conradi* Gardner, n. subsp. (p. 60). Interior of cotype, a right valve (U. S. Nat. Mus. 325530) from 4 to 5 miles below Lumberton, Robeson County, N. C.; height 15.7 millimeters; width 19.0 millimeters.
- FIGURES 38-39. *Astarte (Ashtarotha) concentrica bella* Conrad (p. 60). Left valve (U. S. Nat. Mus. 325522) from Lieutenant Run, Petersburg, Va.; height 25.7 millimeters; width 29.0 millimeters.
38. Interior of left valve.
  39. Exterior of left valve.
- FIGURE 40. *Astarte (Ashtarotha) concentrica* Conrad (p. 59). Exterior of left valve shown in figure 34.
- FIGURE 41. *Astarte (Ashtarotha) concentrica conradi* Gardner, n. subsp. (p. 60). Exterior of cotype, a left valve (U. S. Nat. Mus. 325530) from 4 to 5 miles below Lumberton, Robeson County, N. C.; height 16.8 millimeters; width 21.3 millimeters.

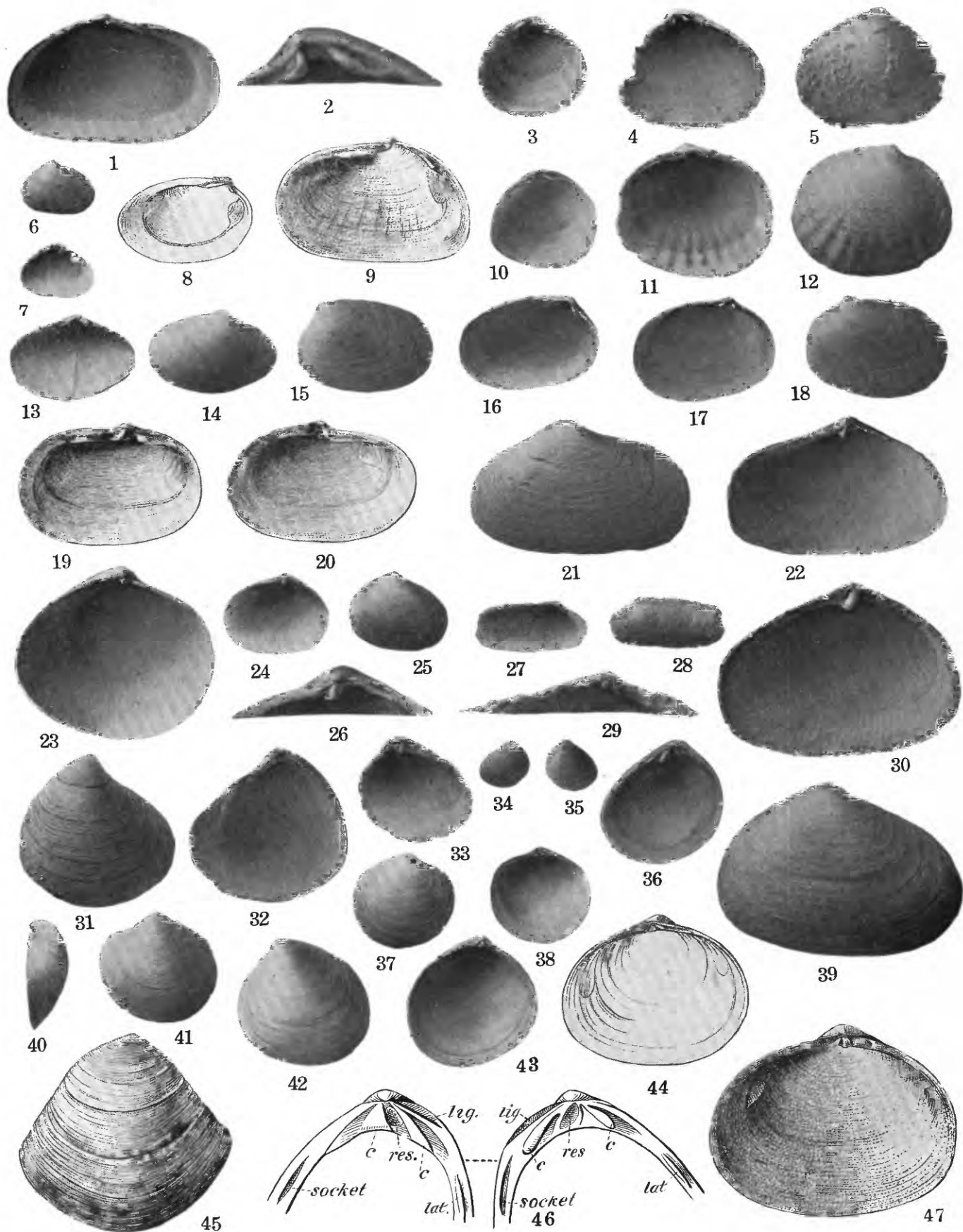


## PLATE 13

- FIGURES 1-4. *Glans (Pleuromeris) tridentata decemcostata* Conrad (p. 71). Double valves and the right and left valves of other individuals (U. S. Nat. Mus. 325572) from 2 miles below Lumberton, Robeson County, N. C.
1. Exterior of double valves viewed from left; height 6.8 millimeters; width 7.8 millimeters.
  2. Interior of right valve; height 6.8 millimeters; width 8.0 millimeters.
  3. Interior of left valve; height 6.7 millimeters; width 7.7 millimeters.
  4. Double valves viewed from front; diameter 5.2 millimeters.
- FIGURE 5. *Pseudochama corticosa* (Conrad) (p. 89). Double valves viewed from left. (After Tuomey and Holmes.)
- FIGURES 6-9. *Glans (Pteromeris) perplana* (Conrad) (p. 72). Right and left valves of different individuals (U. S. Nat. Mus. 325512) from Neills Eddy Landing, Cape Fear River, N. C.
6. Exterior of left valve; height 8.0 millimeters; width 7.8 millimeters.
  7. Interior of left valve shown in figure 6.
  8. Interior of right valve; height 7.5 millimeters; width 7.9 millimeters.
  9. Exterior of right valve shown in figure 8.
- FIGURES 10-11. *Crassinella dupliniana* Dall (p. 64). Holotype, double valves (U. S. Nat. Mus. 114922) from Natural Well, Duplin County, N. C.; height 3.1 millimeters; width 3.2 millimeters.
10. Exterior of left valve. (After Dall.)
  11. Interior of right valve. (After Dall.)
- FIGURES 12-15. *Chama striata* Emmons (p. 88). Right and left valves of different individuals (U. S. Nat. Mus. 325541) from Neills Eddy Landing, Cape Fear River, N. C.
12. Exterior of left valve; height 24.0 millimeters; width 24.0 millimeters.
  13. Interior of right valve; height 17.0 millimeters; width 18.5 millimeters.
  14. Exterior of right valve shown in figure 13.
  15. Interior of left valve shown in figure 12.
- FIGURE 16. *Pseudochama corticosa* (Conrad) (p. 89). Interior of right valve. (After Tuomey and Holmes.)
- FIGURE 17. *Phacoides (Cardiolumina) postalveatus* Gardner, n. sp. (p. 77). Exterior of holotype, a left valve (U. S. Nat. Mus. 325539) from Yorktown, Va.; height 3.3 millimeters; width 3.4 millimeters.
- FIGURE 18. *Crassinella nansemondensis* Gardner, n. sp. (p. 64). Interior of paratype (U. S. Nat. Mus. 325515), from 1½ miles southeast of Reids Ferry, Nansemond County, Va.; height 2.7 millimeters; width 3.1 millimeters.
- FIGURES 19-22. *Glans (Pteromeris) perplana abbreviata* (Conrad) (p. 72). A right and a left valve (U. S. Nat. Mus. 325513) from Magnolia, N. C.
19. Interior of right valve; height 5.3 millimeters; width 5.0 millimeters.
  20. Exterior of right valve.
  21. Exterior of left valve; height 3.1 millimeters; width 3.2 millimeters.
  22. Interior of left valve.
- FIGURES 23-24. *Phacoides (Luciniscia) cribrarius* (Say) (p. 77). A left valve (U. S. Nat. Mus. 325535) from Yorktown, Va.; height 10.0 millimeters; width 10.6 millimeters.
23. Interior of left valve,  $\times 2$ .
  24. Exterior of left valve,  $\times 2$ .
- FIGURES 25-26. *Phacoides (Cardiolumina) trisulcatus multistriatus* (Conrad) (p. 76). A left valve (U. S. Nat. Mus. 325538) from city rock quarry, Wilmington, N. C.; height 5.8 millimeters; width 6.3 millimeters.
25. Interior of left valve.
  26. Exterior of left valve.
- FIGURE 27. *Crassinella nansemondensis* Gardner, n. sp. (p. 64). Interior of holotype (U. S. Nat. Mus. 325514) half a mile below the Suffolk dam, Nansemond County, Va.; height 3.3 millimeters; width 3.5 millimeters.
- FIGURE 28. *Pseudochama corticosa* (Conrad) (p. 89). Profile of double valves from front. (After Tuomey and Holmes.)
- FIGURES 29-30. *Phacoides (Luciniscia) cribrarius* (Say) (p. 77). A right valve (U. S. Nat. Mus. 525536) from 5 miles northeast of Smithfield, Va.; height 12.8 millimeters; width 12.9 millimeters.
29. Exterior of right valve,  $\times 2$ .
  30. Interior of right valve,  $\times 2$ .
- FIGURES 31-32. *Ctena microimbricata* Gardner, n. sp. (p. 75). Holotype, a right valve (U. S. Nat. Mus. 325540) from Natural Well, Duplin County, N. C.; height 9.8 millimeters; width 11.2 millimeters.
31. Detail of sculpture of holotype,  $\times 10$ .
  32. Exterior of holotype.
- FIGURE 33. *Ctena speciosa* (Rogers and Rogers) (p. 75). Exterior of right valve (U. S. Nat. Mus. 145067) from Bellefield, York River, Va.; height 14.1 millimeters; width 16.4 millimeters.
- FIGURES 34-37. *Phacoides (Parvilucina) multilineatus* (Tuomey and Holmes) Dall (p. 78). A right and a left valve of different individuals (U. S. Nat. Mus. 325537) from Neills Eddy Landing, Cape Fear River, N. C.
34. Interior of left valve; height 7.5 millimeters; width 7.3 millimeters.
  35. Interior of right valve; height 6.5 millimeters; width 6.6 millimeters.
  36. Exterior of right valve shown in figure 35.
  37. Exterior of left valve shown in figure 34.



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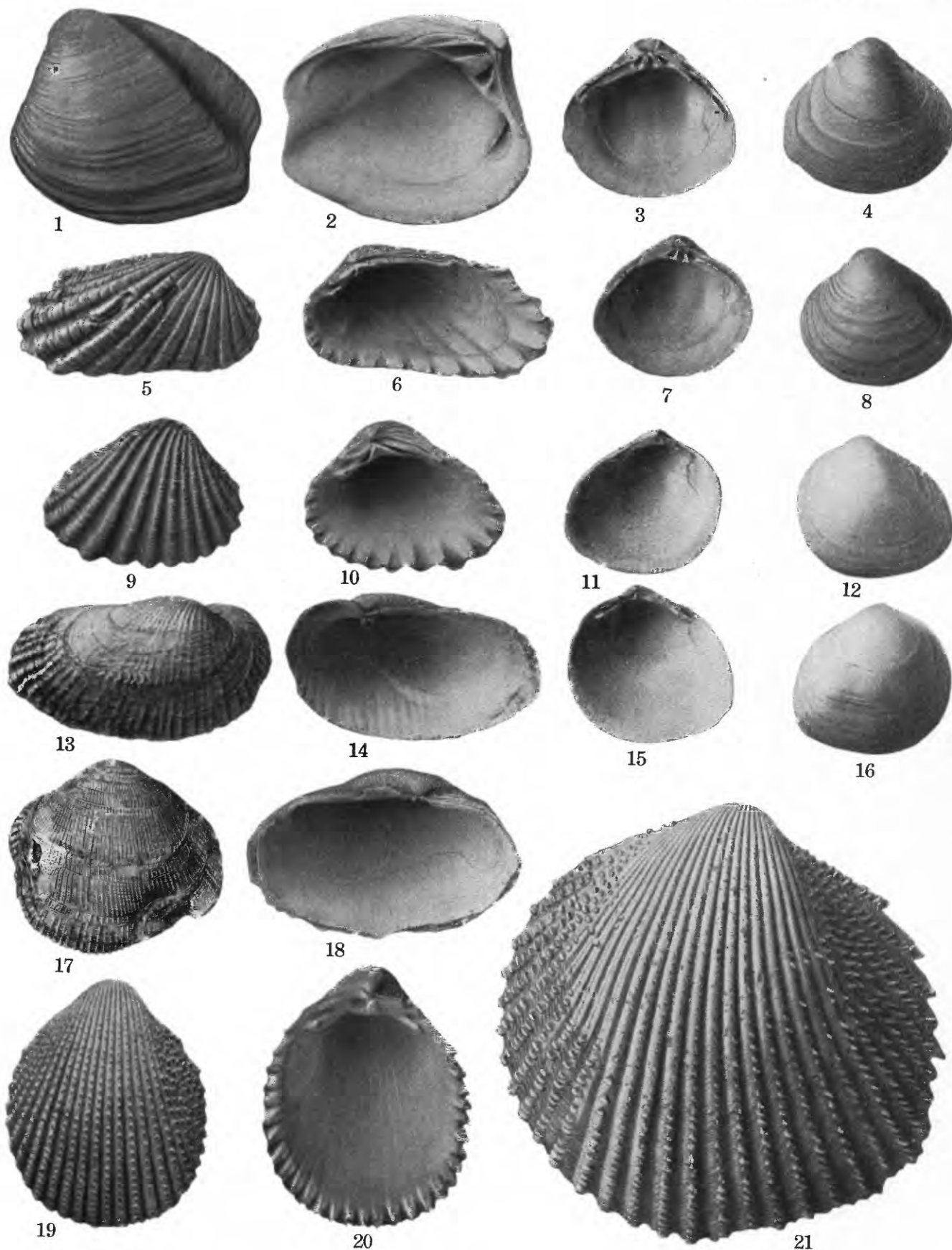
# PLATE 14

- FIGURE 1. *Erycina carolinensis elongata* Gardner, n. subsp. (p. 82). Interior of holotype, a left valve (U. S. Nat. Mus. 325542) from Neills Eddy Landing, Cape Fear River, N. C.; height 7.5 millimeters; width 12.7 millimeters.
- FIGURES 2-5. *Bornia triangula* Dall (p. 82).
2. Hinge of holotype, a right valve (Acad. Nat. Sci. Philadelphia 1597) from Petersburg, Va.,  $\times 12$ .
  3. Interior of paratype, a left valve (U. S. Nat. Mus. 325547) from Yorktown, York River, Va.; height 3.0 millimeters; width 3.3 millimeters.
  4. Interior of holotype, a right valve (Acad. Nat. Sci. Philadelphia 1597) from Petersburg, Va.,  $\times 4$ .
  5. Exterior of holotype shown in figure 4,  $\times 4$ .
- FIGURES 6-7. *Sportella gibberosa* Gardner, n. sp. (p. 84). Cotypes, a right and a left valve of different individuals (U. S. Nat. Mus. 325544) from Walkers Bluff, Cape Fear River, Bladen County, N. C.
6. Exterior of right valve; height 3.2 millimeters; width 4.5 millimeters.
  7. Interior of left valve; height 3.3 millimeters; width 4.5 millimeters.
- FIGURE 8. *Mysella stantoni* (Dall) (p. 86). Interior of holotype, a right valve (U. S. Nat. Mus. 115102) from Natural Well, Duplin County, N. C.; height 2.2 millimeters; width 3.6 millimeters. (After Dall.)
- FIGURE 9. *Erycina carolinensis* Dall (p. 81). Interior of lectotype, a right valve (U. S. Nat. Mus. 115096) from Natural Well, Duplin County, N. C.; height 5.7 millimeters; width 9.0 millimeters. (After Dall.)
- FIGURE 10. *Bornia triangula* Dall (p. 82). Interior of paratype, a right valve (U. S. Nat. Mus. 325547) from Yorktown, York County, Va.; height 3.0 millimeters; width 3.3 millimeters.
- FIGURES 11-12. *Bornia bladenensis* Gardner, n. sp. (p. 83). Holotype, a right valve (U. S. Nat. Mus. 325546) from Walkers Bluff, Bladen County, N. C.; height 3.9 millimeters; width 4.75 millimeters.
11. Interior of holotype.
  12. Exterior of holotype.
- FIGURES 13-14. *Mysella majorina* Gardner, n. sp. (p. 86). Two cotypes, the right and left valves of different individuals (U. S. Nat. Mus. 325549) from Neills Eddy Landing, Cape Fear River, N. C.
13. Interior of right valve; height 2.7 millimeters; width 4.0 millimeters.
  14. Exterior of left valve; height 2.7 millimeters; width 4.1 millimeters.
- FIGURES 15-16. *Mysella vellaini* Gardner, n. sp. (p. 86). Holotype, a right valve (U. S. Nat. Mus. 325548) from Walkers Bluff, Bladen County, N. C.; height 3.0 millimeters; width 4.2 millimeters.
15. Exterior of holotype.
  16. Interior of holotype.
- FIGURES 17-18. *Mysella bladenensis* Gardner, n. sp. (p. 86). Holotype, a right valve (U. S. Nat. Mus. 325550) from Walkers Bluff, Bladen County, N. C.; height 3.0 millimeters; width 4.5 millimeters.
17. Interior of holotype.
  18. Exterior of holotype.
- FIGURES 19-20. *Sportella constricta* (Conrad) (p. 83). A right and a left valve of different individuals (U. S. Nat. Mus. 155730) from the Caloosahatchee River, Fla.
19. Interior of right valve; height 6.0 millimeters; width 9.0 millimeters.
  20. Interior of left valve; height 5.7 millimeters; width 9.0 millimeters.
- FIGURES 21-22. *Sportella waccamawensis* Gardner, n. sp. (p. 85). Holotype, a right valve (U. S. Nat. Mus. 325545) from Walkers Bluff, Cape Fear River, N. C.; height 8.2 millimeters; width 13.5 millimeters.
21. Exterior of holotype.
  22. Interior of holotype.
- FIGURE 23. *Aligena rhomboidea* Gardner, n. sp. (p. 87). Interior of holotype, a left valve (U. S. Nat. Mus. 325552) from Natural Well, Duplin County, N. C.; height 7.8 millimeters; width 8.8 millimeters.
- FIGURES 24-26. *Aligena laevis* H. C. Lea (p. 87). A right valve (Acad. Nat. Sci. Philadelphia 1582).
24. Interior of right valve,  $\times 4$ .
  25. Exterior of right valve,  $\times 4$ .
  26. Hinge of right valve,  $\times 12$ .
- FIGURES 27-29. *Sportella compressa* (H. C. Lea) (p. 85). A left valve (Acad. Nat. Sci. Philadelphia 1596).
27. Interior of left valve,  $\times 4$ .
  28. Exterior of left valve,  $\times 4$ .
  29. Hinge of left valve,  $\times 12$ .
- FIGURE 30. *Sportella calpix* Gardner, n. sp. (p. 84). Interior of holotype, a right valve (U. S. Nat. Mus. 325543) from  $1\frac{1}{2}$  miles below Tar Ferry, Hertford County, N. C.; height 10.2 millimeters; width 14.7 millimeters.
- FIGURES 31-32. *Aligena chowanensis* Gardner, n. sp. (p. 87). Holotype, a right valve (U. S. Nat. Mus. 325551) from Colerain Landing, Bertie County, N. C.; height 4.7 millimeters; width 4.7 millimeters.
31. Exterior of holotype.
  32. Interior of holotype.
- FIGURES 33-36. *Incertae sedis*. (p. 74). Two valves of a single individual (U. S. Nat. Mus. 325557) from Suffolk, Va.; height 1.7 millimeters; width 1.8 millimeters.
33. Interior of left valve,  $\times 12$ .
  34. Exterior of left valve,  $\times 5$ .
  35. Exterior of right valve,  $\times 5$ .
  36. Interior of right valve,  $\times 12$ .
- FIGURES 37-38. *Diplodonta leana coleana* Gardner, n. subsp. (p. 80). Holotype, a right valve (U. S. Nat. Mus. 325556) from Urbanna, Rappahannock River, Va.; height 18.0 millimeters; width 19.1 millimeters.
37. Exterior of right valve.
  38. Interior of right valve.
- FIGURE 39. *Sportella calpix* Gardner, n. sp. (p. 84). Exterior of holotype shown in figure 30.
- FIGURES 40-41. *Diplodonta caloosensis* Dall (p. 80). Figured specimen, a left valve (U. S. Nat. Mus. 325553) Neills Eddy Landing, Cape Fear River, N. C.; height 20.6 millimeters; width 22.3 millimeters; convexity 6.5 millimeters.
40. Profile of figured specimen.
  41. Exterior of figured specimen.
- FIGURES 42-43. *Diplodonta (Phlyctiderma) soror* (C. B. Adams) (p. 81). A left valve (U. S. Nat. Mus. 325555) from Natural Well, N. C.; height 12.3 millimeters; width 12.7 millimeters.
42. Exterior of left valve.
  43. Interior of left valve.
- FIGURE 44. *Cooperella carpenteri* Dall (p. 119). Interior of holotype of "*Diplodonta yorkensis*" Dall, a left valve (U. S. Nat. Mus. 144548) from Yorktown, Va.; height 8.7 millimeters; width 10.9 millimeters. (After Dall.)
- FIGURE 45. *Crassinella lunulata harrisi* Gardner, n. subsp. (p. 63). Exterior of left valve of holotype (U. S. Nat. Mus. 1630) from Yorktown, Va.; height 5.1 millimeters; width 5.2 millimeters. (After Dall.)
- FIGURE 46. *Erycinella ovalis* Conrad (p. 73). Drawings of hinge. (After Dall.)
- FIGURE 47. *Cooperella carpenteri* Dall (p. 119). Interior of right valve (U. S. Nat. Mus. 155714) from Petersburg, Va.,  $\times 3$  (After Dall.)



## PLATE 15

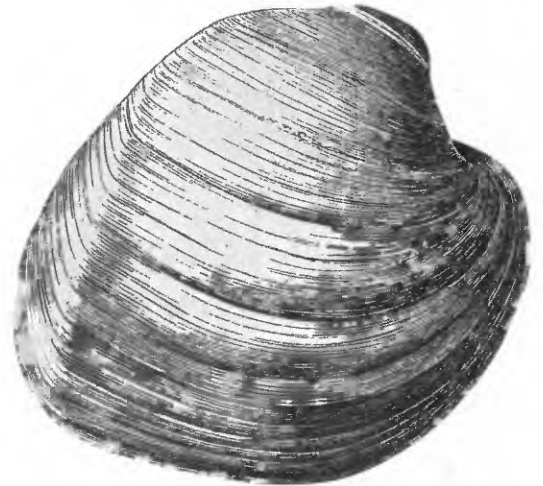
- FIGURES 1-2. *Euloxa latisulcata* Conrad (p. 65). Left valve (U. S. Nat. Mus. 214407) from the lower layer at old Claremont Wharf, James River, Va.; height 20.0 millimeters; width 23.4 millimeters.
1. Exterior of left valve  $\times 2$ .
  2. Interior of left valve,  $\times 2$ .
- FIGURES 3-4. *Corbicula densata* (Conrad) (p. 65). Right valve (U. S. Nat. Mus. 325534) from Wilmington, N. C.; height 29.0 millimeters; width 31.8 millimeters.
3. Interior of right valve.
  4. Exterior of right valve.
- FIGURES 5-6. *Carditamera arata verdevilla* Gardner n. subsp. (p. 69). Holotype, a right valve (U. S. Nat. Mus. 325511) from 8 to 9 miles south of Greenville, Pitt County, N. C.; height 22.3 millimeters; width 46.0 millimeters; convexity 10.0 millimeters.
5. Exterior of holotype.
  6. Interior of holotype.
- FIGURES 7-8. *Corbicula densata* (Conrad) (p. 65). Left valve (U. S. Nat. Mus. 325534) from Wilmington, N. C.; height 26.3 millimeters; width 29.3 millimeters; convexity 9.5 millimeters.
7. Interior of left valve.
  8. Exterior of left valve.
- FIGURES 9-10. *Carditamera columbiana* Gardner, n. sp. (p. 69). Holotype, a right valve (U. S. Nat. Mus. 325510) from Neills Eddy Landing, Cape Fear River, N. C.; height 27.5 millimeters; width 37.0 millimeters.
9. Exterior of holotype.
  10. Interior of holotype.
- FIGURES 11-12. *Laevicardium sublineatum* Conrad (p. 94). Left valve (U. S. Nat. Mus. 325559) from Neills Eddy Landing, Cape Fear River, N. C.; height 26.0 millimeters; width 28.5 millimeters.
11. Interior view of left valve.
  12. Exterior of left valve.
- FIGURES 13-14. *Petricola (Rupellaria) grinnelli* Olsson (p. 117). Right valve (U. S. Nat. Mus. 325562) from Palmyra Bluff, Halifax County, N. C.; height 13.5 millimeters; width 23.5 millimeters.
13. Exterior of right valve,  $\times 2$ .
  14. Interior of right valve,  $\times 2$ .
- FIGURES 15-16. *Laevicardium sublineatum* Conrad (p. 94). (U. S. Nat. Mus. 325559) from Neills Eddy Landing, Cape Fear River, N. C.; height 28.7 millimeters; width 29.0 millimeters.
15. Interior of right valve.
  16. Exterior of right valve.
- FIGURE 17. *Pleuropytis centenaria* Conrad? (p. 119). Exterior of holotype of *Petricola (Rupellaria) harrisii* Dall (U. S. Nat. Mus. 145020) from Bellefield, York River, Va.; height 20.5 millimeters; width 22.5 millimeters. (After Dall.)
- FIGURE 18. *Petricola (Rupellaria) grinnelli* Olsson (p. 117). Interior of left valve (U. S. Nat. Mus. 325561) from Wilmington, N. C.; height  $16.0 \pm$  millimeters; width 24.8 millimeters,  $\times 2$ .
- FIGURES 19-20. *Trachycardium isocardia* (Linnaeus) (p. 91). Paired (U. S. Nat. Mus. 57147), Recent from the coast of Florida; height 47.5 millimeters; width 37.5 millimeters.
19. Exterior of left valve.
  20. Interior of right valve.
- FIGURE 21. *Trachycardium muricatum* (Linnaeus) (p. 92). Exterior of left valve (Wagner Free Inst. Sci.) from Cape Fear River, N. C.; height 80 millimeters; width 80 millimeters.



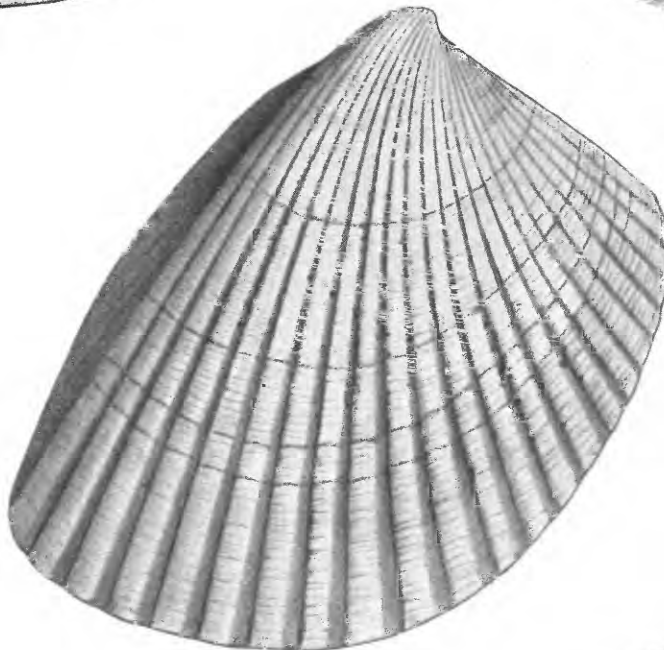
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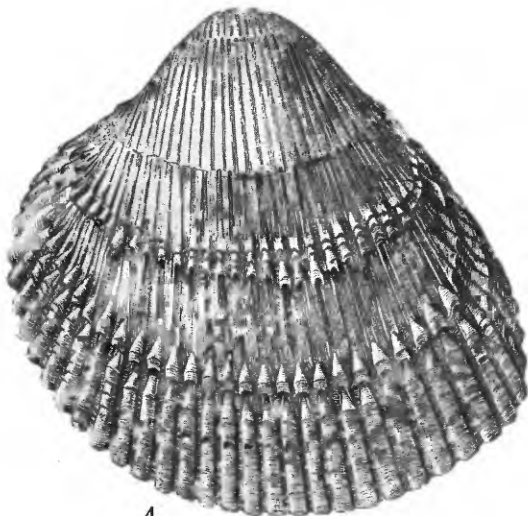
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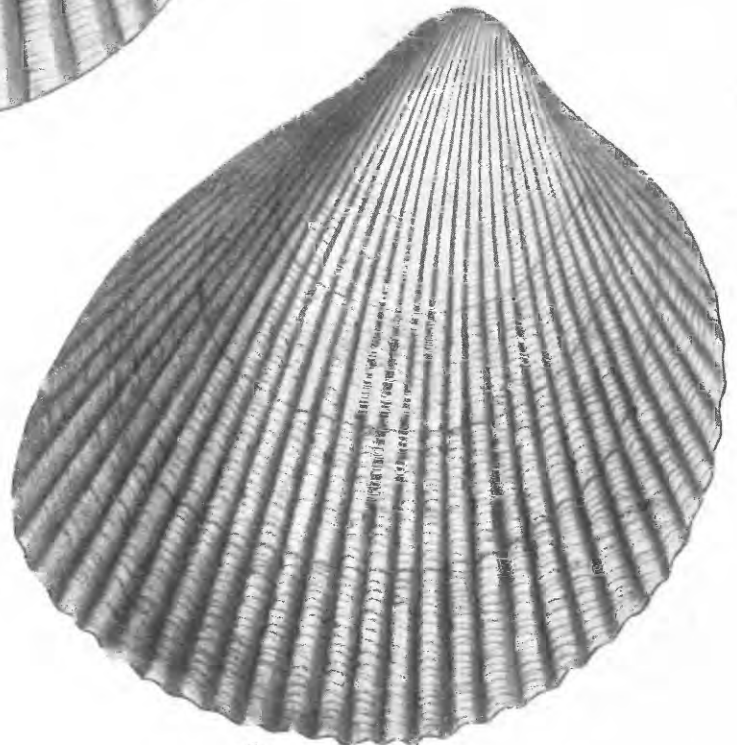
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## PLATE 16

FIGURES 1-2. *Isocardia fraterna glenni* Gardner, n. subsp. (p. 68).

1. Interior of paratype, a left valve (Maryland Geol. Survey, Baltimore, Md., collection) from Jones Wharf, St. Marys County, Md.; height 53.3 millimeters; width 67.1 millimeters. (After Glenn.)
2. Exterior of holotype, a right valve (Maryland Geol. Survey, Baltimore, Md., collection) from Jones Wharf, St. Marys County, Md.; height 59.0 millimeters; width 73.0 millimeters. (After Glenn.)

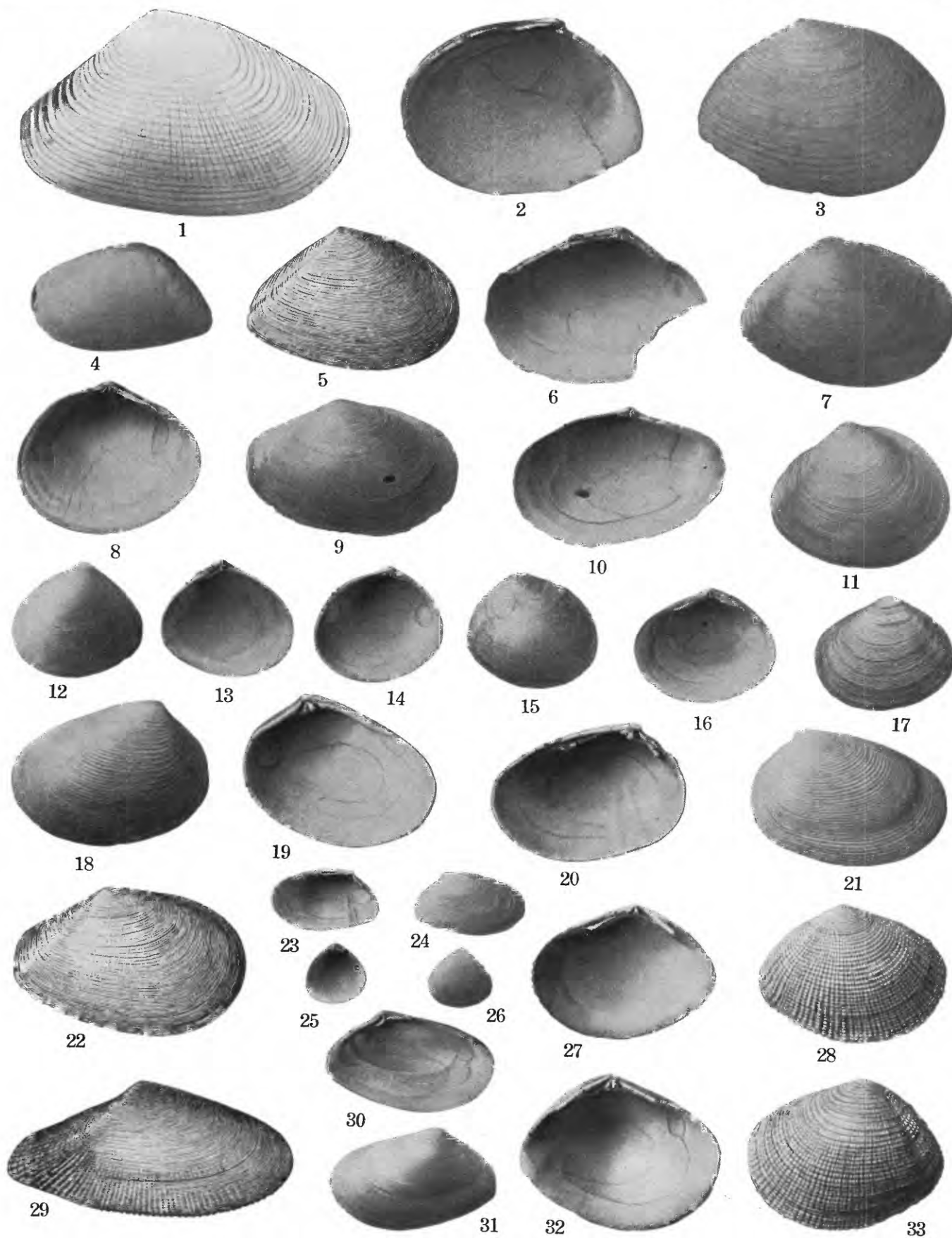
FIGURE 3. *Cerastoderma virginianum* (Conrad) (p. 91). Exterior of holotype, a right valve from the James River near Smithfield, Va.; "length about 4 inches." (After Conrad.)

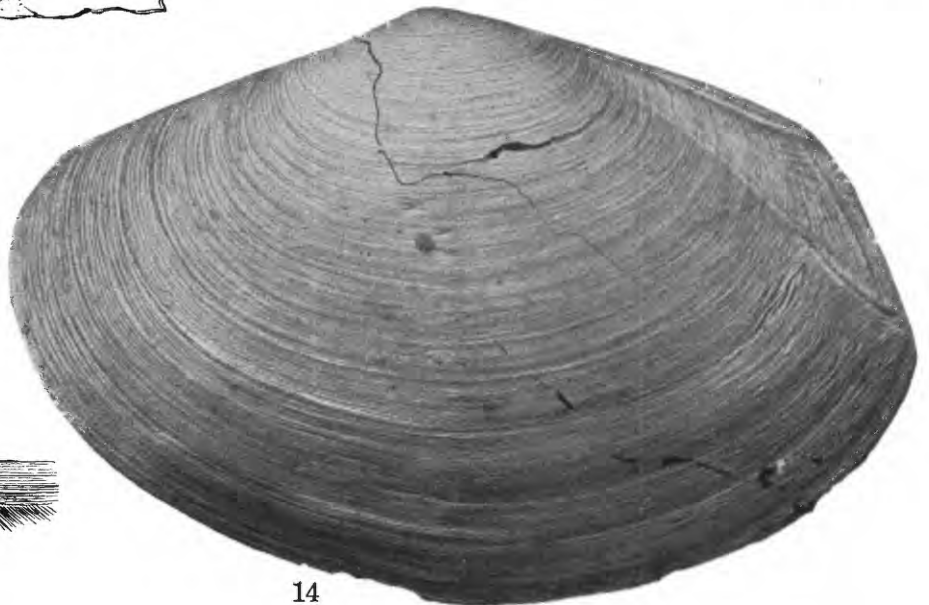
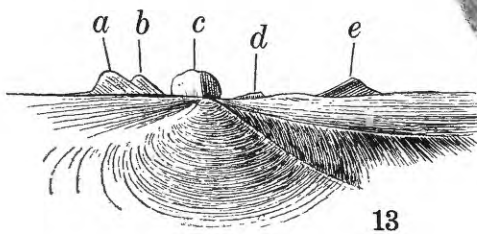
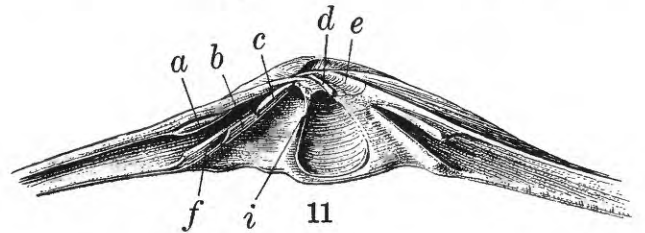
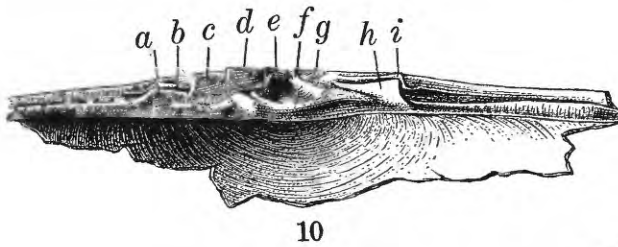
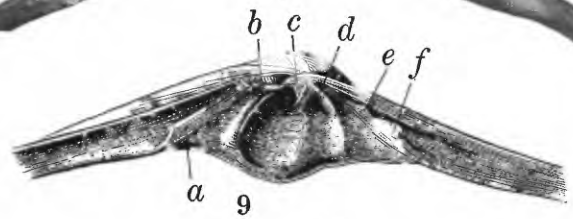
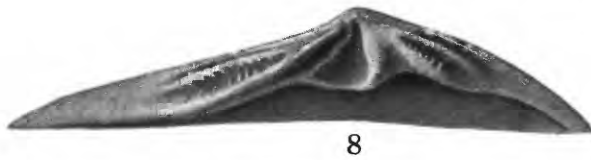
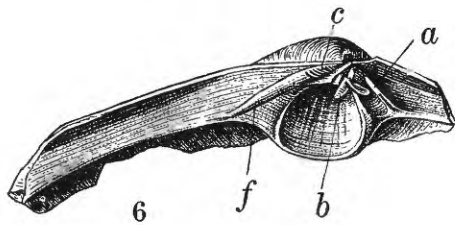
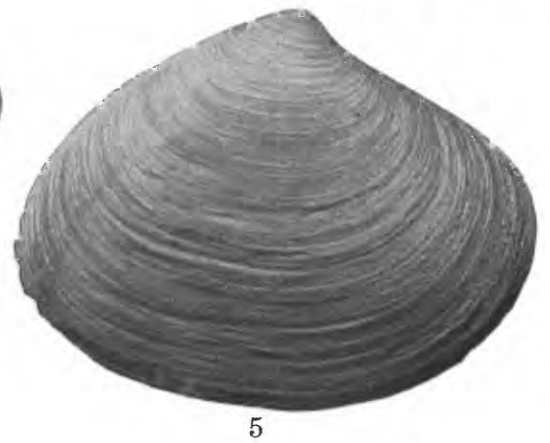
FIGURE 4. *Cerastoderma laqueatum* (Conrad) (p. 90). Exterior of left valve (Maryland Geol. Survey, Baltimore, Md., collection) from Jones Wharf, St. Marys County, Md.  $\times \frac{3}{4}$ . (After Glenn.)

FIGURE 5. *Cerastoderma acutilaqueatum* (Conrad) (p. 90). Exterior of holotype, a right valve from Yorktown, Va.; "length 4 inches; height  $4\frac{1}{2}$  inches." (After Conrad.)

## PLATE 17

- FIGURE 1. *Tellina egena* Conrad (p. 98). Exterior of holotype, a right valve from the James River near Smithfield, Va.  $\times 1$ . (After Conrad.)
- FIGURES 2-3. *Tellina (Moerella?) calpix* Gardner, n. sp. (p. 98). Holotype, a right valve (U. S. Nat. Mus. 325595) from 8 to 9 miles south of Greenville, Pitt County, N. C.; height 8.0 millimeters; width 11.5 millimeters.
2. Interior of holotype,  $\times 4$ .
3. Exterior of holotype,  $\times 4$ .
- FIGURE 4. *Tellina (Moerella) sayi* (Deshayes ms.) Dall (p. 95). Exterior of left valve (U. S. Nat. Mus. 128444), Recent off the coast of South Carolina; height 10.0 millimeters; width 17.4 millimeters.
- FIGURE 5. *Tellina (Moerella) macilenta* Dall (p. 97). Exterior of holotype, a right valve (U. S. Nat. Mus. 115045) from Natural Well, Duplin County, N. C.; height 10.8 millimeters; width 16.5 millimeters. (After Dall.)
- FIGURES 6-7. *Tellina (Moerella?) verdevilla* Gardner, n. sp. (p. 97).
6. Interior of paratype, a right valve (U. S. Nat. Mus. 325596) from 6 miles below Greenville, Pitt County, N. C.; height 15.0 millimeters; width 21.0 millimeters.
7. Exterior of holotype, a right valve (U. S. Nat. Mus. 325596) from 6 miles below Greenville, Pitt County, N. C.; height 13.8 millimeters; width 20.0 millimeters.
- FIGURE 8. *Macoma cookei* Gardner, n. sp. (p. 100). Interior of holotype, a right valve (U. S. Nat. Mus. 325592) from Yorktown; York River, Va.; height 28.0 millimeters; width 34.3 millimeters.
- FIGURES 9-10. *Macoma virginiana* (Conrad) (p. 98). A right valve (U. S. Nat. Mus. 325594) from 1 mile northeast of Suffolk, Va., height 12.3 millimeters; width 19.8 millimeters.
9. Exterior,  $\times 2$ .
10. Interior,  $\times 2$ .
- FIGURE 11. *Macoma cookei* Gardner, n. sp. (p. 100). Exterior of holotype.
- FIGURES 12-15. *Abra aequalis* (Say) (p. 104). A right and a left valve of different individuals (U. S. Nat. Mus. 325585) from half to three-quarters of a mile above Edenhouse Point, Chowan River, N. C.
12. Exterior of left valve; height 10.5 millimeters; width 12.0 millimeters.
13. Interior of left valve shown in figure 12.
14. Interior of right valve; height 10.6 millimeters; width 12.0 millimeters.
15. Exterior of right valve shown in figure 14.
- FIGURES 16-17. *Semele subovata alta* Gardner n. subsp. (p. 101). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325582) from 2 miles northeast of Lizzie, Greene County, N. C.; height 21.0 millimeters; width 26.3 millimeters.
16. Interior of right valve of holotype,  $\times 2$ .
17. Exterior of left valve of holotype,  $\times 2$ .
- FIGURES 18-21. *Semele (Semelina) nuculoides* (Conrad) Dall (p. 102). The right and left valves of different individuals (U. S. Nat. Mus. 325581) from Neills Eddy Landing, Cape Fear River, N. C.
18. Exterior of left valve; height 4.0 millimeters; width 5.6 millimeters.
19. Interior of left valve shown in figure 18.
20. Interior of right valve; height 3.8 millimeters; width 5.6 millimeters.
21. Exterior of right valve shown in figure 20.
- FIGURE 22. *Macoma virginiana conradi* Dall (p. 99). Exterior of holotype, a right valve (U. S. Nat. Mus. 144475) from Yorktown, York River, Va.; height 14.0 millimeters; width 21.7 millimeters. (After Dall.)
- FIGURES 23-24. *Abra subreflexa* Conrad (p. 103).
23. Interior of right valve (U. S. Nat. Mus. 325584) from Colerain Landing, Chowan River, N. C.; height 5.6 millimeters; width 10.4 millimeters.
24. Exterior of right valve shown in figure 23.
- FIGURES 25-26. *Abra aequalis deltoidea* Gardner, n. subsp. (p. 104). Cotypes, a right and a left valve of different individuals (U. S. Nat. Mus. 325586) from 2 miles below Lumberton, Robeson County, N. C.
25. Interior of right valve; height 11.2 millimeters; width 11.4 millimeters.
26. Exterior of left valve; height 11.1 millimeters; width 11.9 millimeters.
- FIGURES 27-28. *Semele bellastrata* (Conrad) (p. 102).
27. Interior of right valve (U. S. Nat. Mus. 325583) from Neills Eddy Landing, Cape Fear River, N. C.; height 13.2 millimeters; width 18.3 millimeters.
28. Exterior of right valve shown in figure 27.
- FIGURE 29. *Donax aequilibrata* Dall (p. 106). Exterior of holotype, a right valve (U. S. Nat. Mus. 108450) from Mrs. Guion's marl pit, Cape Fear River, near Cronly, N. C.; height 8.5 millimeters; width 17.9 millimeters. (After Dall.)
- FIGURES 30-31. *Abra subreflexa* Conrad (p. 103).
30. Interior of left valve (U. S. Nat. Mus. 325584) from Colerain Landing, Chowan River, N. C.; height 9.0 millimeters; width 15.6 millimeters.
31. Exterior of left valve shown in figure 30.
- FIGURES 32-33. *Semele bellastrata* (Conrad) (p. 102).
32. Interior of left valve (U. S. Nat. Mus. 325583) from Neills Eddy Landing, Cape Fear River, N. C.; height 14.5 millimeters; width 19.0 millimeters.
33. Exterior of left valve shown in figure 32.





## PLATE 18

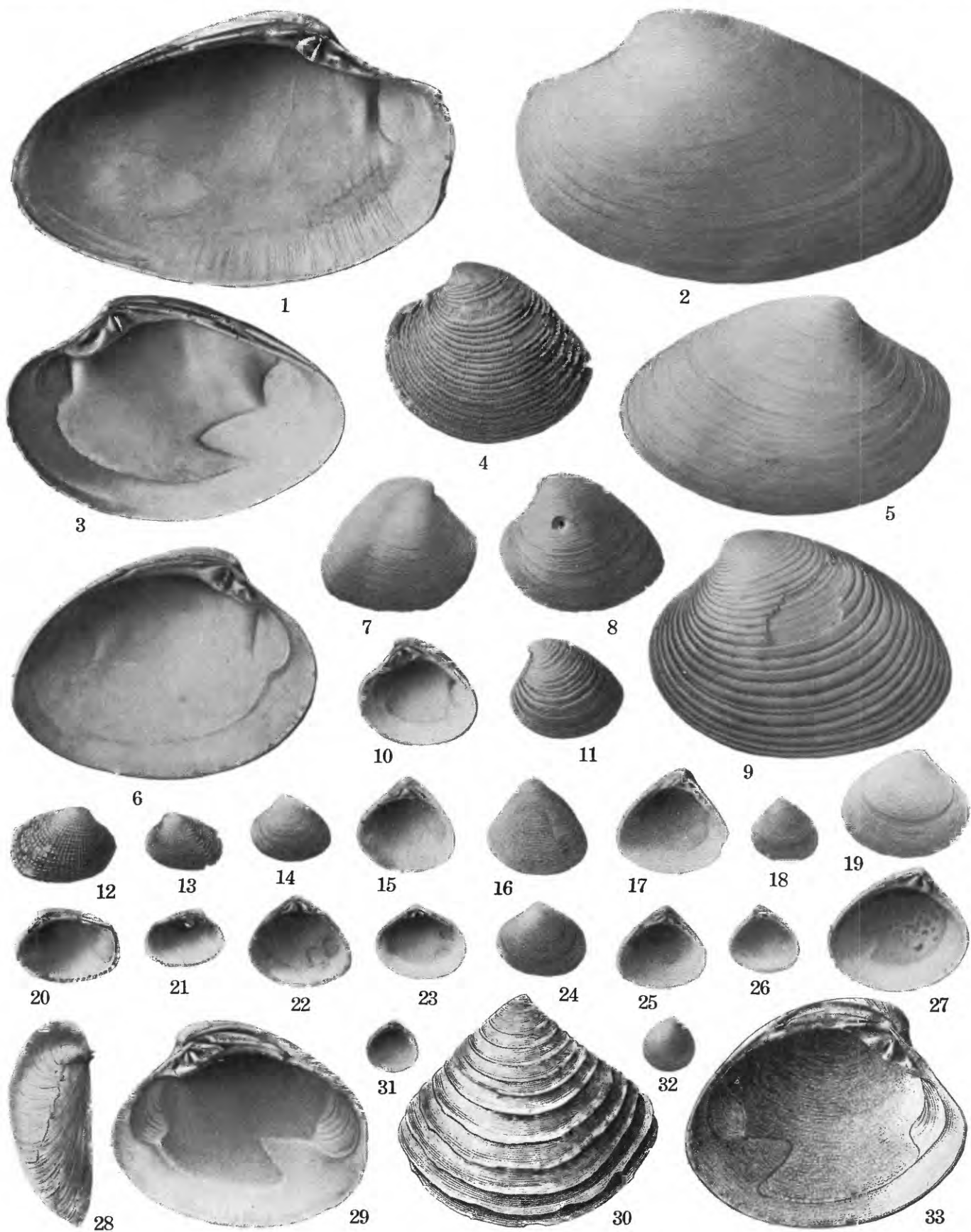
- FIGURE 1. *Spisula (Mactromeris) bowlerensis* Gardner, n. sp. (p. 112). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 498201) from 1½ miles below Bowlers Wharf, Rappahannock River, Va.; height 53.0 millimeters; width 70.0 millimeters. Interior of left valve of holotype.
- FIGURES 2-4. *Spisula (Hemimactra) rappahannockensis* Gardner, n. sp. (p. 110).
2. Exterior of holotype, a right valve (U. S. Nat. Mus. 325601) from 1 to 2 miles below Bowlers Wharf, Rappahannock River, Va.; height 21.0 millimeters; width 31.5 millimeters.
  3. Exterior of paratype, a left valve (U. S. Nat. Mus. 325600) from Union Mills, 2½ miles south of Farnham, Richmond County, Va.; height 15.0 millimeters; width 23.0 millimeters.
  4. Interior of holotype shown in figure 2.
- FIGURE 5. *Spisula (Mactromeris) bowlerensis* Gardner, n. sp. (p. 112). Exterior of right valve of holotype the left valve of which is shown in figure 1.
- FIGURE 6. *Labiosa (Raëta) alta* (Conrad) (p. 109). Hinge plate of left valve: *a*, anterior lamina; *b*, cardinal tooth with one arm projecting over the chondrophore; *c*, ligament scar with septum below it; *f*, anterior lamina. (After Dall.)
- FIGURE 7. *Spisula (Hemimactra) rappahannockensis* Gardner, n. sp. (p. 110). Hinge plate of a left valve (U. S. Nat. Mus. 325601) from 1 to 2 miles below Bowlers Wharf, Rappahannock River, Va., × 3.
- FIGURE 8. *Mesodesma spatha* Gardner, n. sp. (p. 115). Hinge of holotype, a right valve (U. S. Nat. Mus. 325591) from 1 mile north-east of Suffolk, Va., × 10.
- FIGURES 9-11. *Mactra (Mactrotoma) fragilis* Gmelin (p. 109).
9. Hinge plate of left valve: *a*, Posterior lamina; *b*, ligamentary scar with septum below it; *c*, spur, roof of the pit; *d*, cardinal tooth with *e*, accessory lamella, and *f*, anterior lamina. (After Dall.)
  10. Right valve from below, showing the profile of the hinge teeth: *a*, Anterior ventral lamina, and *b*, anterior dorsal lamina; *c*, accessory lamella of right cardinal tooth, *d*, anterior arm, and *e*, posterior arm of same; the space between the teeth *a*, *c*, *d*, *e*, and the edge of the chondrophore is the ventral sinus, that between *a* and *b* is the anterior sinus; *f*, septum between the ligament (attached to the shell at *g*) and the resilium; *h* and *i*, ventral and dorsal posterior laminae, respectively. (After Dall.)
  11. Hinge plate of right valve: *a*, Anterior dorsal lamina; *b*, accessory lamella of right cardinal, *c*, anterior arm (*i*, posterior arm) of same; *d*, septum between the resilium and ligament; *e*, ligamentary scar; *f*, anterior ventral lamina. (After Dall.)
- FIGURE 12. *Mesodesma spatha* Gardner, n. sp. (p. 115). Interior of holotype, a right valve (U. S. Nat. Mus. 325591) from 1 mile northeast of Suffolk, Va.; height 6.4 millimeters; width 10.3 millimeters.
- FIGURE 13. *Mactra (Mactrotoma) fragilis* Gmelin (p. 109). Profile of hinge plate of left valve: *a*, Anterior lamina; *b*, accessory lamella; *c*, cardinal tooth; *d*, septum; *e*, posterior lamina.
- FIGURE 14. *Mactra (Mactrotoma) fragilis precursor* Gardner, n. subsp. (p. 109). Holotype, a left valve (U. S. Nat. Mus. 325593) from Neills Eddy Landing, Cape Fear River, N. C.; height 79.0 millimeters; width 121.0 millimeters.



## PLATE 19

- FIGURES 1–2. *Macrocallista reposta* (Conrad) (p. 123). A left valve (U. S. Nat. Mus. 325575) from 2 miles below Lumberton, Robeson County, N. C.; height 50.0 millimeters; width 85.0± millimeters.
1. Interior of left valve.
  2. Exterior of left valve.
- FIGURE 3. *Macrocallista reposta* (Conrad) (p. 123). Interior of right valve (U. S. Nat. Mus. 325577) from 4 to 5 miles below Lumberton, Robeson County, N. C.; height 42.5 millimeters; width 62.8 millimeters.
- FIGURE 4. *Chione* (*Chione*) *cortinaria* (Rogers and Rogers) (p. 127). Exterior of left valve (U. S. Nat. Mus. 146126) from Grove Wharf, James River, Va.; height 23.5 millimeters; width 26.5 millimeters × 1½.
- FIGURE 5. *Macrocallista reposta* (Conrad) (p. 123). Exterior of right valve shown in figure 3.
- FIGURE 6. *Macrocallista* (*Costacallista*) *emmonsi* Gardner, n. sp. (p. 123). Interior of holotype, a left valve (U. S. Nat. Mus. 107834) from Natural Well(?), Duplin County, N. C.; height 43.0 millimeters; width 56.5 millimeters.
- FIGURES 7–8. *Callocardia* (*Agriopoma*) *chioneformis* Gardner, n. sp. (p. 126).
7. Paratype, a right valve (U. S. Nat. Mus. 325564) from Wilmington, N. C.; height 17.5 millimeters; width 20.5 millimeters × 1½.
  8. Holotype, a left valve (U. S. Nat. Mus. 325564), from Wilmington, N. C.; height 26.5 millimeters; width 31.0 millimeters.
- FIGURE 9. *Macrocallista* (*Costacallista*) *emmonsi* Gardner, n. sp. (p. 123). Exterior of holotype shown in figure 6.
- FIGURES 10–11. *Chione* (*Chione*) *dalli* Olsson (p. 129). Topotypes, a right and a left valve (U. S. Nat. Mus. 325529) from lower layer at Claremont Wharf, James River, Va.
10. Interior of right valve; height 20.0 millimeters; width 22.3 millimeters.
  11. Exterior of left valve; height 19.5 millimeters; width 21.0 millimeters.
- FIGURES 12–13. *Chione* (*Chione*) *grus* (Holmes) (p. 128). A right and a left valve (U. S. Nat. Mus. 325565) from Neills Eddy Landing, Cape Fear River, N. C.
12. Exterior of right valve; height 6.8 millimeters; width 9.5 millimeters.
  13. Exterior of left valve of another individual; height 5.0 millimeters; width 7.5 millimeters.
- FIGURE 14. *Gemma magna insulcata* Gardner, n. subsp. (p. 137). Exterior of paratype, a left valve (U. S. Nat. Mus. 325570) from Walkers Bluff, Cape Fear River, N. C.; height 3.4 millimeters; width 4.1 millimeters.
- FIGURES 15–17. *Gemma magna virginiana* Dall (p. 136). Cotypes, a right and a left valve of different individuals (U. S. Nat. Mus. 144633) from Yorktown, Va.
15. Interior of right cotype; height 3.4 millimeters; width 3.5 millimeters.
  16. Exterior of right cotype shown in figure 15.
  17. Interior of left cotype; height 3.7 millimeters; width 4.1 millimeters.
- FIGURE 18. *Gemma magna virginiana* Dall (p. 136). Interior of topotype, a left valve (U. S. Nat. Mus. 325571) from Yorktown, Va.; height 3.3 millimeters; width 3.6 millimeters.
- FIGURE 19. *Gemma magna majorina* Gardner, n. subsp. (p. 136). Exterior of right cotype (U. S. Nat. Mus. 325566) from 1 mile east of Lizzie, Greene County, N. C.; height 5.6 millimeters; width 6.6 millimeters.
- FIGURES 20–21. *Chione* (*Chione*) *grus* (Holmes) (p. 128).
20. Interior of right valve shown in figure 12.
  21. Interior of left valve shown in figure 13.
- FIGURE 22. *Gemma magna insulcata* Gardner, n. subsp. (p. 137). Interior of holotype, a right valve (U. S. Nat. Mus. 325567) from Neills Eddy Landing, Cape Fear River, N. C.; height 4.5 millimeters; width 5.2 millimeters.
- FIGURES 23–24. *Gemma cravenensis* Gardner, n. sp. (p. 137). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325569) from Rock Landing, Craven County, N. C.; height 3.7 millimeters; width 4.6 millimeters.
23. Interior of right valve, × 4.
  24. Exterior of left valve, × 4.
- FIGURE 25–26. *Gemma magna virginiana* Dall (p. 136).
25. Interior of cotype, a left valve (U. S. Nat. Mus. 144633) from Yorktown, Va.; height 3.0 millimeters; width 3.2 millimeters.
  26. Interior of cotype, a right valve (U. S. Nat. Mus. 144633) from Yorktown, Va.; height 3.2 millimeters; width 3.3 millimeters.
- FIGURE 27. *Gemma magna majorina* Gardner, n. subsp. (p. 136). Interior of left cotype (U. S. Nat. Mus. 325566) from 1 mile east of Lizzie, Greene County, N. C.; height 6.6 millimeters; width 7.3 millimeters.
- FIGURES 28–29. *Callocardia* (*Agriopoma*) *castoriana* Gardner, n. sp. (p. 126). Holotype, a right valve (U. S. Nat. Mus. 325563) from 1 mile north of Castoria, Greene County, N. C.; height 39.0 millimeters; width 49.0 millimeters; convexity 14.2 millimeters.
28. Profile of holotype from front.
  29. Interior of holotype.
- FIGURE 30. *Crassinella lunulata* (Conrad) (p. 62). Exterior of a left valve (U. S. Nat. Mus. 6123) from Natural Well, Duplin County, N. C.; height 5.9 millimeters; width 6.7 millimeters. (After Dall.)
- FIGURES 31–32. *Gemma verdevilla* Gardner, n. sp. (p. 138). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325568) from 8 to 9 miles southeast of Greenville, Pitt County, N. C.; height 2.6 millimeters; width 2.6 millimeters.
31. Interior of right valve, × 4.
  32. Exterior of left valve, × 4.
- FIGURE 33. *Callocardia* (*Agriopoma*) *sayana* (Conrad) (p. 124). Interior of a left valve (U. S. Nat. Mus. 143732) from the Chop-tank River, a quarter to half a mile below Barkers Landing, Talbot County, Md.; height 40.0 millimeters; width 45.0 millimeters. (After Dall.)

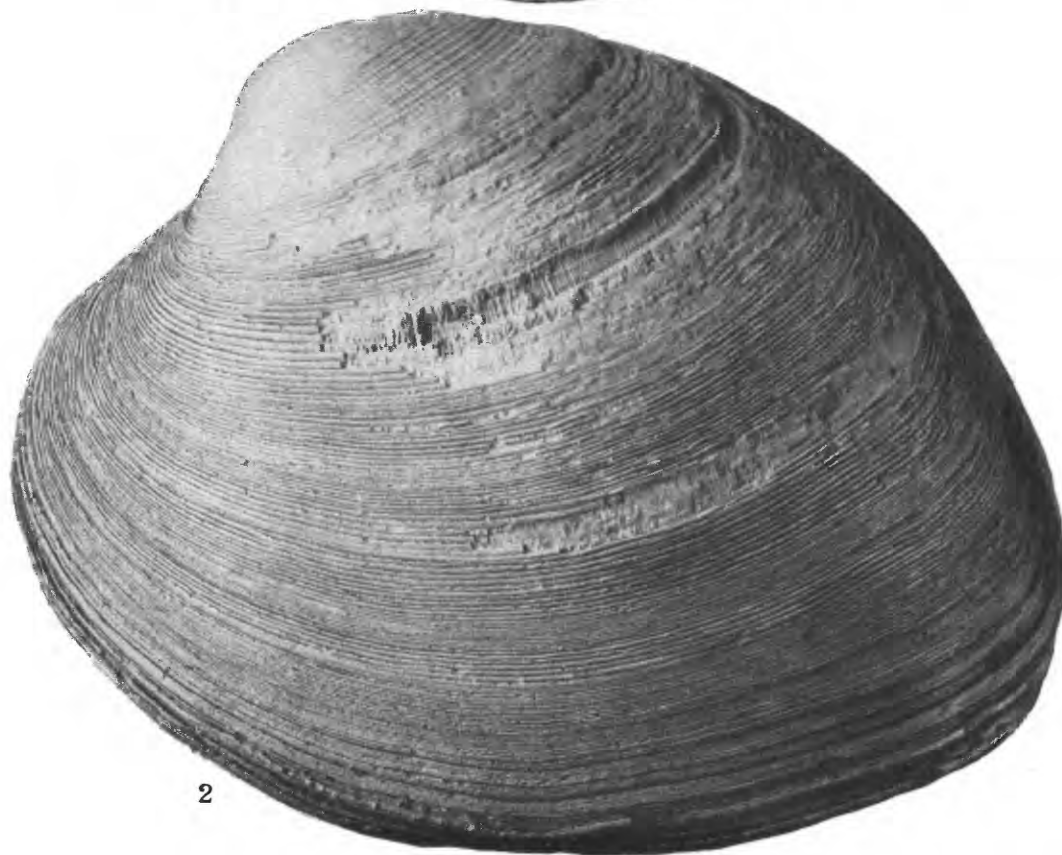




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PLATE 20

FIGURES 1-2. *Venus (Mercenaria) campechiensis carolinensis* Conrad (p.132). A left valve (U. S. Nat. Mus. 325573) from Walkers Bluff, Cape Fear River, N. C.; height 119.0 millimeters; width 153.0 millimeters.

1. Interior of left valve,  $\times$  0.95.
2. Exterior of left valve,  $\times$  0.95.

## PLATE 21

FIGURES 1-3. *Venus (Mercenaria) berryi* Gardner, n. sp. (p. 133). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325574) from 2½ to 3 miles below Bowlers Wharf, Va.; height 57.0 millimeters; width 62.5 millimeters; diameter 37.6 millimeters.

1. Interior of left valve.
2. Dorsal view of double valves.
3. Interior of right valve.

FIGURES 4-6. *Venus (Mercenaria) berryi* Gardner, n. sp. (p. 133).

4. Exterior of adult paratype, a right valve (U. S. Nat. Mus. 325574) from 2½ to 3 miles below Bowlers Wharf, Va.; figured to show fusing of concentric lamellae; height 46.5 millimeters; width 54.0 millimeters.
5. Exterior of adolescent paratype, a right valve (U. S. Nat. Mus. 325576) from 1 to 2 miles below Bowlers Wharf, Essex County, Va.; height 8.0 millimeters; width 8.5 millimeters.
6. Exterior of left valve of holotype shown in figure 1.

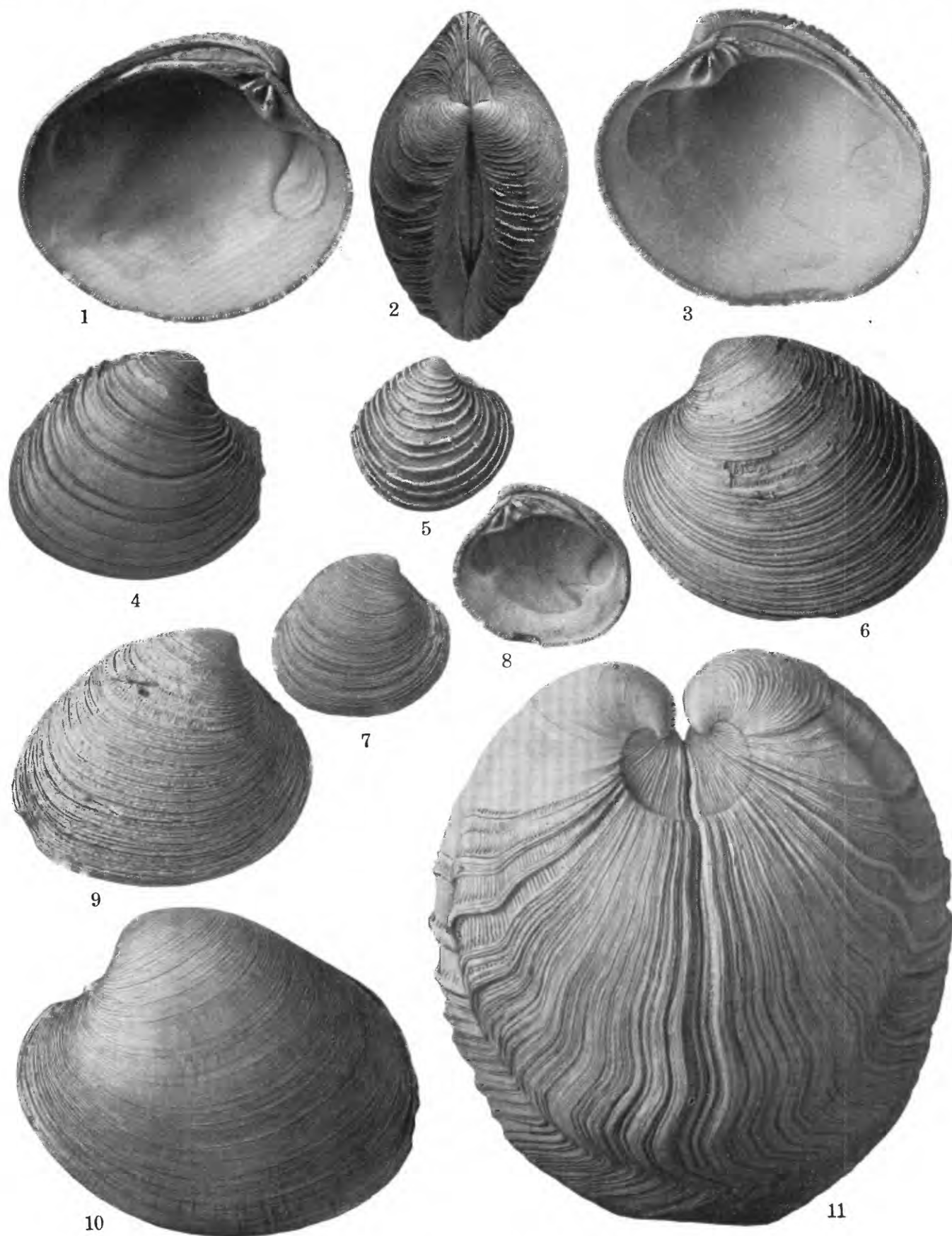
FIGURES 7-8. *Venus (Mercenaria) plena nucea* Dall (p. 134). Holotype, a right valve (U. S. Nat. Mus. 163418) from Bellefield, York River, Va.; height 30.0 millimeters; width 33.0 millimeters.

7. Exterior of holotype.
8. Interior of holotype.

FIGURE 9. *Venus (Mercenaria) plena inflata* Dall (p. 134). Exterior of holotype, a right valve (U. S. Nat. Mus. 163419) from Bellefield, York River, Va.; height 51.0 millimeters; width 60.0 millimeters.

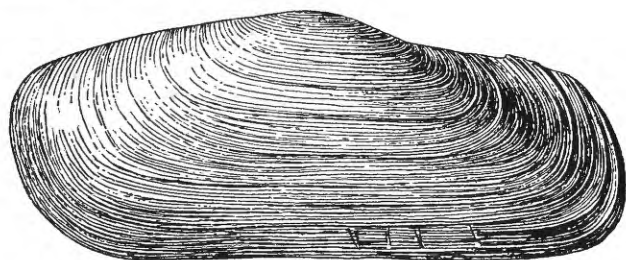
FIGURE 10. *Venus (Mercenaria) mercenaria notata* Say (p. 130). Exterior of left valve (U. S. Nat. Mus. 46867), Recent on the east coast of Florida; height 60.0 millimeters; width 76.0 millimeters.

FIGURE 11. *Venus (Mercenaria) campechiensis tridacnoides* (Lamarek) (p. 132). Profile of double valves from the Wagner Free Institute of Science of Philadelphia; diameter 100.0 millimeters.

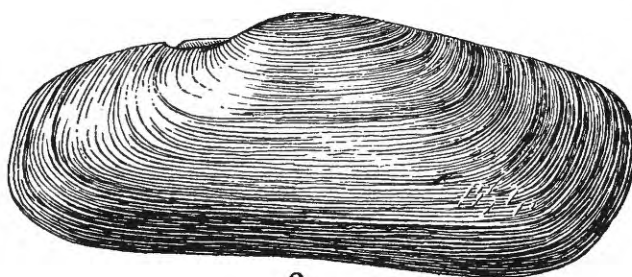


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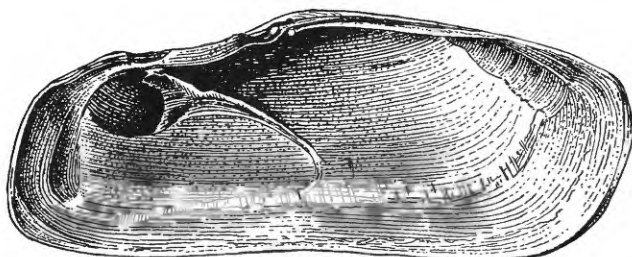




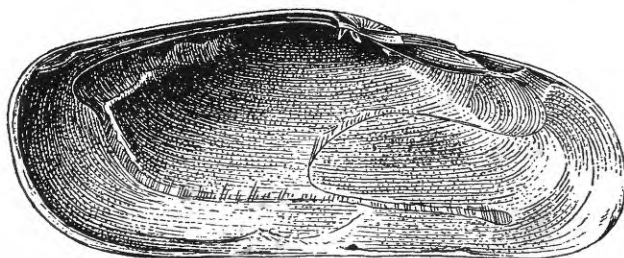
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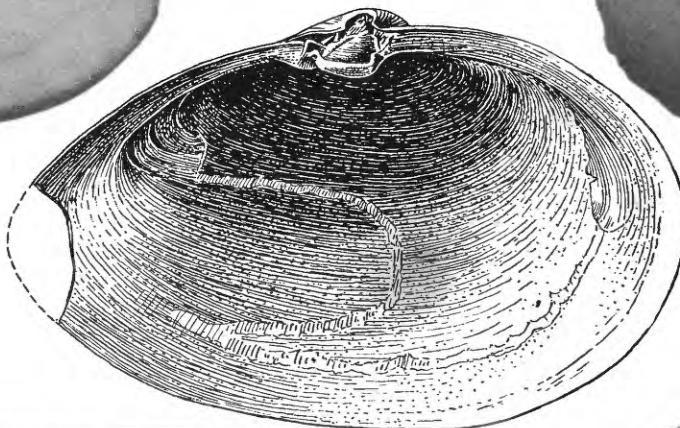
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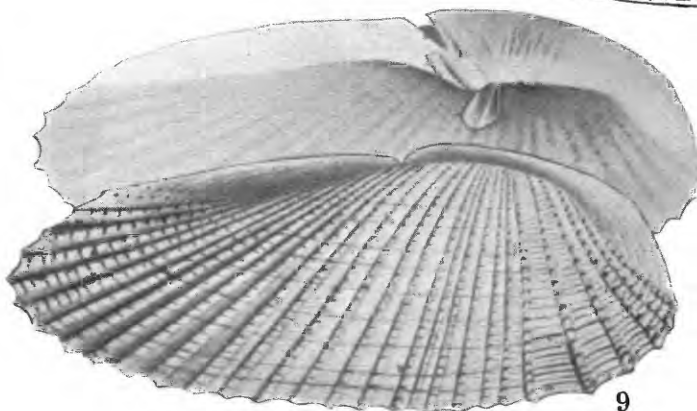
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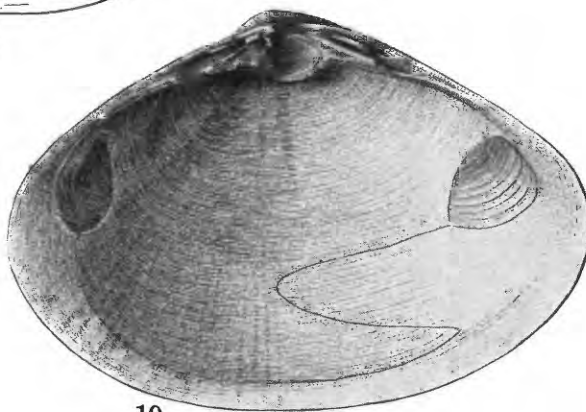
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## PLATE 22

FIGURES 1-4. *Tagelus gibbus* (Spengler) (p. 107).

1. Exterior of left valve from Wailes Bluff (near Cornfield Harbor), St. Marys County, Md. (After Clark.)
2. Exterior of right valve from Wailes Bluff (near Cornfield Harbor), St. Marys County, Md. (After Clark.)
3. Interior of left valve shown in figure 1. (After Clark.)
4. Interior of right valve shown in figure 2. (After Clark.)

FIGURE 5. *Tagelus gibbus carolinensis* (Conrad) (p. 108). Exterior of left valve (U. S. Nat. Mus. 145293) from Wilmington, N. C.; height 23.0 millimeters; width 69 millimeters.

FIGURES 6-7. *Spisula* (*Hemimactra*) *similis* (Say) (p. 111). A Recent shell is figured (U. S. Nat. Mus. 95569).

6. Interior of left valve  $\times 1$ .
7. Exterior of right valve  $\times 1$ .

FIGURE 8. *Mya arenaria* Linnaeus (p. 138). Interior of left valve from Wailes Bluff (near Cornfield Harbor), St. Marys County Md.,  $\times 5/6$ . (After Clark.)

FIGURE 9. *Barnea* (*Scobinopholas*) *arcuata* (Conrad) (p. 141). Exterior of right valve and hinge of left valve of holotype from Suffolk, Va. (After Conrad.)

FIGURE 10. *Spisula* (*Mactromeris*) *duplinensis* Dall (p. 112). Interior of holotype, a right valve (U. S. Nat. Mus. 153784) from Natural Well, Duplin County, N. C.; height  $42.0 \pm$  millimeters; width  $58.0 \pm$  millimeters. (After Dall.)

# PLATE 23

FIGURES 1-2. *Donax fossor* Say (p. 106).

1. Exterior of left valve (U. S. Nat. Mus. 325587) from 4 miles south of Elizabethtown, N. C.; height 4.9 millimeters; width 9.0 millimeters.
2. Exterior of right valve (U. S. Nat. Mus. 325587) from 4 miles south of Elizabethtown, N. C.; height 3.3 millimeters; width 5.0 millimeters.

FIGURES 3-4. *Donax emmonsii preaequilibrata* Gardner, n. subsp. (p. 105). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325590) from 2 miles below Lumberton, Robeson County, N. C.; height 8.0 millimeters; width 14.4 millimeters.

3. Interior of left valve of holotype,  $\times 3$ .
4. Exterior of right valve of holotype,  $\times 3$ .

FIGURE 5. *Donax emmonsii* Dall (p. 105). Exterior of holotype, a right valve (U. S. Nat. Mus. 108447) from Mrs. Guion's marl-pit near Cronly, Cape Fear River, N. C.; height 6.7 millimeters; width 10.2 millimeters. (After Dall.)

FIGURES 6-7. *Donax chuckatuckensis* Gardner, n. sp. (p. 106).

6. Exterior of holotype, a left valve (U. S. Nat. Mus. 325589) from a quarter of a mile north of Chuckatuck, Nansemond County Va.; height 3.6 millimeters; width 5.2 millimeters.
7. Interior of holotype,  $\times 3$ .

FIGURES 8-9. *Spisula (Hemimactra) modicella* (Conrad) (p. 111).

8. Interior of immature left valve (U. S. Nat. Mus. 325598) from 1 mile northeast of Suffolk, Va.; height 7.9 millimeters; width 11.7 millimeters.
9. Exterior of valve shown in figure 8.

FIGURES 10-11. *Donax fossor* Say (p. 106).

10. Interior of valve shown in figure 1.
11. Interior of valve shown in figure 2.

FIGURES 12-15. *Mulinia congesta* (Conrad) (p. 113). The right and left valves of two individuals (U. S. Nat. Mus. 325602) from 1 mile northeast of Suffolk, Va.

12. Exterior of left valve; height 15.3 millimeters; width 22.0 millimeters.
13. Interior of left valve shown in figure 12.
14. Interior of right valve; height 15.5 millimeters; width 21.0 millimeters.
15. Exterior of right valve shown in figure 14.

FIGURES 16-17. *Spisula (Hemimactra) modicella alta* Gardner, n. subsp. (p. 111).

16. Exterior of holotype, a right valve (U. S. Nat. Mus. 325599) from Rock Landing, N. C.; height 13.2 millimeters; width 18.0 millimeters.
17. Interior of holotype.

FIGURES 18-19. *Spisula (Hemimactra) modicella* (Conrad) (p. 111).

18. Interior of a right valve (U. S. Nat. Mus. 325598) from 1 mile northeast of Suffolk, Va.; height 11.2 millimeters; width 15.0 millimeters,  $\times 2$ .
19. Exterior of right valve shown in figure 18.

FIGURE 20. *Ervilia lata* Dall (p. 115). Interior of holotype, a right valve (U. S. Nat. Mus. 115054) from Natural Well, Duplin County, N. C.; height 3.6 millimeters; width 5.2 millimeters. (After Dall.)

FIGURES 21-24. *Mulinia congesta* (Conrad) (p. 113). A right and a left valve of different individuals (U. S. Nat. Mus. 325603) from 1½ miles west of Smithfield, Va.

21. Exterior of left valve; height 24.5 millimeters; width 26.5 millimeters.
22. Interior of left valve shown in figure 21.
23. Interior of right valve; height 23.0 millimeters; width 25.5 millimeters.
24. Exterior of right valve shown in figure 23.

FIGURE 25. *Ervilia lata radiata* Gardner, n. subsp. (p. 116). Interior of holotype, a right valve (U. S. Nat. Mus. 325597) from Neills Eddy Landing, Cape Fear River, N. C.; height 2.6 millimeters; width 4.0 millimeters.

FIGURE 26. *Corbula (Caryocorbula?) scutata* Gardner, n. sp. (p. 140). Exterior of right valve of holotype, (U. S. Nat. Mus. 497058) from Shell Creek, De Soto County, Fla.; height 6.4 millimeters; width 9.0 millimeters  $\times 3$ .

FIGURES 27-28. *Corbula (Caryocorbula) conradi* Gardner, n. sp. (p. 139). Holotype, the right and left valves of the same individual (U. S. Nat. Mus. 325605) from 15½ miles above Bells Bridge, Edgecombe County, N. C.; height of closed valves 6.7 millimeters; width 11.0 millimeters.

27. Exterior of left valve,  $\times 3$ .
28. Exterior of right valve,  $\times 3$ .

FIGURE 29. *Ervilia lata radiata* Gardner, n. subsp. (p. 116). Exterior of paratype, a left valve (U. S. Nat. Mus. 325597) from Neills Eddy Landing, Cape Fear River, N. C.; height 2.6 millimeters; width 4.2 millimeters.

FIGURES 30-32. *Corbula (Caryocorbula?) scutata* Gardner, n. sp. (p. 140).

30. Interior of right valve of holotype shown in figure 26.
31. Interior of left valve of holotype shown in figure 26.
32. Double valves of holotype shown in figure 26 viewed from the rear, diameter, 5.7 millimeters.

FIGURES 33-34. *Corbula (Caryocorbula) conradi retusa* Gardner, n. subsp. (p. 140). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325604) from half to three-quarters of a mile below Edenhouse Point, Bertie County, N. C.; height 5.0 millimeters; width 7.7 millimeters.

33. Exterior of right valve,  $\times 4$ .
34. Exterior of left valve,  $\times 4$ .

FIGURE 35. *Kuphus calamus* (H. C. Lea) (p. 143). Fragment of tube (U. S. Nat. Mus. 325608) from Baileys Creek, James River, Va.; outside diameter of tube 11.6 millimeters; inside diameter of tube 7.0 millimeters.

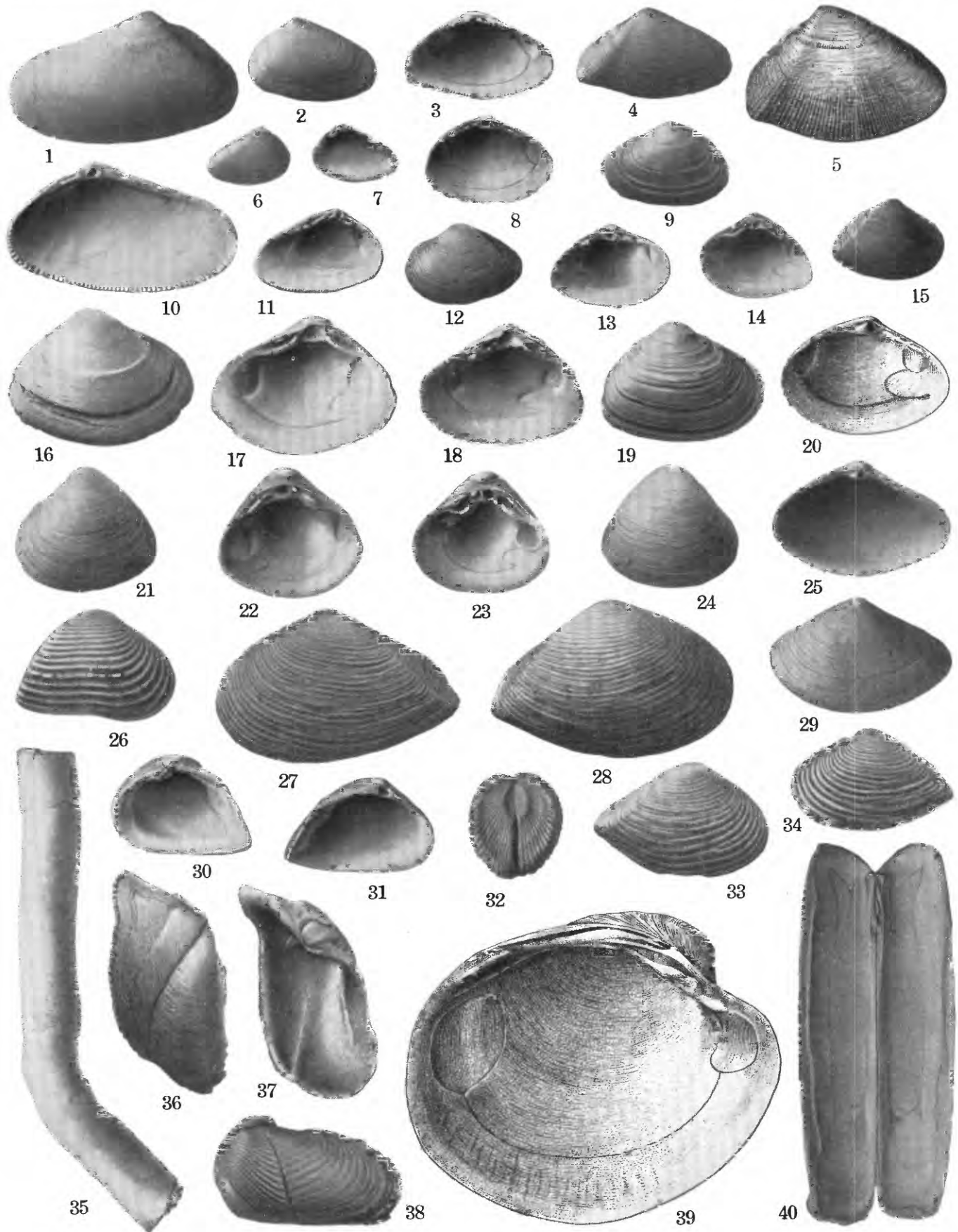
FIGURES 36-37. *Zirfaea rhomboidea* (H. C. Lea) (p. 142).

36. Exterior of left valve of holotype (Acad. Nat. Sci., Philadelphia 1583),  $\times 6$ .
37. Interior of right valve of holotype,  $\times 6$ .

FIGURE 38. *Martesia cuneiformis* (Say) (p. 143). Exterior of left valve (U. S. Nat. Mus. 46850), Recent from the east coast of Florida, height 9.6 millimeters; width 17.5 millimeters,  $\times 2$ .

FIGURE 39. *Isocardia fraterna carolina* Dall (p. 67). Interior of paratype (U. S. Nat. Mus. 146166) from Grove Wharf, James River, Va.; height 67.0 millimeters; width 84.0 millimeters; convexity 28.5 millimeters. (After Dall.)

FIGURE 40. *Solen viridis* Say (p. 108). Interior of double valves of specimen (U. S. Nat. Mus. 153356), Recent from Smiths Island, Va.; height 7.5 millimeters; width 35.5 millimeters,  $\times 2$ .



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