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

PART 1. PELECYPODA

BY

JULIA GARDNER

WITH A SUMMARY OF THE STRATIGRAPHY

By W. C. MANSFIELD
Abstract

Stratigraphy of the Miocene of Virginia and the Miocene and Pliocene of North Carolina, by W. C. Mansfield

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Superfamily Cyrenaacea

Family Cyrenidae.

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Family Isocardiaidae.

Superfamily Carditacea

Family Carditidae.

Family Condylocardiidae.

Superfamily Leptonacea

Family Leptoniidae.

Family Sportellidae.

Family Montacutiidae.

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PART 1. 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 them any stratigraphic significance that they may possess. The accompanying 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 and a similar bibliography for North Carolina by Miller and Stephenson. Most of the important later publications have been noted in several papers by me.

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

1 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 zoal studies, particularly of the Pecten and Astarte groups, are essential alike to the stratigrapher and the paleontologist concerned with the molluscan faunas of the Middle Atlantic seaboard.

Clark, W. B., and Miller, B. L., Physiography and geology of the Coastal Plain province of Virginia: Virginia Geol. Survey Bull. 4, pp. 45-191, 1912.


MOLLUSCA FROM MIocene AND LOWER Pliocene OF VIRGINIA AND NORTH CAROLINA

described in 1904 by Clark, Shattuck, and Dall; 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 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 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 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, are as follows:

Upper Miocene:
Yorktown formation:
Zone 2, or Turritella atticosta zone:
Upper part (beds at Suffolk).
Middle part (beds at Yorktown).
Lower part (including Ochama-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. 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
part of the State,\textsuperscript{10} and the Waccamaw formation, in the southern part,\textsuperscript{11} 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 (in part).
   - Upper Marine and London clay (?), Maryland.
1828. Vanuxem, Lardner, and Morton, S. G.:
   - Tertiary (in part).
1829. Rogers, W. B.:
   - 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. Twomey, 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. Mareon, 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.
1867. Toddler, C.:
   - Miocene (for Richmond, infusorial deposits).
1880. Dana, J. D.:
   - Miocene, Yorktown period (in part).


\textsuperscript{11} Miller, B. L., Tertiary formations: North Carolina Geol. and Econ. Survey, vol. 3, pp. 236–238, 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. Barton, 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. Virginian: 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.
1911. Watson, T. L.:
  Yorktown.
  St. Marys.
  Calvert.
1911. Berry, E. W.:
  Places Richmond diatomaceous deposits in 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.
      Murfreesboro 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.
      Murfreesboro 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).
      zone 2 (Crassatellites meridionalis).
        zone 1 (Bulliopsis 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

<table>
<thead>
<tr>
<th>European equivalent</th>
<th>New Jersey</th>
<th>Maryland</th>
<th>Virginia</th>
<th>North Carolina</th>
<th>South Carolina</th>
<th>Georgia</th>
<th>Florida</th>
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<tbody>
<tr>
<td>Pliocene</td>
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<tr>
<td>Upper</td>
<td>Sicilian (Arnian)</td>
<td>Deposits at Wailes Bluff</td>
<td>(7)</td>
<td>Deposits on Yonges Island</td>
<td>Deposits on Myakka River</td>
<td>Marl on North Creek</td>
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<tr>
<td>Middle</td>
<td>Astian</td>
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<td>Lower</td>
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<td>Tortonian or upper</td>
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<td>Vindobonian</td>
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<td>Helvetian</td>
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<tr>
<td>Kirkwood formation</td>
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<tr>
<td>Calvert formation</td>
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</tr>
</tbody>
</table>

1 Uppermost Yorktown, with bed at Mt. Gould at top.  
2 Beds at Yorktown, Va.  
3 Equivalent to the beds at Yorktown, Va.  
4 Chama-bearing bed.  
5 Mainly concealed except at low-water stage.  
6 Exact correlation with the Calvert formation not fully established.

The fossiliferous beds in the Pleistocene not necessarily correlated.

The fauna included by Ball in the Myakka River fauna may include some Pleistocene.

Beds at Grove Plantation tentatively put in the Waccamaw formation by Cooke; may be older.

Position relative to Caloosahatchee marl not precisely known.

Mainly occupied except at low-water stage.

Exact correlation with the Calvert formation not fully established.

401085—42 (Page 4)
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, *Pedation maxillatum* (Deshayes), and *Pecten madisonius* Say. Certain deposits have yielded vertebrate remains and fossil plants. A separation of the deposits into faunal zones corresponding to those recognized by Shattuck 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 1 ½ 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 collected 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 may be recognized in Virginia.

The Horsehead, Stratford, and Nomini Cliffs 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 mainly of a rather compact greenish-gray diatomaceous sandy clay and contains a few poorly preserved invertebrate fossils. The upper limit of the formation has been drawn at a plane about 5 feet above a thin bed containing many *Isocardia*, which may represent the *Isocardia* bed referred to zone 14 of Shattuck in the Calvert formation of Maryland.

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 1 ½ 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 *Crossesatellites burgidulus* (Conrad), *Phacoides crenulatus* (Conrad), *Diplodonta subvexa* (Conrad), a large variety of *Isocardia fraterma* (Say), *Cardium* sp., and *Venus plea* (Conrad) ?. In Maryland *Crossesatellites burgidulus* 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, *Crossesatellites burgidulus*. 13 Shattuck, G. B., Maryland Geol. Survey, Miocene, pp. lxxi-lxxxvii, 1904.

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, Eluxea latissulcata (Conrad), Chione cf. C. athleta Conrad, Spisula confraja (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.

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 middleseensis Mansfield, P. eborae urbananaensis Mansfield, Crassatellites meridionalis surryensis Mansfield, and C. undulatus urbananaensis 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 Schmidt’s Bluff, 8½ miles below Claremont Wharf, Surry County, Va.

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, P. clintonius Say, Pecten eborae watsonensis Mansfield, Astarte undulata dentoidea Gardner, Astarte undulata vaginulata Dall, Crassatellites undulatus clypeatus Dall, Phaenoides (Pseudomithra) anodontae Say, Venericardia granulata Say, Venus rileyi Conrad, Spisula confraja Conrad, and Kaphra columna 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 middleseensis Mansfield, Pedalion maxillatum (Deshayes). Pedalion maxillatum and Pecten madisonius are abundant. The lower part consists of more clay........................................ 25

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

Pleistocene:
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

* Shattuck, G. B., Maryland Geol. Survey, Miocene, p. lxxx, 1904.
Unconformity.

Miocene:

Yorktown formation, zone 1:

Brown to gray medium-grained sands with fossil impressions


Covered.

St. Marys formation, zone 2:


Blue clayey sand with many fossils, especially *Arca*, *Pecten*, and *Pedation*.


Blue fine-grained clayey sand, slightly fossiliferous.


(The series of blue clays forming zone 2 do not contain black grains observed in other beds.)

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: Indurated shell bed in a matrix of gray to buff glauconitic sand containing many *Pecten jeffersonius* Say and *Ostrea disparilis* Conrad.

PART 1. PELECYPODA

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.

Sand similar to above but containing *Pecten eburneus urbannaenus* Mansfield in great abundance, as well as *Pedalion maxillatum* (Deshayes).

Concealed to railroad tracks.

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 deltoides* Gardner. Some of the species that appear here first are *Conus marylandicus* Green, "Drillia" *lunata* (H. C. Lea), *Pecten jeffersonius* Say, *Phacoidea cebrium* (Say), *Divericella quadrivulata* (D'Orbigny), and *Cardium virginianum* Conrad. Other fossils are listed on page 8.
Zone 1 includes part of the Murfreesboro stage of Olsson.16 The term "Murfreesboro" is preoccupied, having been used by Safford and Killebrew17 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 Mansfield18 (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 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 Area improvera Conrad. Among the mactroids, Malinia 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 192919 I suggested the contemporaneity of the deposit at the Biggs farm and the Duplin marl, and in 193020 I noted the presence of Conus adversarius Conrad and Fasciolaria rhomboides 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.

**Acestocina (fragment).**

**Terebra (fragment).**

*Drillia* cf. D. myrmecoon Dall.

*Conus adversarius Conrad.

*Olivella nitidula (Dillwyn).

*Fasciolaria rhomboide Rogers.

*Marginella bella Conrad var.

*Fasciolaria rhomboide Rogers.

*Urosalpinx trossulus Conrad.

*Seila adamsi (H. C. Lea).

*Turritella sp.

**Ostrea sculpturata.**

**Crepidula fornicata cymbaeformis Conrad.**

**Crepidula aculeata costata Morton.**


PART 1. PELECYPODA

Polinices duplicatus Say.
Calliostoma Mitchellii (Conrad).
Fissuridea sp. cf. specimen from Darlington, S. C.
Cadulus thallus (Conrad).
Nuculana acuta (Conrad).
Glycymeris subovata tsumeyi Dall?
Eostra trigintinarea (Conrad) MacNeil (identified by MacNeil).
Ostrea sculturata Conrad.
Pecten cf. P. eboeius eboeius Conrad (fragments).
Plicatula marginata Say.
Crassinella galvestonensis Harris.
Venericardia granulata Say var.
Venericardia periplana abbreviata Conrad.
Cardita arata verdevila Gardner.
*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 County, 8 miles northwest of LaGrange (U. S. G. S. sta. 11822); in Wayne County, 1/4 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.

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 (1½ 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, z, a, b, and c 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).
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).
Crussatellites undulatus cyclopterus Dall.
Venericardia granulata Say.
Phacoides anodonta (Say).
Cardium virginianum Conrad (rare).
Isocardia carolina Dall (rare).
Chione cirtinaria (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 redinica (Say) (rare).
Area (Nodita) incile Say.
Area (Striarca) centenaria Say.
Ostrea sculturata Conrad (rare).
Pecten decemarius Conrad (rare).
Pecten virginianus Conrad (rare).
Pecten jeffersonius edgecombensis Conrad.
Astarte coheni Conrad (rare)?
Astarte undulata Say.
Astarte arata Conrad (rare).
Crussatellites undulatus (Say).
Chama congregata Conrad.
Cardita arata (Conrad) (rare).
Venericardia granulata Say.
Mulinia congesta (Conrad) (occurs near the top of zone 2).

Coral:
Astrea 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

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MOLLUSCA FROM MIOCENE AND LOWER PLIOCENE OF VIRGINIA AND NORTH CAROLINA

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.
Liostraea sulcosa (Conrad).
Fusinus exilis (Conrad).
Psychosiphon altillis (Conrad).
Psychosiphon inequata (Conrad).
Scalaspira struensosa Conrad.

Bed e:

Caecum stevensoni Meyer.
Glycymeris americana (De France).
Ostrea disparilis Conrad.
Pecten jeffersonius edgecombensis Conrad.
Plicatula marginata Say.
Crasseolites 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

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 Belfield 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. 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.—Continued

Unconformity.

Miocene:

Yorktown formation, zone 2:

Bluish to gray sands with shell impressions—4
Bluish to gray clayey sands containing many Mulinia congesta, etc., near the base and top. The following species were collected near the top of this 12-15 foot bed: Fissurella cf. specimens from Suffolk, Va., Glycymeris subovata tuomeyi Dall, Pecten jeffersonius Say, Pecten eboreus eboreus Conrad, Crassatellites undulatus Say, Phacoides cornutus Conrad, Venus tridacnoides (Lamarck), Mulinia congesta Conrad.

Brownish coarse sands containing dark particles and a few pebbles 1 inch or less in diameter. Ostrea is the most common fossil.

Clayey sands, sparsely fossiliferous. The following species were collected above zone 1: Urosalpinx trossulus Conrad, Liridea sulcosa Conrad, *Turritella aticoastata Conrad (like form from Chama-bearing bed below old Kings Mill Wharf, James River, Va.), Crepidula aculeata costata Morton, Fissurella redimicula Say, Solaria superum Conrad. Dentalium attenuatum Say, Mytilus conradinus D'Orbigny.


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 murfreesboronensis Mansfield, Astarte hartfordensis Gardner, Astarte undulata deltoidea Gardner, Venericardia granulata Say, Isocardia cardinensis Dall.

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. 11282). 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 Mound Gould Landing, Bertie County, where the bed rises about 10 feet above the beach and is unconformably 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:

- *Acestina canaliculata* Say.
- *Marginella imatula* Conrad.
- *Marginella bella* Conrad.
- *Olivella mutica* Say.
- *Oliva nitidula* (Dillwyn).
- *Scaphella mutabilis* Conrad.
- *Busycon canaliculatum* canaliferum Conrad.
- *Utita chowanensis* Gardner.
- *Ilyanassa granifera* sexdentata Conrad.
- *Anachis milleri* Gardner.
- *Sella adamsi* (H. C. Lea).
- *Turritella variabilis* Conrad (stout variety).
- *Crepidula fornica* cymbaformis Conrad.
- *Nucula proxima* Say.
- *Nucula acuta* (Say).
- *Glycymeris subovata* Say.
- *Eontia carolinensis* (Conrad).
- *Area improcera* Conrad.
- *Ostrea sculpturata* Conrad.
- *Pecten eboreus bertiensis* Mansfield.
- *Modiolus ducatellii* Conrad.
- *Astarte concentrica* Conrad.
- *Crassatellites undulatus* Say.
- *Venericardia granulata* Say (a low form).
- *Phacoidea multistriata* 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.**

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,
many individuals of *Spisula* and one fragment of* Dentitium 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.

In the southern part of the State abundantly fossiliferous strata of the Waccamaw formation overlie Cretaceous beds at Neills Eddy Landing, at Walkers Bluff on the Cape Fear River, 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 fauna 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 e-e on the map included in my paper of 1929.

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

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terebra (Hastula) simplex Conrad</td>
<td>St. Marys</td>
</tr>
<tr>
<td>Conus diluvianus Green</td>
<td>Do.</td>
</tr>
<tr>
<td>Conus marylandicus Green</td>
<td>Yorktown, zone 1 and higher beds.</td>
</tr>
<tr>
<td>Oliva eborae Conrad</td>
<td>St. Marys.</td>
</tr>
<tr>
<td>Busycotypus coronatus Conrad</td>
<td>Do.</td>
</tr>
<tr>
<td>Busycotypus coronatus rugosum Conrad</td>
<td>Calvert, Choptank, and St. Marys.</td>
</tr>
<tr>
<td>Busycotypus maximum fllosum Conrad</td>
<td>Yorktown and higher beds.</td>
</tr>
<tr>
<td>Fusinus parillus Conrad</td>
<td>St. Marys.</td>
</tr>
<tr>
<td>Fusinus propeparilis Mansfield</td>
<td>Yorktown, zone 1.</td>
</tr>
<tr>
<td>Alectron peralta Conrad</td>
<td>St. Marys.</td>
</tr>
<tr>
<td>Turritella plebela Say</td>
<td>Calvert, Choptank, and St. Marys.</td>
</tr>
<tr>
<td>Turritella plebela carinata Gardner</td>
<td>St. Marys.</td>
</tr>
<tr>
<td>Turritella pilisbryi Gardner</td>
<td>Yorktown, zone 1.</td>
</tr>
<tr>
<td>Turritella terstriata Rogers</td>
<td>Do.</td>
</tr>
<tr>
<td>Calliostoma humile Conrad</td>
<td>St. Marys.</td>
</tr>
<tr>
<td>Glycymeris tumulosa (Conrad)</td>
<td>Not above the St. Marys.</td>
</tr>
<tr>
<td>Glycymeris americana Defrance</td>
<td>Yorktown, zone 2 and higher beds.</td>
</tr>
<tr>
<td>Area incide Say</td>
<td>Yorktown, <em>Chama</em>-bearing bed and higher beds.</td>
</tr>
<tr>
<td>Arca idorea Conrad</td>
<td>St. Marys.</td>
</tr>
<tr>
<td>Arca virginiae Wagnor</td>
<td>Do.</td>
</tr>
<tr>
<td>Pedallon maxillatum (Deshayes)</td>
<td>Calvert, Choptank, St. Marys, mechanically mixed with zone 1 of Yorktown.</td>
</tr>
<tr>
<td>Astarte perplana Conrad</td>
<td>St. Marys.</td>
</tr>
<tr>
<td>Astarte symmetrica Conrad</td>
<td>Yorktown, zone 2, middle and upper parts.</td>
</tr>
<tr>
<td>Cardium taenioplagia Dall</td>
<td>Yorktown, zone 2.</td>
</tr>
<tr>
<td>Chione dalli Olsson</td>
<td>St. Marys.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>TABLE 2. — Geologic ranges of species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Virginia</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>North Carolina</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Calvert</strong></td>
</tr>
<tr>
<td><strong>Choptank</strong></td>
</tr>
<tr>
<td><strong>St. Marys</strong></td>
</tr>
<tr>
<td><strong>Zone 1</strong></td>
</tr>
<tr>
<td><strong>Zone 2</strong></td>
</tr>
<tr>
<td><strong>Undifferented</strong></td>
</tr>
<tr>
<td><strong>Yorktown</strong></td>
</tr>
<tr>
<td><strong>Zone 1</strong></td>
</tr>
<tr>
<td><strong>Zone 2</strong></td>
</tr>
<tr>
<td><strong>Undifferented</strong></td>
</tr>
<tr>
<td><strong>Zone 1</strong></td>
</tr>
<tr>
<td><strong>Zone 2</strong></td>
</tr>
<tr>
<td><strong>Undifferented</strong></td>
</tr>
<tr>
<td><strong>Duplin</strong></td>
</tr>
<tr>
<td><strong>Pliocene, Waccamaw</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Nucula proxima Say.</td>
</tr>
<tr>
<td>Yoldia laevis (Say)</td>
</tr>
<tr>
<td>Glycymeris laevis (Tuomey and Holmes)</td>
</tr>
<tr>
<td>Glycymeris tumulus (Conrad)</td>
</tr>
<tr>
<td>Glycymeris duplicata Dall.</td>
</tr>
<tr>
<td>Arcella (Scapharca) scalaris Conrad.</td>
</tr>
<tr>
<td>Arcella (Scapharca) lillona Say.</td>
</tr>
<tr>
<td>Arcella (Scapharca) calicestosa Dall.</td>
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<tr>
<td>Arcella (Scapharca) carolinensis Wagner</td>
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<tr>
<td>Ostrea (Ostrea) laevigata Say.</td>
</tr>
<tr>
<td>Ostrea (Ostrea) carolinensis Say.</td>
</tr>
<tr>
<td>Pecten raveneli Dall.</td>
</tr>
<tr>
<td>Pecten (Lyropecten) jeffersonii septenarius Say.</td>
</tr>
<tr>
<td>Pecten (Lyropecten) madisoni Say.</td>
</tr>
<tr>
<td>Pecten (Lyropecten) elstoni Say</td>
</tr>
<tr>
<td>Pecten (Lyropecten) virginianus Conrad</td>
</tr>
<tr>
<td>Pecten (Lyropecten) marylandicus Wagner</td>
</tr>
<tr>
<td>Pecten (Lyropecten) eremophilus Tucker</td>
</tr>
<tr>
<td>Pecten (Chlamys) decemarius Conrad.</td>
</tr>
<tr>
<td>Pecten (Plagiotrochus) gibbus (Linnaeus)</td>
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<tr>
<td>Pecten (Plagiotrochus) eborus Conrad.</td>
</tr>
<tr>
<td>Pecten (Plagiotrochus) plagiostoma Gardner.</td>
</tr>
<tr>
<td>Pecten (Amusium) mortoni Ravenel.</td>
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<tr>
<td>Plicatula margiinata Say.</td>
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<td>Pododesmus (Monia?) philippi Gardner.</td>
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<tr>
<td>Mytilus (Mollusca) recurvus Rafinesque.</td>
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<tr>
<td>Crenella precursor Gardner.</td>
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<tr>
<td>Thraxis conradi Couthoux.</td>
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<tr>
<td>Thraxis transversa H. C. Lea.</td>
</tr>
<tr>
<td>Thraxis madellaensis Gardner.</td>
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<td>Pandora (Kenneria) arenosa Conrad.</td>
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<tr>
<td>Pandora (Kenneria) naviculoides Gardner.</td>
</tr>
<tr>
<td>(Pandora) (Kenneria) dalli Gardner.</td>
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<tr>
<td>Verticordia (Trigoniina) emmensis Conrad.</td>
</tr>
<tr>
<td>Verticordia (Trigoniina) eharwakensis Gardner.</td>
</tr>
<tr>
<td>Verticordia (Trigoniina) rogersi Gardner.</td>
</tr>
<tr>
<td>Coralliophaga? microreticulata Gardner.</td>
</tr>
<tr>
<td>Astarte symmetricalis Conrad</td>
</tr>
<tr>
<td>Astarte exaltata Conrad.</td>
</tr>
<tr>
<td>Astarte rosnokensis Gardner.</td>
</tr>
<tr>
<td>Astarte stephensi Gardner.</td>
</tr>
<tr>
<td>Astarte arata Conrad.</td>
</tr>
<tr>
<td>Astarte hertfordensis Gardner.</td>
</tr>
<tr>
<td>Astarte hertfordensis meherrinensis Gardner.</td>
</tr>
<tr>
<td>Astarte berryi Gardner.</td>
</tr>
<tr>
<td>Astarte (Astartochara) raphanoides Gymn.</td>
</tr>
<tr>
<td>Astarte (Astartochara) griffonensis Gardner.</td>
</tr>
<tr>
<td>Astarte (Astartochara) undulata Say.</td>
</tr>
<tr>
<td>Astarte (Astartochara) undulata dolioidea Gardner.</td>
</tr>
<tr>
<td>Astarte (Astartochara) undulata gymnula Dall.</td>
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<tr>
<td>Astarte (Astartochara) concentrica Conrad.</td>
</tr>
<tr>
<td>Astarte (Astartochara) concentrica bella Conrad.</td>
</tr>
<tr>
<td>Astarte (Astartochara) concentrica conradi Gardner.</td>
</tr>
<tr>
<td>Crassinae (Crassinae) harrisi Gardner.</td>
</tr>
<tr>
<td>(7) St. Marys</td>
</tr>
<tr>
<td>(7) Yorktown</td>
</tr>
<tr>
<td>(7) Undifferented</td>
</tr>
<tr>
<td>(7) Yorktown</td>
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<tr>
<td>(7) Undifferented</td>
</tr>
<tr>
<td>(7) Yorktown</td>
</tr>
<tr>
<td>(7) Undifferented</td>
</tr>
<tr>
<td>(7) Duplin</td>
</tr>
<tr>
<td>(7) Pliocene, Waccamaw</td>
</tr>
<tr>
<td>Species</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Crassinella galvestonensis (Harris)</td>
</tr>
<tr>
<td>Crassinella dupliciniana Dall</td>
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<tr>
<td>Crassinella nansenomendensis Gardner, n. sp.</td>
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<tr>
<td>Corbicula densata Conrad</td>
</tr>
<tr>
<td>Carditamera arata Conrad</td>
</tr>
<tr>
<td>Carditamera arata verdevilla Gardner, n. subsp.</td>
</tr>
<tr>
<td>Carditamera arata columbiana Gardner, n. subsp.</td>
</tr>
<tr>
<td>Pleuroceris tridentata (Say)</td>
</tr>
<tr>
<td>Pleuroceris tridentata decemcostata Conrad</td>
</tr>
<tr>
<td>Pteromeris periplana Conrad</td>
</tr>
<tr>
<td>Pteromeris periplana abbreviata Conrad</td>
</tr>
<tr>
<td>Erycinella ovalis Conrad</td>
</tr>
<tr>
<td>Erycinella phyllocheilus (Conrad) Gardner</td>
</tr>
<tr>
<td>Chama striata Emmons</td>
</tr>
<tr>
<td>Phacoidea (Cavilucina) trisulcatus (Conrad)</td>
</tr>
<tr>
<td>Phacoidea (Cavilucina) trisulcatus multistratiatus (Conrad)</td>
</tr>
<tr>
<td>Phacoidea (Cardiolumina) postal veatus Gardner, n. sp.</td>
</tr>
<tr>
<td>Phacoidea (Lucinaea) eribrans (Say)</td>
</tr>
<tr>
<td>Phacoidea (Pavolucina) multistratiatus (Tuomey and Holmes)</td>
</tr>
<tr>
<td>Ctena speciosa (Rogers)</td>
</tr>
<tr>
<td>Ctena microimbricata Gardner, n. sp.</td>
</tr>
<tr>
<td>Diplodonta caloosensis Dall</td>
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<tr>
<td>Diplodonta leuca Dall</td>
</tr>
<tr>
<td>Diplodonta (Phylodonta) soror (C. B. Adams)</td>
</tr>
<tr>
<td>Erycinella carolinensis Dall</td>
</tr>
<tr>
<td>Erycinella carolinensis elongata Gardner, n. subsp.</td>
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<tr>
<td>Bornia trianguila Dall</td>
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<tr>
<td>Bornia bladenensis Gardner, n. sp.</td>
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<tr>
<td>Myella bladenensis Gardner, n. sp.</td>
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<tr>
<td>Myella bladenensis Gardner, n. sp.</td>
</tr>
<tr>
<td>Myella viola Gardner, n. sp.</td>
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<tr>
<td>Sportella consticta (Conrad) Dall</td>
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<td>Sportella clausa Gardner, n. sp.</td>
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<tr>
<td>Sportella gibberosa Gardner, n. sp.</td>
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<tr>
<td>Sportella waccamawensis Gardner, n. sp.</td>
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<tr>
<td>Sportella compressa (H. C. Lea) Dall</td>
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<td>Alligina chowanensis Gardner, n. sp.</td>
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<tr>
<td>Alligina rhomboidea Gardner, n. sp.</td>
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<td>Cardium (Trachycardium) isocardioida (Linnæus)</td>
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<td>Cardium (Cerastoderma) cortisquatum Conrad</td>
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<tr>
<td>Cardium (Cerastoderma) virginianum Conrad</td>
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<tr>
<td>Cardium (Laevicardium) sublineatum Conrad</td>
</tr>
<tr>
<td>Isoardiola fratera Say</td>
</tr>
<tr>
<td>Isoardiola fratera viola Gardner, n. subsp.</td>
</tr>
<tr>
<td>Isoardiola fratera carolina Dall</td>
</tr>
<tr>
<td>Petriola (Rupellaria) grimaldi Olson</td>
</tr>
<tr>
<td>Cooperella carpenteri Dall</td>
</tr>
<tr>
<td>Dosinia (Dosinia) acetabulum Conrad</td>
</tr>
<tr>
<td>Dosinia (Dosinia) elegans Conrad</td>
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<tr>
<td>Macrouristastis repostna (Conrad)</td>
</tr>
<tr>
<td>Callocardia (Agriopectra) chioneformis Gardner, n. sp.</td>
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<tr>
<td>Callocardia (Agriopectra) castoriana Gardner, n. sp.</td>
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<td>Macrouristastis (Costasteria) emmonis Gardner, n. sp.</td>
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<tr>
<td>Chione (Chionea) (Rogeri) Dall</td>
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<td>Chione (Chionea) dalli Olson</td>
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<tr>
<td>Chione (Timolca) grus (Holmes)</td>
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<tr>
<td>Venus (Mercenaria) berryl Gardner, n. sp.</td>
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<tr>
<td>Venus (Mercenaria) plena infraflata Dall</td>
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<tr>
<td>Venus (Mercenaria) campechiensis tridacnoides (Lamarck)</td>
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<tr>
<td>Venus (Mercenaria) campechiensis carolinensis Conrad</td>
</tr>
<tr>
<td>Venus (Mercenaria) mercenaria notata Say</td>
</tr>
<tr>
<td>Gemma magna insulcata Gardner, n. subsp.</td>
</tr>
<tr>
<td>Gemma magna majorina Gardner, n. subsp.</td>
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</tbody>
</table>

1 Fide Gardner.
2 Collected near Franklin by Mansfield.
### Table 2.—Geologic ranges of species—Continued

<table>
<thead>
<tr>
<th>Gemma magna virginiana Dall.</th>
<th>Virginia</th>
<th>North Carolina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tellina (Moerella?) calpix Gardner, n. sp.</td>
<td>St. Marys Zone 1</td>
<td>Yorktown Zone 1</td>
</tr>
<tr>
<td>Tellina (Moerella) sayi (Deshayes Ms.) Dall.</td>
<td>undifferentiated</td>
<td>X</td>
</tr>
<tr>
<td>Tellina egna Conrad</td>
<td>Virginia</td>
<td>North Carolina</td>
</tr>
<tr>
<td>Macoma virginiana Conrad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macoma virginiana conradi Dall</td>
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<tr>
<td>Macoma cooki Gardner, n. sp.</td>
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<tr>
<td>Semele subovata alta Gardner, n. subsp.</td>
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<tr>
<td>Semele bellastrata (Conrad) Dall</td>
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<tr>
<td>Semele macleides (Conrad) Dall</td>
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<td></td>
</tr>
<tr>
<td>Abra subreflexa Say</td>
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<tr>
<td>Abra aequalis Say</td>
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<tr>
<td>Abra aequalis deltoidea Gardner, n. subsp.</td>
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<tr>
<td>Tagelus gibbus (Spengler)</td>
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<td>Tagelus gibbus carolinensis (Conrad)</td>
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<td>Donax eburni preaequilibrata Gardner, n. subsp.</td>
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<tr>
<td>Donax fossor Say</td>
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<td>Donax chukatuckensis Gardner, n. sp</td>
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<td></td>
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<tr>
<td>Solen viridis Say</td>
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<tr>
<td>Mastra (Mactrotoma) fragilis precursor Gardner, n. subsp.</td>
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<td>Spiusula (Mactromeris) bowleriensis Gardner, n. sp.</td>
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<td>Spiusula (Hemimastra) similis (Say)</td>
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<td>Spiusula (Hemimastra) medieella (Conrad)</td>
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<td>Spiusula (Hemimastra) alta Gardner, n. subsp.</td>
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<td>Spisula (Hemimastra) raphanumcokeus Gardner, n. subsp.</td>
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<td>Mulinia congesta (Conrad) Dall</td>
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<td>Mesodesma spatha Gardner, n. sp.</td>
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<td>Ervilia lata Dall</td>
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<tr>
<td>Ervilia lata radiata Gardner, n. subsp.</td>
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<td>Corbula (Caryoscrobula) retusa Gardner, n. subsp.</td>
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<td>Corbula (Caryoscrobula) seutata Gardner, n. sp.</td>
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<td>Barnea (Scobinopholus) arneta (Conrad) Dall</td>
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<tr>
<td>Martesia cuneiformis (Say) Fischer</td>
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<tr>
<td>Kuphus calamus (H. C. Lea)</td>
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</table>
### Virginia and North Carolina Localities

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.
- King and Queen County:
  - 10. Walkerton, 3 miles northeast of.
- New Kent County:
  - 11. Lanexa.
- James City County:
- Gloucester County:
  - 15. Ware River.
- Prince George County:
  - 16. Near mouth of Baileys Creek.
- Surry County:
  - 17. Claremont, old Claremont Wharf, Claremont Wharf, 6½ miles below Claremont, Sunken Marsh Creek 2 miles below Claremont, and 8½ miles below Claremont Wharf (probably Schmidts Bluff).
- Dinwiddle County:
- 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. Bonns 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:
- Nansemond County:
  - 29. Chuckatuck, a quarter of a mile north of.
  - 30. Everets, a quarter of a mile east of.

**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.
- Bertie County:
  - 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, 1½ miles above, an eighth of a mile below, and 1 to 1½ 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. Williamson, 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 2½ miles southeast of.
- Wilson County:
  - 49. Wilson, Hominy Swamp, 1 mile west of, 3 miles east-southeast of, 5 miles south of.
  - 50. Stantonburg, 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, 6½ 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.
PART 1. PELECYPODA

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. Crony.
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 PRIONODISMACEA
Superfamily NUCULACEA
Family NUCULIDAE

Genus NUCULA Lamarck

Type by monotypy: Area nucleus Linnaeus. Recent in the European seas. The group has been exhaustively treated by Schenck 32.

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 subcuneate 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 32 refers to Nucula s. s. the Lower Cretaceous species, Nucula gaultiana 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
1836. Nucula proxima Say, Tuomey and Holmes, Pleocene fossils of South Carolina, p. 53, pl. 17, figs. 7–9.
1858. Nucula proxima Say, Holmes, Post-Pleocene fossils of South Carolina, p. 17, pl. 3, fig. 6.

Valves obliquely subangular, 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 denticulocrenate. 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 projects 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.

31 Idem, p. 22.
Type locality: Upper Marlboro, Md., is cited as the type locality. The collector was Mr. J.Williams, 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, 5 miles above Yorktown, York County; 1½ miles west of Smithfield, Beams 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, 1¾ 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 works 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; Colemain Landing, Mount Gould Landing, and ½ to ¾ mile above Edenton House 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 Greensville, 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 Fairmount, Robeson County. Pliocene, Waccamaw formation. Walkers Bluff, Bladen County; Lake Waccamaw, Crony, 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.; Chocowhatchee 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.; Pliostocene, Dismal Swamp Canal, posts 15 to 16, Va.; quarantine station well, North Carolina; Walles Bluff, near Cornfield Harbor, Md.; Simmons Bluff, Savannah River, S. C.; Rose Bluff, Nassau County, Fla.; Eau Gallie, Brevard County, Fla.; Dayton Beach, 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


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.


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*


1831. *Nucula laevis* Say, American conchology, pl. 12, right-hand figures, descriptive text.


1864. *Yoldia laevis* (Say) Conrad. Meek, Miocene check list; Smithsonian Misc. Coll., No. 185, p. 3.


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 arched 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; 34% miles above Yorktown, Yorktown, York County; Claremont Wharf, Surry County; Ferguson's Wharf, 1 1/2 miles west of Smithfield, and 5 miles northeast of Smithfield; 1 1/2 miles below Blackwater Bridge, 2 1/2 to 3 miles south of Zuni, 7 to 7 1/2 miles below Zuni, Isle of Wight County; 2 to 2 1/2 miles below South Quay, Blackwater River, 1 1/2 mile north of Chuckatuck, 1 1/2 mile east of Everets, Exits, 5 1/2 miles northwest of Suffolk, 2 1/2 miles northwest of Suffolk, 1 1/2 miles northwest of Suffolk; 1 1/2 miles north of Suffolk, 1 mile west of Suffolk, 1 1/2 mile below the Suffolk waterside dam, 1 mile northeast of Suffolk, and 1 1/2 miles northeast of Suffolk, Nansemond County.

North Carolina: Yorktown formation, 1 mile above Branches Bridge; 3/4 to 2 miles below Branches Bridge, and Branches Bridge, Northampton County; 2 1/2 miles northwest of Murfreesboro, 1 1/2 miles above Murfreesboro, 1 mile above Murfreesboro, Murfreesboro, Tar Ferry, and Mount Pleasant Landing, Hertford County; Durham's farm near Halfax, Palmyra Bluff, and 3 1/2 miles below Palmyra Bluff, Halifax County; Hamilton Bluff, 1/2 mile below Hamilton Landing, 3 miles west of Williamson, 2 1/2 miles northwest of Williamson, and 1 mile northwest of Williamson, Martin County; 6 to 7 miles below Rocky Mount, 5 miles below New Bridge, 15 1/2 miles above Bella Bridge, 1/2 mile above Bella Bridge, mouth of Swift Creek, and Shiloh Mills, Edgecombe County; 2 miles below Todd's Station, 3 miles southwest of Frog Level; 8 to 9 miles west of Greenville, 3 miles west of Greenville, 6 miles below Greenville, 6% 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, 1/2 mile east of Lizzie, and 4 miles east of Lizzie in Dog Swamp, Greene County; 1/2 to 1/4 mile above Edenhouse Point, Bertie County. Duplin marl, 1 1/2 miles northeast of Fairmont, Robeson County, Pliocene, Waccanaw formation, 4 miles south of Elizabethtown and Wilkes 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 ARCAE

Family ARCIDAE


Genus ARCA (Linnaeus) Lamarck

1758. Linnaeus, Systema naturae, 10th ed., p. 693.


Arca none 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 systeme des habitations des vers testaces, p. 172), "Pour le type da genre j'ai donne la fig. 2, pl. XIX, de la charniere de l'Arca antiquata Lin. qu'on trouve figuree dans Chemn. 7, pag. 201, tab. 53, fig. 548," may justly claim priority. As Reinhart 33 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 none be established as the type species has been presented to the International Commission on Zoological Nomenclature by Reinhart. 33 This seems on the whole a wiser method of salvaging a widely accepted type than an attempt to invoke "virtual autonomy" in its behalf.

In the hope of a favorable decision from the commission Arca none has been retained as the type of the genus in this report.

The Arcas typified by A. none are equivalent, 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 carilage 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


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

The Barbatia are elongated shells, covered with a hairy periostracum; 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 (Stephen-son, 1923; Wade, 1926) and the genotype is a Recent species.

Subgenus GRANOARCA Conrad


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

Barbatia (Granoarca) propatula (Conrad) Conrad

Plate 2, figure 1


1845. Arca propatula Conrad, Fossils of the medial Tertiary of the United States, p. 61, pl. 32, fig. 1.

1856. Arca bians Tuomey and Holmes, Pleistocene fossils of South Carolina, p. 34, pl. 14, figs. 4, 5. Not Arca bians Bronn, 1842, nor Reeve, 1844.


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; umbonal slope rounded, rather elevated; ribs about 32, square, not profoundly prominent, about equal in width to the interspaces, which have transverse imbricated lines; ribs largest about the umbonal slope, very distinct on the posterior slope, which is concave toward the hinge line; posterior margin oblique, concave, extremely widely rounded; summit of umbo moderately elevated, slightly reflu; 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.

33 Reinhart, F. 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 tupid, 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. campylata* 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.

**Genus ANADARA Gray**


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 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, 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 con-fronted 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, 1889.

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 synonomy 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 Choctawhatchee. 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 Crony, Columbus County; Wilmington, New Hanover County.


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

Plate 2, figure 5; plate 3, figure 3


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


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, 3½ 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 undoubted.[ly very close to *Anadara linoosa* (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. linoosa* of Say, with a more marked contraction of the basal margin and a wider cardinal area. Furthermore the known distribution of *A. linoosa* does not include a fauna of so cool water as that indicated by the type locality of *protracta*.

**Anadara callicestosa (Dall) Mansfield**

Plate 3, figures 2, 6


Shell of moderate size, rather thin, rhomboidal, with small, prominent, mediodorsal, prosoconchbeaks situated at about the anterior third of its length; left valve with about 37 squarish subequal radial ribs, separated by narrower channelled 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 recrudeles 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 20 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. Length 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 callipeura* 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.

**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 rhomboideal, 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 increments; 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 lace-like pattern of the surface sculpture, which was noted in the original description of A. calliostosa (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

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

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 55, altitude 55, diameter 45 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 distinctly 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, 1888.
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**


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

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

**Anadara (Cunearea) scalaris** (Conrad) Dall

Plate 2, figure 2


1856. *Arca scalaris* Conrad. Tuomey and Holmes, Pliocene fossils of South Carolina, p. 43, pl. 16, figs. 1, 2.


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; umbonal 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 common 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 *Echophora* 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 GLYCNYMERIDAE**

**Genus GLYCNYMEUS Da Costa**


Shell heavy, equivale, 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, multivinicular, the ligament furrows arranged in concentric rhombs. Hinge margin aruncate, set with two series of strong transverse teeth, chevron-shaped medi ally, the distal teeth oblique to horizontal; teeth progressively obliterated during growth by the subsidence of the ligament area. Adductor scars distinct, the posterior but tressed. 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


1856. *Pectunculus laevis* Tuomey and Holmes, Pliocene fossils of South Carolina, p. 50, pl. 17, fig. 5.
PART 1. PECTENODA


Somewhat oval, thick, inequilateral, concentrically striate, or grooved; beak 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, Md.

The outline of the shell serves also to distinguish it from Glycymeris parvis (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 duplicinosis Dall

Plate 2, figure 3; plate 5, figure 5

Sheel 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 aruncate; 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 Land, Craven County. Duplin marl, Natural Well, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County.

Glycymeris americana (Defrance) Dall

Plate 1, figures 16-21


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 aruncate; 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.


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 even and rounded ventrally, cuneate dorsally, decidedly tumid in the umbal 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 parvis (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.

1856. *Pectunculus lentiformis* Conrad. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 48, pl. 17, fig. 2.

1856. *Pectunculus quinquerguata* Conrad. Tuomey and Holmes, ibid., 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.


A very careful and conscientious scrutiny of a large number of specimens has resulted in the above synonymy. *G. pessa* 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, obsolete 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. quinquerguata*. 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 *inquinquagata* 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, 1888.

*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 *pennea* (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. pennea* the anterior lateral margin is more or less sharply truncated and the anterior umbonal slopes are more or less angular. The cardinal area of *pennea* is wider than in *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 Ecphora and Con-
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, 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


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 **Brachydontes**. 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 **taleus calami**, or a typographical error is evident."

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**Subgenus ISCHADION Jukes-Browne**


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 diverging 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


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


1900. **Mytilus hamatus** Say. Clark, Maryland Geol. Survey, Pilocene and Pleistocene, p. 203, pl. 60, figs. 5, 6.

Moule recourbée. Test obovale, cunéiforme, recourbé, à striés longitudinales de trois longueurs; épidère noirâtre; nacre-violette; becs obliques, à un angle décurent, de chaque côté; bord inférieur et intérieur strié, crenelé; 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 brillante 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 biff and sometimes trifid toward the tip; color dark fuscous; within dark purpurescent, with a whitish margin.

Length 1½ inches, breadth nearly ½ 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.
MOLLUSCA FROM MIOCENE AND LOWER PLIOCENE OF VIRGINIA AND NORTH CAROLINA

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

Genus CRENELLA Brown


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 irations, rarely dichotomous toward the ventral margin; interareas slightly narrower; increments mostly microscopic, 3 or 4 of them exaggerated. Inner margin obscurely crenulated. Interior lined with a calcareaous layer continued to the pallial line. Hinge noncrenulate. Ligament furrow shallow, extending from beneath the umbones about one-fourth the distance down the posterior margin. Anterior adductor muscle impression elongated; posterior semi-oval. 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 of the same species. 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 Muller

1776. Pecten Muller, Zoologie 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


Type by original designation: Pecten sievac 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


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 submargin; 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 ribs; 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. hemicycloides 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, Robeson County. The species is represented by a single valve.

Outside distribution: Pliocene, Caloosahatchee marl, Caloosahatchee River, Fla. (1) 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**


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 subequally angular; 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.

*Plagioctenium* 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 *Plagioctenium*, 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 (Plagioctenium) gibbus (Linnaeus) Dall**

*Plate 5, figure 3*


1838. *Pecten distilatus* Say. Holmes, Post-Pleistocene fossils of South Carolina, p. 12, pl. 2, fig. 12.


**O. testa radilis 20 glabris, gibba. Habitat in M. Americano.—Linnaeus, 1738.**

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, Slocum 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**


Type by subsequent designation, Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 4, p. 695. 1888: *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*


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

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


Shell ovate, slightly convex, with about 10 broad, flattened ribs disappearing on the umbo, some of them sulcated; radiating striae numerous, distinct, subaequabas; 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 *decennarius* 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 *decennarius* 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, 1888.

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. 1 1/2 miles above Murfreesboro and 1 mile above Murfreesboro, Hertford County; Halifax, Halifax County; 1/2 mile above Bells Bridge and 3/4 mile below Bells Bridge, Edgecombe County; 2 miles west of Greenville, Pitt County.

Subgenus LYROPECTEN Conrad


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, *Gigantpecten Rovereta* 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) madisoniana** (Say) Glenn

Plate 4, figure 2; plate 9, figure 7


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 4 1/2 inches; breadth 4 1/2 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) madisoniana*, 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) madisoniana* are relatively wide—wider than *C. jeffersonia*—and usually with 15 or 16 ribs. Each rib bears 3 scabrulous 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, Beads and Wye Mills, Queen Annes County, Md.; Fairhaven and Lyons Creek, Anne Arundel County, Md.; Whites Landing, Magruders Ferry, and Trumans Wharf, Prince Georges County, Md.; Chesapeake Beach and Pitt Point, Calvert County, Md.; Choptank formation, Greensboro, Caroline County, Md.; Skippton, 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

PART 1. PELECYPODA


1904. pecten (chlamys) jeffersonius Say. Glenn, Maryland Geol. Survey, Miocene, p. 378, pl. C, fig. 2.


1882. chlamys (lyropecten) jeffersonius Say. Mansfield, Florida Geol. Survey Bull. 8, p. 59, pi. 11, fig. 1.


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, very fine striae; ribs elevated, rounded, with 8 or 7 striae on the back of each; intervening grooves profound; ears equal; slods 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 2% inches, breadth 5% 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.

<table>
<thead>
<tr>
<th>Number of ribs</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
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<th>21</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Chlamys (lyropecten) jeffersonius (Say)</td>
<td>1</td>
<td>9</td>
<td>14</td>
<td>37</td>
<td>36</td>
<td>33</td>
<td>26</td>
<td>14</td>
<td>13</td>
<td>20</td>
<td>29</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Chlamys (lyropecten) jeffersonius (Say) subs. septenaria (Say)</td>
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<td>9</td>
<td>13</td>
<td>37</td>
<td>35</td>
<td>32</td>
<td>24</td>
<td>4</td>
<td>3</td>
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</tr>
<tr>
<td>Chlamys (lyropecten) jeffersonius subs. edgecombensis (Conrad)</td>
<td>1</td>
<td>9</td>
<td>13</td>
<td>37</td>
<td>35</td>
<td>32</td>
<td>24</td>
<td>4</td>
<td>3</td>
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</table>

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.

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 the 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, Belvedere, and Indian Field Point, York County; 3 miles northeast of Walkerton, King and Queen County; near the mouth of Bailes Creek, Prince George County; Petersburg, Dinwiddie County; Kings Mill, James City County; old Claremont Wharf, Claremont Wharf, Schmidts Bluff, 6% miles below Claremont Wharf, Sunken Marsh Creek, Coham Wharf, Surry County; 1½ miles west of Smithfield, 1½ miles above Zuni, 2½ to 3 miles northwest of Zuni, 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; Delaware Park, Maddelys Bluff, 3 to 4 miles above the lower Seaboard Railway bridge, and ½ to ¾ mile above the lower Seaboard Railway bridge, Southampton County; ¼ mile east of Everets, Exit, 1½ miles southeast of Reids Ferry, 1½ miles north of Suffolk, 5½ miles northwest of Suffolk, 1 mile west of Suffolk, and ½ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1½ miles above Branches Bridge, 1 mile above Branches Bridge, Branches Bridge, Northampton County; 2½ miles northwest of Murfreesboro, 1¼ miles above Murfreesboro, 1 mile above Murfreesboro, near Murfreesboro, Dogwood Landing, Hertford County; Halifax, 1½ miles northeast of Enfield, ½ mile west of Enfield, and Palmyra Bluff, Halifax County; Compass Creek (1 mile from mouth), 1½ miles below Bells Bridge, ½ mile above Bells Bridge, ½ 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, 1 1/2 miles west of Greenville, and Greenville (just south of the county bridge), Pitt County; 1 1/2 miles northeast of Chocowinity, Beaufort County; 6 miles west of Goldsboro, Wayne County; 4 miles east of Lizzie, Greene County.


Chlamys (Lyropecten) jeffersonia septenaria (Say) Mansfield Plate 4, figure 1

1856. Pecten septenarius Say. Tuomey and Holmes, Pleistocene fossils of South Carolina, p. 31, pl. 13, figs. 1-4.

Shell convex, suborbicular; auricles subequal; surface with numerous slightly scalid 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, 8 1/2 miles below Claremont Wharf, Sunken Marsh Creek, Surry County; Petersburg, Dinwiddie County; James River, 7 to 7 1/2 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 1/2 mile below Suffolk, Nansemond County.

North Carolina: 1 mile above Branches Bridge, Northampton County; Miocene, Yorktown formation. Halifax and Pamyrn, Halifax County; 3/4 mile below Bells Bridge, 3/4 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; resiliat 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 110.0 millimeters, width 118.0± millimeters. Holotype, a right valve: U. S. Nat. Mus. 32493.

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


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


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 umboonal 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 umboonal region to the periphery. Interspaces wider than the primary radial threads, separated by linear interspaces and interradial areas. Auricles fairly large, subequal. Ears large, unequal, the anterior byssal ear of ernestsmithi is much more pointed at the cardinal margin than that of caloosaensis.


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. caloosaënsis Dall, of the Florida Pliocene, by the sculptured intercoastal areas; and from C. peedénsinis (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 AEGUIPECTEN Fischer


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.

Aeguipecten 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


1856. Pecten eboracensis Conrad, Fossils of the medial Tertiary of the United States, p. 48, pl. 23, fig. 2; pl. 24, fig. 3.


1845. Pecten eboracensis Conrad. Tuomey and Holmes, Pliocene fossils of South Carolina, p. 28, pl. 11, figs. 1-5.

1858. Pecten eboracensis Emmons, North Carolina Geol. Survey Rept., p. 279, fig. 197.


1892. Chlamys (Plesipecten) eboracensis eboracensis Conrad. Mansfield, Florida Geol. Survey Bull. 8, p. 60, pl. 12, fig. 11.


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:

<table>
<thead>
<tr>
<th>Ribs</th>
<th>17</th>
<th>18</th>
<th>19</th>
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<td>2</td>
<td>2</td>
<td>7</td>
<td>28</td>
<td>70</td>
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</tr>
<tr>
<td></td>
<td>95</td>
<td>59</td>
<td>31</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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 Chlamys (Aequipecten) eboracensis run as follows:

<table>
<thead>
<tr>
<th>Costae</th>
<th>19</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22</td>
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<tr>
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</tr>
<tr>
<td></td>
<td>7</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

In the coarser and slightly higher sands 1 1/2 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 eboracensis:

<table>
<thead>
<tr>
<th>Costae</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
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<tbody>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>1</td>
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</tbody>
</table>

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, 1 1/2 miles west of Smithfield, 3/4 mile northeast of Smithfield, 1 1/2 miles northeast of Smithfield, 5 miles northeast of Smithfield, at Tugwell, 6 1/2 to 7 miles below Zuni, 7 to 7 1/2 miles below Zuni, Isle of Wight County; Hitchcock, Greensville County; Sycamore and 3/4 to 5 1/2 mile above the lower Seaboard Railway bridge over Meherrin River, Southampton County; 3/4 mile north of Chuckatuck, 1/4 mile east of Everets, Exit, 1 1/4 miles southeast of Reids Ferry, 5 1/2 miles northwest of Suffolk, 2 1/2 miles northwest of Suffolk, 1 1/2 miles northwest of Suffolk, 1 1/2 miles northeast of Suffolk, 1 1/4 miles northeast of Suffolk, 1 1/4 miles northeast of Suffolk, 1 1/4 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; 2 1/2 miles northwest of Murfreesboro, 1 1/2 miles above Murfreesboro, near Murfreesboro, 3 to 4 miles below Tar Ferry, Tar Ferry, 1 1/4 miles below Tar Ferry, Dogwood Landing, and Mount Pleasant Landing, Hertford County; Colerain Landing, Mount Gould Landing, and 3/4 to 7/4 mile above Edenton Point, Bertie County; Halifax, Palmyra Bluff, 2 1/2 miles below Palmyra Bluff, Halifax County; Hamilton Bluff, 4 miles northwest of Williamson, 2 1/4 miles north of Williamson, and 1 mile northwest of Williamson, Martin County; 3 1/2 miles northwest of Rocky Mount, 2 miles west of Rocky Mount, 3/4 mile north of New Bridge, 5 miles below New Bridge, 6 1/4 miles below New Bridge, 15 1/4 miles above Beils Bridge, 1/4 mile above Beils Bridge, 3/4 mile below Beils Bridge, 1 to 1 1/4 miles below Beils Bridge, Shiloh Mills, Tarboro, and 1 mile below old Sparta Bridge, Edgecombe County; 2 miles below Ulysses Station, 2 miles southeast of Tugwell, 1 1/2 miles northeast of Farnamville, 3 miles south of Farmville, 2 1/4 miles northeast of Farmville, 3 miles south of Farmville, 2 1/4 miles northeast of Farmville, 2 1/4 miles north of Farmville, 3 miles southeast of Frog Level, 5 to 9 miles west of Greenville, 3 miles west of Greenville, 2 miles west of Greenville, 1 1/4 miles west of Greenville, 4 miles west of Greenville, 2 miles west of Greenville, 3 miles southeast of Greenville, 3 miles west of Greenville, 1 mile north of Greenville, 1 1/4 miles south of the county bridge, 1 1/4 miles east of Greenville, 6 miles below Greenville (at Cherry Landing), 6 1/4 miles below Greenville (at Tar's Landing), 9 to 10 miles south of Greenville, Harles Creek (about 3 1/2 miles from the Tar), 1 mile northwest of Galloway Cross Roads, 3 1/4 mile north of Grimesland, Griton, and 3 miles east of Griton, Pitt County; 2 1/4 miles northwest of Chocowinity and 1 1/2 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 northeast of Stanstonsburg, Wilson County; 1 mile north of Castoria, 3 miles 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, 2 1/2 miles south of Clifton, 3 miles south of Clifton, and 4 miles south of Clifton, 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 1/2 miles below Lumberton, Fairmont, 1 1/2 miles northeast of Fairmont, and 4 miles northeast of Fairmont, Robeson County. Fliocene, Waecanaw formation, Black Rock Landing, 4 miles east of Elizabethtown, and Walkers Bluff, Bladen County; Nells 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 Tetetlia, Vera Cruz, Mexico; Tuxtpec, Oaxaca, Mexico. Waccamaw formation, Todd Ferry, Horry County, S. C., Caloosahatchee marl, Caloosa-
hatchee 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. Pliocene fossils of South Carolina, p. 29, pl. 11, figs. 6-10.


1932. Chlamys (Placopecten) comparilis Tuomey and Holmes. Mansfield, Florida Geol. Survey Bull. 8, p. 61, pl. 11, figs. 5, 6.


Shell orbicular, convex, somewhat thick, evolute, with concentric lines of growth, ears nearly equal. Lower valve, buccal ear notched, radially 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. Pliocene 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


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 hypotetical Lyropecten jeffersonius with obsolete primary ribbing. Placopecten resembles Chlamys in the relatively 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 pectinal 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


1858. Pecten princepoides Emmons, North Carolina Geol. Survey Rept., p. 230, fig. 158.


1904. Pecten (Chlamys) clintonia Say. Glenn, Maryland Geol. Survey, Miocene, p. 375, pl. 99, fig. 5.


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 Bruguière's figure, are much more prominent and distinct.—Say, 1824.

Type locality: Maryland [7].

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 Coham 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, Bertford 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


Shell ovate, compressed; ribs numerous, consisting of narrow, nearly smooth suture disposed in pairs; interstices 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, Mehering [Meherin] 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 striaions, 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

1849. *Pecten virginianus* Conrad, Fossils of the medial Tertiary of the United States, p. 46, pl. 21, fig. 10.


Shell orbicular; inferior valve convex, with numerous irregular, impressed, radiating lines; sinus of the ear profound, and a deep groove margina 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 ctenolum, 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 Bailey's 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


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 it is rarely developed and is never strong. A concentric incrustation may be observed in some species, particularly toward the ventral margin. The discrepancy in ornamentation so common in Pseudamussium 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 the Pecten group, and perhaps for this reason the genus is relatively rare.

Amusium mortoni (Ravenel) Conrad

Plate 8, figures 1, 2


1855. Pecten mortoni Ravenel. Tauney and Holmes, Pleocene fossils of South Carolina, p. 27, pl. 10, figs. 1, 2.


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


Oribucular, 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, subequall, striated externally.

This species is nearly allied to the P. pleuronecutis 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 specimens in my possession, although not perfect, is sufficiently so to determine its size; it is 8½ 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 Echphora 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.; Choctawhatchet formation, northern Florida. Pliocene, Waccamaw formation, Todd's Ferry, Horry County; the Grove, Cooper River, and Smith's Goose Creek, Berkeley County, S. C.; Calosohatchee marl, Calosohatchee River and Shell Creek, Fla.

Family SPONGYLLIDAE

Genus PLECTATULA Lamarck

1801. Plectatula Lamarck, Systeme des animaux sans vertebres, p. 122.

Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einricht, etc., pp. 61, 177, Gotra, 1818): Plectatus 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.

Plectatula 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


1855. *Plicatula marginata* Say. Tshomey and Holmes, Pleocone fossils of South Carolina, p. 24, pl. 7, figs. 11-14.


1932. *Plicatula marginata* Say. Mansfield, Florida Geol. Survey Bull. 8, p. 60, pl. 12, figs. 9, 10.

Shell ovate-cuneiform, somewhat arculate at base; with about 3 much elevated folds, producing very profound undulations on the edge of the shell; the intermediate fold is bidual; 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 1/8 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 *P. 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, 76 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 1/2 miles below Zuni, 12 to 14 miles below Zuni, 2 miles northwest of Smithfield, 1 1/2 miles west of Smithfield, 1/2 mile northeast of Smithfield, 1 1/2 miles northeast of Smithfield, 5 miles northeast of Smithfield, and Benns Church, Isle of Wight County; Sycamore, 1/2 to 1 1/2 mile below Sycamore, Møddelys Bluff, Southampton County; a quarter of a mile north of Suffolk, 1 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 1/2 miles above Branches Bridge, 1 mile above Branches Bridge, and Branches Bridge, Northampton County; 1 1/2 miles above Murfreesboro, 1 mile above Murfreesboro, and near Murfreesboro, Hertford County; Palmyra Bluff, Halifax County; 3 miles west of Woodstock, 2 1/2 miles northwest of Woodstock, 1 mile northwest of Williamston, and Hamilton Bluff, Martin County; 5 1/2 miles below New Bridge, Swift Creek, 15 1/2 miles above Bells Bridge, 1 1/2 mile above Bells Bridge, Shiloh Mills, Tarboro (at L. E. Fountain's farm), and 1 mile below old Sparta Bridge, Edgecombe County; 2 miles below Todd Station, 1 1/2 miles northeast of Farmville, 3 miles south of Farmville, 2 1/2 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, 3 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 Chowcunty, 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 Stantonburg, Wilson County; 1 mile northeast of Custorla, 1/2 mile east of Lizzie, 2 miles northeast of Lizzie, 4 miles east of Lizzie, and 1 1/2 miles east of Ormondsville, Greene County, 1 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 1/2 miles south of Clinton, 3 miles south of Clinton, and 4 miles south of Clinton, Sampson County; 3 miles northeast of Warsaw, Mag-nolia, 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 1/4 miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Lake Waccamaw, Crumly, and Neilis Eddy Landing, Columbus County; Wilmington, New Hanover County.


Superfamily ANOMIACEA

Family ANOMIIDAE

Genus PODODESMUS Philippi 1837


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


Shell ovate, not plicated; radially 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


Shell of medium size, moderately compressed, sub-circular, unusually symmetrical for the genus. Um-bones 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 um-bones 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.

Type locality: Cronly, Columbus County.

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 Bowers Wharf, Essex County; 2½ miles below Bayport, Middlesex County; old Clarenmont Wharf, Schmidts Bluff, and 8½ miles below Clarenmont Wharf, Surry County.

Superfamily **OSTRACEA**

Family **OSTREIDAE**

Genus *OSTREA* (Linnaeus) Lamarck


Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einricht, etc., pp. 98, 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 Priocniodesmacea. Later, as the evolutionary changes are traced in the nepionic shells, it may be possible to treat the group in a less arbitrary manner.
MOLLUSCA FROM MIOCENE AND LOWER PLIOCENE OF VIRGINIA AND NORTH CAROLINA

Superfamily ANATINACEA

Family PERIPLOMATIDAE

Genus PERIPLOMA Schumacher


Type by monotypy: Periploma inaequivalvis 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


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 (Cochlodesma) antiqua Conrad

Plate 10, figure 3


1838. Periploma antiqua Conrad, Fossils of the medial Tertiary of the United States, p. 16, pl. 8, fig. 3.


Shell ovate, rather elevated, convex, thin, and fragile; with obsolete concentric suture; 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


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

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


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 palleale.” 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, etablir sur une coquille que je n’avais pas vue, et qui parait n’etre 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 cellulo-crystalline, 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*


1904. (? *Thracia conradi* Couthouy. Glenn, Maryland Geol. Survey, Miocene, p. 299, pl. 35, fig. 4.


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 nearly 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 extremely 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, nympha! 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 osseolium. External color a pale ashly white, surface covered with a thin, light, chernenous 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 subtringular or pyriform; pallial impression very superficial like the others, with a profound, subangular excavation posteriorly.

Length 2\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\) 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; 3\(\frac{1}{2}\) to 1\(\frac{1}{2}\) 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 Meherin River, Northampton County; Watsons Mill on Kirby Creek, 2\(\frac{1}{2}\) miles northwest of Murfreesboro, and 1\(\frac{1}{2}\) miles above Murfreesboro on the Meherin River, Hertford County; Halifax (on Quankey Creek) and Palmyra Bluff (on the Roanoke River), Halifax County; 1\(\frac{1}{2}\) mile above Bell's 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*


Shell subelliptical, very inequilateral, acuminately 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; nympha! callosity small, oblique. Diameter 0.10, length 0.13, breadth 0.23 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 palaeal 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.


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* Miheles 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 (?) 1 1/2 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 spines 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:** Maddely's 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 Maddely's Bluff, on the Meherrin River.

**Distribution:** Virginia: Miocene, Yorktown formation, Maddely's Bluff on the Meherrin River, Southampton County.

**Family Pandoridae**

**Genus Pandora (Bruguière) Lamarck**

1798. *Pandora* Bruguière, Tableau encyclopédique et méthodique, vol. 1, pl. 230, figs. a–c. (No ext.)


**Type by monotypy:** Tellina *inaequivalvis* 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
Pandora, (Kennerlia) bicarinata

Subgenus KENNERLIA Carpenter


Type by subsequent designation (Stoliczka, India Geol. Survey Mem., Cretaceous fauna southern India, vol. 3, p. 61, 1871) : Pandora (Kennerlia) bicarinata Carpenter, 1864 = Pandora bicarinata Conrad, 1853. Forrester Island, Alaska, to Point Abreojos, Lower California.

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

Pandora (Kennerlia) arenosa Conrad

Plate 10, figures 16, 19, 20


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


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 incurred, 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 right 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 round, well up toward the dorsal margin. Pallial line punctate, not situated, 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, Nansound 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 most nearly approaches it in 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 incurved 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 called 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


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

1883. Pandora crassidens Conrad, Fossils of the medial Terti­ary of the United States, p. 2, pl. 1, fig. 2.


1904. *Pandora (Clidiophora) crassidens* Conrad. Glenn, Mary­land Geol. Survey, Mio­cene, p. 357, pl. 95, figs. 1, 2.

1982. *Pandora (Clidiophora) crassidens* Mann­field, Florida Geol. Survey Bull. 8, p. 73, pl. 12, figs. 4, 7.

Shells 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 inferio­ry, terminat­ing above in a very slightly 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 fosset­shaped; 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 impres­sions 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 6½ miles below Greenville (at Tarps Landing), Pitt County. Pliocene, Wacucamaw 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. Lunules 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. Ligan­ment internal; lodged in the right valve between the middle and posterior cardinals; surf­face 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 sunk—the anterior sub­tund 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 37.5 millimeters, width 59.6 millimeters, semidiameter (left valve) 8.2 millimeters.


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, Maddelys 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


Shells 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. Posterior dorsal margin and is sublinear and sharply perforate, strongly anterior. Lunule not developed. Umbones very low and inconspicuous, outlined 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-acute, 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 round, 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.

Hholotype, 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, *Pandora trilineata* Say, 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 Wiccacon 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.


Shells 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 rounded. Pallial line punctate, non-sinus, 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 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 *Kenneria*; its anterior limit is often ill defined, and the hiatus between such a tooth and the incurred and calloused inner surface of the anterior margins of *Kenneria* 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 cruciata* s. s., though similar in dentition, are relatively higher, less slate, 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 ¼ mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, Tar Ferry on Wicacoa Creek (opposite Harrellsville), Hertford County.

Holocene, Wacumaw 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


1830. *Pandora trilineata* Say, American conchology, pl. 2, and unpublished text.


1886. *Pandora (Clidiophora) floridana* (Dall ms.). Dall, idem, p. 312.


*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 conceivably 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 % of inch, greatest breadth % of 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; from 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 **POROMYXACEA**

Family **VERTICORDIIDAE**

Genus **VERTICORDIA** (Searles Wood ms.) Sowerby


Type by monotypy: *Verticordia cardiformis* Sowerby. Pliocene (Coralline Crag) of Suffolk, England.

Shell nacreous, equiva1ve, 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 characterized by 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


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. emmonsi* 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 interradials. The radials are, furthermore, less numerous than in *V. emmonsi* 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. ¾ mile northeast of Smithfield (on Mrs. Chalmers' farm; type locality) and Benns Church, ¾ mile from the old church, Isle of Wight County; 1 mile west of Suffolk, Nansemond County.

**Verticordia (Trigonulina) emmonsi** Conrad

Plate 10, figure 14


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 situation 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, 1908.

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 hemicircle in gentle curves, convex posteriorly; interradials 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 muscle impressions small. Pallial line conspicuously distant from margin; feebly sinuated. Margins strongly denticulate.

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 (Trigonolina) 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. emmonsi 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. emmonsi 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. emmonsi 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


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


1840. Astarte symmetrica Conrad, Fossils of the medial Tertiary of the United States, p. 44, pl. 21, fig. 7.


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, 1894.

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, subtrigonal 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, Dinwiddle 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


1845. *Astarte exaltata* Conrad, Fossils of the medial Tertiary of the United States, p. 66, pl. 37, fig. 6.


Obovate, acute, convex; umbo sulcated; apex very prominent; lunule elongated and profound. Height and length equal, % inch.—Conrad, 1841.

Figured specimens, a right and left valve of different individuals, U. S. Nat. Mus. 352519.

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, opisthodetic; 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 nympha. Muscle impressions distinct—the anterior subrotund or reiform, the posterior rudely quadrate. Palial 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, 8½ miles below Claremont Wharf, 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.

*Outside distribution: Miocene, Calvert formation, Maryland.*
Astarte coheni Conrad

1840. Astarte coheni Conrad, Fossils of the medial Tertiary of the United States, p. 43, pl. 21, fig. 5.

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 ¼ to ½ mile below Sycamore, ¼ to ½ mile above the lower Seaboard Railway bridge, and Maddedly 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 feebly undulation due to the resting stages; a faint secondary striaation 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, ¼ to ½ 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; 1½ miles above Murfreesboro, Hertford County; Halifax on Quantkey Creek, Mr. Durham's farm, ½ mile above the Atlantic Coast Line Railroad bridge, and Palmira Bluff, Halifax County; 1½ miles above Bells Bridge and ¼ 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, opisthodetic; 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 ligamental 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. 325356.

Type locality: Murfreesboro, Hertford County, N. C.

Astarte hertfordensis s. s. is the most convex of all the obliquely trigoanal 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.

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. 325351.

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 ¾ to ½ mile above the lower Seaboard Railway bridge over the Meherrin River, Southhampton 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 trigoanal. 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-
Astarte stephensoni is characterized by the compressed valves, obliquely trangular outline, by the obliquely directed umbones, and by the faint but distinct secondary striation developed near the ventral margin. *A. rosmokensis* Gardner is higher both relatively and absolutely, usually less inequilateral, and more strikingly narrowly 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. Stephens-son 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, 1 1/2 miles above Murfreesboro on the Meherrin River, Hertford County; Halifax on the Roanoke River, Halifax County.

*Astarte arata* Conrad

Plate 12, figures 13, 14


Shell ovate-trigonal, convex, with concentric scalariform sulci and fine intermediate striae; lunule very large, ovate, deeply sunken; 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 trauuma. 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; nympha 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.
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. Subtruncated 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, opisthodetic; 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 subquadrat. 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 north 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; ⅔ 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), 1½ 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 ASHTAROTA Dall


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
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°. 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, opisthodetic; 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 quadrato. Pallial line entire, rather distant. 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, 5/4 mile below Jones Point, Essex County; 24½ 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°. 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, opisthodetic; 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 quadrato. Pallial line entire, rather distant. Inner margins finely and rather feebly 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


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, Tomney and Holmes, Pleistocene fossils of South Carolina, p. 70, pl. 20, figs. 1, 2.


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 impressions very distinct.

Length four-fifths of an inch, breadth rather less than ninetenths 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 evanescing 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, 1¼ miles northeast of Smithfield, ¼ mile north of Smithfield, ¼ mile from Beaufort 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, Maddelys Bluff, lower Seaboard Railway bridge, and ½ to ¾ mile above the lower Seaboard Railway bridge; the Meherrin River, Branch Fork, 1½ miles above the mouth of the Nottoway, ¾ 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; 2¼ miles northwest of Murfreesboro, 1¼ 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, 16½ miles above Bells Bridge, ¾ mile above Bells Bridge, ¾ mile above Bells Bridge, 1¼ miles above Bells Bridge, 1½ miles above Bells Bridge into the Tar River, Shiloh Mills, and 1 mile below old Sparta Bridge, Edgecombe County; 2 miles below Todd Station, 2 miles southwest of Farmville, 3 miles south of Farmville, 2¼ 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 Cross Roads, 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 northeast of Stanstonsburg, Wilson County; 8 miles west of Goldsboro, Wayne County; 1 mile north of Castoria, half a mile east of Lizzie (on the property of David Summerill), Greene County; Rock Landing on the Neuse River, Craven County. Duplin marl, Lumampton (near the bottling works), Robeson County.


*Astarte (Ashtarotha) undulata vaginulata* Dall

Plate 12, figures 26, 27


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, Mattapony River, King and Queen County; Lanexa, New Kent County; Clarendon Wharf, Schmidts Bluff, 8½ miles below Clarendon 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


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.


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 evanescing concentric undulations.

Distribution: Virginia: Miocene, Yorktown formation, Indian Field Point, York County; mouth of Baileys Creek, Prince George County; Clarendon Wharf, Schmidts Bluff, 8½ miles below Clarendon 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, figures 32-34, 40


1840. *Astarte concentrica* Conrad, Fossils of the medial Tertiary of the United States, p. 44, pl. 21, fig. 6.


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 crenulatus. Length 1½ inches, height ½ 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 feelly 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 1½ 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 Beaus Church, and Everet's farm near Beaus Church, Isle of Wight County; ¼ mile north of Chuckatuck, 1½ miles southwest of Reeds Ferry, ¼ mile north of Suffolk, 1¼ miles north of Suffolk, ¼ 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 Harrelsville), ½ miles below Tar Ferry, 3 to 4 miles below Tar Ferry, Dogwood Landing on the Chowan River, Mount Pleasant Landing, Bertie County; Colerain Landing and ¼ mile above Edenhouse Point on the Chowan River, Bertie County; Palmry Bluff, Halifax County; 2½ miles northwest of Williamson on the land of Joseph Cherry, 1 mile northwest of Williamson, 1 mile southeast of Williamson, Martin County; 1½ miles above Bells Bridge, ½ mile above Bells Bridge, ¾ mile below Bells Bridge, 1 mile below Bells Bridge, Shiloh Mills, Tarboro, Tar River, Edgecombe County; 2 miles below Todd Station, 2 miles southeast of Tugwell (on Jacobs Branch), 1½ miles northeast of Farmville, 2½ 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 Chochowini, 1 mile northeast of Chochowini, Beaufort County; 1 mile west of Wilson (on Frank Barnes' land at Homley Swamp), Wilson County; 1 mile east of Lizzie (on the land of T. N. Lasister), Greene County. 2 miles northwest of Maple Cypress on the Neuse River, Rock Landing on the Neuse River, Craven County. Duplin marl, 3 miles south of Clinton, (on Gun 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, Ports 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 palatal 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 Lamberton, 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


1856. Astarte concentrica Conrad. Tuomey and Holmes, Pliocene fossils of South Carolina, p. 71, pl. 20, fig. 3.


Triangular, compressed; marked by very regular, closely arranged, fine, concentric lines. *A. concentrica* Tauney and Holmes (not Conrad), Pleocene fossils of South Carolina, 71, 20, 3; Emmons, North Carolina Geol. Survey Rept. 289, 212.

Locality, Virginia.

Differ from *concentrica* in being proportionally shorter and in much finer and more regular lines.—Conrad, 1893.

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 Meckinville River, Northampton County.

Outside distribution: Pliocene, Waccamaw, Waccamaw, S. C.

Family CRASSATELLITIDAE

Genus CRASSATELLITES Krüger


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 Muskeldrücker und einzelnen Querreifen, welche auf der Oberfläche mit dem untern Rande der Schalen gleichlaufend. Haftig 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 gibsula* as *Crassatella gibbosula* Lamarck.

Stewart 56 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 56 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 (*gibosa* 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 crassatells 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 57 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-

MOLLUSCA FROM MIOCENE AND LOWER PLIOCENE OF VIRGINIA AND NORTH CAROLINA

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


Type by monotypy: *Crassinella martinecenis* d'Orbigny = Theta parva C. B. Adams. Recent in the West Indies.

The genus is characterized by the small, trigonal, compressed outline; the acute, erect, or slightly opisthogyrate 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

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. 82, pl. 6, fig. 9.
1932. *Crassinella lunulata* (Conrad). Mansfield, Florida Geol. Survey Bull. 5, 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 *harriisi*. 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
PART 1. PELECYPODA

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 Area zone and the Cancellaria zone of the Choctawhatchee of Florida.

Distribution: Virginia: Miocene, Yorktown formation, 4 miles northeast of Walkerton on the Mattapony River, King and Queen County; 1/4 mile above Yorktown, York County; 3 miles below Yorktown, York County; old Claremont Wharf on the James River, Surry County; Lieutenant Run near Petersburg, Dinwiddie County; 1/4 mile northeast of Smithfield, Benns Church (1/4 mile from the old church), J. J. Everet's farm near Benns Church, 3 miles north of Zuni, and 12 to 14 miles below Zuni on the Blackwater River, Isle of Wight County; Maddellys Bluff, 1/2 to 3 miles above the lower Seaboard Railway bridge, and 2 1/2 to 3 miles below the lower Seaboard Railway over the Meekinn River, Southampton County; 1/4 mile north of Chuckatuck, 1/4 miles southeast of Reids Ferry, Exit, 5 1/2 miles northwest of Suffolk, 2 1/2 miles northwest of Suffolk, 1/4 miles north of Suffolk, 1/4 miles northwest of Suffolk, 1/4 miles northeast of Suffolk, 1 mile east of Suffolk, 1 mile west of Suffolk, 1/4 mile below the Suffolk waterworks dam, and 1/4 mile from the drainage ditch of the Norfolk & Western Railway just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1 1/4 miles above Branches Bridge and Branches Bridge, Northampton County; 1 1/4 miles above Murfreeboro, 1 mile above Murfreeboro, Tar Ferry on Wiccanoc Creek (opposite Harrellsville), 1 1/4 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 1/2 to 3 mile above Edenhouse Point, Bertie County; Palmyra Bluff, Halifax County; 1 1/4 miles above Bells Bridge, 100 yards below Bells Bridge, 1/4 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 1/2 miles northeast of Farmville, 3 miles south of Farmville, 2 1/4 miles north of Standard, 8 to 9 miles west of Greenville (on the east side of Piney Branch), 8 to 9 miles southeast of Greenerville, and 9 to 10 miles southeast of Greenville, Pitt County; 1 mile west of Wilson (in Homity Swamp, on the farm of Frank Barnes), Wilson County; 1 mile north of Castorla, 1/4 mile east of Lizzie (on the farm of David Summerill), 1 mile east of Lizzie (on the farm of T. L. Lassiter), Greene County; 2 1/4 miles northwest of Chocowinity, Beaufort County; 2 miles southwest of Maple Cypress, and Rock Landing, Craven County. Duplin muri, 2 1/4 miles south of Clinton (on Gunn Chimney Branch, on the land of Hugh Moore), 10 miles south of Clinton (on the land of J. N. Powell), Sampson County; 1 1/4 miles north of Magnolia, at the Natural Well, and W. H. Kornegay's muri pit, Duplin County; Fairmont and 1 1/4 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, Crumby (1/4 mile east of the factories), and Nells Eddy Landing (3 miles north of Crumby), Columbus County; Wilmington, New Hanover County.

Outside distribution: Miocene, Duplin muri, Darlington, Darlington County, S. C. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Nixons and Todds Ferry, Horry County, S. C. Caloosahatchee muri, Caloosahatchee River, Shell Creek, and Alligator Creek, Fl. Croatian sand, Siocums Creek, Craven County, N. C. Pleistocene, (?) Laubele, Caloosahatchee River, Fla. (Vaughan).

Crassinella lunulata harrisi Gardner, n. subsp.

Plate 14, figure 45


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, 1/4 mile above Yorktown, Yorktown, and 1/4 miles below Yorktown, York County; 1/4 mile north of Chuckatuck, 1/4 miles southeast of Reids Ferry, 1 mile northeast of Suffolk, and 1/4 mile below the Suffolk waterworks dam, Nansemond County.
MOLLUSCA FROM MIOCENE AND LOWER PLIOCENE OF VIRGINIA AND NORTH CAROLINA

Crassinella galvestonensis (Harris)


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 Asarite 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 *Eriphyla lunulata* and have received the name *harrisi*.

Outside distribution: Miocene, Galveston well, Texas, 300 feet to 2,600 feet.

Crassinella dupliniana Dall

Plate 13, figures 10, 11


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, flat-tish, 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. 114992.

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; Nellis Eddy Landing, 3 miles north of Crumley, 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 lines, 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, semidiameter 0.5 millimeter. Left valve of another individual (holotype), height 3.3 millimeters, width 3.5 millimeters, semidiameter 0.5 millimeter.


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 CYRINIDAE

Genus CORBICULA Megerle von Muhlfeldt


Type by monotypy: *Tellina fluminantis* 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.
Cardinal of the left very slender and laminar. Laterals anterior cardinal of right valve and the posterior middle cardinals in the left valve robust, subequal, fanlike beneath the umbones—the middle and posterior near the median vertical. Ligament marginal, feebly sulcate; the middle cardinals somewhat stouter strong nymph. Three cardinals in each valve diverge mate, often very much eroded. Surface sculptured carinated. Umbones strongly gibbous, involute, proximal. Posterior slope more or less depressed, often obscurely nearly semielliptical. Posterior dorsal margin more subequilateral. Anterior end quite evenly rounded, 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 1/4 inches, height 1 1/8 inches. Locality, vicinity of Petersburg, Va.; Mr. Tuomey; rare.—Conrad, 1854.

Shell of medium size, rounded-trigonal to oblate-spherical, 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 incremenals 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, opisthodetic, mounted on a short but conspicuously strong nympha. 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, Nells 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 EULOXA Conrad


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, 1862.

Euloxa 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 Euloxa has been left tentatively under that heterogeneous group.

Euloxa latisulcata (Conrad) Conrad

Plate 15, figures 1, 2


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, 1860.

Shell heavy, porcellaneous, subtriangular to subquadrate, convex, strongly inequilateral. Umbones strongly anterior, in some individuals set within the anterior sixth, their spines 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 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, opisthodetic, mounted on a narrow nympha 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 unnoticed.

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


Type by tautonomy: Coralliophaga coralliophaga Gmelin. Pliocene of Florida; Pleistocene and Recent of mid-America.

Shell thin, slightly gaping posteriorly. Outline irregular, very inequilateral, oblong, subcylindrical, often modioliform. 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 modioliform. 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 works 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
PART 1. PELECYPODA

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


Type by monotypy: *Chama cor* Linnaeus, 1767 = *Cardiumhumanum* Linnaeus, 1768. Recent off the European coasts and fossil in the Pliocene and Pleistocene of the Celtic Province.

Shell equivalent, 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


1828. *IsoCARDia rustica* Conrad (part), Fossils of the medial Tertiary of the United States, p. 20, pl. 11, fig. 1.

1852. *IsoCARDia conradi* D'Orbigny, Prodrome paléontologie, vol. 3, p. 121.


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) 3 1/2 inches, breadth rather less.

Small specimen, greatest length rather over 1 1/4 inches, breadth nearly 1 1/8 inches.—Say, 1824.

**Type locality**: Maryland [1].

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 propor­tions 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 opisthodetic 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 (8 1/4 miles below Claremont Wharf), Surry County.

**Isocardia fraterna carolina Dall**

Plate 11, figure 5; plate 23, figure 39


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 the specimens to 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 sensible specimens of *I. humana* are higher and less orbicular than the types of *I. carolina*, which are evidently sensible 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 subround 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**


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 opisthodetic; 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 semieliptical 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


Shell equivale, 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 *Cupricardia* 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* Bruguère. Lateral 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 verdewilla** 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 increments 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 *Cancelloaria* 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


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


Type by monotypy: Pterygyria decemcostata Conrad = Pterygyria decemcostata Conrad = Glans (Pterygyria) 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, 1887.

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.

Pterygyria 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.29 Stewart attributes Cardita to Bruguière, 1792, and considers Cardita sulcata Bruguère = Chama antiquata Linnaeus, as the type of genus. The designation was made by Children, 1823. The small size and the development of a lateral denticity ally Pterygyria with Glans rather than with Cardita.

Glans (Pterygyria) tridentata (Say) Gardner


1829. Cardita tridentata Say, American conchology, pl. 40, figs. 1–5 with explanatory text.

1852. Cardita tridentata Say, Holmes, Post-Pleocene fossils of South Carolina, p. 31, pl. 6, fig. 8.


Not Cardita tridentata Reeve, 1843.

Shell suborbicular, subquadrilateral, thick, and ponderous, with about 18 convex longitudinal ribs cancellate by concentric elevated lines, which do not penetrate into the interstall 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 the type of genus. All other known species are found only in the fossil state.—Say, 1826.

Shell rounded, trigonal, subquadrilateral, 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. Lunate minute, cordate. Ecarteoon 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 fringes, most conspicuous anteriorly, obsolete in the interradial channels. Ligament external, opisthodetic. 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 nympha; middle cardinal strong and prominent, triangular, the apex of the triangle directly beneath the apices of the umbones; posterior 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 denticated 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 HIs 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; ½ mile northeast of Smithfield, Benns Church, ½ mile from the old church and at Mr. Everet's farm near Benns Church, Isle of Wight County; ¼ mile north of Chuckatuck, 1¼ miles southeast of Reeds Ferry, ½ miles northwest of Suffolk, 1 mile west of Suffolk, 1½ miles northeast of Suffolk, 1 mile northeast of Suffolk, ½ mile below the Sun.
folk waterworks dam and along the drainage ditch east of Jericho ditch, Nanselmond 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, 1½ 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 Castle, and 1 mile east of Lizzle (on the farm of T. N. Lassiter), Greene County; Tar Ferry on Wiccan Creek (opposite Harrelsville) 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. Kornegey's marl pit near Magnolia, Duplin County. Pliocene, Waccamaw formation, Lake Waccamaw, Crony (half a mile east of the factories), and Neills Eddy Landing (3 miles north of Crony), Columbus County.

Outside distribution: Miocene, Duplin marl, Porter's Landing on the Savannah River, Effingham County, Ga. Piocene, 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. Croatian sand, Slocums Creek and Maillisons, Craven County, N. C. Pliocene, Waccamaw formation, Lake Waccamaw, Crony (half a mile east of the factories), and Neills Eddy Landing (3 miles north of Crony), Columbus County.

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.

1858. Cardita tridentata Say. Tuomey and Holmes, Pliocene fossils of South Carolina, p. 67, pl. 19, figs. 9, 10.


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; interradial 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 interradial 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 round 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 Choctawahatchee, 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. Kornegey, 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 (Asbepole), Robeson County; 4 miles south of Clarksboro, Bladen County. Piocene, 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 Crony on the Cape Fear River), Columbus County; Wilmington (on Blunts Creek and at the city rock quarry), New Hanover County.


Subgenus: PTEROMERIS Conrad, 1862


Type by original designation: Cardita periplana 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 hifd.—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

1845. Astarte radians Conrad, Fossils of the medial Tertiary of the United States, p. 77, pl. 43, fig. 13.
1853. Cardita perplana Conrad. Tuomey and Holmes, Pliocene fossils of South Carolina, p. 68, pl. 19, fig. 11.

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 interradials; radials overridden by microscopic undulatory growth lines. Ligament external, opisthodetic; 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 semil 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 (¼ 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; Colora 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, ½ miles north of Magnolia, and W. H. Kornegay's marl pit near Magnolia, Duplin County; Lumbeerton and 2 miles below Lumbeerton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff on the Cape Fear River, Bladen County; Lake Waccamaw, Crumy, and Neills Eddy Landing on the Cape Fear (3 miles north of Crumy), 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 Tilly's Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla. Courtney sand, Stocums 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

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, Pliocene fossils of South Carolina, p. 69, pl. 19, fig. 12.
1932. Venericardia (Pteromeris) perplana var. abbreviata (Conrad). Mansfield, Florida Geol. Survey Bull. 8, p. 88, pl. 16, fig. 5.

Trigonal, elevated, convex-depressed, ribs about 11, angular, minutely granulated; posterior extremity angulated. This and the preceding species Cardita perplana to 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 *Ephora* zone of the Choctawhatchee formation and rare in the *Cancellaria* zone above it.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, York County; Benns Church, ¼ mile from the old church and Everet’s farm near Benns Church, Isle of Wright County; ¼ mile north of Chucksawatch, ¼ mile southeast of Red’s Ferry, ½ mile northwest of Suffolk, 1 mile west of Suffolk, 1 mile northeast of Suffolk, Suffolk, and 1½ 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, 1½ 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, Darlington, Darlington County, S. C. Choctawhatchee formation, northern Florida. Pliocene, Waccamaw formation, Nixons and Tilley’s Lake, Horry County, S. C. Caloosahatchee marl, Shell Creek, Fla. Croatan sand, Scolums Creek, Craven County, N. C.

**Family CONDYLOCARDIDAE** 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 prodissocochn 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, 1863.

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Genus ERYCINELLA Conrad


Type by monotypy: *Erycinella ovalis* Conrad.

This genus is nearly allied to *Erycina* of Lamarck 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, 1863.

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.


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,

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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 resilial 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 resilial 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.

Erycina 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, 1 mile north of the old church and Mr. Everest's farm near Benns Church, Isle of Wight County; 11/2 miles north of Chincoteague, 1 mile west of Suffolk, 1 mile northeast of Suffolk, half a mile below the Suffolk waterworks dam, and along the drainag 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 Wicacoan Creek (opposite Harrellsville), Hertford County; Colerain Landing, Bertie County.

Pelecyphoda (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 resilial 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 sulcate 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± 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 Erycina ovalis Conrad in spite of quite radical differences, and for that reason it has been placed tentatively with the latter near the Condylocardinae 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,4 who illustrates the genera and offers a chronological table of the evolution of the Lucinae.

Genus CTENA Mösch


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.

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 quadrangular. 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 Ctena are restricted in number of both species and individuals but have a fairly wide distribution in the tropical and temperate faunas.

**Ctena speciosa** (Rogers and Rogers) Gardner

Plate 13, figure 33


1856. *Lucina squamosa* Lamarck. Tuomey and Holmes, Pleocene fossils of South Carolina, p. 57, pl. 18, figs. 6, 7.


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, 1857.

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 *Ctena 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).

**Ctena magnoliana** (Dall) Gardner


1932. *Codakia (Jagonia) magnoliana* Dall. Mansfield, Florida Geol. Survey Bull. 8, p. 95, pl. 20, fig. 1.

Shell small, thin, inequilateral, the beaks five-eighths 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 divericate, similar, radial riblets, crossed by fine, rounded, equal, close-set threads, narrower than the riblets, and which in crossing the latter are slightly arcuate convexity 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 *Ctena magnoliana* in Florida is restricted to the *Cancellaria* zone of the Choctawhatchee formation.

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

**Ctena 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; semielliptical. 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.

Otena 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 2½ 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


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 subcentral, erect or prosogyrate. Lunule commonly profound. Escutcheon obsolete. Anterior and posterior dorsal areas usually differentiated. Sculpture dominantly concentric. Ligate 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 CARDIOLUMINOCUS Sacco

1901. Cardiolucina Sacco, I Molluschi dei Terreni Terziari del Piemonte e della Liguria, pt. 29, p. 59.

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, 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 Cavilucina and designated as the type Lucina trisulcata Conrad of the upper Miocene and Pliocene faunas of the southeastern United States. He included under Cavilucina 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


1982. 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; discl 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.

4 Chavan, A., Essai critique de classification des Lucines (Suite), Jour. conchylologie, 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 truncated. 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 but vigorous dentition. The 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


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 (Lucinisa) crenulata (Say) Dall

Plate 13, figures 23, 24, 29, 30
MOLLUSCA FROM MIOCENE AND LOWER PLIOCENE OF VIRGINIA AND NORTH CAROLINA

1856. *Lucina cribraria* Say. Tuomey and Holmes, Pleocene fossils of South Carolina, p. 58, pl. 18, figs. 8, 9.


1932. *Phacoides (Lucinisca) cribrarius* (Say). Mansfield, Flor­ida Geol. Survey Bull. 8, p. 97, pl. 21, figs. 22, 23.


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 1/60 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 (Lucinisca)* occurs in abundance in the *Cancelloaria* 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, 1½ to 2 miles above Branches Bridge, ½ mile below Branches Bridge, and Maddely's Bluff (on the Meherrin River), Northampton County; Murfreesboro, Hertford County; Halifax, ½ mile above the Atlantic Coast Line Railroad bridge (on Mr. Durham's farm), and Palmyra Bluff, Halifax County; 2½ miles northwest of William­ton (on Joseph Cherry's farm), Martin County, 15½ miles above Bells Bridge and ½ mile above Bells Bridge, Edgecombe County. Duplin marl, 4 miles south of Clinton, Sampson County.


Subgenus *PARVILTICINA* Dall


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, Pleo­cene fossils of South Carolina, p. 61, pl. 18, figs. 16, 17.


1858. *Lucina multilineata* "Conrad." Holmes, Post-Pleocene fossils of South Carolina, p. 29, pl. 6, fig. 6.


PART 1. PELECYPODA


Shell orbicular, concentrically and closely ribbed, radiately striate.

This little fossil has the outline and general characters of L. cremulata, 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. 325587) 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. multilinear of Conrad. Conrad's form was not named "multilinear" 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 interradials of scarcely greater width; radials obsolete in the umbonal region; concentric lirae very fine, overriding the radials and minutely cancelling them. Ligament episthodetic, mounted on a linear nympha. 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 multilinear is larger and more inflated than Phacoides cremulata, 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 Roberson and 4 to 5 miles north of Lamberton, Robeson County. Phacoides, Waccamaw formation, 4 miles south of Elizabethtown (on Hammond Creek) and Walkers Bluff (on the Cape Fear River), Bladen County; Lake Waccamaw, Cron (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. Croatian sand, Croatai beds, Craven County, N. C. Ploocene (?), Chattian 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.; Brevard County, Fla.; Labelle, Hendry County, Fla. Recent, (?), Indian Pass, Fla., to Horn Island, Miss., in less than 50 fathoms.

Family DIPLODONTIDAE

Genus DIPLODONTA Bronn


Type by subsequent designation (Herrmannsen, Indicia generum Malacozoneorum, vol. 1, p. 392): Venus lupina Brocchi. Miocene and Pliocene of the Piedmont of Italy.

Shell equivalent, 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


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. Caloosa-hatchi marl.

Dimensions of figured specimen: Height 20.6 millimeters, width 22.3 millimeters, convexity 0.5 millimeters.

Figured specimen, a left valve: U. S. Nat. Mus. 325553.

Locality of figured specimen: Neills Eddy Landing, 3 miles north of Crony, 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.


Diplodonta leana Dall


P. testa suborbiculari, pene aequilaterali, posticè et antice rotundata convexa, tenui, striata; striae concentricae, minimae; natibus prominentibus, subrectis; valva sinistrà dentibus duobus cardinalibus, quorum unus bifidus, lateralibus nullis.

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; 21⁄2 miles northwest of Suffolk and 1 mile northeast of Suffolk, Nansemond County.

North Carolina: Miocene, Duplin marl. 11⁄2 miles northeast of Fulmont, 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. Increments 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.
PART 1. PELECYPODA

Section PHLYCTIDERMA Dall


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, 1859.

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 biavonensis Holmes. Post-Pleocene fossils of South Carolina, p. 29, pl. 6, fig. 5.


L. t. suborbicularis; margine superiore antieae et postieae decivia, inferiore antieae subarcuata; cinereo-albidis; microscopice erubescives punctulis; striis concentricis exilissimis creberrimis; umbo piriformis; anterior t. suborbiculari; margine superiore antice et postieae declivi, inferiore antice subarcuata; cinereo-albidis; microscopice erubescives punctulis; striis concentricis exilissimis creberrimis; umbonis prominentibus; apicibus subglobosis; lamulai minusssimi; limbo simplici; dentibus lateralis 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 equilaterial, 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 shagged by microscopic punctae, which are imperfectly radial in arrangement and are largest and most numerous on the posterior slope. Ligament external, opisthodetic. Nymph short, inconspicuous; most abundant on the posterior slope. Ligament perfectly radial in arrangement and are largest and shagreened by microscopic punctae, which are impressed 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 shagged 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 Co. Recent, Wadmalaw Sound, S. C. Recent, Tortugas to Texas and south to Jamaica and the Antilles in less than 50 fathoms.

Superfamily LEPTONOCÉA

Family LEPTONIDÆ

Genus ERYCINA Lamarck


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 19


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 increscent lines but very little radial striation; hinge normal, the lamellae rather long, and the hook (or cardinal) small; resiliary 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, latitude 7, diameter 4 millimeters.

This is the largest and apparently the most common species of Erycina in the later Tertiary of the Carolinas. Occasional specimens a little faint radial striation may be observed under the shelter of the concentric sculpture, but many speci-
Erycina carolinensis elongata Gardner, n. subsp.

Plate 14, figure 1


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 kurzia 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: Miocene, Duplin marl, Natural Well and 1/2 miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Lake Waccamaw, Columbus County.

Erycina carolinensis elongata Dall

Plate 14, figures 2, 3, 4, 5, 10


1904. Bornia triangula Dall. Glenn, Maryland Geol. Survey, Miocene, p. 330, pl. 88, figs. 9c, 9h.

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 umbal 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.

Genus Bornia Philippi


Type by subsequent designation (Stoliczka, Geol. Survey India, Mem., Palaeontologia India, Cretaceous fauna of southern India, vol. 3, p. 268): Bornia corbuloides Philippi. Recent in the Mediterranean.

The shell is moderately compressed, subtriangular to transversely elliptical and subequilateral. The surface may be smooth or feebly rippled and faintly striate concentrically. There is a feebly 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
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 1% miles below Yorktown, York County; Petersburg, Dinwiddie County; Mr. Everet's farm near Benns Church, Isle of Wight County; 1% miles northeast of Suffolk and 1% mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1% miles below Tar Ferry on Wicacocon 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 1% miles north of Magnolia, Duplin County; Lumberton (near the bottling works), Robeson County.

Pliocene: Waccamaw formation, Walkers Bluff, Bladen 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 worthwhile 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.


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


1845. Amphidesma constricta Conrad, Fossils of the medial Tertiary of the United States, p. 76, pl. 43, fig. 10.


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 incremental.

Hinge conspicuously robust. Ligamentary attachment opisthodetic, 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 constrieta (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 1% miles north of Magnolia, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff, Baden 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 stratified with submicroscopic increments, 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 opisthodetic, 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. petropolitana 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. constrieta (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 Edenhous Point, Bertie County. Duplin marl, ½ miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Baden 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, opisthodetic; 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 of rather distant radiating striations; interior of valve.

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; Neills Eddy Landing, 3 miles north of Cronly, Columbus County.

**Sportella compressa** (H. C. Lea) Dall

Plate 14, figures 27-29


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; beads 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.


Type locality: Petersburg, Va. Yorktown formation. *Sportella compressa* (H. C. Lea) is separated from *S. protea* (Conrad) by a heavier shell, by an elongate and oval rather than a sublanceolate outline, and by the absence of punctae on the external surface. No other of the coexistent *Sportella* 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, Tyllys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River, Fl. Croatan sand, Slocums Creek, Craven County, N. C. (Dall).

**Family MONTACUTIDAE**

**Genus MYSELIA** Angas


1878 (not earlier than Nov. 12, fide Iredale). *Rochefortia* Vélain, Archives de zoologie experimentale et générale, vol. 6, p. 132.


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 *Rochefortia* Vélain, 1876; and apparently the priority of *Mysella* Angas has been established by Iredale. Many of the recent species of *Rochefortia* are commensal with crustacea.
Mollusca from Miocene and Lower Pliocene of Virginia and North Carolina

Mysella stantoni (Dall) Gardner


Shell minute, 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, resiliatory notch small; adductor scars high, rather large, and distinct; margin simple, entire. Longitude 3.6, latitude 2.4 [2.2], diameter 1.5 [0.8] millimeters—Dall, 1900.

Holotype, a right valve: U. S. Nat. Mus. 115109.

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 Crony, 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 toward 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 0.9 millimeter.

Holotype, a right valve: U. S. Nat. Mus. 1325548.

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. Velain, the author of the genus Rochefortia.


Mysella velaini 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 mediad. Incremental sculpture strong, irregular, most conspicuous anteriorly. Resilifer concealed beneath the tip of the umbones. Dental laminae short, subequal, feebly 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. Velain, the author of the genus Rochefortia.

Distribution: North Carolina: Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Neills Eddy Landing, 3 miles north of Crony, 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 cotyphes: 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. Cotyphes, a right and a left valve of different individuals: U. S. Nat. Mus. 325559.

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.


Genus ALIGENA H. C. Lea


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 Fulcrella," 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. triulocatus 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 Rudistids 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

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.
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 inequivalent, inequilateral, small, rather compressed, 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 subspinose 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-median, 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. congestata Conrad. The medio-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. congestata. The right valve is more flattened than in C. congestata 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. congestata occurs not only in the Cancellaria zone but also in the underlying Echphora zone. C. congestata 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, 21/2 miles south of Clinton, 4 miles south of Clinton, Sampson County; 3 miles northeast of Warsaw, Natural Well, 1 1/2 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, 13/4 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, Tillrys Lake, Horry County, S. C. Caloosahatchee marl, Caloosahatchee River and Shell Creek, Fla.
Genus **PSEUDOCHAMA** Odhner


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.\(^4\)

**Pseudochama corticosa** (Conrad) Gardner

Plate 13, figures 5, 16, 28


1838. *Chama corticosa* Conrad, Fossils of the medial Tertiary of the United States, p. 32, pl. 17, fig. 3.


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, dishlike; 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 Murfreeboro, Hertford County; 6 miles west of Goldsboro, Wayne County; Rock Landing, Craven County. Duplin marl, Natural Well, 1½ miles north of Magnolia, Duplin County; Lamberton (near the bottling works), Robeson County.

Outside distribution: Miocene, Duplin marl, Darlington, Darlington County, S. C.

Superfamily CARDIACEA

Family **CARDIIDAE**

Genus **CARDIUM** Linnaeus


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.


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.

Cerastoderma laqueatum (Conrad) Conrad

Plate 16, figure 4


1838. Cardium laqueatum Conrad, Fossils of the medial Tertiary of the United States, p. 31, pl. 17, fig. 1.


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.

Cabinet of the Academy.

Inhabits—Fossil from Maryland.

Length 1½ 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 arcuate posteriorly, slightly arcuate ventrally. Umbones inflated. Radial ribs generally rounded, less frequently flat-topped or triangular, slightly wider than the interradials, 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 increamentals 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 area 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 waltoniænum, 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, Suffolk County, Va.; shallow beds at Bow ers Wharf, Essex County; old Claremont Wharf, 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.; Langley Bluff and St. Marys River, St. Marys County, Md.

Cerastoderma acutilaqueatum (Conrad) Conrad

Plate 16, figure 5


1840. Cardium acutilaqueatum Conrad, idem, p. 34, pl. 18, fig. 2.


Shell oblique, ovate, rounded at base and posterior extremity; ribs about 30, subtriangular, narrow, prominent; posterior margin very long, oblique, and subrectilinear; umbo narrow, summit very prominent; margin profoundly crenate. Length 4 inches, height 4½ 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 % mile below Sycamore, Southampton County; % mile north of Chuckatuck, % mile north of Suffolk, 1 mile north of Suffolk, 1% mile northeast of Suffolk, and % mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 2 miles below Toddy Station, 2 miles southeast of Taggwell (on Jacobs Branch), 3 miles south of Farmville, % mile 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% mile north of Chuckatuck, 2% miles northwest of Suffolk, 1 mile west of Suffolk, 2% miles below Sycamore, Southampton County; % mile north of Chuckatuck, 2% miles below the Suffolk waterworks dam, Nansemond County.

Outside distribution: Miocene, Choctawhatchee formation, Alum Bluff (upper bed) (Dall), Calhoun County, Fla. (?). Miocene, Gay Head, Mass. (Dall).

Cerastoderma virginianum (Conrad) Conrad

Plate 16, figure 3


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 stria-tion. The posterior area is unsulptured 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, 1832).

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, Bellesfield, York County; % mile 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 % mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County.

North Carolina: Miocene, Yorktown formation, % mile above Branches Bridge, 1 mile above Branches Bridge, and Braches Bridge, Northampton County; Halifax (on Mr. Durham's farm), % 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'Aguirre 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


1845. Cardium isocardia Linnaeus. Reeve, Conchologia Iconica, vol. 2, Cardium, pl. 17, fig. 84.


1858. Cardium isocardia Linnaeus, Holmes, Post-Pleocene fossils of South Carolina, p. 25, pl. 5, fig. 4.


Cardium testa cordata; sulcus squamis fornicatis imbricatis.—Linnaeus, 1768.

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 confused 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, Abbaquoa, 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


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, 1888.

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. *Dallocardia* Stewart should probably include, however, *T. oedalium* Dall from the Caloosahatchee of Florida and *T. bowdenense* Dall from Jamaica. *T. ustrie* Gardiner, with 35 ribs, abundant in the Shool 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 DALLOCARDIA Stewart


Type by original designation: *Cardium quadrigerinum* Conrad. Recent off the California coast near Santa Barbara.

The differences that separate *Dallocardia* from *Trachycardium* s.s. seem of doubtful subgeneric value. The hinge of *Dallocardia* is similar to that of *Trachycardium* but not so heavy, and the ornamentation on the crests of the medial ribs are, in *Dallocardia*, 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


*C. testa* subcordata sulcata lateribus muricata. Habitat ad stream Campecheense.—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 precursoral forms are sufficiently close to have been confused with the Recent species in the early check lists and synonymies. The closely related *oedalium* Dall described from the Caloosahatchee Pliocene of southern Florida, is represented in the Choctawhatchee Miocene of northern Florida by *oedalium 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 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 hareyense. They were collected in the Duplin marl, 1 mile east of Darlington, S. C.

A shell from the Cape Fear is figured.

Genus TRIGONIOCARDIA Dall


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. Trigoniocardia 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 Trigoniocardia has the anterior laterals crowded against the cardinals. * * * The hinge of Trigoniocardia 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 Trigoniocardia is related to it.—Stewart, 1930.

Trigoniocardia has not been recognized in strata older than the Miocene.

Subgenus AMERICARDIA Stewart


Type by original designation: Cardium medium Linnaeus, Systema naturae, 10th ed., p. 678. 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 Trigoniocardia. In the symmetry of the dentition, Americardia suggests the oriental group of Ctenocardia H. and A. Adams.

Trigoniocardia (Americardia) media (Linnaeus) Stewart


1844. Cardium medium Linnaeus. Reeve, Conchologia iconica, vol. 2, Cardium, pl. 6, fig. 30.


1904. Cardium (Fragum) medium Linne. Glenn, Maryland Geol. Survey, Miocene, p. 322, pi. 86, figs. 6a, 6b.

C. testa subcordata subangulata; valvulis angulatis subcristis 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. 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 1 1/4 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 (Buequey, Duttenberg, and Dollfus, Mollusques marins du Roussillon, vol. 2, p. 288, 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-
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

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, Pliocene fossils of South Carolina, p. 64, pl. 19, fig. 3.

Obliquely obvate, 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, ¼ mile north of Chuckatuck and 1¼ miles northeast of Suffolk, Nansemond County.
North Carolina: Miocene, Yorktown formation, ¼ to ½ mile above Edenhouse Point, Bertie County. Duplin marl, Natural Well and at several neighboring localities, Duplin County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Lake Waccamaw, Crony (⅓ 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

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 Einricht, 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, opisthodetic. Two cardinalis, 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


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, opisthodetic. Two cardinalis 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

Tellina declivis Conrad, Fossils of the medial Tertiary of the United States, p. 55, pl. 19, fig. 1.


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 Amphidroma 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, opisthogyrately 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 grooves 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. calpix, 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 Zunz, Isle of Wight County; ⅔ 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, Pamyrna Bluff, Halifax County; half a mile above Bells Bridge, Tar River, Edgecombe County; Tar Ferry on Wicacoac Creek (opposite Harrellsville), 1½ miles below Tar Ferry, and Mount Pleasant Landing, Hertford County; ⅔ 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.; Calooshatchee marl, Shell Creek, Fla.

Tellina (Moerella) sayi (Deshayes ms.) Dall

Plate 17, figure 4


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. Troup and Holmes, Pliocene fossils of South Carolina, p. 91, pl. 22, fig. 6.

1868. *Angulus politus* Say. Holmes, Post-Pleistocene fossils of South Carolina, p. 45, pl. 8, fig. 2.

1900. *Tellina sayi* Deshayes, ms., 5th Dall.


Shell transversely subtrigonal, 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, 1852.

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, opisthogryate, 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, opisthotetic; 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 semilittiptical. 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 Pleocene. It is well characterized among its Tertiary congener 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 precurusal form. Mansfield, 1932, has noted the similarity of *piewa* 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: Pleocene, Waccamaw formation, Walkers Bluff, Bladen County; Nellis Eddy Landing, 3 miles north of Crony, Columbus County.


**Tellina (Moerella) dupliniana** Dall


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 105°, 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 sinuses 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 aracuation 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-
er, 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 unwise to subordinate the species.

Distribution: Virginia: Miocene, Yorktown formation, Yorktown, and 1 mile below Yorktown, York County; 5½ miles northwest of Smithfield, and ¾ mile northeast of Smithfield, Isle of Wight County: Sycamore, Southampton County; 1½ miles southeast of Reic's Ferry, 1¾ miles north of Suffolk, 1¼ miles north of Suffolk, 1¼ miles northeast of Suffolk, 1 mile northeast of Suffolk, and 1½ 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, Wicacoa Creek, and 3 to 4 miles below Tugwell, Hertford County; Colerain Landing and ¾ 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 mile north of Magnolia, and the marl pit of W. H. Kornegay near Magnolia, Duplin County; 1 mile west of Lambert (on the farm of Charles Rowland), Duplin County, 3 miles northwest of Fairmont (on Andrew Jones' farm), and 1½ miles northeast of Fairmount (on the farm of D. E. Lewis), and 1½ miles northeast of Fairmount (on the farm of Andrew Jones), Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County.

Outsider distribution: *Moerella?, verdinella* Gardiner, n. sp.

**Tellina (Moerella?) verdinella** Gardiner, n. sp.

Plate 17, figures 6, 7

Shell thin, ovate, subcuneate posteriorly, flexuouts. 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 increments. Hinge characters of only the right valve known. Ligament external, opisthodetic; 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. Palial 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-
otype: Height 15.0 millimeters, width 21.0 millimeters. Holotype and paratype, both right valves: U. S. Nat. Mus. 325595.

Type locality: 6 miles below Greenville, Pitt County, N. C. Yorktown formation.

_Tellina verdewilla_, 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 maculenta_ 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 _verdewilla_ 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 grooving 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 decrvis_ 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. decrvis_ 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_


1840. _Tellina egena_ Conrad, Fossils of the medial Tertiary of the United States, p. 35, pl. 19, fig. 2.


Shell subtriangular, convex, with fine, crowded, concentric lines and obscure, radiating striae; anterior margin oblique, rectilinear; extremity subangulated; dorsal margin but little arced; 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.


Type by monotypy: _Macoma tenuera_ 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 Psammobriss lusoria_ Say, 1822.
PART 1. PELECYPODA

1856. Tellina lusoria Conrad. Tuomey and Holmes, Pliocene fossils of South Carolina, p. 89, pl. 22, fig. 5.

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 Pleurobida lusoria was probably based on a large specimen of the shell, which he afterwards described under the name of Tellina tena. From that species the present shell differs, as Conrad states it does from lusoria, by being higher, more arculate 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 umbo, and the dorsal and ventral margins converging at a low angle, obscurely truncated distally. Umbones posterior, opisthotrygate. Surface feebly sculptured with incrementalis. Ligament external, opisthodetic, 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.


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 Cancellariida zone of the Chocawhatchee 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 Bowlers Wharf, Essex County. Yorktown formation, Yorktown, 1 mile below Yorktown, and % miles below Yorktown, York County; mouth of Baileys Creek, Prince George County; 7 to 7½ miles below Zuni, 1½ miles northeast of Smithfield, and % mile northeast of Smithfield, Isle of Wight County; ½ miles southeast of Reids Ferry, ½ miles north of Suffolk, ½ miles north of Suffolk, ½ mile northwest of Suffolk, 1 mile northeast of Suffolk, and % mile below the Suffolk waterworks dam, Nansemond County.

Macoma virginiana conradi Dall
Plate 17, figure 22

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 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, ½ miles northwest of Suffolk, and 1 mile northeast of Suffolk, Nansemond County.
Mollusca from Miocene and Lower Pliocene of Virginia and North Carolina

Macoma carolinensis Gardner and Aldrich


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. virginiana* has a uniform, fairly steep slope, while that of *M. carolinensis* 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. 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, Caloosa­
hatchee 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 opisthodetic; nympha 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.

Family SEMELIDAE Dall

The family is most readily separable from the Telliniidae by the presence of an internal resilium.

Genus SEMELA Schumacher


Type by monotypy: *Tellina recticula* Spengler=Tellina profossa Pulteney. Pliocene of South Carolina and Florida and living from Virginia to Fernando de Noronha 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


PART 1. PELECYPODA


1893. **Abra (Amphidens) subovata** Say. Conrad, idem, p. 574.


1904. **Semele subovata** (Say). Glenn, Maryland Geol. Survey, Miocene, p. 255, pl. 72, figs. 6, 8.


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 **Semele** 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. bellastraia** (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, 3½ mile northeast of Smithfield, Beams Church; ½ 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, ½ to ¾ mile below Sycamore, Maddox Bluff, and ½ to ¾ mile above the lower Seaboard Railway bridge over the Meher­rin River, Southampton County; ½ mile northeast of Suffolk, 1 mile west of Suffolk, ¾ 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. 32558.

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. Miocene, Waccamaw formation, Wilmington, New Hanover County.
Semele bellastrati (Conrad) Dall  
Plate 17, figures 27, 28, 32, 33


1932. *Semele bellastrati* (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.


Mansfield reports the doubtful occurrence of the species in the Ecphora zone of the Chotawhatchee 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 bellastrati* of 1837. The two varieties of Dall, *duplinensis* and *appressa*, 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; Crony and Neills Eddy Landing (3 miles north of Crony), Columbus County.

Outside distribution: Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horry County, S. C. Caloosaatchee marl, Caloosaatchee 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


Type by original designation: *Semelina nuculoides* Conrad. Upper Miocene of Virginia and North Carolina, Pliocene (Caloosaatchee) 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


1845. *Amphidesma nuculoides* Conrad, Fossils of the medial Tertiary of the United States, p. 73, pl. 41, fig. 6.


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 values of *Semelina nuculoides* are reported by Mansfield from the Cancellaria zone of the Choctawatchee 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, Crongy, Neils Eddy Landing (3 miles north of Crongy), Columbus County; Wilmington, New Hanover County.

Outside distribution: Pliocene, Caloosahatchee marl, Caloosa-hatchee River, Fla. Recent, Cape Hatteras south to the West Indies in both deep and shallow water.

Genus ABRA (Leach ms.) Lamarck


Type by subsequent designation (Herrmannsen, Indices generum Malacozoorum, vol. 1, p. 1, 1846: Macra tenus 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 Reclzn, 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 46 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, prosoogyrate. 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 margines 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


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 46 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, opis­thygoryrate, 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. Resiliat pit deep, oblique, elongated, subparallel to the posterior dorsal margin. Lateral margins of right valve grooved to receive the modified dorsal margines 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 margines. Its transversely elongate outline, however, sharply separates it from the associated Abra.

Distribution: Virginia: Miocene, Yorktown formation, York-town, York County; Petersburg, Dinwiddie County; mouth of Baileys Creek, Prince George County; Claremont Wharf (upper bed), and Sunken Marsh Creek (upper bed), Surry County; 34 mile northeast of Smithfield, Bens Church, and 12 to 14 miles below Zuni, Isle of Wight County; Sycamore, and 14 to 16 mile above the lower Seaboard Railway bridge, Southampton County; 1½ miles southeast of Reid's Ferry, 2½ miles north­west of Suffolk, 1½ miles north of Suffolk, 1½ 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.

46 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 G冲动 Landing, and a half to ¾ mile above Edenhouse Point, Bertie County; Halifax on Quankey Creek (just below the county bridge) and Palmyra Bluff, Halifax County; 3 miles west of Williamson and 2½ miles northwest of Williamson (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


1830. *Amphidesma aequalis* Say, Am. conchology, facing pl. 28, 28 unnumbered lateral figures.


1856. *Amphidesma aequalis* Conrad. Tuomey and Holmes, Pleistocene fossils of South Carolina, p. 63, pl. 23, fig. 3.


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 subfusciform, 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 umbal angle smaller than those from more northern localities. The fossils are generally of this type rather than the more rounded northern recent specimens.—Dull, 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 Edenhouse 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 subtriaangular, 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 Chocotawhatchee 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 ¾ to ½ mile above Edenhouse Point, Bertie County; Halifax on Quankey Creek (just below the Pleasant Landing, Hertford County; Colerain Landing and ¾ to % mile above Edenhouse Point, Bertie County; 2½ miles northwest of Williamson (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 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 incremental 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 Lamberton, Robeson County, N. C. Duplin marl.
PART 1. PELECYPODA

The extremes of the subspecies seem quite distinct from *Abra aequalis* s. s., but the connecting series determines the true relation. *A. aequalis deltoides* 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 Lumbeerton, 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 Lumbeerton and 4 to 5 miles below Lumbeerton, Robeson County. Pliocene, Waccamaw formation, Neills Eddy Landing, Columbus County.

Family DONACIDAE Deshayes

Genus DONAX (Linnaeus) Lamarck


Type by subsequent designation (Schmidt, C. F., Versuch über die beste Einricht, 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 vari-colored 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 emmonsi** Dall

Plate 23, figure 5


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' [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 emmonsi* 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 Williamson (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 Lumbeerton, 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 emmonsi 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 emmonsi* 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. emmonsi preaequilibrata* is mostly limited to the Duplin marl of Robeson County. Its development in the environs of Lumbeerton 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. 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


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, 1882.

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. Um-bones 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 microscopie, 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

1849. *Donax protrudens* Conrad, idem, 2d ser., vol. 1, p. 208, pl. 39, fig. 8. (Senile stage.)
1856. *Donax variabilis* Tuomey and Holmes (not Say), Pliocene fossils of South Carolina, p. 95, pl. 25, fig. 6.

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
tinate 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 orna-
mentation to D. transversa Deshayes, the type of Para-
donax 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, ½
mile above Edenton Point, Craven County. Duplin
marl, 1½ 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
Crony), 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, Caloosa-
hatchee River, Fla. Croatan sand, Slocums Creek, Craven
County, N. C. Pleistocene, Simmons Bluff, S. C.; Rose Bluff on
the Waccamaw formation, Tillys Lake, Horry County, and Goose
marl, ¾ miles north of Magnolia, Duplin County; 4 miles
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.


Type by original designation: Solen guineensis [guineensis]
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
medially 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 incre-
mental 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 pos-
terior 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

1855. Chama angustior, etc., Lister, Historiae conchylo-
orum, fig. 265.

1794. Solen gibbus Spengler, Skr. Naturhistorie-Seisk. Klogen-

202, pl. 198, fig. 1067.

1818. Solen cariboae Lamarck, Histoire naturelle des animaux

1827. Solecurtus cariboae Lamarck. Blainville, Dictionaire des

1831. Solecurtus cariboae Blainville. Conrad, American ma-
rine conchology, p. 22, pl. 4, fig. 3.

1841. Solecurtus cariboae Lamarck. Gould, Invertebrata of
Massachusetts, p. 30.

1845. Solecurtus cariboae Lamarck. Mighels, Boston Jour.

p. 404. Not of Conrad, 1845, Fossils of the media-
Tertiary of the United States, p. 75, pl. 43, fig. 1.

1858. P. [anopaea.] cariboae Emmons, North Carolina Geol.
Survey Rept., p. 269, fig. 228a.

1858. Siliquaria cariboae Blainville. Holmes, Post-Pleocene
fossils of South Carolina, p. 54, pl. 8, fig. 14.


1900. Tagelus gibbus Spengler. Dall, Wagner Free Inst. Trans.,
vol. 3, pt. 5, p. 983.

1906. Tagelus gibbus (Spengler). Clark, Maryland Geol. Sur-
vey, Pliocene and Pleistocene, p. 200, pl. 57, figs. 1–4.

México Bol. 22, p. 83, lám. 12, fig. 2.

Solen gibbus, testa linear, valvula antice et postice gibbos-
lineari obliqua.—Spengler, 1794.

Type locality not known.

Valves thin, gaping, inequilateral, transversely ellipti-
cal. Umbones flattened, slightly posterior. Postum-
bonal portion of shell narrower than preumbral, by
reason of the abrupt though slight contraction behind
the beaks. Both anterior and posterior dorsal margins
approximately parallel to the base. Anterior and pos-
terior 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 ob-
scure keel that extends from the umbone to the pos-
terior ventral margin. Surface sculptured with irreg-
ular 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. They have been recognized in rocks as old as the Cretaceous.

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PART 1. PELECYPODA

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Subgenus MACTROTOMA Dall


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 lamelae in nearly the same plane, closely pressed 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


M. testa ovata tenue laevi pellucida planiuscula, vulva transversim striata rugosauca, Chem. Conch. 6, t. 24, f. 238.—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.

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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 3.55 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 muscle 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.


Superfamily MACTRACEA

Family MACTRIDAE


Genus MACTRA Linnaeus


Type by subsequent designation (Anton, Verzeichniss der Conchylinien, p. 2, 1899): 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.
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 *Mastra* 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. (Maцитrona) 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**


Type by subsequent designation (Gray, Zool. Soc. London Proc., pt. 15, p. 185, 1847); *Mastra 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 *Mastra*. Furthermore, the laterals of *Mastra* 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 *Maotromeris* are relatively large and thin, and seemingly they differ more from the type of *Hemimactra* than *Hemimactra* differs from *Spisula*.

**Subgenus HEMIMACTRA Swainson**


Type by monotypy: *Mastra gigantea* Lamarck = *Mastra 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 sinusuous toward the posterior margin. Surface smooth except for increments. 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 28.0 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 herein. 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 ridge that becomes obsolete in the adults. The new species is separated from *S. confragosa* Conrad and *S. subparvula* 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, Union Mills, 2½ miles south of Farnham, Richmond County. Yorktown formation, Yorktown, York County; ½ mile northeast of Smithfield, Isle of Wight County; ¼ mile north of Chuckatuck, ¼ mile 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 (Conrad) Meek**

Plate 23, figures 8, 9, 18, 19


1838. *Mactra modicella* Conrad, Fossils of the medial Tertiary of the United States, p. 25, pl. 13, fig. 3.


Shell subtrangular, 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; ½ mile northeast of Smithfield, Isle of Wight County; ¼ mile north of Chuckatuck, ¼ mile 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 28, 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 18.2 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) cruspedota*, an abundant species in the Shoal River formation. It is much less elongated transversely than the St. Mary's 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


1856. *Mactra similis* Say. Tuomey and Holmes, Pleiocene fossils of South Carolina, p. 97, pl. 23, fig. 8.


Shell subtrigonic, 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 1½ inches, nearly; width 1½ 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 subparvulis 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 1½ miles northeast of Fairmont, Robeson County. Pliocene, Waccamaw formation, Croney, ½ 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, Abappoola, and St. Andrews, S. C.; Orient, Hillsborough County, Fl.; Kissimmee well (at a depth of 96 feet), Osceola County, Fl. Recent, Massachusetts to Florida and the Gulf of Mexico.

Section MACTROMERIS Conrad


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, equivalent, inequilateral. Anterior end slightly excavated dorsally, rounded laterally. Posterior end gently sloping, very slightly arched dorsally, obscurely truncated laterally. Ventral margin straight medi ally, 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: 1½ 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 ½ miles below Bowlers Wharf, Essex County.

Spisula (Mactromeris) duplinensis Dall
Plate 22, figure 10

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. polyyma Stimpson of the same size. It is probably the shell referred to S. similis Say by Tuomey and Holmes and Emmons.—Dall, 1898.

*Tuomey and Holmes, Pliocene fossils of South Carolina, p. 97, pl. 23, fig. 8, 1850.
*Emmons, E., North Carolina Geol. Survey Rept., p. 298, 1858.
PART 1. PELECYPODA

Holotype, a right valve: U. S. Nat. Mus. 133784.
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


Type by subsequent designation (Herrmannsen, Indics generum Malacozoorum, vol. 2, p. 61, July 1847): Mastra 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 distinct; 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

1838. Mactra congesta Conrad, Fossils of the medial Tertiary of the United States, p. 27, pl. 15, fig. 2.
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. Piecocene fossils of South Carolina, p. 98, pl. 23, fig. 10.
1898. 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 near the 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 23.5 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 Lamberton, 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 Areta 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; 3 miles northeast of Smithfield, 1½ miles northeast of Smithfield, 2 miles west of Smithfield, 1½ miles west of Smithfield, and Bensus Church, Isle of Wight County; 2½ to 5 miles northwest of Zuni, 2 miles northwest of Zuni, 1½ miles above Zuni, 1 mile north of Zuni, 4½ miles north of Zuni, Zuni (near the pumping station), 1½ miles north of Zuni, Isle of Wight County; Hitchcock, Greensville County; Sycamore, Harcum's store, ¾ to ½ mile below Sycamore, the lower Seaboard Railway bridge, and Maddelys Bluff, Southampton County; 2 miles below South Quay; ½ mile north of Chuckatuck, Chuckatuck mill dam, Evetts, Exit, 1½ miles southeast of Redds Ferry, 1½ miles north of Suffolk, 1½ 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 Meherria River, 1½ miles above Branches Bridge, 4 miles above Branches Bridge, 5½ miles northeast of Murfreesboro (at Watson's Mill on Kirby Creek), 1½ miles above Murfreesboro, 1 mile above Murfreesboro, and near Murfreesboro, Hertford County; Tar Ferry on Wiccan 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 Quaney Creek, just below the county bridge), 1½ miles northeast of Enfield, ½ mile west of Enfield, Puluya Bluff, and ¾ miles below Puluya Bluff, Halifax County; 1½ 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, 2½ mile northwest of the Rocky Mount waterworks, 1½ mile north of the Rocky Mount waterworks, 4 to 5 miles below Rocky Mount (at Capt. Turner Battle's), Compass Creek (at a point 1 mile from the confluence with the Tar), ¾ mile below New Bridge, 5 miles below New Bridge, Swift Creek, 1½ miles above Bells Bridge, ¾ mile above Bells Bridge, 100 yards below Bells Bridge, ¾ 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 Williamson (on Joseph Cherry's farm), Martin County; 2 miles below Todd Station, 2 miles southeast of Tugwell (on Jacobs Branch), 1½ miles northeast of Farmville, 3 miles south of Farmville, 2½ miles north of Standard, near Standard, 3 miles southwest of Frog Level (on J. A. Nobles branch), 8 to 9 miles west of Greenville (on the east side of Pinelog Branch), 3 miles west of Greenville (on Schoolhouse Branch), Greenville (just east of the county bridge), 6½ miles below Greenville (at Tafts Landing), 8 to 9 miles southeast of Greenville, 1½ miles west of Galloway Crossroads, and 8 to 10 miles south of Greenville, Pitt County; 2½ miles northwest of Chocowinity, and 1¼ miles northwest of Chocowinity, Beaufort County; 2 miles southwest of Maple Cypress, Rock Landing, Craven County; 1 mile west of Wilson (at Harmon 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 Fairmont, 1½ miles northwest of Fairmont, 4 miles northeast of Fairmont, and 2 miles northwest of Farmville, Robeson County. Pliocene, Waccamaw for. Inst. Sci. Trans., vol. 3, pt. 4, p. 899, pi. 27, fig. 29. Shell small, equilateral, somewhat compressed, with small, little-elongated, 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 granulose 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


Type by subsequent designation (Anton, Verzeichnis der Conchyligen, 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 sulcalated laterals in the left valve received between the sulcalated 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 subtruncated. Base line nearly straight. Surface smooth or marked with feeble increamentals. 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 on 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


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.

**Ervilla lata** Dall

Plate 23, figure 20


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 48° (8.2), 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, 1888.

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 5 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 linear, which vary rather widely in strength in different individuals, and on the posterior slope, with distinct though microscopic 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.
developed over the entire shell but is stronger anteriorly. The pallial sinus is broad and broadly rounded.

**Petricola (Rupellaria) grinnelli Olsson**

Plate 13, figures 13, 14, 18


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 obliquely 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 nympha. 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 ovate, 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+ millimeters, width 24.8 millimeters, convexity 5.8 millimeters.

*P. grinnelli* Olsson is characterized by the laminar texture, the irregular *Pleiotryps*-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; 1½ miles below Bells Bridge, Tar River, Edgecombe County. Pliocene, Waccamaw formation, Walkers Bluff (?), Bladen County; Wilmington (?), New Hanover County.

**Subgenus PETRICOIARIA Stoliczka**


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**


1832. **Petricola pholadiformis** Lamarck. Conrad, American marine conchology, p. 37, pi. 7, fig. 3.

1834. **Petricola pholadiformis** Lamarck. Sowerby, Thesaurus conchyliorum, pt. 15, p. 771, pi. 166, fig. 1.


1845. **Petricola pholadiformis** Lamarck. Sowerby, Thesaurus conchyliorum, pt. 15, p. 771, pl. 166, fig. 1.

1854. **Petricola pholadiformis** Lamarck. Dall, U. S. Nat. Mus. Bull. 37, p. 35, pi. 59, fig. 15; pi. 64, fig. 140a.


*P. testa transversim elongata; lateres posticae brevissimae, sulci longitudinales lumelloso-dentatiss utrinque radiato; antico subgloboso . . . Largeur, 48 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 Crony, Columbus County.
Outside distribution: Pleistocene, Sankaty Head (early fauna), Mass.; Wailes 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, Pliocene fossils of South Carolina, p. 87, pl. 21, fig. 5. Not *P. pholadiformis* Lamarck, 1818.

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, equivale, but very inequilateral; 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; nympha 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 subcircular; the posterior semiepiphractic. 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 Humbert, 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 Pleiorywis Conrad


Type by monotypy: *Pleiorywis ocuta* 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 valve; muscular impressions large. (Miocene.)—Conrad, 1862.

Conrad placed this genus under the family Petricolidae.

The group of *Pleiorywis 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 *Pleiorytis*, 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 *Pleiorytis* it is short and nearly vertical. In *Asaphis*, in the left valve, the dorsal margin is tabulated in front of the bifid cardinal; in *Pleiorytis* there is a well-developed laminar, left anterior cardinal.

The general relations of *Pleiorytis* 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 esca 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 *Pleiorytis centenaria* and may, as indicated by Mansfield, 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 *Pleiorytis*.

### Pleiorytis centenaria (Conrad) Conrad


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 nympha 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.

**Family COOPERELLIDAE**

**Genus COOPERELLA** Carpenter


*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, 1894.

Shell small, thin, smooth, or concentrically striate or undulate, equivale, nearly equilateral, with entire margins; ligament long, feeble, profuse, amphidetic; resilium short, stout, opisthodetic, 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, 1923, described a species from the Bowden, but he referred it to a new subgenus Cooperellopsis.

**Cooperella carpenteri** Dall

1900. *Diplodonta yorkensis* Dall, idem, vol. 3, pt. 5, p. 1185, pl. 43, fig. 8.

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. 15714.

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, Benns Church, Isle of Wight County; Sycamore on the Nottoway River and 1/2 to 3/4 mile above the lower Seaboard Railway bridge over the Meherrin River, Southampton County; 5 1/2 miles northwest of Suffolk, 2 1/2 miles northwest of Suffolk, 1 1/2 miles north of Suffolk, 1 1/2 miles northeast of Suffolk, 1 mile northeast of Suffolk, and 1/2 mile below the Suffolk waterworks dam, Nansemond County.

North Carolina: Miocene, Yorktown formation, 1/4 mile above Belis Bridge, Tar River, Edgecombe County; Dogwood Landing, Hertford County. Duplin marl, Natural Well, Duplin County (Dall).

Family VENERIDAE

Subfamily DOSINIINAE

Genus DOSINIA Scopoli


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 prodissocochn 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 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


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. 29, pl. 6, fig. 1.


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.


1904. *Dosinia acetabulum* Conrad. Glenn, Maryland Geol. Survey, Mon. 24, p. 73, pl. 13, fig. 2.


1932. *Dosinia (Dosinidia) acetabulum* (Conrad). Maryland Geol. Survey Bull. 22, p. 81, pl. 11, figs. 7, 12.

**PART 1. PELECTYPODA**


1903. *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 Bose, 1906, and by Toula, 1909, may be referable to *D. delicatissima* Brown and Pillsby, 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 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 Everets 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 north-west of Murfreesboro, 1½ miles above Murfreesboro, and near Murfreesboro, Hartford County; Halifax (at Quankey
Creek, just below the county bridge) and at Palmyra Bluff, Halifax County; 2 miles west of Rocky Mount, ¼ mile above Bells Bridge over the Tar River, ¼ mile below Bells Bridge, 1 mile below Bells Bridge, ½ mile below Bells Bridge, Shiloh Mills, and 1 mile below old Sparta Bridge, Edgecombe County, 2 miles southeast of Tuswell (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 Pineloge Branch), 1½ miles west of Greenville (on Schoolhouse Branch), Greenville (just east of the county bridge), 6 miles below Greenville, 6½ miles below Greenville (at Tafts Landing), 8 to 9 miles southeast of Greenville, 1½ miles west of Galloway Crossroads, 9 to 10 miles south of Greenville (on Fred Haddock's farm), 1 mile northwest of Galloway Crossroads, and ½ mile north of Grimesland, Pitt County; 2½ miles northwest of Chowconinity, Beaufort County; half a mile east of Lizzie (on David Summer's farm), Greene County.

Outside distribution: Miocene, Santa Maria Tetetla, Vera Cruz, Mexico. Calvert formation. Atlantic City (well bore), Arundel County, Md.; Whites Landing, Prince Georges County, Md.; Galloway Crossroads, and St. Leonard Creek, Calvert 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 Langley's Bluff, St. Marys County, Md.

**Dosinia (Dosinidia) elegans** (Conrad) Conrad

Plate 11, figure 1

1838. Pectunculus albidus, etc., Lister, pl. 288, fig. 124.


1856. Venus concentrica Gmelin. Tuomey and Holmes, Pleocene fossils of South Carolina, p. 82, pl. 21, fig. 7.


1928. Dosinia (Dosinidia) elegans (Conrad). Palmer, Paleontographica 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.

Lenticiform, 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 2½ inches, length 2½ 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 Caloosaheatee Pliocene at Shell Creek, Desoto County, Fla., measures 61 millimeters in height and 68 millimeters in width.

**Dosinia elegans** Conrad resembles his *D. acutabulum* 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 marginals, it is always persistent and moderately prominent over the entire surface. The hinge is less heavy and rude than in *D. acutabulum*, 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 analagous to that of *D. acutabulum* 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; Nells Bddy Landing, 3 miles north of Crumy, 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. Caloosaheatee marl, half a mile above the Atlantic Coast Line Railroad bridge, Putnam County, Fla. Caloosaheatee River, Snell Creek, and Alligator Creek, Fla. Pliocene, North Creek near Osprey, Manatee County, Fla.; Labelle, Hendry County, Fla.; Fort Lauderdale, Broward County, Fla.; Torch Key, Fla. Recent, Haters to Aspilihan in less than 50 fathoms.

**Subfamily MERETRICINAE**

**Genus MACROCALLISTA** Meek


Type by monotypy: *Venus gigantea* Gmelin= *Venus nimboea* Solander, Pliocene and Pleistocene of the Carolinas and Florida.
PART 1. PELECTYPODA

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 palatal sinus are group characters. The dental formula is similar to that of Callioides. 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. Callioides 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

1926. Callista (Callioides) 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 arched; 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 3¾ inches.

Locality, Suffolk, Va.—Conrad, 1834.

Dimensions of figured specimens: Right valve (U. S. Nat. Mus. 325575), height 42.5 millimeters, width 62.8 millimeters; left valve (U. S. Nat. Mus. 325576), height 40.0 millimeters, width 50.0 millimeters, height 85.0± 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. nimbusa (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. nimbusa (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. nimbusa. 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. nimbusa, 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, 1832, from the Cancellaria zone of the Chotawhatchee formation of Florida.

Distribution: Virginia: Miocene, Yorktown formation, Suffolk, Nansemond County (Conrad). 
North Carolina: Miocene, Yorktown formation, Colerain Landing (1) and ¾ to ½ mile above Edenton House Point (?), Bertie County. The young forms obtained at these two Yorktown localities are probably, though not certainly, referable to Macrocallista reposta. Duplin marl, 2½ miles south of Clinton and 4 miles south of Clinton, Sampson County; Natural Well, ½ 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 1½ 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 ericyna 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 lamina, 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. 107884.

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


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


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


1838. Cytherea sayana Conrad, Fossils of the medial Tertiary of the United States, p. 13, pl. 7, fig. 3.


1856. Venus sayana D'Orbigny. Tuomey and Holmes, Pleocene fossils of South Carolina, p. 53, pl. 21, fig. 9.

1858. Cytherea (misprint for Cytherea) sayana Emmons, North Carolina Geol. Survey Rept., p. 294, fig. 221.


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; umbro rather prominent; lunule dilated, cordate, marked by a simple line.

Length 1½ inch[es], breadth more than 1½ 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, opisthodetic; nymph sublinear, extending a little more than a third of the way to the base; groove behind it deep. Hinge plate heavy.

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 plionea 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 mornhuana (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. mornhuana (Linsley).

Distribution: Virginia: Miocene, St. Marys formation, 1 to 2 miles below Bowlers Wharf, ½ 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, 1½ miles west of Smithfield, Zuni (near the pumping station), Isle of Wight County; ¾ mile north of Chuckatuck, ¼ mile east of Everets Post Office, 5½ miles northwest of Suffolk, 2½ miles northwest of Suffolk, 1 mile west of Suffolk, 1½ miles north of Suffolk, 1½ miles north of Suffolk, 1½ miles east of Suffolk, 1 mile northeast of Suffolk, and ½ 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 Quannock Creek, just below the county bridge) and Palmyra Bluff. Roanoke River, Halifax County; 2½ miles northwest of Williamson (on Joseph Cherry's farm) and 3 miles west of Williamson, Martin County; 1½ miles above Bells Bridge, ½ mile above Bells Bridge, Tar River, and Shiloh Mills, Edgecombe County; 2 miles southeast of Tugwell (on Jacobs Branch), 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 Pine log Branch), 2 miles west of Greenville, 1½ miles west of Grimesland, Pitt County; 2½ miles north-west of Chocowinity, Beaufort County; 1 mile west of Wilson (at Hominy Swamp, on the land of Frank Barnes), Wilson County; ½ mile east of Lizzie (on the land of David Summerall), Greene County; Tar Ferry, 1½ miles below Tar Ferry, Wiccanec Creek (opposite Harrelsville), and Mount Pleasant Landing, Bertie County; Colerain Landing and ½ to ¾ mile above Edenton House Point, Bertie County. Duplin marl, 2 miles below Lumberton, Fairmont (Ashepole), and ½ 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; Nells Eddy Landing (3 miles north of Crony), 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 Nixons Lake, Horry County, S. C. Caloshaatchee marl. Kissimmee well (at a depth of 150 feet), Osceola County, Fla.; Caloshaatchee River and Alligator Creek, Fla. Croatan sand, Slocomb 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, de­efined 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. Ligma­ment 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.


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


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 fluttering 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, cancelling the disk. The lunule and esuch­

Shell subcordate, inflated, with very regular, concentric, closely approximate, and very prominent lamellae, 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, Virginia. This beautiful shell rarely shows the concentric ridges perfect, from their prominence and thinness.—W. B. and H. D. Rogers, 1857.

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 lamellar; 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 lamellar; the central cardinal stout and bifid; the posterior cardinal laminal 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 of C. cribraria seldom exceed 30, whereas in C. cortinaria they usually number between 40 and 45; the lamellae of C. cortinaria are lower, the fluting 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 precursory form of cribraria. He reports cortinaria from Florida, in the Echophora 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).
Chione (Chione) cribraria (Conrad) Dal1


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 profusely crenulated. Length 1½ inches, height 1½ inches nearly.


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 dissect 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 1½ 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 sinusous 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, linguliform, 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; ¾ mile north of Chuckatuck, Nansemond County.

North Carolina: Miocene, Yorktown formation, Wilson, Wilson County; Colerain Landing and ¼ to ¾ mile above Edenhouse Point, Bertie County; Rock Landing, Craven County. Duplin marl, Natural Well, 1¼ miles north of Magnolia, and the marl pits of Frank Wilson and W. H. Kornegay, Duplin County; 2 miles below Lamberton, Robeson County. Pliocene, Waccamaw formation, Walkers Bluff, Bladen County; Lake Waccamaw, Crony (½ mile east of the factories), and Neills Eddy Landing (3 miles north of Crony), Columbus County; Wilmington, New Hanover County.

Outside distribution: Pliocene, Waccamaw formation, Nixons and Tillys Lake, Horne 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) Dal1

Plate 19, figures 12, 13, 20, 21


1855. *Tapes grus* Holmes, Post-Pliocene fossils of South Carolina, p. 37, pl. 7, fig. 5.


Shell small, convex, transversely oblong, subhomboidal, in-equilateral, 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 subtruncate, 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
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


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 umbon, 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 Hall, 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. corinnae 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. Area 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 sublaminar, 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 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


*Venus* (Venus) is not represented in the Tertiary or Recent east coast faunas.

**Subgenus MERCENARIA** Schumacher


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


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.


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


1904 *Venus rileyi* Conrad. Glenn, Maryland Geol. Survey, Miocene, p. 304, pi. 76, figs. 4, 5.


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 subquadrat 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 dissect 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 obliteration of the surface sculpture, which, however, is manifested at least by vigorous incremental. 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 subsurface radial sculpture. Ligament powerful, opisthodetic, 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 mantle. Inner margins finely crenate.

Venus (Mercenaria) campechiensis rileyi is constant 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 trigonalar or circular; the moderately light shells; the rather compressed valves; and the thin, anitcerumbones.

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, 128.0 millimeters; diameter 53.0 millimeters, 51.5 millimeters. These dimensions suggest the Suffolk race, but the shells are larger and relatively heavier, with a more oblique posterior dorsal margin and a lateral margin more often bluntly pointed rather than truncate. 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 usually 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.
Suffolk, 1 mile northeast of Suffolk, ½ mile below the Suffolk waterworks dam, and the drainage ditch just east of Jericho ditch, Nansemond County.

North Carolina: Miocene, Yorktown formation, 2½ miles northwest of Murfreesboro (at Watsons Mill on Kirbys Creek), Tar Ferry on Wiccan River (opposite Harrellsville), 1½ miles below Tar Ferry, 3 to 4 miles below Tar Ferry, and Dogwood Landing on the Chowan River, Bertie County; Cole-Tar Ferry on Wiccan Creek (opposite Harrellsville), 1½ miles northwest of Williamston, and 2½ miles northwest of Williamsburg on the Neuse River, Craven County. Duplin marl, 3 miles south of Castoria, ½ mile east of Lizzie (on David Summerill's property), 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), 2½ miles north of Standard, 8 to 9 miles west of Greenville; 2 miles west of Greenville, 1½ miles west of Greenville (on Schoolhouse Branch), Pitt County; Greenville (just east of the county bridge), 6 miles below Greenville, 6½ miles below Greenville (at Tafts Landing), 9 to 10 miles south of Greenville, 1 mile northwest of Galloway Crossroads, and ¾ mile north of Grimeland, Pitt County; 2½ miles northwest of Chocowinity and 1¼ miles northeast of Chocowinity, Beaufort County; 1 mile north of Castoria, ½ mile east of Lizzie (on David Summerill'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 1½ miles north of Magnolia, Duplin County; Lumberton (near the bottling works) and 1½ miles northeast of Fairmont (on the property of Andrew Jones), Robeson County.

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 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; Wilmington (at the city rock quarry), New Hanover County.

**Venus (Mercenaria) campechiensis tridacnoides (Lamarck)** Conrad

Plate 21, figure 11

PART 1. PELECYPODA

1839. Mercenaria percrassa Conrad, idem, vol. 4, p. 278, pl. 19, fig. 1.


C. testa transversa ovata, corrugata; striis verticalibus; limbo superiore undatim plicato.


Habite . . . Fossile d'Italie. Largeur, 11 centimètres. Coquille singulière; grande, plissée, en son limbe, comme dans limbo superiore undatim plicato. 

Verticales.—Lamarck, 1818.

Les tridacnes, ayant dans les interstices de ses sillons des stries locality of the undulations.—Say, 1824.

That a valve 107.5 millimeters in width will have a proves that the species varies somewhat in form and in the maximum thickness of 33.70 millimeters. The outline varies with the outline; the escutcheon is variable, as Say has noted, and the undulations are undulated in compliance with the undulations of the disk; anterior margin flattened and simply wrinkled.

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 nympha 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 semilunatus, 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 prebinal 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; Ferguson's Wharf, Grove Wharf on the James River, Surry County; Bens Church, 1½ miles above Zuni and 12 to 14 miles above Zuni on the Blackwater River, Isle of Wight County; Sycamore, ½ to 1½ mile below Sycamore on the Nottoway River, ½ to 1½ 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 north-west of Williamson, 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, outline 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 nympha, 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, compressed-cuneiform but more elevated than either of 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.


*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* Linneaus. 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 Undergraduate School, Johns Hopkins University, who, though best known as an administrator and as a notable contributor to knowledge of the Tertiary flora, 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


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 umbo. Umbones gibbos, 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 gibbos; 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; semilobal. 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


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 [39.0], 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 umboonal region, often flattening...
PART 1. PELECYPODA

Gemma magnas Dall


1926. Gemma magna Dall. Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 206, pl. 43, fig. 22.


Shell trigonal, moderately convex, the anterior end slightly shorter, rounded; the posterior end longer, more pointed; beaks high, pointed; lunule slightly flattened, bounded by an incised line often feebly, 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 insculata); G. magna s.s. reaches distinctly greater dimensions in Robeson County than in Duplin County and is usually

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, 1903.

Genus GEMMA Deshayes


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° 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


1926. Gemma magna Dall. Palmer, Palaeontographica Americana, vol. 1, No. 5, p. 206, pl. 43, fig. 22.
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, 1 1/2 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 1 1/2 miles northeast of Fairfield (on the property of Andrew Jones), Robeson County. Pliocene, Waccamaw formation, 4 miles south of Elizabeth town (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 Cratty), 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


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); 1 1/2 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 Waccamaw Creek (opposite Harrellsville), Hert­ford County; Colerain Landing (smooth type only) and % to % mile above Edenhouse Point on the Chowan River (sulcate 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, opisthodetic; nymph short, sublinear; groove behind it narrow. Hinge concentred; 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 lamina­lar; 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, lino­guiform, 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.

Gemma magna majorina

Distribution: Virginia: Miocene, Yorktown formation, 1 mile northeast of Suffolk, and 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 1/2 mile below Hamilton Landing, 3 miles west of Williamson, and 2½ miles northwest of Williamson (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 Green ville, and 2 miles east of Grifton (on J. F. Brooks' property), Pitt County; 2½ miles northwest of Chocowinity, Beaufort County; 2 miles southwest of Maple Cypress (on the Neuse River), Craven County; 1 mile west of Wilson (In Hambly Swamp, on the property of Frank Barnes) (smooth race as well as sulcated), Wilson County; 1 mile north of Castorida and 1 mile east of Lizzie (both smooth and sulcate races), Greene County; Tar Ferry and 1½ miles below Tar Ferry on Wiccacon Creek (opposite Harrellsville), Bertie County; ½ to ¾ mile above Edenhouse Point on the Chowan River, Bertie County.

Gemma magna insulcata Gardner, n. subsp.

Shell trigonal or approximately so. Valves evenly inflated. Apical angle not far from 60°; 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 impres sions 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.

Type locality: 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; Crony (1/2 mile east of the factories) and Neills Eddy Landing (3 miles of Crony), Columbus County.

Gemma cravenensis Gardner, n. sp.

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 medi ally, 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 lamar 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 incremental striae. Ligament external, opisthodetic, seated on linear nymphs. Hinge delicate, sculptured by the incrementals. Adductor scars subequal. Pallial sinus deep.

Davies 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 sites 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

1822. Mya mercenaria Say, ibid.
1858. Mya arenaria Linnaeus. Holmes, Post-Pliocene fossils of South Carolina, p. 55, pl. 8, fig. 15.
1899. Mya arenaria Linnaeus. Dall, U. S. Nat. Mus. Bull. 37, p. 70, pl. 49, figs. 1, 2; pl. 55, fig. 2; pl. 60, fig. 2.
1906. Mya arenaria Linnaeus. Clark, Maryland Geol. Survey, Plioceen and Pleistocene, p. 194, pl. 53, figs. 5, 6; pl. 54, figs. 1–4.


*M. testa ovata postice rotundata*, cardinis dente antorssum porrecto rotundato denticuloque lateral!.

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 gravelly mud flats of the New England coast, it is found portion of the valves from the evenly rounded forms clams 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 Nells Eddy Landing, Columbus County.

Outside distribution: Pleistocene, Waccamaw formation, Lake Waccamaw and Nells Eddy Landing, Columbus County.

Both valves concentrically rugose, the sculpture on the right 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


Cuneocorbula Dall and authors, not Cuneocorbula Cossman, 1886.

Type by original designation: *Corbula alabamensis* 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...
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; 6½ miles below Greenville (at Tafts Landing), Pitt County; 2 miles southwest of Maple Cypress, Craven County; Dogwood Landing and Mount Pleasant Landing, Hertford County; Coderain 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
PLATES 1–23
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 (Isechadium) 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 ± millimeters width 26.0 ± 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 ± millimeters; width 31.0 ± millimeters. (After Tuomey and Holmes.)

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 ± millimeter width 100.0 ± millimeter. (After Conrad.)

Figure 2. Anadara (Cuneaetra) scalaris (Conrad) (p. 26). Exterior of left valve and hinge of right valve; height 54.0 ± millimeter; width 64.0 ± 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 ± millimeters; width 86.0 ± 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 ± millimeters; width 86.0 ± 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.


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.


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.
PELECYPODS.
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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.
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. (Plagiotremus) 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* (*Placopeden*) *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.
PELECYPODS.
PLATE 6

Figure 1. *Chlamys* (*Placopecten*) *clintonia* (Say) (p. 37). Exterior of left valve; height 100.0+ millimeters; width 104.0 millimeters (After Glenn.)

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.)

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 (Aequipecteni) eborea (Conrad) (p. 36). Exterior of right valve (double valves); height 83.0 ± millimeters; width 90.0 ± millimeters. (After Tuomey and Holmes.)


2. Exterior of right valve of holotype (double valves); height 65.0 ± millimeters; width 65.0 ± 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 ± millimeters. (After Tuomey and Holmes.)

Figures 5–6. Chlamys (Aequipecteni) eborea (Conrad) (p. 36).

5. Profile of double valves; convexity 23.0 ± millimeters. (After Tuomey and Holmes.)

6. Detail of sculpture and of ventral margin. (After Tuomey and Holmes.)

Figure 7. Chlamys (Aequipecteni) comparilis (Tuomey and Holmes) (p. 37). Exterior of left valve of holotype(?). (After Tuomey and Holmes.)

Figure 8. Chlamys (Aequipecteni) eborea (Conrad) (p. 36). Exterior of left valve. (After Tuomey and Holmes.)
Plate 8

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.)
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.

   2. Cluster of burrows showing openings at smaller ends, X 3.
   3. Fragment of ventral portion of shell, X 2.
   5. Fragment of anterior portion of left valve, X 2.

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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FIGURES 1-2. *Thracia maddeyensis* 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± millimeters; width 52.5± millimeters. (After Conrad.)

Figure 4. *Thracia conradi* Couthey (p. 43). Exterior of left valve and overtopping margin of right; height 74.0 millimeters; width 90.0± millimeters. (After Gould, 1870, and Dall, 1889.)

5. Interior of right valve (Acad. Nat. Sci. Philadelphia 1385); height 1.8± millimeters; width 2.6± millimeters.
6. Interior of right valve (U. S. Nat. Mus. 325509); height 4.8± millimeters; width 7.3 millimeters.
7. Exterior of same right valve.
8. Interior of left valve (U. S. Nat. Mus. 325509); height 5.1± millimeters; width 7.9 millimeters.
10. Interior of right valve (Acad. Nat. Sci. Philadelphia 1385); height 1.8± millimeters; width 2.6± 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.

12. Interior of holotype, a right valve (U. S. Nat. Mus. 325506); height 2.5 millimeters; width 2.8 millimeters.

Figure 14. *Verticordia (Trigonulina) emmonsi* 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). Exterior of right valve (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) creasidens majorina* Gardner, n. subsp. (p. 47). Interior of paratype, a left valve (U. S. Nat. Mus. 325500); height 25.0± millimeters; width 35.0± 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) tsuomeyi* 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) creasidens 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) prodromes 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 ± millimeters; width 30.0 ± 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 ± 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) prodromes 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.)


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 ± millimeters; width 33.0 ± millimeters. (After Tuomey and Holmes.)

Figure 15. Isocardia fraterna Say (p. 67). Exterior of right valve and hinge of right valve. (After Say.)
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 exulata* 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 herfordensis* 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 25.0 millimeters; width 25.7 millimeters.
12. Exterior of right valve of holotype.


FIGURE 15. *Astarte caken* Conrad (p. 53). Exterior of right valve; height 18.0± millimeters; width 18.5± millimeters. (After Conrad.)

FIGURES 16-17. *Astarte stephensonii* 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.

17. Interior of holotype.

FIGURE 18. *Astarte herfordensis 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.


20. Interior of holotype.


FIGURE 22. *Astarte (Ashtarotha) griffonis* 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 berrig* Gardner, n. sp. (p. 56). Holotype, a left valve (U. S. Nat. Mus. 325533) from 2½ miles northwest of Chocowinity, Beaufort County, N. C.; height 25.0 millimeters; width 27.2 millimeters.

23. Interior of holotype.

FIGURE 25. *Astarte (Ashtarotha) undulata* Say (p. 57). Exterior of right valve (U. S. Nat. Mus. 325521) from 1¾ miles northeast of Chocowinity, N. C.; height 25.0 millimeters; width 28.5 millimeters.

FIGURES 26-27. *Astarte (Ashtarotha) undulata variegata* 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.

27. Interior of lectotype.

FIGURE 28. *Astarte (Ashtarotha) griffonis* 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 7½ miles below Zuni, Isle of Wight County, Va.; height 23.5 millimeters; width 24.7 millimeters.

29. Interior of holotype.
30. Exterior of holotype.


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± millimeters.

35. Interior of paratype.
36. Exterior of paratype.

FIGURE 37. *Astarte (Ashtarotha) concentrica conscidis* 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.


38. Interior of left valve.

FIGURE 40. *Astarte (Ashtarotha) concentrica* Conrad (p. 59). Exterior of left valve shown in figure 34.

FIGURE 41. *Astarte (Ashtarotha) concentrica conscidis* 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.

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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. Interior 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.
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* (*Cardiolucina*) *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 Beids Ferry, Nansemond County, Va.; height 2.7 millimeters; width 3.1 millimeters.


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.


23. Interior of left valve, × 2.
24. Exterior of left valve, × 2.


25. Interior 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.)


29. Exterior of right valve, × 2.
30. Interior of right valve, × 2.

FIGURES 31–32. *Ctena microimbriata* 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, × 10.
32. Exterior of holotype.


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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Figures 40-41. 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 6-7. Sportella gibbosa Gardner, n. sp. (p. 84). Cotytes, 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.
8. Figures 31-32. Myella 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.)


13. Interior of right valve; height 6.0 millimeters; width 9.0 millimeters.
14. Interior of left valve; height 5.7 millimeters; width 9.0 millimeters.
15. Exterior of left valve; height 5.7 millimeters; width 9.0 millimeters.
16. Exterior of right valve; height 5.7 millimeters; width 9.0 millimeters.

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.

22. Interior of holotype.

23. Interior of right valve; height 7.5 millimeters; width 8.5 millimeters.
27. Hinge of right valve, × 4. 28. Exterior of left valve, × 4. 29. Hinge of left valve, × 12.
30. Sportella calpix Gardner, n. sp. (p. 84). Interior of holotype, a right valve (U. S. Nat. Mus. 325543) from Tar Ferry, Hertford County, N. C.; height 10.2 millimeters; width 14.7 millimeters.
31-32. Anigena chowanensis Gardner, n. sp. (p. 87). Holotype, a right valve (U. S. Nat. Mus. 325550) from Walkers Bluff, Bladen County, N. C.; height 3.0 millimeters; width 4.5 millimeters.

31. Exterior of holotype. 32. Interior of holotype.

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, × 12. 34. Exterior of left valve, × 5. 35. Interior of right valve, × 5.
36. Interior of right valve, × 12.

37. Exterior of right valve. 38. Interior of right valve.

39. Sportella calpix Gardner, n. sp. (p. 84). Exterior of holotype shown in figure 30.

40. Profile of figured specimen. 41. Exterior of figured specimen.

42-43. Diploleotia (Phylidoida) soor (C. B. Adams) (p. 81). A left valve (U. S. Nat. Mus. 325555) from Natural Well, Bladen County, N. C.; height 12.5 millimeters; width 12.7 millimeters.
42. Exterior of left valve. 43. Interior of left valve.

44. Cooperella carpenteri Dall (p. 119). Interior of holotype of "Diploleotia yorkensis" Dall, a left valve (U. S. Nat. Mus. 144548) from Yorktown, Va.; height 8.7 millimeters; width 10.9 millimeters. (After Dall.)

45. Crassinella lumulata harrisi Gardner, n. subsp. (p. 65). Exterior of left valve of holotype (U. S. Nat. Mus. 1650) from Yorktown, Va.; height 5.1 millimeters; width 5.2 millimeters. (After Dall.)

46. Bryacinella ovalis Conrad (p. 73). Drawings of hinge. (After Dall.)

47. Cooperella carpenteri Dall. (p. 119). Interior of right valve (U. S. Nat. Mus. 155714) from Petersburg, Va., × 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 × 2.
2. Interior of left valve, × 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 arala verdenella* 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.

10. Interior of holotype.


11. Interior view of left valve.
12. Exterior of left valve.


15. Interior of right valve.

Figure 17. *Pleurotis centenaria* Conrad? (p. 110). Exterior of holotype of *Petricola (Rupellaria) harrisii* Dall (U. S. Nat. Mus. 145820) from Bellefield, York River, Va.; height 20.5 millimeters; width 22.5 millimeters. (After Dall.)

Figure 18. *Petricola (Rupellaria) grimelli* Olsson (p. 117). Interior of left valve (U. S. Nat. Mus. 325561) from Wilmington, N. C.; height 16.0 ± millimeters; width 24.8 millimeters, × 2.

Figures 19–20. *Trachycardium isocardia* (Linnaeus) (p. 91). Paired (U. S. Nat. Mus. 57117), Recent from the coast of Florida; height 47.5 millimeters; width 37.5 millimeters.

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.
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. × ¾. (After Glenn.)

Figure 5. *Cerastoderma acutilaqueatum* (Conrad) (p. 90). Exterior of holotype, a right valve from Yorktown, Va.; “length 4 inches; height 4½ inches.” (After Conrad.)
FIGURE 1. *Tellina egena* Conrad (p. 98). Exterior of holotype, a right valve from the James River near Smithfield, Va. × 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, × 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* Ball (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.)

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.


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.
10. Interior, X 2.


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, × 2.
17. Exterior of left valve of holotype, × 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.

FIGURE 22. *Macoma virginiiana 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.)

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). Cotytype, 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.

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 bellastrita* (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).
1. 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.
2. 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.
3. 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 (Raeta) alta* (Conrad) (p. 109). Hinge plate of left valve: a, anterior lamina; b, cardinal tooth with one arm projecting over the chondrophore; c, ligamentary 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., X 3.

FIGURE 8. *Mesodesma spatha* Gardner, n. sp. (p. 115). Hinge of holotype, a right valve (U.S. Nat. Mus. 325591) from 1 mile northeast of Suffolk, Va., X 10.

9. Hinge plate of left valve: a, Posterior lamina; b, ligamentary scar with septum below it; c, spur, roofin 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. 325592) from Neills Eddy Landing, Cape Fear River, N. C.; height 79.0 millimeters; width 121.0 millimeters.
FIGURES 30-32. Interior of holotype. FIGURES 28-29. Profile of holotype from front. FIGURE 27. Interior of cotype, a right valve (U. S. Nat. Mus. 144633) from Yorktown, Va.; height 3.2 millimeters; width 3.3 millimeters.

26. Interior of cotype, a left valve (U. S. Nat. Mus. 144633) from Yorktown, Va.; height 3.0 millimeters; width 3.2 millimeters.

25. Interior of cotype, a right valve (U. S. Nat. Mus. 144633) from Yorktown, Va.; height 3.0 millimeters; width 3.2 millimeters.

24. Exterior of left valve shown in figure 13. 23. Interior of right cotype; height 3.4 millimeters; width 3.5 millimeters.

22. Exterior of right valve; height 6.8 millimeters; width 9.5 millimeters.

21. Exterior of right valve; height 6.8 millimeters; width 9.5 millimeters.

20. Exterior of right valve; height 6.8 millimeters; width 9.5 millimeters.

19. Exterior of right valve; height 6.8 millimeters; width 9.5 millimeters.

18. Exterior of left valve (U. S. Nat. Mus. 325564) from Wilmington, N. C.; height 17.5 millimeters; width 20.5 millimeters X 1½.

17. Exterior of left cotype; height 3.7 millimeters; width 4.1 millimeters.

16. Exterior of right cotype; height 3.7 millimeters; width 4.1 millimeters.

15. Interior of right cotype; height 3.4 millimeters; width 3.5 millimeters.

14. Exterior of right valve shown in figure 3.

13. Interior of left cotype (U. S. Nat. Mus. 325566) from 1 mile east of Lizzie, Greene County, N. C.; height 5.9 millimeters; width 6.7 millimeters.

12. Exterior of left valve; height 19.5 millimeters; width 21.0 millimeters.

11. Interior of left valve; height 19.5 millimeters; width 21.0 millimeters.

10. Interior of right valve; height 20.0 millimeters; width 22.3 millimeters.

9. Paratype, a right valve (U. S. Nat. Mus. 325564) from Wilmington, N. C.; height 17.5 millimeters; width 20.5 millimeters X 1½.

8. Holotype, a left valve (U. S. Nat. Mus. 325564), from Wilmington, N. C.; height 26.5 millimeters; width 31.0 millimeters.

7. Paratype, a right valve (U. S. Nat. Mus. 325564) from Wilmington, N. C.; height 26.5 millimeters; width 31.0 millimeters.

6. Interior of a right 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, × 0.95.
2. Exterior of left valve, × 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 57.6 millimeters.

1. Interior of left valve.
2. Dorsal view of double valves.
3. Interior of right valve.


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* (Lamarck) (p. 132). Profile of double valves from the Wagner Free Institute of Science of Philadelphia; diameter 100.0 millimeters.

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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.

6. Interior of left valve X 1.

*Figure 8. Mya arenaria* Linnaeus (p. 138). Interior of left valve from Wailes Bluff (near Cornfield Harbor), St. Marys County Md., X 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± millimeters; width 58.0± millimeters. (After Dall.)
PLATE 23


FIGURES 3-4. *Donax emmonsi preaequilibrata* Gardner, n. subsp. (p. 105). Holotype, the right and left valves of a single individual (U. S. Nat. Mus. 325500) from 2 miles below Lumberton, Robeson County, N. C.; height 8.0 millimeters; width 14.4 millimeters.

3. Interior of left valve of holotype, × 3.

4. Exterior of right valve of holotype, × 3.

FIGURE 5. *Donax emmonsi* Dall (p. 105). Exterior of holotype, a right valve (U. S. Nat. Mus. 108447) from Mrs. Guion's marl-pit near Croney, Cape Fear River, N. C.; height 6.7 millimeters; width 18.2 millimeters. (After Dall.)


7. Interior of holotype, × 3.


9. Exterior of valve shown in figure 8.


11. Exterior of valve shown in figure 12.

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 15.5 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. Interior of right valve shown in figure 14.


17. Interior of holotype.


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. 326609) from 1/2 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 radius* 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 (Caryocoorbula?) sedata* 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; × 3.

FIGURES 27-28. *Corbula (Caryocoorbula) conradi retusa* Gardner, n. sp. (p. 139). Holotype, the right and left valves of the same individual (U. S. Nat. Mus. 325605) from 1/2 miles above Belle Bridge, Edgecombe County, N. C.; height of closed valves 6.7 millimeters; width 11.0 millimeters.

27. Exterior of left valve, × 3.

28. Exterior of right valve, × 3.


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 (Caryocoorbula) 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 Edenhope Point, Bertie County, N. C.; height 5.0 millimeters; width 7.7 millimeters.

33. Exterior of right valve, × 4.

34. Exterior of left valve, × 4.


37. Interior of right valve of holotype, × 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; × 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. 153850), Recent from Smiths Island, Va.; height 7.5 millimeters; width 35.5 millimeters; × 2
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