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PALÆONTOGRAPHICA AMERICANA

ILLUSTRATED CONTRIBUTIONS

TO THE

INVERTEBRATE PALEONTOLOGY

OF

AMERICA

Vol. I

No. 1—Atlantic Slope Arcas

BY PEARL G. SHELDON

ITHACA
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1916



PREFACE

SEVERAL years ago we commenced a series of papers in "Bulletins of American Paleontology," dealing with the molluscan remains in the various horizons of our southern Tertiaries. In these the subject matter is treated stratigraphically; in other words, the Midway stage was first taken up, then the Lignitic, and now the Claiborne is in press. Other papers dealing with special localities or horizons have also been published. In future numbers we hope to discuss all important Tertiary horizons stratigraphically. This seems the natural way for all investigation of this preliminary nature. Witness for example Hall's works on the paleontology of New York as well as the paleontologic matter included in our various state survey reports. Such papers if printed in small octavo form are convenient for field use as well as laboratory study.

But as years pass by and the faunas of the various horizons are better understood, and vast amounts of material collect in our museums, there comes a time when a purely biologic phase of investigation may be advantageously undertaken. Note for example the more recent works of Clarke and Ruedemann of the New York survey. This calls for a larger sized publication, admitting plates of sufficient dimensions to contain for comparison representatives of many closely allied types of life. And, the larger size page will be found not inconvenient in laboratory and museum where desks and tables are at hand; in the field, a work arranged biologically would scarcely ever be called for. Accordingly, this new work has been begun to receive such papers on invertebrate paleontology as are arranged systematically, papers that will be of direct assistance to students of biologic evolution.

The first of these papers, unpretentious and seemingly easy of preparation, has cost the author a vast amount of study here and elsewhere to make sure that no serious omissions of specific or varietal forms have been made either in the text or plates, and that the figures and text indicate clearly the characteristic features of each form discussed.

Paleontological Laboratory
Cornell University
October 30, 1916

G. D. HARRIS

THE ATLANTIC SLOPE ARCAS

BY PEARL G. SHELDON

This treatment of the *Arcas** is intended to include: the synonymy, description, and distribution of the Tertiary and recent species of the genus which occur in the beds along the coast of the eastern United States; also references to the Cretaceous species, to the deep water forms which occur off the coast, and to the recent and Tertiary species of the Caribbean district.

In measuring the specimens they were placed on crosssection paper with the hinge along a horizontal line and the point of the beak on a vertical line. Measurements were taken from the line through the beak to the line touching the anterior point of the shell; from the line through the beak to the line touching the posterior point; from the hinge line to the highest and to the lowest points of the shell. Distances anterior to the beak and those above the hinge line were marked +, and those posterior to the beak and below the hinge line —. The diameter was measured at the widest part of the shell. Semidiam. means the diameter of a single valve.

Because of the radiating sculpture and convexity of the shell, in photographing the specimens it was usually impossible to bring out the details of sculpture with equal distinctness over the entire surface. In practice, the detail usually photographed best at the end away from the source of light. Ordinarily in this genus the sculpture is stronger toward the anterior and weaker toward the posterior end, therefore the specimens were usually photographed with the posterior end nearer the light in order to give a comparatively true figure. Likewise, the angle of the teeth on the hinge varies and some cast little or no shadow. For the same reason the crenulations along the ventral margin were often lost. The muscle scars photographed indistinctly. In general, detail was lost where the light rays were perpendicular to the surface of the shell or tended to be parallel to radial sculpture, crenulations, etc. The lighting was arranged to bring out the most important specific characters. Unless otherwise stated, the figures are natural size.

Dall (Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, 1898) placed all the species under the genus *Arca* and gave *Barbata*, *Noëtia*, *Scapharca*, etc., which at various times have been given the rank of genera, the rank of subgenera and groups or sections. These di-

*The major part of this paper formed a thesis presented to the faculty of the Graduate School of Cornell University in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Sincere thanks are due Professor G. D. Harris for aid, suggestions and criticism. Nearly all of the Tertiary material used was collected by Professor Harris or his students.

vitions intergrade thoroughly. Dall's treatment of the genus has been followed. Besides the groups represented here Dall recognizes the following:

Subgenus *Barbatia*.

Group of *A. rubrofusca* Smith (*Lissarca* Smith, 1876)

Group of *A. tortuosa* L. (*Trisidos* Bolten, 1798, + *Trisis* Oken, 1815).

Group of *A. celox* Benson (*Scaphula* Benson, 1835, not of Swainson, 1840; *Scaphura* Gray, 1847, by typographical error).

Subgenus *Scapharca*.

Group of *A. senilis* Lam. (*Senilia*.(Gray, 1840) Adams, 1858).

Subgenus *Lunarca* (Gray) Adams, based on *L. costata* Gray. Possibly a malformed shell.

THE TYPICAL ARKS

The *Arcae* of the group to which *A. noæ* Linné belongs have an opening in the ventral margin for the byssus; the form is often irregular; cardinal area wide and rather flat with low margins, diagonal grooves in the cardinal area disconnected instead of uniting to form continuous diamond-shaped grooves as in some of the other groups; beaks small and pointed; hinge straight and narrow; teeth small and numerous; inner margin of the valves smooth or nearly so.

Arca hatchetigbeensis Harris

Plate I, Figures 1, 2, 3

Arca subprotracta Aldrich, Geol. Surv. Ala., Bull 1, p. 50, 1886, *vide* Harris.

Arca hatchetigbeensis Harris, Bull. Am. Pal., vol. 2, no. 9, p. 47, pl. 7, figs. 10, 10a, 1897.

Arca hatchetigbeensis Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 622, 1898.

"Size and general form as indicated by the figure; surface covered by well-defined but somewhat irregular, imbricate, concentric lines, crossed by raised, radiating fine costæ; young shell not extremely elongate, with surface marking of equal strength everywhere; in adults the medial sinus becomes more pronounced, the radiating ribs before the sinus being stronger than those behind the same, and the shell is more or less distorted.

This species differs from *protracta* Con.—*subprotracta* Heilp.—by its much less elongate form, broader anterior, the presence of two particularly strong costæ located medially on the post-umbonal slope. By examining the type specimen of *A. protracta* in the Academy's collection at Philadelphia it will be seen that it agrees somewhat more nearly with this species than would be supposed from Conrad's figure, yet the agreement can scarcely constitute specific identity.

Locality (Lignitic).—Alabama: Hatchetigbee,—Harris," 1897.

A. hatchetigbeensis is closely related to the fossil form of *A. umbonata*, but the imbrication is finer and in *A. umbonata* the large ribs on the posterior slope begin about at the angle of the umbonal ridge and are subequal in size, while in *A. hatchetigbeensis* the largest ribs are near the center of the posterior slope; those near the cardinal margin are smaller and the fine sculpture extends over the umbonal ridge to the large central ribs.

Dimensions.—Lon. +11, -30; alt. +3, -16; semidiam. 11 mm.

Occurrence.—Lignitic Eocene of Hatchetigbee, Alabama.

Type.—C. U. Museum.

Arca subprotracta Heilprin

Plate I, Figure 4

Byssarca protracta Conrad, Acad. Nat. Sci. Phil., Proc. for 1847, p. 295, 1848; Journ., 2d. ser., vol. 1, p. 126, pl. 13, fig. 36, 1848.

Not *Arca protracta* Rogers, Am. Phil. Soc., Trans., vol. 5, p. 332, 1837; vol. 6, pl. 26, fig. 5, 1839.

Navicula protracta Conrad, Acad. Nat. Sci. Phila., Proc. for 1854, p. 29.

Arca subprotracta Heilprin, Acad. Nat. Sci. Phila., Proc. for 1881, p. 449, 1882.

"Trapezoidal, elongated, with numerous radiating lines, some of which are double, and others alternated in size and finely crenulated; dorsal margin parallel with the base; anterior margin truncated, posterior a little concave, oblique and very acutely rounded or subangular; basal margin slightly contracted; hinge long, rectilinear, very regular and gradually increasing in width towards the extremities from the apex; cardinal area wide, depressed concave, with a few fine, impressed, angular lines.

Length $1\frac{1}{2}$; height $1\frac{1}{2}$ in. nearly.

"A pretty species of which I found one valve only."—*Conrad*, 1848.

Occurrence.—"Newer Eocene [Oligocene] of Mississippi.—*Conrad*.

Arca paratina Dall

Plate I, Figures 5, 6, 7

Arca paratina Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 621, pl. 33, fig. 14, 1898.

"Shell elongated, not very thick or high, not much distorted, but with a variable byssal gape, inequilateral, the beaks at or near the anterior fourth; moderately alate in front and behind; beaks low, pointed, not inflated, their apices slightly prosogyrate; cardinal area long, narrow, lozenge-shaped, flattish, with longitudinal striæ, the site of the resilium marked on each valve by two grooves forming a small triangle, within which are traces of the inception of other grooves; sculpture chiefly of fine radial riblets overrunning and somewhat imbricated by not prominent lines of growth; the radials which end on the margin of the byssal foramen are perceptibly finer than the rest, those on the posterior dorsal slope are more or less fasciculated, the ends of the fascicles dentating the posterior margin; on the dorsal anterior part the riblets increase somewhat in size, but are not fasciculated; the dorsal border in front is anterior to the rest of the margin; between the dorsal posterior extreme and the ventral posterior angle there is often an irregular, but not deep emargination; the borders of the byssal foramen are irregularly emarginate; interior smooth, the margin denticulated by the sculpture except at the foramen; hinge-line straight, minutely denticulate; the teeth in the center smaller, those towards the ends inclined outward slightly, above, and a little larger; there are about twenty three anterior and forty posterior teeth, with no marked hiatus between the series. Lon. of shell 28, alt. of hinge-line 8.5, of beaks 10, diam. at the umbonal part 10 mm. It is quite possible that the shell grows to a considerably larger size.

"This species is distinguishable at once from the *A. occidentalis* of the same size by its uniformly more delicate and much more numerous ribs, and by its greater length in proportion to its height. It is also usually less alate behind and of more uniform, undistorted shape. Differences of form and proportion seem to separate it sufficiently from *A. subprotracta* Heilprin * * *"—Dall, 1898.

Dimensions.—Small valve, lon. +4, -11; alt. +1, -5.5; semidium, 3 mm.

Occurrence.—Oligocene of the Chipola beds on the Chipola River, and of the lower bed at Alum Bluff, Calhoun County, Florida.—Dall. Oligocene of Bailey's Ferry, Florida, and Pliocene of the Croatan beds of North Carolina.—*C. U. Museum*.

Arca occidentalis Philippi

Plate I, Figures 8, 9, 10, 11

Arca occidentalis Phil., Abbild. u. Beschr., 3, p. 14, pl. 17b, fig. 4a-c, 1847.

Arca zebra Swainson, Zool. Ill., No. 26, pl. 118, 1831; *ex parte*.

Arca noæ of many authors, not of Linné,

Dall has separated the east American form from the Mediterranean *A. noæ* with the above synonymy,

Shell oblong, inflated; hinge line as long or nearly as long as the shell; posterior end emarginate; ventral margin with an opening for the byssus; ribs numerous, smaller in the depression opposite the byssal opening, interspaces with from one to several fine riblets; along the posterior cardinal margin and the umbonal ridge radiating strips which are smooth or show only fine riblets; the depression between these smooth ridges with a few normal ribs; beaks small and pointed, little curved; cardinal area wide, flatly concave, ligament area with disconnected diagonal grooves; hinge straight, narrow, with numerous fine, vertical teeth; inner margin practically smooth; color white or yellowish with zigzag markings of reddish brown.

Dimensions.—Lon. +18, -50; alt. +5, -25; diam. 30 mm.

Occurrence.—Oligocene of the Bowden beds, Jamaica; Miocene (?) of Curaçao; Pliocene of the Caloosahatchie marls, Florida; Pleistocene of the Florida Keys, Yucatan and most of the West Indian Islands; recent in the Antilles generally, and along the eastern coast of the United States northward to the vicinity of Cape Hatteras, North Carolina.—Dall. Recent from Florida and the West Indies.—*C. U. Museum*.

Arca umbonata Lamarck

Plate I, Figures 12, 13, 14, 15, 16, 17

Arca umbonata Lamarck, An. s. vert, vol. 6, p. 37, 1819.

Arca imbricata of several authors.

Arca umbonata Arango, Fauna Malacologica Cubana, p. 261, 1879.

Arca umbonata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 620, 659, 1898; pt. 5, pl. 38, figs. 4, 4a, 1900

"A testâ transversim oblongâ, ventricosâ; angulato-sinuâtâ; decussatim substriatâ; umbonibus magnis, arcuatis: latere postico brevissimo.

"List. Conch. t. 367. f. 207.

"Habite les mers de la Jamaïque. Mus. no. Elle est très-bâillante au bord supérieur. Largeur, 50 millimètres."—*Lamarck*, 1819.

Anterior and posterior are reversed in Lamarck's description.

Ribs on the center of the shell small and rather even, larger anteriorly; posterior slope with four to six larger, more widely spaced ribs; fine ribs in some of the interspaces, especially on the anterior part of the shell, ribs crossed by concentric raised lines which give the part of the shell anterior to the umbonal ridge an imbricated nodular appearance; radial sculpture predominant on the posterior slope; umbonal ridge usually angular; cardinal area wide with diagonal grooves; teeth numerous, nearly vertical, smaller where the grooves cross the hinge; posterior margin nearly straight; byssal opening large; shell unevenly stained with blackish or bluish brown; epidermis long and scaly, chiefly about the margin and posterior slope.

"Like all the group, this nestling species is variable in form according to its station, but I have been unable to find any characters to separate the fossil and recent shells when allowance is made for the deformations alluded to * * *. It probably retreated to warmer waters during the Miocene invasion of Florida and did not succeed in returning until the end of the Pliocene, as it has not turned up in the Caloosahatchie marls. The form doubtfully identified by Professor Heilprin with *A. Listeri* is connected by a fuller series with the others."—*Dall*.

Many authors have united the Atlantic and Pacific forms under the name of *A. imbricata* Bruguière. *Dall* placed *A. Listeri* (Tryon) Heilprin, W. F. I. S. Trans., vol. 1, p. 113, 1887, and *Barbatia Bonacazyi* Gabb, Am. Phil. Soc., Trans., vol. 15, p. 254, 1873, under *A. umbonata*. *A. americana* d'Orbigny, 1846, Voyage dans l'Amérique Méridionale, Moll., p. 632; Hist. Isla Cuba, pt. 2, vol. 5, Moll., p. 342, vol. 8, pl. 28, figs. 1, 2, is this species.

Dimensions.—Lon. +14,-31; alt. +7,-21; diam. \approx 5 mm.

Occurrence.—"Oligocene of the Chipola beds, Calhoun County, Florida; of the Ballast Point Silex beds, Tampa Bay, Florida; of the Alum Bluff sands at Oak Grove, Santa Rosa County, Florida. Also in the Pleistocene of the Florida Keys and the Antilles, and living from Cape Hatteras, North Carolina, south to Santa Caterina, Brazil, and throughout the Antilles."—*Dall*. Oligocene of Bailey's Ferry, Florida, and recent from Florida, Galveston, Texas, the West Indies, Aspinwall and Brazil.—*C. U. Museum*.

Arca wagneriana Dall

Plate I, Figures 18, 19

Arca (Arcoptera) aviculæformis Heilprin, Wagner Free Inst. Sci., Trans., vol. 1, p. 98, pl. 13, figs. 32, 32a, 1887.

Not *Arca aviculæformis* Nyst, Tabl., Synopt., p. 12, 1848; *Arca aviculoides* Reeve, 1844, *vide* Dall; not *A. aviculoides* de Koninck, Des. An. Fos., p. 114, 1844.

Arcoptera aviculæformis Dana, Man. Geol., 4th ed., p. 900, fig. 1510, 1895,

Arca Wagneriana Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 619, 1893; pt. 5, pl. 39, figs. 6, 7, 1900.

"Shell elongated, aviculaeform, rostrated anteriorly, winged posteriorly, with a prominent obtuse carination on the umbonal slope bounding the wing; rostrum declivous, marked off from the body of the shell by a broad hollow; basal margin of shell sinuous, showing a median opening, and rapidly sloping upward in the direction of the rostrum; posterior border deeply emarginate.

Umbones acute, very eccentric, moderately elevated, and but slightly incurved, with a gradual continuous slope to either extremity of shell; hinge-line nearly the whole length of shell, very narrow, pectinated with a crowded series of lamellar, transversely directed teeth, which exhibit a tendency to become oblique and v-shaped on the posterior half of the line; ligamental area broad, open, arching upward in a gentle curve, longitudinally lined, and irregularly grooved by numerous diagonal or v-shaped furrows resembling insect borings.

Surface of shell ornamented with numerous radiating, wavy lines, alternating in coarseness, which become more or less obsolete on the umbonal slope, and are wholly wanting on both the beak and wing, which only show concentric lines of growth, of the radiating lines on the anterior part of the shell the series runs about as follows: coarse line, followed by two finer lines, then a slightly more prominent single line, again two finer lines, and then a coarse line, same as first, marking the coarse lines at intervals of about six or seven; interior of shell deep, cuneiform; margin entire.

"Length, 5.4 inches; width across the beaks, 2.5 inches.

"Caloosahatchie, in the banks below Fort Thompson."—*Heilprin*, 1887.

"This fine species is quite variable in the development of the extended wings which suggested Professor Heilprin's name. In many specimens the posterior wing does not exceed that usual in *A. occidentalis*, while in others it may extend an inch beyond the rest of the shell. The anterior wing is less prominent and not a little more constant, but is frequently paralleled by fossil and even by recent specimens of *A. occidentalis* Phil. So far as yet known this species is confined to the Floridan Pliocene. The character of the cardinal area is similar to that of *A. novæ*."—*Dall*.

The anterior as well as posterior teeth may be v-shaped. The ribs are finer than in *A. occidentalis*.

Dimensions.—(Small valve), lon. +16,-29; alt. +3,-13; semidiam. 8 mm.

Occurrence.—Pliocene marls of the Caloosahatchie, Shell Creek, and Myakka River.—*Dall*. Pliocene of Shell Creek, Florida.—*C. U. Museum*.

Arca aquila Heilprin

Plate II, Figures 1, 2

Arca aquila Heilprin, Wagner Free Inst. Sci., Trans., vol. 1, p. 97, pl. 12, fig. 31, 1887.

Arca aquila Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 621, pl. 31, fig. 12, 1898.

"Shell (known only by its left valve) elongated, rectangular, winged, profoundly sulcated on the posterior slope; anterior border vertical, straight; basal line slightly sinuous beyond the middle; hinge-line straight, of nearly equal length with the base; teeth very numerous, gradually increasing in size toward either end, where they are

markedly oblique: hinge-area broad, obscurely furrowed in longitudinal lines; beak moderately elevated, incurved, the apex directed backward; surface of the shell radiately ribbed, the ribs sinuous, beaded—especially on the anterior portion of the shell, where they are separated by an intermediate fine line—becoming obsolete in the posterior sulcus and on the wing where they are represented by two pairs of lines; lines of growth prominent towards the base and on the wing; basal margin crenulated.

"Length 1.25 inches; height, from base to hinge-line, .5 inch.

"This winged ark is at once distinguished from *A. aviculæformis* * * * by the absence of the anterior rostrum and its rectangular form. The last character, in addition to differences in the ornamentation, also serves to distinguish it from the Miocene *Arca incile*, which resembles it somewhat in the pterination of the posterior slope—"Heilprin, 1887.

"This very neat species appears to be somewhat rare, and has only been found in the original locality as yet."—Dall.

Occurrence.—"Pliocene marls of the Caloosahatchie River, Florida."—Dall.

Arca bowdeniana Dall; Plate II, Figure 3; (Wagner Free Inst. Sci., Trans., vol. 3, p. 622, pl. 33, fig. 12, 1898) from the Oligocene of the Bowden beds, Jamaica, and Pliocene of Limon, Costa Rica, is a small species with very anterior beaks and sculpture like that of *A. umbonata* and the diameter is greatest posteriorly.

Subgenus *Barbatia* (Gray) Adams

Barbatia Gray, Synops. Brit. Mus., 1840, p. (?); *ibid*, 1844, p. 81. Type *Arca barbata* L., II and A. Adams, Gen. Rec. Moll., ii., p. 534, 1858.

"The type form of this group is tolerably regular and seldom deformed, like the typical Arks, from the anfractuositities of its station; the reticulated sculpture shows few irregularities; the cardinal area is narrow with numerous grooves for the resilium, which forms a series of elongated concentric lozenges on the area; the shell is not conspicuously truncate or keeled; the teeth are small and vertical in the middle of the series and toward the end diverge distally and become larger and more distant. In some species these distal teeth are often broken up, like those of *Cucullæa*, but this feature is not constant in the species. Several groups or sections are recognizable, though they range into one another through their peripheral species. Such are the following:

"Group of *A. barbata* L. (*Barbatia* s. s.). This includes *A. (B.) mississippiensis* Conrad from the Vicksburgian Oligocene.

"Group of *A. candida* Gmelin (*Calloarca* Gray, 1857, + *Plagiarca* Conrad, 1875). This includes *A. cuculoides* Conrad (+*A. lima* Conrad, 1847 not of Reeve, 1844, = *A. Conradi* Desh.) from the Jacksonian; *A. marylandica* Conrad and *A. arcuata* Heilprin, Upper Oligocene and Older Miocene; and several other species. *Litharca (lithodomus)* Gray, 1840, is probably based on a specimen of *A. candida*, which had grown in the burrow of a *Lithodomus*. Upper Cretaceous to recent.

Group of *A. propatula* Conrad (*Granoarca* Conrad; 1862)=*A. hians* Tuomey and Holmes, 1855, not of Brown, 1842; nor of Reeve (?—*A. protracta* Rogers, not of Conrad, 1847). Miocene.

Group of *A. centenaria* Say (*Striarca* Conrad, 1862). Miocene.

Group of *A. donaciformis* Reeve (*Acar* Gray, 1847, +*Daphoderma* Moersch, 1853, +*Fossularca* Cossmann, 1887. Eocene to recent.

"In *Striarca* the lozenge occupied by the ligament and its transverse grooves for the resilium cover the entire cardinal area; in typical *Acar* the lozenge is obliquely directed backward, leaving the anterior part of the area bare; in *Fossularca* the lozenge is small, very short, and directly between the beaks, leaving a bare space before and behind it. *A. cælata* Conrad (*A. Adamsi* Shuttleworth) is a typical *Fossularca*.

"Group of *A. heterodonta* Desh. (*Les Cucullaires* Desh., 1860; *Cucullaria* Conrad, 1869, +*Nemodon* Conrad, 1869). Cretaceous (Ripley) to recent.

"In the *Barbatias* as well as in *Glycymeris* (*Pectunculus auct.*) the growth of the shell often results in a greater or less absorption of the middle part of the series of teeth; the distal teeth are always more or less oblique, especially those behind the beaks. In *Cucullaria* the latter are about, if not quite, parallel with the hinge-line. Consequently, it may follow that in the process of growth the same individual may at an early stage have a series of vertical median denticles, and at a later stage may present a hiatus destitute of teeth between the anterior and posterior parts of the series. Judging from the species I have been able to examine, the entire narrow cardinal area is originally covered by the ligament, but the grooves containing the resilium extend very obliquely backward from the beaks, as in typical *Acar*. Notwithstanding the resemblance of the hinge in these Tertiary and recent species to that of the Paleozoic and early Mesozoic *Parallelodon*, I am of the opinion that the relations of the former are really closer with the true Arks, and that the similarities will prove to be analogical rather than homologous. The recent abyssal species I have formerly referred to *Macrodon*, should probably be grouped under *Cucullaria*."—Dall, 1898.

Arca barbata Linné

Plate II, Figures 4, 5, 6, 7

Arca barbata Linné, Syst. Nat., p. 693, 1758.

"*Pectunculus ð fusco rufescens, admodum densè striatus*," Lister, Hist. Conch., tab. 231, fig. 65, 1170.

Arca barbata Gmelin, Syst. Nat., vol. 6, p. 3306, 1792.

Arca barbata Reeve, Conch. Icon., pl. 13. *Arca* no. 83, 1844.

Barbatia barbata H. and A. Adams, Gen. Rec. Moll., vol. 2, p. 534, pl. 124, figs. 4, 4a, 4b, 1858.

Arca barbata Arango, Fauna Malacologica Cubana, p. 263, 1879.

Arca (Barbatia) barbata Dall, U. S. Nat. Mus., Bull. 37, p. 40, 1889.

Barbatia barbata Dall, Wagner Free Inst., Sci., Trans., vol. 3, pt. 4, pp. 614, 615, 659, 1898.

"A. testa oblonga striata apicibus barbata, natibus incurvis approximatus, margine integerrimo clauso.

Mus. Tessin. 116. t. 6. f. 1,

Bonan. recr. 2. t. 79.

Guall. test. 91. f. F.

Argenv. conch. t. 25. f. M.

Habitat in M. Mediterraneo.

"*Testa apice rotundata, integra; striæ ex punctis callosis concatenatis; alternis striis majoribus. Barba ex striis versus apicem imprimis tenuiorem rigens.*"—*Linne*, 1758.

This species is irregularly colored with light and dark brown, the ribs are granulated, numerous and fine with slightly larger ribs at intervals on the middle of the valve; epidermis bristly; teeth fine at the center of the hinge, long and oblique distally; ligament area with several v-shaped grooves; inner margin smooth; byssal opening usually small.

Dimensions.—Lon. +17,-32; alt. +5,-22; diam. 20 mm.

Occurrence.—Recent from North Carolina to Barbados.—*Dall*. Recent from the Mediterranean, Florida and the West Indies.—*C. U. Museum*. This is a common recent and fossil European species.

Arca cuculoides Conrad

Plate II, Figures 8, 9, 10, 11, 12

Arca cuculoides Conrad, Fos. Tert. Form., p. 37, 1833.

Byssarca cuculoides Conrad, Am. Journ. Sci., 2d. ser., vol. 1, p. 219, 1846.

Byssarca lima Conrad, Acad. Nat. Sci. Phila., Proc. for 1847, p. 295; Journ., 2d. ser., vol. 1, p. 125, pl. 13, fig. 23, 1848—*A. Conradi* Deshayes.

Not *Arca lima* Reeve, Conch. Icon., *Arca* no. 101, 1844.

Navicula cuculoides et lima Conrad, Acad. Nat. Sci. Phila., Proc. for 1854, p. 29.

Cucullearca lima et cuculoides Conrad, Am. Journ. Conch., vol. 1, p. 11, 1865.

Barbatia (Culloarca) cuculoides Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 615, 624, 1898.

"Shell compressed, thick, inequivalve, reticulated; with a broad subcentral sinus, passing from the beak to the basal margin: posterior side elongated, strongly ribbed, and carinated; anterior side with numerous striæ; anterior end truncated. Length $2\frac{1}{4}$ inches. Breadth $1\frac{1}{2}$ inches.

"The hinge of this shell approaches cucullæa, in the interval between the beaks, having arcuated grooves under the beak; line of series of hinge teeth widely interrupted, and transverse at the extremities.

"*Locality.* Claiborne, Alab.

"*Cab. Acad. N. S.*"—*Conrad*, 1833.

Ribs smallest near the middle of the valve, becoming wider and smoother toward the umbonal ridge and larger and more widely spaced anteriorly; posterior slope with small, smooth ribs, this region separated from the rest of the shell by a sharp radial ridge which is often serrate; ribs anterior to the umbonal ridge mostly nodular and with finer ribs in some of the interspaces; cardinal area longer behind with numerous regular grooves; teeth continuous in the young, those in the center very small, distal teeth long and oblique, usually irregular in old specimens; outline variable, shell higher posteriorly. The ribbing varies on different shells, but the species is characterized by the sharp rib down the umbonal ridge and the ribs usually are quite different on different parts of the shell.

The variety figured and described by Professor Harris (Bull. Am. Pal., vol. 2, no. 9, p. 47, pl. 8, figs. 1, 1a, 1897), has a more pointed posterior basal angle and rougher posterior ribs than the type. It is from the Sabine Eocene of Gregg's Landing, Alabama. *Navicula aspersa* Conrad, Wailes, Agr. and Geol. Mississippi, p. 289, pl. 14, fig. 5, 1854; *Navicula aspera* Conrad, Acad. Nat. Sci. Phila., Proc. for 1855, p. 258, 1855; not *Arca aspera* Phil., Moll. Sicil., 1836 (*vide* Dall) has been listed in synonymies as the young of *A. cuculoides*, but the specimen in the Philadelphia Academy is *Acar reticulata*.

Dimensions.—Lon. +18, -40; alt. +7, -39; semidium. 19 mm.

Occurrence.—Upper Eocene (Jacksonian) near Claiborne, Alabama; Jackson, Mississippi; Cleveland County, Arkansas; and in the Lower Oligocene at Vicksburg, Mississippi.—Dall. Sabine Eocene of Gregg's Landing, Alabama and Pendleton, Texas, and Jackson Eocene of Jackson, Mississippi, of Montgomery, Grandview Bluff, Gibson's Landing and Bunker Hill Landing, Louisiana and of Texas.—*C. U. Museum*.

Arca mississippiensis Conrad

Plate III, Figures 1, 2, 3, 4

Byssarca mississippiensis Conrad, Acad. Nat. Sci., Phila., Proc. for 1847, p. 295; Journ., 2d. ser., vol. 1, p. 125, pl. 13, fig. 32, 1848.

Not *Arca mississippiensis* Conrad, Acad. Nat. Sci. Phila., Journ., 2d. ser., vol. 1, p. 125, pl. 13, figs. 11, 15, 1848.

Navicula mississippiensis Conrad, Acad. Nat. Sci. Phila., Proc. for 1854, p. 29.

Cucullearca mississippiensis Conrad, Am. Journ. Conch., vol. 1, p. 11, 1865.

Barbatia mississippiensis Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 625, 1898.

"Trapezoidal, with numerous closely arranged radiating lines, crenulated by fine concentric lines, the crenulation most distinct anteriorly, where the radii are largest; anterior end truncated or a little convex, direct: posterior margin obliquely truncated above; basal margin widely and profoundly arched; hinge line long, linear, minutely crenulated, expanded towards the extremities, and with prominent teeth; cardinal area with fine, very closely-arranged lines, angulated under the apex. Length 1 6-10.

"Differs from the preceding [*B. lima*] in having a longer hinge, finer radii, etc., and is a much smaller species and more abundant."—Conrad, 1848.

This species is much like *A. marylandica*. It is separated from *A. cuculoides* by its even ribbing and lack of the sharp umbonal ridge which characterizes that species.

Dimensions.—(Small valve), lon. +9, -20; alt. +2.5, -16; semidium. 6 mm.

Occurrence.—Vicksburg Oligocene of Vicksburg, Mississippi.—*C. U. Museum*.

Arca marylandica Conrad

Plate III, Figures 5, 6, 7

Byssarca marylandica Conrad, Fos. Med. Tert., p. 54, pl. 29, fig. 1, 1840.

Navicula marylandica Conrad, Acad. Nat. Sci. Phila., Proc. for 1854, p. 29.

Barbatia (*Byssarca*) *marylandica* Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 580, 1863.

Arca marylandica Heilprin, Acad. Nat. Sci. Phila., Proc. for 1880, p. 21.

Barbatia (*Colloarca*) *marylandica* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 623, 1898.

Arca (*Barbatia*) *marylandica* Glenn, Maryland Geol. Surv., Miocene, p. 392, pl. 106, fig. 7, 1904.

"Shell oblong, compressed, thin, with very numerous radiating granulated striæ; beaks not prominent; base much contracted or emarginate anterior to the middle; posterior side dilated, the superior margin very oblique and emarginate; extremity angulated, and situated nearer to the line of the hinge than to that of the base; cardinal teeth minute, except towards the extremities of the cardinal line, where they are comparatively very large and oblique; inner margin entire.

"*Locality.* Cliffs of Calvert, Md. * * *."—*Conrad*, 1840.

Ribs not varying conspicuously over the shell, often alternating with finer ribs anteriorly, smoother and usually double posteriorly; posterior part of the shell two-angled or broadly rounded; cardinal area with numerous v-shaped grooves; form of shell often irregular. This species lacks the sharp umbonal ridge of *A. cuculoides*.

Byssarca marilandica Lea, Acad. Nat. Sci. Phila., Proc. for 1848, p. 97, and *Arca marylandicus* Heilprin, Acad. Nat. Sci. Phila., Proc. for 1881, p. 451, are misprints for this species.

Dimensions.—Lon. +17.-36; alt. +6.-30; semidiam. 14 mm.

Occurrence.—Oligocene of the Ballast Point silex beds, Tampa Bay, the lower (Chipola) bed at Alum Bluff, the Chipola marl of the Chipola River, Florida; older Miocene of Jericho, Cumberland County, New Jersey; Middle Miocene of Plum Point, Calvert Cliffs, and Centreville, Maryland. Possibly also in the Jacksonian.—*Dall*. Calvert Miocene of three miles west of Centreville, Plum Point, Centreville, Maryland.—*Glenn*. Oligocene of Bailey's Perry, Florida.—*C. U. Museum*.

Arca arcula Heilprin

Plate III, Figures 8, 9

Arca arcula Heilprin, Wagner Free Inst. Sci., Trans., vol. 1, p. 118, pl. 16, fig. 65, 1887.

Barbatia (Calloarca) arcula Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 624, pl. 33, fig. 4, 1898.

"Shell moderately elongated, sharply angulated on the posterior slope, the dorsal and ventral borders nearly straight and parallel with one another; dorsal (hinge) line not much more than half the length of shell; anterior border projecting forward basally; posterior border acutely angulated with the base; beaks anterior, not very prominent, nor very widely separated; ligamental area narrow; teeth almost obsolete in the middle of the hinge-line, becoming oblique toward either extremity; interior of shell deep; external surface closely ribbed, the ribs strongly imbricated by the rugose lines of growth; ribs most prominent on the posterior slope, where they are echinated.

"Length, 1.7 inch; height to top of umbo, 1 inch."—*Heilprin*, 1887.

"Shell subovate, thin, inflated, the beaks low and prosogyrous; the cardinal area narrow and very closely and minutely furrowed longitudinally, the furrows showing a slight angle behind the beaks; sculpture of close set, fine radial ribs, rather regularly imbricated at successive lines of growth; on the posterior dorsal slope are six or eight nodulous larger ribs; the beaks are situated a little behind the anterior third; byssal foramen narrow, very anterior; hinge with a few large v-shaped teeth at the ends, the

middle teeth vertical, small, or even obsolete mesially; margins of the valve slightly or not at all crenulated by the sculpture. Length of shell 47, of hinge-line 30, height 31, diameter 26 mm.

"This species is very evenly and regularly fluted at the imbrications, differing in that respect from any of the other species mentioned here. It is notable also for its inflated and thin valves and the bluntly truncate posterior end, though the latter may be abnormal.—Dall."

Occurrence.—Oligocene of the Ballast Point silex beds, Tampa Bay, Florida.—Dall.

Arca phalacra Dall

Plate III, Figure 10

Barbatia (Calloarca) phalacra Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 626, pl. 33, fig. 3, 1898.

"Shell thin, moderately convex, equivalve, inequilateral; the prosogyrate beaks within the anterior fourth low and somewhat compressed; sculpture of very numerous fine, even, mostly dichotomous riblets without nodules or reticulation over the whole shell, crossed only by feeble incremental lines; cardinal area very narrow, with a few longitudinal grooves; hinge-teeth small, short, and vertical mesially without any gap in the series, distally longer, larger, and more oblique; hinge-line 0.6 of the whole length; internal margin of the valves smooth, byssal gape inconspicuous. Lon. 23.5, alt. 11, diam., 9 mm.

"This is a very modest and neat little species which does not seem identifiable with any of the others. It is, perhaps, nearest to *B. mississippiensis* Conrad, but is smaller, less flattened, and more regular."—Dall, 1898.

Occurrence.—Oligocene of the Chipola marls, Chipola River, and of the Oak Grove sands, Florida.—Dall.

Arca candida Gmelin

Plate III, Figures 11, 12

Arca candida Helblingi, Chemnitz, 7, p. 195, pl. 55, fig. 542.

Arca candida Gmelin, Syst. Nat., 6, p. 3311, 1792.

Arca Helblingii Bruguiere, Encyc. Meth., p. 195, 1797.

Arca jamaicensis Gmelin, Syst. Nat., 6, p. 3312, 1792.

Barbatia (Calloarca) candida Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 626, 1898.

"A. testa pellucida rhomboidali anterius producta posterius truncata decussatim striata: natibus remotis, margine posterius hiante; hiatus ovato ciliato.

Chemn. Conch. 7. t. 55 f. 542.

β) *Chemn. Conch.* 7. t. 55. f. 544.

Habitat in Oceano americano et ad Africæ littus occidentale, *testa alba, quasi granulata, epidermide villosa ex atro subfusca obducta.*"—Gmelin, 1792.

The synonymy is taken from Dall, who says, "There are some difficulties in the

nomenclature of this species which I have not the literature to straighten out. As far as I am now able to ascertain, the first name applied to this shell was *candida*, and the first binomial Latin name was that of Gmelin. It is a well known West Indian species conspicuous for its large size, white shell, and compressed, flattish valves. It is quite possible that some of the early authors named this wide-spread species more than once, and in this connection the *A. ovata* and *complanata* should be examined."

Recent and fossil shells from the Caribbean district reported as *A. velata* Sowerby are probably this species.

"Shell thin to solid, rather compressed, subtrapezoidal, gaping at the anterior base; anterior end generally truncate; posterior end pointed and obliquely truncate above; beaks high, separated by a moderately wide area; surface sculptured with fine to rather strong double or single, large or small ribs which are heavier on the posterior slope. These are crossed by rude, irregular growth lines and ridges, causing the surface to appear somewhat cancellated and beaded; epidermis heavy, shaggy; teeth feebly developed. Color white.

"Length, 60; height, 35; diameter, 28 mm."—*Dall and Simpson*, (Mollusca of Porto Rico, Bull. U. S. Fish Comm., vol. 20, for 1900, pt. 1, p. 460, 1901).

Occurrence.—Oligocene of the Bowden beds, Jamaica, of the Chipola beds at Alum Bluff and on the Chipola River, Florida; Pliocene of Trinidad; Pleistocene of the Antilles generally, and recent from Cape Hatteras, North Carolina, to Brazil at Santa Caterina, and possibly the African coast.—*Dall*. Recent from Santo Domingo.—*C. U. Museum*.

Arca caloosahatchiensis (new name)

Plate III, Figure 13

Barbatia (Calloarca) irregularis Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 623, pl. 33, fig. 5, 1898.

Not *Arca irregularis* Deshayes, Des. Coq. Fos., vol. 1, p. 208, pl. 32, figs. 9, 10, 1830.

Not *Arca irregularis* d'Orbigny, Pal. Franç., Terr. Crét., vol. 3, p. 240, pl. 326, figs. 4, 5, 1844.

"Shell thin, elongate, irregularly distorted; beaks prosogyrate; at the anterior third rather low and compressed; cardinal area long, rather narrow, with very numerous (twelve) concentric grooves; surface irregular, sculptured with numerous fine radiating, somewhat imbricated ribs, of which those in front of the beaks and on the posterior dorsal slope tend to be larger and more elevated; there is a tendency to alternate or pair among the ribs in some specimens; the imbrications or nodules on the ribs are somewhat regularly spaced and correspond to elevated concentric lines in harmony with the lines of growth; the posterior dorsal slope is bounded by rounded ridges radiating from the beaks; the posterior cardinal margin is elevated and angular with more or less of a depression between it and the radial ridge on each side; the byssal foramen is wide and irregular; the hinge-line is long and straight; the teeth, vertical and very small medially, are sometimes obsolete in the middle of the hinge; distally they become rather distant and quite oblique, as well as larger; the internal margin, though irregular, is not fluted. Lon. of adult 51, alt. 25, diameter 20 mm.

"This species is distinguished from *B. marylandica* by its smaller altitude, its coarser and more prominent sculpture, and more irregular hinge; the beaks are also more anterior."—*Dall*, 1898.

Occurrence.—Oligocene of the silex beds at Ballast Point, Tampa Bay (fragment)? Pliocene marls of Shell Creek, Alligator Creek, and the Caloosahatchie.—*Dall*.

Arca nodulosa Müller

Plate III, Figures 14, 15

Arca nodulosa Müller, Zoologie Danicæ Prodrömus, p. 247, 1776.

Arca nodulosa Gmelin, Syst. Nat., vol. 6, p. 3309, 1792.

Arca nodulosa Broegger, Norges Geologiske Undersögelse, No. 31, pl. 15, figs. 13a, 13b, 1901.

"*Arca testa oblonga nodulis striata, natibus incurvis remotis, margine integerrimo clauso. Müll. zool. dan. prodr. 2984. Habitat in omni mari europæo, fabæ equinæ magnitudine, natibus approximatis.*"—*Gmelin*, 1792.

Dall (U. S. Nat. Mus., Bull. 37, p. 42, 1889; *Wagner Free Inst. Sci., Trans.*, vol. 3, pt. 4, p. 659, 1898), places this species in *Calloarca* and lists it from the Florida Keys. *Thiele* (*Zool. Jahrb.*, Jena, Suppl. 11, pt. 2, p. 127, 1910), lists it from St. Thomas. It occurs as a fossil in Europe.

Arca propatula Conrad

Plate IV, Figure 1

Arca propatula Conrad, Acad. Nat. Sci. Phila., Proc. for 1843, p. 323; *Fos. Med. Tert.*, p. 61, pl. 32, fig. 1, 1845.

Arca hians Tuomey and Holmes, Pleioc. Fos. S. Car., p. 34, pl. 14, figs. 4, 5, 1855. Not of Bronn, 1842 (*vide Dall*), or Reeve, *Conch. Icon.*, Arca no. 62, 1844.

Arca hians Whitfield and Hovey, *Am. Mus. Nat. Hist., Bull.*, vol. 11, pt. 4, pp. 444-447, 1901.

Barbatia (Granoarca) propatula Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, pp. 290, 580, 1863.

Arca (Granoarca) propatula Tryon, *Struct. and Syst. Conch.*, vol. 3, p. 254, pl. 129, fig. 5, 1884.

Barbatia (Granoarca) propatula Dall, *Wagner Free Inst. Sci., Trans.*, vol. 3, pt. 4, p. 627, 1898; pt. 6, p. 1601, 1903.

"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 interstices, which have transverse imbricated lines; ribs largest about the umbonal slope, very distinct on the posterior slope, which is concave towards the hinge-line; posterior margin oblique, concave extremity widely rounded; summit of umbo moderately elevated, slightly retuse; cardinal area wide, with diverging grooves; series of teeth slightly sinuous anteriorly; teeth numerous; at the posterior extremity, the series suddenly becomes dilated, and the teeth interrupted or tubercular; inner margin crenate; crenæ profound and remote posteriorly. Length, four inches; height rather more than one and one-third inches.

"*Locality*. James River, below City Point. Petersburg, Mr. Tuomey; Ware River, Gloucester County, Virginia, Mr. Ruffin.

"Perhaps this may prove to be an old specimen of *A. arata*, Say."—*Conrad*, 1843.

Tuomey's shell was proportionately longer than Conrad's.

Occurrence.—Miocene of Virginia, on the James River below City Point, Petersburg, and on the Ware River, Gloucester County; Darlington, South Carolina; Sumter District, South Carolina.—*Dall*.

Arca virginiae Wagner

Plate IV, Figures 2, 3, 4

Arca virginiae W. Wagner, Trans. Wagner Inst., v., pl. 1, fig. 3 (*vide* Dall).

Arca virginiae Bronn, Index Pal. Nomencl., p. 99, 1848; Syst., p. 281, 1849.

Barbatia (Granoarca) virginiae Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 627, pl. 32, fig. 23, 1898.

Arca (Barbatia) virginiae Glenn, Maryland Geol. Surv., Miocene, p. 392, pl. 106, fig. 8, 1904.

"*Arca virginiae* is a large, solid, elongated shell, equivalve but very inequilateral, the beaks being situated near the anterior fifth of the length, low and prosogyrate, distant, and separated by a wide cardinal area with numerous (nine) slightly angular longitudinal concentric grooves; sculpture of about twenty-five strong radial ribs, smaller on the posterior dorsal area, somewhat flattened, and on the posterior part with a shallow, wide mesial furrow; hinge-line .65 as long as the shell; teeth vertical, in two series, beginning mesially very small, distally larger, and with a tendency to break up or become irregular; muscular impressions deep; margin fluted in harmony with the ends of the ribs. Lon. 83, alt. 52, diam. 42 mm.

"This shell is about midway in its characters between *Barbatia (Granoarca)*, *Anadara*, and *Scapharca*, illustrating very well the manner in which the subordinate groups of the genus *Arca* intergrade * * *."—*Dall*.

Occurrence.—Miocene of Virginia, (Nansemond River?)—*Dall*. St. Mary's Miocene of St. Mary's River, Maryland, (imperfect, probably this species).—*Glenn*. Miocene of Claremont Wharf, James River, Virginia.—*C. U. Museum*.

Arca centenaria Say

Plate IV, Figures 5, 6, 7

Arca centenaria Say, Acad. Nat. Sci. Phila., Journ., 1st. ser., vol. 4, p. 138, pl. 10, fig. 2, 1824.

Striarca (Arca centenaria) Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, pp. 290, 580, 1863.

Barbatia (Striarca) centenaria Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 615, 628, 1898; pt. 6, p. 1601, 1903.

Arca (Barbatia) centenaria Glenn, Maryland Geol. Surv., Miocene, p. 391, pl. 106, figs. 5, 6, 1904.

"Shell transversely oval, subrhomboidal, obtusely contracted at the base with numerous alternate longitudinal striae.

"* * * Striae from one hundred to one hundred and eighty and more in number: disappearing on the hinge margin; with hardly obvious transverse minute wrinkles, and larger, remote, irregular ones of increment: beaks but little prominent, not remote: base widely but not deeply contracted, nearly parallel with the hinge margin: anterior and posterior margins obtusely rounded: series of teeth rectilinear, uninterrupted, decurved at the tips; space between the beaks with numerous grooves proceeding from the teeth:

inner margin not very distinctly crenated: muscular impressions elevated, and forming a broad line each side, from the cavity of the beak to the margin.

"Length nine-tenths of an inch, breadth nearly one inch and a half."—*Say*, 1824.

Say used the term length for height and breadth for length.

This species does not closely resemble any other American *Arca*. The beaks are elevated and little curved; the ligament area is transversely striated, each groove corresponding with a groove in the ligament; the teeth are usually partly dissolved so that they are hollow, as in the fossil *Adamsi*; the upper edge of the line of teeth is straight, but the lower edge is evenly arcuate, so that the teeth are very short at the center and increase in length toward the ends of the hinge, where they make an angle of 45 degrees with the hinge-line; the extreme distal teeth are shorter and nearly horizontal; the inner margin is nearly smooth except in the young.

Dimensions.—Lon. +15,-25; alt. +5,-24; semidiam. 12 mm.

Occurrence.—Older Miocene of Jericho, Cumberland County, New Jersey, and in the Virginia Miocene at Coggin's Point, Petersburg, Grove Wharf, on the James River, and the Miocene beds of the York River.—*Dall*. Choptank Miocene of Jones Wharf; Calvert Miocene of Church Hill, Fairhaven, Maryland.—*Glenn*. Miocene of Evergreen, James River, Yorktown, Kingsmill, Bellefield and Grove Wharf, Virginia.—*C. U. Museum*.

Arca reticulata Gmelin

Plate IV, Figures 8, 9, 10, 11, 12

Arca reticulata Gmelin, Syst. Nat., 6, p. 3311, 1792.

Arca reticulata Chemnitz, Conch. Cab., 7, p. 193, pl. 54, fig. 540.

Arca squamosa. domingensis et clathrata Lam., An. s. Vert., vol. 6, pp. 45, 40, and 46, 1819.

Arca gradata Brod. and Sby., Zool. Journ., vol. 4, p. 365, 1829.

Arca divaricata Sby., P. Z. S., 1833, p. 18; Reeve, Conch. Icon., *Arca*, pl. 16, fig. 108, 1844.

Barbatia (Acar) reticulata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 629, 1898.

"A. testa subrhomboidea decussatim striata alba: natibus approximatis, vulva cordata.

List. Conch. t. 233, f. 67.

Martini Besch, Berl. Naturf. 3. t. 6. f. 9.

Chemn. Conch. 7. t. 54. f. 540.

Habitat - - - *arcae Noae affinis; utrum hujus, an sequentis familiae?*"—*Gmelin*, 1792.

The synonymy is taken from *Dall*. This includes forms of varietal value. Specimens in the Newcomb collection from Panama and Trinidad are radially and concentrically ridged, the concentric ridges the stronger on the middle of the shell, giving rise to the name *gradata*; the diverging, radiating ridges are about as strong as or stronger than the concentric ridges on the posterior slope, but the sculpture is not conspicuously different on different parts of the shell. Only the posterior part of the cardinal area is covered by the ligament; the inner margin is finely crenulated. A specimen from Cuba is very similar to one labelled *Acar donaciformis* from the Mediterranean. These are smaller and thicker and the crenulations on the posterior inner margin are not so closely

connected with the external sculpture, but form long, even ridges on the thick margin. Specimens labelled from Paumotus and from the Mediterranean which are evidently *A. divaricata* are thin and the sculpture of the posterior part is conspicuously different from that of the rest of the shell, the ribs there are fewer than in the other forms, more conspicuously diverging and are much stronger than the concentric sculpture. The posterior ribs rise along the umbonal ridge. The crenulations of the posterior margin are larger to correspond with the larger posterior ribs and a secondary set of fine wrinkles overruns the main crenulations.

Acar reticulata is characterized by its small, nearly white, well-sculptured shell, concentric ridges and posterior ribs rising along the umbonal ridge. The teeth are grooved at the sides and many of them are v-shaped. The name *clathrata* was used by DeFrance (1816), M'Coy and Reeve, *squamosa* by de Koninck (1842), and *reticulata* by M'Coy (1844). *Navicula aspersa* Conrad is this species, not the young of *A. cuculoides*.

Dimensions.—Large shell, lon. +10, -17.5; alt. +3, -13; diam. 15 mm.

Occurrence.—Eocene of the Jacksonian at Moody's Branch, Jackson, Mississippi; Oligocene of the Bowden beds, Jamaica; Matura, Trinidad; of the Tampa silex beds at Ballast Point, Florida, and on the Chipola River, Pliocene of Limon, Costa Rica, and of the Caloosahatchie marls; Pleistocene of the Antilles generally; and recent from Cape Hatteras to Barbados and the Gulf of Campeachy.—*Dall*. Recent from Trinidad, Cuba, Panama, Paumotus and the Mediterranean.—*C. U. Museum*.

Arca millifila Dall

Plate IV, Figures 13, 14

Arca (Acar) millifila Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 6, pl. 56, figs. 21, 24, 1903.

"Pliocene marl of Shell Creek, Florida; the ligament is typical of *Acar*, the radial threads are minutely granular, especially on the posterior dorsal slope; the shell is thin and the scars obscure."—*Dall*, 1903.

Arca Harrisii (new name)

Plate IV, Figure 15

Arca inornata Meyer, Geol. Surv. Ala., Bull. 1, p. 79, pl. 1, fig. 24, 1886.

Arca inornata deGregorio, Faune Éocénique de l'Alabama, p. 197, pl. 24, fig. 29, 1890.

Arca (Fossularca?) inornata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 658, 1898.

Not *Arca (Cucullaea) inornata* Meek and Hayden, Acad. Nat. Sci. Phila., Proc. for 1858, p. 51, 1858.

"Trapezoidal; anterior side truncated, flat; beak small; ligament area very low; teeth smallest toward the middle; covered with indistinct concentric lines; margin entire.

"Resembles *Arca lævigata*, Caillat, from the Paris basin, but is less oblong."—*Meyer*, 1886.

From the descriptions this species appears to be nearest *Fossularca*. The name *inornata* is preoccupied by Meek and Hayden. Their species, from the Black Hills, has been placed in *Grammatodon*. Meyer's species is renamed in honor of Professor G. D. Harris for his work on the Eocene.

Occurrence.—Eocene of Claiborne, Alabama.—*Meyer*.

Arca Adamsi (Shuttleworth) Smith

Plate IV, Figures 16, 17, 18; Plate V, Figure 1

Arca cœlata Conrad, Fos. Med. Tert., p. 61, pl. 32, fig. 2, 1845.

Not *Arca cœlata* Reeve, Conch. Icon., *Arca* no. 110, 1844.

Barbatia (Arca) cœlata Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 580, 1863.

Arca lactea of various authors, not of Linné.

Arca (Acar) Adamsii Shuttleworth, MS., Smith, Lin. Soc., Zool., Journ., vol. 20, p. 499, pl. 30, figs. 6, 6a, 1890.

Arca Adamsi Dall, Bull. Mus. Comp. Zool. Harvard, vol. 12, p. 243, 1886.

Barbatia (Fossularca) Adamsi Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 629, 1898.

"Trapezoidal, disk widely and not profoundly contracted; ribs numerous, alternated towards the base, tuberculated, aculeated anteriorly and posteriorly; posterior slope depressed; umbo acutely angulated behind; basal margin slightly arched; posterior margin obliquely truncated; beaks approximate.

"*Loc.* Wilmington, N. C., Mr. Hodge."—*Conrad*, 1845.

"This species is well distinguished from the similar looking *A. lactea* of Europe by the fact that its radial riblets are formed by rows of trailing blisters or hollow flutings, which are very friable and often entirely worn off, leaving the shell practically smooth. Though the shell has long been labelled with Shuttleworth's name in collections, the first published description I have met with is that of Mr. E. A. Smith, * * * Conrad's specific name is preoccupied. The fossils agree exactly with the living specimens, except that those from the Oligocene are usually somewhat smaller than the full-grown recent shells."—*Dall*.

Ligament occupying only a small, diamond shaped area between the beaks; line of teeth interrupted opposite the ligament. Dall, (Bull. Mus. Comp. Zool. Harvard, vol. 12, p. 243, 1886; U. S. Nat. Mus., Proc., vol. 24, p. 508, pl. 31, fig. 1, 1902), called a dwarf, short, squarish form with greater proportional diameter the variety *Conradiana*.

Dimensions.—Lon. +4, -7; alt. +1, -6; semidiam. 3 mm.

Occurrence.—Oligocene of the Bowden beds, Jamaica, of the Chipola River and Oak Grove, Florida; Miocene of Duplin County, North Carolina; Pliocene marls of the Caloosahatchie, Shell Creek, and Alligator Creek, Florida, and the Waccamaw River, South Carolina. Recent, with a range from Cape Hatteras, North Carolina, to the island of Fernando Noronha, on the coast of Brazil, in five to one hundred and sixteen fathoms.—*Dall*. Oligocene of Bailey's Ferry, Florida; Miocene of Curry and the Natural Well, North Carolina; Pliocene of the Croatan beds, North Carolina; and recent from Cuba.—*C. U. Museum*.

Barbatia (Fossularca?) ovalina Dall; Plate V, Figure 2; (Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 630, pl. 32, fig. 18, 1898), from the Oligocene of Bowden, Jamaica, has the form of a *Nucula*, the cardinal margin of a *Limopsis*, and the teeth of an *Arca*. Lon. 3.2 mm.

***Arca lignitifera* Aldrich**

Plate V, Figures 3, 4

Arca (Barbatia) lignitifera Aldrich, Nautilus, vol. 22, p. 75, pl. 5, figs. 6, 7, Dec. 1908.

"Shell small, thin, extremities rounded, moderately convex, beaks small and flattened; surface marked by many radial riblets crossed by irregularly spaced lines of growth; a depressed area running from beaks to base nearly central; valves smooth internally, but showing faint lines corresponding to some of the riblets. Hinge line long, slightly curved; the hinge carries four close-set teeth anteriorly, next a short vacant space, and then ten to thirteen small teeth, larger and more nearly parallel to the hinge line as they approach the posterior.

"Lon. 5 mm.; alt. 3 mm.

"LOCALITY. Six miles east of Thomasville, Ala., Wood's Bluff horizon."—*Aldrich*, 1908.

Occurrence.—[Sabine] Eocene of Alabama.—*Aldrich*.

***Arca Aldrichi* Dall**

Plate V, Figure 5

Barbatia (Cucullaria) Aldrichi Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 630, fig. 19, 1898.

"Shell small, elongate, thin, somewhat pointed behind, rounded in front, moderately convex, with low, prosogyrate beaks; cardinal area very narrow and elongated, widest in front of the beaks; surface evenly sculptured by fine equal, flattish radial riblets, separated by narrower grooves and crossed by irregularly spaced impressed lines; inner margin of the valves smooth or slightly fluted in harmony with the ribs, especially behind; beaks in the anterior fourth; hinge-line about two-thirds the length of the shell; hinge anteriorly with four oblique, rather close-set teeth, separated by a wide gap from the posterior teeth, which are about six in number, smaller proximally, and parallel with the hinge-line. Lon. 8.3, alt. 5, diam. 4 mm.

"A single specimen of this interesting shell was obtained, adding a new group to the list of Eocene forms found in the Claibornian. The hinge is somewhat like that of *Arca (Cucullaria) Caillati* Deshayes, but wants the central vertical denticles. The form is more like that of *A. gracilis*, Desh., but wider and more regular."—*Dall*, 1898.

Occurrence.—Claiborne sands, Claiborne, Alabama.—*Dall*.

***Arca taeniata* Dall**

Plate V, Figures 6, 7

Barbatia (Cucullaria) taeniata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 631, pl. 25, figs. 1, 1a, 1898.

"Shell thin, elongated, arcuate, mesially compressed, in general inflated; the beaks near the anterior fifth; anterior end rounded, short; posterior higher, produced, and

bent down; base receding mesially; cardinal area short and wide in front of the beaks, long and narrow behind them, in front smooth or longitudinally striated, behind with a few oblique grooves; sculpture of small, flat, radial ribs arranged in pairs with narrower interspaces, and between every set of two pairs and the next a wider interspace, as if the ribs were quadripartite; these ribs cover all the shell, more sparsely on the posterior dorsal slope, and are crossed at wide but not perfectly regular intervals by narrow, flat, concentric ridges; inner margin of the valves smooth, except when modified by the external ribbing; hinge two-thirds as long as the shell, with four rather large oblique anterior teeth separated by a wide edentulous gap from a row of about twenty short vertical teeth, which merge into a group of six or seven oblique posterior teeth, becoming larger distally; the extreme distal teeth in full-grown specimens sometimes break up into irregular granules. Length of adult shell 52, of hinge-line 29, alt. of shell 23, diam. 21 mm.—Dall, 1898.

Occurrence.—Pliocene marls of the Caloosahatchie and Shell Creek, Florida, and of the Croatan beds of North Carolina, at Mrs. Guion's marl pit.—Dall.

Macrodon asperula Dall; Plate V, Figures 8, 9; Dall, Bull. Mus. Comp. Zool. Harvard, vol. 9, p. 120, 1881; vol. 12, p. 244, p. 8, figs. 4, 4a, 1886; U. S. Nat. Mus., Bull. 37, p. 42, pl. 8, figs. 4, 4a; *Bentharca asperula* Verrill and Bush, Proc. U. S. Nat. Mus., vol. 20, p. 842, 1898; *Barbatia (Cucullaria) asperula* Dall, Wagner Free Inst. Sci., Trans., vol. 3, p. 659, 1898, is given by Dall as recent from Fernandina to Yucatan in three hundred and ten to fifteen hundred and sixty-eight fathoms. The name is preoccupied in *Arca* by Deshayes, An. S. Vert., vol. 1, p. 883, pl. 66, figs. 4-6, 1860. Dall's species might be called *Arca paserula*.

Macrodon sagrinata Dall; Plate V, Figure 10; Dall, Bull. Mus. Comp. Zool. Harvard, vol. 12, p. 245, 1886; U. S. Nat. Mus., Bull. 37, p. 42, 1889; *Barbatia (Cucullaria) sagrinata* Dall, Wagner Free Inst. Sci., Trans., vol. 3, p. 659; *Arca (Cucullaria) sagrinata* Dall, U. S. Nat. Mus., Proc., vol. 24, p. 508, pl. 31, fig. 2, 1902, is from water eighty fathoms deep northwest of Cuba.

Arca profundicola Verrill; Plate V, Figures 11, 12; Verrill, Trans. Conn. Acad., vol. 6, p. 439, pl. 44, figs. 23, 23a, 1885; Dall, Bull. Mus. Comp. Zool. Harvard, vol. 12, p. 245, 1886; *Macrodon profundicola* Dall, U. S. Nat. Mus., Bull. 37, p. 42, pl. 46, figs. 23, 23a, 1889; *Barbatia (Cucullaria) profundicola* Dall, Wagner Free Inst. Sci., Trans., vol. 3, p. 659, 1898; *Bathyarca profundicola* Verrill and Bush, Proc. U. S. Nat. Mus., vol. 20, p. 844, pl. 78, fig. 2, 1898, has been found in deep water off the northeastern and southern coasts of the United States.

Arca lactocomata Dall; Plate V, Figures 13, 14; Dall, Bull. Mus. Comp. Zool. Harvard, vol. 12, p. 243, pl. 6, figs. 9, 10, 1886; vol. 18, pp. 433-435, 1889; U. S. Nat. Mus., Bull. 37, p. 40, pl. 6, figs. 9, 10, 1889, is from eighty-two to one hundred and sixty-nine fathoms from Martinique and Barbados.

Arca (Barbatia) pterøssa E. A. Smith; Plate V, Figures 15, 16, 17; Smith, Challenger Rep., Lam., p. 262, pl. 17, figs. 4-4b, 1885; *Bathyarca pterøssa* Verrill and Bush, Proc. U. S. Nat. Mus., vol. 20, p. 843, 1898; *Arca (Cucullaria) pterøssa* Dall, Bull. Mus.

Comp. Zool. Harvard, vol. 43, p. 399, 1908, was found off Culebra Island, West Indies, and near the Azores and in the North Pacific.

Subgenus *Noëtia* Gray

Noëtia Gray, Syn. Cont. Brit. Mus., 1840. (Dall).

Subgenus *Noëtia* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 616, 1898.

The *Noëtias* form a distinct division of the *Arcas*. Dall says the known fossils are all American and the recent species American and Indo-Pacific. The shell is equivalve, the posterior part is separated from the rest of the shell by a distinct umbonal ridge and in *A. reversa*, the type of the group, is so short that the beaks are posterior. The cardinal area usually appears twisted on account of its concave anterior part with raised margin and flat posterior part. The ligament is crossed by transverse grooves which usually extend the width of the ligament in front of the beaks but are weaker posteriorly. Behind the ligament is a bare strip of the cardinal area which is usually oblique to the hinge-line, but in *A. reversa* it lies between the beaks and the ligament is entirely anterior. At the anterior end of the hinge and part way between the center and posterior end the teeth are v-shaped. Nearly all the interspaces show a fine interstitial rib.

Arca incile Say

Plate V, Figures 18, 19, 20, 21, 22, 23, 24, 25

Arca incile Say, Acad. Nat. Sci. Phila., Journ., 1st ser., vol. 4, p. 139, pl. 10, fig. 3, 1824; Conrad,

Fos. Tert. Form., p. 16, pl. 2, fig. 1, 1832; Fos. Med. Tert., p. 56, pl. 29, fig. 5, 1840.

Anomolocardia (Arca) incile Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 580, 1863.

Anadara incile Meek, Miocene Check List, Smith Misc. Coll. (183), p. 6, 1864.

Noëtia protexta Conrad, Kerr's Geol. Rep. N. Car., App. A, p. 19, pl. 3, fig. 5, 1875.

Arca (Noëtia) incile Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 632, 1898.

"Shell transversely rhomboidal, with about twenty-seven ribs: anterior hinge margin compressed and angulated.

"Disk prominent from the beaks to the anterior part of the base: ribs with transverse granules; those anterior to the middle alternating with very slender and but little prominent lines and with a groove on each: anterior margin longer to the base than the posterior end, and contracted in the middle: series of teeth nearly rectilinear, entire; interval between the teeth and the apices with a few transverse lines or wrinkles; a single oblique groove from the apex to a little before the middle, and six or seven narrow ones from the teeth outwards behind the apices: beaks placed very far backward: inner margin crenated: muscular impressions a little elevated, posterior one short: basal margin not parallel with the hinge margin * * * ."—Say, 1824.

In Say's description anterior and posterior are reversed.

Ribs twenty-seven to thirty-two, one specimen has thirty-four; a fine interstitial rib in the interspaces, sometimes wanting near the middle of the shell; ribs close-set on the anterior part of the shell except near the hinge, broader, higher and with wider interspaces about the umbonal ridge; posterior ribs with a longitudinal sulcus; beaks very anterior, elevated; cardinal area long, the portion occupied by the ligament diamond shaped

and extending backward to a point about half way from the beaks to the posterior extremity of the hinge in the adult, shorter in the young; ligament area with transverse grooves which are stronger in front of the beaks; posterior part of the cardinal area longitudinally striated; hinge-line as long or nearly as long as the shell; umbonal ridge angular; shell long and rectangular, anterior margin rounded, ventral nearly straight and descending so that the lowest point of the shell is at the posterior end, posterior end usually emarginate and nearly at right angles to the hinge; hinge narrow; line of teeth straight, posterior teeth oblique, anterior teeth vertical except at the end of the hinge, where a few are usually bent at a right angle, as in *A. ponderosa*.

It is apparent that Conrad's *Noetia protexta* from the Miocene of North Carolina is the same as Say's *A. incile*. The specimen of *A. trigintinaria* Conrad (Acad. Nat. Sci. Phila., Proc., p. 289, 1862), in the museum of the Academy, is intermediate between *incile* and *limula*. It is not a separate species, but rather a variety of *incile*. It is from the Miocene of South Carolina. *A. incilis* Kerr, Geol. Rep. N. Car., 1875, is a misprint for *A. incile*.

Dimensions.—Lon.+8,-26; alt.+5,-18; diam. 22 mm. Large valve.—Lon. 45, alt. 30, semidiam. 14 mm.

Occurrence.—Miocene of Maryland, Virginia, and North Carolina; near Darlington, South Carolina, at various points near and at the Natural Well, Duplin County, North Carolina; Petersburg, Dinwiddie, York River, and borders of the Dismal Swamp, Virginia, and Choptank, Maryland.—*Dall*. Miocene of Grove Wharf, Evergreen, Kingsmill, Yorktown, Bellefield and Shackelford, Virginia; Magnolia, North Carolina; Darlington C. H., South Carolina; Tertiary of James River, Virginia.—*C. U. Museum*.

Arca limula Conrad

Plate V, Figure 26; Plate VI, Figures 1, 2, 3, 4, 5

Arca limula Conrad, Fos. Tert. Form., p. 15, pl. 1, fig. 1, 1832; Fos. Med. Tert., p. 60, pl. 31, fig. 3, 1845.

Noetia (Arca) limula Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 580, 1863.

Arca (Noetia) limula Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 617, 631, 659, pl. 31, figs. 14, 14b, 1898.

"Oblong, sinuous, rather thin; ribs numerous, crossed by striæ, which are equally distinct in the interstices; ribs double on the posterior side where they alternate with fine lines; umbo angulated behind; hinge area narrow, oblique, and transversely striated; basal margin contracted near the middle; inner margin crenate * * *.

"This shell has a general resemblance to *Arca ponderosa*, of Say, but cannot be confounded with that species."—*Conrad*, 1832.

Dall (Wagner Free Inst. Sci., Trans., vol. 3, p. 632, 1898) gives the two following varieties of *A. limula*:

Arca limula var. *platyura* Dall

Pliocene of the Caloosahatchie and Alligator Creek * * *.

Shell with the posterior end of the cardinal border elevated and forming nearly a right angle with the posterior margin of the valves, thus giving the posterior part of the shell a higher and more angular look, which at first seems very distinct.

***Arca limula* var. *filosa* Conrad**

Noëtia ponderosa Say, var. *N. carolinensis* Conrad, Proc. Acad. Nat. Sci. Phila., for 1862, p. 290; not *Arca carolinensis* Wagner, 1847.

Arca carolinensis Heilprin, Proc. Acad. Nat. Sci. Phila. for 1881, p. 450.

Noëtia filosa Conrad, Kerr's Geol. Rep. N. Car., App. A, p. 20, pl. 4, fig. 3, 1875.

Miocene of North Carolina: at Sullivan's marl-pit, Green County, North Carolina, eight miles east of Snow Hill * * *.

This variety has more numerous (thirty-five) ribs when adult and a less angular outline than the typical form.

* * * A variety analogous to *platyura* is possessed by all the species of *Noëtia*, but is perhaps more conspicuous in *A. limula* * * *.

In *A. limula* there are from twenty-eight to thirty-five ribs. In the long, rounded form they are often narrower and more crowded anteriorly, as in *A. incile*. Ribs about the umbonal ridge often with a fine riblet like the interstitial rib in the mesial sulcus; interspaces crossed by even, concentric lines which give a beaded appearance to the interstitial ribs but are less marked on the primary ribs as a rule; posterior strip of the cardinal area not covered by the ligament; ligament transversely grooved, grooves stronger in front; anterior margin of the cardinal area elevated, posterior rounded; teeth as in *A. ponderosa*; muscle scars with raised margins; anterior margin of the shell rounded, basal curved or sinuous with the lowest part of the shell usually near the posterior end; posterior margin usually with a bend near the hinge.

Typical *A. limula* has a sinuous base and an angle near the top of the posterior margin. It is separated from *A. incile* by its larger size, irregular outline, by the angle in the posterior margin and especially by the hinge and position of the beaks. The long, irregular shape and more anterior beaks separate it from *A. ponderosa*. Specimens from South Carolina, probably from the Pliocene, are, however, closely related to *A. ponderosa*. They have a more rectangular outline than typical *limula*, a relatively longer hinge-line, less anterior beaks, and have little or no bend in the posterior margin. *A. limulus* Morton 1834 and *A. limatula* Emmons, 1858, are misprints for *A. limula*. Conrad (Acad. Nat. Sci. Phila., Proc. for 1864, p. 211) withdrew his variety *carolinensis* from the species *ponderosa*.

Dimensions.—Lon. +22, -35; alt. +9, -36; semidiem. 19 mm.

Occurrence.—Miocene: North Carolina, at Wilmington, New Berne; Virginia, at various points on the York and James Rivers; also in Maryland and South Carolina, and at Heislerville, Cumberland County, New Jersey. Pliocene: De Leon Springs, Florida; in the marls of the Caloosahatchie and Shell Creek; near Brunswick, Georgia; Waccamaw beds, South Carolina.—*Dall*. Pliocene of Waccamaw, South Carolina, and the Croatan beds, North Carolina.—*C. U. Museum*.

Arca ponderosa Say

Plate VI, Figures 6, 7, 8, 9, 10

Arca ponderosa Say, Acad. Nat. Sci. Phila., Journ., 1st. ser., vol. 2, p. 267, 1822.*Arca contraria* Reeve, Conch. Icon., *Arca* no. 55, 1844.*Arca elegans* Phil., Zeitschr. Mal., 1847, p. 92 (*vide* Dall). Not *A. elegans* Perry, Conchology, pl. 60, fig. 1, 1811; *A. elegans* Roemer, 1836; *A. elegans* d'Orbigny, 1844; *A. elegans* Wood, 1846, or *A. elegans* de Koninck.*Noetia ponderosa* H. and A. Adams, Gen. Rec. Moll., vol. 2, p. 537, 1858.*Arca* (*Noetia*) *ponderosa* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 617, 632, 633, 659, 1898.

"Shell somewhat oblique, very thick and ponderous, with from 25-28 ribs, each marked by an impressed line; interstitial spaces equal to the width of the ribs; umbones very prominent; apices remote from each other, and opposite to the middle of the hinge, spaces between them with longitudinal lines as prominent as their corresponding teeth; anterior margin cordate, flattened, distinguished from the disk by an abrupt angular ridge; posterior edge rounded, very short; inferior edge nearly rectilinear, or contracted in the middle * * *."—*Say*, 1822.

In the original description anterior and posterior are reversed.

Ribs twenty-five to thirty-two; width of ribs and interspaces not varying much on the different parts of the shell; ribs with a mesial sulcus, sometimes with two sulci; a fine interstitial rib in each interspace, more prominent on the umbonal ridge and sometimes indistinct on other parts of the shell; ribs and interspaces crossed by fine, evenly spaced, concentric lines which are stronger in the interspaces; umbonal ridge angular, posterior end produced, posterior margin nearly straight; muscle scars with an elevated border; anterior margin of cardinal area elevated; ligament area longer anteriorly and bounded posteriorly by a narrow uncovered strip extending diagonally backward from the beaks; transverse grooves in the ligament stronger anteriorly; line of teeth curved at the ends, central teeth fine and vertical, anterior teeth larger and v-shaped, posterior teeth large and oblique with smaller, v-shaped teeth toward the center of the line; epidermis brownish black.

This is a variable species. Specimens from the Pleistocene of Louisiana and South Carolina are mostly short and high like some recent shells from Ft. Barrance, Florida. A valve from the Pliocene of the Croatan beds is unusually long, low and flat, and another from the same beds is unusually large, 71 mm. long and 61 mm. high. Neither of these can be placed in the species *limula* which is present in the same beds.

It is apparent that Reeve's *A. contraria* is the same as Say's species. Dall places *A. elegans* in synonymy with *A. ponderosa* and says, "There can be little or no doubt that the names of Reeve and Philippi are based on young specimens of this somewhat variable shell." This is one of the best known of the recent *Arcas* and is easily recognized by its heavy shell, interstitial ribs and twisted appearance.

Dimensions (long form).—Lon.+25,-31; alt.+9,-34; diam. 40 mm.

Occurrence.—Pleistocene of Cape May and Atlantic City, New Jersey; of Maryland, near Cornfield Harbor, at Wailes Bluff, on the Potomac River; of Simmons Bluff, South Carolina; and many points on the coast of Florida; recent on the eastern coasts of North

America from Cape Cod to Yucatan.—*Dall*. Pliocene of the Croatan beds, North Carolina: Pleistocene of Georgetown, South Carolina; of Crowley Oil Company and Knapp's wells, Grand Chenier, and New Orleans, Louisiana: recent from Point au Fer, Louisiana; Galveston, Texas; and Long Key, Cedar Keys and Ft. Barrance, Florida.—*C. U. Museum*.

The *Noëtias* show a variation which reaches an extreme in *A. reversa* Gray (Plate VI, Figures 11, 12), from the west coast of tropical America. In *A. incile* the shell is long with a long hinge-line and very anterior beaks. In typical *limula* the beaks are nearly as anterior when distances are measured parallel to the base instead of parallel to the hinge, but the hinge-line is much shorter so that the beaks are a comparatively short distance in front of the center of the hinge. In *A. ponderosa* both shell and hinge are short and the beaks are opposite the center of the hinge. *A. reversa* is still shorter and all the ligament area and nearly all the hinge are anterior to the beaks. With the shortening of the hinge it has become wider, the line of teeth more curved and the v-shaped teeth, which are inconspicuous in *A. incile*, have become more prominent; the width of the bare strip behind the ligament has decreased; the shell has developed a truncation so pronounced in *A. reversa* that the posterior parts of the two valves lie nearly in the same plane. *A. reversa*, however, is probably not descended from the other species mentioned. *A. (Noëtia) modesta* Grzybowski, from the Tertiary of Peru, is as short as *reversa* and the posterior part is concave. Grzybowski's *A. reversa*, from the Tertiary of Peru, is much larger than the recent form. C. B. Adams, Carpenter, Kobelt and Dall place *A. hemicardium* Koch in synonymy with *A. reversa*.

A. trinitaria Guppy; Plate VII, Figures 1, 2; (Quart. Jour. Geol. Soc., vol. 22, p. 583, pl. 26, figs. 3a, 3b, 1866; Schuchert, U. S. Nat. Mus., Bull. no. 53, pt. 1, p. 57, 1905), from Manzanilla, Trinidad, is very similar to *A. reversa*, but is smaller. It has forty ribs and a flat, cordate posterior portion. Dall (Wagner Free Inst. Sci., Trans., vol. 3, p. 658) lists this species as Oligocene. *A. centrota* Guppy; Plate VII, Figure 3; (Proc. Sci. Assoc. Trinidad, p. 175, Dec. 1867; Schuchert, U. S. Nat. Mus., Bull. no. 53, pt. 1, p. 55, 1905), fossil from Trinidad, also belongs to *Noëtia*. It is given by Dall as probably a Miocene species. The original description is repeated in Ann. Nat. Hist., 4th. ser., vol. 15, p. 51, 1875, and a figure is given in Geol. Mag., 1874, pl. 18, fig. 23. It has 36-38 ribs with fine interstitial ribs in the narrow interspaces and there is an angle in the posterior margin near the hinge. It is about 25 mm. long and resembles the young of *A. limula*, but is nearer to *A. Martinii* Recluz. Specimens in the C. U. Museum from Maranhão, Brazil; Plate VII, Figures 4, 5; are evidently the recent species which Guppy (Ann. Nat. Hist., 1875, p. 51, pl. 7, figs. 4a, 4b) collected from the Gulf of Paria and referred to *A. centrota*. They also agree well with *A. bisulcata* Lamarck (An. s. Vert., vol. 6, p. 45, 1819), and with *A. Martinii* Recluz (Jour. de Conch., vol. 3, p. 409, pl. 12, figs. 3, 4, 5, 1852), from southern Brazil. Dall states that the name *Martinii* is preoccupied by Bolten. The living species should probably receive the name *bisulcata* with *centrota* as an ancestral form or possibly the same species. The Maranhão shells have a small cardinal area not entirely covered by the ligament, the interspaces are rather narrow and are nearly filled by the fine interstitial ribs, the shell is often yellow

or pinkish, especially near the beaks; the posterior part shows two ridges running from the beaks, one, as in *A. limula*, to the angle with the ventral margin, the other to the angle in the posterior margin near the hinge. The margin is crenulated in the younger shells, but only feebly so in the old specimens.

Dall states that *Arca trapezia* Desh., from West Mexico, also belongs in *Noctia*. Specimens in the Newcomb collection labelled *Scapharca trapezia* Desh., which correspond with Reeve's figure and description do not belong to this group, however.

Subgenus *Scapharca* Gray

Section *Scapharca*

"Group of *A. inequivalvis* Brug. [*Scapharca* (Gray, 1847) Adams, 1858.]

"Moderately thin, elongate-ovate, with prosocoelous beaks, rather narrow cardinal area, not wholly covered by the ligament and usually with concentric resiliary lozenge-like grooving; tooth series uninterrupted, the teeth small, similar, somewhat larger and more oblique distally, the right valve smaller, the sculpture on the two valves usually similar or not markedly discrepant; the epidermis much as in *Argina*."—Dall.

Arca rhomboidella Lea

Plate VII, Figures 6, 7, 8, 9, 10

Arca rhomboidella Lea, Contributions to Geol., p. 74, pl. 2, fig. 52, 1833.

Anomolocardia rhomboidella Conrad, Smith. Misc. Coll., Eocene and Oligocene Checklist, p. 4, 1866.

Arca rhomboidella de Gregorio, Faune Éoc. Alabama, p. 196, pl. 24, fig. 28, 1890.

Arca (*Cucullarca*) *cuculloid* de Gregorio, l. c., p. 195, pl. 24, figs. 17-20.

Arca rhomboidella Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 625, 1898.

"Description. Shell rhomboidal, very inequilateral, compressed at base, longitudinally and closely ribbed; substance of the shell thin; beaks small, pointed; ribs about thirty-three, obsoletely tuberculated on the anterior portion; teeth lamellar, oblique; cicatrices scarcely perceptible; cavity of the shell rather shallow; margin crenulate.

"Diam * * * Length .2, Breadth 7-10ths, of an inch.

"Observations. This pretty little species forms, by its parallel sides, nearly a perfect rhomboid. It has some resemblance to the *centenaria* of Say, which is described by him, as well as Mr. Conrad, as being 'subrhomboidal.' The figures, however, are both trapezoidal, and, therefore, differ in outline from the description. It may also be distinguished by the ribs, the *centenaria* being striate. The figure of Mr. Sowerby's *duplicata* has a close similarity to our shell, but differs in having the 'ribs sulcated along the middle.'"—Lea, 1833.

Lea's specimen was young. Shell with a wide sulcus over the umbo to the base, the ribs finest in this sulcus, the anterior and often the posterior ribs divided by a mesial groove; fine ribs alternate with the primary set and sometimes there are three sets formed by the secondary ribs between the large ribs and still smaller ribs rising in the interspaces between these two sets; cardinal area in the larger specimens with eight or nine close-set, v-shaped grooves posteriorly, fewer anteriorly; posterior margin of the

cardinal area elevated, anterior square or slightly raised; teeth fine and vertical at the center, rapidly becoming oblique and longer distally; sides of the teeth grooved; anterior margin of the shell rounded with an angle at the hinge-line, basal margin nearly parallel to the hinge, posterior margin in young shells nearly straight and perpendicular to the hinge and base lines, in larger specimens somewhat produced below and emarginate above with a sharp angle at the hinge-line; inner margin with fine crenulations.

This species lies between *Barbatia* and *Scapharca*. The outline of the shell and form of the cardinal area are like the *Scapharca*, but the teeth and the close grooving of the cardinal area are like *Barbatia*. The ribbing is intermediate between the two groups.

Dimensions.—Lon. +12.5, -24; alt. +2.5, -17; semidiam. 8.5 mm.

Occurrence.—Lisbon, Alabama, the Eocene of Orangeburg, South Carolina, and according to Haldeman from the Eocene of Virginia.—*Dall*. Claiborne Eocene of Claiborne, Alabama.—*C. U. Museum*.

Arca vaughani Casey

Plate VII, Figure 11

Arca rhomboidella var. *Vaughan*, U. S. Geol. Surv., Bull. 142, pl. 3, fig. 8, 1896.

Arca vaughani Casey, Acad. Nat. Sci. Phila., Proc. for 1903, p. 265, 1903.

" * * * A species, quite common in the Lower Claiborne at St. Maurice, La., and allied somewhat to *rhomboidella* Lea. It attained a length of more than 20 mm., with a height of 12 mm. or more, obliquely rhomboidal, moderately inequilateral, rounded anteriorly and posteriorly and broadly rounded ventrally. It is moderately inflated, the radiating concavity at the middle of the umbones almost obsolete and having merely slightly wider intervals between the ribs, the latter 41-43 in number. The hinge-line is long and straight, the teeth becoming larger and very oblique laterally but well developed throughout, with their sides finely ribbed, giving to each tooth a bipectinate appearance. The area under the beaks is ample and broadly, divaricately striate. This species differs from *rhomboidella* in its much larger size, more numerous ribs, rounded ventral edge and many other characters, and may be named *vaughani*. A fair illustration of it was given by Mr. Vaughan (Bull. Geol. Surv., 142, Pl. III, fig. 8), in whose honor it is named. A modification of the true *rhomboidella*, but still smaller in size, also occurs sparingly at St. Maurice."—*Casey*, 1903.

Unless *A. vaughani* grows to a larger size than that given in the description the statement of the comparative size of *Vaughani* and *rhomboidella* would not hold true. The type of *rhomboidella* was a young specimen. Unlike *rhomboidella*, in *A. vaughani* the ribs are only slightly or not at all grooved.

Dimensions.—Lon. +7, -13; alt. +2, -12; semidiam. 5 mm.

Occurrence.—Lower Claiborne of St. Maurice, Louisiana.—*C. U. Museum*.

Arca invidiosa Casey

Arca invidiosa Casey, Acad. Nat. Sci. Phila., Proc. for 1903, p. 264, 1903.

"From the Red Bluff formation of Mississippi I have before me specimens of a small

Arca, probably allied somewhat to the Claibornian rhomboidella of Lea. It is subrhomboidal, very inequilateral, moderately inflated, broadly rounded ventrally, the anterior and posterior sides oblique, the former rounded, the latter longer and nearly straight. The beaks are rather broad, moderately elevated above the hinge-line, bisected by a feeble depression which becomes obsolete ventrally. The hinge-line is straight externally, broadly feebly arcuate internally, the line of teeth more than three-fourths as long as the shell, the lateral teeth becoming longer and strongly oblique. The space between the beaks and the hinge-line is flattened, nearly smooth except some fine, close-set parallel lines of growth, but at the posterior end there are some coarser parallel and feebly oblique lines. The radial ribs are 28 to 31 in number, rather coarse and separated by much less than their own widths, except in the feebly depressed area radiating from the middle of the beaks where they become finer and relatively much more widely separated, and generally with one fine intermediate rib between them in this region toward the ventral margin only; the ribs also become smaller but very close-set posteriorly in the flattened area toward the hinge-line. The surface posteriorly at an angle of about 30 degrees with the hinge-line is convex, becoming rapidly declivous and explanate to the latter. The muscular scars are rather deep. Lines of growth produce feeble transverse and rather widely separated nodules on the ribs generally becoming obsolete posteriorly. The length of a moderately large individual of this species is 11.5 mm., the height 6 mm."—Casey, 1903.

Arca delicatula Casey

Arca delicatula Casey, Acad. Nat. Sci. Phila., Proc. for 1903, p. 265, 1903.

"Occurs in the Lower Vicksburg limestone in great abundance. It may be regarded as a homologue of *invidiosa* and is doubtless one of the smallest known members of the family. It is elongate, very inequilateral, obliquely parallelogramic, moderately inflated, becoming flattened posteriorly toward the hinge-line, the latter long, thin and straight, the teeth small. The space between the hinge-line and the beaks rather low, flat and smooth or nearly so, narrowing very gradually posteriorly. The umbonal impression, with its diminished ribs, is nearly as in *invidiosa* and many other species. The ribs are some 28 in number, relatively moderately coarse, being generally separated by their own widths, flattened. Length of a moderately large valve 6 mm., height 2.6-2.8 mm."—Casey, 1903.

Arca Lesueurii Dall

Plate VII, Figures 12, 13, 14, 15, 16

Lesueur, Walnut Hills Fos., pl. 5, fig. 8, 1829 (*vide* Dall).

Arca Mississippiensis Conrad, Acad. Nat. Sci. Phila., Proc. for 1847, p. 294; Journ., 2d. ser., vol. 1, p. 125, pl. 13, figs. 11, 15, 1848.

Not *Byssocarca mississippiensis* Conrad, Acad. Nat. Sci. Phila., Journ., 2d. ser., vol. 1, p. 125, pl. 13, fig. 32, 1848.

Anomalocardia Mississippiensis Conrad, Am. Journ. Conch., vol. 1, p. 11, 1865.

Not *Cucullearca Mississippiensis* Conrad, Am. Journ. Conch., vol. 1, p. 11, 1865.

Scapharca (Scapharca) Lesueurii Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 643, 1898.

"A species of *Arca* occurs in great abundance at Vicksburg, which Lesueur obtained many years since and named it, but I have forgotten the name, and know not whether he published it in Europe or not. It is rhomboidal, ventricose, with rather distant ribs in the right valve, slightly grooved in the middle; in the left valve ribs double and granulated; inner margin profoundly toothed * * *."—*Conrad*, 1848.

Dall in 1898 named this species *Lesueuri*, retaining the name *mississippiensis* for *Conrad's* *Byssarca mississippiensis*.

Shell inequivalve with very different sculpture on the two valves; beaks incurved, mesially impressed at the tip; ribs twenty-four to twenty-eight, those of the left valve wider than the interspaces and divided by such a deep groove that they appear double except near the hinge, conspicuously beaded except on the distal parts of the posterior ribs; the ribs of the right valve narrower than the interspaces and much less grooved and beaded, especially near the middle of the shell; ribs square, rising from flat interspaces; cardinal area small, wider in front of the beaks, with several grooves, some of which usually do not extend in front of the beaks; hinge narrow, the teeth fine at the center, larger and more oblique distally; anterior and basal margins rounded, posterior end produced and rounded.

This abundant and characteristic species from the Vicksburg beds is readily distinguished by its small size and unusual sculpture.

Dimensions.—Lon. +6.5, -14; alt. +2.5, -12.5; semidiam. 6 mm.

Occurrence.—Vicksburgian Oligocene of Mississippi.—*Dall*. Oligocene of Vicksburg, Mississippi.—*C. U. Museum*.

Arca latidentata Dall

Plate VII, Figures 17, 18, 19, 20

Scapharca (Scapharca) latidentata Dall, *Wagner Free Inst. Sci., Trans.*, vol. 3, pt. 4, pp. 638, 647, pl. 32, fig. 15, 1898.

"Shell small, ovate, moderately convex, with low, quite anterior, mesially sulcate, prosocelous beaks; left valve with about thirty rounded, radiating, undivided ribs, separated by slightly wider interspaces, and crossed by numerous smaller concentric ridges which become beadlike on the ribs and vary in prominence in different specimens; base evenly arcuate, ends rounded; cardinal area narrow, impressed, smooth, with one or two grooves behind the beaks, but none elsewhere; valves slightly twisted, so that the basal margin is not in a single plane; line of teeth interrupted a little behind the beaks, the anterior series having the anterior and posterior teeth larger and the intervening teeth thinner and more closely adjacent, all nearly vertical; posterior teeth vertical, shorter, the series longer, the teeth smallest proximally and regularly increasing in size towards the distal end of the series, equidistant and regular; inner margin of the valve deeply fluted. Lon. 18, height 11, diam. 9 mm.

"This little shell looks a good deal like the young of *Anadara aresta* Dall, but has the beaks less central, less prominent, and distinctly impressed mesially, giving a somewhat bilobed aspect to the very young."—*Dall*, 1898.

The original description applies only to valves about the size of the type. The majority of the specimens are larger and with age they thicken and become much inflated, the posterior part is more attenuate than in the smaller specimens and the ends of the ribs often have a medial groove; the cardinal area has more grooves, some of which usually extend in front of the beaks. There are twenty-nine to thirty-three ribs and the cardinal margin is elevated behind and also slightly elevated in front near the beaks as in *A. hypomela*. *A. latidentata* is distinguished from the young of *A. hypomela* by its semi-circular posterior margin.

Dimensions.—Lon. +7, -18; alt. +2.5, -12.5; diam. 14 mm. A large valve is 28 mm. long.

Occurrence.—Oligocene of Ballast Point, Tampa Bay, of the lower bed at Alum Bluff, and in the Chipola marls of Florida, and probably from the Oak Grove sands in western Florida.—*Dall*. Oligocene of Bailey's Ferry, Florida.—*C. U. Museum*.

Arca acompsa Dall

Plate VII, Figure 21

Scapharca (Scapharca) acompsa Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 648, pl. 33, fig. 15, 1898.

"Shell rectangular, elongate, rather compressed, with low, prosocelous beaks, situated at about the anterior fourth of the whole length; right valve with about thirty-six flattened radial ribs, with much narrower interspaces; the anterior (twenty-two) ribs are mesially divided by a sharp groove and feebly rippled above; the posterior ribs are flat, smooth, and increase in width backward; the anterior end of the shell is evenly rounded, the base straight and parallel with the hinge-line, the posterior end wider, a little produced below and with a conspicuous angle above; cardinal area long, very narrow, with one or two grooves, and bordered behind with an elevated margin; hinge-line straight, long, with numerous small, uninterrupted teeth very short mesially, longer and somewhat more oblique distally; inner margin of the valves fluted, shell thin and delicate. Lon. 20, alt. 10.5, semi-diam. 4.5 mm.

"Only two right valves of this little species have been examined. It resembles the young of *A. hypomela* but is immediately distinguishable by its more compressed and rectangular form and smooth, flat posterior ribs."—*Dall*, 1898.

Occurrence.—Oligocene of the Chipola River, Florida, marl.—*Dall*.

Arca hypomela Dall

Plate VII, Figures 22, 23, 24, 25

Scapharca (Scapharca) hypomela Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 637, 647, 648, pl. 33, fig. 1, 1898.

Arca (Scapharca) hypomela Maury, Bull. Am. Pal., vol. 3, p. 372, 1902.

"Shell of moderate size, long, inflated, with rather low, mesially compressed, prosogyrate beaks; left valve with about forty-three deeply channelled, flat-topped ribs with fine, regular, concentric beading, except on the posterior slope, where the ribs are lower,

flatter, and obsolete channelled; near the margin some of the ribs have a second set of finer grooves; hinge-line straight, anterior end descending vertically, then obliquely rounded into the base, which is nearly parallel with the hinge-line; the posterior end descends more obliquely and the basal angle is prolonged a little and rounded; the interspaces between the ribs in both valves are very narrow, and on the right valve the beading is less conspicuous; the cardinal area is somewhat concave, flattish, with three or four concentric grooves in lozenge form; teeth of the hinge similar, numerous, not interrupted, short, vertical, the distal teeth a little longer and more oblique; margin of the valves fluted, the right valve slightly smaller than the other. Lon. 50, alt. 25, diam. 20 mm.

"This species has the appearance of being the Oligocene ancestor of the Miocene *A. lienosa*, from which it differs by its smaller size, closer and rather narrower ribbing."—*Dall*, 1898.

Ribs thirty-five to forty-three, commonly forty or more; sometimes the ribs are as narrow as, or narrower than the interspaces, but not commonly; posterior margin usually serrate.

Dimensions.—Lon. +13, -29; alt. +5, -20; diam. 25 mm. This is a rather small specimen.

Occurrence.—Oligocene of the Ballast Point silex beds, Tampa Bay, of the lower bed at Alum Bluff, and of the Chipola marl, Chipola River, Florida.—*Dall*. Oligocene of Bailey's Ferry, Florida.—*C. U. Museum*.

Arca lienosa Say

Plate VII, Figures 26, 27, 28; Plate VIII, Figures 1, 2

Arca lienosa Say, Am. Conch., 4, pl. 36, fig. 1, 1832.

Arca protracta Rogers, Am. Phil. Soc., Trans., vol. 5, p. 332, 1837; vol. 6, pl. 26, fig. 5, 1839.

Arca protracta Conrad, Fos. Med. Tert., p. 58, pl. 30, fig. 5, 1845.

Arca protracta Cushman, Boston Soc. Nat. Hist., Proc., vol. 33, p. 264, 1907.

Not *Byssarca protracta* Conrad, Acad. Nat. Sci. Phila., Journ., 2d. ser., vol. 1, p. 126, pl. 13, fig. 36, 1848.

Arca lienosa Tuomey and Holmes, Pleioc. Fos. S. Car., p. 40, pl. 15, figs. 2, 3, 1855.

Arca lienosa Emmons, Geol. N. Car., p. 284, fig. 204, 1858.

Scapharca (Arca) lienosa Conrad, Acad. Nat. Sci., Phila., Proc. for 1882, p. 579, 1863.

Arca lienosa Heilprin, Wagner Free Inst. Sci., Trans., vol. 1, p. 97, 1887 (ex parte).

Scaphara (Scaphara) lienosa Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 636, 1898.

"Shell rather thin, transversely oblong; ribs about forty, somewhat flattened and much broader than the intervening spaces which are very narrow, and with a longitudinal impressed line, particularly on those of the posterior margin, which are almost bifid; and with numerous slightly elevated transverse lines, which being divided by the longitudinal striae appear granulated: *beak* but little prominent, and nearly opposite to the posterior third of the length of the hinge margin: *area* narrow and elongated: *hinge margin* rectilinear, angulated at each extremity; teeth numerous, small; *posterior margin* obliquely rounded inwards, no part of it extending further backward than the angle: *anterior margin* obliquely truncate: *inner margin* crenate."—*Say*, 1832.

Anterior and posterior are reversed in the original description.

Ribs thirty-eight to forty-three, usually as wide or wider than the interspaces, somewhat more closely set on the middle of the valve; ribs near the umbonal ridge and generally on other parts of the shell with a finer secondary groove each side of the main longitudinal groove; ribs beaded; cardinal area rather narrow with about three or four irregular, concentric grooves and a transverse line between the beaks, cardinal area wider in front with raised margin posteriorly and near the beaks anteriorly; beaks mesially sulcate; posterior margin straight in the adult, emarginate in the young; basal margin slightly curved to arcuate, sometimes sinuate.

With age *A. lienosa* becomes long, narrow and inflated with produced posterior end and sometimes a sinuate basal margin and the cardinal area is wider with irregular grooves. *A. protracta* Rogers, from Prince George County, Virginia, is probably an old *A. lienosa*. A specimen from Kingsmill, Virginia, shows small, even teeth pointing away from the beaks, as in Rogers' specimen, though they are somewhat longer at the ends of the hinge and as a rule the teeth in old *A. lienosa* are larger and less regular. The teeth of *protracta* resemble those of *A. secticostata*. The lines of growth near the beak as drawn in Rogers' figure do not show the alation of the young *A. lienosa*. The Virginia specimens resembling *A. protracta* show this alation. Shells from North Carolina approach *protracta*. Heilprin united *lienosa* and *floridana*=*secticostata*. One of his specimens from the Caloosahatchie was six inches long and three inches high. *A. hypomela* lacks the posterior emargination or alation of *A. lienosa*.

Dimensions.—Lon. +18,-40; alt. +6,-30; semidiam. 17 mm. Lon. of a large valve 87, alt. 51 mm.

Occurrence.—Miocene of York and James River, Virginia, of Wilmington and Duplin County, North Carolina, and of the upper bed at Alum Bluff, Florida; Pliocene of the Waccamaw District, South Carolina, the Caloosahatchie River, Alligator and Shell Creeks, Florida * * *. Not known in the recent state.—*Dall*. Miocene of Kingsmill, and Bellefield, Virginia; Duplin County, North Carolina; the upper bed at Alum Bluff, Florida.—*C. U. Museum*.

Arca secticostata Reeve

Plate VIII, Figures 3, 4, 5

Arca secticostata Reeve, Conch. Icon., *Arca* no. 38, pl. 6, 1844.

Anadara secticostata Gray, Ann. Nat. Hist., 2d. ser., vol. 19, p. 371, 1857.

Anomalocardia floridana Conrad, Am. Journ. Conch., vol. 5, p. 108, pl. 13, fig. 2, 1869.

Scapharca secticostata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 636, 637, 659, 1898; pt. 6, p. 1616, 1903.

"*Arca testâ elongato-ovatâ, gibbissimâ, tenuiculâ, lateribus superiù angulatis, infrâ subobliquè rotundatis; albidâ, fuscescente partim tinctâ; radiatim costatâ, costis numerosis, angustis, ad quadragenas, quamplurimis sulco subprnfondo divisis; ligamenti areâ elongatâ, latiusculâ; umbonibus tumidis.*

"THE CUT-RIBBED ARK. Shell elongately ovate, very gibbous, rather thin, sides angulated at the upper part, rather obliquely rounded beneath; whitish, partially stained

with light rusty brown; radiately ribbed, ribs numerous, narrow, about forty in number, most of which are cut or divided by a rather deep groove; area of the ligament elongated, rather wide; umbones full * * *.

"This shell is probably one of those that have been confounded with the *Arca anti-quata* * * *; it differs in having a much greater number of ribs, and a larger proportion of them more distinctly grooved."—Reeve, 1844.

Three complete specimens of this rather rare species show thirty-three, thirty-four and thirty-seven ribs. One is stained with reddish brown on the umbo and near the hinge like Reeve's shell, the other two are nearly white like the shell Conrad named *Anomalocardia floridana*. Shell slightly inequivalve, posterior end produced, somewhat attenuate; teeth small and even; epidermis brown, thick and scaly near the margins. *A. sesticostata* is very similar to its ancestor *A. lienosa*. The ribs are comparatively narrower, the secondary longitudinal grooves appear only near the umbonal ridge and the beading on the ribs is not so conspicuous. In two specimens the posterior margin is nearly straight in the young part of the shells, but in one the young is auriculate. Recent shells listed as *A. lienosa* are *A. sesticostata*.

Dimensions.—Lon. +26, -58; alt. +8, -37; diam. 45 mm.

Occurrence.—Pleistocene of North Creek, Little Sarasota Bay, Florida.—Dall. Recent from Long Key, Gulf of Mexico; Galveston, Texas.—Conrad. Recent from Porto Rico.—Dall. Recent from Vera Cruz, Mexico.—Baker. Recent from Tampico, Mexico.—Hinkley. Recent from Florida.—C. U. Museum. Bull. 37, U. S. Nat. Mus., gives the range of *A. lienosa* Say, recent, as from Hatteras to Trinidad. This is *A. sesticostata*.

Arca dodona Dall

Plate VIII, Figures 6, 7, 8, 9, 10

Scapharca (*Scapharca*) *dodona* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 640, pl. 31, figs. 1, 8, 8a, 1898.

Arca (*Scapharca*) *dodona* Maury, Bull. Am. Pal., vol. 3, p. 375, 1902.

"Shell small, solid, inequilateral, inflated, and rounded in front, pointed and attenuated behind; with mesially impressed, prosocelous beaks; left valve with thirty-six squarish radial ribs, each with a deep central groove longitudinally, the portions on each side with a shallower longitudinal sulcus, so that each rib, except in young shells, is composed of four threads set in two pairs; the ribs separated from each other by channelled interspaces about half as wide as the ribs; concentric sculpture of numerous rather close set, regular, blunt, elevated lines, which appear on the riblets as fine undulations; beaks at the anterior third; cardinal area, with a raised margin, lozenge-shaped, rather wide, slightly narrower behind the beaks, with about four rather wavy sets of concentric grooves; hinge-line short, solid, the teeth not interrupted, larger distally, the most anterior tending to break up into granulations, about fifty in all, subvertical, shorter in the middle of the hinge; margins of the valve deeply fluted; right valve with wider interspaces and narrower, often tripartite, ribs. Lon. 40, alt. 28, diam. 30 mm.

"This fine shell has a neat and elegant surface sculpture, and is one of several which the Oak Grove marl contains and which appear to be new."—Dall, 1898.

The ornamentation of this species closely resembles that of *A. subrostrata*. The interspaces are narrower in *A. dodona*. Otherwise the two species are distinct. In *A. subrostrata* the posterior part is not so attenuate, the hinge is proportionately shorter, even in the largest specimens of *A. dodona* there is no gap in the hinge teeth as in the older specimens of *A. subrostrata* and the posterior margin of *A. dodona* makes a decided angle with the hinge-line, which is not the case in *A. subrostrata*. In general form *A. dodona* resembles *A. santarosana*, but it is proportionately longer and the ribbing is different.

Dimensions.—Lon. +17,-34; alt. +7,-27; diam. 35 mm. This is an unusually large specimen.

Occurrence.—Oligocene marl of Oak Grove, Santa Rosa County, Florida.—Dall. Oligocene of Oak Grove, Florida.—C. U. Museum.

Arca santarosana Dall

Plate IX, Figures 1, 2, 3

Scapharca (*Scapharca*) *santarosana* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 641, 642, pl. 31, figs. 2, 10, 1898.

Arca (*Scapharca*) *santarosana* Maury, Bull. Am. Pal., vol. 3, p. 375, 1902.

"Shell small, short, plump, rostrate, with moderately elevated, mesially sulcate prooccelous beaks; left valve with thirty elevated, squarish, radial ribs, separated by slightly narrower channelled interspaces; the ribs on the posterior slope are low, smaller, and nearly smooth; those on the middle of the shell have mostly near the margin a shallow mesial sulcus; in those still more anterior the sulcus is deeper and wider, dividing each rib over most of its length into two more or less rounded riblets; concentric sculpture of regularly spaced elevated lines, which on the ribs appear as prominent ripples; right valve having the ribs narrower and less strongly sculptured, and the sulci less distinct; cardinal area short, with about three concentric grooves; beaks within the anterior fourth; hinge-line short, with about fifty-seven rather irregular, closely adjacent, nearly vertical teeth, longer and more oblique distally; margins strongly fluted; base flexuous, posterior end narrow, pointed, without any marked angle at the end of the hinge-line. Lon. 36.5, alt. 28, diam. 28 mm.

"This species is most nearly related to *A. staminata* Dall, from which it can be distinguished especially by its lower beaks, more oblique posterior slope, more flexuous base, and attenuated posterior end."—Dall, 1898.

Ribs twenty-eight to thirty-two; some of the specimens from Bailey's Ferry are short and have a wide cardinal area with many grooves. The beaks are more anterior and more sulcate than in *A. staminata*. This species somewhat resembles a variety of *A. staminea* from Patuxent River, Maryland, but the latter is less nodulous on the central and anterior portions and the ribs on the umbonal ridge are striated.

Dimensions.—Lon. +9,-24; alt. +7,-20; semidiam. 14 mm.

Occurrence.—Oligocene of the Chipola River marl, of the lower bed at Alum Bluff,

of the Sopchoppy limestone, and of the Oak Grove sands, Santa Rosa County, Florida.—*Dall*. Oligocene of Oak Grove and Bailey's Ferry, Florida.—*C. U. Museum*.

Arca staminata Dall

Plate IX, Figures 4, 5, 6

Scapharca (*Scapharca*) *staminata* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 641, 642, pl. 31, figs. 11, 13, 1898.

Scapharca staminata Maury, Bull. Am. Pal., vol. 3, pp. 369, 372, 1902.

"Shell of moderate size, plump, rhombic, with well-elevated, hardly sulcate, slightly prosocœlous beaks, situated in the anterior third of the length; left valve with twenty-eight or twenty-nine radial ribs, the posterior of which are smooth and almost rounded; those on the middle of the valve are squarish, with wider channelled interspaces, and rippled or furnished with transverse nodulation above, which grows stronger and more crowded anteriorly; the ribs are not sulcate or dichotomous, and hardly differ on the two valves; hinge-line straight, rather long, and with conspicuous angles at the ends; anterior end of the valve rounded, base nearly parallel with the hinge-line, posterior end somewhat produced; beaks narrow, cardinal area with from three to five sets of lozenge-shaped groovings; hinge strong, the teeth in two adjacent series, somewhat oblique, smaller mesially, at the anterior end of the hinge sometimes more or less broken into granules; inner margin of the valves fluted, interior radially striate. Lon. of a large valve 47, alt. 37 mm.; lon. of figured shell 39, alt. 30, diam. 28 mm.

"This species differs from *A. santarosana*, which occurs in the same beds, by its more rhombic form, proportionately longer hinge-line, and unsulcate ribs. It is also a larger and less elegantly sculptured shell. *A. staminea* Say, of which *staminata* may prove to be an Oligocene race, has a proportionately longer hinge-line, is more sharply truncate behind, and more obliquely rounded in front, the beaks are less elevated and wider, the ribs anteriorly are only sparsely and feebly nodular, while the aspect of the whole shell is less elegant."—*Dall*, 1898.

Ribs twenty-six to thirty.

Dimensions.—Lon. +16, -33; alt. +8, -30; diam. 42 mm.

Occurrence.—Oligocene of the lower bed at Alum Bluff, and perhaps at Roberts, Escambia County, Florida.—*Dall*. Oligocene of the lower bed at Alum Bluff, and Bailey's Ferry, Florida.—*C. U. Museum*.

Arca staminea Say

Plate IX, Figures 7, 8, 9, 10, 11, 12, 13

Arca staminea Say, Am. Conch., 4, pl. 36, fig. 2, 1832.

Arca elevata Conrad, Fos. Med. Tert., no. 1, cover, 1840.

Arca callipleura Conrad, Fos. Med. Tert., pp. 54, 56, 59, pl. 29, fig. 2, 1840.

Arca triquetra Conrad, Acad. Nat. Sci. Phila., Proc., vol 1, p. 305, 1843; Fos. Med. Tert., p. 59, pl. 31, fig. 2, 1845.

Scapharca (*Arca*) *callipleura* Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 579, 1863.

Scapharca (*Arca*) *triquetra* Conrad, l. c., p. 580.

Scapharca (*Scapharca*) *staminea* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 642, 657, 658, 1898.

Arca (*Scapharca*) *staminea* Glenn, Maryland Geol. Surv., Miocene, pp. 386, 387, 390, pl. 105, figs. 2-6, 1904.

"Shell thick, prominently convex; with about twenty-eight ribs which are rounded and narrower than the intervening spaces, excepting on the anterior side, where they are broader, and simply wrinkled, those of the anterior part of the disk have one or two longitudinal impressed lines; they are crossed by numerous transverse, elevated lines, which are hardly more distant from each other than their own width; intervening spaces wrinkled: *beaks* distant, curved a little backward, and the tip a little behind the middle of the hinge margin: *area* flattened, a little curved, rather spacious, with obvious impressed, oblique lines: *hinge margin* rectilinear, with small, numerous teeth: *posterior margin* regularly arcuated: *base* subrectilinear, very deeply crenated: *anterior margin* oblique, rectilinear: *anterior side* abruptly compressed * * *.

"It seems to be related to some of the varieties of *A. granosa*, L.; but the ribs are more slender; the apex is curved a little backward, &c."—Say, 1832.

In Say's description posterior and anterior are interchanged. Anterior part of the shell inflated, posterior sharply flattened, forming almost a right angle with the rest of the shell; between the anterior inflation and umbonal ridge the shell is flattened and often shows a wide, shallow sulcus which increases toward the ventral margin; outline rhomboidal, anterior margin rounded, basal nearly straight and parallel to the hinge-line or somewhat sinuate posteriorly, posterior margin nearly straight, forming a sharp angle with the hinge-line and almost a right angle with the ventral margin; ribs twenty-six to thirty, commonly about twenty-seven; anterior ribs often divided by a shallow sulcus, ribs about the umbonal ridge often with two or more longitudinal sulci producing a striated appearance; ligament area wide, with five or six concentric furrows usually; teeth often irregular at both ends of the hinge.

It is apparent that Conrad's *A. elevata* is the same as *A. staminea* Say. Glenn (Maryland Geol. Surv., Miocene, p. 388), says, "A careful comparison of what are doubtless the type specimens of *A. callipleura* shows that it is but a short, elevated, thickened and well sculptured form of *A. staminea*." *A. triquetra* Conrad is a short, high and little sculptured form of *A. staminea*. Short, high specimens of the species are not uncommon. A long, rounded, well-sculptured variety of *A. staminea* approaches *A. idonea* closely.

Dimensions.—Lon. +16, -32; alt. +11, -30; diam. 44 mm.

Occurrence.—Miocene of Calvert Cliffs, Choptank River and Jones's Wharf, near Centreville, Maryland; of York River, Virginia, and Walton County, Florida.—Dall. Choptank Miocene of Governor Run, two miles south of Governor Run, Flag Pond, Jones Wharf, Cuckold Creek, Turner, Dover Bridge, Peach Blossom Creek, Greensboro, Maryland.—Glenn. Miocene of Choptank River, Governor Run and Patuxent River, Maryland.—C. U. Museum.

Arca idonea Conrad

Plate IX, Figures 14, 15, 16, 17

Arca idonea Conrad, Fos. Tert. Form., p. 16, pl. 1, fig. 5, 1832.*Arca stillicidium* Conrad, l. c., p. 15, pl. 1, fig. 3, (young).*Arca idonea* Conrad, Fos. Med. Tert., p. 55, pl. 29, fig. 3, 1840.*Scapharca (Arca) idonea* Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 579, 1863.*Scapharca (Scapharca) idonea* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 639, 1898.*Arca (Scapharca) idonea* Glenn, Maryland Geol. Surv., Miocene, pp. 387, 389, pl. 106, figs. 1, 2, 1904.

"Cordate, inequivalve, ventricose, and slightly sinuous; ribs about 25, narrow and crenulated; the crenulations most distinct on the larger valve; beaks very prominent and distant; area with undulated grooves; hinge with the series of teeth contracted in the centre, and a little decurved at the ends.

"*Locality.* St. Mary's River. Md. Upper Tertiary."—Conrad, 1832.

Shell large and heavy; ribs twenty-four to thirty-two; ribs on the middle of the shell broad and flat and as wide as or wider than the interspaces, anterior ribs usually narrower than the interspaces, posterior ribs rounded; the anterior ribs and the distal part of the central ribs with a longitudinal sulcus, ribs about the umbonal ridge often with two or more sulci, making them appear striated; interspaces about the umbonal ridge sometimes striated; cardinal area wide, with four to eight, commonly five, concentric grooves on the larger specimens; distal teeth usually irregular in the older specimens; posterior end produced.

This species is related to *A. staminea* from which it differs by its larger size and more rounded form, the posterior side is more produced, the posterior and ventral margins more rounded, the umbonal ridge less angular, the hinge-line is proportionately shorter, the ends of the hinge do not form a conspicuous angle with the anterior and posterior margins, the shell is more evenly inflated, there is only a slight flattening or none anterior to the umbonal ridge, in *A. staminea* the ribs are mostly high and narrow while in *A. idonea* they are broader and flatter, specimens of *idonea* from Maryland have less anterior beaks, but this does not hold true for specimens from Florida.

This abundant species has a wide variation in form. Conrad's type, from St. Mary's River, is short and has only twenty-five ribs. The upper bed at Alum Bluff, Florida, also contains a short form with twenty-five or twenty-six ribs. The ribs are high and square. It resembles *A. staminea* in its little produced, nearly straight posterior margin and beaks nearer the anterior end of the hinge than in the Maryland forms. It is separated from *A. staminea* by its square ribs and rounded umbonal ridge.

The common variety from St. Mary's River, which was described by Conrad in 1840, usually has twenty-nine or thirty ribs and is more produced posteriorly than the type. It is also found at Alum Bluff, Florida.

In the preceding varieties the shell is little, if any, higher posteriorly than near the middle. A variety from the upper bed at Alum Bluff is elongated along the umbonal ridge so that the greatest height of the shell is behind the middle. The anterior margin curves outward a little from the hinge for a short distance, then evenly around to the posterior margin, which is oblique to the hinge. There are twenty-four to twenty-six ribs

which, as in the other varieties from the same locality, are rather nodulous, square, and have only shallow sulci. In general *A. idonea* from Alum Bluff has more anterior beaks than in specimens from Maryland and in this last variety the short anterior and produced posterior parts bring the beaks well within the anterior third. The beaks are little elevated, and are prosogyrate and the cardinal area is wider in front of the beaks than behind, unlike the common variety.

Conrad, himself, in 1840 stated that his species *A. stillicidium* was the young of *A. idonea*. *A. stillicidium* Heilprin, 1881 and 1882 and *stillicidium* Glenn, 1904, are misprints for *A. stillicidium*, and *idoneus* Morton, 1834, is a misprint for *idonea*.

Dimensions.—Lon. +24,-41; alt. +14,-40; diam. 50 mm.

Occurrence.—Typical form from the Miocene of St. Mary's River, Maryland, and the upper bed at Alum Bluff, Florida; the elongated variety with thirty-one ribs from St. Mary's, at Windmill Point, and in Surry County, Virginia, and in the Miocene of Alum Bluff, Florida; a more angular type than either of these from the Miocene of St. Mary's River, Maryland.—*Dall*. St. Mary's Miocene of Cove Point, Langley's Bluff, St. Mary's River, Maryland.—*Glenn*. Miocene of St. Mary's, Maryland, and the upper bed at Alum Bluff, Florida.—*C. U. Museum*.

Arca carolinensis Wagner

Plate X, Figures 1, 2

Arca carolinensis Wagner, *Inst.*, Trans., 5, p. 9, pl. 1, fig. 4. 1847 (*vide Dall*).

Arca Carolinensis Bronn, *Index Pal.*, Nom., p. 93, 1848; *Syst.*, p. 281, 1849.

Not *Noëtia (Arca) Carolinensis* Conrad, *Acad. Nat. Sci. Phila.*, Proc. for 1862, p. 580, 1863.

Not *Barbatia Carolinensis* Conrad, *Kerr's Geol. Rep. N. Car.*, App. A, p. 4, pl. 1, fig. 11, 1875.

Scapharca (Scapharca) carolinensis Dall, *Wagner Free Inst. Sci.*, Trans., vol. 3, pt. 4, pp. 615, 632, 639, pl. 33, fig. 11, 1898.

"Shell large, solid, squarish, moderately inflated, with subcentral, prosocelous, rather elevated beaks; left valve with about thirty 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 channelled; the posterior ribs smaller, rounded, and more closely set; cardinal area short, rather wide, smooth, or longitudinally striate, with three concentric lozenge-shaped groovings; hinge-line short, solid; the teeth not interrupted, strong, about forty-five 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. Lon. 56, alt. 55, diam. 43 mm. (type specimen).

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

Occurrence.—Miocene of North Carolina? Wagner; of York River, Virginia, station 2250; of Duplin County, North Carolina (young).—*Dall*. Miocene of North Carolina.—*C. U. Museum*.

Arca callicestosa Dall

Plate X, Figures 3, 4, 5

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

"Shell of moderate size, rather thin, rhomboidal, with small, prominent, mediusulcate, prosocelous beaks situated at about the anterior third of its length; left valve with about thirty-seven squarish subequal radial ribs, separated by narrower channelled interspaces; on the tops of these ribs are four longitudinal threads, the inner pair larger and more prominent but separated by a somewhat deeper sulcus than those external to the inner threads; concentric sculpture of fine, close, rounded, slightly elevated threads, which overrun the whole shell, ribs, and interspaces, and at short intervals, at the intersection with the inner pair of rib-threads, they become minutely nodulous, while the reticulations have a punctate appearance, giving a surface somewhat like fine lace and peculiar, as far as observed, to this species; cardinal area short, rather narrow, with sharply elevated boundaries and a single incised set of grooves forming a lozenge-shaped figure anteriorly; hinge-line short, teeth in two adjacent series, anterior with fifteen, posterior with twenty-six or twenty-seven 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. Lon. 32, alt. 27, diam. 20 mm. (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 callipleura* 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.

The type specimen is not full-grown. About a dozen valves of this distinct species are in the C. U. Museum. The adult shell has a somewhat more produced posterior end and the cardinal area is wider with several grooves; there are often six riblets nearly equal in size on each rib; besides the characteristic lace like reticulation the anterior ribs usually show a coarser nodulation; on the right valve the ribs from the center of the shell to the umbonal ridge are smoother as in *Cunearca*; ribs thirty-six to thirty-eight.

A single left valve fossil from Nicaragua somewhat resembles this species in form and markings. It is larger and more oblique, the young more inflated, the ribs narrower and the fine reticulation, though present, is inconspicuous except near the umbonal ridge. The shell is labelled *Scapharca holoserica* Reeve, but it is distinct from that species.

Dimensions.—Lon. +17,-33; alt. +5,-35; semidiam. 16 mm.

Occurrence.—Upper bed (Miocene) at Gaskin's Wharf, on the Nansemond River, sixteen miles below Suffolk, Virginia.—*Dall*. Miocene of North Carolina.—*C. U. Museum*.

Arca arata Say

Plate X, Figures 6, 7, 8

Arca arata Say, Acad. Nat. Sci. Phila., Journ., 1st. ser., vol. 4, p. 137, pl. 10, fig. 1, 1824.

Arca arata Conrad, Fos. Med. Tert., p. 58, pl. 30, fig. 6, 1845.

Scapharca (Arca) arata Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 579, 1863.

Scapharca (Scapharca) arata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 643, 644, 645, 1898.

Arca arata Bullen Newton, Geol. Mag., n. s., vol. 9, pp. 304, 305, 1902.

Arca (Scapharca) arata Glenn, Maryland Geol. Surv., Miocene, p. 388, pl. 105, figs. 7a, 7b, 1904.

"Shell transversely oblong, subrhomboidal, with about twenty-six longitudinal ribs; basal edge nearly parallel to the hinge margin, which latter terminates anteriorly in an angle.

"*Ribs* somewhat flattened, as wide or rather wider than the intervening spaces; the whole surface concentrically wrinkled: *umbones* not remarkably prominent: *apices* remote, the intervening space rhomboidal, with continued indented lines, arcuated under the apices: *hinge margin* perfectly rectilinear, angulated at the extremities, the anterior one a little projecting: *teeth* in a continued, uninterrupted line, parallel, excepting at the two extremities of the line, which decline a little, and the teeth are there decidedly longer and oblique with respect to the others of the range: *posterior end* obliquely rounded to the base: *base* nearly rectilinear and parallel to the hinge margin, and deeply crenated on the inner margin: *anterior end* produced below the middle and rounded, and a little contracted near the superior angle.

"Length from the hinge margin to the base one inch and three-tenths, breadth two inches and a half * * *"—*Say*, 1824.

In the original description anterior and posterior and length and breadth are interchanged.

Dimensions.—Small valve, lon. +12,-23; alt. +3,-18; semidiam. 9 mm.

Occurrence.—Miocene of St. Mary's County, Maryland.—*Dall*. St. Mary's formation, St. Mary's River (quite rare).—*Glenn*. St. Mary's, Maryland.—*C. U. Museum*.

Arca improcera Conrad

Plate X, Figures 9, 10, 11, 12, 13, 14, 15, 16

Arca improcera Conrad, Fos. Med. Tert., p. 60, pl. 31, fig. 5, 1845.

Scapharca (Arca) improcera Conrad, Acad. Nat. Sci., Phila., Proc. for 1862, p. 579, 1863.

Arca plicatura (juvenis) Heilprin, Acad. Nat. Sci., Phila., Proc. for 1881, p. 451, 1882.

Scapharca (Scapharca) improcera Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 643, 644, 646, 1898.

"Trapezoidal; disk slightly flattened from beak to base; ribs about 34, square, approximate, little prominent, convex and crenulated anteriorly; anterior margin rounded,

extremity of hinge angulated; basal margin straight or slightly contracted in the middle; posterior margin oblique, emarginate above, extremity rounded; cardinal area narrow, with two or three angulated grooves; series of teeth slightly arched towards the extremities; margin densely crenate.

"Loc. Wilmington, N. C.

"This is probably identical with a recent species of the southern coast, abundant in the Post Pliocene marl of the Potomac river, St. Mary's Co., Md. The Miocene shell is thicker than the more recent specimens."—*Conrad*, 1845.

"This shell should not, in my opinion, be united with *A. plicatura*, as has been done by Heilprin. When properly discriminated it is a smaller and more rhombical shell, with lower and more anterior beaks, and more produced and pointed posterior end; the base and hinge-line are nearly parallel, and the latter is narrower in specimens of the same size than in *A. plicatura*. Both have about thirty-five ribs, but in *A. improcera* these are plain, while in *A. plicatura* the anterior ribs are prettily nodulous.

"*Arca buccula* Conrad (Fos. Med. Tert., p. 60, pl. 31, fig. 4) appears to be a short, heavy, stunted, and abnormally thickened variety of this species, such as might be produced by an unfavorable environment. It is confined to the Upper Miocene marls of Duplin County, North Carolina."—*Dall*.

A. improcera, *A. buccula*, *A. subsinuata*, *A. transversa* and the forms placed by Dall under *A. plicatura* are closely related, are difficult to separate satisfactorily and have been arranged differently by different authors. The synonymy given here for *improcera* and *plicatura* follows Dall. In general the specimens fall into groups corresponding with certain species. Those with a small, thick shell, rather low posteriorly, oblong shape and long hinge may be placed in *A. improcera*. There are short, thick shells from Duplin County, North Carolina, which Conrad called *A. buccula*, (Plate X, Figures 17, 18). *A. transversa* is thinner than *A. improcera* and higher posteriorly. The larger, irregular, rounded shells may all be placed under *plicatura* for convenience. They vary much and grade into both *improcera* and *transversa*. The distinctions Dall has made in the sculpture of *plicatura* and *improcera* will not hold true for all specimens. Some have the discrepant sculpture and the nodulation of *plicatura* and the form of *improcera*. *A. subsinuata* should perhaps be included in *plicatura*. Specimens from the Croatan beds show a variation from the nearly straight base of *subsinuata* to the rounded base of *plicatura*.

Dimensions.—Lon. +10,-18; alt. +3,-15; diam. 16 mm.

Occurrence.—Upper Miocene of Warwick, Virginia; of Duplin County and Wilmington, North Carolina; of Timminsville and Darlington, South Carolina; Pliocene of the Caloosahatchie River and Shell Creek, Florida.—*Dall*. Miocene of Magnolia, North Carolina, and Darlington Church House, South Carolina.—*C. U. Museum*.

Arca plicatura Conrad

Plate X, Figures 19, 20

Arca plicatura Conrad, Fos. Med. Tert., p. 61, pl. 32, fig. 4, 1845; Heilprin, Acad. Nat. Sci. Phila., Proc. for 1881, p. 451, 1882 (*ex parte*).

Arca lineolata Conrad, Fos. Med. Tert., p. 61, pl. 32, fig. 3, 1845; not of Roemer. 1836.

Arca sublineolata Orbigny, Prodr. Pal., 3, p. 125.

Arca æquicostata Conrad, Fos. Med. Tert., p. 60, pl. 31, fig. 6, 1845; Tuomey and Holmes (?), Pleioc. Fos. S. Car., p. 44, pl. 16, figs. 3, 4, 1856.

Arca brevidesma Conrad, Fos. Med. Tert., p. 62, pl. 32, fig. 5, 1845.

Scapharca (Arca) plicatura Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 579, 1863.

Scapharca (Scapharca) plicatura Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 643, 644, 1898.

"Trapezoidal, ventricose; ribs about 31, rounded, approximate, rough with coarse concentric wrinkles; umbonial slope rounded; posterior margin oblique, curved; basal margin slightly tumid posterior to the middle; posterior extremity acutely rounded; series of cardinal teeth narrow, obsolete about the middle of the hinge line; within sulcated.

! Loc. Occurs with the preceding species. [Neuse River, Craven co., N. C.]

"The furrows within corresponding to the ribs are very distinct in this species, and the marginal teeth very long and profound posteriorly."—Conrad, 1845.

"This is a considerably larger species than *A. improcera*, more rounded and with a tendency to nodulation of the ribs. I am somewhat doubtful if the shell figured by Tuomey and Holmes is to be identified with it. It has a very close resemblance to *A. arata* Say, and is much larger than any specimens of *plicatura* I have seen. The sculpture of the two valves in *plicatura* is markedly discrepant, which is not the case in *improcera*. In this, the former more nearly approaches *A. transversa*, but the latter has reverted to the rhombical form of *improcera*.

"* * * This species [*A. transversa*] has the rounded nodulous ribs and discrepantly sculptured valves of *A. plicatura*, with the more rhombic form and solidity of *A. improcera*, with both of which it is doubtless genetically connected."—Dall.

Dimensions.—Lon. +13, -24; alt. +4, -21; diam. 23 mm.

Occurrence.—Upper Miocene of Duplin County, North Carolina, of the Sumter District, South Carolina, and of De Leon Springs, Florida; Pliocene of the Waccamaw beds of South Carolina.—Dall. Pliocene of the Waccamaw beds of South Carolina and the Croatan beds of North Carolina.—C. U. Museum.

Arca subsinuata Conrad

Plate X, Figures 21, 22

Arca subsinuata Conrad, Fos. Med. Tert., p. 62, pl. 32, fig. 6, 1845.

Scapharca (Arca) subsinuata Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 580, 1863.

Scapharca (Scapharca) subsinuata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 645, 1898.

"Subrhomboidal, inequivalved, slightly sinuous, or subreflected posteriorly; disk flattened; ribs about 34, square, little prominent, narrower than the interstices; concentric wrinkles somewhat imbricated; umbonial slope rounded; posterior slope somewhat flattened, not depressed; posterior margin straight, oblique, extremity rounded; basal margin nearly straight; summits prominent, distant; cardinal area with angulated grooves; series of teeth narrow, the teeth fine, interrupted towards the extremities of the series.

"Loc. Near Newbern, N. C."—Conrad, 1845.

This belongs with the larger fossil members of the *A. transversa* group and perhaps should be united with *A. plicatura*.

Dimensions.—Lon. +12, -21; alt. +4, -18; semidiam. 8 mm.

Occurrence.—Pliocene of the Croatan beds, near New Berne, North Carolina.—Dall.
Pliocene of the Croatan beds, N. C.—*C. U. Museum*.

Arca campyla Dall

Plate XI, Figures 1, 2, 3

Scapharca (*Scapharca*) *campyla* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 644, pl. 31, figs. 3, 4, pl. 32, fig. 22, 1898.

"Shell of moderate size, solid, rather rude, the posterior end strongly twisted to the right, the beaks low, and the form somewhat compressed; the umbones are very slightly bent forward, and are situated at about the anterior third; left valve with about thirty low, flat radial ribs, becoming wider and sparser posteriorly, crossed by rather rude incremental lines, but not nodulous or dichotomous, and with subequal, rather shallow channelled interspaces; the right valve is similarly sculptured and somewhat smaller; cardinal area rather long, narrow, with numerous slightly angular, longitudinal grooves; ends of the hinge-line moderately angular, anterior end of shell rounded, posterior produced, base flexuous, inner margins fluted; teeth numerous, small, uninterrupted, nearly vertical, the distal ones larger and tending to break up into granules. Lon. of a large valve 50, alt. 34 mm; of figured specimen, lon. 38, alt. 27, diam. 20 mm.

"This species is one of the most abundant in the Floridan Pliocene, and is easily distinguished from any other by its compressed appearance and twisted shape. Some of the allied species have a slight flexuosity, but in none is this feature so pronounced as in *A. campyla*. A variety with thinner shell and narrower and slightly more elevated ribs was at first thought to be distinct, and may be named var. *arctica*."—Dall, 1898.

Occurrence.—Pliocene of the Caloosahatchie, Shell Creek, Alligator Creek, and Myakka River, Florida.—Dall.

Arca transversa Say

Plate XI, Figures 4, 5, 6

Arca transversa Say, Acad. Nat. Sci. Phila., Journ., 1st. ser., vol. 2, p. 269, 1822.

Arca transversa Gould, Invert. Mass., p. 96, 1841.

Arca transversa De Kay, Nat. Hist. N. Y., vol. 5, p. 177, pl. 12, fig. 212, 1843.

Scapharca (*Scapharca*) *transversa* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 643-646, 659, 1898.

Not *Arca transversa* Portlock, Rep. Geol. Londonderry, p. 428, pl. 34, fig. 4, 1843.

Not *Cucullæa transversa* Rogers, Am. Phil. Soc., Trans., vol. 6, p. 373, pl. 29, fig. 1, 1839, = *A. (C.)*

Rogersiana Nyst, Tabl. Synopt. Arcaécés, p. 63, 1848, *vide* Dall, = *A. Rogersi* Heilprin, Acad. Nat. Sci. Phila., Proc. for 1881, p. 449, 1882.

"Shell transversely oblong, rhomboidal, with from thirty-two to thirty-five ribs, placed at nearly the length of their own diameters distant from each other; apices separated by a long narrow space, and situate at the termination of the posterior third of

the length of the hinge margin; extremities of the hinge margin angulated; anterior edge, superior moiety rectilinear; posterior edge rounded; inferior edge nearly rectilinear, or very obtusely rounded; on the hinge space one or two angulated lines are drawn from the apex, diverging to the hinge edge * * *,'—Say, 1822.

The name *transversa* arose from the fact that Say interchanged length and height and anterior and posterior.

Shell inequivalve; ribs thirty to thirty-five, those on the left valve entire, high, narrow, rounded and irregularly nodulous, those on the right valve broader and flatter anterior to the umbonal ridge; beaks mesially sulcate; cardinal area narrow with two or three v-shaped grooves; posterior margin of the cardinal area elevated; hinge narrow; teeth fine at the center, longer and more oblique distally where the ends of the series curve downward; anterior margin rounded, basal margin rounded or nearly straight, posterior margin rounded below, nearly straight above with an angle at the hinge; inner margin fluted; epidermis brown.

A. transversa var. *busana* Harris, (Bull. Am. Pal., vol. 1, no. 3, p. 6, 1895), is from the Deep Well of Galveston, Texas. It is longer and less inflated than the usual form.

Shells from the Pleistocene of New Orleans, Louisiana, are larger and more irregular than the recent *transversa*, but are not so large as shells of this group from the Waccamaw beds of South Carolina which have been placed under *A. plicatura*.

A. transversa Portlock was renamed *A. Portlocki* by Deshayes. It has been placed in *Ctenodonta*.

Dimensions.—Lon. +8,-17; alt. +2.5,-15; diam. 14 mm.

Occurrence.—Pliocene of Myakka River and De Land, Florida; Pleistocene of North Creek, Little Sarasota Bay, Florida; of Simmons Bluff, South Carolina, Wailes Bluff, Maryland, and Sconset, Rhode Island. Recent from Cape Cod south to Key West, Florida, and southwest to Vera Cruz and the Gulf of Campeachy, Mexico, in shallow water. * * * It is not known below the Upper Pliocene.—*Dall*. Pleistocene from New Orleans, Chenier, Knapp's Wells, Gymnasium Well and Lydia, Louisiana, and of Wailes Bluff, Maryland; recent from Cameron and Point-au-Fer, Louisiana, Galveston, Texas, Ft. Barrance, Florida, and from Aspinwall.—*C. U. Museum*.

Arca triphera Dall

Plate XI, Figure 7

Scapharca (*Scapharca*) *triphera* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 648, pl. 33, fig. 6, 1898.

"Shell subequivalve, of moderate size, elongate, not much inflated, subrectangular, with low beaks slightly prosocœlous and marked by a conspicuous wide mesial sulcation; umbones situated at the anterior third of the length; left valve with about thirty-eight rounded subequal ribs separated by narrower interspaces; in the adult about a dozen of the anterior ribs may be squared off and deeply mesially sulcate near the margin, while a few of the ribs on the posterior dorsal slope are narrower, smoother, and more widely separated; transverse sculpture of elevated lines which are somewhat regularly spaced, and

in crossing the ribs develop into sharp, thick transverse nodulations; cardinal area very narrow and with an elevated margin behind, slightly wider in front of the beaks longitudinally striate; ends of the hinge-line angular; anterior end bluntly rounded, base parallel with the hinge-line, posterior end subtruncate, a little produced below; hinge with numerous rather crowded subvertical teeth in an uninterrupted series; inner margin of the valves deeply fluted. Lon. of largest valve 28, alt. 14; of younger valve 18, alt. 8.5, diam. 7 mm.

"The larger valves of this rare species are distorted or worn so that a younger one has been selected for figuring. The most conspicuous feature of the shell is the deep sulcation of the beaks, which gives them a bilobed appearance."—Dall, 1898.

Occurrence.—Pliocene marls of the Caloosahatchie River, Florida.—Dall.

Gabb described *Arca Chiriquiensis* from the Tertiary of Chiriqui, Central America (Acad. Nat. Sci. Phila., Proc. for 1860, p. 567, 1861). Later, (Acad. Nat. Sci. Phila., Journ., 2d. ser., vol. 8, pp. 345 and 378), he placed this species, together with fossils from St. Domingo and Costa Rica and Sowerby's *A. patricia* (Quart. Journ. Geol. Soc. Lond., vol. 6, p. 52, 1850) from St. Domingo, all under *A. grandis* Broderip and Sowerby, (Zool. Journ., vol. 4, p. 365; Reeve, Conch. Icon., *Arca* no. 4, 1843). Dall, (Wagner Free Inst. Sci., Trans., vol. 3, p. 642), calls the Chiriqui and St. Domingo fossils Oligocene and separates them from *grandis* under the name *Scapharca (Scapharca) chiriquiensis* Gabb. He says that the species "has about thirty rounded ribs with subequal channelled interspaces, the anterior ribs being granulose or nodiferous, the shell remarkably high, short, solid, and wide. The measurements of a well-grown specimen are: alt. 42, lon. 45, and diam. 44 mm.; the length of the cardinal area is 28 mm. It is one of the species on the border line between *Scapharca* and *Anadara*, the two valves being similarly sculptured and almost equal."

Evidently at least two species of fossil shells have been confused here. In the Gabb collection from St. Domingo there are two valves as large and heavy as specimens of *A. grandis* from the west coast. These fossils do not show enough variation from the recent form to warrant placing them in a separate species. There are a few small valves, the largest 23 mm. long, of a short, well-sculptured *Scapharca* which are distinct from the young of *A. grandis*. They are short and high like *A. chiriquiensis*, but unlike this, the left valve is more nodulous than the right, conspicuous nodules extending over nearly the entire valve, and the ribs of the left valve are square and wider than the interspaces. There are also from St. Domingo two worn valves which resemble the young of *A. grandis* in form but appear to be a separate species. The lack of figures of *A. patricia* and *A. chiriquiensis* has added to the confusion.

Scapharca (Scapharca) halidonata Dall; Plate XI, Figure 8; (Wagner Free Inst. Sci., Trans., vol. 3, p. 646, pl. 33, fig. 24, 1898), from the Bowden beds, Jamaica, and of Curaçao is of the general type of *A. secticostata* but is proportionately much shorter. The fossil *A. consobrina* Sowerby; Plate XI, Figures 9, 10; (Quart. Journ. Geol. Soc. Lond., vol. 6, p. 52, pl. 10, fig. 12, 1850), from St. Domingo also belongs to the group of which *A. secticostata* is the recent representative. The name *consobrina* had already been used

by d'Orbigny for a French fossil (Pal. Française, Terrains Crétacés, vol. 3, p. 209, pl. 311, figs. 4-7, 1844). In the Gabb collection from St. Domingo are shells of another species with the general form of this group but ribbing like that of *A. aresta* and *A. campsa*.

Arca inequilateralis Guppy; Plate XI, Figures 11, 12; (Quart. Journ. Geol. Soc. Lond., vol. 22, p. 293, pl. 18, figs. 2a, 2b, 1866; Schuchert, U. S. Nat. Mus., Bull., no. 53, p. 56, 1905), from the Oligocene of Bowden, Jamaica, is referred to the group *Scapharca* by Dall, who says, "This species is closely related to *A. latidentata* Dall, * * * but may be distinguished from it at once by the shorter, more delicate, and much more numerous hinge-teeth of the Jamaica shell. The latter is also thinner and more elegant in sculpture and less inflated. It somewhat resembles the young of *A. hypomela* Dall and *A. floridana*."

Scapharca (Scapharca) actinophora Dall; Plate XI, Figure 13; (Wagner Free Inst. Sci., Trans., vol. 3, p. 647, pl. 33, fig. 26, 1898), from the Oligocene of Monkey Hill, Panama Railway, is a long shell with beaks in the anterior fourth, about forty entire ribs, arcuate base and narrow, attenuated and rounded posterior end.

Scapharca (Scapharca) donacia Dall; Plate XI, Figure 14; (Wagner Free Inst. Sci., Trans., vol. 3, p. 649, pl. 33, fig. 13, 1898), from the Oligocene of Bowden, Jamaica, is a small, donaciform shell (6.8 mm. long), with about twenty-four smooth, entire ribs and attenuated posterior end.

Dall lists *A. auriculata* Lamarck; Plate XI, Fig. 19; (An. s. Vert., vol. 6, p. 43, 1819; Reeve, Conch. Icon., *Arca* no. 35, pl. 6, 1844), under the section *Scapharca* and gives its occurrence as follows:—?Oligocene of Bowden, Jamaica; Pliocene of Limon, Costa Rica; Pleistocene of the Antilles; Recent from Key West to Martinique, in fifteen to forty fathoms.

A. Deshayesii Hanley; Plate XI, Figures 15, 16, 17, 18; [Ill. Cat. Biv. Shells, p. 157, 1842, (Dall, Moll. Porto Rico, Bull. U. S. Fish Comm. for 1900, vol. 20, pt. 1, p. 461, 1901); Reeve, Conch. Icon., *Arca* no. 47, pl. 7, 1844] is found recent in the West Indies and has been reported fossil from the mainland of southern North America. Dall lists it recent from Pernambuco, (Wash. Acad. Sci., Proc., vol. 3, p. 141, 1901). It has about twenty-seven narrow, rounded and finely nodulous ribs, the anterior with a median groove; epidermis brown, thick, scaly between the ribs with bristles near the umbonal ridge. The shell is practically equivalve and is as near *Anadara* as *Scapharca*. The young is auriculate behind and has evidently been confused with *A. auriculata* Lamarck. Dautzenberg, (Mém. Soc. Zool. France, vol. 13, p. 236, 1900), unites the *A. hemidermos* Philippi of d'Orbigny, (Hist. Isla Cuba, pt. 2, vol. 5, Moll., p. 345), with *Deshayesii*.

Arca Websteri Pilsbry (Acad. Nat. Sci. Phila., Proc., vol. 62, p. 488, 1910), appears to be a *Scapharca*. It is from the Oligocene of Haiti. There is also an *Arca* sp. undet. from the same place, (l. c., p. 489).

Section *Anadara* Gray

"Group of *A. antiqua* L. (*Anadara* (Gray, 1847) Adams, 1858, in synonymy, — *Anomalocardia* Adams, 1858, not of Schumacher, 1817).

"Shell heavy, trigonal or oblong, inflated, with prosocelous beaks, with a wide area

wholly covered by the ligament and usually with numerous furrows for the resilium forming concentric lozenges; teeth similar, in a long, uninterrupted series, slightly larger and more oblique distally; valves equal and similarly sculptured; epidermis usually pilose and profuse.

"The young shell is often and the adult sometimes auriculate behind. The transition to *Scapharca* s. s. is very gradual and complete."—Dall, 1898.

Arca subrostrata Conrad

Plate XII, Figures 1, 3, 3, 4

Arca subrostrata Conrad, Acad. Nat. Sci. Phila., Proc., vol. 1, p. 30, 1841; Journ., 1st. ser., vol. 8, pt. 2, p. 185, 1842; Fos. Med. Tert., p. 58, pl. 30, fig. 7, 1845.

Not *Arca subrostrata* Sowerby, Quart. Journ. Geol. Soc. Lond., vol. 3, pp. 413, 418, pl. 15, figs. 8, 9, 1847.

Scapharca tenuicardo Conrad, Am. Journ. Conch., vol. 5, p. 39, pl. 2, fig. 4, 1869.

Scapharca (Arca) subrostrata Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 580, 1863.

Scapharca (Anadara) subrostrata Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 655, 1898.

Arca (Scapharca) subrostrata Glenn, Maryland Geol. Surv., Miocene, p. 385, pl. 104, figs. 2, 3a, 3b, 1904.

"Ovate; profoundly ventricose; ribs about 30, little prominent, flat, longitudinally sulcated; posterior side produced, cuneiform; rounded at the extremity; hinge linear in the middle, teeth obsolete, except towards the extremities; within slightly sulcated; crenulations of the margin sulcated in the middle. Length 2 inches."—Conrad, 1841.

Shell slightly inequivalve; beaks mesially sulcate; ribs twenty-nine to thirty-two, each rib with a longitudinal sulcus and usually a shallower sulcus on each side of this, dividing each rib into four riblets, sometimes more than four riblets posteriorly; central ribs sometimes nodulous; interspaces usually narrower than the ribs; cardinal area with five to eight concentric grooves; hinge-line short; older shells with central teeth obsolete and distal teeth irregular. In the ribbing this species resembles *A. dodona*, but otherwise the two species are distinct. It is evident that *Scapharca tenuicardo* Conrad, is a synonym of *A. subrostrata*. This is one of the species that show the close relation between the sections *Scapharca* and *Anadara*. The young has the characters of *Scapharca*, but the old shell shows some of the characters of *Anadara*. It is placed by Dall in the latter group.

Dimensions.—Lon. +15,-35; alt. +7,-29; semidiam. 14 mm.

Occurrence.—Miocene of Maryland in Talbot and Calvert Counties, at Calvert Cliffs, Skipton, Centreville, Plum Point, and other localities. A single valve, stated to be from the Miocene of North Carolina, is in the National Museum.—Dall. Calvert Miocene of Chesapeake Beach, 3 miles south of Chesapeake Beach, Plum Point, Truman's Wharf, White's Landing, Church Hill, 3 miles West of Centreville, Reed's Wye Mills, near Skipton.—Glenn. Miocene of Plum Point and Chesapeake Landing, Maryland.—C. U. Museum.

Arca elnia Glenn

Plate XII, Figures 5, 6

Arca (Scapharca) elnia Glenn, Maryland Geol. Surv., Miocene, p. 386, pl. 104, figs. 4a, 4b, 1904.

"Shell large, moderately thick, but slightly elongated, not inflated, with prominent prosocœlous beak; cardinal area wide, with numerous irregular, zigzag, longitudinal grooves, bounded by a single deep curved groove from the beak to the ends of the hinge-line; hinge-line narrow; teeth small, obsolete medially, tending to become irregular at both ends of the series; right valve with about thirty-one low ribs hardly as wide on anterior dorsal slope as intervening spaces, broader and more elevated on posterior dorsal slope; each rib mesially sulcated by a groove with one or more subordinate grooves on either side; growth lines distinct; margin a continuous curve from anterior end of hinge line to posterior end of base, there sharply curved; posterior margin oblique to hinge line; interior margin crenulated; dorsal and posterior slopes meet in an angle that becomes rounded near the basal margin.

"This species seems to be intermediate between *A. staminea* and *A. subrostrata*, being perhaps more nearly related to the latter.

"Length, 60 mm.; height, 48 mm.; diameter, 22 mm."—*Glenn*, 1904.

Occurrence.—Choptank Miocene of Jones Wharf, lower bed at Governor Run, 2 miles south of Governor Run, Maryland.—*Glenn*.

Arca clisea Dall

Plate XII, Figures 7, 8

Scapharca (Anadara) clisea Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 657, pl. 33, fig. 25, 1898.

Arca (Scapharca) clisea Glenn, Maryland Geol. Surv., Miocene, p. 386, pl. 105, fig. 1, 1904.

"Shell large, heavy, inflated, short, with small, high, somewhat prosocœlous beaks, the two halves of the wide cardinal area inclined to one another in the adult at an angle of about forty-five degrees; left valve with about thirty strong, flattened subequal radial ribs with narrower interspaces; in the young the ribs are furnished with small transverse nodulations, which gradually become obscure in the adult; the only transverse sculpture is of the ordinary incremental lines; the ribs in the adult are flat topped and rarely show any tendency to mesial sulcation, and when present it appears only on a few of the anterior ribs near the margin; the anterior end is obliquely rounded to the base, the posterior end a little produced basally; the cardinal area is exceptionally wide, with a single impressed line joining the beaks and six or seven concentric lozenges defined by sharp grooves; a deep groove also bounds the area; hinge-line straight with numerous small vertical teeth, becoming much larger distally and tending to break up into granules at both ends of the series in the senile shell. Lon. 51, alt. 53, diam. 53 mm.

"This shell is apparently related to *A. callipleura* and *A. staminea* Conrad, and a larger series of specimens may oblige us to unite all three as varies of a single species. At present, however, the differences seem too great to admit of this course. In *A. callipleura* the ribs are granulated and triply sulcate, while in the present form they are simple. *A. clisea* has no posterior truncation like that figured by Conrad in *A. callipleura*. *A. staminea* is more squarely compressed before and behind, with a tendency

to incurvation of the posterior basal margin; it is a smaller shell with more posterior beaks, and less roundly inflated. We have a large series of this species from many localities, and these differences characterize them all. The forms are easily differentiated, so far as our present knowledge goes, and therefore are better kept apart. In all the pairs of *A. staminea* in the collection the right valve is distinctly smaller than and fits into the other, while in *A. disca* the margins meet evenly."—*Dall*, 1898.

Glenn thinks this shell is more closely related to *A. idouca* than to any other. Some of the short, high forms of *A. staminea* approach *A. disca*. A left valve from Evergreen, Virginia, which resembles *A. disca* is related to *A. staminea*, but is well rounded instead of angular. The specimen figured is related to *idouca*.

Occurrence.—Chesapeake Miocene of Maryland, and at St. Mary's River and Crisfield; of Nomini Cliffs, Virginia; and of Walton County, Florida.—*Dall*. St. Mary's Miocene of St. Mary's River, Crisfield well at depth of 140 feet.—*Glenn*. Miocene of North Carolina.—*C. U. Museum*.

Arca aresta Dall

Plate XII, Figures 9, 10, 11

Scapharca (Anadara) aresta Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 638, 655, pl. 33, fig. 2, 1898.

"Shell of moderate size and thickness, arcuate below, straight above, with small but prominent prosocelous beaks, left valve with twenty-seven square-topped, narrow, entire radial ribs, separated by wider interspaces; the ribs on the middle of the shell are somewhat narrower than the others; all are crossed by evenly spaced, moderately prominent elevated lines, festooned in the interspaces, and forming small, square ripples on the ribs; both valves similarly sculptured; cardinal area narrow, with elevated margins behind, wider and short in front of the beaks; the portion in front of the beaks is longitudinally striated, behind the beaks there are three or four concentric, lozenge-shaped groovings; a single transverse groove usually passes between the beaks; hinge-line straight; teeth in two nearly equal series, overlapping a little proximally, the teeth rather crowded and nearly vertical; base of the valves arcuate, rounded into the anterior end, posterior end a little produced; internal margins of the valves fluted. Lon. 41, alt. 28, diam. 26 mm.

"This very neat and distinct species appears to be the most common Ark in the upper or Miocene bed at Alum Bluff."—*Dall*, 1898.

Ribs twenty-four to twenty-nine, usually twenty-seven; beaks mesially sulcate. The prominent characters of this species are the broad, rounded and festooned interspaces, the narrow, square-topped ribs and the unusual form. The anterior and posterior extremities are both nearer to the hinge-line than to a parallel line through the lowest point of the base; the posterior portion is often attenuated, but in young specimens this part is relatively broader and more evenly rounded; the greatest inflation is anterior to the middle of the shell.

Dimensions.—Lon. +15,-31; alt. +6,-24; diam. 32 mm.

Occurrence.—Chesapeake Miocene of Alum Bluff, Calhoun County, Florida.—*Dall*. Miocene of the Upper bed at Alum Bluff, Florida.—*C. U. Museum*.

Arca campsa Dall

Plate XII, Figure 12; Plate XIII, Figures, 1, 2, 3

Scapharca (Anadara) campsa Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 656, pl. 32, fig. 21, 1898.

"Shell of moderate size, solid, and heavy, with a straight and angulate upper margin, obliquely rounded anterior, produced posterior, and arcuate basal margin; beaks low, much incurved, mesially impressed, and rather anterior; left valve with about twenty-two narrow ribs separated by wider interspaces, crossed by little elevated, regularly spaced incremental lines; the ribs are not nodulous, the anterior ones are flattish or rarely have a shallow sulcus mesially near the margin; they are subequal, but in specimens in which the mesial depression of the valve is especially strong, the ribs included in it are narrower and closer together than usual; hinge-line nearly as long as the shell, angular, but not auriculate distally; the beaks are within the anterior third; cardinal area wider in front, narrow behind, longitudinally striated with a few grooves which circumscribe a 'stemmed' arrow-head figure, few of them reaching as far forward as the beaks; teeth in two adjacent series, the anterior shorter with a pronounced thickening of the shell below it, over the vertical face of which the teeth extend rather irregularly or are supplemented by denticular wrinkles; posterior series longer, numerous, vertical, distally much wider, and more or less oblique; interior margin of the valves with strong, short flutings. Lon. 47; alt. 28; diam. 27 mm.

"This is quite a peculiar species, the teeth of which recall *Argina*, while all the other characters of the shell indicate its section to be *Anadara*, another instance, if one were needed, to illustrate the mutability of the dental forms in this family. It cannot be confounded with any of our other species."—*Dall*, 1898.

Ribs twenty-one or twenty-two; cardinal area with margin elevated behind the beaks; the mesial sulcation of the beaks passing over the umbo and down to the ventral margin as a broad flattening or sulcation. This shell is distinguished by its wide, rounded interspaces and narrow, square-topped ribs crossed by elevated lines as in *A. aresta* and by its mesial depression. In a pair of valves which belong together this depression is more marked on the left valve.

Dimensions.—Lon. +16,-36; alt. +6,-25; diam. 29 mm. Dimensions of a large valve, lon. 64, alt. 43 mm.

Occurrence.—Chesapeake Miocene or upper bed at Alum Bluff, Florida.—*Dall*. Miocene of the upper bed at Alum Bluff, Florida.—*C. U. Museum*. Dr. Maury lists this species from the Oligocene of Alum Bluff, but the specimens listed prove to have come from the upper bed.

Arca rustica Tuomey and Holmes

Plate XIII, Figures 4, 5

Arca rustica Tuomey and Holmes, Pleioc. Fos. S. Car., p. 39, pl. 15, fig. 1, 1857.Not *A. rustica* Contejean, 1859 (*vide* Dall).*Scapharca (Arca) rustica* Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 580, 1863.*Arca crassicosta* Heilprin, Wagner Free Inst. Sci., Trans., vol. 1, p. 96, pl. 13, fig. 30, 1887.*Arca crassicosta* Dana, Man. Geol., 4th. ed., p. 900, fig. 1508, 1895.*Scapharca (Anadara) rustica* Dall, Wagner Free Inst. Sci., Trans., vol. 3, p. 653, pl. 31, figs. 6, 9, 1898.

"A. testa crassa, sub-quadrata, radiatim costata; costis sub-squamosis; latere buccali brevioribus, costis crenatis; latere anali carinato, angulato, truncato, costis majoribus; umbonibus inter se fere contingentibus.

"Shell thick, somewhat square, radiately, and unequally ribbed; ribs almost squamose; buccal side very short, ribs crenate; anal side carinate, angular, truncate, ribs very large; ligament area narrow, umbones nearly touching.

"This fossil is readily distinguished by the coarse ribs and deeply excavated interstices on the anal side. The margin is strongly crenulated * * *."—*Tuomey and Holmes*, 1857.

"The collection of more material since Professor Heilprin's publication leaves no doubt whatever as to the identity of this splendid species with that of Tuomey and Holmes. It seems to be characteristic of the southern Pliocene. The beaks are much incurved and distinctly prosocelous, the cardinal area short and wide in front of them, long and narrow with much elevated margins behind; the anterior part of the area is transversely grooved at right angles to the hinge-line; the posterior part has converging grooves, thus forming three or four concentric triangles. The hinge is composed of a short anterior and long posterior series of subequal vertical teeth vertically striated on their flat surfaces; there are over forty teeth, of which twelve are anterior; the two series are closely approximated. Many of the specimens have a strong posterior auriculation which is more prominent in the young; one specimen measures thirty-two millimeters on the hinge-line and twenty-eight millimeters below the auriculation. An adult measures fifty-three millimeters long, thirty-six millimeters high, and forty millimeters in diameter. The largest valve obtained is seventy-one millimeters long and has fifty-four posterior and seventeen anterior teeth. In this specimen there are nine longitudinal grooves, and the three or four middle ones are extended in front of the beaks, contrary to the rule in younger specimens, giving the grooved area as a whole the form of a long, narrow "stemmed" arrow-head. In this valve the hinge-line is sixty millimeters long and the vertical of the beak is ten millimeters from the anterior end.

"On the whole, this is one of the finest and most striking species in our whole Tertiary fauna."—*Dall*.

Ribs seventeen to twenty-two, large and coarse near the umbonal ridge, smaller and more closely set anteriorly and posteriorly. Several Old World fossil species have been called *A. rustica* since Tuomey and Holmes used the name.

Dimensions.—(Small valve), lon. +10,-36; alt. +5,-29; semidiam. 18 mm.

Occurrence.—Pliocene of the Waccamaw beds of South Carolina; and of the Caloosahatchie, Shell Creek, Alligator Creek, and Myakka River, Florida.—*Dall*. Pliocene of Shell Creek, Florida.—*C. U. Museum*.

Arca catasarca Dall

Plate XIII, Figure 6

Scapharca (Anadara) catasarca Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 654, pl. 32, fig. 20, 1898.

"Shell elongate, solid, subrhomboidal, with very anterior, high, prosocœlous beaks; right valve with twenty-three strong, narrow, rounded ribs, separated by wider, very deep channelled interspaces; concentric sculpture of incremental lines, which are slightly elevated at regular intervals, and cause over much of the valve the tops of the ribs to appear obscurely nodulous; the ribs on the anterior end, though simple in the young, are sharply mesially sulcate in the adult, those on the posterior dorsal slope lower and more rude than those on the body of the shell; the hinge-line is straight, the cardinal area differs from that of *A. rustica* only by having but a single transverse groove anteriorly between the beaks; both valves are similarly sculptured, but no adult left valve was collected; the hinge-line is straight and shorter than the shell; there are about fifteen anterior and four times as many similar vertical posterior teeth, the proximal ends of the series slightly overlapping; the hinge-line in the specimen figured is forty-six millimeters long, the vertical of the beak falls at 8.5 millimeters from the anterior end; inner margins thickened, with short flutings. Lon. 55, alt. 36, diam. 45 mm.

"This fine species appears to be rare, and was found only at Alligator Creek * * *. The young has much the outline of *A. auriculata*, but is not markedly auriculate. It is proportionately shorter than the adult. The species belongs to the same subordinate group as *A. rustica*, as is shown by the minor characters.

"A single broken valve, probably of this species, is among the material from Shell Creek."—*Dall*, 1898.

Occurrence.—Pliocene marl of Alligator and Shell Creeks, Florida.—*Dall*.

Section *Cunearca* Dall, 1898

"Group of *A. incongrua* Say. (*Cunearca* Dall.)

"Thin, trigonal, inflated, with erect beaks; the cardinal area short, amphidetic, equilateral, set off by deep grooves from the rest of the sculpture, smooth or transversely striated, without furrows; hinge-teeth divisible into two series, smaller proximally, larger and more oblique distally, often more or less A-shaped; the right valve smaller; sculpture of the two valves obviously discrepant; the epidermis smooth or not pilose."—*Dall*.

Arca initiator Dall

Plate XIII, Figures 7, 8, 9

Scapharca (Cunearca) initiator Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 634, pl. 32, fig. 11, 1898.

"Shell small, solid, oblique, with prosogyrate beaks, somewhat impressed mesially near the apices of the valves; right valve ovate-rhombic with twenty strong, rounded, nodulous, radial ribs, separated by wider interspaces; left valve decidedly smaller, with the ribs smooth, squarish, and without nodules, except a few on some of the shorter anterior ribs; cardinal area wider in front of the beaks, narrower behind them; margins of the valves internally fluted; hinge-line short, with about twenty-two subequal vertical teeth. Lon. (of left valve) 5, alt. 4.7, diam. 5 mm.

"This little shell was at first thought to be the young of a larger species, but nothing allied to it of a larger size has turned up at any locality in the formation, while its solidity gives it a mature appearance. The cardinal area differs in form from any of the known species in the adult state."—*Dall*, 1898.

Evidently the words right and left are interchanged in the original description. More than half of the ligament lies behind the beaks and it does not cover the entire cardinal area, but leaves a broad, uncovered band along the anterior and posterior margins of the cardinal area. There is no sulcation parallel to the umbonal ridge as in *A. incongrua*.

Dimensions.—(Left valve), lon. +2.5,-4; alt. +1,-4.5; semidiam. 3 mm.

Occurrence.—Oligocene of the Chipola beds, Chipola River, Florida.—*Dall*. Oligocene of Sour Lake, Texas.—*C. U. Museum*.

Arca scalaris Conrad

Plate XIII, Figures 10, 11

Arca scalaris Conrad, Acad. Nat. Sci. Phila., Proc. for 1843, p. 324, 1843.

Arca scalaris Conrad, Fos. Med. Tert., p. 59, pl. 31, fig. 1, 1845.

Arca scalaris Tuomey and Holmes, Pleiocene Fos. S. Car., p. 43, pl. 16, figs. 1, 2, 1856.

Scapharca (Arca) scalaris Conrad, Acad. Nat. Sci., Phila., Proc. for 1862, p. 580, 1863.

Scapharca (Cunearca) scalaris Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 634, 1898.

"Obliquely rhomboidal, elevated, ventricose, ribs about twenty-three, broad, square, prominent, profoundly and robustly crenate, wider than the interstices, seven on the posterior slope, prominent; posterior slope flattened; umbonial slope angulated; summit elevated, narrowed; anterior margin obliquely truncated; anterior basal margin obliquely subtruncated; posterior extremity subangulated; beaks remote; area with transverse slightly impressed lines; cardinal teeth irregular, oblique towards the extremities of the hinge line; within with furrows corresponding to the ribs; margin profoundly crenate. Length two inches; height, one and a half inches * * *.

"Allied to *A. incongrua* Say. The description applies to the left valve only as the opposite one has not yet been found."—*Conrad*, 1843.

Dimensions (Small left valve).—Lon. +12,-15; alt. +4,-20; semidiam. 10 mm.

Occurrence.—Darlington District, South Carolina.—*Tuomey* and *Holmes*. Miocene of Petersburg, Virginia; of Duplin County, North Carolina, and of the upper bed at Alum Bluff, Florida.—*Dall*. Miocene of North and South Carolina (young), and of Petersburg, Virginia.—*C. U. Museum*.

Arca scalarina Heilprin

Plate XIII, Figure 12; Plate XIV, Figures 1, 2, 3

Arca scalarina Heilprin, Wagner Free Inst. Sci., Trans., vol. 1, p. 94, pl. 12, fig. 29, 1887.*Scapharca (Cunearca) scalarina* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 634, 1898.

"Shell obliquely rhomboidal, elevated, ventricose, angulated posteriorly, flattened; anterior end short, evenly rounded; beaks prominent, transverse, about eight, distant; ligament-area diamond-shaped, nearly smooth in the young shell, with delicate transverse lines—in the adult, with a limited number of coarse, sinuous longitudinal lines; hinge-line straight, somewhat more than one-half the greatest length of shell; teeth numerous, somewhat oblique toward either end.

"Ribs prominent, about twenty-four, broad, square, robustly crenate, those of the left valve broader than the interspaces, flattened posteriorly, about eight on the anal angulation; those of the right valve of about the same width as the interspaces (the anterior ones the broadest), with an interstitial secondary rounded rib in the center of the interspace; the two valves unequal, the basal margin of the left valve greatly protruding beyond that of the right; base profoundly crenulated.

"Length, 3.3 inches; height, 2.5 inches.

"* * * It closely resembles the shell identified by Tuomey and Holmes with *Arca scalaris* of Conrad * * *. Through the kindness of Prof. Whitfield I have been permitted to make a comparison with the type-forms described and figured by Tuomey and Holmes, and find that their shell differs very materially from the Florida fossil. In the first place it is decidedly more oblique, and secondly, the ribs adjoining the posterior slope (on the left valve) are not nearly as broad relatively, nor as flattened, as they are in *A. scalarina*; the ribs of the left valve are more remotely placed from one another, and lack the pronounced interstitial secondary rib, which is so prominently defined in the Florida fossil. Its place is taken by a hair line, which is present in some of the intercostal spaces. The characters of the Florida shell are remarkably constant * * * and were I as positive of the stability of characters of the Carolina fossil, I should have no hesitation in regarding the two as specifically distinct * * *. As it is, the characters of the two are sufficiently distinct, indeed, fully as well-marked as those which separate the Florida fossil from the recent *Arca incongrua* of the Southern coast, which may, with much plausibility, be looked upon as its immediate descendant. The recent species agrees more nearly in the general outline of the shell, being upright rather than oblique, but differs in the less width (in the left valve) of the ribs, and in lacking the true interstitial rib of the right valve (although an indication of it appears in a faint elevated line), agreeing in this respect with the South Carolina fossil. That the three forms are most intimately related there can be no question, and I believe there is likewise little or no question that all lie on the same line of descent."—*Heilprin*, 1887.

"This magnificent species is the largest and most distinct of the entire group, and so far has been obtained only on the Caloosahatchie River * * *"—*Dall*.

Occurrence.—Pliocene marls of the Caloosahatchie, Florida.—*Dall*.

Arca incongrua Say

Plate XIV, Figures 4, 5, 6, 7

Arca incongrua Say, Acad. Nat. Sci. Phila., Journ., vol. 2, p. 268, 1822.*Arca incongrua* Reeve, Conch. Icon., *Arca* no. 50, 1844.*Scapharca (Cunearca) incongrua* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 618, 635, 659, 1898.

"Shell somewhat rhomboidal, with from twenty-six to twenty-eight ribs, placed nearer to each other than the length of their own diameters, and crossed by elevated, obtuse, equal and equidistant lines, which are altogether wanting on ten rays of the disc of the left valve; apices opposite to the middle of the hinge, distant from each other, with a lanceolate space between them, of which the breadth is about one-third of its length; extremities of the hinge margin angulated; posterior edge rounded; inferior edge rounded, that of the left valve extended a little beyond the regular curve in the middle; anterior margin cordate, flattened; anterior edge nearly rectilinear * * *.

"This species, which is very abundant on our coast, strongly resembles *A. rhombea*, but, agreeably to the figure in the Encyc. Meth., it differs in the width of the space on the hinge margin, in the width of the spaces between the ribs, and in its more rectilinear anterior edge."—*Say*, 1822.

In the original description right and left, anterior and posterior are interchanged.

Left valve much the larger; ribs twenty-six to thirty; left valve with all the ribs wider than the interspaces, which are very narrow about the center of the shell; anterior ribs coarse, posterior finer; interspaces widest on the anterior part; ribs with transverse, conspicuous, raised lines which are long and narrow except near the umbo, where they are rounder; ribs of the right valve from the center to the umbonal ridge narrow and nearly smooth; left valve with a shallow sulcus anterior and parallel to the umbonal ridge; ligament covering practically all the cardinal area and bounded by a deep groove; ligament area with faint transverse striations; teeth longer and oblique distally. *A. incongrua* shows hardly a trace of an interstitial rib on the right valve. There is a thin light brown epidermis.

This is one of the commonest east coast shells. The closely related form *A. brasiliana* Lamarck; Plate XIV, Figure 8; (*An. s. Vert.*, vol. 6, p. 44, 1819), is smaller than *A. incongrua*, it is proportionately shorter and higher with a short, abrupt posterior slope and straight posterior margin. The abrupt change from nodulous to smooth ribs on the right valve produces an apparent sulcus on the side of the umbo. The shell from the West Coast figured by Reeve as *A. Brasiliana* is referred by Dall to *A. nodosa* Wood. Dall says, (*Wagner Free Inst. Sci., Trans.*, vol. 3, p. 635), "The typical *A. incongrua* is quite variable in form, and I have not seen specimens which could be unhesitatingly referred to it from older beds than the Pleistocene, or more southern localities, living, than the coast of Texas. Here it is mixed with specimens of the *brasiliana* type, towards which the *incongrua* tends to vary. The Costa Rica Pliocene fossils are exactly like *brasiliana*; the Antillean shells also, while varying a good deal, retain the dimensions of *brasiliana* and more or less of its other characters. It is probable that the two forms would

better be kept apart, at least until more is known."

Dimensions.—Lon. +24,-29; alt. +7,-37; diam. 40 mm.

Occurrence.—Upper Miocene of the Galveston artesian well (?); Pliocene of Port Limon, Costa Rica; typical specimens from Pleistocene of Wailes Bluff, Maryland, Simmons Bluff, South Carolina, and Brunswick, Georgia; recent from North Carolina south to Texas, and (var. ? *braziliana*) from Texas south and east to Cape Roque and south to Rio, Rio Grande do Sul, San Paulo, and Santa Caterina, Brazil.—*Dall*. Pleistocene of New Orleans and Grand Chenier, Louisiana, and of Simmons Bluff and Georgetown, South Carolina; recent from Point-au-Fer and Cameron, Louisiana, Galveston, Texas, and from Florida.—*C. U. Museum*. *A. brasiliana* recent from Aspinwall.—*C. U. Museum*.

Arca alcima Dall

Plate XV, Figures 1, 2

Scapharca (Cunearca) alcima Dall, *Wagner Free Inst. Sci., Trans.*, vol. 3, pt. 4, p. 635, pl. 31, figs. 5, 7, 1898.

"Shell of moderate size, short, high, inflated, with elevated prosogyrate beaks; left valve with thirty strong, squarely nodulous, radial ribs somewhat narrower than the interspaces, without obvious concentric sculpture, front edge rounded, posterior less rounded and longer, meeting the base at a rather blunt angle, this part of the shell being somewhat produced; right valve with twenty-seven less prominent ribs, of which the posterior dozen have the nodules obsolete or absent and those on the anterior ribs somewhat less marked than on the other valve; cardinal area short, wide, with the beaks incurved over it; inner margin of the valves sharply fluted; hinge-teeth slightly larger and more oblique distally, in general nearly vertical, close set, and about thirty-two in number, not obviously divided in the center. Lon. 27, alt. 27, diam. 22 mm.; lon. of hinge-line 15 mm.

"This is one of those species on the border-line of groups which make it so difficult to divide the Arks into clear-cut sections; it has the hinge, cardinal area, and discrepant sculpture of *Cunearca*; the valves are slightly unequal, and it seems most properly assigned to a place in this section. It is obviously a form ancestral to such species as *Arca Chemnitzii* Phil. (*A. bicops* Orb. + *A. antillarum* Dunker, *vide* Kobelt, + *A. Orbigny* Kobelt), which is referred to *Anomalocardia* (= *Anadara*) by Ihering, and is found recent in the West Indies. This species, which has been distributed under the (MS.?) name of *A. rhombica* Rawson, is also inequivalve, with discrepant sculpture, and probably should be referred to this section.

"From *A. Chemnitzii* the present species differs by its larger size, more oblique shape, narrower and more numerous ribs * * *."—*Dall*, 1898.

A. Chemnitzii is figured on Plate XV, Figures 3, 4.

Occurrence.—Pliocene marls of the Caloosahatchie at Alligator Creek, Florida.—*Dall*.

Arca filicata Guppy; Plate XV, Figure 5; (Quart. Journ. Geol. Soc., vol. 22, p. 583, pl. 26, fig. 5, 1866; Schuchert, U. S. Nat. Mus., Bull., no. 53, p. 56, 1905), from Manzanilla, Trinidad, evidently belongs to *Cunearca*. It is small, "rather inequivalve, with about thirty ribs, broader than their interstices, and nodosely crenate, becoming nearly smooth on the disk of the right valve," and the ligament area is wide. Dall (Wagner Free Inst. Sci., Trans., vol. 3, p. 636) calls the beds in which this occurs Eocene. *Scapharca* (*Cunearca*) *cumanensis* Dall, (Wagner Free Inst. Sci., Trans., vol. 3, p. 633, 1898) from the Oligocene of Cumana, Venezuela, and an island in Lake Henriquillo, St. Domingo, is the species listed by Guppy (Geol. Mag., Oct. 1874, p. 443) as *A. incongrua* from Cumana. "Shell small, resembling *S. incongrua* Say in miniature, but with higher, more prominent, and uncompressed beaks, with the ribs of the posterior slope of the right valve smooth instead of nodulose; the valve higher and shorter, with the beaks more anterior, and the hinge-line somewhat shorter. Lon. of adult shell 26, alt. 25, diam. 21 mm. * * *"—Dall.

Section *Argina* Gray

"Group of *A. pexata* Say. (*Argina* (Gray, 1840) Adams, 1858.)

"Thin, ovate-oblong, rounded; beaks prosocelous, with the right valve smaller, the cardinal area opisthodic, or nearly so, and very narrow, the hinge-teeth in two series—the anterior shorter, usually irregular or broken up, the posterior longer, normal; the epidermis imbricated and profuse; inhabiting salt water."—Dall, 1898.

Arca campechensis Dillwyn

Plate XV, Figures 6, 7, 8, 9, 10, 11, 12, 13

"*Pectunculus densè et profundè striatus, ovali figurâ*," Lister, Hist. Conch., tab. 237, fig. 71, 1770; Bay of Campeachy.

Arca No. 22; Schroeter, Einleit. Conch., 3, p. 288, 1786.

Arca campechensis Gmel., Syst. Nat., 6, p. 3312, 1792.

Arca ovalis Bruguière, Enc. Meth., p. 110, 1792.

Arca declivis Solander MSS., fide Dillwyn, 1817.

Arca campechensis Dillwyn, Descr. Cat. Rec. Sh., vol. 1, p. 238, 1817 (Syn. partim exclus.), Jamaica and Carolina; not of Wood, Ind. Test., p. 46, pl. 9, fig. 28, 1825.

Arca pexata Say, Acad. Nat. Sci. Phila., Journ., vol. 2, p. 268, 1822.

Arca scapha Ravenel, Cat., p. 5, 1834, fide Stimpson.

Not *Arca scapha* Lamarck, An. s. Vert., vol. 6, p. 42, 1819; Reeve, Conch. Icon., *Arca* no. 25, 1844.

Arca americana (Gray) Wood, Index Test. Suppl., pl. 2, *Arca*, fig. 1, 1828; *ibid.*, ed. Hanley, p. 205, 1856; Tryon, Am. Mar. Couch., p. 179, pl. 37, fig. 470, 1874.

Arca americana Reeve, Conch. Icon., *Arca*, fig. 21, 1844; Holmes, Post.-Pl. Fos. S. Car., p. 19, pl. 4, figs. 2, 2a, 1858.

Arca pexata Greene, Mass. Cat., 1833; Gould, Rep. Inv. Mass., p. 95, fig. 60, 1841; Reeve, Conch. Icon., *Arca*, fig. 22, 1844; De Kay, Nat. Hist. N. Y., Moll., p. 176, p. 12, fig. 211, 1843; Tryon, Struct. and Syst. Conch., vol. 3, p. 255, pl. 126, figs. 46, 47, 1884.

Arca campechensis Ravenel, Cat. Coll., p. 5, 1834; Arango, Moll. Cubana, p. 262, 1880.

Arca Holmesii Stimpson, S. I. Checklist, p. 2, 1860; Tryon, Am. Mar. Conch., p. 179, pl. 37, fig. 471, 1874.

Not *Arca americana* Orb., Moll. Cuba, 2, p. 317, pl. 28, figs. 1, 2, 1853.

Scapharca (Argina) campechensis Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, pp. 650, 659, 1898.

"Shell ovate-heart-shaped, with longitudinal ribs, and crowded transverse striae; margin crenated * * *.

"Shell about an inch and a quarter long, and an inch and three quarters broad; white, tinged with flesh colour at the margin and summits; it has about twenty-five longitudinal ribs, which are crossed with crowded imbricated striae, and at first sight has more the appearance of a *Cardium* than of an *Arca*."—*Dillwyn*, 1817.

Shell inequivalve, nearly round to rounded quadrate, with much incurved beaks which nearly touch so that the posterior part of the cardinal area appears lens shaped from above; ribs twenty-six to thirty-seven, square on the right valve, often rounded on the left, especially on the posterior part of the shell; ribs usually as wide as or wider than the interspaces; ribs of the left valve often, and of the right valve sometimes with a median groove, sometimes practically all the ribs of both valves are grooved, sometimes little grooving on either valve, the species is very variable in this respect, but the grooving is usually stronger on the left valve; beaks very far forward; hinge-line somewhat curved; posterior series of teeth long, teeth oblique distally, v-shaped near the middle of the series; anterior series short, broad and irregular; cardinal area long and very narrow posteriorly, wider and very short anteriorly; margin fluted.

Although this species varies widely in form and ribbing it is easily distinguished from other east coast species by its hinge and cardinal area.

"This very interesting species, of which the synonymy might be much extended, affords an excellent illustration of the effects of environment upon the recent form. Its northern limit is at Cape Cod, where the shell is often large, always coarse, and with a dense hirsute periostracum * * *. As we proceed southward, in this species, as in many other shells, we find the shell becoming less earthy and more porcellanous, the sculpture more neat, the periostracum less profuse, and the general size less. South of Cape Hatteras the chalky, thin type, common in the north, is seldom if ever found. In the Gulf of Mexico and the Antilles the shell is still smaller than in the Carolinas * * *. A somewhat similar series of differences is observable in the Pleistocene fossils, though less pronounced.

"Gmelin's description was inadequate, and only identifiable by his reference to Lister. The species was elucidated by Dillwyn * * *.

"The typical *A. campechensis* is the rounded southern form which Stimpson afterwards called *A. Holmesii*, as he himself recognized. Say's description of *A. pexata* included all the varieties of our eastern coast, but Gould first described the shell so as to make this name apply more particularly to the somewhat elongated, earthy northern variety. Gray's *A. americana* was founded on a very elongated, more porcellanous form, such as is common in South Carolina waters. The study of a large series of recent specimens, ranging from Jamaica to Cape Cod, obliges me to recognize that no sharp line of discrimination can be drawn between the several varieties. The number of ribs varies

from twenty-six in the roundest, *A. Holmesii*, to thirty-five in the most elongated, *A. americana*; but the short, round ones often have as many ribs as the elongated specimens * * *. The anterior granular series of teeth is much shorter than in *A. tolepeia*, and does not extend much in front of the beaks."—*Dall*.

The synonymy is largely taken from *Dall*. The references to *Lister*, *Schroeter*, *Gmelin*, *Bruguière* and *Solander* are also given by *Dillwyn*. *Dillwyn's* reference to *Lister*, *Enc. Meth.*, t. 310, f. 1, is incorrect. The *A. ovalis* included in the synonymy is not *A. ovalis* *Gabb*, (*Acad. Nat. Sci. Phila.*, *Journ.*, 2d ser., vol. 8, pp. 291, 321, pl. 41, figs. 10, 10a), from the Cretaceous of Peru. European fossils have also been named *A. ovalis*.

Dimensions.—Long form, lon.+21,-45; alt.+7,-50; semidiam. 23 mm. Round form, lon.+15,-35; alt.+5,-38; diam. 36 mm.

Occurrence.—"The species does not descend below the uppermost Miocene, if, indeed, any of the specimens are so old. I have only identified it with certainty from the Pleistocene of Georgia, of Simmons Bluff, South Carolina, of New Jersey, and southern New England."—*Dall*. Pleistocene of Grand Chenier, Pumping Station no. 7, and New Orleans, Louisiana and Georgetown, South Carolina; recent from Cameron and Point-au-Fer, Louisiana; Galveston, Texas, Mobile, Alabama, Ft. Barrence, Florida, and from South Carolina.—*C. U. Museum*.

Scapharca (Argina) tolepeia *Dall*; Plate XV, Figures 14, 15; (*Wagner Free Inst. Sci.*, *Trans.*, vol. 3, p. 649, pl. 33, figs. 7, 8, 1898), from the Oligocene of Rio Amina, St. Domingo; Bowden, Jamaica, and Cumana, Venezuela, is smaller (28 mm. long) than *A. campechensis*, is much more inflated and rotund and has finer and more nodulose sculpture. It has about thirty-four ribs. *Dall* places in synonymy with his species the *Arca pexata* listed by *Guppy*, (*Geol. Mag.*, Oct. 1874), fossil from Caribbean beds. *Guppy* also listed *A. pexata* *Say* from St. Domingo and Cumana in *Quart. Journ. Geol. Soc. Lond.*, vol. 22, pp. 575, 576, 1866. Among fossils from St. Domingo in the *C. U. Museum* there are specimens belonging to several small, inflated species varying from *Argina* to section *Scapharca*.

Section *Bathyarca*, *Kobelt*

"Group of *A. pectunculoides* *Scacchi* (*Bathyarca* *Kobelt*, 1891.)

"Shell small, usually abyssal, inflated, with prosogyrate beaks and a rather narrow but long furrowed area, the hinge-margin nearly or quite as long as the shell; teeth few, oblique, in two series, often separated by a wide gap in the center; the right valve smaller, the sculpture of the two valves often very discrepant; epidermis usually imbricated.

"These small deep-water Arks go back to the Eocene in time and form a very recognizable group, related to *Scapharca* as *Lissarca* is to *Barbatia*."—*Dall*.

Scapharca (Bathyarca) Hendersoni *Dall*; Plate XVI, Figure 1; (*Dall*, *Wagner Free Inst. Sci.*, *Trans.*, vol. 3, p. 653, pl. 33, fig. 9, 1898), from the Oligocene of the Bowden beds, Jamaica, is very small (2 mm. long), "much inflated, the hinge-line as long as the

shell, which is of a rounded triangular form, with rather prominent prosocelous beaks; left valve with fine, elevated, rounded concentric lines, crossed by closer, less prominent, and finer radial lines; in the right valve, as usual in this section of the genus, the radial sculpture predominates over the concentric, the latter though present being inconspicuous; cardinal area moderately wide, the beaks being nearly medial, the surface of the area longitudinally striated; hinge with about five nearly vertical anterior teeth separated by a wide unarmed gap from six or seven smaller, more oblique posterior teeth; margin of the valves thin, entire, or microscopically crenulated; the inner edges of the adductor scars slightly raised above the inner surface of the valve * * *. It resembles *A. pectunculoides* Scacchi and *A. glomerula* Dall, of the recent fauna, but is smaller, more inflated, and more triangular than either of them."

Scapharca (Bathyarca) Spenceri Dall; Plate XVI, Figures 2, 3; (Dall, Wagner Free Inst. Sci., Trans., vol. 3, p. 652, pl. 32, figs. 16, 24, 1898), from the Pliocene of Tehuantepec, is large for the section, (18 mm. long), "inflated, ovate, with prominent prosocelous beaks; left valve with fine, rounded, concentric elevated lines, close set, and with very narrow interspaces, which show fine, close radial striae, some of which on the anterior end of the shell are more prominent; right valve with fine, close-set radial ribs, coarser on the middle of the shell, separated by narrower, sharp, channelled grooves; transverse sculpture of evenly spaced, low, sharp elevated lines which cross the ribs without becoming much thickened; cardinal area very narrow behind, wider but not distinctly limited in front, the cardinal margin elevated anteriorly, with seven or eight concentric grooves mostly behind the umbones; ends of the hinge angular behind; the teeth in two series hardly separated, eight to twelve in front, ten to fourteen behind, not crowded, smaller mesially, larger and more oblique distally, the anterior series somewhat irregular; inner margin of the valves with fine crenulations, stronger in the left valve, the outer edge almost or quite entire."

Scapharca (Bathyarca) glomerula Dall; Plate XVI, Figures 4, 5; (Dall, Bull. Mus. Comp. Zool. Harvard, vol. 9, p. 121, 1881; vol. 12, p. 241, pl. 8, figs. 9, 9a, 1886; U. S. Nat. Mus., Bull. 37, p. 42, pl. 8, figs. 9, 9a, 1889; Wagner Free Inst. Sci., Trans., vol. 3, p. 659, 1898), recent from Hatteras to St. Vincent in one hundred to six hundred and eighty-three fathoms, is similar in general shape, size and sculpture to *A. pectunculoides*, but is shorter and higher; the hinge is straight with from fifteen to seventeen stout nearly vertical teeth, usually in a continuous series, those at the ends of the series oblique; the sculpture of the two valves is different, the radiating sculpture stronger on the right valve; the radiating sculpture appears inside the shell within the margin in a series of small ridges, generally with the same level as the rest of the interior, but sometimes rising into little tubercles, and separated by rather deep, short, narrow depressions, which do not extend far inward nor over the smooth margin. The dimensions of *A. glomerula* are: lon. 5.75, alt. 5.0, diam. 5.0; lon of hinge-line, 4.25 mm. Dall places *Arca (Scapharca?) inaequisculpta* E. A. Smith, (Challenger Rep. Lam., p. 267, pl. 17, figs. 8-8c, 1885), from deep water off Culebra Island, West Indies, in synonymy with this species.

Scapharca (Bathyarca) polygyra Dall; Plate XVI, Figures 6, 7; (Dall, Bull. Mus.

Zool. Harvard, vol. 9, p. 122, 1881; vol. 12, p. 241, pl. 8, figs. 3, 3a, 1886; U. S. Nat. Mus., Bull. 37, p. 42, pl. 8, figs. 3, 3a, 1889; Wagner Free Inst. Sci., Trans., vol. 3, p. 659, 1898), recent from Barbados and Grenada, has the dimensions: lon. 9.75, alt. 6.0, max. diam. 5.0; lon. of hinge-line, 6.0 mm. It is "slightly inequilateral, nearly equivalve, moderately evenly inflated, whitish, with little or very fugacious epidermis; sculpture very remarkable, consisting, first, of very even, broad, rounded, regular, concentric waves (twelve or thirteen in number), separated by sharp, deep grooves. In dead or worn shells these waves are smooth, or nearly so, but in perfectly fresh (and especially young) shells on the surface of the broad slightly flattened waves may be seen what look like two rows of subcylindrical, slightly irregular grains of sand, arranged side by side, with their longer axes radiating from the beak; these granules, if so they may be termed, are really hollow, and are the thinnest possible bubbles of shelly matter which leave, when rubbed off by any slight friction, a couple of zigzag slightly elevated lines where their bases were fixed to the shell; a very slight friction will obliterate this, and then the shell will be nearly smooth * * *; the narrow furrow for the ligament goes straight across to the margin from the beak (which is nearly opposite the middle of the hinge-line) instead of obliquely * * *."

Arca pectunculoides Scacchi; Plate XVI, Figures 9, 10, 11; (Scacchi, Not. Conch. foss. Gravina in Ann. Civ. due Sicil., vol. 6, p. 82, 1834; Broegger, Norges Geologiske Undersoegelse, no. 31, pl. 13, figs. 17a, 17b, 1901; var. *orbiculata* Dall; Plate XVI, Figure 8; Dall, Bull. Mus. Comp. Zool. Harvard, vol. 9, p. 121, 1881; vol. 12, p. 240, pl. 8, fig. 5, 1886; U. S. Nat. Mus., Bull. 37, p. 42, pl. 8, fig. 5, 1889; var. *crenulata* Verrill, Trans. Conn. Acad., vol. 5, p. 575, 1882; *Scapharca (Bathyarca) pectunculoides* Dall, Wagner Free Inst. Sci., Trans., vol. 3, pp. 619, 659, 1898), belongs to *Bathyarca*. Its range is given by Dall as from Norway to St. Vincent. It is a well-known European species and is found as a fossil. The shell is thin, with fine radiating and concentric lines; left valve slightly larger; cardinal area wider in front of the beaks; ligament occupying only the posterior part of the cardinal area; teeth oblique, in two series, with a gap opposite the beaks; anterior part of the shell with a shallow sulcation extending to a notch in the ventral margin; inner margin smooth.

Dall says that the American specimens are shorter and rounder than those from farther east in the Atlantic sea-bed and the Norwegian and Arctic seas. He described a nearly round variety from the Gulf of Mexico as variety *orbiculata*. "*Arca grenophia* Risso may be this species, but it was not figured, and the description is quite insufficient. *Arca pectunculoides* var. *crenulata* Verrill, appears to have the form of var. *orbiculata*, the teeth of the Gulf specimens above mentioned, the marginal crenulations of *glomerula*, and the sculpture of the type of *pectunculoides*."—Dall.

Arca glacialis Gray; Plate XVI, Figures 12, 13, 14; (Gray, Parry's First Voyage, Supp. to App., p. 244, 1824; Bjoerlykke, Norges Geologiske Undersoegelse, no. 25, p. 69, fig. 1, 1898; Broegger, l. c., no. 31, p. 120, pl. 6, figs. 1-4, 1901; Friele and Grieg, Norwegian North-Atlantic expedition, vol. 7, Mollusca 3, p. 19, 1901), is found recent in the Arctic seas and has been reported south to New England. It is also found in the Pleis-

tocene. It has a thin shell, evenly rounded in front and produced behind with an oblique posterior margin; surface with numerous fine radiating lines; hinge-line short; teeth small, with a gap opposite the beaks; cardinal area wider in front, narrower behind, with a raised margin; posterior part of the cardinal area with several fine, close-set longitudinal grooves; inner margin smooth.

Bathyarca abyssorum Verrill and Bush; Plate XVI, Figure 16; (Verrill and Bush, Proc. U. S. Nat. Mus., vol. 20, p. 843, pl. 76, fig. 9, 1898), was found in 1825 to 1859 fathoms, off Delaware Bay. A single specimen of a form related to *pectunculoides*, from a depth of 27 fathoms, Gulf of Maine, was named *Bathyarca anomala* by Verrill and Bush, (Proc. U. S. Nat. Mus., vol. 20, pp. 843, 844, pl. 77, fig. 8, 1898); Plate XVI, Figure 15. It is not *Arca anomala* Reeve, (Conch. Icon., *Arca* no. 9, pl. 2, 1843); *Arca anomala* Blake and Hudleston, (Quart. Journ. Geol. Soc. London, vol. 33, p. 398, pl. 15, fig. 7, 1877); or *Arca anomala* d'Eichwald, [Naturhist. Skizze, p. 211, (Lethaea Rossica, vol. 3, p. 78, pl. 4, fig. 12, a, b, c, 1853)]. The *Bathyarca* might be called *Arca (Bathyarca) Verrillbushi*.

Arca (Scapharca) culebrensis E. A. Smith; Plate XVI, Figures 17, 18, 19; (Challenger Rep., Lam., p. 268, pl. 17, figs. 9-9b, 1885), is similar to the variety *septentrionalis* of *A. pectunculoides* and was obtained off Culebra Island, West Indies, in 390 fathoms.

Cretaceous Species

Barbatia Carolinensis Conrad, (Kerr's Rep. N. Car., App. A, p. 4, pl. 1, fig. 11, 1875; Tryon, Struct. and Syst. Conch., vol. 3, p. 254, pl. 127, fig. 79), is from the Cretaceous of North Carolina. It is not *A. carolinensis* Wagner, 1847. *Barbatia lintea* Conrad, (l. c., p. 4, pl. 1, fig. 12), is also from the Cretaceous of North Carolina. Dall states that it is not *Arca lintea* Conrad, Dead Sea Expedition, 1852. *Barbatia lineata* Tryon, (Struct. and Syst. Conch., vol. 3, p. 254, pl. 127, fig. 65), and *Barbatia lineata* Meek, (U. S. Geol. Surv. Territories, vol. 9, p. 78; 1876), are misprints for the former species, not *Arca lineata* Goldfuss. Conrad also described a *Cibota lintea* from the Cretaceous of Mississippi, (Acad. Nat. Sci. Phila., Journ., 2d. ser., vol. 3, p. 328, pl. 34, fig. 11, 1858.)

Dall, (Wagner Free Inst. Sci., Trans., vol. 3, p. 615), includes *Nemodon* Conrad, (Am. Journ. Conch., vol. 5, p. 97, 1869), in the subgenus *Barbatia*. The following Cretaceous species have been referred to *Nemodon* by Whitfield, (U. S. Geol. Surv., Monographs, vol. 9, pp. 83-86, 1885), Johnson, (Acad. Nat. Sci. Phila., Proc. for 1905, vol. 57, p. 9) and Weller, (Geol. Surv. N. Jersey, Cret. Pal., pp. 385-391, 1907):—*Arca (Macrodon) Eufalensis* Gabb, Acad. Nat. Sci. Phila., Journ., 2d. ser., vol. 4, p. 398, pl. 68, fig. 39, 1860, from New Jersey, Georgia, Alabama, Mississippi and Arkansas; *Trigonarca eufalensis* Conrad, Am. Journ. Conch., vol. 3, p. 9, 1867;=*Nemodon conradi* Johnson, 1905, from New Jersey; *Leda angulata* Gabb, Acad. Nat. Sci. Phila., Proc. for 1860, p. 95, pl. 2, fig. 12;=*Nemodon angulatum* Gabb, Acad. Nat. Sci. Phila., Proc. for 1876, p. 316, from New Jersey; *Nemodon brevifrons* Conrad, Kerr's Geol. Rep. N. Car., App. A, p. 4, pl. 1, fig. 15, 1875, from New Jersey, North Carolina and Mississippi. This last is not *Arca brevifrons* Sowerby, Zool. Soc. London, Proc. for 1833, p. 22, or *Arca brevifrons*

Conrad, Dead Sea Expedition, p. 215, 1852. The preceding species is not *Arca angulata* King, Zool. Journ., vol. 5, p. 336, 1831.

Weller, (Geol. Surv. N. Jersey), has referred the following New Jersey Cretaceous species to *Arca*:—

Cibota obesa Whitfield, U. S. Geol. Surv., Monog., vol. 9, p. 93, pl. 11, figs. 30, 31, 1885; not *Arca obesa* Sowerby, Zool. Soc., Proc., pt. 1, p. 21, 1833; Reeve, Conch. Icon., *Arca* no. 3, 1843.

Arca uniopsis Conrad, Acad. Nat. Sci., Phila., Journ., 2d. ser., vol. 2, p. 275, pl. 24, fig. 17, 1853=*Cibota uniopsis* Whitfield, U. S. Geol. Surv., Monog., vol. 9, p. 92, pl. 11, figs. 32, 33, 1885.

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

Arca quindecemradiata Gabb, Acad. Nat. Sci. Phila., Proc. for 1860, p. 95, pl. 2, fig. 2. Weller places in synonymy with this species *Cibota multiradiata* Gabb, l. c., p. 95, pl. 2, fig. 1; *Arca altirostris* Gabb, Acad. Nat. Sci. Phila., Proc. for 1861, p. 325; *Cucullaea transversa* Gabb, l. c., p. 326, and *Cucullaea gabbi* Johnson, Acad. Nat. Sci. Phila., Proc. for 1905, p. 8.

Nemoarca cretacea Conrad, from the Cretaceous of New Jersey, likewise *Arca Saffordii* Gabb, from the Cretaceous of New Jersey, have sometimes been classed as *Arcas*. Weller places them in *Nemoarca* and *Breviarca* respectively. The former is not *Arca cretacea* d'Orbigny. A number of Mesozoic species from the interior states and Texas have been classed as *Arcas*. The *Cucullaeas* have often been called *Arcas*. Of Eocene species Dall says, "*A. gigantea* Conrad is probably identical with *Cucullaea onochela* Rogers. *Noëtia pulchra* Gabb, from the Eocene of Texas, 1860, is *Trinacria decisa*. There is an *A. pulchra* of Sowerby dating from 1824."

The following species are undescribed, described from incomplete specimens, etc.:—

Eocene.—In the Report on the Geology of South Carolina, 1848, pp. 156, 161, 210, Tuomey named an undescribed species *A. obliqua* T. It may have been figured in the unpublished plates mentioned in the preface. The name was used by Portlock in 1843, in the Report on the Geology of the County of Londonderry, for a Paleozoic fossil. It has also been used for a South American fossil, and for recent shells by Reeve and Philippi.

Eocene.—In the Acad. Nat. Sci. Phila., Proc. for 1852, p. 194, 1854, Tuomey described a species from North Carolina as follows: "ARCA CANCELLATA: shell thin, very inequilateral, cancellated by radiating lines and approximating transverse lines; umbones prominent; beaks close; hinge-line slightly curved; posterior margin rounded, compressed; anterior margin much contracted.

"*Dimen.* Length 2.5 in.; br. 3.5 in."

It was not figured and the name is preoccupied by Gmelin, Syst. Nat., 6, p. 3308, 1792. In 1809 Martin used the name *Arcites cancellatus* for a British fossil which Sowerby in 1824 called *Arca cancellata*.

Oligocene.—In the 16th Ann. Rep. of the State Geologist of Indiana, p. 414, 1889, "*Arca acuminata*, Vicksburg Group, Mississippi", is given in a list of specimens in the state museum. There is a recent *Arca acuminata* Krauss from South Africa, (Südafrikanischen Mollusken, p. 14, pl. 1, fig. 11, 1848).

Oligocene.—*A. oronlensis* Gabb, Acad. Nat. Sci., Phila., Journ., 2d. ser., vol. 8, p. 346, pl. 44, fig. 21; Dall, Wagner Free Inst. Sci., Trans., vol. 3, pt. 4, p. 658, is from Panama and Costa Rica. *Arca (Anadara) Pennelli* Gabb, Am. Phil. Soc., Trans., 2d. ser., vol. 15, p. 254, 1873, and *Arca multilineata* Gabb, l. c., p. 254, from St. Domingo, were not figured. Dall lists them as Oligocene.

Miocene.—*A. maxillata* Con., Acad. Nat. Sci. Phila., Journ., vol. 6, p. 264, 1831, from Maryland, was briefly described and was not figured. The specimen was a cast.

Miocene.—In the Second Bulletin of the Proc. Nat. Institution Promotion Sci., p. 181, 1842, Conrad lists *A. depleura* Conrad together with *A. subrostrata* from a locality in Maryland. On p. 183 it is listed from another locality and spelled *dipleura*. Apparently it was never described and doubtless is a synonym of some of Conrad's other species.

Miocene.—Among the Galveston deep well fossils Professor Harris found specimens most nearly like the west coast *A. labiata* and he called them *Arca labiata* Sowerby, var., Bull. Am. Pal., vol. 1, no. 3, p. 7, pl. 1, figs. 1, 1a, 1895. They were young specimens and fragments.

Middle Tertiary.—*Arca granulifera* Conrad is given in the list of Middle Tertiary fossils in Morton's Synopsis Organic Remains Cretaceous Group, 1834, Appendix, p. 2. Apparently it was not described.

Tertiary.—*A. costata* Heilprin, Acad. Nat. Sci. Phila., Proc. for 1882, p. 154, was evidently intended for *A. caelata*. It is not *A. (Lunarca) costata* Gray.

Tertiary.—*Arca Ruffini?* is given in a list of fossils from Mexico, (Inst. Geol. Mexico, Bol., nums. 4, 5, 6, p. 230, 1897). This is probably due to a mistake in copying *A. Ruffini?*, which is *Anomia Ruffini*, from an earlier list, (l. c., num. 3, p. 9, 1896), taken from Heilprin, (Acad. Nat. Sci. Phila., Proc. for 1891, p. 142, 1891).

Recent.—*Arca contracta* Reeve, Conch. Icon., *Corbula* no. 27, pl. 4, 1844, was intended to be *Corbula contracta* Say.

This text was written chiefly in 1910 and 1911. Since then the following new species of *Arca* have been published:

Arca dariensis Brown and Pilsbry, Acad. Nat. Sci. Phila., Proc., vol. 63, p. 362, pl. 22, fig. 10, 1911, from the Oligocene of the Isthmus of Panama.

Arca gatunensis Toulia, Jahrb. Geol. Reichsanstalt, Wien, vol. 61, p. 493, pl. 30, fig. 4, 1911, from Gatun, Panama Canal.

Barbatia simonlsi Whitney, Univ. Texas, Bull., no. 184, p. 11, pl. 1, fig. 6, 1911, from the Cretaceous of Texas.

Arca (Scapharca) limonica Dall, Smith Misc. Coll., vol. 59, no. 2, p. 2, 1912, from the Pleistocene of the Isthmus of Panama.

Arca (Noëtia) Macdonaldi Dall, l. c., p. 9.

Arca (Scapharca) Pittieri Dall, l. c., p. 9. These last two species are from Costa Rica and may be older than *limonica*.

Arca (Noëtia) sheldoniana Maury, Acad. Nat. Sci. Phila., Journ., 2d. ser., vol. 15, p. 43, pl. 8, figs. 10, 11, 1912, from the Oligocene of Trinidad.

Arca (Cunearca) chemnitzoides Maury, l. c., p. 44, pl. 7, figs. 13, 14, 15, pl. 8, fig. 1, from the Oligocene of Trinidad.

Arca (Argina) billingsiana Maury, l. c., p. 45, pl. 8, figs. 2, 3, from the Oligocene of Trinidad.

Arca (Argina) schultzeana Maury, l. c., p. 46, pl. 7, figs. 10, 11, 12, recent from Trinidad.

Arca (Argina) brightonensis Maury, l. c., p. 46, pl. 8, figs. 4, 5, 6, from the Oligocene of Trinidad.

Arca (Argina) pariaensis Maury, l. c., p. 47, pl. 8, figs. 7, 8, 9, recent from Trinidad.

Arca sp. indet. Maury, l. c., p. 47, pl. 7, fig. 16, from the Oligocene of Trinidad.

Arca sp. indet. Maury, l. c., p. 47, from the Oligocene of Trinidad.

Arca dalli Brown and Pilsbry, Acad. Nat. Sci. Phila., Proc., vol. 64, p. 510, pl. 24, fig. 4, 1913, from the Oligocene of the Isthmus of Panama. This is not *Arca (Macrodon) dalli* E. A. Smith, (Challenger Rept. Lam., p. 269, pl. 17, figs. 10-10b, 1885). The Panama species might be called *Arca Balboai*.

Arca grammatodonta Dall, U. S. Nat. Mus., Bull. 90, p. 118, pl. 20, figs. 1, 2, pl. 22, fig. 3, 1915, from the Oligocene of the Tampa silex beds at Ballast Point, Tampa Bay, Florida. This species belongs to the True Arks.

Arca (Barbatia) uandi Gardner, Maryland Geol. Surv., Upper Cretaceous, pp. 96, 535, 539, 917, pl. 21, figs. 5, 6, 1916, from the Cretaceous of Delaware.

Nemodon Stantonii Gardner, l. c., pp. 94, 525, 527, 915, pl. 19, fig. 15, from the Cretaceous of Maryland.

Nemodon cecilius Gardner, l. c., pp. 94, 525, 528, 916, pl. 20, figs. 5-7, from the Cretaceous of Maryland.

Arca (Scapharca) staminea Say, subspecies *rubisiniana* Mansfield, U. S. Nat. Mus., Proc., vol. 51, p. 603, pl. 113, figs. 1, 3, 10, 1916.

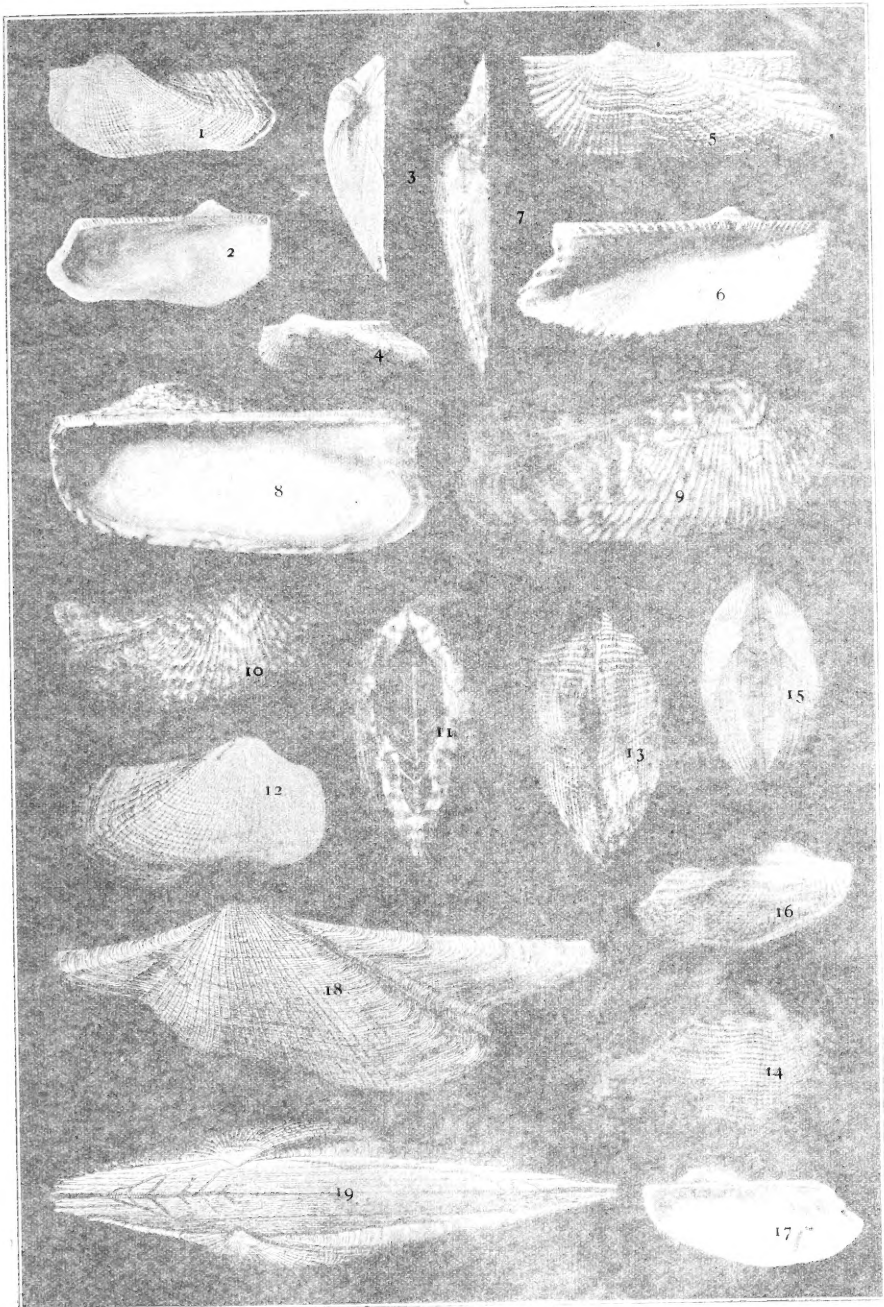
The Zoological Record lists the following species: *Arca (Scapharca) chavesi*, Mexico Miocene, Engerrand and Urbina, "Primera nota acerca de la Fauna Miocénica de Zuluza (Chiapas). Mexico Bol. Soc. Geol. Mex. 6 1910 (119-140)."

Notes on *Noëtia*.—It has been stated, (p. 25), that the known fossils are all American. *Arca Okeni* Mayer, as figured and described by Mayer, (Journ. de Conch., t. 6, p. 185, pl. 14, figs. 7, 8, 1857), and Dollfus and Dautzenberg, (Mém. Soc. Géol. France, Paléont., t. 20, Mém. No. 27, p. 337, pl. 27, figs. 19-27, 1913), from the Middle Tertiary of France and central Europe, is a characteristic *Noëtia*. Dollfus and Dautzenberg compare it with *A. Martinii* Recluz. Mayer compared it with True Arks. This is interesting since the subgenus *Noëtia* appears to be more closely related to the Typical Arks than to any other group. *Barbatia cafria* Bartsch, (U. S. Nat. Mus., Bull. 91, p. 183, pl. 38, figs. 1, 5, 1915), recent from Port Alfred, South Africa, is clearly a *Noëtia* also

EXPLANATION OF PLATES

PLATE I

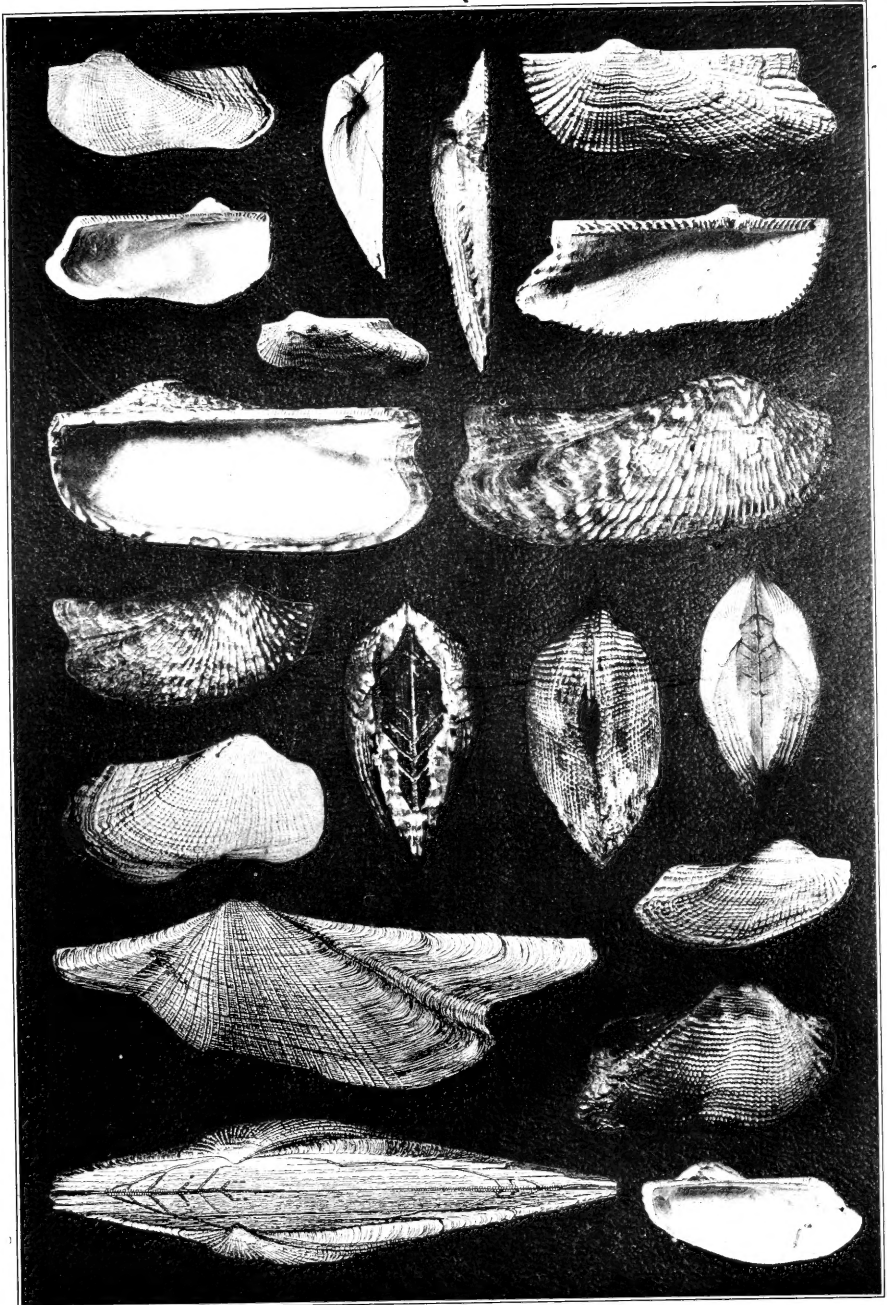
FIGURE	PAGE
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Eocene of Hatchetigbee, Alabama; type specimen; umbo distorted and worn anteriorly; beading of anterior ribs lost in photograph; photographed to show the low, fine ribs extending over the umbonal ridge with two higher, coarser ribs on the middle of the posterior slope.	
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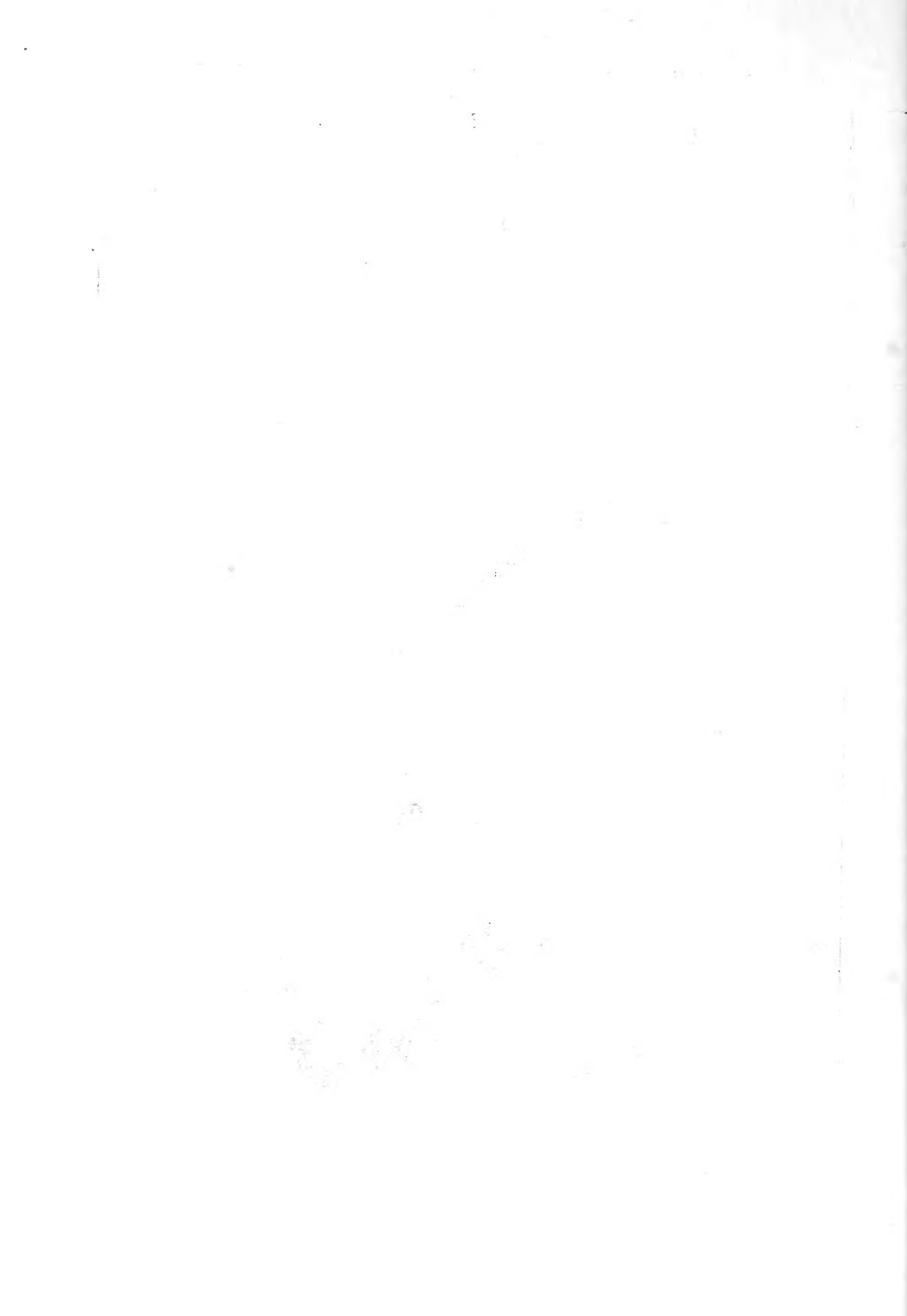


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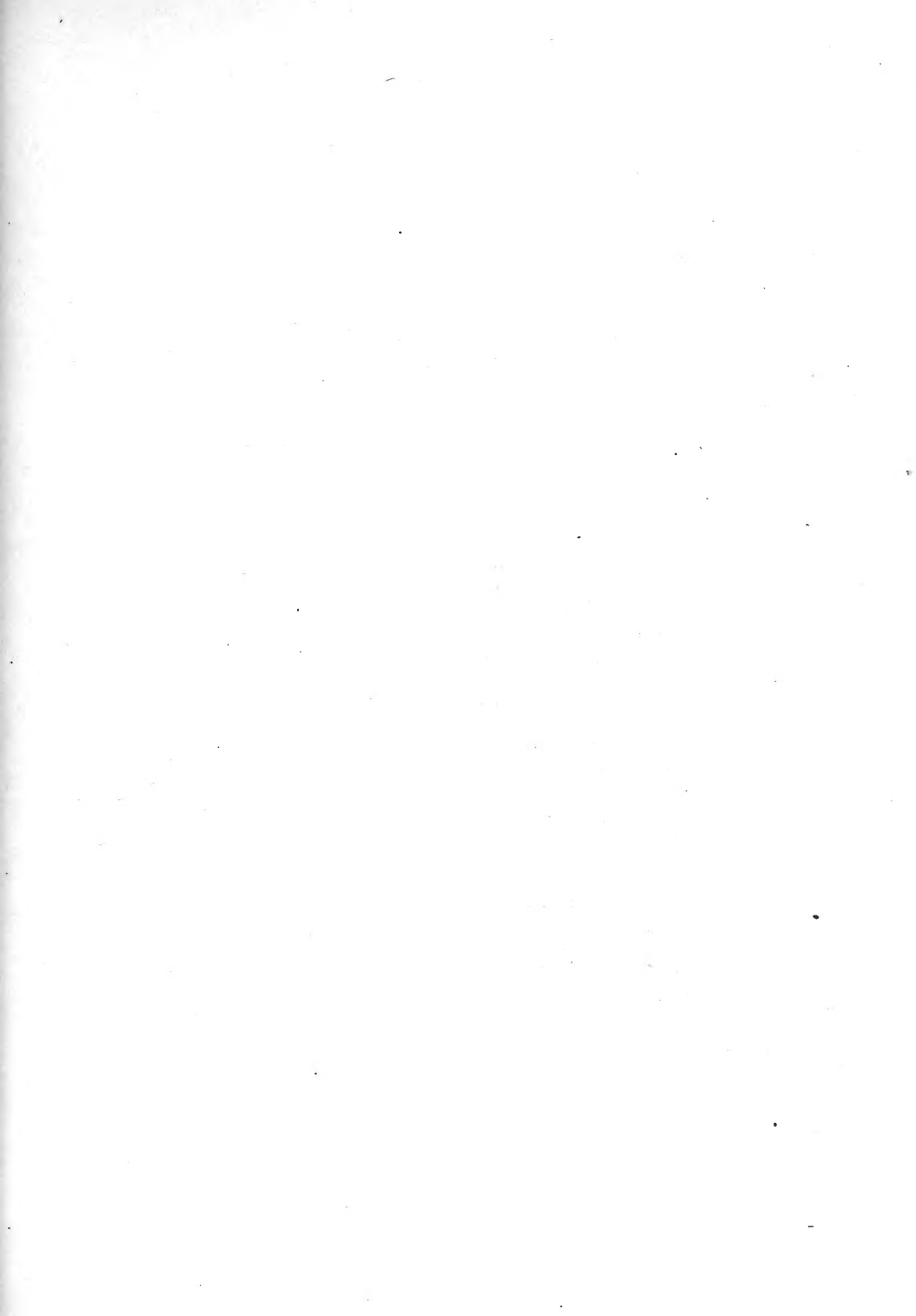


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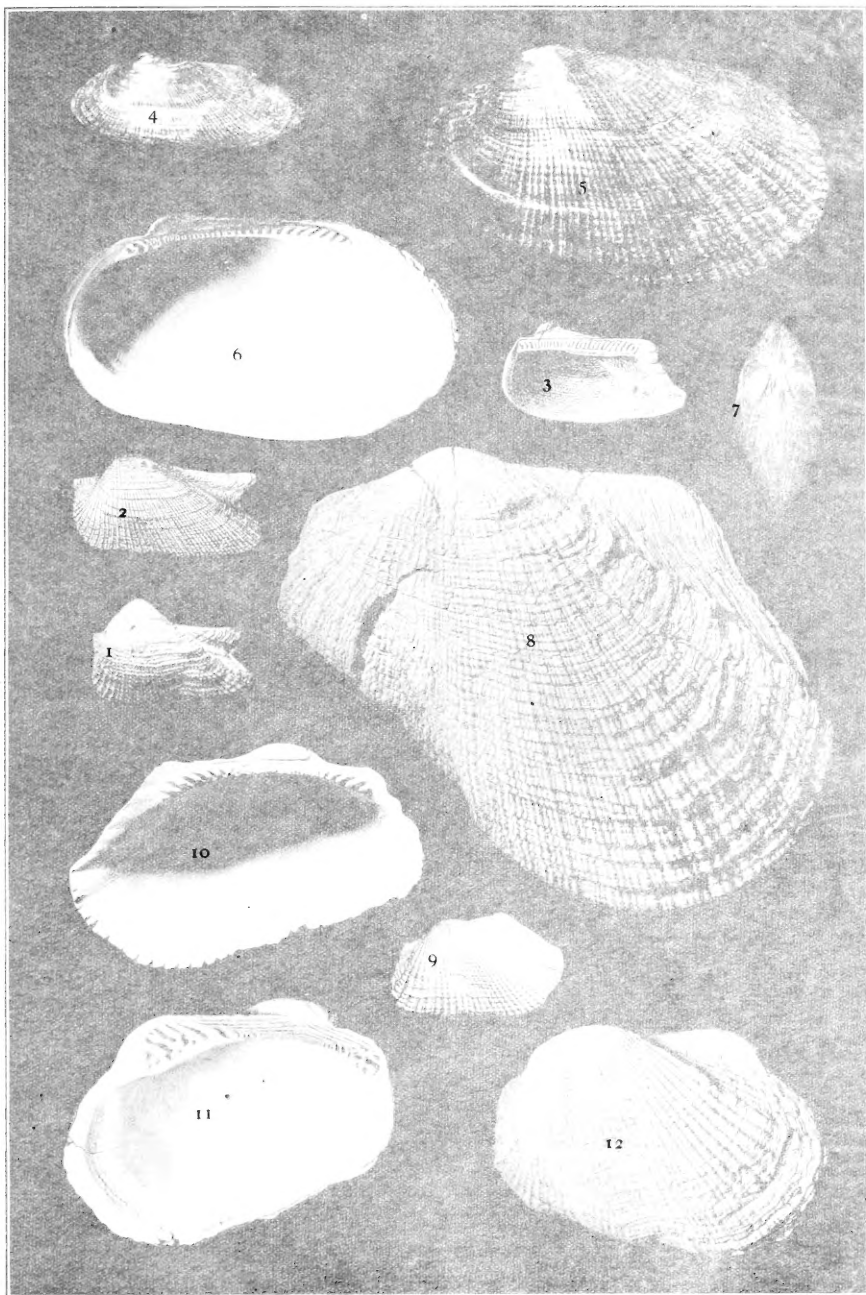


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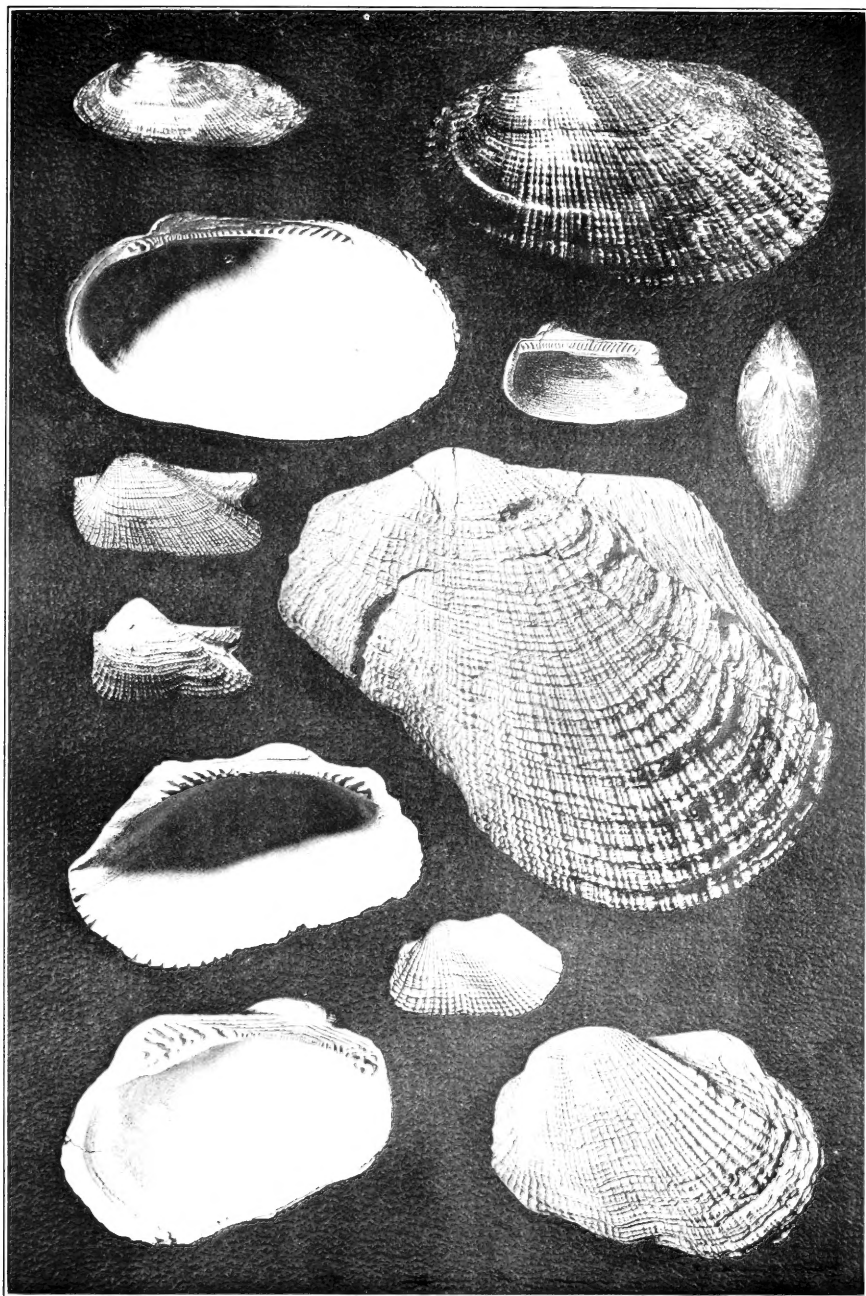




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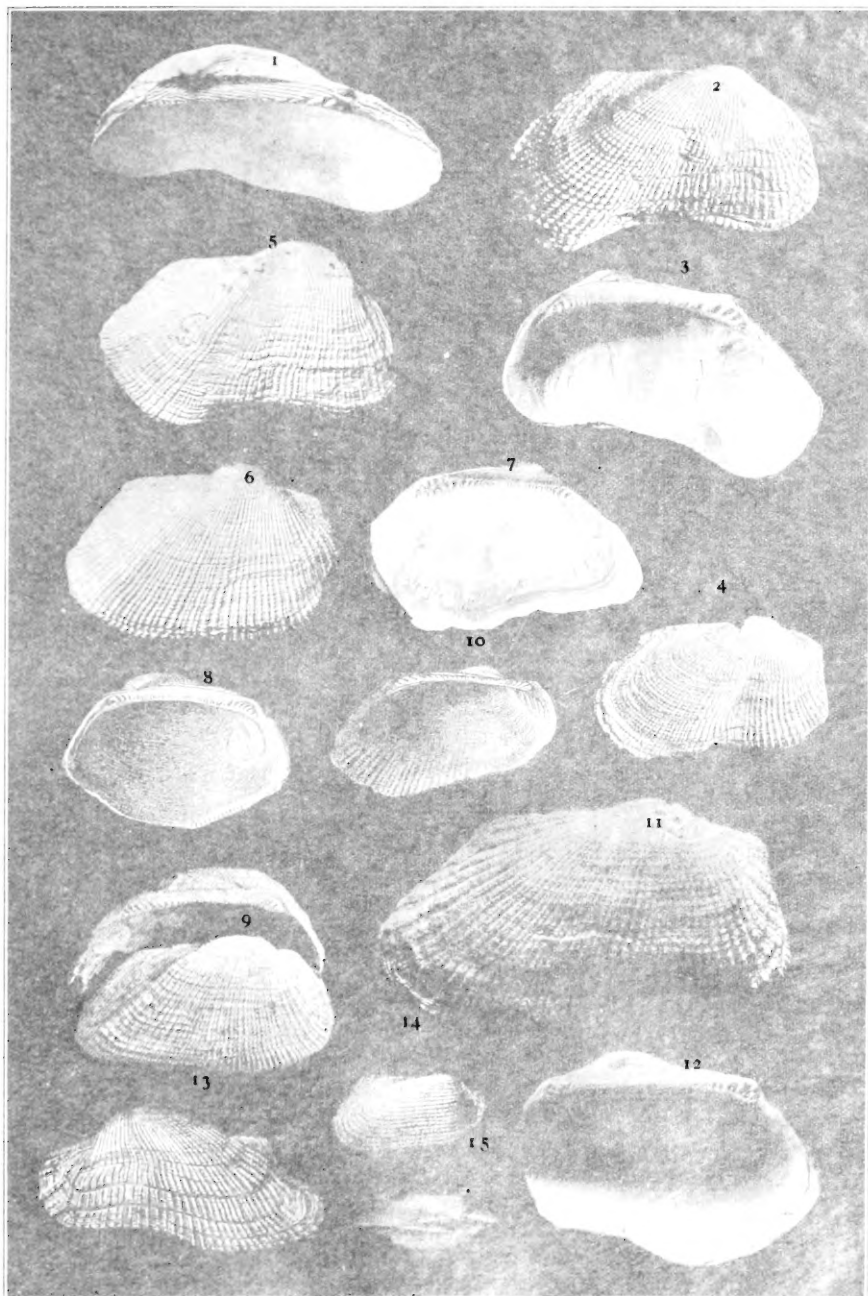
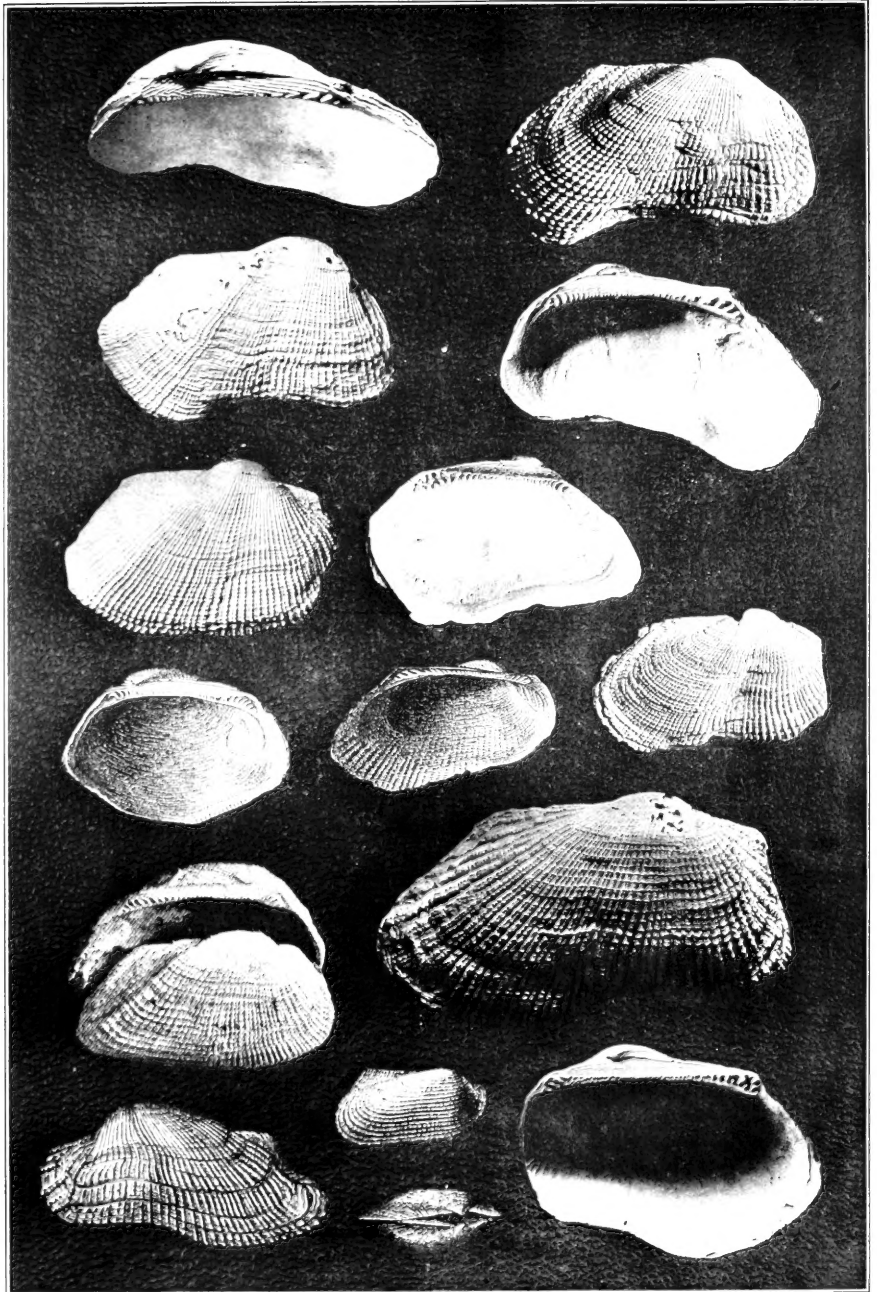


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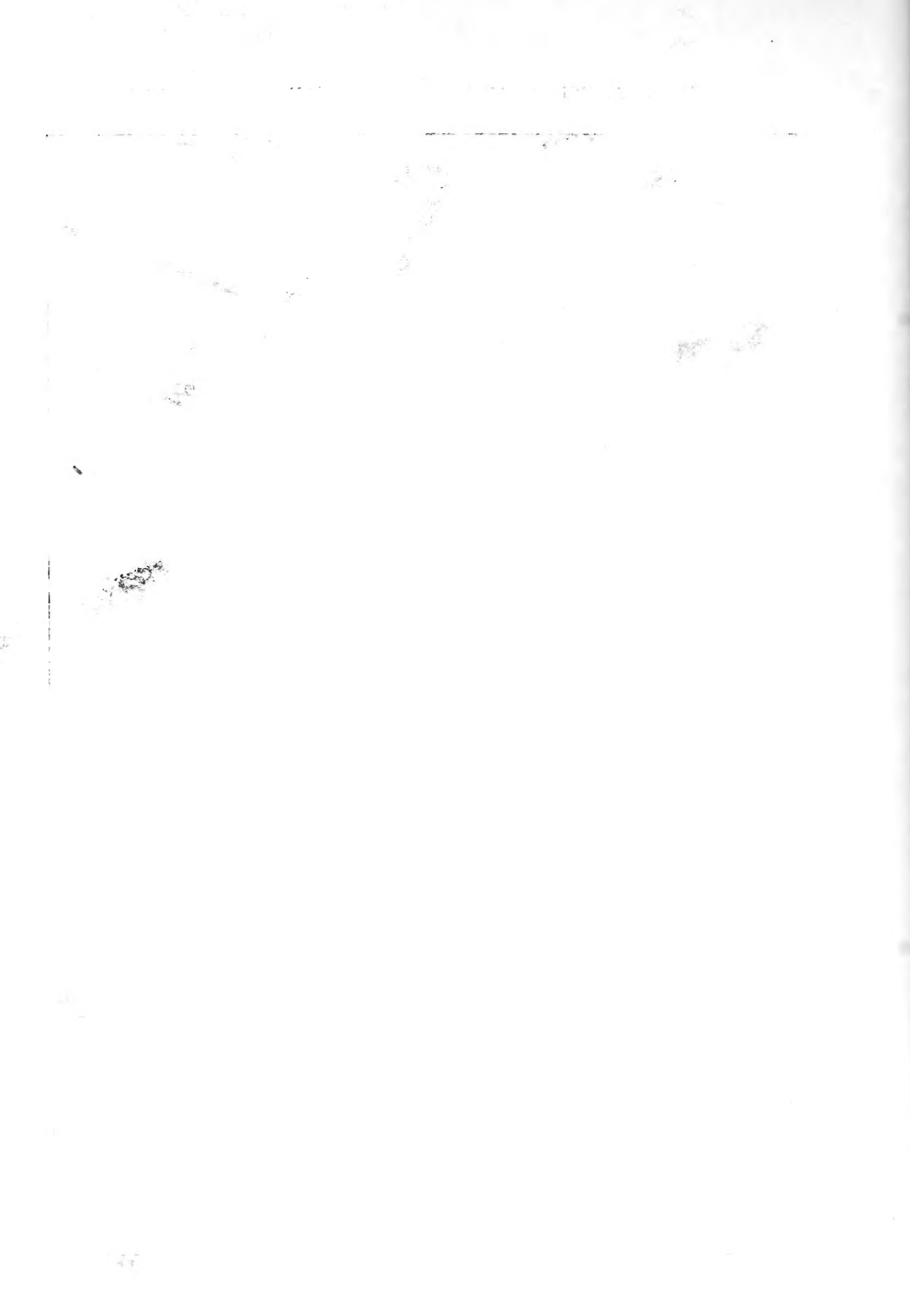


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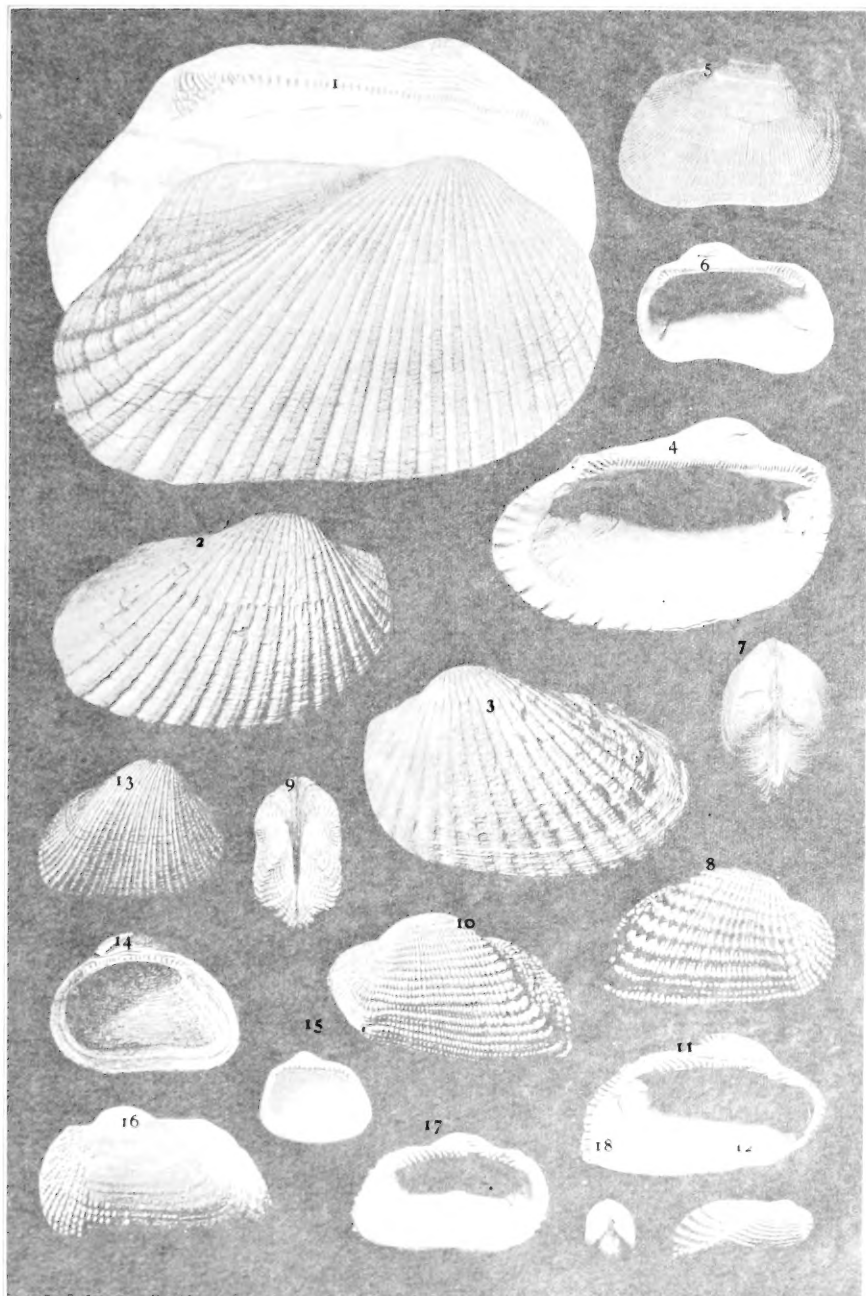


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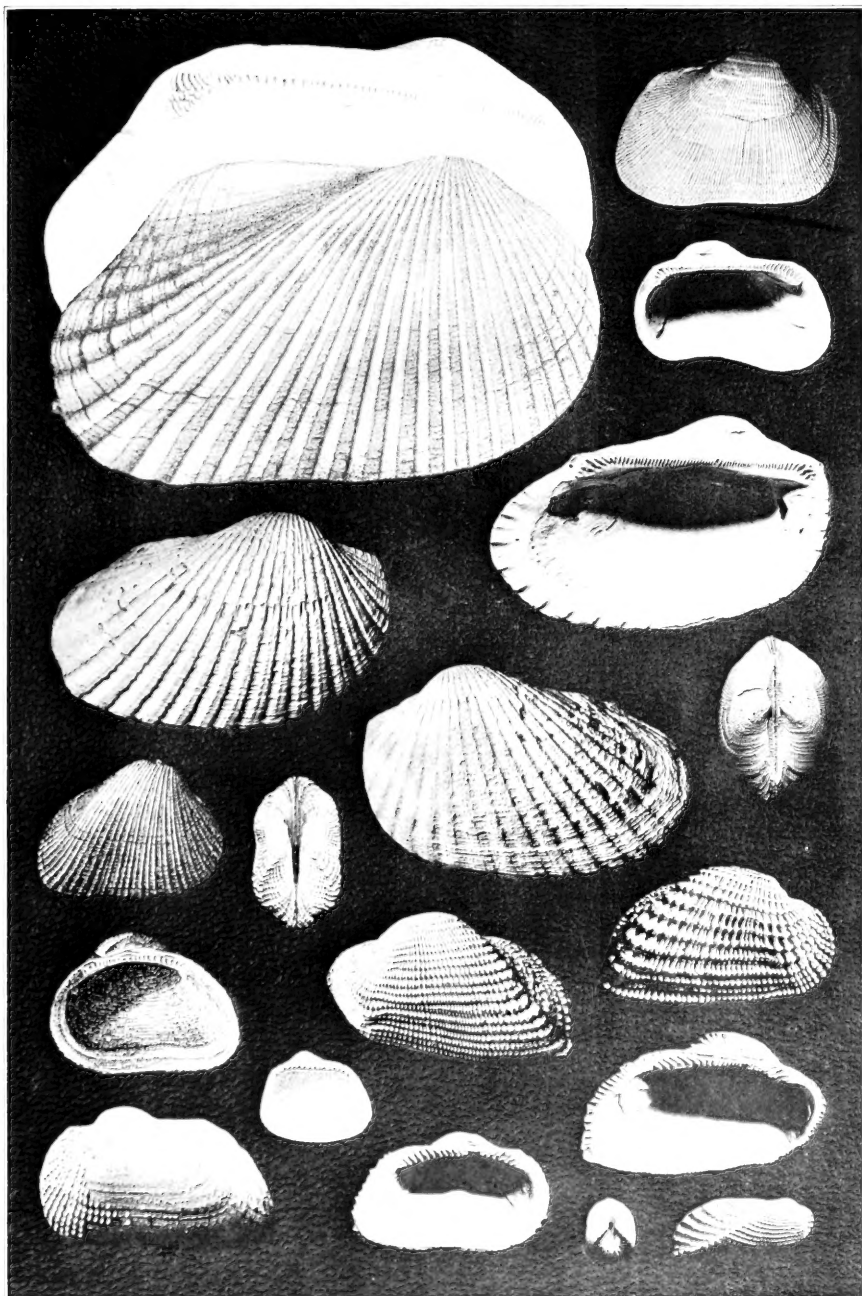




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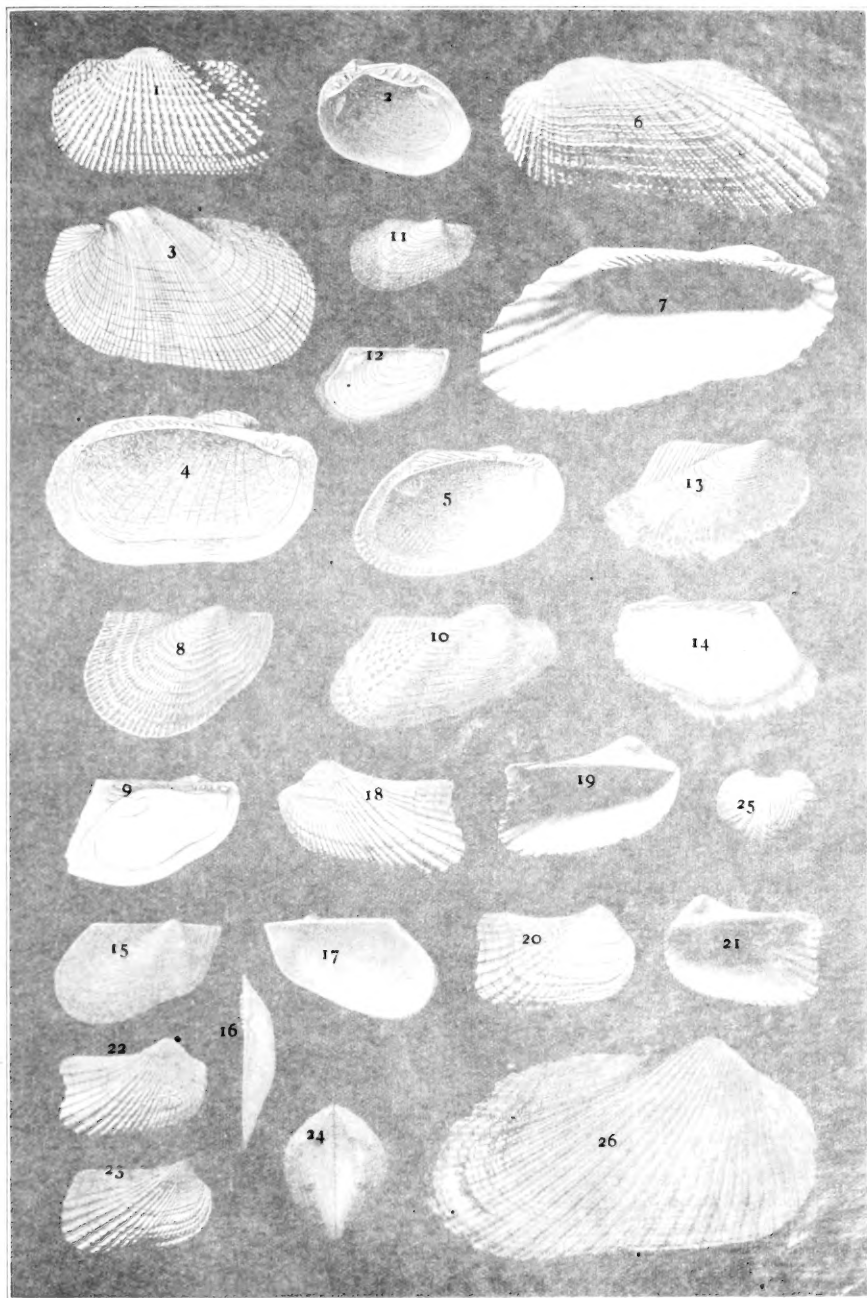


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13, 14. <i>Arca ectocomata</i> Dall..... ^p	24
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19. Interior of the same. The groove extending from the beak to the middle of the hinge marks the posterior limit of the ligament.	
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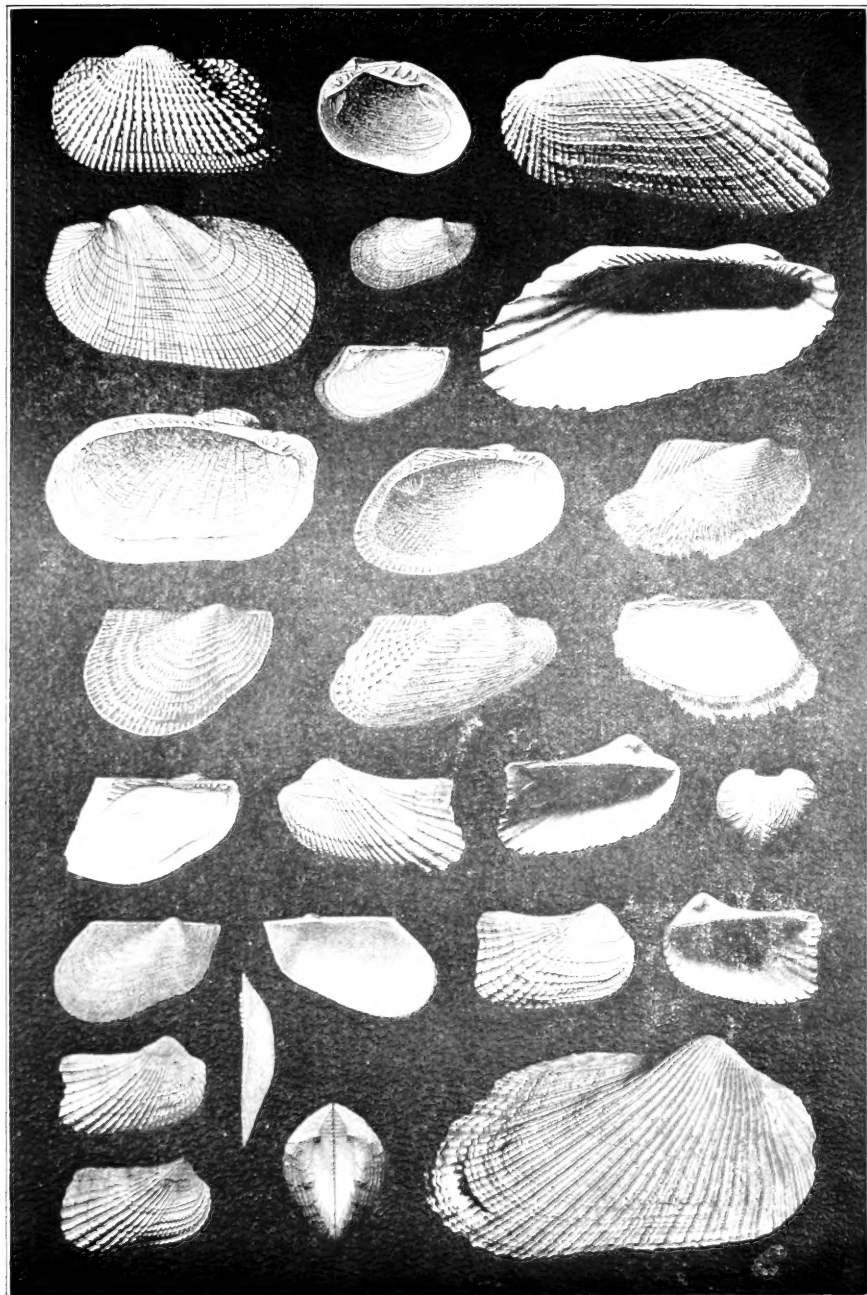




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8. Umbonal view of the same.	
9. <i>Arca ponderosa</i> Say; Pliocene of the Croatan Bed, North Carolina. This form is larger than the recent <i>A. ponderosa</i> and some authors place it in <i>A. limula</i> . It is intermediate between the two species.	
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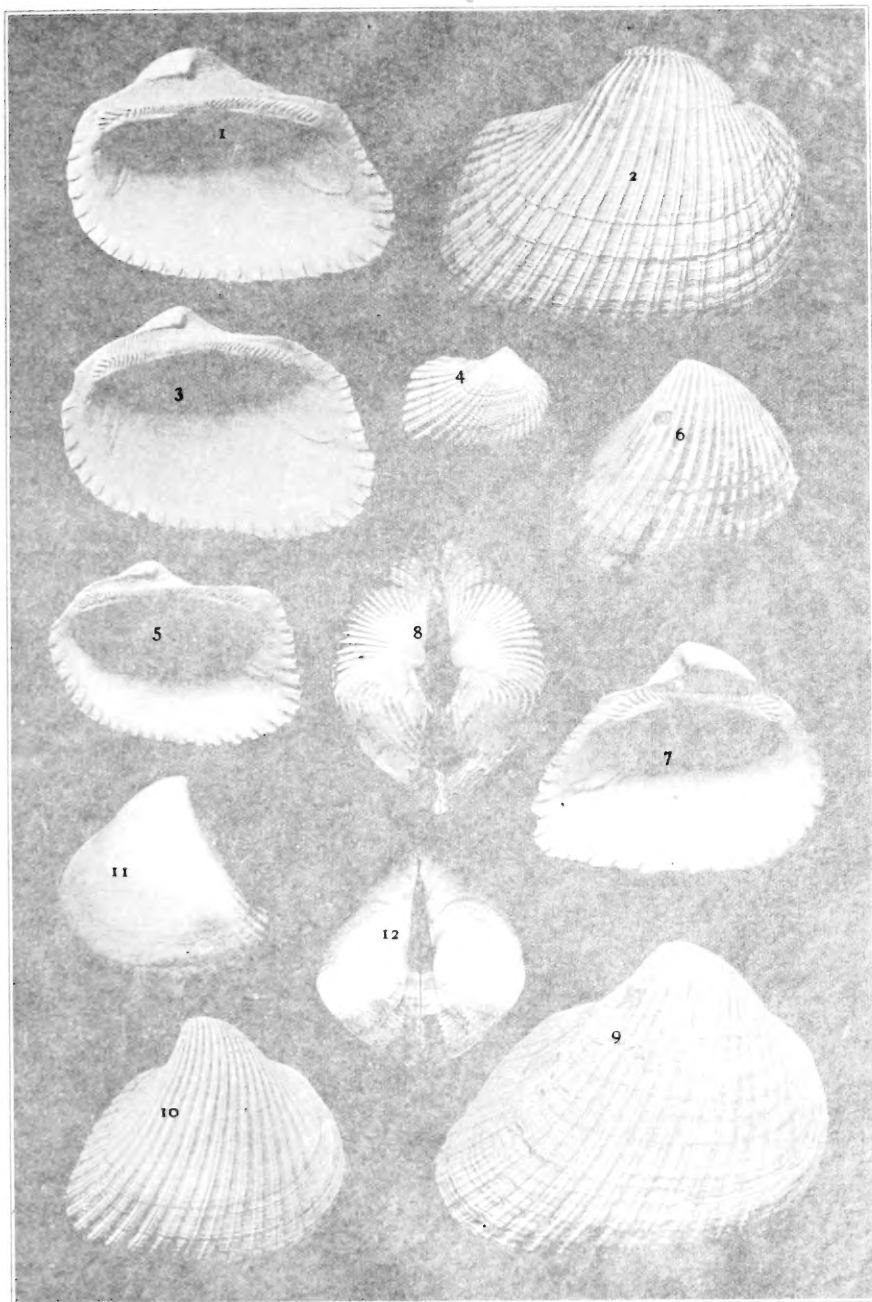


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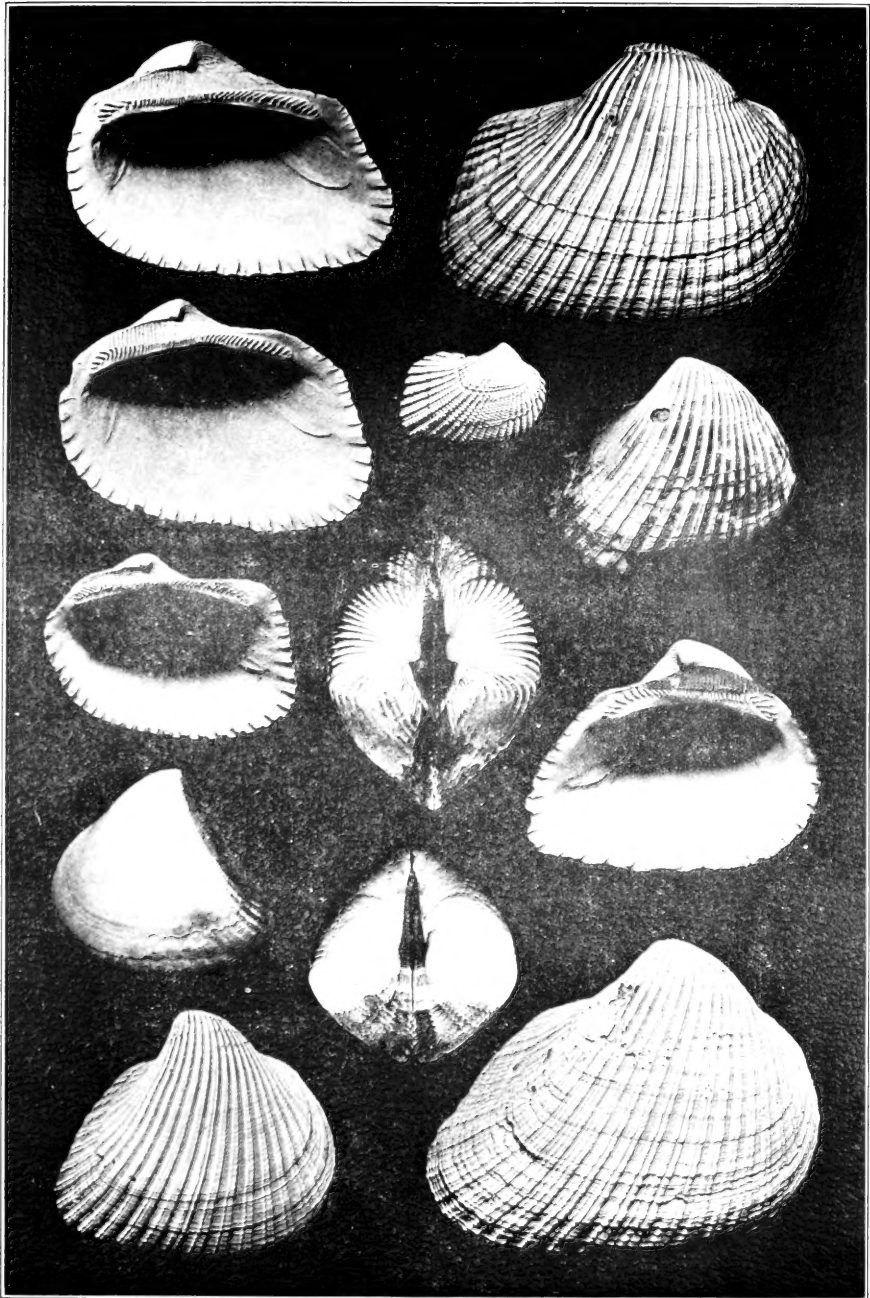




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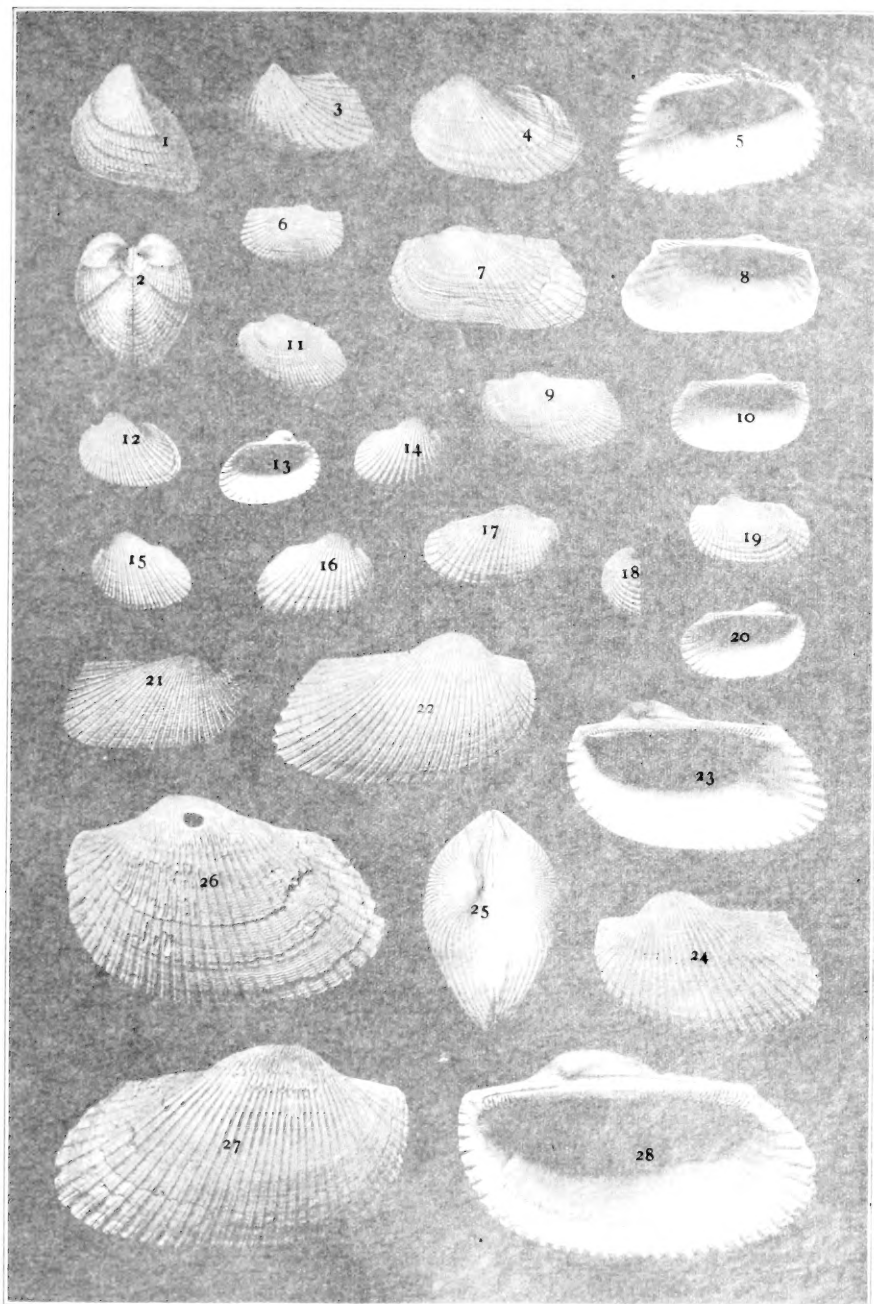


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5. <i>Arca bisulcata</i> Lamarck; recent from Maranhão, Brazil; ×2; showing the toothed margin of the young.	29
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7. <i>Arca rhomboidella</i> Lea; Claiborne of Claiborne, Alabama; a full-grown specimen.	
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Oligocene of Vicksburg, Mississippi. This shows the double beaded ribs of the left valve.	
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18. Anterior end of the same; figured to show the convexity of old individuals.	
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Oligocene of Bailey's Ferry, Florida.	
23. Interior of the same.	
24. <i>Arca hypomela</i> Dall; Oligocene of Bailey's Ferry, Florida; individual with narrow ribs.	
25. Umbonal view of the same.	
26. <i>Arca lienosa</i> Say.....	35
Miocene of Kingsmill, Virginia; a valve with arcuate ventral margin.	
27. <i>Arca lienosa</i> Say; Miocene of North Carolina; a valve with the ventral margin nearly parallel to the hinge.	
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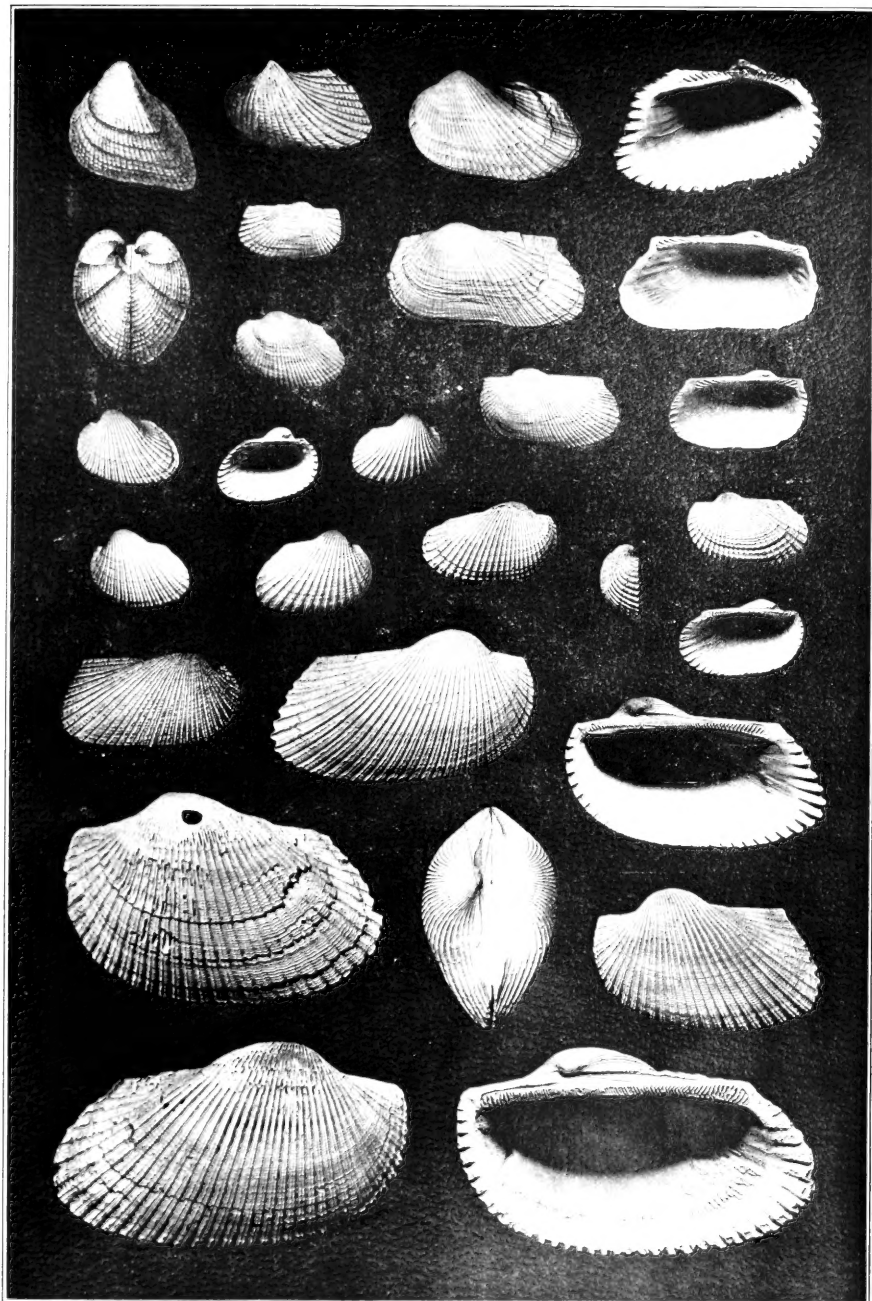




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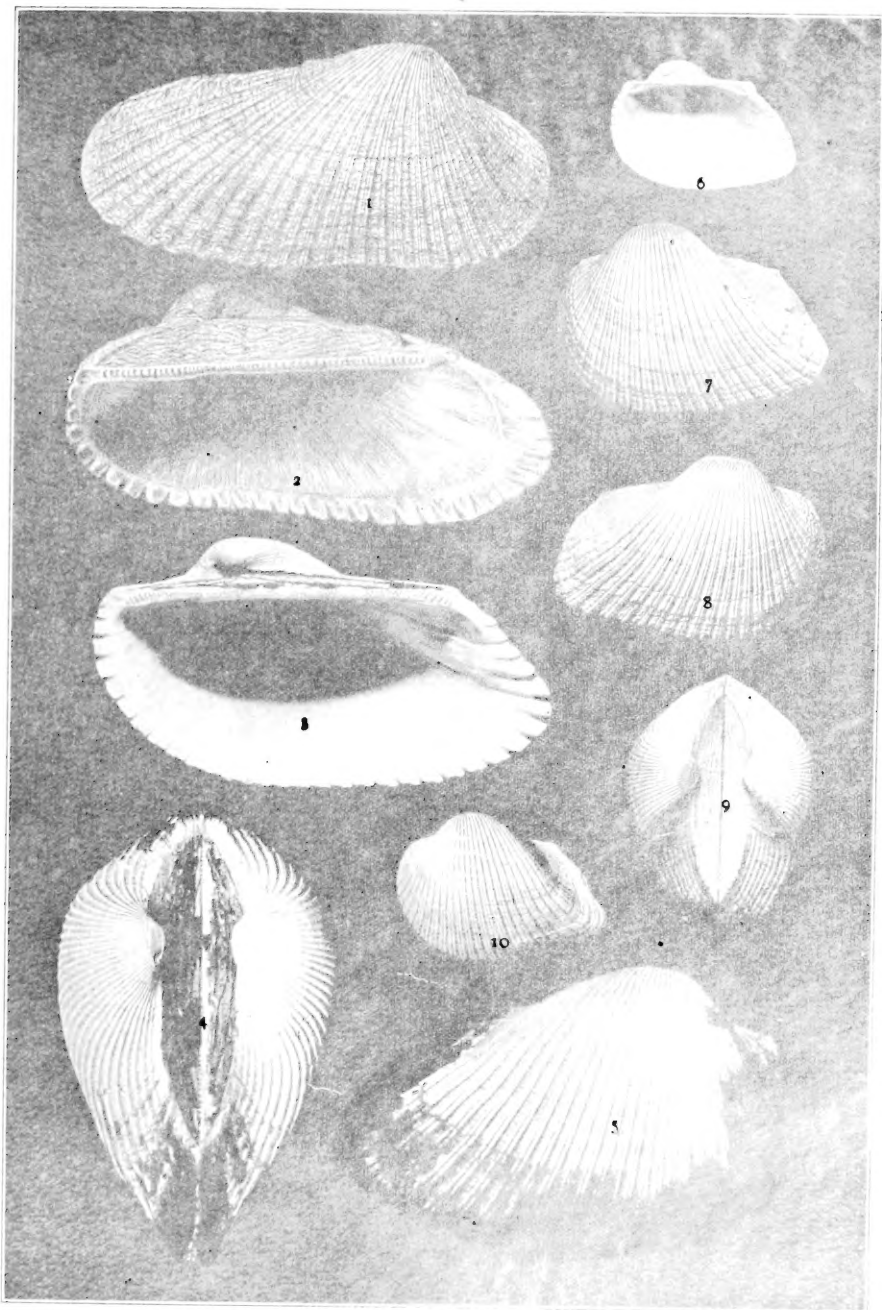


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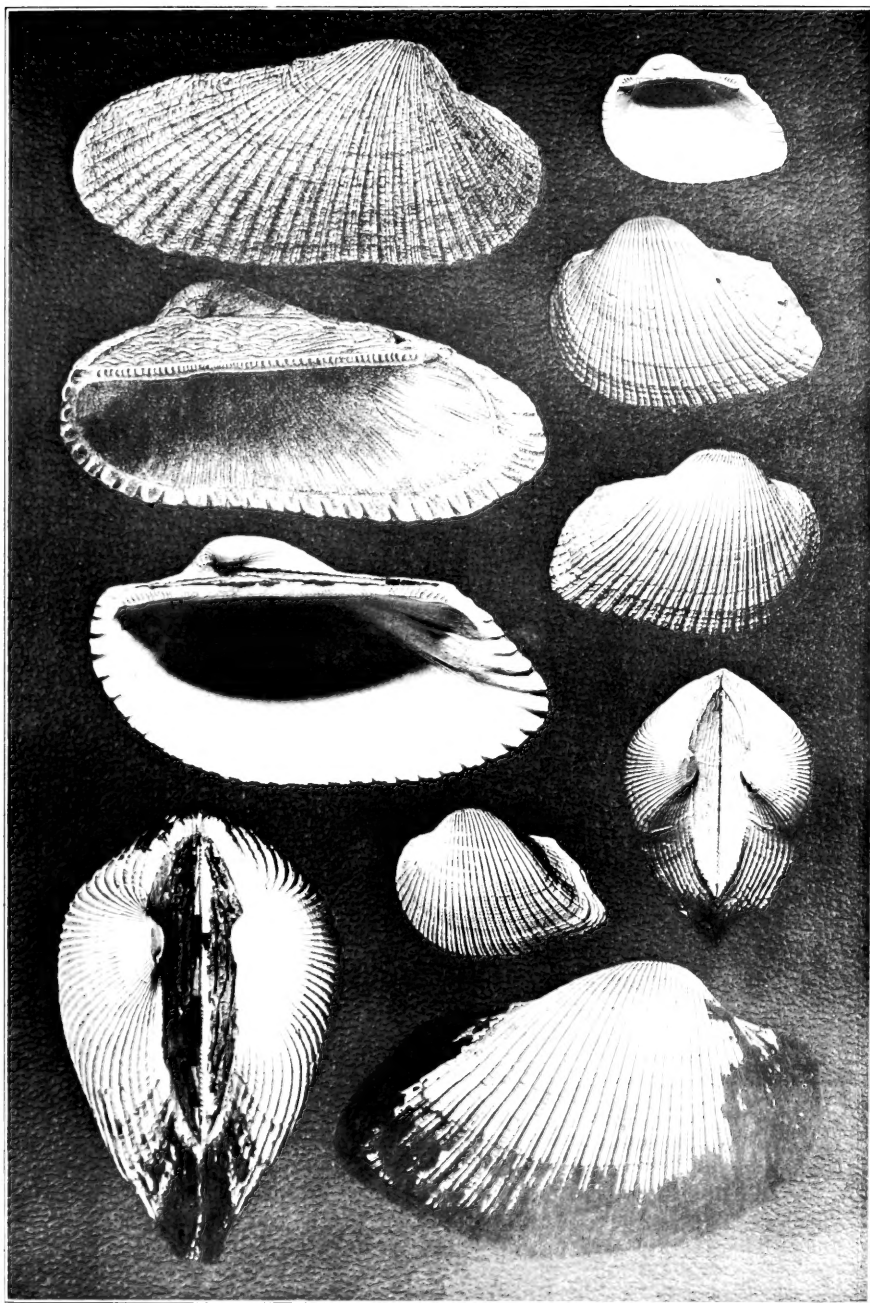






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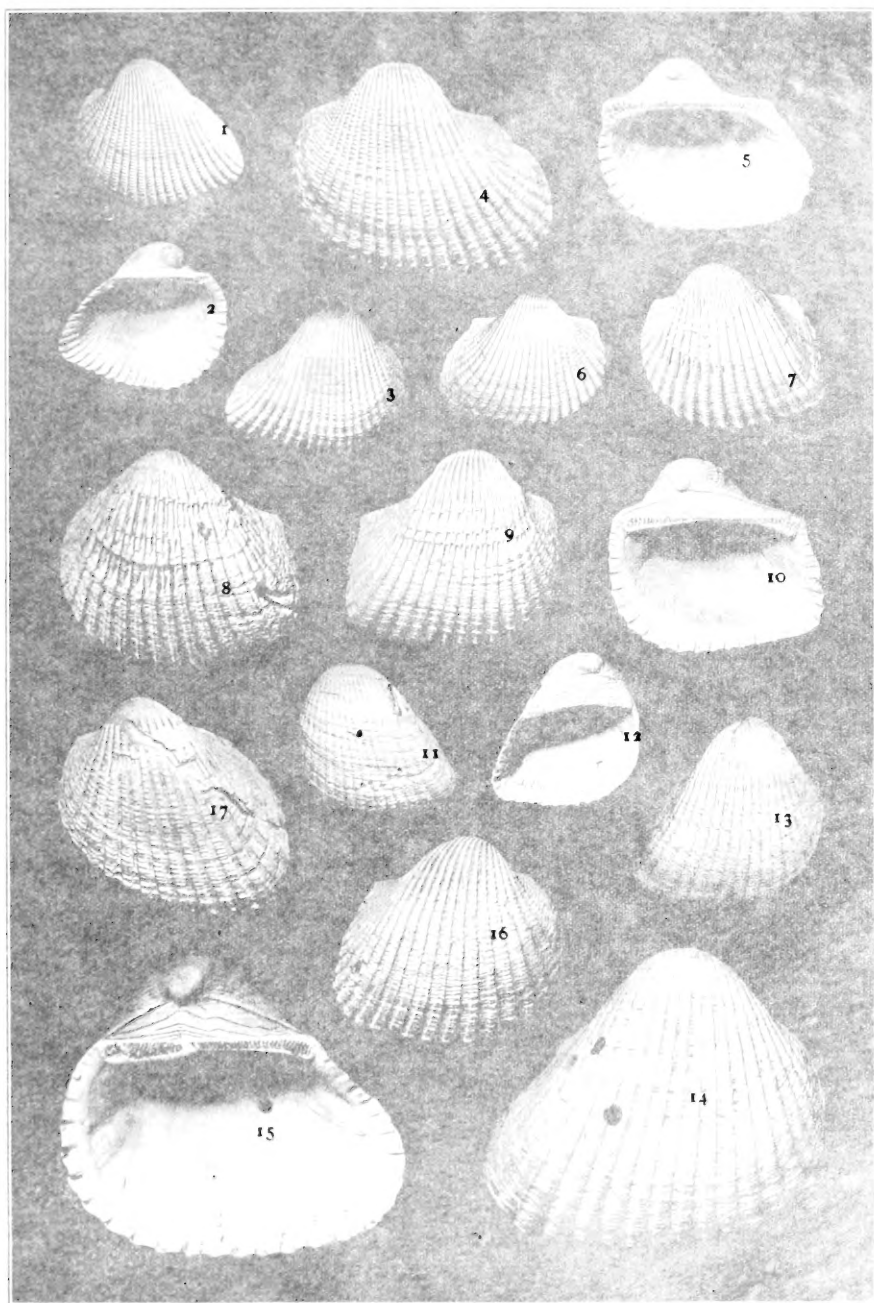


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3. <i>Arca santarosana</i> Dall; Oligocene of Oak Grove, Florida; right valve.	
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Probably from Alum Bluff; the upper part of the posterior margin is slightly broken.	
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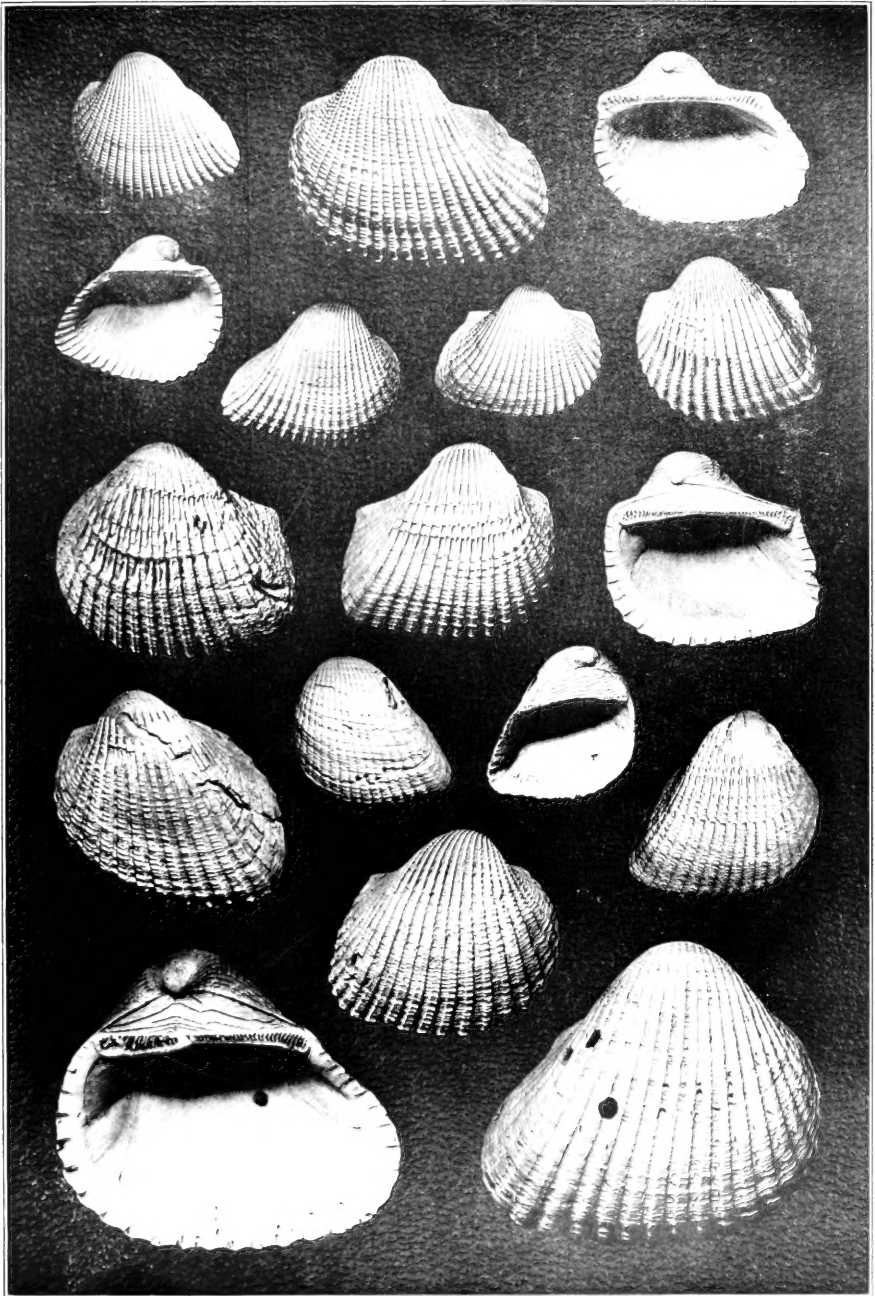




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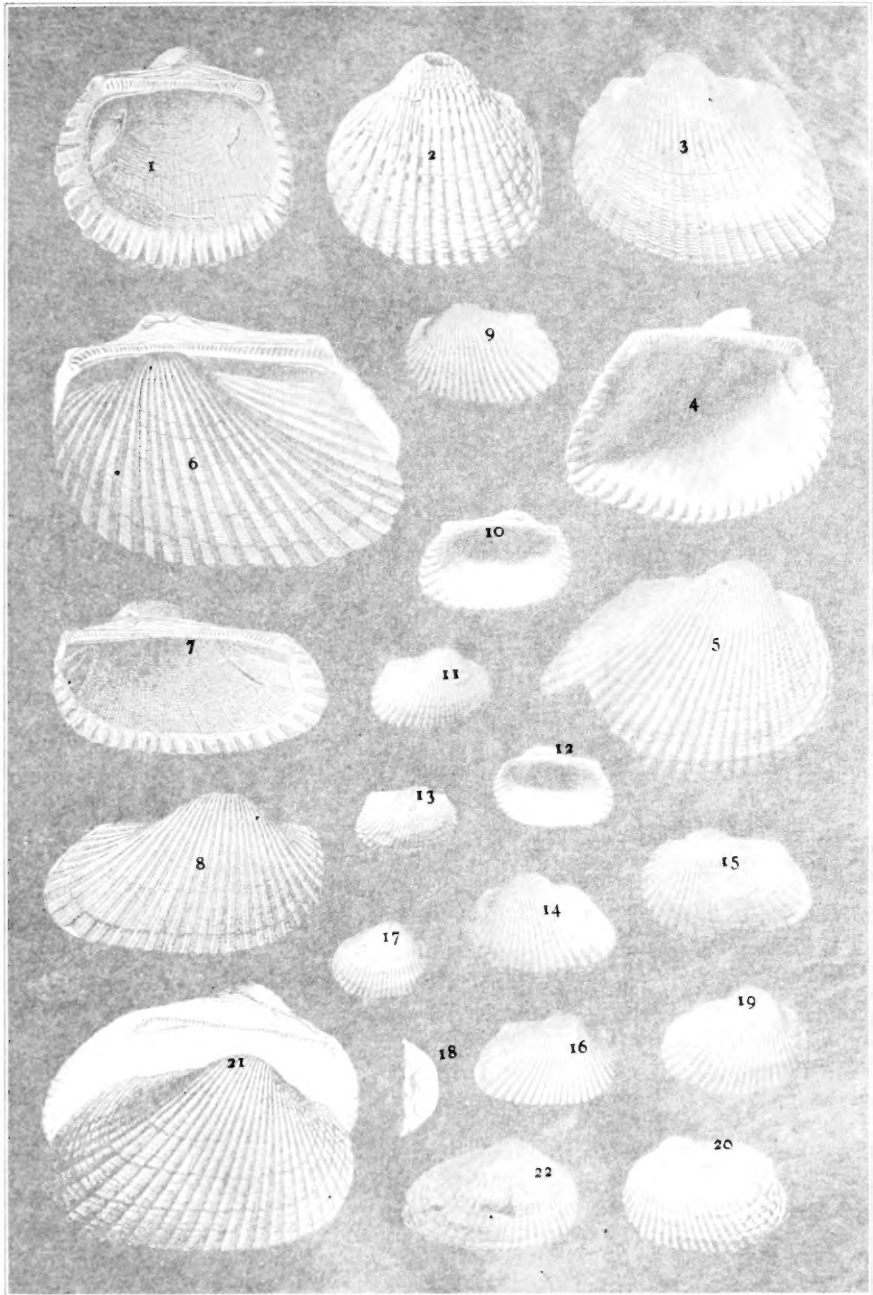


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4. Interior of the same.	
5. <i>Arca callicestosa</i> Dall; Miocene of North Carolina; exterior of a right valve showing the smoother ribs behind the middle.	
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After Say.	
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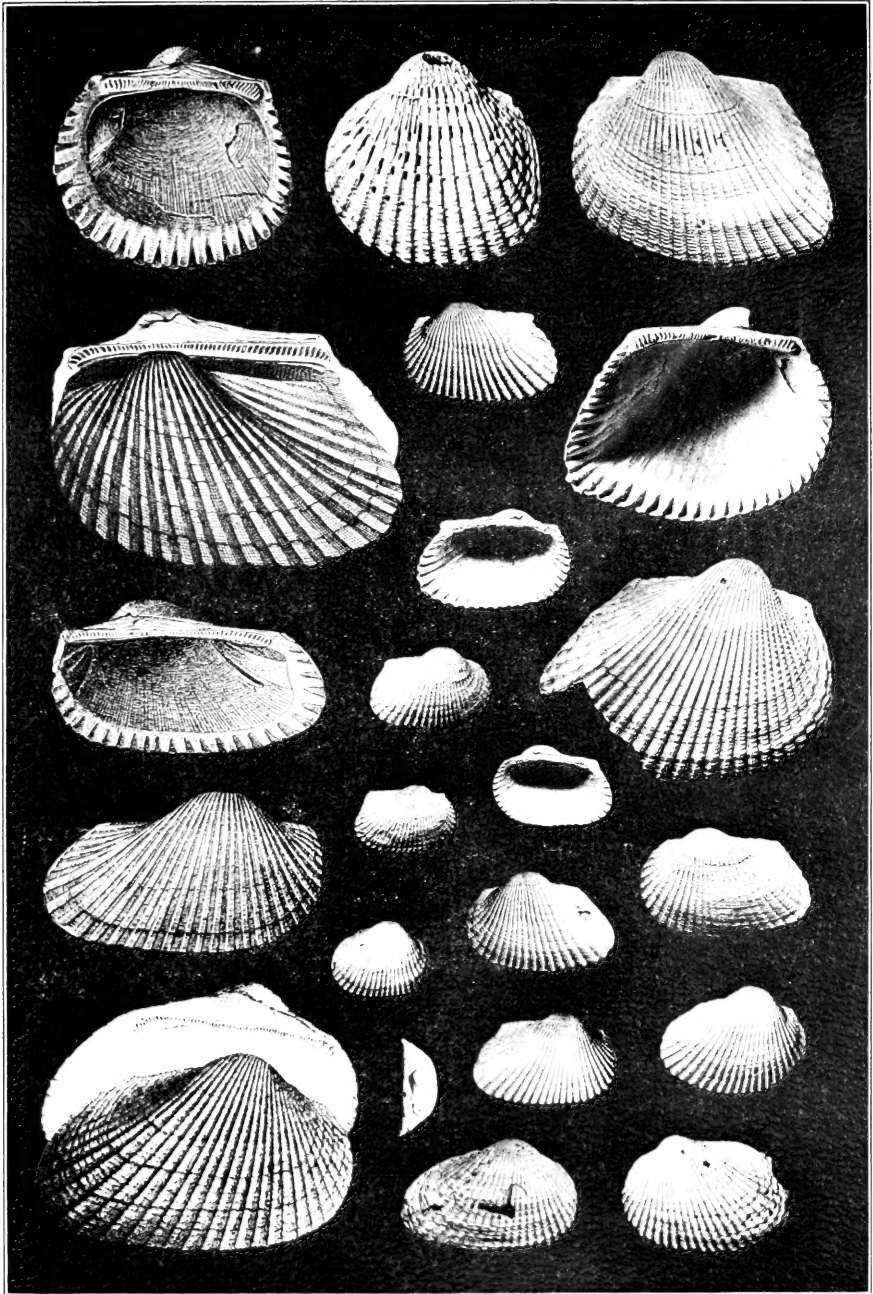




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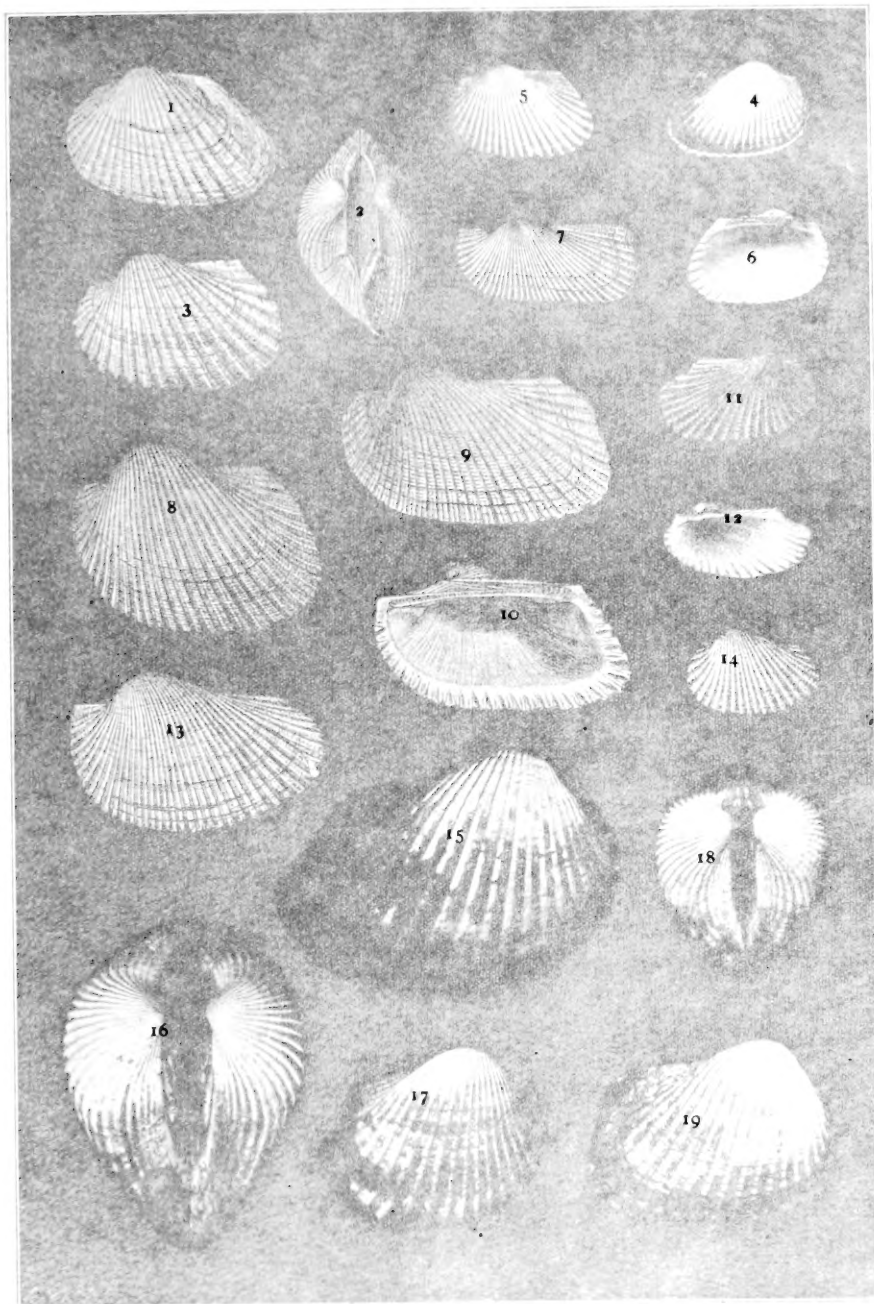
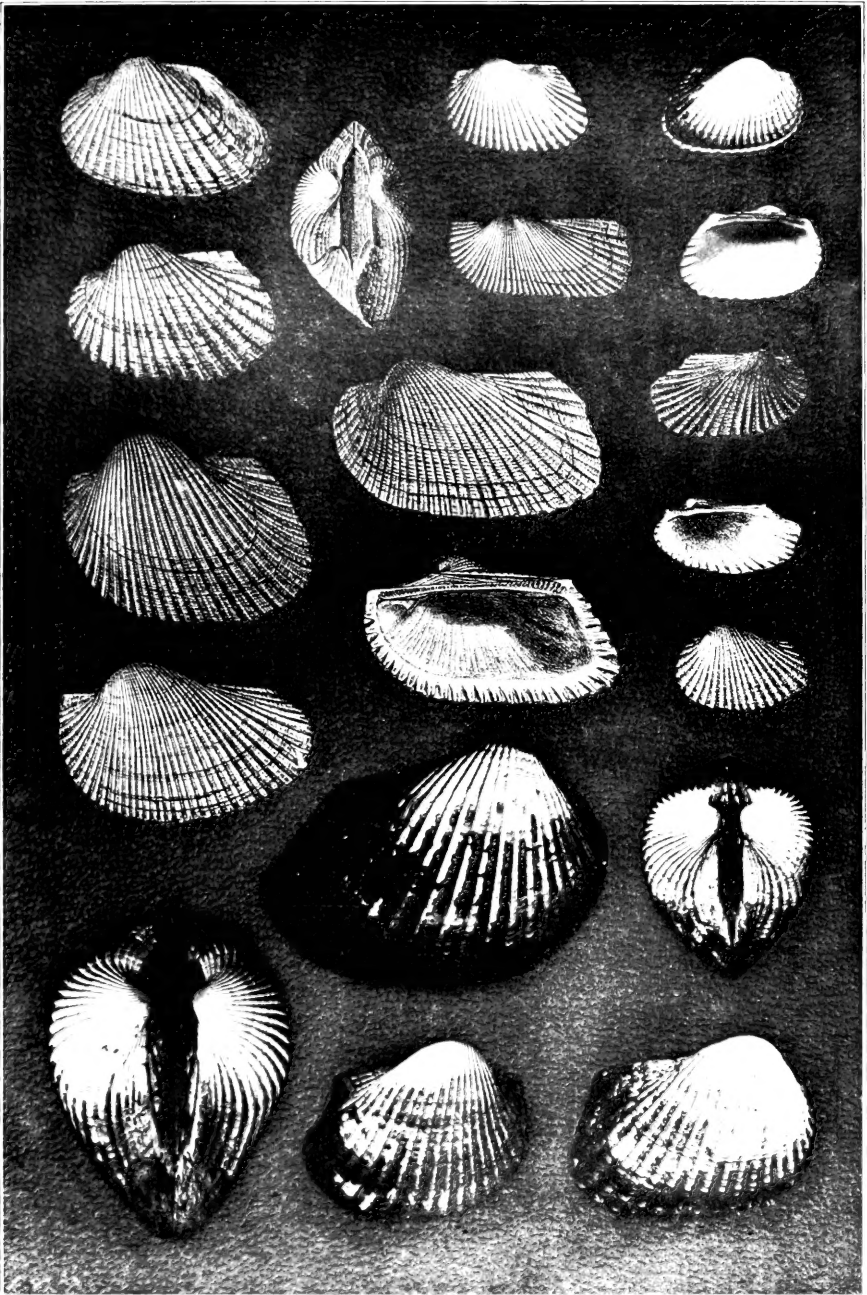


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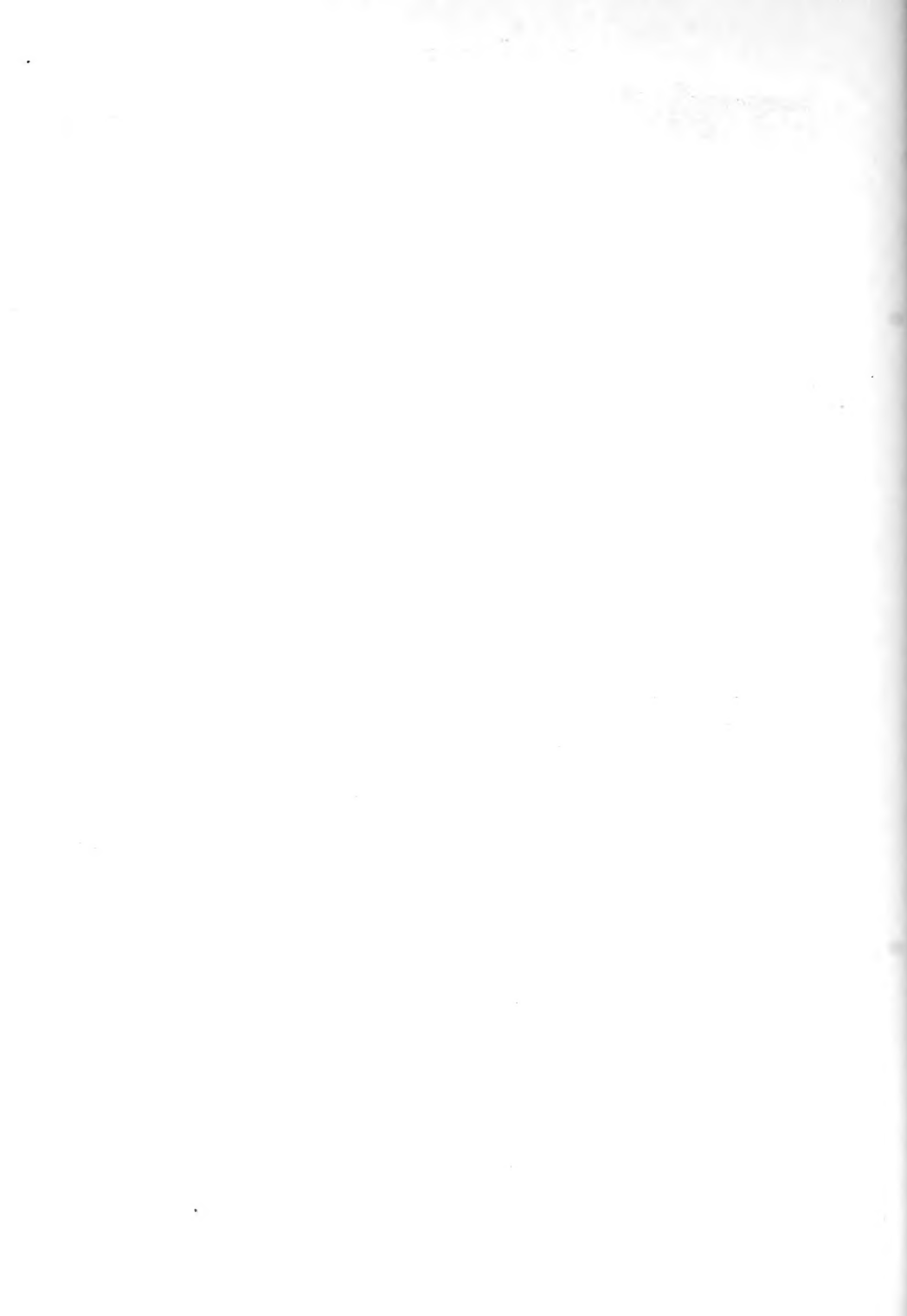
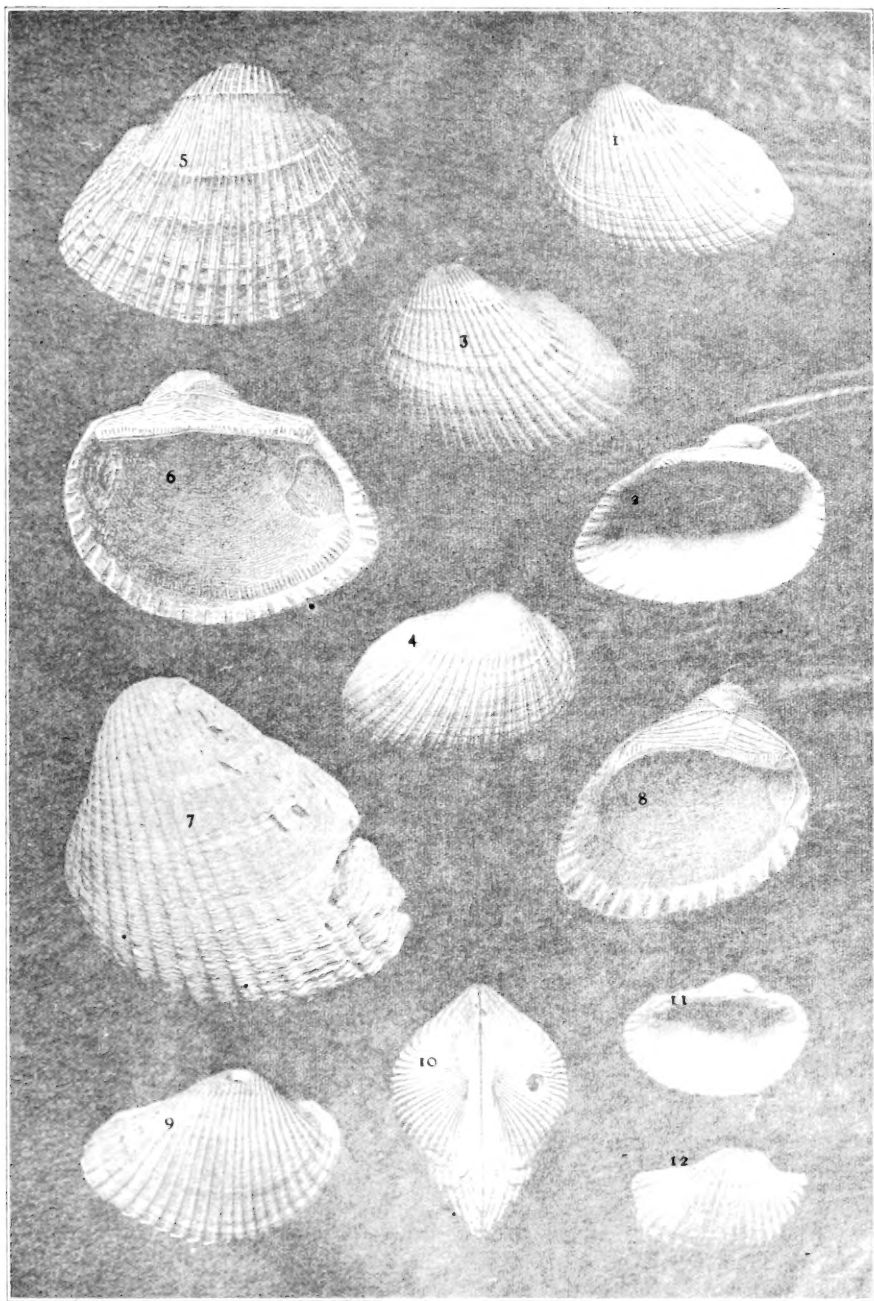


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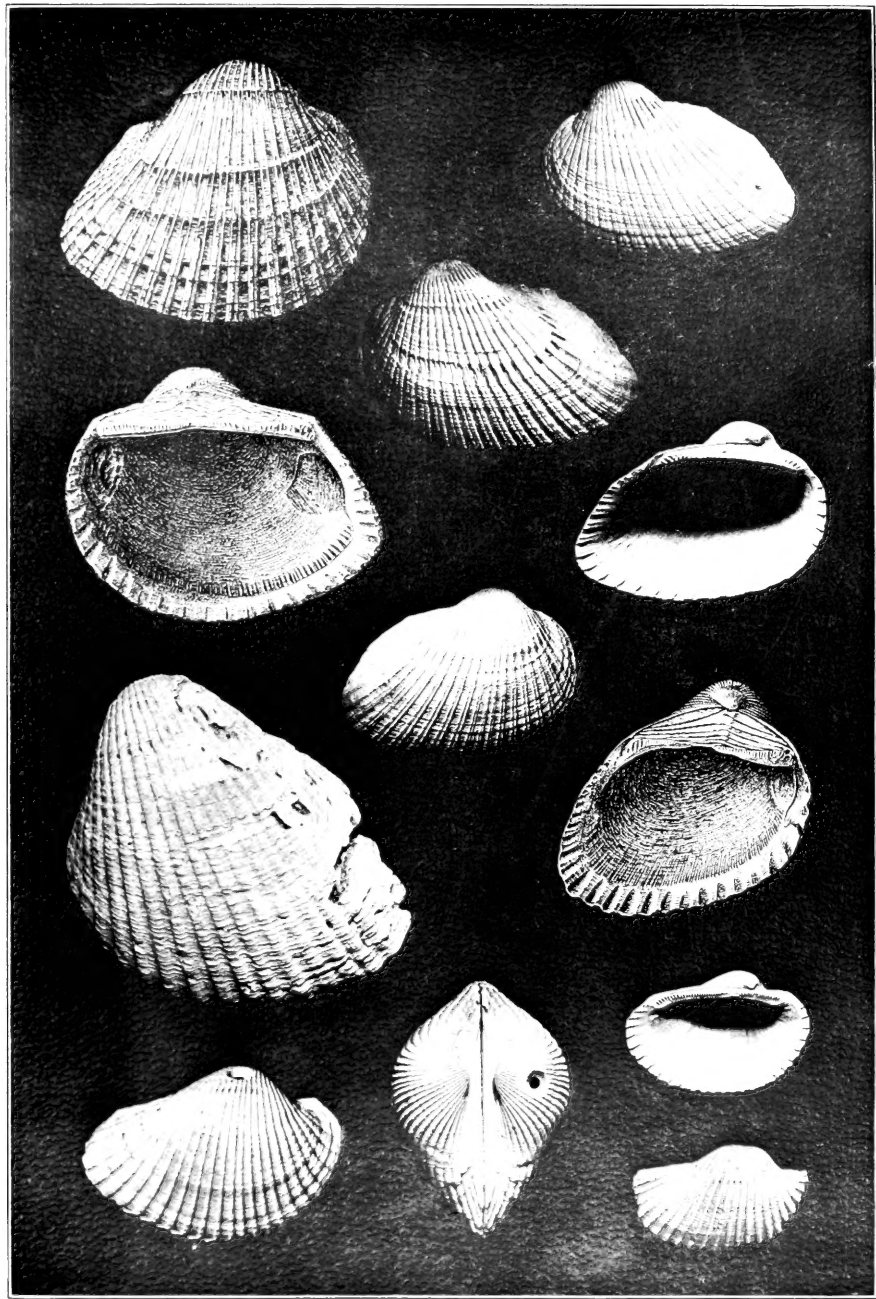




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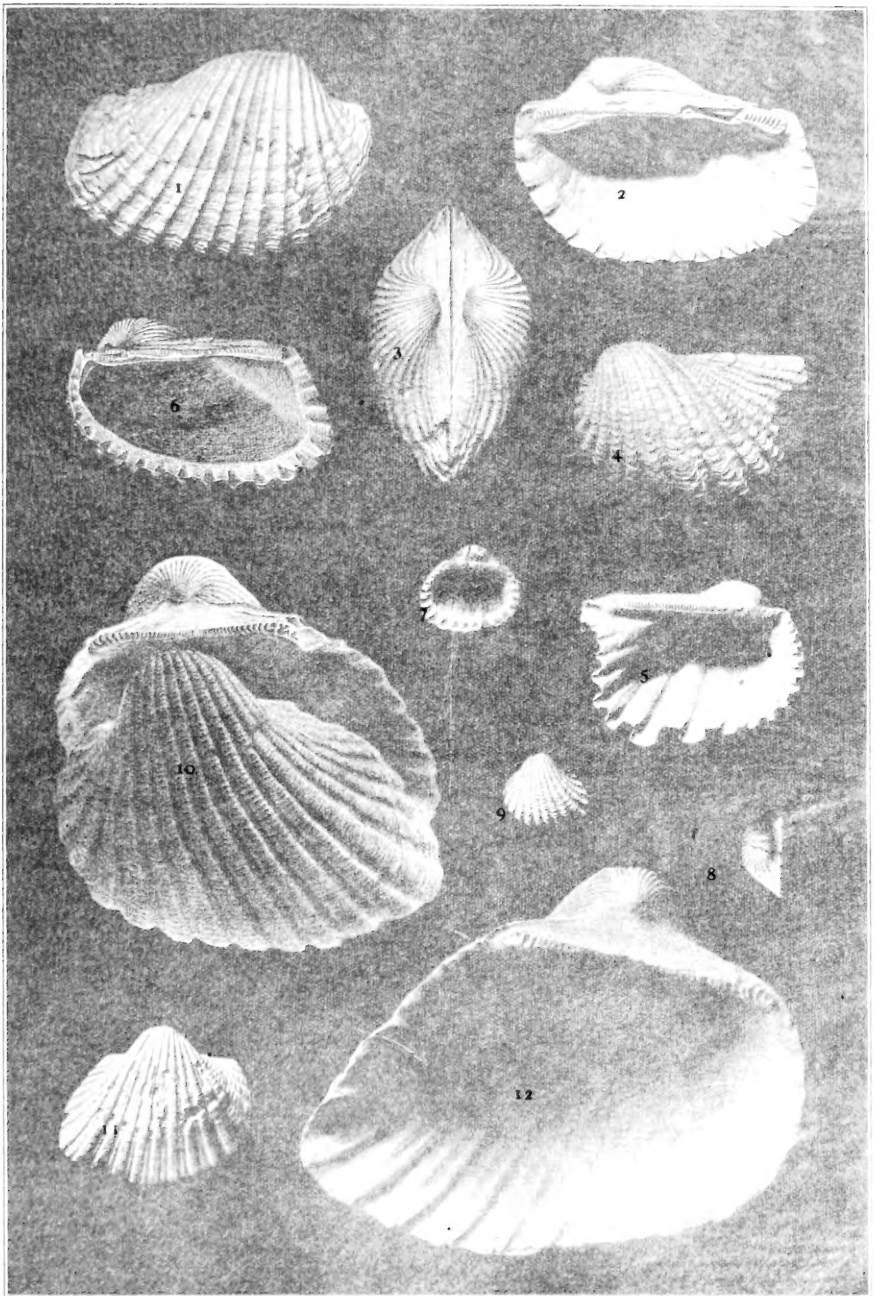


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7. <i>Arca initiator</i> Dall.....	56
Oligocene of Sour Lake, Texas; $\times 2.7$; interior of a large left valve.	
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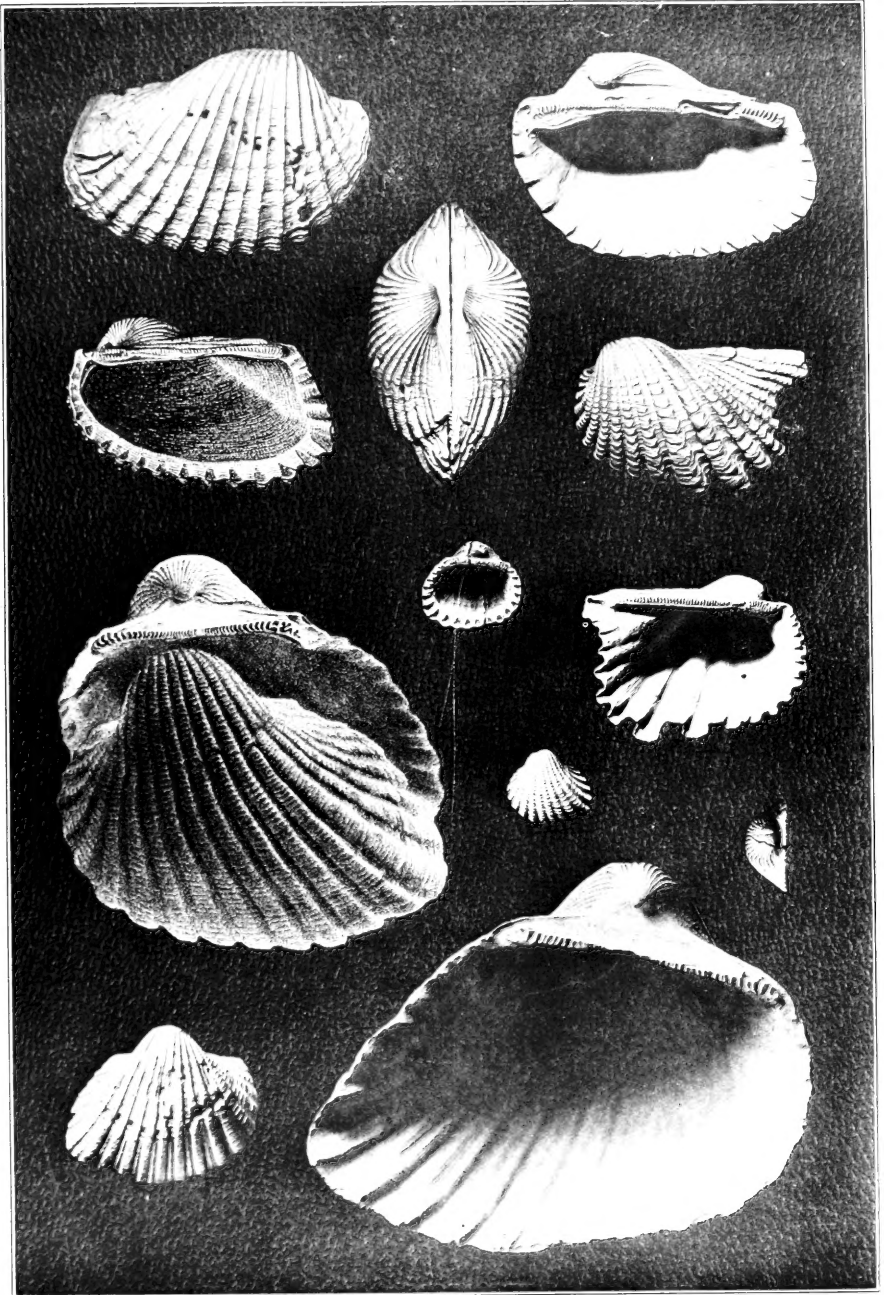
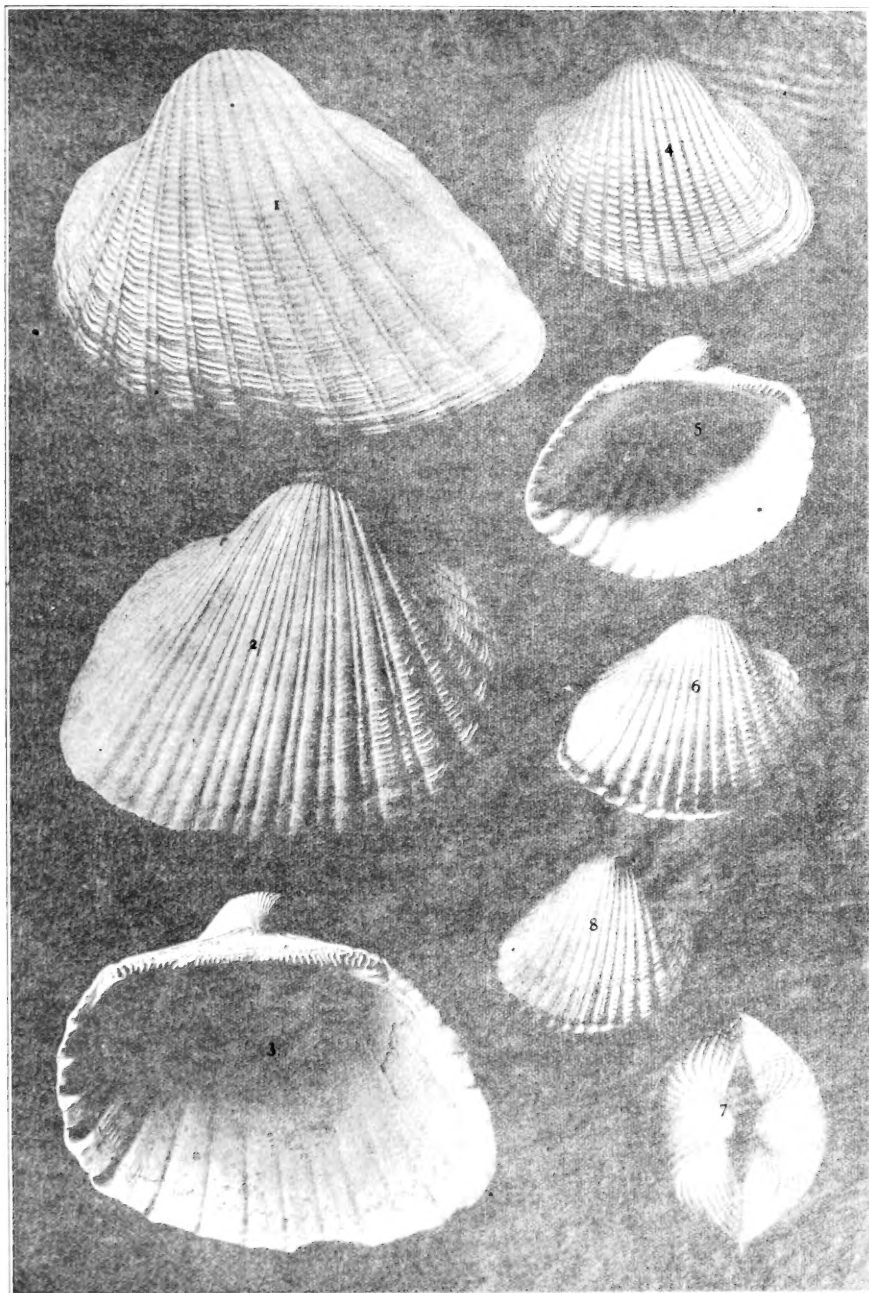




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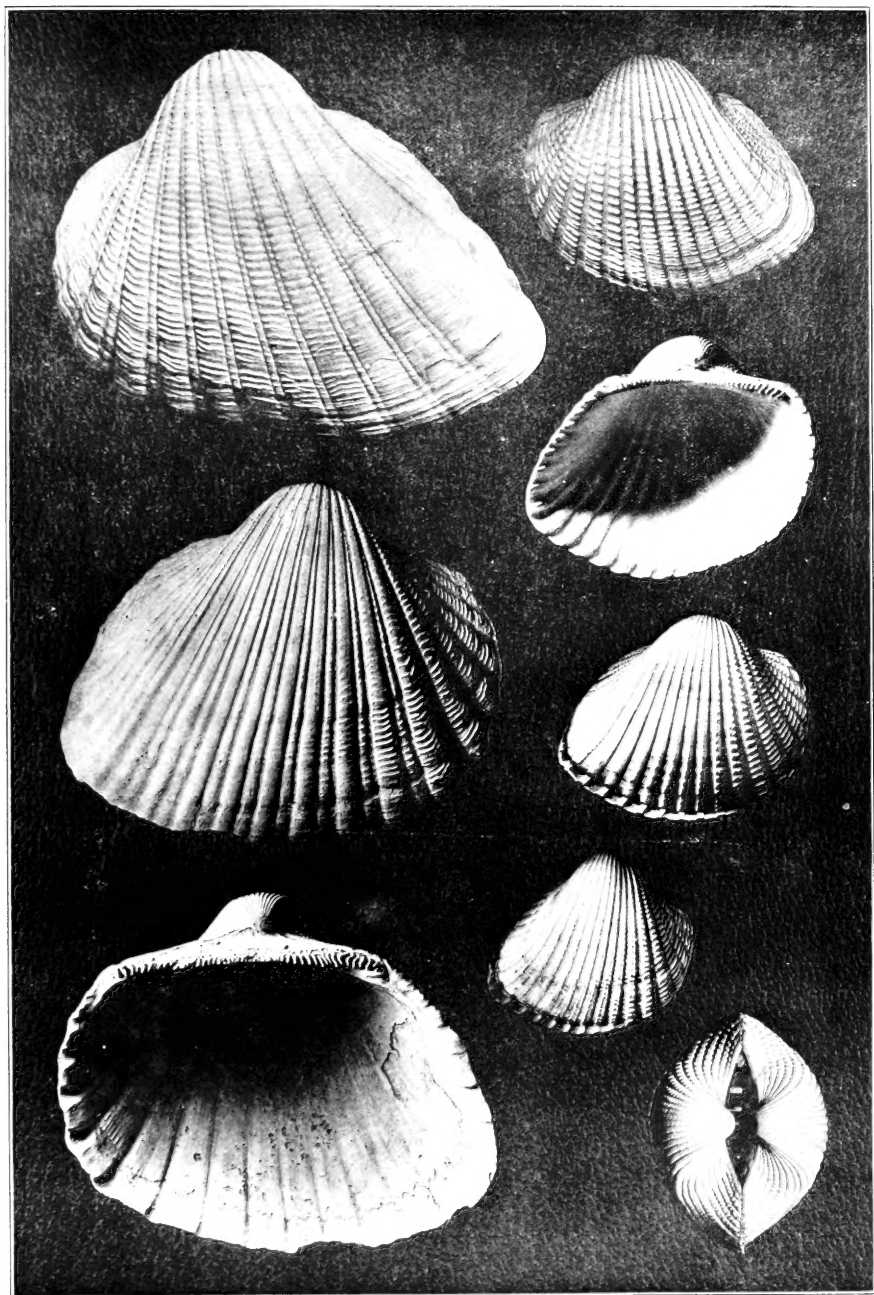
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2. <i>Arca scalarina</i> Heilprin; Pliocene of Shell Creek, Florida; exterior of a right valve lent by the U. S. National Museum. This figure and the preceding show the differences between the two valves in form and sculpture.	
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8. <i>Arca brasiliiana</i> Lamarck.....	59
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Pliocene of Shell Creek, Florida; exterior of the valve figured on plate 13. <i>A. scalarina</i> is the finest of the <i>Cunearcas</i> and illustrates the tendency for the largest members of several groups to appear in the Pliocene.	
2. <i>Arca scalarina</i> Heilprin; Pliocene of Shell Creek, Florida; exterior of a right valve lent by the U. S. National Museum. This figure and the preceding show the differences between the two valves in form and sculpture.	
3. Interior of the same.	
4. <i>Arca incongrua</i> Say.....	59
Recent from Florida; exterior of a left valve.	
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6. <i>Arca incongrua</i> Say; recent from Florida; right side showing the ribbing of the right valve and the extension of the left valve beyond the right.	
7. <i>Arca incongrua</i> Say; recent from Florida; umbonal view. Strips of the ligament are torn off. There are no diagonal grooves, but the ligament tends to break up into transverse strips when dry.	
8. <i>Arca brasiliiana</i> Lamarck.....	59
Recent from Aspinwall. This figure shows the simulated sulcus on the anterior side of the umbo.	



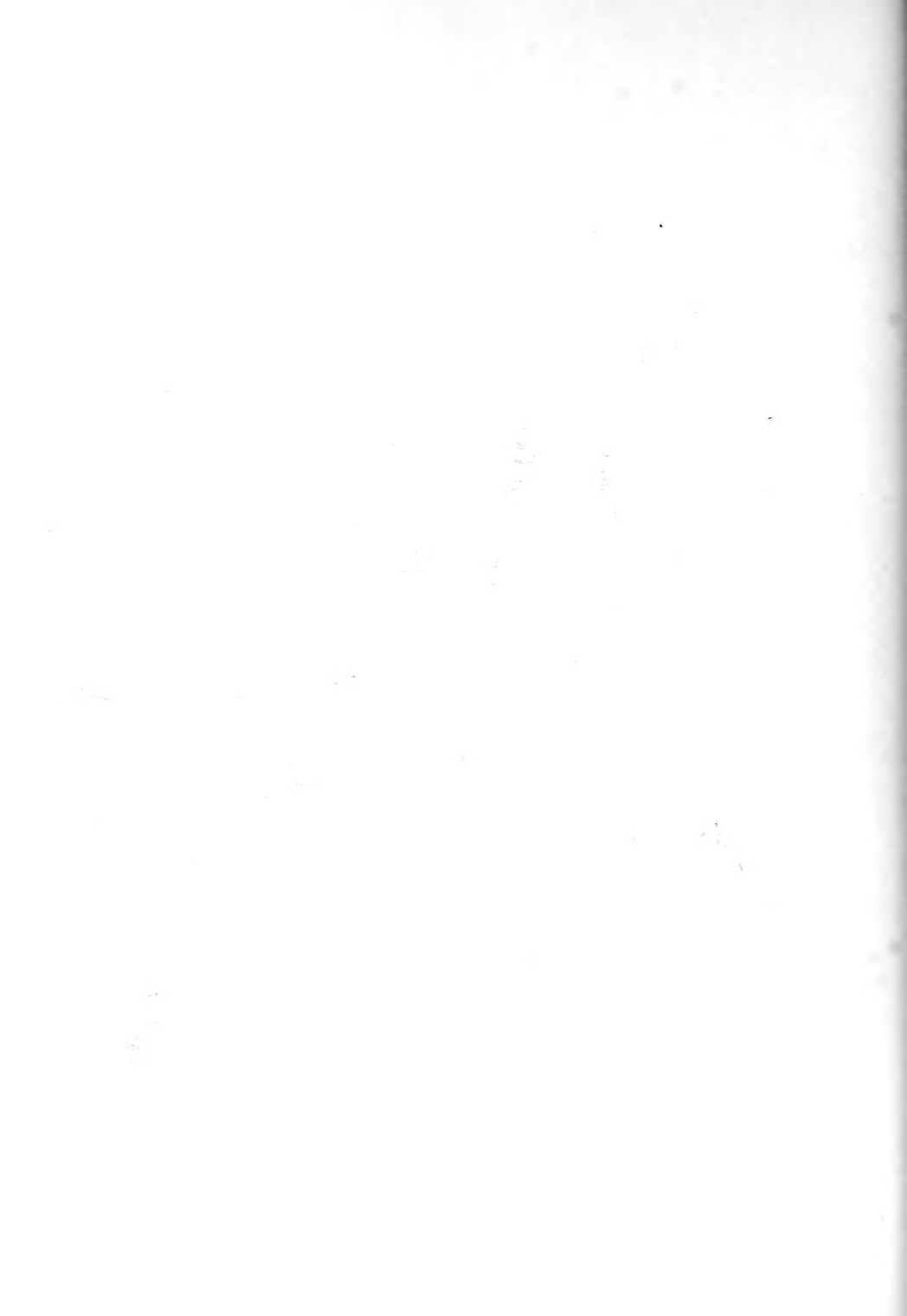


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3. <i>Arca Chemnitzii</i> Philippi	60
Recent from Aspinwall.	
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4. <i>Arca Chemnitzii</i> Philippi ; recent from Aspinwall.	
The ribs are less nodular near the umbonal ridge on the right valve, but the discrepancy is not so great as in <i>A. incongrua</i> , <i>brasilitana</i> and other <i>Cunearcas</i> . Neither is the extension of the left valve beyond the right very great. On some specimens there is a small diamond-shaped groove, or even two, at the center of the ligament area. Otherwise the cardinal area is typical of <i>Cunearca</i> .	
5. <i>Arca filicata</i> Guppy	61
"Manzanilla, Trinidad." After Guppy.	
6. <i>Arca campechensis</i> Dillwyn	61
Recent from Aspinwall ; typical form.	
7. Umbonal view of the same.	
8. <i>Arca campechensis</i> Dillwyn ; recent from Point-au-Fer, Louisiana ; a <i>Cardium</i> -like form with grooved ribs.	
9. <i>Arca campechensis</i> Dillwyn ; Pleistocene of Georgetown, South Carolina. This is an example of the variety <i>americana</i> .	
10. <i>Arca campechensis</i> Dillwyn ; recent from South Carolina ; umbonal view of var. <i>americana</i> . The dark patch just behind the left beak is a stain. The patch a little farther back is ligament. The posterior portion of the narrow ligament is gone, exposing the teeth. There are fringes of epidermis between the anterior ribs.	
11. <i>Arca campechensis</i> Dillwyn ; recent from Mobile, Alabama. This form may be classed as var. <i>pexata</i> .	
12. Umbonal view of the same.	
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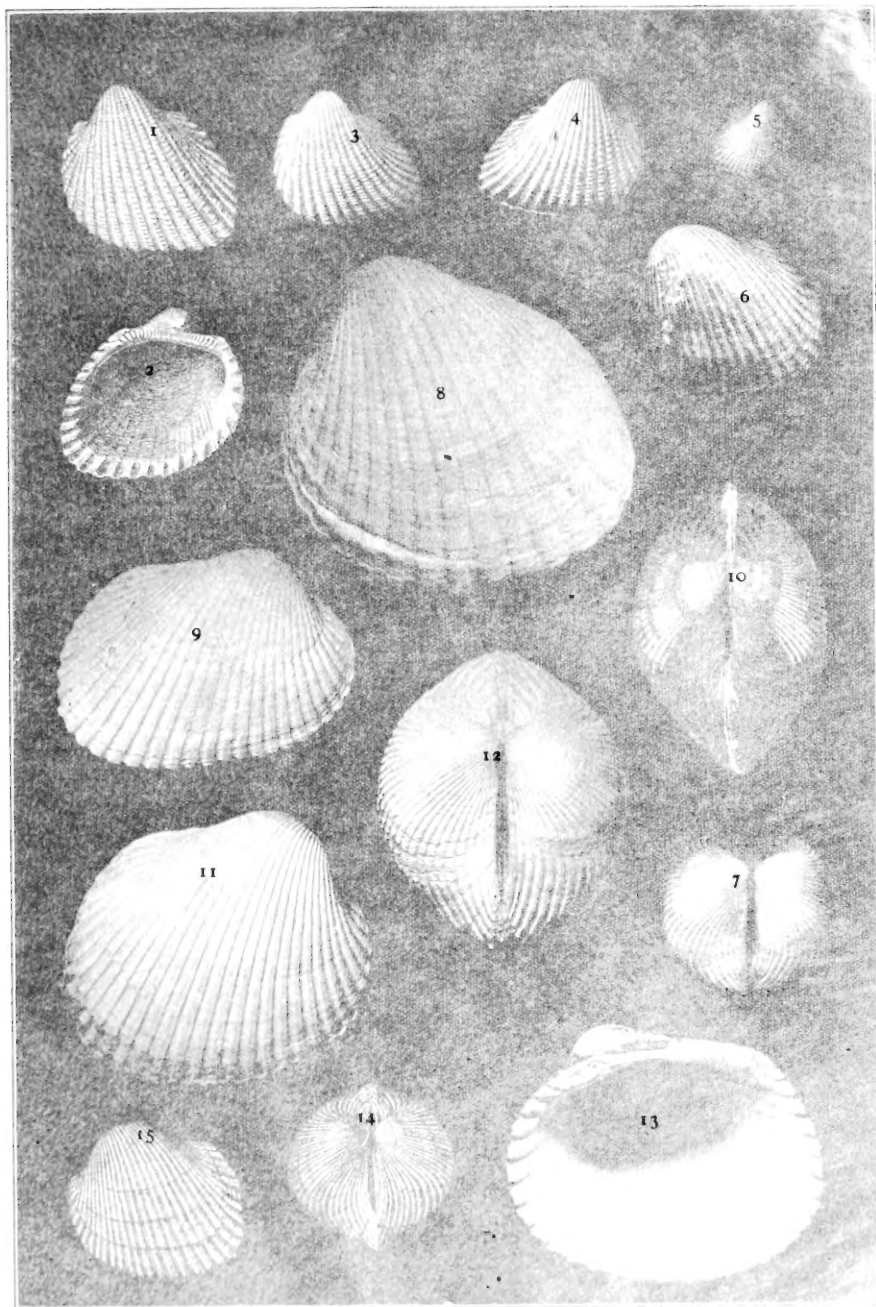


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3. <i>Arca Chemnitzii</i> Philippi..... Recent from Aspinwall. All the ribs of the left valve are nodular, though the distal parts of the posterior ribs tend to be smoother.	60
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5. <i>Arca flicata</i> Guppy..... "Manzanilla, Trinidad." After Guppy.	61
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7. Umbonal view of the same.	
8. <i>Arca campechensis</i> Dillwyn; recent from Point-au-Fer, Louisiana; a <i>Cardium</i> -like form with grooved ribs.	
9. <i>Arca campechensis</i> Dillwyn; Pleistocene of Georgetown, South Carolina. This is an example of the variety <i>americana</i> .	
10. <i>Arca campechensis</i> Dillwyn; recent from South Carolina; umbonal view of var. <i>americana</i> . The dark patch just behind the left beak is a stain. The patch a little farther back is ligament. The posterior portion of the narrow ligament is gone, exposing the teeth. There are fringes of epidermis between the anterior ribs.	
11. <i>Arca campechensis</i> Dillwyn; recent from Mobile, Alabama. This form may be classed as var. <i>pevata</i> .	
12. Umbonal view of the same.	
13. <i>Arca campechensis</i> Dillwyn; recent; view of the interior to show the teeth. The posterior part of the ligament is gone.	
14. <i>Arca tolepis</i> Dall..... "Oligocene of Bowden, Jamaica; dorsal view; 28 mm." After Dall.	63
15. <i>Arca tolepis</i> Dall. "The same, side view." After Dall.	

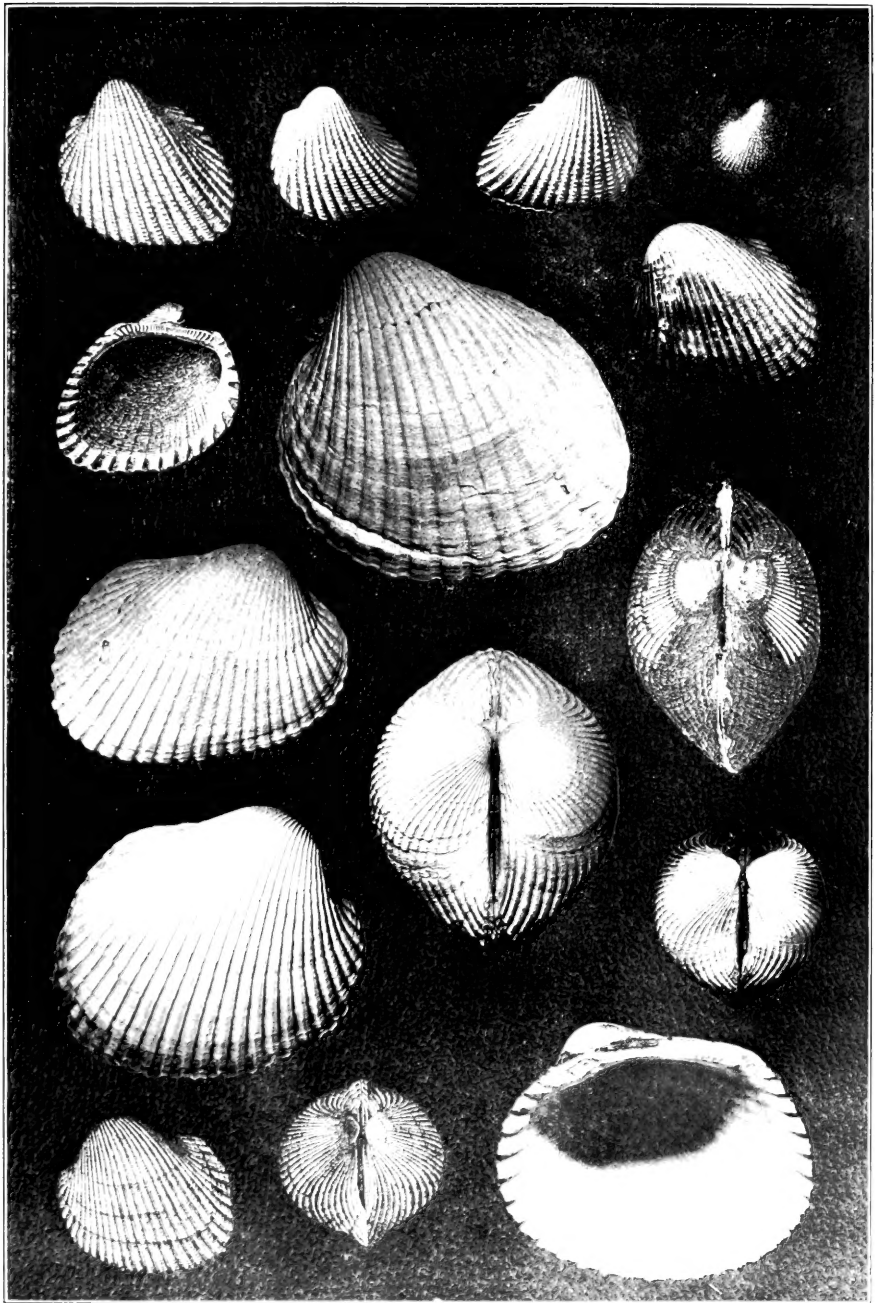




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"Pliocene of Tehuantepec; restored left valve; 18 mm." After Dall.	
3. <i>Arca Spenceri</i> Dall. "Pliocene of Tehuantepec; hinge of right valve; 16 mm." After Dall.	
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"5.75." After Dall.	
5. <i>Arca glomerula</i> Dall. After Dall.	
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"9.75." After Dall.	
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8. " <i>Arca pectunculoides</i> var. <i>orbiculata</i> Dall; 8.o.".....	65
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9. <i>Arca pectunculoides</i> Scacchi.....	65
Recent from Finmark; \times 4.4. The posterior ribbing is obscured by the illumination. It is similar to that of the rest of the shell.	
10. Umbonal view of the same; \times 3.8. The ligament occupies only the posterior part of the cardinal area.	
11. <i>Arca pectunculoides</i> Scacchi; recent from Finmark; \times 4.4. The light streak down the posterior slope was caused by the light used for illumination passing through the thin shell.	
12. <i>Arca glacialis</i> Gray.....	65
Uddevalla, Sweden; \times 2.63; probably Pleistocene. The anterior sculpture is like that on the rest of the shell. To the naked eye this shell appears finely radially striate, but magnification brings out an even reticulation.	
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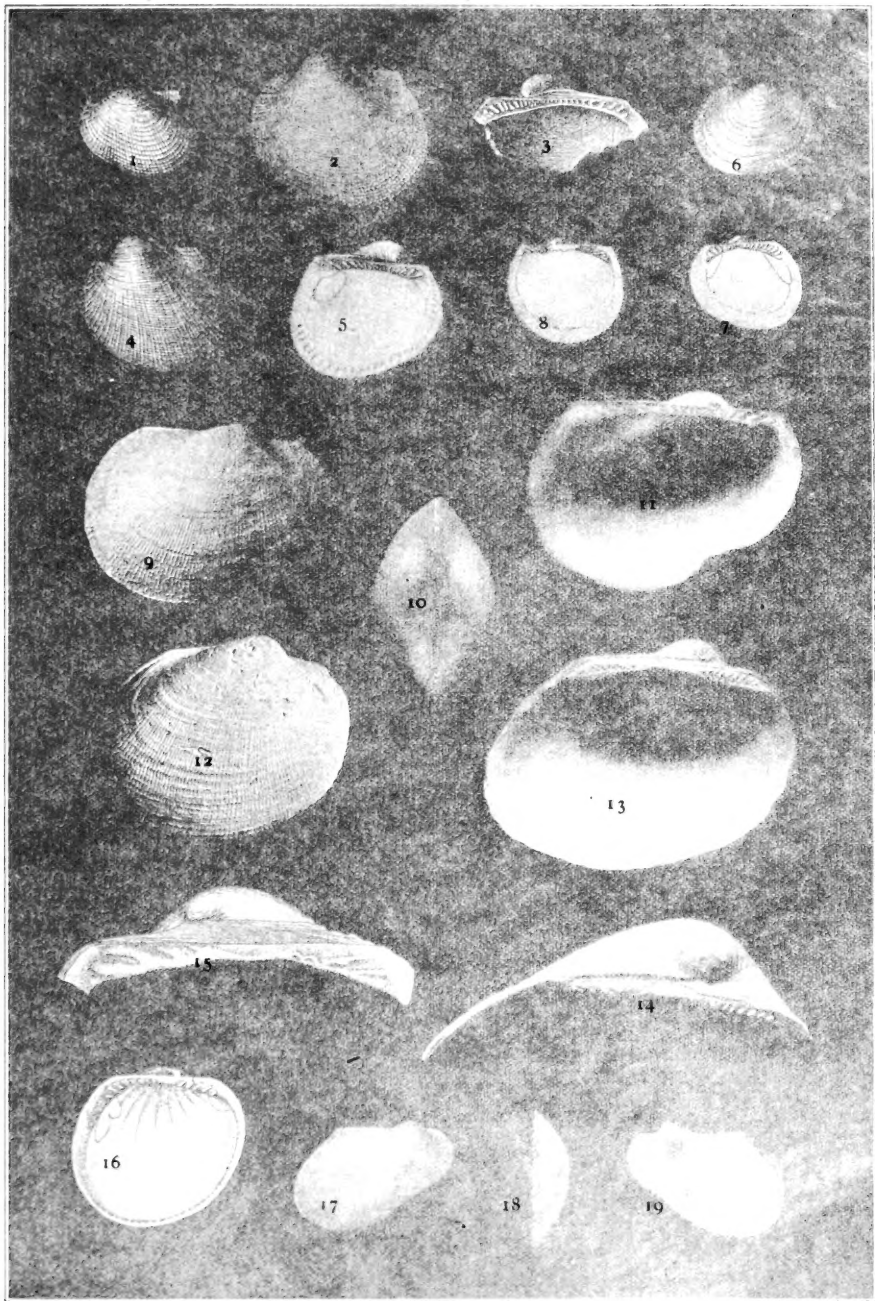
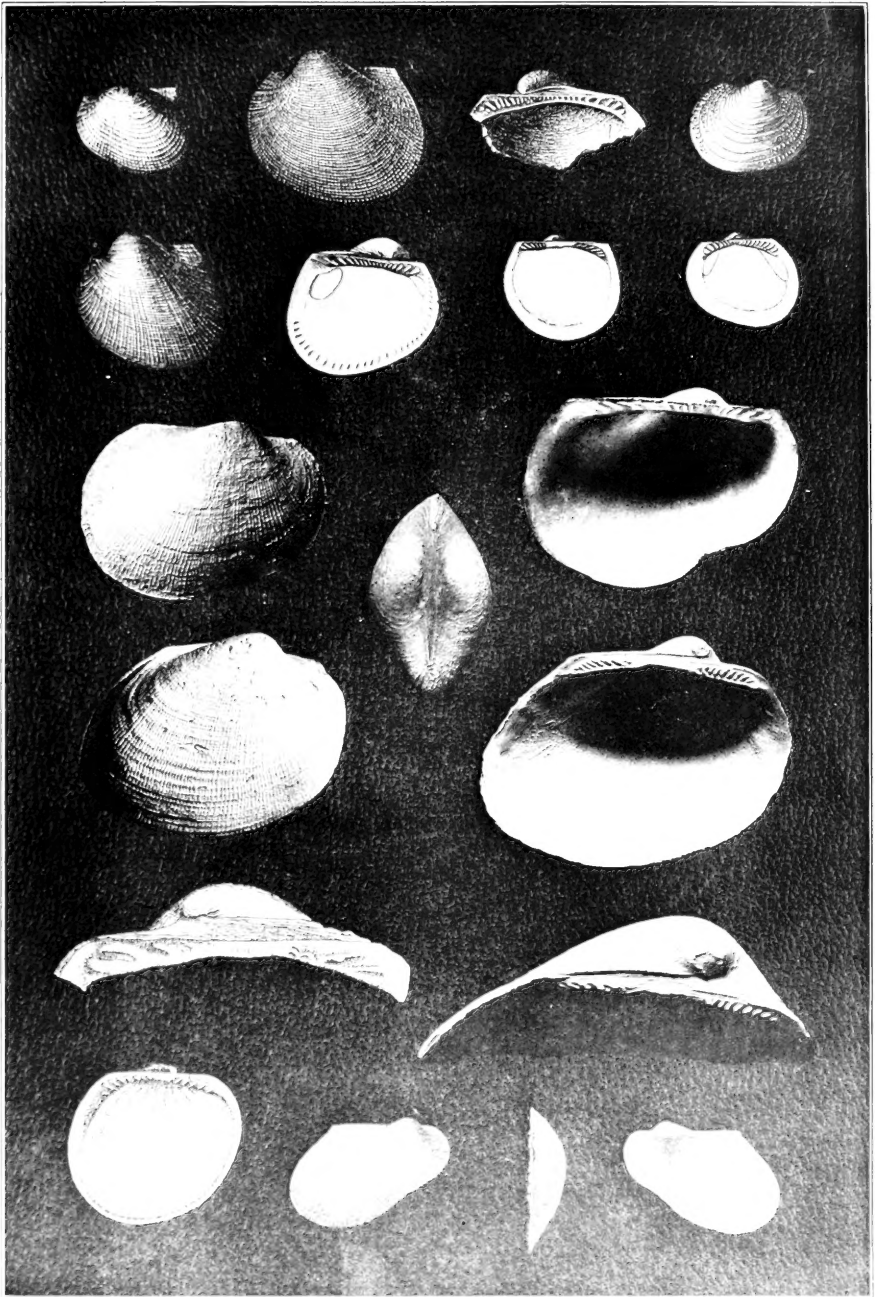
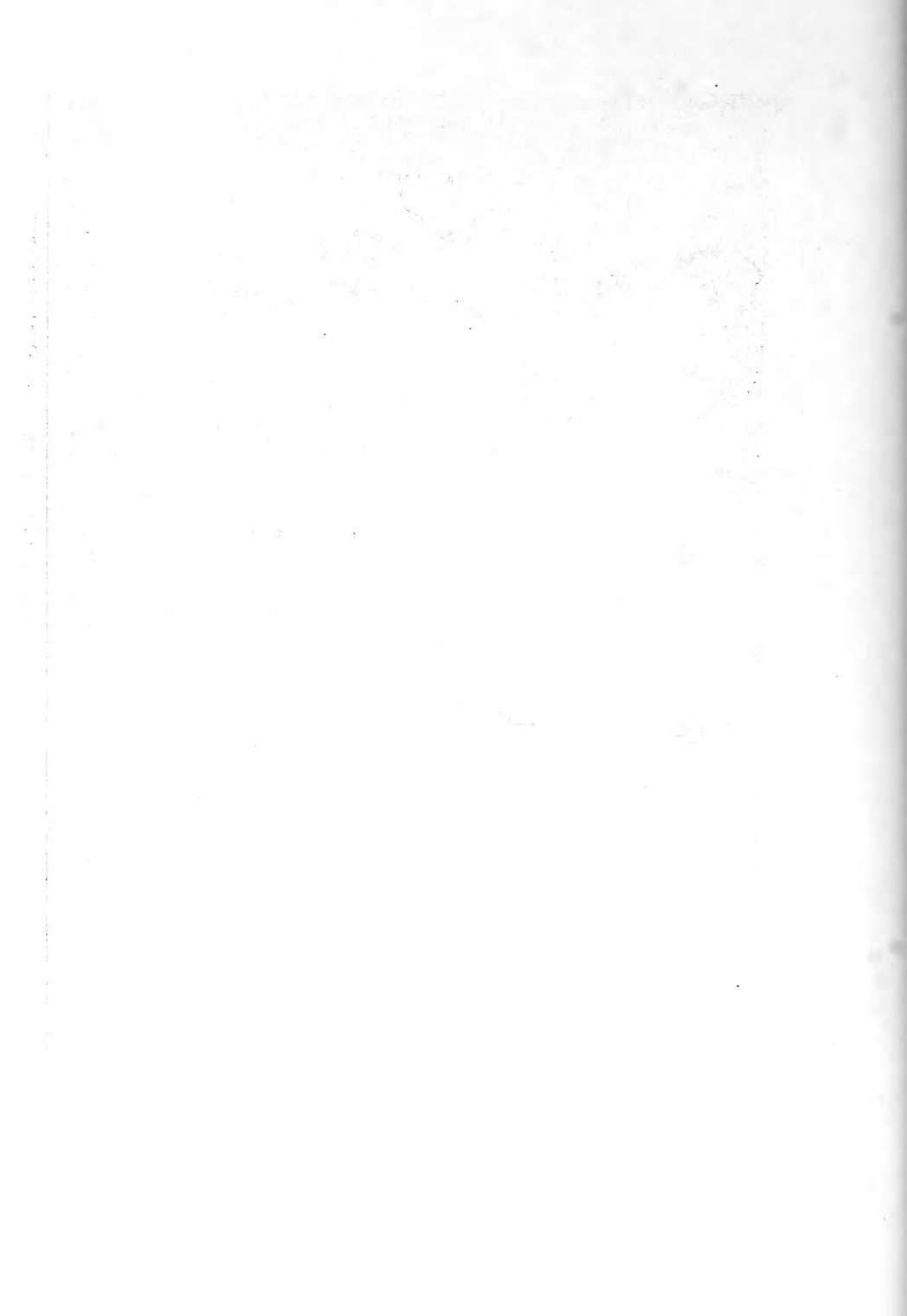


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"Oligocene of Bowden; 2 mm." After Dall.				
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"Pliocene of Tehuantepec; restored left valve; 18 mm." After Dall.				
3. <i>Arca Spenceri</i> Dall. "Pliocene of Tehuantepec; hinge of right valve; 16 mm."				
After Dall.	8	2	4	
4. <i>Arca glomerula</i> Dall.....				64
"5.75." After Dall.				
5. <i>Arca glomerula</i> Dall. After Dall.				
6. <i>Arca polycyca</i> Dall.....				64
"9.75." After Dall.				
7. <i>Arca polycyca</i> Dall. After Dall.				
8. " <i>Arca pectunculooides</i> var. <i>orbiculata</i> Dall; 8.0.".....				65
After Dall.				
9. <i>Arca pectunculooides</i> Scacchi.....			e	65
Recent from Finmark; × 4.4. The posterior ribbing is obscured by the illumination. It is similar to that of the rest of the shell.		δ ₁		
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13. <i>Arca glacialis</i> Gray; Uddevalla, Sweden; probably Pleistocene; × 2.77; interior of a left valve.				
14. Oblique view of the same; figured to show the cardinal area.				
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δ₁ε₁δ₁ι₁





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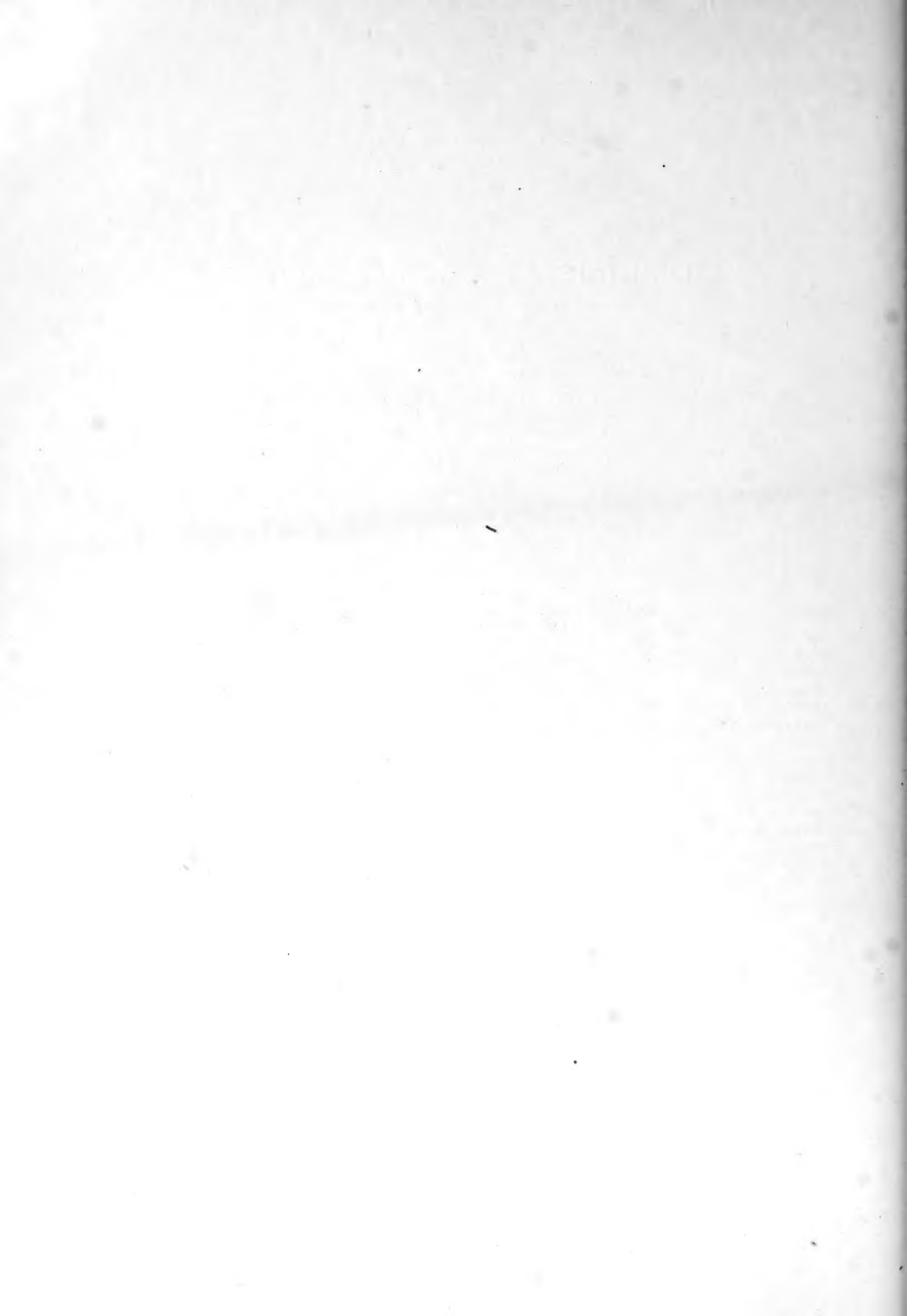
Subdivisional Names Applied to the Arcas

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	<i>b</i> Calloarca		<i>b</i> Anadara
	<i>c</i> Granoarca		<i>c</i> Cunearca
	<i>d</i> Striarca		<i>d</i> Argina
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ERRATA

PAGE	LINE	
7	13	For "oblique and" read "oblique, end".
7	14	For "hinge long" read "hinge line long".
7	17	For "height $1\frac{1}{2}$ " read "height $\frac{1}{2}$ ".
9	6	For "fine ribs" read "fine riblets".
9	23	For "p. 113" read "p. 118".
9	38	Read " <i>=Arca aviculoides</i> Reeve".
10	25	Omit "not".
10	31	For "8 mm." read "7 mm."
10	40	After "middle;" insert "posterior border deeply emarginated;"
11	30	For "range" read "merge".
12	2	For "?— <i>A. protracta</i> Rogers" read "?= <i>A. protracta</i> Rogers 1837".
12	5	For " <i>Daphoderma</i> " read " <i>Daphnoderma</i> ".
12	17	For "about" read "almost".
12	33	For "1170" read "1770".
12	40	For "apicibus" and "approximatus" read "apicibus" and "approximatis".
24	31	For "1806" read "1886".
24	36	For " <i>lactocomata</i> " read " <i>ectocomata</i> ".
30	28	For "7-10ths" read "7-20ths".
35	32	For "1682" read "1862".
36	39	For " <i>sulco subprnfondo</i> " read " <i>sulco subprofundo</i> ".

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PALÆONTOGRAPHICA AMERICANA

ILLUSTRATED CONTRIBUTIONS

TO THE

INVERTEBRATE PALEONTOLOGY

OF

AMERICA

VOL. I

No. 2.—The Genera *Lutetia* and *Alveinus*

Especially as developed in America

(Pages 105-118, Plate 17)

By GILBERT D. HARRIS

ITHACA
HARRIS COMPANY

1920



THE HISTORY OF THE

REPUBLIC OF THE UNITED STATES

OF AMERICA

.P15

THE GENERA

LUTETIA AND ALVEINUS

ESPECIALLY AS DEVELOPED IN AMERICA

BY GILBERT D. HARRIS

The diminutive representatives of these genera escaped the attention of Tertiary paleontologists till the middle of the last century, both in the Old World and the New. The known species are few, and as a rule they are not abundantly represented by individuals at any locality, nor can the localities where found be classed as numerous. These facts coupled with the diminutive size of the specimens have led to a general lack of comprehension of their outstanding characteristics, a lack of their biologic relations, and a lack of their phylogenetic development. Perhaps their diminutive size has been at the bottom of most of these misunderstandings. Dall has well remarked:

"The study of these minute forms is very difficult; even with a compound microscope various lights and a good series are needed to bring out the characters. A very slight amount of wear or solution suffices to materially alter the minute teeth, and the observer has to be constantly on his guard against being misled."

In reviewing the illustrations of representatives of these genera it becomes at once evident that they are not made sufficiently large or at least with sufficient detail to indicate the more telling features of, for example, hinge structure. An attempt, through micro-photographic and various other enlarging processes is herewith made to more clearly show such salient features.

Naturally, since *Lutetia* is the older of the generic terms and was founded on Paris Basin material, a review of such material must form the basis, as it were, and serve as an introduction to the study of *Alveinus* and its relatives as developed in America.

Genus *Lutetia* Deshayes

Description des Animaux sans Vertèbres Découverts dans le Bassin de Paris.

Vol. 1, 1858, p. 787

Plates published 1864; pl. 16 *bis*, figs. 34, 35, 36

Testa minima, orbiculato-globosa, æquivalvi, clausa, marginibus integris. Cardo angustus, inæqualiter tridentatus, dentibus duobus divaricatis, uno antico obliquely interposito. Cicatriculæ musculares minimæ, ovate, submarginales, æquales. Impressio pallii simplex. Ligamentum externum, nymphis brevibus, planis, affixum.

Coquille petite, orbiculaire, globuleuse, équivalve, parfaitement close, ayant les bords simples et entiers. Charnière étroite composée de trois dents inégales sur chaque valve, les deux postérieures divergentes, la troisième antérieure obliquement intercalée entre elles. Impressions musculaires petites.

ovales, submarginales, égales. Impression du manteau simple. Ligament externe attaché à des nymphes courtes et plates.

Les petites coquilles pour lesquelles nous proposons aujourd'hui un genre nouveau, sont connus de nous depuis longtemps. Assez abondamment répandues dans diverses localités du calcaire grossier, elles ne pouvaient échapper à l'assiduité de nos recherches, mais leur caractère étant difficile à saisir à cause de la petitesse des coquilles, nous avons rencontré des obstacles pour en établir la classification définitive. A cause de la charnière, nous devions les approcher des Vénus ou des Cythérées, mais l'impression du manteau étant simple, nous avons dû leur chercher d'autres rapports; la famille des Lucines paraissait leur convenir, mais elles s'en éloignent par les impressions musculaires; dans les Lucines elles sont grandes, comme on le sait, ici, au contraire, elles sont petites et entièrement détachées. Il ne nous restait donc plus que la famille des *Cardium* ou celle des Cardites, où nos coquilles pussent trouver leur rapports naturels, et nous avons préféré celle-ci parce que par leur charnières elles ne pouvaient néanmoins convenir à aucun des genres connus; il a donc fallu en créer un et le nom que nous avons choisi rappelle que c'est dans le bassin de Paris qu'il a été découvert.

Les coquilles que nous réunissons dans le genre *Luletia* sont fort petites, orbiculaires, globuleuses, subcordiformes, parfaitement closes; les bords des valves sont entiers. La charnière est d'une structure toute spéciale, elle est étroite, et il faut se servir d'un grossissement assez puissant pour en étudier les détails. Sur la valve droite, immédiatement au-dessous du crochet, on trouve deux dents presque égales, très divergentes; l'antérieure est presque parallèle au bord supérieur, tandis que la postérieure tombe perpendiculairement. Dans l'angle presque droit qui résulte de la position de ces deux dents, une troisième s'introduit plus longue, plus épaisse comme si la dent latérale d'une cythérée, par exemple, en se déplaçant, s'introduisait au milieu des dents cardinales. La valve gauche offre des dispositions à peu près semblables, seulement les deux dents divergentes s'inclinent du côté postérieur et la dent antérieure vient se heurter perpendiculairement contre la dent cardinale médiane. Au-dessus de la dent antérieure est creusée une longue fossette parallèle au bord, dans laquelle vient tomber la grande dent de la valve opposée. Dans la seconde espèce, dont nous ne connaissons qu'une valve gauche, les mêmes parties s'y trouvent, mais réduites de longueur et de largeur.

En arrière de la charnière, on distingue avec peine une petite nymphe large, plate, séparée au dehors par une sillone très étroite mais profonde; sur cette nymphe s'attachait un ligament externe fort petit.

Les impressions musculaires sont très différentes de celles des Lucines ou des Diplodontes; elles sont petites, ovalaires, égales, submarginales, elles s'avancent jusqu'au milieu du grand diamètre de la coquille, elles sont entièrement isolées, si ce n'est par une impression palléale simple, parallèle au bord, mais séparée de lui par une large zone.

Il est évident que les *Luletia* constituent un genre parfaitement distinct, ainsi que le prouvent les caractères que nous venons d'exposer; nous avons indiqué précédemment leur rapports avec les genres les plus raparochés. Ces coquilles sont certainement marines, car elles se rencontrent uniquement dans des dépôts marins et elles n'ont aucun des caractères des coquilles lacustres.

Deux espèces seulement nous sont connues dans le bassin de Paris, il en existait quelques autres dans le bassin de la Gironde ou d'autres localités du même âge.

The type of the genus *Luletia* is *L. parisiensis* Desh., whose specific characteristics are practically all included in the discussion given above. Grignon and Mouchy are especially mentioned by Deshayes as localities for this species, though he also found it at Parnes, Damery, Moutnirrel, Brasles, Saint-Félix and Saint Thomas. As to size, Deshayes says the largest may be 3 mm. in length and 2 mm. in width.

Luletia umbonata Deshayes describes on p. 789 of his work already cited and illustrates by figures 12-14 on plate 59. This is represented in his collection, by the left valve only, from Mercin (Sables inférieurs). He says this is distinguished from *parisiensis* by several good characteristics; it is roundish, spherical, very much inflated and convex, nearly equilateral, with microscopic, transverse striae which are unequal, wanting medially and on the beaks; the latter are large, prominent and slightly oblique and "dominate" a broad, oval lunule which is circumscribed by a simple stria. The anterior side,

a little shorter than the posterior, is broadly rounded, while the posterior is somewhat restricted. Cardinal margin narrow. The dentition of the left valve, the only one then known, practically that of *parisiensis*: the two posterior teeth very small, diverging but little, but the long anterior tooth at its posterior extremity completely uniting with the middle tooth, while in *parisiensis* this union is less complete. Muscular impressions undetermined. Dimensions: about 2 mm.

The types of these two species were from the Deshayes collection.

The outstanding features of the genus *Lutetia* as understood by the present writer, may be summed up as follows: Shell very small, nearly smooth within and without, though showing traces of concentric undulations; rather inflated, nearly circular in outline; left valve with a compound, hammer-shaped tooth beneath the umbo, extending forward at some distance below the margin of the shell, and a tooth-like ridge extending from the umbo diagonally backwards and forming the lower margin of the nymph; right valve with two parallel lamellæ, the lower one near the lower margin of the cardinal platform, the upper one just beneath the lunular margin of the shell connecting more or less intimately with a strong cardinal that extends from near the beak obliquely backwards across the cardinal platform; lunular margin of the left valve grooved, of the right carinated; ligamental margin of the left valve carinated, of the right grooved, basal margin of either valve generally showing signs of grooving; muscular scars very inconspicuous, roundish, connected by a faint non-sinuate palleal line.

Deshayes mentioned the occurrence of species of this genus in the Gironde basin. The species figured by Bernard as "Fig. 21—Développement de *Lutetia* sp. (Miocène de Dax)" in Bulletin de la Société Géologique de France, 1895, p. 139, and herewith reproduced as Fig. 1 can scarcely be referred to *Lutetia*, especially if the lower sketches, "4D" are meant to illustrate adult specimens. For, not only is there a distant cartilage pit in either valve beneath the umbo precisely in the place occupied by the very strong cardinal tooth of the right valve of *Lutetia* (or its socket is the left), but the shape of the anterior lamellar teeth are not as described by Deshayes nor as seen in Paris Basin specimens in the U. S. National Museum, identified by Cossmann (see Fig. 2).

Bernard's remarks on the hinge structure of his "*Lutetia*" from Dax are as follows:

"J'ai suivi le développement depuis les stades les plus anciens sur une espèce de *Lutetia* de Dax (Fig. 21). C'est un développement typique de forme à 3 dents cardinales, où les dents latérales antérieures ne se développent pas. Les *Kellyellidés* restent au stade qui précède le stade permanent des *Cyréuidés*, *Vénéridés*, etc.; la lame *l* n'atteint pas le sommet et *z* reste indivis et simplement arqué. On sait d'ailleurs que les *Kellyella* des grandes profondeurs ont été prises pour des embryons d'*Isocardia*.

V. Dr.	1	.	3	L	LP	I	:	III
V. G.	2	:	4	L	LP	II		

Cossmann seemingly copies Bernard's 4th "stade" in the development of this Dax "*Lutetia*" as Fig. 117 in his and Peyrot's *Conchologie Néogénique de l'Aquitaine*, vol. 1, 1909-12, p. 609. A photographic replica of his drawing is herewith introduced as Figure 3.

Before describing this Aquitanian form (as *L. girondica*) Cossmann makes these introductory remarks:

Kellyellidæ, Fischer, 1887. Coquille petite, équivalve, close, suborbiculaire; ligament interne, logé dans une rainure ou fossette sous le crochet; charnière incomplètement développée, à lamelles antérieures prolongées ou confondues avec les cardinales; lamelles postérieures non constantes; ligne palléale non sinueuse; bords lisses.

Fischer a admis dans cette Famille les quatre Genres *Kellyella* Sars, *Allopagus* Stol., *Lutelia* Desh., *Turtonia* Forbes; mais il leur a attribué un ligament externe, tandis que Félix Bernard insiste bien sur la position interne du ligament; on en aperçoit d'ailleurs nettement la fossette dans le Genre *Lutelia* qui est le seul de cette Famille qu'on trouve représentant en Aquitaine.

Lutelia Desh., 1860. Coquille orbiculaire ou subtrigone, globuleuse; formule de la charnière, d'après F. Bernard:

$$\begin{array}{ccccccccccc} \text{I} & : & \text{III} & - & \text{L} & - & \text{P} & \text{I} & : & \text{P} & \text{III} \\ \text{II} & : & 2 & - & \text{L} & - & & & & \text{P} & \text{II} \end{array}$$

Félix Bernard n'a pas interprété cette charnière comme Fischer; ayant suivi le développement ontogénique d'une petite espèce de Dax qu'on trouvera décrite ci-après, il a observé que les dents antérieures sont restées au stade de développement qui précède le stade permanent des autre Familles; le dent I est en face de la lamelle III et elle n'atteint pas le summit; sur la valve opposée 2 et AII se composent de deux bombements du bord cardinal, dans le prolongement l'une de l'autre; enfin les lamelles postérieures sont au contraire très allongées et très minces, on les confondrait avec de simples rainures du bord, si l'on ne vérifiait qu'elles s'emboîtent exactement d'une valve sur l'autre (G.—T. : *L. parisiensis* Desh. Eoc.)

Ce Genre représenté par trois espèces dans l'Eocene du Bassin de Paris, une à chaque niveau, existe également dans le Miocène inférieur, ainsi que Deshayes l'avait lui-même signalé; seulement Benoist a attribué le nom *burdigalensis* Desh. à une toute autre coquille qu'à une *Lutelia*, de sorte que nous avons été obligés de donner un nom nouveau à celle du Burdigalien, que Deshayes avait évidemment en vue dans le text qui accompagne la description des *Lutelia* parisiennes.

D'autre part, la coquille de Claiborne que l'un de nous a rapportée au même Genre (Cossm. Notes compl. Alab., 1894, p. 13) est un peu différente d'après M. Dall: *Alveinus minutus* Conrad (1865) peut donc être conservé comme génotype d'un S.-G. distinct qui différerait par l'existence d'une faible nymphe, ce qui l'écarterait complètement de *Lutelia* et même des *Kellyellidæ* d'après Félix Bernard. Nous n'avons pas les éléments nécessaires pour trancher la question en ce qui concerne *Alveinus*, mais nous constatons que la form. de la coquille et sa charnière sont exactement celles de *Lutelia*.

It seems evident from the above quotations that Felix Bernard in working out the early growth stages of certain bivalves took as one species the *Lutelia*-like form from the Gironde, later referred to by Cossmann as *L. girondica*. He noted the well defined pit beneath the umbo. This seemed to conform with his idea of the "internal" origin of the ligament. The teeth seemed to have been arrested in their development at an earlier stage than in the Venerids. Cossmann and Peyrot apparently assumed that what Bernard found in the Miocene "*Lutelia*" was applicable to the Paris Basin forms without further study or consultation with the Parisian specimens themselves. Note the hinge structure of *L. parisiensis* copied from Deshayes' work (pl. 17, figs. 12, of the present work). Note the same in pl. 17, figs. 3, 4 from *L. umbonata* taken from specimens in the U. S. Nat. Museum identified some time ago by Cossmann. Compare with these, Figs. 1 and 3 of this paper and see how vastly different are the hinge structures of the Eocene forms. The latter we would suppose to be degenerate, not primitive. Note that even in the small photographic illustrations of *L. parisiensis*, *umbonata* and *deficiens* in Cossmann's Iconographie, pl. 33, the strong cardinal tooth of the right valve of these Eocene forms may be seen occupying precisely the place of the ligamental "fossette" of *girondica*.

Since the above paragraph was written we have had occasion to study the half dozen

specimens in our collection sent by Cossmann labelled: *Lutetia burdigalensis* Desh., *Aquitaine*, *Mérignac*, which we supposed to be the same as *girondica*, and have indicated, in Fig. 4, the hinge characteristics.

It appears that this is a *Lutetia*-like form with well developed resilum, before which is seen in the right valve often a trace of the strong, cardinal of *Lutetia*, though here nearly effaced by the encroachment of the resilium. In fact it forms the anterior margin of the pit. This Miocene form, as will be seen later on, should doubtless be referred to Conrad's genus *Alveinus*.

Before closing the discussion of European *Lutetia* mention should be made of von Koenen's *L. ovalis* and *concentrica* from the lower Oligocene of Lattorf (Nordd. Unt. Olig. Moll. Faun., Lief. 5, 1893, pp. 1228, 1229, pl. 79, figs. 16-18, and pl. 87, figs. 10-13). The former is herewith reproduced (Pl. 17, figs. 5, 6) somewhat enlarged, showing that it most probably does belong to this genus, but the latter is more probably a Venerid.

AMERICAN FORMS

Although *Alveinus* has been known on this Continent for over a half century, especially from the Jackson Eocene, typical *Lutetia* seems thus far never to have been recorded. However, it occurs fairly abundantly in a foraminiferal marl in east Texas as described below.

Lutetia texana, n. sp.

Plate 17, Figures 7, 8

Specific characterization.—General appearance like that of the type of the genus, *parisensis*, though perhaps a little more elliptical in outline; size ranging from 1 to 2 mm. in greatest diameter; surface rather smooth and shining though showing traces of concentric undulations; lunular area large and occasionally well defined by a radiating, impressed line that sometimes produces a slight notch on the anterior margin of the shell, though in no way comparable in depth to the same feature in the species of *Kelliella* herein described; interior smooth and shining with but faint traces of muscular scars; margin of the *right valve* keeled as it were in the form of a faint anterior lateral over the lunular area, changing below into a grooved-margin appearance; ligamental margin deeply channelled, passing below into the regularly, more faintly grooved margin mentioned above; cardinal platform comparatively narrow, showing below and anteriorly a rather strong tooth turned beak-wards and separated by a deep pit from a small, short, thin tooth nearer the lunule margin just beneath the beak; connected more or less intimately with the latter and extending obliquely backwards is the strongest tooth of the hinge structure; just behind this tooth a depressed area marks the pit for the tooth in the opposite valve, passing upwards and backwards into the ill defined ligamental area; *left valve* with anterior, lunular margin showing a groove; ligamental margin keeled, forming as it were a long posterior lateral tooth; remaining margin appearing more or

less channelled; hinge platform rather narrow, showing anteriorly and beneath the umbo the usual hammer-shaped tooth of this genus with "head" immediately beneath the umbo and with pits above and below the "handle" for the reception of the teeth in the opposite valve; posteriorly a deep pit for the reception of the large, oblique tooth of the opposite valve, followed posteriorly by a ridge-like tooth which forms the lower margin of the nymph.

The appearance and dentition of this species is like that of typical *Lutetia*. Though smaller, it might perhaps be referred to a sub-species of *umbonata* Desh. The strong sub-umbonal tooth in the right valve with the corresponding deep pit in the left—both taking the exact place of the resillum in *Alveinus*—serves to distinguish this species at once from any other species heretofore described from our American Tertiaries.

Horizon.—St. Maurice, middle Eocene.

Locality.—San Augustine road, 5.5 miles east of Nacadoches Hill on east side of Tuscon Creek, Texas.—*Olsson*.

Type specimens figured.—Pal. Mus. Cornell Univ.

Alveinus minutus Conrad

Plate 17, Figures 11-15

A. minuta Con. Amer. Jour. Conch., vol. 1, 1865, p. 138, pl. 10, fig. 2.

A. parva Con., *ibid.*, p. 10, *n. nud.*

A. minutus Con., Proc. Phila. Acad. Nat. Sci., 1872, p. 53, pl. 1, fig. 6.

A. minutus Meyer, Bull. 1, Geol. Surv. Ala., 1886, p. 84, pl. 1, fig. 19.

A. parvus de Greg., Mon. Faun. Eoc. Ala., 1899, p. 210, pl. 30, fig. 14.

Lutetia parva Cossm., Notes Complem. &c., 1893, p. 13.

A. minutus Dall, Trans. Wag. III, 1900, p. 1166.

Conrad's original description of Alveinus.—Equivalved, smooth; anterior, posterior and ventral margins channelled within; hinge of right valve emarginate under the apex, and having one pyramidal tooth anteriorly; hinge of left valve with a pit under the apex and two compressed diverging teeth anteriorly; pallial line entire?

Conrad's description of A. minutus.—Suboval or suborbicular, very inequilateral, convex, smooth and shining; margins rounded.

This is a minute shell, much enlarged in the figure, and common in a small quantity of marl which accompanies the specimens. The family to which it should be referred is undetermined. A microscopic channel margins the valves within.

Conrad's figures, both in the Journal of Conchology and the Proceedings of the Philadelphia Academy are lacking in detail, but with his description there is no question as to what shell he was describing. In the latter publication he notes the occurrence of the pit beneath the apex of both valves, and mentions its general *Dosinia*-like exterior appearance. His description there given as to dentition is far more accurately drawn than in the description quoted above, even more so than in Meyer's diagnosis. As is well known, though Conrad described this species as coming, with others, from Enterprise, it really came from the Jackson horizon of Garland's Creek, Miss. (See Amer. Jour. Sci., 1885, p. 307). Meyer's figure is from a Claiborne, Alabama, specimen.

Dall seems to have been the first to study a large suit of *Alveinus* along with typical European *Lutetia*, and as a result of such study comes to the conclusion that *Lutetia* and *Alveinus* though closely related should be kept as distinct genera. Cossmann speaks of comparing the hinge structure in these two forms under the microscope and finding that the "disposition des dents est à peu près identique; peut-être la fossette cardinale de la coquille américaine est elle un peu plus profondément creusée, mais je ne pense pas que cette différence soit suffisante pour mériter la création d'un genre *Alveinus* distinct de *Lutetia*, qui est d'ailleurs antérieur de cinq années à celui de Conrad."

So far as the specimens from Claiborne are concerned (figs. 14, 15), they are seemingly referable to the species *minutus*, though generally but about half the dimensions of the well developed Jackson representatives. Through the kindness of the Hon. T. H. Aldrich I have been able to examine a considerable number of specimens from Claiborne and have illustrated two specimens as figures on Plate 17. In a few minute, juvenile specimens the thin, small tooth just below the lunular margin, underneath the umbo in the right valve is slightly bent down posteriorly towards the center of the shell, suggesting the presence in the earliest stage of development of a *Lutetia*-like tooth where the *Alveinus* pit later occurs.

Alveinus rotundatus Dall

A. rotundatus Dall, Trans. Wag. III, 1900, p. 1167, pl. 45, figs. 25, 28.

The statements of Dall regarding this species are as follows:

Oligocene marl of Calhoun County, Florida; Burns.

Shell resembling *A. minutus* Conrad but smaller, more inflated, more elevated, more nearly equi-lateral, a proportionately heavier and more solid shell. No trace of an attachment for an external ligament could be found on any of the specimens. Alt. 1.9, long. 3.2, diam. 1.2 mm.

At first this species was regarded as merely a local race of *A. minutus*, but the comparison of many specimens showed the characters to be constant and the difference of horizon in the geological column is quite marked, so I have thought it best to treat it as a species. See insert Figure 6.

Alveinus, with its deep "pit" in place of the large umbonal tooth of *Lutetia*, is doubtless an off-shoot from a *Lutetia*-like stock in precisely the same way that the Gironde "*Lutetia*" with its prominent pit is a derivative of some older *Lutetia*-like strain. In fact, "*Lutetia*" *givondica* could well be referred to the genus *Alveinus*, such differences as exist between it and *minutus* or *rotundus* may well be regarded as specific. This statement is based not so much on Bernard's and Cossmann's drawings of the species as on the enlarged photographic illustrations of *givondica* on Pl. 26, figs. 16-19 of Cossmann and Peyrot's Aquitanian monograph. These show a form and dental structure varying but slightly from *minutus*.

Before discussing more in detail the phylogeny of these various species it seems desirable to carefully note the characteristics of *Kelliella boettgeri*, a species found not uncommonly in association with *Alveinus minutus* in the Jackson beds of Mississippi.

Kelliella hoettgeri Meyer

Plate 17, Figures 16-18

K? hoettgeri Mr., Bull. Geol. Surv., Ala., 1886, p. 83, pl. 3, fig. 15.*K. hoettgeri* Dall, Trans. Wag. III, 1900, p. 1167.

Meyer's original description.—Very small, orbicular, tumid, inequilateral, umbo turned anteriorly a cordate lunule is defined by an impressed line; surface closely and regularly covered with concentric ribs; hinge of the right valve with two diverging cardinal teeth below the umbo, and a horizontal one which is lamelliform before and beneath them; left valve with a short, oblique tooth below the umbo, and anteriorly with a horizontal S-shaped one; anterior adductor long; margin entire.

Locality.—Jackson, Miss.; common.

The pallial line is apparently simple. The shell in its dentition resembles somewhat the genus *Lutetia* Desh. of the Paris Basin, but on comparing with two species of this genus which I have, proves to be different. The genus *Kelliella* Sars., as far as I am aware, is not a known fossil. I have no specimens of *Kelliella*, but according to its description and figure, I am inclined to put this small, remarkable Jackson shell into this genus.

The exterior of this shell is at once differentiated from that of *Lutetia* sp. by its strong concentric ribbing; especially basally and the sharp line of definition marking off the general shell surface from the feebly striate, large lunule.

Meyer's description of the interior of the shell will bear some amplification.

Right valve. *Margin:* Upper lunular, grooved medially; below lunular limit and basally generally, with fine but sharply incised groove about interior margin of shell; below the umbo a slight submarginal ridge disappearing soon posteriorly presumably for ligament insertion but reappearing again posteriorly in the form of a thin short lamellar lateral tooth, which in turn gives way posteriorly to the well-defined medial groove of the posterior ligamental margin. *Teeth:* Dental platform rather prominent, anteriorly with (1) a semilamellar tooth, extending roughly parallel to the ligamental margin of the shell, more or less obtusely pointed medially, curving upwards and (2) just anterior to the beak a second lamelliform tooth bent somewhat downwards and uniting posteriorly with (3) an oblique cardinal which is narrow above, broader below, with a tendency to bifurcation; (4) one third way from umbo to posterior adductor, a trace of a posterior lateral as described above. (In young shells, often only 1 and 3 are observable and 1 is very short, though prominent, and located near the anterior margin of the shell.)

Left valve. *Margin:* Lunular margin faintly keeled above, channelled below; basally faintly but sharply keeled about the inner margin of the shell as far as the posterior adductor; ligamental margin not sharply keeled, though clearly so just above the posterior adductor scar. *Teeth:* On prominent cardinal platform, showing (1) a more or less undulating anterior tooth curving up beak-wards posteriorly and finally sending down a faint ridge towards the lower margin of the cardinal plateau; just behind the umbo a very strong oblique tooth, though increasing in strength posteriorly, rounds over and disappears before reaching the lower margin of the cardinal platform.

The dentition is here somewhat more vigorously developed than in species of *Lutetia* though the general plan is the same. The ligament is, on the contrary, much weaker than in *Lutetia*. The exterior concentric markings are evenly, and distinctly shown. The lunule seems large and is sharply and clearly defined from the remaining shell sur-

face by a deeply incised line, the termination of this line often showing as a notch in the anterior margin of the shell.

LIGAMENTAL DEVELOPMENT

By studying the development of the teeth and ligamental characteristics of certain Venerids, well illustrated by Bernard in his article already referred to (See his drawing inserted herewith as fig. 8) one notes the very close resemblance in certain stages to the hinge structure of *Lutetia*. See fig. 2. Deshayes believed the ligament to be external, but it would seem from his illustrations and from the specimens herewith illustrated that perhaps the word "external" should be changed to "somewhat submerged". The ligamental platform is well shown in the figure of *parisiensis* (Pl. 17, fig. 1, 2) See it also, in *umbonata* and *texana* illustrated on the same plate, especially in the left valve where it is bordered antero-basally by a tooth-like ridge.

In "*Lutetia burdigalensis* Desh., Aquitanian, Méregnac" Cossmann (insert fig. 4) the ligamental matter is largely concentrated into a so-called internal cartilage, the great central tooth in the right valve of *Lutetia* proper is here reduced to a thin plate defining the lower anterior margin of the resilium pit. None of our half dozen specimens of this species furnished by Cossmann show anything like the prominence of internal ligamental development indicated by Cossmann's "*Lutetia*," herewith photo-copied as fig. 3.

In adult *Alveinus minutus* it often appears that there is not only a well-developed resilium, but that judging from the striated area above there was also a functional marginal ligament. This is particularly obvious in certain large left valves (fig. 5). The anterior sublunular tooth, however, so strong and conspicuous in some *Lutetias*, is here greatly reduced, and but rarely, in very young stages, does it show indications of a branch passing anterior to the resilium pit as described above under *L. burdigalensis* and shown in fig. 4. This feature, however, seems to be retained in a slight degree by the specimen figured by Dall from the old Miocene of Florida (fig. 6).

SUMMARY

(1) In the Mid-Eocene *Lutetia* is found in both the Old and New World with, among others, a strong, oblique tooth or corresponding socket immediately beneath the umbo. Ligament not strongly developed, somewhat submerged, defined below in the left valve by a slight, tooth-like prominence. In the upper Eocene of America at least, appears a form usually referred to *Kelliella* with comparatively strong dentition but obscure ligamental area. But along with this appears Conrad's genus *Alveinus* with resilium pit and traces of marginal ligament while the dentition is greatly weakened. Practically the same state of dental reduction is seen in *A. rotundatus* Dall from the old Miocene of Florida and in "*Lutetia burdigalensis*" of the Aquitanian of France. This species, "*L. girondica*" of Cossmann and Peyrot's Aquitanian monograph, if correctly illustrated by Cossmann in the text figure (our insert fig. 3) sometimes shows a strength of resilium development in excess of American species of *Alveinus*.

(2) Judging merely from the ligamental condition in *Lutetia umbonata* (Cuisian) and

Alveinus (Claibornian-Burdigalian) one might conclude that this structure was at first external and became later internal, not the reverse, as determined by the ontogeny of various forms by Bernard.

(3) *Lutetia*, in practically its typical form, is now known in America.

(4) It would seem more proper to refer *burdigalensis* (*girondica*) to *Alveinus*, owing to the extreme resilium development.

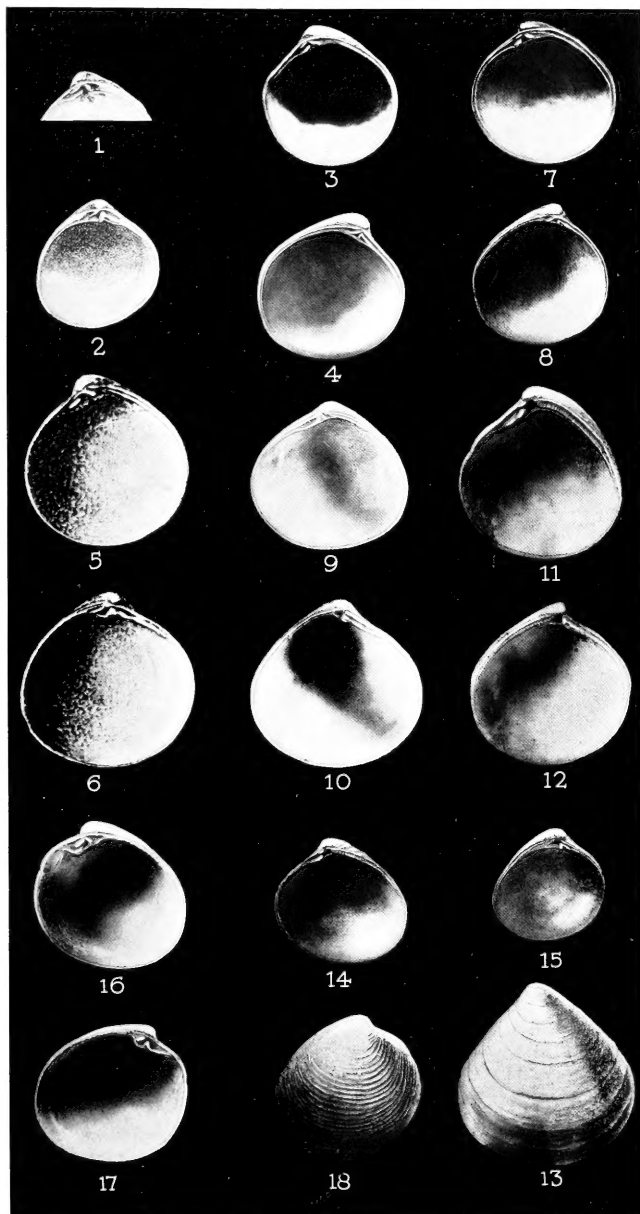
(5) All species so far carefully examined show signs of a large lunule, whose basal, anterior limit tends to interrupt the continuity of the anterior margin of the shell. This feature is very pronounced in *Kelliella*.

Palaeontological Laboratory, July 31, 1920

PLATE XVII

PLATE XVII

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PALÆONTOGRAPHICA AMERICANA

ILLUSTRATED CONTRIBUTIONS

TO THE

INVERTEBRATE PALEONTOLOGY

OF

AMERICA

VOL. I

No 3. — The Rudistids of Trinidad

(Pages 119-162, Plates 18-28)

By G. D. HARRIS AND FLOYD HODSON

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PREFATORY REMARKS

During the months of August and September of the years 1920 and 1921 the senior author had the opportunity to visit the island of Trinidad under the auspices of the Trinidad Petroleum Development Company. Sundry paleontological collections, mainly of Miocene age, had already been received at Cornell from the Island some months before these visits were made. During the present year, 1922, other collections from various horizons have been received. The classification and description of all this material is proceeding as rapidly as time will permit and it is hoped that the greater part will be ready for publication during the coming year.

The present paper takes up one small group of mollusks represented on the Island, the Rudistids, which appear so different from anything already published that their depiction with such detail as is now possible seems eminently desirable.

The occurrence of this type of molluscan life on the Island seems never to have been suspected, at least not reported, till our first visit (1920) referred to above. Guppy had noted the occurrence of Cretaceous fossils at Point à Pierre but seems not to have surmised the existence of Rudistid forms; his reference to large *Naticas* suggests that he may have seen the upper valves of some Caprinoid form and supposed them to be large univalves. Etheridge says in "Appendix J" of Wall and Sawkins Report of 1860:

"The compact limestones of the Older Parian group, both at Point à Pierre and in the interior, contain numerous regular masses of crystalline carbonate of lime, which has evidently resulted from a change of organic remains, but the form is usually so far obliterated that even the genus cannot be determined."

The Rudistid character of many of the fossil remains at the so-called Stack Rock at Point à Pierre cannot be doubted, as the illustrations on Plates 10 and 11 will show. But by far the best specimens we have so far discovered come from the banks and bed of a small stream west of the Plum Road, about two miles north-east of Mt. Harris, in the eastern part of the Island. Here the calcareous material in which the fossils are imbedded is less crystalline and hence the forms of the various species represented can be quite easily determined. Cross-sections with polished surfaces show the canal systems to great advantage as may be seen by consulting Plate 4.

Trinidad is an island mass that has been the site of extensive earth movements; folds, faults and overthrusts may be expected almost anywhere. Question has already arisen as to the extent and continuity of these calcareous, Cretaceous outcroppings, some believing them simply great boulder-like masses floated in Miocene deposits, others that quite probably they are still in connection with extensive Cretaceous formations below.

The horizon they represent in the Cretaceous is probably about Cenomanian though the accompanying fossils are generally too indefinite to make the determination certain.

The review of the Rudistid literature, more specifically that of the canalled *Caprinidæ*, by the junior author, brings to light certain noteworthy facts:

- a. Much has been written on this type of life; comparatively little in English, mostly in French.
- b. Generic names have been applied often to forms differing but slightly, yet none seem applicable to the most abundant and best preserved specimens from Trinidad.

The summation of characteristics ascribed to known genera may well serve as an introduction to the description of the Trinidad forms.

+ + +

We are indebted to the Trinidad Petroleum Development Company for the privilege of publishing these interesting details, and especially to Mr. G. A. Waring, in charge of geological work on the Island for his great assistance in securing large shipments of organic remains.

*Paleontological Laboratory,
Cornell University,
Ithaca, N. Y.
September 22, 1922*

THE RUDISTIDS OF TRINIDAD

BY

G. D. HARRIS AND FLOYD HODSON

GENERAL CHARACTERISTICS AND DISTRIBUTION OF RUDISTIDS

Rudistids are aberrant, sessile Pelecypods which may be attached by either valve; the valves may be twisted, capuloid, or straight and conical; the test may be replete with cavities in one or both valves; the canals may be true cavities found in the inner layers of the test (Caprinoid forms) or highly developed prismatic cellular structure in the outer layers of the test (as in *Hippurites*). The position of the ligament varies, being internal, marginal, external, or even absent. The form, kind, and relative disposition of the cardinal teeth vary.

This type of life originated in the Jurassic and reached its maximum development and expansion during the Cretaceous period. Thick beds were often formed from the remains of these sessile gregarious animals, which thrived in large colonies in clear, warm, shallow seas. Douvillé,* especially, has emphasized the almost identical geographic distribution of this type of molluscan life with certain large foraminiferal genera. In general it is his Mésogée, the Tethys of others, extending from the Mediterranean-East Indian region of the Old World and including the West Indies and Mexican region of the New. Certain Ammonites, Belemnites and Echini are also limited to this zone.

POSITION OF RUDISTIDS IN THE ANIMAL KINGDOM

The strange appearance made by these fossils in their usual state of preservation caused them formerly to be referred by different authors to widely different classes in the Animal Kingdom. Woodward sums up these references as follows:

(*Manual of Mollusca*, p. 441. 1871.)

1. Buch regarded them as Corals.
2. Desmoulins, as a combination of the Tunicary and Sessile Cerripede.
3. Dr. Carpenter as a group intermediate between the *Conchifera* and *Cerripeda*.
4. Prof. Steenstrup, of Copenhagen, as Annelids.
5. Mr. D. Sharp refers *Hippurites* to the Balani; *Caprinella* to the Chamaceæ.
6. LaPayrouse considered the *Hippurites Orthocerata*; the Radiolites, *Ostracea*.
7. Goldfuss and D'Orbigny place them both with the *Brachiopoda*.
8. Lamarck and Rang, between the *Brachiopoda* and *Ostracea*.
9. Cuvier and Owen, with the Lamellibranchiate bivalves.
10. Deshayes in the same group with the *Ætheria*.
11. Quenstedt, between the *Chamaceæ* and *Cardiaceæ*.

* B. G. S. Fr., (3), vol. 28, pp. 222-226, 1900.

Douvillé* remarks in 1886 that:

Les remarquables travaux de Woodward et de M. Bayle ont démontré d'une manière incontestable que les Rudistes sont des Mollusques lamellibranches qui doivent être placés dans le voisinage des Chamacés. Cette opinion est universellement adoptée aujourd'hui etc., etc.

In 1912 the same author concludes†:

On voit donc que les Chamidés ne sont pas proches parents des Rudistes comme on le dit habituellement, et comme je l'avais cru moi-même au début de mes recherches. Sans doute, ils dérivent des Hétérodontes par le même processus de fixation direct, mais il semble qu'ils dérivent de types différents et à des époques différentes, les Rudistes des Cardiidés à la base du Jurassique supérieur, et les Chamidés des Lucinidés pendant le Crétacé supérieur.

CLASSIFICATION

The term Rudistes was used by Lamarck in his Animaux sans Vertèbres to include six genera which he supposed belonged between *Ostrea* and the Brachiopodes, namely: *Sphærolites*, *Radiolites*, *Calceola*, *Birostrites*, *Discina* and *Crania*. But in more recent usage it may include a great series of forms ranging through *Diceras*, *Requienia*, *Monopleura*, *Caprina*, *Radiolites*, *Hippurites* and even *Chama*. As so understood the first rational classification was made by Munier-Chalmas‡ who divided the then known species into the following seven families, embracing 23 or 24 genera: *Chamidæ*, *Monopleuridæ*, *Balyeidæ*, *Caprinidæ*, *Heterocaprinidæ* and *Radiolites*.

Since this classification was proposed, many modifications have been suggested and many new genera described. Stress in classification is now generally laid on the fact that some forms may be considered "normal", attached by the left valve, or "inverse", attached by the right valve. Some early Jurassic *Diceras* from which all later forms of Rudistids were doubtless derived, were indifferent as to mode of attachment, but in late Jurassic times they were all "normal", attached by the left valve§. Both normal and inverse forms appear in the Cretaceous.

*B. S. G. Fr. (3), vol. 14, p. 389.

†B. G. S. Fr. (4) vol. 12, 1913, p. 454.

‡Journ. de Conchyl., (3), vol. 21, 1873, pp. 71-75.

§Douvillé, B. G. S. Fr. (3), vol. 15, 1887, p. 758.

Note:—It was formerly supposed that in all Chama-like forms the attached valve, whether right or left, had the same dentition; the same remark applies to the free valve. Hence the

	Attached (lower), left valve	N
Normal Rudistid formula:	Free (upper), right valve	B' B
and the <i>Inverse</i> :	Attached (lower), right valve	N
	Free (upper), left valve	B' B

The letters n, b and b' were used for corresponding tooth sockets. See plate 5.

According to Douvillé* the accepted notation is now:

	AII		3b
For normal	AI, 3b	for inverse	AII, PII

i. e., "la charnière des formes inverses dérive directement de celle des formes normales par le développement d'un élément nouveau et la disparition d'un autre élément."

The *Inverse* forms deploy in two great series throughout the Cretaceous. One has been called the *Gyropleurides*, the other, *Monopleurides* †. These two series are differentiated from more primitive forms by the gradual development in the upper valve of an apophysis or muscle-bearing plate, bearing the posterior muscle on its external surface *Monopleurides* on its internal surface (*Gyropleurides*).

Paquier (*loc. cit.*) distinguishes the *Monopleura* from the *Gyropleura* "phylum" by its lack of a posterior myophore plate, so called, in the lower valve. The muscular impression is represented by a thickening more or less defined on the inner shell layer.

The relationship of several of the common genera belonging to these series together with our new forms (in Italics) are roughly expressed in the following table:

<i>Jurassic</i>	<i>Cretaceous</i>	
	Gyropleurides	
	Caprotina Caprina Plagioptychus Hippurites	
	Horiopleura Pachytraga Praeacprina	
	Gyropleura Sphaerucaprina	
Valletia	Schiosia <i>Coalcomana</i>	
	<i>Amphitriscaelus</i> <i>K'ipia</i>	
	Monopleurides	
	Monopleura Agria Polyconites	
	Ichthyosarcolites Radiolites	
Dicerias	Heterodicerias	
	Requienia Matheronia Toucasia	
	Apricardia Bayleia	

I N V E R S E

N O R M A L

* *Sur l'appareil cardinal des Chama*; B. G. S. Fr., CR. somm., vol. 15, 1915, p. 75.

† See Paquier, *Mem. Soc. geol. de Fr.*, vol. 13, 1905, p. 50; also Douvillé B. G. S. Fr., vol. 28, 1900, p. 210.

In studying over the Trinidad material we have found no specimens showing clearly well defined dentition. All except the Plum Road material is in a very unsatisfactory state of preservation. Here, however cross-sections show the shape and positions of the internal cavities and canals to perfection. Naturally, our diagnoses of new forms and determination of relationships with those already described must be based largely on cross-sections. Accordingly, a synoptical key has been prepared showing the main differences and resemblances of our new genera to those already described in so far as arrangement of internal cavities and canals are concerned. It may be stated at the outset that it is only the Rudistids having well defined canals, and more particularly those having canals in both valves, with which we are here concerned. As a rule, the relationship of these American to European forms seems decidedly remote.

KEY TO GENERA

I. CANALS IN ONE VALVE ONLY

- A. *Canals in the upper valve.* Lower valve straight and conical; accessory cavity n' and socket n united.
1. Canals polygonal and radial; polygonal canals on the inside, radial and bifurcating outside; wanting dorsally. Ligament external *Mitrocoprina* Boehm (Palæontogr. vol. 41, 1895, p. 102.)
 2. Canals pyriform, especially the inner series, bifurcating exteriorly; lacking dorsally. Ligament marginal (external) *Plagioplychus* Matheron (Cat. Méth., 1842, p. 144; B. G. S. Fr., vol. 16, 1888, p. 713, p. 718 fig. 5.) Herewith refigured as pl. 5, fig. 9.
- B. *Canals in the lower valve.* Upper valve without accessory cavity n'.
1. Large coiled lower valve with a partition, canals mostly circular; upper valve with myophore polygonal canals. Muscles attached on exterior sides of apophyses in upper valve..... *Ichthyosarcolites* Desmarest. (See Douvillé, B. G. S. Fr., vol. 15, 1887, p. 791).
 2. Lower valve without a partition. No ligament. Form of shell and myocardial arrangement much like *Monopleura*. Very small polygonal canals around the whole circumference. Canals divided by transverse septa as in *Corallochama* *Rousselia* Douvillé (B. G. S. Fr., vol. 26, 1898, p. 151, text fig. 9).

II. CANALS IN BOTH VALVES

A. Interior of upper valve bipartite (*G* and *n+n'*), lower valve without a partition.

1. Cavity *n'* large, separated from small *n*.
 - a. Both valves with double or treble series of polygonal canals throughout periphery..... *Caprinula* d'Orbigny (Paleont. Fran., 1847. See especially Douv. in B. G. S. Fr., vol. 15, 1887, p. 784. See also pl. 5, figs. 5 and 6 of this memoir.
 - b. Upper valve with polygonal canals dorsally; radial ventrally. Lower valve with few canals, none ventrally
..... *Caprina* d'Orbigny (d'Orb. père, 1822. See Douv., B. G. S. Fr., vol. 15, 1887, p. 781, pls. 29, 30, 31).
2. Cavities *n'* and *n* not separated.
 - a. Canals of single series; in upper valve, simple, polygonal or roundish, generally outside of myophores only.
 - a. Canals well developed in upper valve, few in lower valve. Greatest diameter of shell from anterior to posterior
..... *Præcaprina* Paquier (Mem. G. S. Fr., vol. 13, fasc. 4, 1905, p. 72, pls. 8, 9, 10); see also pl. 5, figs. 3 and 4 and pl. 6, figs. 1 and 2 of this memoir.
 - b. Canals of regular pattern, mainly found outside of anterior myophore.
 1. Upper valve high capulid; lower long, curved. Shell short from anterior to posterior
..... *Pachytraga* Paquier, 1900; (see especially Mem. G. S. Fr., vol. 13, fasc. 4, 1905, p. 61, pls. 7-10).
 2. Upper valve Venericardia-like, when decorticated; lower valve short-conical... *Kipia*, n. gen., pl. 7.
 - b. Canals of double or triple series in upper valve.
 - a. Canals not horizontally divided, i. e. not tabulate.
 1. Canals largest and best developed anteriorly and posteriorly, sometimes poorly developed ventrally.....
..... *Offneria* Paquier (Mem. G. S. Fr., vol. 13, fasc. 4, 1905, p. 82, pls. 11, 12).
 2. Canals best developed dorsally, filling $\frac{3}{4}$ ths the whole

- shell cavity. No ligament
- *Polyptchus* Douvillé (B. G. S. Fr.,
vol. 4, 1904, p. 523 and text figs. 1 and 2).
3. With only the one large sinus or cavity (omp) in the lower valve.....*Sphaerucaprina* Gemmellaro (Att. dell' Accad. Gioenia di Scienze Natur. di Catania, 2d. ser. vol. 20, 1865, p. 212, pl. 1).
- b. Canals tabulate, small*Coralliochama* White (Bull. U. S. G. S., No. 22, 1885, p. 9, pls. 1-4).
- B. Interior of both valves bi- or tripartite (*G*, $n+n'$, and often *b* greatly extended).
1. Both valves tripartite, one series of canals, wanting ventrally
-*Amphitriscelus*, n. gen. (see pls. 1-4 of this memoir).
2. Lower valve the larger, tripartite; whole periphery of shell with compound, pyriform canal system. *Coalcomana*, n. gen. (see pl. 6, figs. 4-7 of this memoir).
3. Upper valve the larger, tripartite; dorsally with a few large cavities; radial canals ventrally developed; lower valve small, capulid, not well described.....*Schiosia* Boehm (Ber. d. Naturf. Gesell. zu Freiburg, I. B., 1892, pp. 134-148, pls. 7 and 8).

DESCRIPTION OF SPECIES

Amphitriscelus, n. gen.

Etymology: *amphi*, both - *tris*, thrice - *cælus*, hollow

Amphitriscelus waringi, n. sp.,

Plates 1-4

Generic characterization.— Shell of form and dimensions approximately as shown in the accompanying illustrations; both valves curved, but not in the same plane; surface marked by very fine lines of growth; substance of the shell, including septa within, very thin; canals in a single series, of polygonal type, absent ventrally; both valves with two large "accessory" cavities, hence showing in cross-section a tripartite interior subdivision.

Specific characterization.— Valves usually ranging in length from 15 to 120 mm. and in diameter, at the commissure, from 10 to 35 mm.; cross-section nearly circular, slightly longer from ligament pit to ventral margin than antero-posteriorly; ligamental groove not deeply sunken, extends from commissure to tip of either valve; upper valve usually shorter and more incurved or coiled than the lower; concentric lines of growth

times showing slight irregularities in frequency, or stages of growth; often just above or below the commissure, perhaps 10 mm., the shell suddenly contracts in diameter to the extent of 1 or 2 mm. ; beaks more or less prosogyrate; canals quadrangular; largest anteriorly and posteriorly, smaller above, wanting ventrally; body cavity, 1, more or less pentagonal with one side the (ventral) much the longest, delimited exteriorly by two longitudinal faint grooves, of which the posterior is the more pronounced; posterior cavity, 2, more or less scoop-shaped in cross-section with handle somewhat depressed; anterior cavity, 3, smaller, quadrangular, or becoming more or less triangular to roundish; in distal, abandoned portions of the shell all walls are thickened by calcareous deposits* leaving clearly visible simply a small circular body cavity; near the commissure there is a thickening of some of the internal septa evidently caused by dentition development, though the exact shape and size of the teeth cannot be made out from the material in hand; muscular attachments not clearly shown.

Remarks.— Cross-section made just above and below the commissure, see pl. 5, figs. 1 and 2, show besides some irrelevant matter what seem to be the sections of the teeth of the lower and upper valves. These sections when taken in connection with others would indicate that the teeth of either valve extend but a short distance into the other. Yet specimens when closed are broken apart at the commissure with almost as much difficulty as at any other place. This may be due to secondary crystallization.

Attachment or fixation is by the tip of the lower, right valve, which is generally rather sharply curved and flattened in the plane of the general curvature of the valve. The amount of torsion and the rate of expansion in growth and the general shape as well as size of the lower valve show many and marked variations.

The upper valve shows perhaps still greater variation in general manner of growth than does the lower. It may be nearly as long as the lower or may be little more than capulid.

The upper valve has the appearance of curving off in a plane nearly at right angles to the plane of curvature of the lower valve (See pl. 3, fig. 2). The commissure, especially in young specimens is not normal to the axis of the shell, but is very oblique, being therefore elongate-elliptical in outline.

The most remarkable feature of this genus is the tripartite subdivision and almost complete identity of interior characteristics of both valves when sectioned anywhere except very close to the commissure. We know of no other genus heretofore described showing constantly in both valves two large accessory cavities besides the body cavity. The thinness of the various partition walls, especially where one would look for myo-

* Compare thickness of partition walls in pl. 4, fig. 7, with those of the top of same specimen shown as fig. 6.

phore attachments is noteworthy. Thickening locally may occur, but in most instances seems due to secondary replacement.

Schiosia as originally characterized by Boehm (Ber. Naturf. Gesell. zu Freiburg i. B. 1892, p. 134) has a heavy shell, with a very small lower and a very large upper valve. The lower valve was too poorly preserved to admit of accurate description. The upper is shown herewith as pl. 6, fig. 3. In a subsequent publication (Palæontographica, vol. 41, 1895, p. 129) this author in describing a species, *foro juliensis*, remarks;

The lower valve which belongs to the species just described is not definitely determined. Consequently, therefore the generic determination is uncertain. One may be dealing with a *Caprina*. For the present I place this form in *Schiosia*, because here as with the type of the genus already referred to, over *ma* a large accessory pit is developed. Similar pits are found in *Caprinula* (B. G. S. Fr., XVI, 1888, pl. 23, fig. 6a.) and also in *Sphærucaprina striata* already described. Yet in these there are developed besides the radial, also polygonal mantle marginal canals. In *Caprina*, as in *Schiosia* which has exclusively mantle margin radial canals, the accessory pit over *ma* so far as I am aware is lacking; or it is at least, as represented in Douvillé's text figure (B. G. S. Fr., vol. XVI, 1888, p. 703, text fig. 3) subdivided by a row of septa. Still it is not proven that these septa are not present in *Schiosia* and are simply not preserved in our specimens.

The pit he refers to in this quotation is clearly shown on pl. 11, fig. 2 of this volume of the Palæontographica and seems more analogous to the third accessory cavity of *Amphitriscaelus* than does the broad cavity shown in the type of *Schiosia* herewith copied as fig. 3 on plate 6.

The *Schiosia ramosa* (Boehm) Douvillé from the Caprina limestone of Coalcoma Mexico has been cross-sectioned and described in detail by Douvillé (B. G. S. Fr., vol. 28, 1900, p. 207). It is a curious and interesting form. But we are at a loss to know why it has been considered referable to *Schiosia*. In this genus, as originally described by Boehm the upper valve is very large, the lower very small; here Douvillé says the upper is capulid and the lower often very much elongated. The marginal canals in *Schiosia* are simply radial, but in the Mexican form, pyriform and bifurcating; in *Schiosia*, in the upper valve there is a great pit over *ma* according to Boehm, but in the Mexican form (see pl. 6, figs. 4-7) no such pit is shown. However, in the lower valve, not well described by Boehm but shown in the Mexican form (pl. 6, figs. 6-7) as a pit for tooth B', such an anterior cavity exists.

The arrangement of the body and accessory cavities of the lower valve of this form is strikingly like that of *Amphitriscaelus*, but the peripheral canals are totally different. This peculiar form, first regarded by Boehm as a *Caprina*, later by Douvillé as *Schiosia* may well receive a new generic designation, and *Coalcomana* is here proposed.

In the simplicity of structure of the single polygonal series of canals with a hiatus ventrally, there seems to be a similarity between the upper valve of *Præcaprina varians* and *Am. waringi*. But the former is wholly lacking in a great accessory cavity over "ma" as shown in Paquier's works. (See pl. 5, fig. 3, of the present memoir). The large "b" and the "o" over "ma" in the lower valve show that there is an inherent tendency in this line of Rudistid development to produce large cavities here. Posterior marginal canals seem lacking, still, the great cavity "omp" is doubtless a primitive representative of the same. In an allied genus *Pachytraga (paradoxa)* as shown by Paquier there is however, a fairly regular series of canals outside of "ma". But the systematizing and standardizing of the tripartite interior with the clearly defined uniserial system of canals as shown in *Amphitriscaelus* very probably took place at a somewhat later date than that represented by Paquier's genara, perhaps as late as the Cenomanian. The tripartition in the lower valve of *Coalcomana* accompanied by the complete canalization of the periphery suggest perhaps an even more advanced stage of specialization than that shown by *Amphitriscaelus*. Douvillé suggests that this form (his "*Schiosia ramosa*") is most likely of Cenomanian age (B. G. S. Fr., vol. 28, 1900, p. 217).

Locality and Horizon.—Practically all the material herein discussed is from an outcrop of yellowish gray impure limestone in the bed of a small stream $\frac{1}{4}$ mile above where it crosses the Plum Road just south of the $5\frac{1}{4}$ mile post. Fragmentary material has been found in a stream a short distance south of the 5 mile post. It seems most likely that these fossils represent a Cenomanian horizon, though they may well be as low as the Aptian.

Kipia. New Genus

Kipia trinitaria, n. sp.

Plate 7

Generic Characterization.—Shell small with short, conical lower valve and low capulid upper valve; regular series of canals simple so far as known, developed only anteriorly and ventrally; substance of shell thin especially posteriorly; body cavity occupying practically the whole of the interior of the shell.

Specific Characterization.—Polygonal canals beginning small anterior to the umbo in the upper valve (see pl. 7, fig. 3.) increasing in size to the anterior ventral margin; decreasing posteriorly and becoming of minute size and vanishing at the posterior ventral margin; from the beak anteriorly the shell matter was seemingly thick, but with at least some cavities; one for the myophore of the opposite valve (see fig. 6 for a rough representation of a section just above the commissure); lower valve angular in cross-

section, more or less as shown within the heavy line, fig. 6; canals more numerous and smaller than in the upper valve; well developed anteriorly and ventrally but lacking posteriorly; spaces between body cavity and anterior marginal canal series with cavities whose size and dimensions have not yet been determined; anterior to "ma" (see fig. 6) a deep, narrow pit allows the filling matter of the upper valve to extend downward in a very thin wall one-fourth way to the apex (See fig. 1); attached to a valve of *Amphitriscaelus waringi* along the straight side (fig. 6 opposite "L") from beak to near the commissure as indicated in fig. 1.

Of this strange type we have found but one specimen and that is imperfect. We have naturally felt much hesitation in placing this on record as a new genus and species, yet it is mainly in the matter of the inner series of anterior canals that modifications and improvements in the description above given can be made, a matter, however, that cannot seriously modify the general make-up of our diagnosis. Fragments indicate that there are still other strange types of Rudistids to be found in this eastern Trinidad locality.

Locality and horizon.—Found in connection with *Amphitriscaelus waringi* at the type locality for that species near the $5\frac{1}{4}$ mile post on the Plum Road in the eastern part of Trinidad.

Genus *Caprina*, d'Orb.

Caprina plumensis, n. sp.

Pl. 8; 9, figs. 3, 4

Specific characterization.—Shell of moderate size; upper valve coiled in a loose spiral as shown in figs. 2 and 4, pl. 8; cross-section roughly ovate with ventral portion flattened, tending to be a little carinate just anterior to the basal terminus of the one, strong partition; exterior with fine growth lines, where not decorticated; shell wall thick, with traces of narrow quadrangular canals ventrally, becoming large anteriorly and posteriorly, indefinitely and widely developed along the ligamental margin; anterior tooth (B') generally represented by an open cavity in cross-sections, posterior (B) indicated by a thickening of the exterior wall, in some instances; lower valve as seen in fragments seems to be less coiled, smaller, with a few very large quadrangular canals posteriorly where the shell wall is thick, very small quadrangular canals anteriorly, and with very irregular cavities in the ligamental region.

The specimen from which fig. 2 was drawn was doubtless twice the length shown before it was broken to pieces in extracting the specimen from the matrix.

Much better material must be secured and worked out before the generic position

of this species is well determined.

Locality and horizon. In eastern Trinidad near the Plum Road, associated with *Amphitriscaelus*. Comparatively scarce.

Genus *Præcaprina*

Præcaprina andersoni, n. sp.

Pl. 9, figs. 1, 2

Specific characterization.—Shell of moderate size (upper valve only known); beak closely incoiling on a plane with the anterior margin of the shell, giving the outline of the whole valve a pentagonal appearance with anterior side longest; ventrally the shell is slightly concave anteriorly but rather sharply carinate sub-centrally, with a trace of a second carination further towards the posterior; surface when uneroded covered with a fine spiral costation, especially well defined about the beak; canal system seemingly not far from that of *plumensis*; partition in specimens studied apparently dissolved away.

The shape and method of coiling of this valve suggest strongly *Præcaprina*, yet the canals as far as can be made out are more continuous ventrally and less angular and cavernous anteriorly and posteriorly, than represented in illustrations of that genus.

Locality and Horizon.—Found, very rarely, along with *C. plumensis* and *Amphitriscaelus*, near the Plum Road, eastern Trinidad.

Præcaprina? pennyi, n. sp.,

Pls. 10, 11

Specific characterization. Shell of moderate size; upper valve rather closely coiled with apex nearly in the same plane as the anterior margin of the shell; outline of cross-section, oval, slightly flattened from ligament anteriorly and ventrally; a well defined partition present; quadrangular canals along the anterior and posterior margins with greatest dimension parallel to the shell margin; lower valve slightly curved or mildly irregularly twisted; without a partition; walls generally appearing very thick.

The general appearance of these specimens is like that of *Coralliochama* or *Pachytraga*. The character of the canals along the ligamental margin cannot well be determined with our specimens so broken and in such crystalline condition. So far, we have observed no canals ventrally. They are comparatively few anteriorly and posteriorly.

Locality and Horizon.—The so-called Stack-Rock at Point à Pierre, Trinidad. The European affinities of these specimens would seem to point to a horizon at least equally as low as the Plum Road material. This remark has reference to the fossils in Stack-Rock and implies nothing as to the supposed transplanting of this rock subsequently in beds of far higher horizon. Along this coast loose fossils have been found from time to time, which when studied in connection with other Stack-Rock material may give a more definite clue to the age of the Rudistid remains.

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Plate I (XVIII)

EXPLANATION OF PLATES

Plate 1 (XVIII)

Amphitrisctelus waringi, n. gen., n. sp. (Nat. size).....Page 12

Type specimens; shown as excavated from the matrix, nearly in position of growth. The specimen in the foreground has been broken, showing the body cavity and some additional cavities or canals. The commissure is about opposite where the shell is freed from the rock. The section shown as fig. 4, pl. 4 was made half-way from the commissure to the apex of the upper valve. The lower valve is curved in the plane of the illustration, while the upper is curved away from the observer.

The less curved shell, more in the background, shows very well the sudden increase in diameter about one and a half centimeter below the commissure. Fig. 5 of pl. 4 represents a cross-section made of the lower valve of this specimen just above where it is free from the matrix. Both figures 4 and 5, show a great amount of filling in of the various cavities in the sections remote from the commissure. See other more typical cross-sections, plate 4.



Plate 2 (XIX)

Plate 2 (XIX)

Amphitrisocelus waringi, n. sp. (Nat. size).....Page 12

Figs. 1-3, upper valves ; 4-6, lower valves.

Fig. 1, though an upper valve, is coiled about a foreign object.

Fig. 2 shows well the twisting of valves, whether upper or lower.

Fig. 4 shows the usual mode of growth of the long, more regular forms. The attachment is by the side of the tip turned away from the observer. Notice the position of the ligamental groove.

Fig. 5 shows a common small form with flaring upper section. The amount of twisting from beak to commissure in these short specimens seems quite equal to that shown by the longer forms.

Fig. 6 shows besides the lower valve a short portion of the upper valve, with canals. Notice the change in direction of the shell axis as the commissure is passed.



HARRIS, photo.
et collo.

Plate 3 (XX)

Plate 3 (XX)

Amphitriscelus waringi, n. sp. Page 12
(Figures about $\frac{7}{8}$ nat. size)

- Fig. 1. Lower valve with apex turned toward the observer.
2. Specimen showing both valves united. The lower valve is gently curving, while the upper is so twisted that the beak is hidden in the background behind the main mass of the shell.
3. An upper valve less intensely twisted than that shown by fig. 2.
4. A very slender upper valve.
5. Lower valve showing a common hooked form.



Plate 4 (XXI)

Plate 4 (XXI)

Amphitriscœlus waringi, n. sp., (Nat. size).....Page 12

Figs. 1-4, upper valves; 5-11, lower valves.

Fig. 1 shows not only the shape of a short upper valve with the course of the ligamental groove, but especially the relative position, shape and size of the three internal cavities, No's. 1, 2 and 3 or the body cavity G, the first accessory n-n', and the second accessory 3. This cross-section being taken some little distance from the commissure shows some thickening of the various walls, or filling of the cavities.

Fig. 2 shows a somewhat shorter form with an unusual modification about n. This feature is shown more clearly in fig. 3 which is simply an illustration of the base of 2.

Figs. 4-5 are cross-sections of the type specimens, pl. 1, made at considerable distances from the commissures and hence showing a large amount of refilling or thickening of the walls.

Fig. 6 is the cross-section of the specimen show as fig. 7. This, a lower valve, shows clearly the remarkable similarity between cavity and canal systems of the upper and lower valves of this species.

For views of cross-sections of either valve nearer the commissure, see pl. 5, figs. 1 and 2.

Fig. 7 shows a basal section with thickened walls, while fig. 6, the cross-section of the top of the same specimen, shows little thickening.

Figs. 8-11 show cross-sections of lower valves with various stages of local refilling. Fig. 11 seems to show the tips of the teeth B and B'.

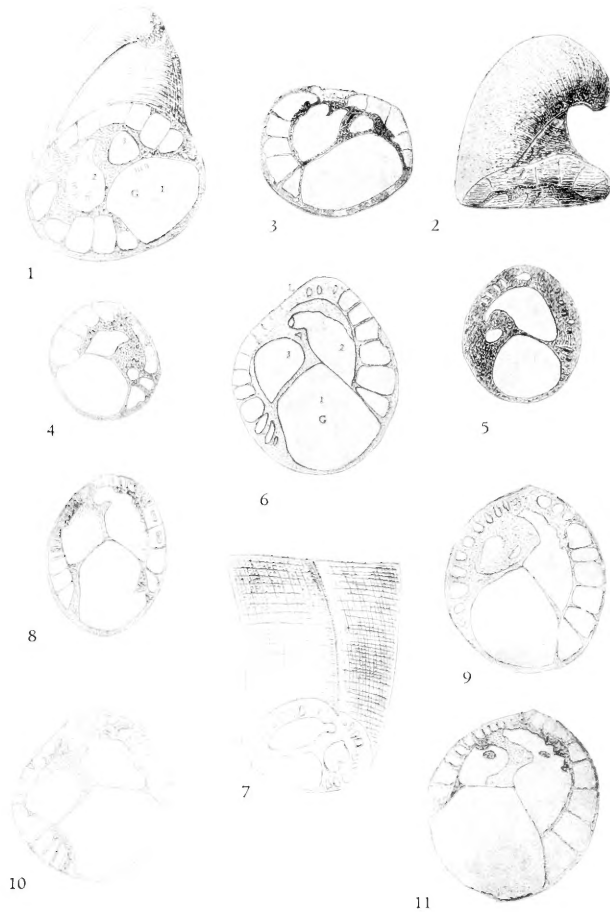


Plate 5 (XXII)

Plate 5 (XXII)

- | FIGURE | PAGE |
|---|------|
| 1,2. <i>Amphitrisceolus waringi</i> , n. sp. (Nat. size)..... | 12 |
| <p>Fig. 1 shows besides some extraneous matter in the various cavities, a platform supporting tooth N as well as tips of teeth B and B' of the opposite valve. This is a lower valve sectioned just below the commissure. The apex of the valve is supposed to be, as usual, directed away from the observer.</p> <p>Fig. 2 illustrates a cross-section of the upper valve of the same individual, made just above the commissure, showing what appear to be dental platforms for B and B' and a portion of N of the lower valve.</p> | |
| 3,4. <i>Præcaprina varians</i> , Paquier, ($x\frac{1}{2}$)..... | 15 |
| <p>Figures taken from Mem. Soc. Géol. de Fr., vol. 13, fasc. 4, pl. 18 to show a somewhat similar canal condition in the upper valve to that of <i>A. waringi</i> but a totally different arrangement of interior cavities. In fig. 4 the cavities o, o', doubtless represent the anterior canal series of fig. 1 and the Omp the posterior series, but the general scheme of internal subdivision seems very different in the two.</p> | |
| 5,6. <i>Caprinula</i> , sp..... | 14 |
| <p>Figures as shown by Douvillé after Woodward in B. G. S. Fr., vol. 15, 1887, p. 785.</p> <p>These show the intricate canal system of both valves and the accessory cavity n' distinct from n. The canal system may well be styled compound-polygonal, though anteriorly in the upper valve there is a short radial series on the exterior.</p> | |
| 7,8. <i>Caprina adversa</i> , d'Orb. ($x\frac{1}{2}$)..... | 14 |
| <p>Slightly modified from Douvillé's figures in B. G. S. Fr., Vol. 16, 1888, pp. 702-703. Note the polygonal canals above in fig. 8, the large ligamental cavity L, the separation of n from n', and the radial canals anteriorly, posteriorly and ventrally. Fig. 7, the lower valve, lacks the partition of the upper and its canal system is extremely simplified.</p> | |
| 9. <i>Plagioptychus aguiloni</i> , d'Orb. ($x\frac{1}{2}$)..... | 10 |
| <p>This is sketched from Douvillé's figure, B. G. S. Fr., vol. 16, 1888, p. 718, text fig. 5. It is introduced to show a subdivisional system of peripheral canals. Note how narrow they are near the exterior but how large and pyriform internally. Canals are lacking along the ligamental margin. The size of n is noteworthy.</p> | |

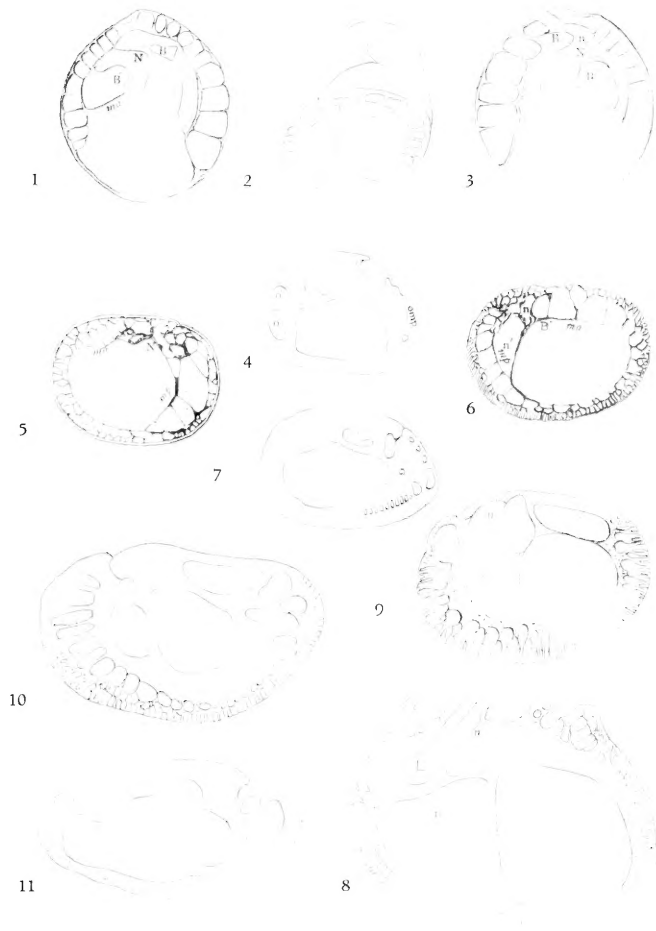




Plate 5 (XXII) concluded

FIGURE	PAGE
10, 11. <i>Sphaerucaprina woodwardi</i> Gemm. (about $\frac{1}{2}$ nat. size).....	14

Modified from Douvillé, in Mem. S. G. de Fr., vol. 18, fasc. 1, pp. 30-31. The polygonal cavities of the upper valve suggest those of *Caprinula* ventrally though not dorsally. The lower valve, fig. 11, is less canalized than the lower of *Caprina*, fig. 7. In the upper valve, fig. 10, n and n' are united, whereas in both *Caprina* and *Caprinula* they are separated.

Plate 6 (XXIII)

Plate 6 (XXIII)

FIGURE

PAGE

- 1, 2. *Præcaprina varians*, Paq., ($\times \frac{1}{2}$).....15
 From Paquier's text figures 10 and 11, Mem. S. G. de Fr., vol. 13, fasc. 4, 1905, p. 75. These show the general shape of the shells and dentition far better than do the cross-sections, pl. 5, figs. 3, 4. Note the position of the beak with reference to 'P' and compare fig. 3.
3. *Schiosia schiosensis*, Boehm14
 Somewhat reduced, from Boehm's article in Ber. Natur. Gesells. zu Freiburg i. B., 1892, pl. 8, fig. 2. Note the great size of this upper valve. (The lower is said to be smaller, capulid). Note also the great cavities dorsally; smaller, radial ones ventrally.
- 4-7. *Coalcomana ramosa*, (Boehm) ($\times \frac{3}{4}$)14
 Boehm's *Caprina ramosa*, or *Schiosia ramosa* of Douvillé, B. S. G. de Fr., vol. 28, 1900, text figs. on p. 207.

The three great cavities in the lower valve suggest the internal arrangement in *Amphitriscaelus* and we strongly suspect better material might show the same system in the upper valves, figs. 4 and 5. However, the complicated pyriform canal system especially as developed ventrally removes this far from our Trinidadian genus.

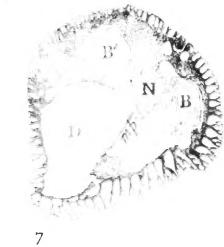
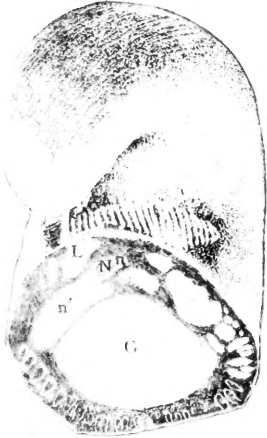
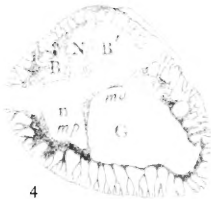
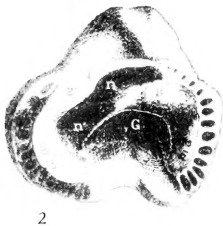
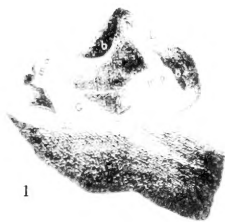




Plate 7 (XXIV)

Plate 7 (XXIV)

Kipia trinitaria, n. gen., n. sp. (x 2).....Page 15

Fig. 1 shows the type specimen *in situ* adhering not only at base but along the ventral side of the lower valve to a large *Amphitriscaelus waringi*. The umbo of the upper valve is directed toward the observer. Note how its filling has passed down between partitions of the lower valve and hardening formed a partition-like extension reaching a third way to the bottom of the lower valve. Between this partition and the exterior there was one complete row of simple, quadrangular canals which fell out in breaking open the rock. Two are especially well shown in fig. 2 as c.

Fig. 3 is a view taken from directly above and shows how the shell when decorticated gives the appearance of a *Venericardia planicosta* though the canals become small and vanish posteriorly as is indicated in fig. 5 (drawn as if viewed from underneath).

Fig. 4 is a view with the ligamental margin directed toward the observer. The marked ligamental groove to the left, l; the umbo of the upper valve, U, the canal region of the lower valve, c; the series of broken canals of the upper valve, the same as shown by c in fig. 3; and the angular character of the cross-section of the lower valve when stripped of the marginal canals: all can be fairly well determined from this figure alone. The last-mentioned feature is represented diagrammatically as fig. 6 (also drawn as if viewed with the beak away from the observer).





Plate 8 (XXV)

Plate 8 (XXV)

- Caprina plumensis**, n. sp., (x7%)Page 16
- Fig. 1. Cross-section of specimen represented by fig. 2, about three-fifths way from aperture to beak.
- Fig. 2. A considerable portion of an upper valve showing the flattened ventral surface and moderate carination below.
- Figs. 3, 5. Cross-sections of upper valves showing character of canals.
- Fig. 4. Apical portion of an upper valve showing a rather pronounced carination.
- Figs. 6, 7. Cross-sections of lower valves.

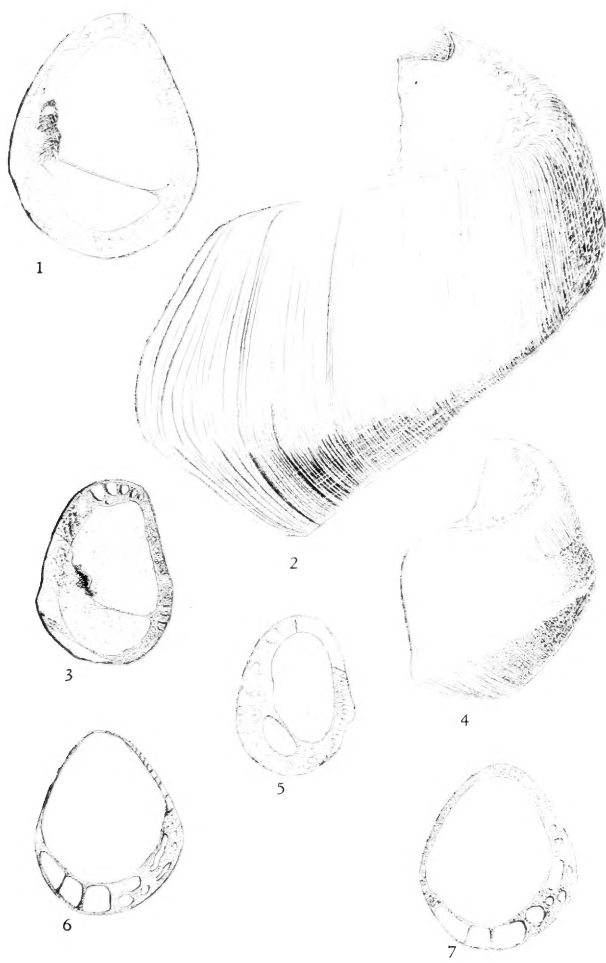




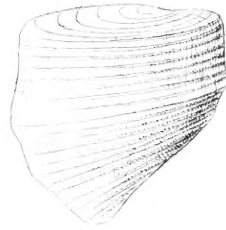
Plate 9 (XXVI)

Plate 9 (XXVI)

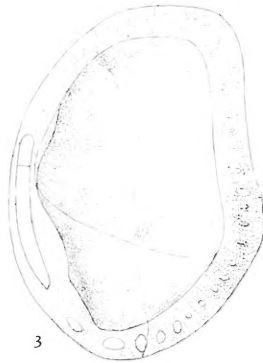
FIGURE	PAGE
1, 2. <i>Præcaprina andersoni</i> , n. sp. (Nat. size).....	17
Fig. 1 shows the very oblique course of the ligamental groove; the thickening of the cardinal margin with indistinct, elongate cavities; and the peripheral canal openings, large anteriorly and posteriorly but narrow and indistinct ventrally.	
Fig. 2 shows the exterior ribbing, the main strong carination and the secondary one below.	
3, 4. <i>Caprina plumensis</i> , n. sp.	16
Fig. 3 is a cross section of the specimen shown as fig. 2, pl. 8, taken somewhat nearer the commissure than that shown as fig. 1, pl. 8.	
Fig. 4 is a cross section of a smaller, upper valve showing thickening of walls and filling of canals.	
5, 6. Unidentified Rudistid remains found associated with <i>Amphitriscolus</i> .	



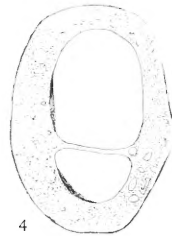
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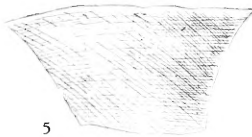
2



3



4



5



6

Plate 10 (XXVII)

Plate 10 (XXVII)

Præcaprina? pennyi, n. sp., (Nat. size).....Page 17

Fig. 1 shows a small, lower valve, somewhat less curved than usual.

Fig. 2 shows the thickened walls and the body cavity (of fig. 1, viewed from above).

Fig. 3 is an upper valve, with portions of the lower attached.

These specimens are in highly crystalline limestone and the internal details are obscured by secondary crystallization. From the "Stack-Rock" at Point-à-Pierre.



Plate II (XXVIII)

Plate II (XXVIII)

Præcaprina? pennyi, n. sp. (x%) Page 17

Fig. 1 shows a lower valve and a short portion of an upper; cavities and canals not well shown.

Fig. 2 is an upper valve with a small portion of a lower attached.

These rough specimens have partially weathered out of a highly crystalline limestone. The coiled form of the upper valves gave rise to the supposition that they were large gastropods. From "Stack-Rock", Point-à-Pierre.



1



2



PALÆONTOGRAPHICA AMERICANA

ILLUSTRATED CONTRIBUTIONS

TO THE

INVERTEBRATE PALEONTOLOGY

OF

AMERICA

VOL. I

No. 4. The Recent Arcs of the Panamic Province

(Pages 163-208, Plates 29-31)

BY CARLOTTA JOAQUINA MAURY

ITHACA
HARRIS COMPANY

1922



P15

THE RECENT ARCAS OF THE PANAMIC PROVINCE

By Carlotta Joaquina Maury

INTRODUCTION

The shells discussed in this paper have been obtained from various collections. In 1918, Mr. Axel Olsson collected many recent shells along the shores of Panama Bay from Bucarn, the port of Tonosi, Los Santos Province, at the extreme northern boundary of the Bay, to Garachine Point, which marks its eastern limit, and also the Pearl Islands, *Islas de las Perlas*, in the midst of the Bay. Mr. Olsson very kindly placed his material in my hands for study.

Dr. Wesley Newcomb, about seventy-five years ago, visited Panama on several occasions and collected a large number of shells from the rock reefs at Panama. His specimens, now in the Cornell University Museum, were also available.

Furthermore, Dr. Dall, Honorary Curator of Mollusca in the United States National Museum, was so good as to loan to me the West Coast Arcas from the National Collection.

Mr. Miner, Curator of the Mollusca of the American Museum of Natural History, also most kindly lent me some beautiful specimens from the Constable Collection in that Museum.

It is very regrettable that it was impossible to have access to the specimens of the Gould Collection from the West coast, which are in the New York State Museum at Albany; and also to the duplicate set from Mazatlan deposited by Carpenter there. These are not available for study because the Mollusca have not yet been unpacked since moving.

It is also unfortunate that although the Curator of the Adams Collection at Amherst College kindly made repeated searches, only one of the three Panama Arcas described by C. B. Adams as new, but never figured, could be found. But as all were examined by Carpenter and compared by him with the Mazatlan species, and placed by him in synonymy, this is not so great a misfortune as it would otherwise have been.

I wish especially to express my indebtedness to Dr. Pearl Sheldon, author of "The Atlantic Slope Arcas." Her very exact knowledge of this genus to which she has devoted years of study, has added greatly to the philosophic comparisons and critical discriminations of the species herein discussed.

DESCRIPTION OF SPECIES

Genus *Arca*, LinnæusSubgenus *Arca*, *sensu stricto*, Lamarck*Arca pacifica* Sowerby

Plate 1, Figure 15

Byssoarca pacifica Sowerby, Proc. Zool. Soc. London, p. 17, 1833.

Arca pacifica Reeve, Conch. Icon., *Arca*, pl. 11, f. 75, 1844.

A. pacifica d'Orbigny, Voy. Amér. Mérid., Moll., p. 639, 1846.

A. pacifica Carpenter, Cat. Reigen Coll. Mollusca, p. 138, 1855-57; Rept. Brit. Assoc. Adv. Sci. p. 310, 1857

A. pacifica Stearns, Proc. U. S. Nat. Mus., 14, p. 309, 1891.

A. pacifica Dall, Proc. U. S. Nat. Mus., 37, p. 251, 1910.

Shell oblong, somewhat trapezoidal, winged posteriorly, gaping ventrally. Color white with rather broad wavy bands of reddish brown. The area inclosing the ligamentary grooves is large and the bare strip surrounding it is usually rather narrow. The ribs are of the same type over the entire shell, but vary in size, those in the center of the valve being generally smaller. As in related forms there may be smoother radiating strips posteriorly. The shell may attain a large size, the type measuring 4 inches in length and one of Carpenter's was over 5 inches. Ours are smaller, the largest only 62 mm. in length, 25 altitude at the beaks, and 20 mm. in semidiameter.

The specimen figured was kindly loaned by Dr. Dall from the National Museum. It measures 80 x 32 x 20 mm.

Arca pacifica is very similar in sculpture, color banding and cardinal area to *A. noæ* Linnæus, from the Mediterranean and to *A. occidentalis* Philippi from the East coast and in the Miocene of Bowden, Jamaica, but *A. pacifica* is characteristically more expanded posteriorly than either of these species.

Cuning's shell which constituted Sowerby's type was from Sta. Elena, Ecuador, dredged at 6-18 fathoms, rocky bottom. The shells adhere together in masses. Stearns recorded the species from Bahia, Ecuador, Lat. 3° North; Mauta, Ecuador, 1° South; and Paita, Peru, 5° South. Its northern limit is the Gulf of California where it is recorded by Carpenter from Guaymas, Mexico. It is rare but large at Mazatlan. Carpenter lists it from Panama, but evidently it is rare there also since it was not found by Adams nor by Zetek and we have only two valves.

Locality—Bucarn, Los Santos Province (Olsson coll.).

Arca mutabilis Sowerby

Plate I, Figure 5

- Byssoarca mutabilis* Sowerby, Proc. Zool. Soc. London, p. 17, 1833.
Arca mutabilis Reeve, Conch. Icon., *Arca*, pl. 13, f. 85, 1844.
A. mutabilis Hanley, Descr. Cat. Rec. Shells, p. 156, 1845.
A. mutabilis d'Orbigny, Voy. Amér. Mérid., Moll., p. 638, 1846.
A. mutabilis C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., 5, p. 483, 1892.
Byssoarca mutabilis Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 139, 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc. London, p. 364, 1863.
Arca mutabilis Dall, Proc. U. S. Nat. Mus., 37, p. 251, 1910.
A. mutabilis Zetek, Molluscos de Panama, p. 38, 1918.

Shell oblong, somewhat rhomboidal, very ventricose, variable and often rude in form, gaping ventrally. Umbonal ridge strong, rounded, sometimes projecting, as in Reeve's figure, beyond the margin. Ribs over the anterior and central area of the valve fine and granulose. On the posterior slope are four to six ribs which are coarser and characteristically dark or blackish in fresh shells. The beaks are uncurved over the cardinal area which is concave and almost entirely covered with a dark, chocolate brown, horny material. The ligamentary grooves are few in number and lie between the beaks. An average shell measures 29 mm. in length, 20 in height and 19 in diameter,

The Old World analogue is *A. imbricata* Brugnière and the East coast analogue is *A. umbonata* Lamarck, which ranges from Cape Hatteras to Santa Caterina, Brazil, and extends back into the Oligocene of Tampa, Florida and that of the Rio Collazo shales, Port Rico.

Arca zebra Swainson, from the Philippines, belongs to the same group and has similar sculpture but differs in the cardinal area and in the presence of the zig-zag markings. *A. truncata* Sowerby is another member of the group.

The type of *Arca mutabilis* was collected by Hugh Cuming on Isla la Plata, Ecuador. Lat. 1° 20' South, about 1830. Adams found seventy specimens at Panama and Taboga Island. It was collected by Frederick Reigen at Mazatlan but is rare there, *vide* Carpenter. Dall records it from Peru. The favorite habitat of the species is under stones and in rock crevices. It ranges from the Gulf of California to Paita, Peru.

Localities.—Bucarn (the Port of Tonosi), Los Santos Province, Panama (Olsson collection); Taboga Island, Panama Bay, twelve miles from Panama City (Newcomb collection).

Arca angulata King

A. angulata King, Zoological Jour., London, 5, p. 336, 1831.

A. angulata Reeve, Conch. Icon., *Arca*, pl. 13, f. 84, 1844

A. angulata Stempel, Fauna Chilensis, Zoologische Jahrbücher, Supplement Band 5, p. 219, Taf. 12, f. 11-9, 1899-1902.

A. angulata Dall, Proc. U. S. Nat. Mus., 37, p. 251, 1910.

Not *A. angulata* Bruguière, Dict. Encycl. Méth., p. 113, No. 28, 1792. *Vide Pectunculus angulosus*, *vide* Nyst.

Not *A. angulata* Reuss, Geogn. Skizze, vol. 11, p. 194, 1843; Verst. Bohm. Kreid., pl. 34, f. 30. Renamed by Nyst. *Arca reussiana*, 1847, and by d'Orbigny *A. subangulata*,--*Vide*, Neues Jahrbuch, p. 874, 1856.

Shell rather small, oblong, more or less medially sulcated and of variable form. The cardinal area is so extremely wide that the shell when resting on its basal edges has the aspect,--as Captain King said in describing the type--of a flat Indian canoe. In his specimen the cardinal area sloped downward so greatly from the central axis to the beaks that the latter are hidden in the dorsal view given by Reeve, but Stempel's figures show variations from convex to flat or somewhat concave areas. The ribbing is fine, coarser on the posterior slope. In general type it seems to resemble that of *A. mutabilis*, but in *mutabilis* the cardinal area is narrower and concave.

Stempel in studying the collection of shells made by Ludwig Plate in Chile and on Juan Fernandez, remarks that the form of *Arca angulata* is very variable. In old shells the cardinal area becomes encrusted with a thick deposit of lime and the beaks so greatly eroded that the specimens look more like oval stones than molluscan shells.

Reeve's figures does not convey a clear idea of the species, but Stempel's series is good.

The type of *A. angulata* was dredged in the offing of Cumberland Bay, Juan Fernandez Island, at 80 fathoms, attached to a coral branch. It was collected by the officers of H. M. S. *Adventure* and *Beagle*, commanded by Captain King on a voyage to southern South America, 1826-1830.

Stempel found many specimens of this species in Plate's collection from the tidal zone among the rocks of the coast of Juan Fernandez and also from a depth of 20 to 40 fathoms off shore.

Arca truncata Sowerby

Plate I, Figure 2.

Byssarca truncata Sowerby, Proc. Zool. Soc., London, p. 19, 1833.

Arca truncata Reeve, Conch. Icon., *Arca*, pl. 11, f. 74, 1844.

Byssarca truncata Carpenter, Rept. Brit. Assoc. Adv. Sci., pp. 310, 319, 1857.

Arca truncata Stearns, Proc. U. S. Nat. Mus., 16, p. 421, 1893.

Not *A. truncata* Reuss, Geogn. Skizze, 11, p. 193, 1843. See *A. curta* Nyst.

Not *A. truncata* Buckm. Fossil from the Lias of Ireland.

There is in the Newcomb collection, a single small specimen which appears to be *Arca truncata*.

This species is very similar to *A. imbricata*, but has wavy brown streaks about the umbo, somewhat like those of *A. zebra*, but less well-marked. Our specimen shows traces of these streaks where the umbo is not worn.

Judging from Reeve, the cardinal area of *truncata* must be flatter than in the related forms, *A. mutabilis* and *A. imbricata*. Our specimen has a very wide, flat area with a small ligamentary area between the beaks. The cardinal area is so wide that Dr. Newcomb identified the shell as *A. angulata* King. Perhaps this is an individual variation.

Outside of the small, diamond-shaped ligamentary area the cardinal area is bare in one shell,—a feature which distinguishes it from *A. mutabilis* in which practically the whole cardinal area has a dark horny covering. The sculpture is of the same type.

Our specimen is very similar to Stempell's figures of *A. angulata*, but does not show the downward slope from the central axis to the beaks. The two Island species, *truncata* and *angulata* are evidently very closely related.

The type of *A. truncata* was collected by Cuming at the Galapagos Island. It is listed from there by Carpenter and by Stearns,—but was not in the collections worked up by Stearns, who apparently refers back to the type.

Locality.—Galapagos Island (Newcomb coll.).

Section *Litharca* Gray*Arca (Litharca) lithodomus* Sowerby

Byssarca lithodomus Sowerby, Proc. Zool. Soc. Lond., p. 16, 1833.

Litharca lithodomus Gray, Synopsis Brit. Mus., p. 155, 1840; p. 81, 1844; Ann. and Mag. Nat. Hist., 2d ser., 19, p. 368, 1857.

Arca lithodomus Reeve, Conch. Icon., *Arca*, pl. 12, f. 76, 1844.

A. lithodomus d'Orbigny, Voy. Amér. Mérid., Moll., p. 639, 1846.

Litharca lithodomus H. and A. Adams, Genera Moll., 2, p. 534, 1858.

L. lithodomus Fischer, Man. de Conch. p. 975, 1887.

L. lithodomus Tryon, Struct. and Syst. Conch. 3, p. 254, pl. 127, f. 68, 1887.

Arca (Barbatia) lithodomus Dall, Proc. U. S. Nat. Mus., 37, p. 252, 1910.

Arca lithodomus Maury, Science, new ser., 54, p. 516, Nov. 1921.

A. candida Gmelin [distorted specimen] Dall, Trans. Wagner Inst. Sci., 3, pt. 4, p. 615, 1898.

Shell cuneiform, posterior end very short, concave and defined by an umbonal ridge so sharp that the angle between the posterior slope and the front of the shell is acute. Anterior end longer and evenly rounded. The first six ribs at the anterior end are well defined, but from that point to beyond the center of the valve the concentric sculpture is dominant. The ribs anterior to the umbonal ridge are well-marked as are also those on the posterior slope. The latter are divided and a few ribs arise in the interspaces. All the ribs are fine and delicate. The concentric sculpture is beautiful and forms with the radiating lines a series of fluted waves.

This ornamentation recalls that of some *Martesias* and other boring forms. The cardinal area and hinge line terminate just behind the beaks. The area is concave, standing at an angle of about 45° at the posterior end and nearly vertical anteriorly. A blackish brown covering lies over the entire area which is marked anteriorly with three or four grooves. Hinge teeth numerous, fine, closely-set and vertical except at the anterior end. This description is based on a young, left valve, length 24 mm., height 11, semidiameter 5 mm. As I noted in *Science*, 1921,—“On the Rediscovery and Validity of *Arca lithodomus*”—This is the first specimen ever found since the type was collected by Cuming at Monte Cristi, Ecuador, Lat. 1° South. The type was 3.5 inches long.

The characters of the cardinal area and hinge show that *Arca lithodomus* belongs to the group of True Arks. Its peculiar form and sculpture are doubtless due to a boring habit. Since *Arca lithodomus* possesses the important characters of the True Arks and differs only in subordinate respects, *Litharca*, established by Gray in 1840, for this species should be a section under the True Arks rather than a coordinate group. It does not belong under *Barbatia*, where it has sometime been placed.

The short posterior slope is analogous to the posterior truncation of *A. reversa* in the subgenus *Noctia*. In certain other respects also *A. lithodomus* recalls *Noctia*. This strengthens the conclusion reached by Dr. Sheldon (*Palæontographica Americana*, 1, p. 69, 1916) that the subgenus *Noctia* appears to be more closely related to the Typical

Arks than to any other group.

Locality.—Bucarn, Los Santos Province, Panama, approximately Lat. 7° 30' North (Olsson coll.).

Subgenus **Noëtia** Gray

Noëtia is a group of comparatively few members. It was thought to be exclusively American and Indo-Pacific, and not to occur in either the fossil or recent faunas of Europe. But, as pointed out by Dr. Sheldon (*Palæontographica Americana*, 1, p. 69, 1916), *Arca okeni* Mayer, from the Middle Tertiary of France, is a true *Noëtia*.

Arca cafria Bartsch, from Port Alfred, Natal, is a living *Noëtia* from the South Indian Ocean, and may be mentioned to show the wide distribution of the subgenus as contrasted with its rarity of species.

On the East coast of America in the recent fauna are *Noëtia ponderosa* Say and *N. bisulcata* Lamarck (+ *N. martinii* Recluz).

The only true recent Noëtias on the West coast of Central America so far known are *Noëtia reversa* Gray, the type of the subgenus, and a new species, *N. olssoni* Sheldon and Maury.

The subgenus *Noëtia* is here placed immediately after *Arca*, *sensu stricto*, to indicate its close relationship to that group, which has been noted under the discussion of *Arca lithodomus*.

Noëtia reversa (Gray) Sowerby

Plate I, Figure 7, 11

- Arca reversa* Sowerby, Proc. Zool. Soc., London, p. 20, 1833.
A. reversa Reeve, Conch. Icon., *Arca*, pl. 1, f. 5, 1844.
A. reversa d'Orbigny, Voy. Amér. Mérid., Moll., p. 635, 1846.
A. reversa C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., 5, p. 485, 1852.
A. reversa Troschel, Archiv für Naturgeschichte, 18, p. 200, 1852.
A. reversa Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 136, 1855-57; Rept. Brit. Assoc. Adv. Sci. p. 310, 1857; Proc. Zool. Soc., London, p. 364, 1863.
A. (Noëtia) reversa Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.
Arca (Noëtia) reversa Sheldon, Paleont. Americana, 1, p. 29, pl. 6, figs. 11, 12, 1916.

Shell of medium size, subtrigonal, inflated, equivalve. Posterior end rather sharply pointed basally and above abruptly truncated. Anterior end rounded. Beaks opisthogyrate. Ribs about thirty-six, flat and closely-set. Interspaces especially those

towards the truncation with a very fine radial thread. Ligament wholly anterior. Epidermis blackish. Length of our largest shell 50 mm., latitude 40; semidiameter 20 mm.

This species was named by Gray from a shell in Mr. Foy's collection from Tumbes, Peru, about Lat. 3° 30' South, dredged at seven fathoms in soft mud. It was described by Sowerby and figured by Reeve. The specific name *reversa* was given because by all the earlier writers the pointed end was thought to be the anterior.

Archer found two valves at Mazatlan and Adams four at Panama, where Carpenter thought it extremely rare. The northern limit of *Noëtia reversa* is the Gulf of California.

Noëtia macdonaldi Dall (Smithsonian Misc. Coll., vol. 59, No. 2077, p. 9, 1912), from the Miocene of Costa Rica is undoubtedly the ancestor of *Noëtia reversa* for it resembles this living species very closely. *Noëtia reversa* is the type of the subgenus.

Localities.—Bucarn, Los Santos Province, Panama, 16 valves; near mouth of Rio Chepo, Panama, 4 valves (Olsson coll.).

Noëtia olssoni Sheldon and Maury, new species.

Plate I, Figure 9.

Shell small, elongated subrhomboidal. Posterior end showing two radiating ridges, the stronger in the usual position of the umbonal ridge, the secondary lying above the center of the posterior slope and causing an obtuse angle in the posterior margin. Shell white, often salmon colored at the umbo. Epidermis dark brown, scaly, more setose on the umbonal ridge. The surface is sculptured with many closely-set, finely crenulated ribs, becoming wider posteriorly, and in each interspace is a fine interstitial rib. Hinge and cardinal area as in *Noëtia*. Ligament area small, anterior part the longer and marked by transverse, parallel grooves. Central teeth small and vertical, distal teeth longer and oblique. Length of largest valve 19 mm., height 11, semidiameter 5 mm.

This is probably the *Arca*, sp. indet. *a* of C. B. Adams (Ann. Lyc. Nat. Hist. New York, vol. 5, p. 488, 1852), from Panama, which Adams described as remarkable for the prominence and sharpness of one of its two umbonal ridges. Carpenter (Proc. Zool. Soc., London, p. 26, 1863), noted that Adams' shell was a species "approaching" the *Noëtia* type.

Our species is definitely a *Noëtia* of the *N. centrota* (+ *martinii* + *bisulcata*) group of the Atlantic Tertiary and recent faunas. It is especially like *Noëtia centrota* Guppy (Proc. Sci. Assoc. Trinidad, p. 175, 1867), from the late Pliocene beds of Matura, Trinidad Island. *Noëtia martinii* Recluz (Jour. de Conch., vol. 3, p. 409, pl. 12, f. 3-5, 1852) from Santa Caterina and Maranhão, Brazil and from the Gulf of Paria, is

the living descendant of *centrota* and, according to Dr. Sheldon, is specifically identical with *centrota*. Recluz's name *martinii* at any rate is invalid because preoccupied by Bolton. According to Dr. Dall, Lamarck's unfigured *A. bisulcata* from Guiana and Brazil is probably identical with *martinii* and if so is the valid name of the recent species.

The chief difference between our species and *N. centrota* is that ours is less expanded posteriorly and the distance between the angle of the posterior margin and the hinge is longer than in *centrota*. This is due to the fact that the posterior part of the cardinal area is shorter in the West coast species. This shortening consists in a reduction of the bare strip behind the ligament rather than in the ligamentary area itself.

Thus, as in *Arca illota* Sowerby, the kinship of this recent West coast species is with an Atlantic Pliocene shell, suggesting again a possible trans-Isthmian migration of the stock in Pliocene time.

Noëtia okeni Mayer (Bull. Soc. Nat. Berne, 1853) well figured by Cossmann and Peyrot (Conch. Néogénique de l'Aquitaine, pl. 9, f. 5-7, 1914, as *Anadara*), from the Aquitanian and Burdigalian of Southern France, and the only *Noëtia* so far known in Europe, has a slight general resemblance in form to *N. olssoni*.

Our species is named in honor of Mr. Axel Olsson by whom it was found.

Locality.—Bucarn, Los Santos Province, Panama (Olsson coll.).

Subgenus *Barbatia* Gray

Barbatia (Barbatia) fusca Bruguière

Plate I, Figure 4

Arca fusca Bruguière, Dict. Ency. Méth., 1, p. 102, No. 10, 1792.

Arca fusca Reeve, Conch. Icon., *Arca*, pl. 12, f. 82, 1844.

Byssarca fusca Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 149, 1855-57, Rept. Brit. Assoc. Adv. Sci., pp. 243, 310, 1857.

Shell ovately oblong, the anterior end short, the posterior elongated; ventral margin gaping slightly. Color reddish-brown, covered with a very fine, bristly epidermis. Each umbo is marked conspicuously with two white rays forming an acute angle near the apex of the beak. Sculpture of very fine, radiating striæ, coarser posteriorly and crossed by the concentric growth lines by which they are prettily beaded. Ligamental area very narrow and situated behind the beaks, which are closely incurved at the anterior end of the cardinal area. Length 44 mm., altitude 22, semidiameter 9 mm.

This species is very close to *Barbatia barbata* Linnæus, from Europe and the Antilles but is distinguished by the presence of the two well-marked white rays at the umbo, contrasting with the dark brown hue of the remainder of the shell. *Barbatia barbata*, however, often shows one irregular white ray. Citations of *B. fusca* from the West Indies are probably based on such specimens of *B. barbata*.

Barbatia fusca is typically from the Philippines, where it was collected by Cum-

ing. Carpenter found two specimens in the Reigen collection from Mazatlan, Gulf of California, Lat. 23° 20' North, but questioned whether they had not been accidentally mixed in from another region, or artificially introduced on ship bottoms or in ballast.

The species has not been reported from the Panamic Province by other authors.

Barbatia (Barbatia) lurida Sowerby

Bysoarca lurida Sowerby, Proc. Zool. Soc., London, p. 19, 1833.

Arca lurida Reeve, Conch. Icon, *Arca*, pl. 14, f. 95, 1844.

Arca? lurida (or *vespertilio*) Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 226, 1857.

Arca (Barbatia) lurida Dall. Proc., U. S. Nat. Mus., 37, p. 252, 1910.

Shell ovate-oblong, rounded anteriorly, produced and roundly pointed posteriorly, angulated at the posterior dorsal margin, ventral margin gaping for the passage of the byssus. Surface radiately striated, the striæ granular. Color chestnut, streaked with light red, and covered with a dark brown epidermis with a few radiating rows of bristles. Beaks sub-approximate. Ligamental area narrow. Length of type 1.5 inches, altitude .8 of an inch.

The type of this species was collected by Cuming at Sta. Elena, Ecuador, approximately Lat. 2° South. It was dredged at twelve fathoms, rocky bottom, and attached to stones,

I find no citation of the occurrence of *Barbatia lurida* from elsewhere than the type locality except Carpenter's questioned reference to its occurrence at Mazatlan, Gulf of California.

Barbatia (Barbatia) vespertilio Carpenter.

Bysoarca vespertilio Carpenter, Catalogue Reigen Coll. Mazatlan Moll. Brit. Mus., p. 140, 1855-57.

Arca? lurida (or *vespertilio*) Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 226, 1857.

Bysoarca vespertilio Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 310, 1857.

Shell oblong, compressed, more turned posteriorly, very inequilateral, margins rounded. Color dark reddish brown with two stains within the valves radiating from the beaks. Epidermis of concentric lamellæ which are scaly anteriorly, and setose between the striæ, the bristles running in rows down the interspaces and imbedded in the lamellæ. Here and there, chiefly on the posterior part of the valve, are rows of strong bristles which there are semitubular. Byssal gap moderate. Surface radiately striated. Beaks subapproximate. Ligament long, narrow, short anteriorly. Hinge teeth rather large, not numerous, the line incurved, anterior series short. Length of type 1.3 inches.

The name *vespertilio* was given by Carpenter because the radiating rows of hairs resembled the framework of a bat's wing.

This species belongs to the group of *Barbatia barbata* Linnæus and *B. setigera* Reeve, but is distinguished according to Carpenter by the structure of the epidermal

lamellæ and the imbedded rows of hairs. Rows of larger bristles occur at regular intervals.

Barbatia vespertilio has never been figured, nor is it cited except by Carpenter. It was collected by Reigen at Mazatlan, Gulf of California, where it is extremely rare.

It seems to be very close to *Barbatia lurida* Sowerby and is quite probably identical with that species, but we have no specimens of either for comparison.

Carpenter's specimens apparently had more numerous and stronger rows of hairs than Sowerby's. Carpenter must have considered the two species as very similar, because he questioned whether a shell in another collection, of uncertain locality, perhaps from Mazatlan was *Arca lurida* or *A. vespertilio*. If identical *lurida* has priority.

Section Calloarca Gray

Barbatia (Calloarca) reeveana d'Orbigny

Plate II, Figure 13

Arca Reeveana d'Orbigny, Voy. Amér. Mérid. Moll., p. 635, 1846.

A. Reeveana C. B. Adams, Ann. Lyc. Nat. Hist. New York, 5, p. 485, 1852.

A. Reeveana Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 310, 1857.

Barbatia reeviana Carpenter, Proc. Zool. Soc., London, p. 364, 1863.

A. (Byssorca) Reeveana Stearns, Proc. United States National Museum, 14, p. 310, 1891;
Idem, 16, pp. 374, 421, 1893.

A. (Barbatia) Reeveana Dall, Proc. United States National Museum, 37, p. 252, 1910.

A. (Barbatia) reeviana Zetek, Los Moluscos de Panama, p. 38, 1918.

A. helblingii Reeve, Conch. Icon., *Arca*, pl. 14, f. 90, 1844. Not of Bruguière, Ency. Méth., *Vers*, 1, p. 99, 1789.

Shell oblong, flat, often very sinuate at the ventral margin, thin for the group, the beaks often central. Sculpture much like that of *Arca candida* Gmelin. Radiating threads are crossed by concentric lines by which they are beaded, especially on the center of the valve. The ribs on the anterior slope are fairly strong, those of the anterior basal region alternate with finer threads, those from the center to the umbonal slope are so deeply grooved as to appear double, those on the posterior slope are much stronger, a marked and characteristic sudden change taking place at the umbonal ridge. In some shells the strong posterior ribbing appears only towards the umbo, the distal parts of these ribs being divided or otherwise becoming less conspicuous. Hinge line arcuate; central teeth fine and closely-set; distal teeth large, long and oblique. Ligament occupying the entire cardinal area. The diamond-shaped grooves are numerous and closely-set. The cardinal planes of the two valves slope together at an acute angle bringing the characteristically flat umbos close together. Length of shell 63 mm., altitude 35, semidiameter 6 mm.

Differences in dentition between the Atlantic analogue, *Arca candida* Gmelin, *A. helbingi* Bruguière, and *A. reeveana* were noted by d'Orbigny but these differences are shown by our specimens to be inconstant.

Arca platensis Philippi (Description de algunos fósiles terciarios de Argentina (Anales de Museo Nacional de Chile, 3, p. 11, pl. 1, f. 8, 1893; von Ihering, Os Molluscos dos Terr. Terciarios da Patagonia [Revista do Museu Paulista, 2, p. 217, 1897; Borchert, Die Mollusken fauna der Paran-Stufe, Stuttgart, p. 29, pl. 2, f. 5, 6, 1901]) from the Tertiary of Argentina is another close ally of *A. reeveana*.

The European Miocene species, *A. (Barbatia) subhelbingi* d'Orbigny and its mutation *variabilis* Mayer, from southwestern France shows a striking resemblance to valves of *reeveana*. (For illustration see Cossmann and Peyrot, Conch. Néogénique de l'Aquitaine, 2, pp. 176-179, pl. 9 f. 8-13, 27-28, 32; pl. 10, f. 61, 1914). This resemblance is not surprising since the French shell is also of the *candida* group.

The type specimens of *A. reeveana* were collected by Cuming at Sta's. Elena and Monte Cristi, Ecuador. Stearns recovered it from Hood, Indefatigable and James Islands of the Galapagos group. It ranges south to Paita, Peru where it was collected by Fontaine. Its favorite habitat is beneath stones at low water mark.

Localities.—Bucarn, Los Santos Province, and also on the northeastern point of Viveros Island, Islas de las Perlas (Olsson coll.); Panama (Newcomb coll.).

THE ARCA REEVEANA GROUP

A. reeveana and its allies form a difficult and confusing series and have led to many incorrect identifications in scientific literature.

There are in the Newcomb collection from the Indo-Pacific region about nine distinct but closely related species of the *Arca reeveana* group. Most of them have been labelled according to the nearest form in Reeve, but about half are not the exact species of Reeve and some probably have never been described. Shells of this group vary widely in outline within the species, making the form very unreliable as a specific character and also making individuals of distinct species appear alike unless closely studied. Shells in the Newcomb collection from distantly separated localities cannot be differentiated specifically; while others from the same locality with a single label prove to be distinct. Again two specimens from the same locality, so unlike in form that they have received different names, are shown by close examination to be identical.

In view of this variability, it seems wiser to name as varieties of *Arca reeveana* two specimens in our Panama collection which belong to this group but are not identical with any species known to us. The differences are great enough to establish them as species instead of varieties if more material should prove that they do not intergrade with *reeveana*.

Calloarca reeveana variety *velataformis* Sheldon and Maury, new variety.

Plate II, Figure 15.

Cf. Arca velata Troschel, Archiv für Naturgeschichte, Berlin, p. 200, 1852; Dall, Proc. U. S. Nat. Mus., 37, p. 252, 1910.

Cf. Arca velata Wimmer, Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften Wien, Math. Natur. Classe, Band 80, p. 511, 1879; Stearns, Proc. U. S. Nat. Mus., 16, p. 421, 1893.

Not *Byssoarca velata* Sowerby, Proc. Zool. Soc. London, p. 18, 1833; Reeve, Conch. Icon., *Arca*, pl. 12, f. 79, 1844.

Shell larger and heavier than the average *Arca reeveana*. Ribbing as in typical shells of that species except on the posterior slope where the distal halves of the ribs are divided and less conspicuous, although this occurs in certain unusual specimens of *A. reeveana*. The form approaches that of *A. velata* Sowerby from Lord Hood's Island, Lat. 21° South, Long. 135° West, and from Anaa or Chain Island, about Lat. 17° S., Long. 145° W. lying East of Tahiti. And our shell may be the same species as the *Arca velata* listed by Wimmer from Hood Island in the Galapagos Group, about Lat. 1° 25' S., Long. 89° 50' W., and possibly the *A. velata* of Troschel in Tschudi's Peruvian collection.

True *A. velata* is a much larger shell and, judging from Reeve's figure, is evenly rounded posteriorly without the concave posterior slope of our shell. The central ribbing appears to be similar but the character of the anterior and posterior ribs of Reeve's illustration is not clear. The Polynesian distribution of true *velata* also makes its presence in the Gulf of Panama very unlikely.

Our specimen is larger, heavier and less flattened than *Arca reeveana* and the beaks are less central. The posterior slope is more clearly defined than in that species and is concave. Superficially our shell more clearly resembles a Newcomb collection *Arca* from Australia, but it is not that species, since two specimens, though of widely different form, both have uniformly fine anterior ribs, while in our shell these ribs are somewhat larger as in *Arca reeveana*. The specimen measures in length 66 mm., altitude 35, diameter 29 mm.

Locality.—Bucarn, Los Santos Province, Panama, (Olsson coll.).

Calloarca reeveana variety *lasperlensis* Sheldon and Maury, new variety.

Plate II, Figure 17.

Cf. Arca decussata Wimmer, Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften Wien, Math. Natur. Classe, Band 80, p. 511, 1879; Stearns, Proc. U. S. Nat. Mus., 16, p. 421, 1893; Dall Proc. U. S. Nat. Mus. 37, p. 252, 1910.

Not *Byssoarca decussata* Sowerby, Proc. Zool. Soc., p. 18, 1833; Reeve, Conch. Icon., *Arca*, pl. 12, f. 81, 1844.

Shell ovate, inflated, pointed posteriorly, arcuate ventrally. The ribbing and the posterior slope are as in variety *velataformis*. Length of shell 53 mm., altitude 34, diameter 27 mm.

This shell is separated from *A. reeveana* by its heavier shell, its inflation, ovate form and concave posterior slope. From variety *velataformis* it differs chiefly in form.

Our shells may be the *Arca decussata* of Wimmer, from Hood Island in the Galapagos Group. But they are not the true *decussata* of Sowerby from Lord Hood's Island, in the Pacific Ocean, Lat. 21° South, Long. 135° West.

Our specimens are ruder and less neatly sculptured and also differ from that species in their markedly concave posterior slope.

There are in the Newcomb collection three young shells from the Paumotu Islands, very near the type locality, which are obviously Sowerby's *decussata*. There are clear differences between this species and other members of the group with which it has been confused. The *A. decussata* of Sowerby is a comparatively regular, less distorted shell with delicately and prettily sculptured valves. The center of the valve is evenly beaded, and grades into stronger ribs anteriorly and posteriorly. The large posterior ribs extend somewhat over the umbonal ridge. In these young shells the large anterior and posterior ribs are beaded. A few ribs in front of the umbonal ridge are divided.

Other shells before us from Australia and Ceylon have been identified as *Arca decussata* Sowerby; but are coarser and more irregular and if included in that species should be called a variety. One from Ceylon is figured for comparison with the true *decussata* Sowerby, renamed by me *A. tuamotana*, from the Tuamotu, formerly called the Paumotu, Group of Pacific Islands.

Locality.—Bucarn, the port of Tonosi, Los Santos Province, Panama; also the northeast point of Viveros Islands, Islas de las Perlas, Panama Bay. (Olsson coll.).

Barbatia (Calloarca) tuamotana Maury, new name.

Plate II, Figure 3

Byssoarca decussata Sowerby, Proc. Zool. Soc. London, p. 18, 1833.

Arca decussata Reeve, Conch. Icon., *Arca*, pl. 12, f. 81, 1844.

Barbatia decussata Hutton (*pars*), New Zealand Moll., Colonial Mus. and Geol. Surv. Wellington, N. Z., p. 162, 1880.

Not *Arca decussata* Linnæus, Syst. Naturæ, p. 1142, 1767.

Not *Arca decussata* Born, Index Mus. Cæs. Vind., p. 77, No. 3, 1778

Not *Arca decussata* Parkinson, Organic Remains, 3, p. 171, pl. 13, f. 1, 1811.

Not *Arca decussata* Münster, Verst. ool. Geb., p. 103, No. 5, 1836.

Not *Arca decussata* Nyst and West, Nouv. Rêch. Coq. Foss. d'Anvers, pp. 11, 25, pl. 2, f. 14, 1839.

Not *Arca decussata* Münster, Beitr. zur Petref. (6) tab. 4, f. 14, 1845.

The above synonymy shows that the specific name *decussata* given by Sowerby, in 1833, to an *Arca* from Lord Hood's Island, had already been applied by Linnæus in 1767, by Born in 1778, and by Parkinson in 1811, to three distinct Arcas, all differing from one another and also from Sowerby's species. Therefore Sowerby's name for the Pacific shell cannot hold, and I propose for his species the name *tuamotana*, since it occurs in typical form in the Tuamotu Archipelago.

The name *decussata* has not only been given to about seven different species, three of which, as above noted, hold priority over Sowerby's; but many forms from Indo-Pacific waters have been erroneously referred to Sowerby's *decussata*, which are really distinct. For example, a Philippine shell regarded by Reeve as identical with Sowerby's *decussata* is a different form, and Dr. Dall, in his forthcoming paper on the Hawaiian Fauna has separated the form from the Hawaiian Islands as *A. hawaiiensis* Dall.

Since such confusion exists regarding the exact characters of the *Arca* called by Sowerby *decussata*, it seemed useful to illustrate our specimen, which is undoubtedly that species, since it was obtained by Dr. Newcomb from the group of Islands, and perhaps even from the very same Island, that constituted the type locality, and since it answers perfectly to the description of the type, differing only in being a younger shell.

The characters of this species are noted in the discussion of *Barbatia reeveana* variety *lasperlensis* Sheldon and Maury.

The type of Sowerby's *Arca decussata* was collected by Cuming at Lord Hood's Island, attached to mother-of-pearl shells. This island is one of the vast group, extending over fifteen degrees of Longitude, comprising seventy-eight islands, until recently called the Paumotu or Submissive Islands, a name given to them by the Tahitians after conquest, but now officially renamed the Tuamotu Archipelago, or Distant Islands. These islands with the exception of Makatea and Tikei are all atolls, very similar in their physical characters.

Lord Hood's Island is now called by its native name, Marutea. It lies in Lat. $21^{\circ} 31'$ South, Long. $135^{\circ} 38'$ West, and was discovered in 1891. It is a cluster of small islets rising from a coral chain only slightly above the water level. The islets are covered with various trees and shrubs. The atoll is eleven miles long and four and three-quarters wide, and incloses a lagoon into which there is no entrance. The island is not inhabited but is visited by natives of Mangareva for pearl shell which is abundant. (See Pacific Island Pilot, Hydrographic Office No. 166, Washington, 1920).

Cuming collected co-types of Sowerby's *Arca decussata* from Anaa or Chain Island, also a member of the Tuamotu Archipelago, lying in Lat. $17^{\circ} 20'$ South, Long. $145^{\circ} 30'$ West, discovered in 1769. It is an atoll nineteen miles long and six miles wide. It is the best cultivated and has the largest export trade of any of the group. Its population has rapidly decreased from an estimated number of five thousand to seven hundred. This was due largely to the terrific hurricane of February, 1879, which destroy-

ed all buildings and plantations. Coconut plantations have been re-established, and the atoll is wooded. The enclosed lagoon is without entrance.

The above geographic details are given because Lord Hood's Island has been confused by conchologists with Hood Island of the Galapagos Group, from which it is very far distant.

Locality.—Tuamotu Islands (type locality). Collected by Dr. Wesley Newcomb about seventy-five years ago.

Section A c a r Gray

Barbatia (Acar) gradata Broderip and Sowerby

Plate II, Figures 4, 6, 9

- Acar gradata* Broderip and Sowerby, Zool. Jour., London, 4, p. 365, 1829.
A. gradata Gray, Zool. Beechey's Voyage, p. 152, pl. 43, f. 1, 1839.
A. gradata Reeve, Conch. Icon., *Acar* pl. 14, f. 92, 1844.
A. gradata Hanley, Descr. Cat. Rec. Shells, p. 155, 1845.
A. gradata d'Orbigny, Voy. Amér. Mérid. Moll., p. 636, 1846.
A. gradata C. B. Adams, Ann. Lyc. Nat. Hist. New York, 5, p. 492, 1852.
A. gradata Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 141, 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc. London, p. 364, 1863.
A. (Byssosarca) gradata Stearns, Proc. United States Nat. Mus., 14, p. 309, 1891; 16, p. 373, 1893.
A. gradata Stempel, Zoologische Jahrbücher, Supplement Band 5, p. 220, 1899.
A. gradata Dall, Proc. United States Nat. Mus. 37, p. 252, 1910.
A. gradata Zetek, Molluscos de Panama. p. 38, 1918.
A. (Byssosarca) pholadiformis C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., 5, p. 484, 1852; Carpenter Proc. Zool. Soc. London, p. 364, 1863.
A. reticulata Gmelin, Dall, Trans. Wagner Inst. Sci., 3, pt. 4, p. 629, 1898 (*pars*); Sheldon, Palæontographica Americana, 1, p. 20, 1916 (*pars*); Dall, Bull. 112, United States Nat. Mus., p. 16, 1921

This small, oblong shell is so richly sculptured that Broderip and Sowerby described the types as resembling, "at first sight a piece of Chinese carving." Our largest specimen is 26 mm. in length, 16 in height and 9 in semidiameter. Frequently the shell is but half this size. The cardinal area is that of typical *Acar*.

This species is recognized by its posterior ribs which arise along the umbonal ridge instead of running up to the beak. This character is shared by a number of related forms of which *A. reticulata* Gmelin, from the Atlantic, *A. domingensis* Lamarck, from the West Indies, *A. clathrata* DeFrance, fossil from Europe, and *A. squamosa* Lamarck from the Pacific, have been listed by several authors as synonyms. Other forms akin to *A. gradata* are *A. divaricata* Sowerby, from the Pacific and *A. donaciformis*

Reeve, from the Mozambique Channel. Sufficient material would probably show that several of these represent a single species with certain distinct varieties.

A related but more distinct species is *A. pulchella* from the Mediterranean.

The East coast analogue is *A. reticulata* Gmelin, which so closely resembles *gradata* that Drs. Dall and Sheldon regard them as identical.

The *reticulata* stock is very ancient, going back to the Jacksonian Eocene of Mississippi. In southwestern France, the Miocene shell, *Acar clathrata* DeFrance var. *acanthis* Fontannes (See Cossmann et Peyrot, Conch. Néogénique de l'Aquitaine, 2, pl. 10, f. 17-18, 1914), is a near ally of *gradata* and *reticulata*.

Considering the variability of *Acar gradata*, it is probable that *A. pusilla* Sowerby (Proc. Zool. Soc. London, p. 18, 1833) from Iquique, Chile, is not more than a variety of *gradata*.

Fide Carpenter, 1863, the unfigured *A. (Byussoarca) pholadiformis* of C. B. Adams, from Taboga Island, Panama Bay, which Carpenter compared with the Mazatlan Arcas, is merely an elongated form of *gradata*. Adams' description of *pholadiformis* would also indicate this.

The type of *A. gradata* was collected by Lieutenant Belcher at Mazatlan, Gulf of California, Lat. 23° 20' North, on the expedition commanded by Captain Beechey. From Mazatlan the species ranges south to Iquique, Chili, Lat 20° 15' South, where a small shell was collected by Plate. This entrance of a Panamic species into the Peruvian molluscan province is very unusual, as they only rarely pass below Paita, Peru, Lat. 5° South. Its most northern locality is San Diego, California. Stearns reported *gradata* from James, Hood, Iudfatigable, and Chatham Islands of the Galapagos group.

Localities.—Panama (Newcomb coll.); San Miguel the Capital of Rey Island and Cocos Point on the western side of Rey Island, in Panama Bay (Olsson coll.).

Barbatia (Acar) gradata variety *pusilla* Sowerby.

Byussoarca pusilla Sowerby, Proc. Zool. Soc. London, p. 18, 1833.

Arca pusilla Reeve, Conch. Icon., *Arca*, notes under Species 112 and 104, 1844. Not figured.

Byussoarca pusilla Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 142, 1855-57.

Arca pusilla Dall, Proc. United States Nat. Mus., 37, p. 252, 1910.

Not *Arca pusilla* Nyst, Réch. Coquilles Foss. d'Anvers, p. 14, pl. 3, f. 55, 1835. Compare *A. pectunculoides* Sacchi.

This shell has never been figured. The specimen which Reeve had chosen for the figure of *Arca pusilla* Sowerby he afterwards decided should be regarded as a somewhat distorted specimen of *A. divaricata*.

This is good evidence that *pusilla* is very close to *gradata* because of the near kinship of that shell to *divaricata*. Plate XVIII on which Reeve planned to figure a true *pusilla* was never made.

A. pusilla and *A. gradata* are so close that the shells which d'Orbigny identified as *pusilla*, Carpenter considered might be a dwarf variety of *gradata*, but he thought the true *pusilla* distinct though related.

This species is not in our collections. According to Dr. Dall it ranges along the coast of Ecuador to Lat. 23° 37' South, at Isla Blanca, Chile. The type locality was Iquique, Chile, 20° 15' South Latitude.

Nyst's *Arca pusilla*, 1835, was an entirely different fossil species from near Antwerp, Belgium.

Barbatia (Acar) illota Sowerby

Plate II, Figures 8, 14

Byssosarca illota Sowerby, Proc. Zool. Soc., London, p. 18, 1833.

Arca illota Reeve, Conch. Icon. *Arca*, pl. 12, f. 78, 1844.

A. illota Hanley, Descr. Cat. Recent Shells, pl. 18, f. 41, 1845.

Byssosarca illota Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 141, 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc. London, p. 364, 1863.

Arca illota Zetek, Los Moluscos de Panama, p. 38, 1918.

Arca tabogensis, C. B. Adams, Ann. Lyc. Nat. Hist., 5, p. 486, 1852.

Shell thin, trapezoidal, rather small, very prettily and delicately sculptured. The fine radiating ribs vary in size and include on the center of the valve primary, secondary and tertiary threads. On the anterior and posterior slopes the primary riblets are coarser and more noticeably beaded than elsewhere, and the tertiary threads are absent. The ribs are not divided but the minor threads develop in the interspaces. In one of our specimens (figure 8), the hinge region has the characters of both *Acar* and *Calloarca*, the younger portion of the cardinal area being that of *Acar*, while in the older stages there has been developed a slope towards the hinge line which bears a number of grooves like those of *Calloarca*, *sensu stricto*. These grooves are on a plane which makes a distinct angle with the cardinal area of the younger stage. The general type of this shell is, however, that of *Acar*, the *Calloarca* character being limited to the secondary portion of the cardinal area. This individual is interesting in thus showing the connection between *Acar* and *Calloarca*. The other specimens are all normal *Acars*. Length of shell 23 mm., altitude 16, diameter 13 mm.

This unusually beautiful *Arca* resembles *Arca (Acar) milifilia* Dall (Trans. Wagner Inst. Sci., 3, pt. 6, pl. 56, figs. 21, 24, 1903) from the Pliocene of Florida. The main difference, judging from the figures, seems to be that the ribbing is more handsomely developed in our recent, Pacific shell. Its striking resemblance to *A. milifilia* suggests an Atlantic origin and perhaps a trans-Isthmian Pliocene migration of the stock.

Reeve's figure of *A. illota* is very confusing because it is so enveloped in the curious epidermis. It is not strange that C. B. Adams did not recognize the shell and thought his a new species which he named *Arca tabogensis*. Carpenter examined Adam's type and found it identical with specimens of *illota*.

The Curator of the Adams' Panama Collection at Amherst College, Miss Crystal Tompson, has kindly loaned seven complete type specimens of *Arca tabogensis* C. B. Adams, from Taboga Island, Panama Bay. These range in size from a length of 20 to nearly 40 mm. In form and sculpture they correspond to our specimens of *Arca illota* and are identical with that species. Adams' shells are all rather thin and delicate and vary considerably in form, some showing a pronounced central sulcation while in others this does not appear. Some are sinuate basally, others not; some are practically closed while others gape noticeably for the passage of the byssus. The epidermis is dark brown.

We have also compared our specimens of *A. illota* with others loaned by Dr. Dall from the National Museum.

The type of *illota* was collected by Cuming under stones in the Gulf of Nicoya, Central America, about Lat. 9° 40' North. It is rare at Mazatlan. I have not seen it recorded south of Panama.

Localities.—Panama (Newcomb coll.); Bucarn, Los Santos Province; and the northeast point of Viveros Island, Islas de las Perlas (Olsson coll.).

Section Fossularca Cossmann

Barbatia (Fossularca) solida Sowerby

Plate II, Figures 7, 12

Byssosarca solida Sowerby, Proc. Zool. Soc. London, p. 18, 1833.

Byssosarca solida Müller, Syn. Test. Viv., p. 186, 1836.

Arca solida Reeve, Conch. Icon., *Arca*, pl. 16, f. 106, 1844.

A. solida Hanley, Descr. Cat., p. 155, 1845.

A. solida d'Orbigny, Voy. Amér. Mérid., p. 633, 1846.

A. solida C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., 5, p. 486, 1852.

Byssosarca solida Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 143, 1855-57; Rept. Brit.

Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc. London, p. 364, 1863.

A. (Byssosarca) solida Stearns, Proc. U. S. Nat. Mus., 14, p. 309, 1891; 16, p. 373, 1893.

A. solida Dall, Proc. U. S. Nat. Mus., 37, p. 252, 1910.

A. solida Zetek, Molluscos de Panama, p. 38, 1918.

Barbatia (Fossularca) solida Dall, Bull. 112, U. S. Nat. Mus., p. 16, 1921.

Shell small, quadrate, adult extremely gibbous, with a rounded umbonal keel. Entire surface finely, radiately striated. Our largest specimen is 20 mm. in length, 14 in height and 14 in diameter.

This species is easily recognized by its form, which is like that of a little jewel box; and its cardinal area with the ligament occupying only a small, symmetrical, diamond-shaped area directly between the beaks.

The Atlantic analogue is *Arca adamsi* Shuttleworth, which ranges from Cape Hatteras to Brazil. A related, but distinct species, is *Arca lactea* Linnæus of European waters.

Fossularca miocenica Cossmann and Peyrot (Couch. Néogénique de l'Aquitaine, 2, pl. 10, f. 37-40, 1914); from the Burdigalian Miocene of Saucats and Dax, southwestern France, is an ancestral form of *lactea* and akin to *solida* and *adamsi*.

Cuming's specimens of *Arca solida* which formed the type were collected at Paita, Peru. Adams found the shell at Panama and Taboga Island in the Bay. Stearns recorded it from Indefatigable Island of the Galapagos group. The species ranges from San Diego, California, to Paita, Peru. The usual habitat is under stones at low water mark.

Localities.—Bucarn, near Tonosi, Los Santos Province (Olsson coll.); Panama (Newcomb coll.).

Section Cucullaria Conrad.

Barbatia (*Cucullaria*) *alternata* Sowerby.

Plate II, Figure 11

Byssosarca alternata Sowerby, Proc. Zool. Soc. London, p. 17, 1833.

Arca alternata Reeve, Conch. Icon. *Arca*, pl. 13, f. 88, 1844.

A. alternata d'Orbigny, Voy. Amér. Mérid. Moll., p. 638, 1846.

A. alternata C. B. Adams, Ann. Lyc. Nat. Hist. N. Y. 5, p. 481, 1852.

Byssosarca alternata Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 310, 1857.

Barbatia alternata Carpenter, Proc. Zool. Soc. London, p. 364, 1863.

Arca alternata Dall, Proc. U. S. Nat. Mus., 37, p. 252, 1910.

A. alternata Zetek, Molluscos de Panama, p. 38, 1918.

Shell rather small and delicate, oblong, more or less contracted medially. Anterior end very short, posterior end elongated, valves slightly gaping ventrally. Central ribs low, closely-set and grooved. Anterior and especially the posterior ribs much stronger, coarser and crenulated. One or two of the strongest ribs define the umbonal ridge making it very sharply angulate. Epidermis tufted. Length of type 1.4 inches. Length of our largest shell 31 mm., height 14, diameter 16 mm.

This species is recognized by its fragile shell and its striking and characteristic ribbing. The cardinal area is long and narrow, wider in front of the beaks, and the ligament occupies only the posterior parts of the area.

Barbatia alternata belongs to the section *Cucullaria* of Conrad. Thus it is a member of the same group as *Cucullaria tenuata* Dall, from the Pliocene of Florida but that shell has a rounded instead of a very sharply carinated umbonal slope.

Cuming's type of *alternata* was from West Colombia, dredged at twelve fathoms, rocky bottom. *Fide* Gould, this species was in Jewett's collection from Mazatlan. Adams, Carpenter, and Zetek have reported it from Panama. Dall gives its southern limit as Ecuador.

Locality.—Panama (Newcomb coll.).

Barbatia (Cucullaria) platei Stempell.

Arca (Barbatia) platei Stempell, Zoologische Jahrbücher, Supplement Band, 5, p. 220, Taf. 12, f. 10, 11, 1899-1902.

A. (Cucullaria) platei Dall, Proc. U. S. Nat. Mus., 37, p. 252, 1910.

This species though extralimital is mentioned as a related member of the *Cucullaria* group.

It inhabits the tidal zone of Juan Fernandez Island, off the coast of northern Chile, about Lat. 33° 40' South.

Subgenus *Scapharca* Gray

Section *Scapharca* Gray

Scapharca (Scapharca) emarginata Sowerby

Arca emarginata Sowerby, Proc. Zool. Soc. London, p. 20, 1833.

A. emarginata Müller, Syn. Test. Vir., p. 180, 1836.

A. emarginata Reeve, Conch. Icon., *Arca*, pl. 4, f. 26, 1844.

A. emarginata Hanley, Descr. Cat., p. 161, 1845.

A. emarginata d'Orbigny, Voy. Amér. Mérid., Moll., p. 635, 1846.

A. emarginata C. B. Adams, Ann. Lyc. Nat. Hist. New York, 5, p. 482, 1852.

A. emarginata Carpenter, Cat. Reigen Coll. Mazatlan Moll.; p. 137, 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc. London, p. 364, 1863.

A. (Scapharca) emarginata Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

Shell elongate, inequivalve; anterior end very short, posterior end roundly produced and alate at the hinge margin due to a distinct notch in the upper posterior margin. Substance thin, the larger ribs being visible within the valves. Color whitish, with a faint, nearly obsolete, black ray on the sulcated beak. Epidermis brown anteriorly to almost black posteriorly; scaly on the anterior part of the shell but setose in the posterior interspaces. Ribs twenty-eight to thirty, flat, closely-set, with very narrow interspaces. Anterior ribs more or less medially grooved and crenulate. Ribs over the umbonal ridge wider and much more conspicuous than elsewhere. Cardinal area long and narrow, somewhat wider anteriorly. Ligamentary grooves few. Teeth very fine centrally, becoming much larger and longer distally, especially toward the posterior end where they are broken up and granular in our older specimen. Our largest shell measures 48 mm. in length, 23 in altitude and 15 mm. in diameter.

Carpenter erroneously states that the emargination is not developed in young shells.

Arca emarginata has no close East coast affinity.

The type of this species was dredged by Cuming at Panama; Real Llejos, Nicaragua; Jipijapa and Atacames, Ecuador, in sandy mud at six to eight fathoms. Adams found three specimens at Panama and Carpenter recorded this species from Mazatlan, Gulf of California, where it was collected by Reigen. Its range is from that locality, Lat. 23° 20' North, to Guayaquil, Ecuador, Lat. 2° 11' South.

Locality.—Panama. Three complete specimens. (Newcomb coll.).

Scapharca (Scapharca) aviculoides Reeve

Plate II, Figure 2

Arca auriculata Sowerby, Proc. Zool. Soc. London, p. 20, 1833.

Not *Arca auriculata* Lamarck.

Arca aviculoides Reeve, Conch. Icon., *Arca*, pl. 10, f. 63, 1844.

A. aviculoides? C. B. Adams, Ann. Lyc. Nat. Hist. New York, 5, p. 481, 1852.

A. aviculoides Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc. London, pp. 364, 552, 1863.

A. (Scapharca) aviculoides Dall, Proc. U. S. Nat. Mus., 37, p. 252, 1910.

A. (Scapharca) aviculoides Zetek, Los Moluscos de Panama, p. 38, 1918.

Shell small, inequivalve, oblong, with a small auriculation posteriorly. Color white with a single, short, striking, black ray on each umbo. Epidermis light-brown. Ribs thirty-four to thirty-eight, the anterior and central ribs rounded, crenulated and faintly grooved. Posterior ribs wider, smoother and entire. Sculpture slightly discrepant, the ribs near the umbonal ridge of the right valve being flatter than those of the left. Beaks low, small, almost in contact. Cardinal area long and narrow with a few grooves. Length of our shell 23 mm., altitude 12, diameter 9 mm. The type was larger, measuring 1.2 inches in length.

This description is based on a shell from Panama which appears to be Reeve's *A. aviculoides*, although Reeve and Sowerby do not mention the dark ray at the beaks which is so conspicuous in our shell. Our specimen is not the young of *A. emarginata* of which we have an immature individual of similar size for comparison.

In spite of conspicuous differences, *Arca aviculoides* seems to be most closely related to the East coast *Arca transversa* group. The posterior outline is unlike, the interspaces are narrower, and *A. transversa* does not have the black ray; but the general group characters are similar.

The name *auriculata* given by Sowerby was preoccupied by Lamarck for the well known Atlantic species. Reeve therefore renamed the Pacific shell, *aviculoides* from its somewhat *Avicula*-like aspect.

Cuming dredged the type at Sta. Elena, Ecuador, at a depth of ten fathoms, muddy bottom. The species ranges from Panama to Guayaquil, Ecuador.

Locality.—Panama (Newcomb coll.).

Scapharca (Scapharca) concinna Sowerby

Plate I, Figure 10

Arca concinna Sowerby, Proc. Zool. Soc. London, p. 20, 1833.

A. concinna Reeve, Conch. Icon., *Arca*, pl. 6, f. 34, 1844.

A. concinna Carpenter, Rept. Brit. Assoc. Adv. Sci., pp. 183, 229, 310, 1857.

Not *A. concinna* Gould.

Shell of small size elongately oval, somewhat cylindrical, evenly inflated, slightly inequivalve; anterior end short, angulate dorsally, rounded ventrally; posterior end produced and rounded. Color white. Epidermis thin, light brown. Ribs thirty-one, some of the anterior, especially on the left valve, medially grooved, and a few of the posterior ribs also show obsolete traces of groovings. Anterior and central ribs prettily crenulated by the concentric growth lines. Posterior nine ribs flatter and nearly smooth. Sculpture somewhat discrepant, the ribs ending at the posterior ventral margin being more rounded and crenulate on the left valve. Interspaces crossed by even, well-marked, transverse, raised lines. Cardinal area narrow, wider in front of the beaks. Hinge straight and delicate; teeth numerous, fine. Length of our largest shell 35 mm., altitude 19, diameter 15 mm.

This pretty species, well-named by Reeve the elegant Ark, in form and general aspect recalls the fossil East coast shell, *Scapharca inaequilateralis* Guppy, from the Miocene of Jamaica and the Dominican Republic, but the recent West coast species is heavier.

The type of *Arca concinna* was collected by Cuming, in 1827-1830, in the Gulf of Nicoya, Central America, about Lat. 9° 40' North, where it was dredged in sand at twelve fathoms.

Apparently this species has never again been found until now, as all the references go back to the type.

According to Carpenter, the shell Gould referred to *A. concinna*, was identical with C. B. Adams' species, *A. similis*, which Carpenter pronounced a mere variation of Sowerby's *Arca tuberculosa*.

Our specimens agree in all respects with Sowerby's description and Reeve's illustration and seem beyond question to be the true *concinna* of Sowerby. The range is thus extended southward to about Lat. 7° 25' North.

Locality.—Bucaru, the port of Tonosi, Los Santos Province, Panama (Olsson coll.) Also two specimens, probably Panama (Newcomb coll.)

Scapharca (Scapharca) trapezia Deshayes.

Plate I, Figures 13, 14

Arca trapezia Deshayes, Rév. Soc. Cur. p. 358, 1839; Mag. de Zool. de Guérin, pl. 21, 1847.*A. trapezia* Nyst, Tabl. Syn. Esp. Vir. et Foss., Genre *Arca*, p. 74, 1848.*A. (Noëtia) trapezia* Dall, Trans. Wagner Inst. Sci., 3, p. 617, 1898.*Scapharca trapezia* Sheldon, Paleont. Amer., 1, p. 30, 1916.*Arca lobata* Reeve, Conch. Icon., *Arca* pl. 3, f. 19, 1844.*A. tuberculosa* Sowerby, Carpenter, (deformed shells), Cat. Reigen Coll. Mazatlan Moll., p. 550 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 202, 1857; p. 528, 1863.

Shell of medium size, more or less oval in form, very oblique, practically equi-valve. Anterior end very short, rounded and inflated. Posterior end produced, rounded basally, widely expanded and strikingly compressed dorsally. Color white, covered with a rather scaly brown epidermis. Ribs twenty-six, prominent, the posterior wider than the anterior and noticeably smoother, the anterior narrow, higher and more or less wrinkled and crenulated. Ligamentary area short, about three-fifths the length of the shell, width medium, little if any wider in front of the beaks, concentric grooves few. Length of shell 53 mm., altitude 39, diameter 32 mm.

This species was erroneously thought by Carpenter to be deformed specimens of *Arca tuberculosa*. It is, however, perfectly distinct and a valid species. The shell is at once distinguished from that of *A. tuberculosa* by its more oblique form and its marked posterior dorsal flattening.

Dr. Dall (Trans. Wagner Inst. Sci., 3, p. 617, 1898) referred *Arca trapezia* to the subgenus *Noëtia*. But, as noted by Dr. Sheldon (Paleont. Americana, 1, p. 30, 1916) our specimens, which correspond perfectly with Reeve's illustration and description, are not referable to *Noëtia*. Reeve's figure taken alone would suggest *Noëtia* because of the posterior flattening, but the shells themselves are not even intermediate forms, since the cardinal area is definitely that of *Scapharca*, and there is no interstitial thread in the interspaces.

The confusion of this species by Carpenter with *Arca tuberculosa* led to his citation of *trapezia* from Panama and Real Llejos, Nicaragua, but the true habitat of *trapezia* apparently is West Mexico.

Locality.—Unknown,—possibly from San Blas, West Mexico, Lat. 22° North (Newcomb coll.).

Scapharca (Scapharca) tuberculosa Sowerby.

Plate I, Figure 12.

Arca tuberculosa Sowerby, Proc. Zool. Soc., London, p. 19, 1833.*A. tuberculosa* Müller, Syn. Test. Vir., p. 179, 1836.*A. tuberculosa* Philippi, Abbild. und Beschr., 1, p. 44, pl. I. f. 2, 1843.

- A. tuberculosa* Reeve, Conch. Icon., *Arca*, pl. 3, f. 18, 1844.
A. tuberculosa Hanley, Descr. Cat., p. 161, 1845.
A. tuberculosa C. B. Adams, Ann. Lyc. Nat. Hist. New York, 5, p. 487, 1852.
A. tuberculosa Troschel, Archiv für Naturgeschichte, 18, p. 200, 1852.
A. tuberculosa Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 135, 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc., p. , 1863.
A. (Scapharca) tuberculosa Dall, Proc. U. S. Nat. Mus., 37, pp. 154, 353, pl. 27, f. 4, 1910.
A. (Scapharca) tuberculosa Zetek, Moluscos de Panama, p. 38, 1918.
 Cf. *A. similis* C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., p. 485, 1852. Unfigured.

Shell elongately ovate, somewhat oblique, evenly inflated, equivalve. Anterior and posterior margins rounded, the posterior somewhat produced, dorsal margin angulated at either end. The valves show two to five marked concentric ridges, indicating interrupted growth stages. Color white, substance porcellaneous. Epidermis dark brown. Ribs prominent, rounded, thirty-three to thirty-seven, tuberculate toward the margin, especially anteriorly. Beaks slightly compressed and medially sulcated. Ligamentary area narrow. Length of shell 48 mm., altitude 35, diameter 26 mm.

It is to be regretted that the type of *Arca similis* C. B. Adams cannot be found in his collection at Amherst College, although the Curator has kindly made an extensive search. Adams' shell was, however, examined many years ago by Carpenter who stated that it was "scarcely a variety of *A. tuberculosa*."

Arca tuberculosa is the "concha prieta" of Peruvian fishermen. Its habitat is muddy mangrove bogs. The sudden closing of the valves makes a characteristic sound like nuts falling in the stillness of the swamps. The mollusc is very commonly used for food on the Peruvian coast.

Cuming collected the type at Real Llejos (Realijo), the port of Leon, Nicaragua, Lat. 12° 43' North. Carpenter found this species very abundant in Reigen's Mazatlan collection, Gulf of California, Lat. 23° 20' North. At Panama, Adams obtained many shells from the natives, by whom it is used for food.

Arca tuberculosa ranges from Ballenas Lagoon, Lower California, to Tumbes Peru, Lat. 3° 30' South.

Localities.—Bucaru, the port of Tonosi, Los Santos Province, Panama (Olsson coll.); Panama (Newcomb coll.).

Scapharca (Scapharca) obesa Sowerby

Plate III, Figures 4, 5

- Arca obesa* Sowerby, Proc. Zool. Soc. London, p. 21, 1833.
A. obesa Reeve, Conch. Icon., *Arca*, pl. 1, f. 3, 1844.
A. obesa d'Orbigny, Voy Amér. Mérid., Moll., p. 633, 1846.
A. (Scapharca) obesa Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

Shell ovate, inequivalve, ventricose. Anterior end rounded, posterior produced and pointed. Color white, covered with a dark brown epidermis, which is bristly in the interspaces. Ribs very numerous, narrow and closely-set, forty-two to forty-four in number, some of the anterior showing traces of faint, medial groovings toward the basal margin. The ribs are smooth, except for arcuate growth lines. Interspaces very narrow on the left valve, wider on the right. Cardinal area medium. Length of largest shell 40 mm., altitude 31, semidiameter 15 mm.

This species is easily distinguished by its ovate, ventricose form and unusually numerous ribs.

There is no living analogue of *Arca obesa* on the East coast; but the Miocene species, *A. dodona* Dall, from Oak Grove, northwest Florida, is rather similar in form to the Panamic shell, but is otherwise distinct.

The type of *Arca obesa* was dredged by Cuming at Atacames, Ecuador, Lat. $0^{\circ} 50'$ North. Apparently the shell has never heretofore been recorded except from the Ecuadorean coast. This formerly was a part of Colombia, and Sowerby's and Reeve's citations therefore refer to West Colombia, while d'Orbigny erroneously refers Atacames to Peru.

Our specimens coincide with Reeve's figure and description and are undoubtedly *A. obesa*. This extends the range of the species to approximately Lat. $7^{\circ} 25'$ North.

Locality.—Bucaru, the port of Tonosi, Los Santos Province, Panama, (Olsson coll.).

Scapharca (Scapharca) formosa Sowerby

Plate III, Figure 11

Arca formosa Sowerby, Proc. Zool. Soc. London, p. 20, 1833.

Not *A. (Cucullæa) formosa* Sowerby, Trans. Geol. Soc. London, 4, pl. 17, f. 7, 1837. See *A. venusta* Nyst.

Arca formosa Hanley, Rec. Bivalve Shells, p. 160, pl. 19, f. 9, 1843.

Not *A. formosa* Klipstein, Beitrage zur Geol. Kennt. der Oost-Alpen., pl. 17, f. 22, 1843. See *A. klipsteiniana* Nyst.

Arca formosa Reeve, Conch. Icon., *Arca*, pl. 2, f. 10, 1844.

A. formosa Nyst, Tabl. Syn. Esp. Viv. et Foss., Genre *Arca*, p. 28, 1848.

A. formosa Carpenter, Rept. Brit. Assoc. Adv. Sci., pp. 183, 234, 310, 1857.

A. (Anadara) formosa Stearns, Proc. U. S. Nat. Mus., 14, p. 309, 1891.

A. (Scapharca) formosa Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

Shell large, oblong, rounded anteriorly, roundly pointed posteriorly, equivalve. Color white, with a broad, irregular ray of light chestnut brown staining the beaks and extending towards the ventral margin. Interior of valves also stained brownish, except at the adductor scars and along the margin beyond the pallial line. Epidermis brown, more or less scaly and in the interspaces bristly. Ribs forty-five, the anterior twenty-five

on either valve being medially grooved and more or less crenulated minutely. The posterior twenty ribs are undivided, smooth and flat. Ligamentary area long, rather broad in the adult shell. Teeth small, numerous; hinge narrow. Length 8.4 mm, altitude 4.7, diameter 3.5 mm. The type was larger and measured 4.8 inches in length and 2.3 in height.

Sowerby in describing the type merely stated that the ribs are numerous. Reeve remarked that thirty-five or thirty-six ribs are present and that the most anterior are medially grooved. In this specimen there are more ribs, and they are grooved as far as the center of the valve, but such characters are not specifically constant in this genus.

This handsome shell has a considerable resemblance to the Atlantic species, *Arca secticostata* Reeve, but is less ventricose, more evenly inflated, and less narrowly pointed posteriorly; and in *A. secticostata* nearly all the ribs are medially grooved.

Sowerby compared *A. formosa* with the Philippine shell, *A. scapha* Chemnitz.

The type of *A. formosa* was dredged by Cuming in the Gulf of Tehuantepec, southwestern Mexico at ten to twelve fathoms in sandy mud.

This species was recorded by Carpenter from Lower California, and by Stearns from Manta, Ecuador, Lat. 1° S., and from Païta, Peru, Lat. 5° 15' S., the southern limit of its range.

The specimen herein described and figured is kindly loaned by the American Museum of National History, Constable collection, from Panama. As far as I am aware, this is the only citation of *A. formosa* from Panama. It was not found there by Adams, Newcomb, Zetek or Olsson.

Arca (Scapharca?) biangulata, Sowerby.

Arca biangulata Sowerby, Proc. Zool. Soc., London, p. 21, 1833.

A. Sowerbyi d'Orbigny, Voy. Amér. Mérid., p. 637, 1846.

Not *A. Sowerbyi* Sowerby, Trans. Geol. Soc. London, 2d ser., vol. 5, pt. 3, pl. 53, f. 25, 1840, fossil from Devonshire, England. This *vide* Nyst., 1848, is *A. angusta* Sowerby, not *angusta* Lamarck.

A. biangulata Nyst. Tabl. Syn. Esp. Viv. et Foss., Genre, *Arca*, p. 12, 1848.

A. (Barbatia) biangulata Dall, Proc. U. S. Nat. Mus., 37, p. 252, 1910.

This species was described by Sowerby as oblong, ventricose, white, radiately ribbed, covered with a bristly, brown epidermis. Dorsal margin acute anteriorly, obtusely angulate posteriorly. Anterior end shorter, higher; posterior end subacuminate. Ligamentary area long, wider anteriorly, flat. Length 2 inches, altitude 1.3, diameter 1.2 inches.

The type was a single specimen dredged by Cuming at Atacames, Ecuador, Lat. 0° 5' North, at seven fathoms.

Reeve of *Arca biangula* Lamarck, fossil from the Paris basin, d'Orbigny re-

named Sowerby's species *Arca Sowerbyi*, but this was not justified because of this difference in orthography.

A specimen thought to be *A. biangulata* by d'Orbigny was collected by Fontaine at Guayaquil, Ecuador. This and the type locality are the only places from which it has been recorded.

Very little is known regarding this unfigured species. Nyst suggested, in 1848, that it should be suppressed since it is not mentioned in Catlow's Catalogue nor in Reeve's Monograph. Only an examination of the type could determine whether this doubtful species is valid.

Dall included *Arca biangulata* under *Barbatia*, but in the original description of Cuming's shells, Sowerby excluded it from *Byssourca* and placed it under the equvalve Arcas. His description suggests a *Scapharca* on the border line of the section *Anadara*.

Scapharca (Scapharca) labiosa Sowerby

Plate III, Figures 1, 3.

Arca labiosa Sowerby, Proc. Zool. Soc., London, p. 21, 1833.

A. labiosa Reeve, Conch. Icon., *Arca* pl. 10, f. 67, 1844.

A. (Scapharca) labiosa Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

Shell of medium size, thin, oblong, moderately inflated, inequivalve, the basal margin of the right valve resting within that of the larger, left valve; anterior end shorter, posterior end obtusely pointed. Beaks situated at the anterior third of the total length. Color whitish or light buff covered with a light brown epidermis. Ribs thirty-eight, flat, the anterior obsoletely wrinkled, the posterior smoother. In spite of the fact that the shell is conspicuously inequivalve, the sculpture is not discrepant, excepting that the ribs of the right valve are squarer at the edges making them appear strap-like. The ribs are entire and practically all of them flat-topped. Ligamentary area narrow. Central hinge teeth fine, anterior and posterior coarser. Length of shell 55 mm., altitude 35, diameter 28 mm.

Carpenter was disposed to think that *A. labiosa* was identical with *A. labiata* (See Rept. Brit. Assoc. Adv. Sci., p. 249, 1857, and Cat. Reigen Coll. Mazatlan Moll., p. 164, 1855-57). Evidently he had no specimens, for those two species are very distinct being of very different form, and referable to different sections, *A. labiata* being a *Cunearca* while *A. labiosa* is a *Scapharca*, *sensu stricto*.

The fauna of the Atlantic coast offers no species analogous to *Arca labiosa*.

This species is thinner and more equivalve than most American Arcas of its general outline; but certain Pacific species show these characters. This suggests the Oriental origin of *Arca labiosa*, as its relationships are with oriental species and not with our East Coast *Arca* fauna.

The type of *Arca labiosa* was dredged by Cuming at Tumbes, Peru, Lat. $3^{\circ} 30' S.$, in soft mud at seven fathoms. I do not find it recorded from elsewhere.

The specimen above described was kindly loaned by the American Museum of Natural History. It is from Peru.

The American Museum also lent me specimens from China which appear to be *Arca labiosa*, but the basal margin is more convexly rounded and the shell is heavier in weight. A small specimen is figured for comparison with the Peruvian. A larger one from China measures 65 mm. in length, 41 in altitude and 32 mm. in diameter. This shows its proportionally greater altitude due to the more arcuate base. But in spite of the geographical remoteness, the Chinese shells seem to show no characters distinguishing them specifically from the Peruvian species.

Scapharca (Scapharca) cepoides Reeve

Plate III, Figure 6

Arca cepoides Reeve, Proc. Zool. Soc. London, p. 47, 1844.

A. cepoides Reeve, Conch. Icon., *Arca*, pl. 10, f. 66, 1844.

A. cepoides Nyst, Tabl. Syn. Esp. Viv. et Foss., Genre *Arca*, p. 18, 1848.

A. (Scapharca) cepoides Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

Shell large, roundly quadrate, very ventricose, inequivalve, the basal margin of the smaller, right, valve resting within that of the larger, left, valve. Substance light, and so thin that the ribs show almost throughout the interior of the shell. Color whitish, tinged with light brown. Epidermis brown, somewhat scaly in the interspaces, but not setose. Ribs about thirty-three, smooth and flat, slightly discrepant in width on the two valves. Beaks tumid. Ligamentary area in the adult shell rather wide. Hinge narrow, straight; teeth fine, numerous. Length of shell 70 mm., altitude 60, diameter 46 mm.

Sowerby and Reeve in describing this species mention a bluish, horny cuticle situated between the shell substance and the epidermis. The specimen here described shows no trace of this. Perhaps this bluish layer and the almost spherical form of the shell led to its being called by Sowerby the onion-like Ark. Sowerby speaks of it as a fine, bold species, but with no striking peculiarity.

Arca cepoides bears no strong resemblance to any Atlantic species. Superficially it might recall *A. (Argina) campechiensis* Dillwyn of the East coast, but the hinge line is straighter and more angulated and the teeth and cardinal area are different from those of that species.

There are, however, in the Pacific fauna other large, thin, inflated Scapharcas as *A. inflata* Reeve from the Philippines, and *A. disparilis* Reeve, appears to resemble *A. cepoides*.

The type of *A. cepoides* was collected by Cuming at San Miguel, Ecuador. I do not find this species recorded from any other locality.

The specimen herein described and figured is kindly loaned by the American Museum of Natural History, Constable collection, from Panama.

Scapharca (*Scapharca*) *grandis* Broderip and Sowerby

Plate III, Figure 13.

- Arca grandis* Broderip and Sowerby, Zool. Jour. London, 4, p. 365, 1829.
A. grandis Reeve, Conch. Icon., *Arca* pl. 1, f. 4, 1844.
A. grandis Hanley, Descr. Cat. Rec. Sh., p. 160, 1845.
A. grandis d'Orbigny, Voy. Amér. Mérid., Moll., p. 637, 1846.
A. grandis C. B. Adams, Ann. Lyc. Nat. Hist. New York, 5, p. 483, 1852.
A. grandis Troschel, Archiv. für Naturgeschichte, 18, p. 200, 1852.
A. grandis Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 132, 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857; Proc. Zool. Soc. London, p. 364, 1863.
A. (Anadara) grandis Dall, Proc. U. S. Nat. Mus., 37, pp. 154, 253, pl. 25, f. 9, 10, 1910.
A. (Anadara) grandis Zetek, Los Moluscos de Panama, p. 35, 1918.
A. quadrilobata Sowerby, Proc. Zool. Soc. London, p. 22, 1833. Not of Lamarck.

Shell very large and heavy, obliquely subquadrangular. Anterior end rounded. Posterior end produced especially in very large, old shells. Ribs about twenty-seven, very prominent over the center of the valve, flatter and weaker beyond the umbonal ridge. Ligamentary area extremely wide. Epidermis so dark as to be almost black. Our largest specimen measures in length 130 mm., altitude 114, diameter 120 mm.; weight three pounds ten ounces.

This is the giant member of the genus *Arca*, and is at once recognized by its great size and weight.

Arca grandis bears some resemblance to the more northern species, *A. multcostata* Sowerby; but its striking affinity is with *Arca patricia* Sowerby (Quart. Jour. Geol. Soc. London, p. 52, 1849; Maury, Bull. Amer. Pal., No. 29, p. 29, pl. 27, f. 1, 1917) from the Miocene of the Dominican Republic and of Panama. The resemblance between *grandis* and *patricia* is so great that they have sometimes been considered to be identical. Certainly *grandis* is the descendent of *patricia*.

As to the habitats of these two species, *A. grandis* lives in mud between tides at Panama. *A. patricia* at Caimito, Dominican Republic, occurs in beds containing flakes and masses of selenite and is associated with lignitic layers, suggesting aridity and near shore conditions. It would seem to have inhabited shallow lagoons or salt marshes. It appears stratigraphically to mark a rising coast line, withdrawal of the sea off shore and the inception of a stratigraphic break between marine deposits.

Arca grandis is referred by Dr. Dall and by Zetek to the section *Anadara* Gray, of the subgenus *Scapharca*; but the characters of both *grandis* and *patricia* are intermediate between *Anadara* and *Scapharca*, *sensu stricto*. Moreover, since the section *Anadara* Gray is a rather artificial group and the relationships of *grandis* seem to be with *Scapharca*, it is here classified under that section.

Cuming collected *Arca grandis* at Real Llejos, Nicaragua, and in the Bay of Guayaquil, Ecuador, where it was later found by Fontaine. It is also common at Mazatlan. On the Peruvian coast and in Panama it is used for food. Mr. Olsson found it especially abundant on the beach near the mouth of Rio Chepo, where the people use the shells for paving in front of their houses.

Arca grandis ranges from Magdalena Bay, Lower California, to Tumbes, Peru.

Localities.—Mouth of Rio Chepo, Panama; San Miguel, Rey Island, Panama Bay (Olsson coll.); Panama (Newcomb coll.).

Scapharca (Scapharca) multicosata Sowerby

Arca multicosata Sowerby, Proc. Zool. Soc. London, p. 21, 1833.

A. multicosata Reeve, Conch. Icon., *Arca* pl. 4, f. 23, 1844.

A. multicosata Hanley, Rec. Shells, p. 19, f. 12, 1845.

A. multicosata Carpenter, Cat. Reigen Coll. Mazatlan Moll. p. 134, 1855-1857; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857.

Scapharca multicosata Dall, Bull. 112, U. S. N. M., p. 16, 1921.

Shell large, solid, ovate-rhombic, equivalve. Dorsal margin angulated anteriorly and posteriorly. Anterior shorter, posterior region with a well-marked, rounded umbonal carina passing to the posterior basal margin. Color of shell ivory white covered with a brown horny epidermis, somewhat velvety in the interspaces. Ribs about thirty-six, rounded and smooth except the anterior which are slightly granular. Beaks sub-approximate. Ligamentary area rather wide. Length of type 2.8 inches, altitude 2.4 diameter 2.1 inches.

Arca multicosata bears some resemblance to *A. grandis* but is much lighter, with numerous ribs and its epidermis in somewhat velvety.

The type of *Arca multicosata* was dredged by Cuming in the Gulf of Tehuantepec, southwestern Mexico, at a depth of twelve fathoms. A specimen was found by Archer at Mazatlan and identified by Carpenter.

The range of this species is from the Gulf of Tehuantepec northward to San Diego, California.

Section *Cunearca* Dall*Scapharca* (*Cunearca*) *nux* Sowerby

Plate III, Figures 7, 8

Arca nux Sowerby, Proc. Zool. Soc. London, p. 19, 1833.*A. nux* Reeve, Conch. Icon., *Arca*, pl. 1, f. 1, 1844.*A. nux* d'Orbigny, Voy. Amér. Mérid., Moll., p. 638, 1846.*A. nux* Carpenter, Rept. Brit. Assoc. Adv. Sci., pp. 229, 310, 1857.*A.* (*Scapharca*) *nux* Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.*A.* (*Scapharca*) *nux* Zetek, Moluscos de Panama, p. 38, 1918.

Shell small, inequivalve, sub-rhomboidal, oblique, roundly inflated making the diameter almost equal to the other measurements. Color white, epidermis thin, brown and horny. Ribs twenty-two or twenty-three. Sculpture discrepant. Ribs of the left valve ornamented with closely-set, transverse ridges, independent of the concentric growth lines, not so conspicuous posteriorly. Right valve showing the transverse ridges only at the anterior end and around the umbo, ribs ending in the posterior ventral margin smooth. Cardinal area that of *Cunearca*, diamond-shaped and showing grooves only in rare specimens. Beaks small, high and pointed. Length of a large shell 25 mm., altitude 23, diameter 22 mm.

The ligamentary area shows faint concentric grooves in rare individuals, as sometimes occurs in *Cunearca chemnitzii* Philippi, but *A. nux* is decidedly a *Cunearca*, not a *Scapharca*, *sensu stricto*. Therefore, this adds a fourth member of the section *Cunearca* to the Panamic Arcas, the others being *C. æquatorialis* d'Orbigny, *C. bifrons* Carpenter and *C. labiata* Sowerby.

Of East coast species *Cunearca nux* resembles the Tertiary shells, *C. alcima* Dall from Florida and *C. chemnitzoides* Maury from Trinidad Island, and the living species *C. chemnitzii* Philippi from Colon and elsewhere on the East coast. *C. chemnitzii* is larger than *nux*, not so roundly inflated and the ribs of the right valve are not so smooth.

Cunearca nux is easily distinguished from *bifrons* and *æquatorialis* by its small size, pointed form and by its sculpture.

The type of *Cunearca nux* was dredged by Cuming at Jipijapa, Ecuador, Lat. 10° 15' South, at twelve fathoms. It was not found at Panama by Adams, but was listed from there by Carpenter and by Dall, and collected there by Zetek. Apparently it has not been found north of Panama.

Locality.—Bucart, the port of Tonosi, Los Santos Province, Panama, (Olsson coll.).

Scapharca (*Cunearca*) *æquatorialis* d'Orbigny

Plate III, Figures 2, 9

Arca æquatorialis d'Orbigny, Voy. Amér. Mérid., Moll., p. 636, 1846.*A.* (*Cunearca*) *æquatorialis* Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

A. ovata Reeve, Proc. Zool. Soc. London, p. 44, 1844; Conch. Icon., *Arca*, pl. 8, f. 49, 1844. Not *ovata* of Gmelin, 1791.

Shell of medium size, thin, inequivalve. Color white, often brightly stained with reddish brown. Epidermis fawn-colored, very thin. Ribs about thirty to thirty-two, the anterior coarsely nodose, the posterior flat, smooth and less prominent. Sculpture somewhat discrepant, the ribs on the left valve being broader than those on the right. Ligamentary area diamond-shaped. Length 35 mm., altitude 29, diameter 26 mm.

The species resembles young shells of *Cunearca incongrua* Say, from the East coast; but is smaller than adult specimens of *incongrua* and is usually marked with the bright reddish stain, and the details of sculpture of the left valve are different.

Apparently *Cunearca aequatorialis* is now for the first time recorded outside of the type locality which was Sta. Elena, Ecuador, about Lat. 2° South. It was not found by Adams or Zetek at Panama nor listed by Carpenter. d'Orbigny and Dall refer only to Cuming's type locality.

The range of this species is now extended to about Lat. 7° 25' North.

Locality.—Bucaru, Los. Santos Province, Panama (Olsson coll.).

Scapharca (Cunearca) bifrons Carpenter

Plate III, Figure 12

Arca inaequivalvis Sowerby, Genera of Shells, *Arca*, pl. 80, f. 3, 1832 (no locality).

Not *Arca inaequivalvis* Bruguière, Encycl. Méth., Vers. 1, pt. 1, p. 106, pl. 305, f. 3, 1792.

Not *inaequivalvis* Goldfuss, Zieten verst. Wurt., pl. 70, f. 3, 1833; Petref. Germaniae, pl. 122, f. 12, 1840.

Arca cardiiformis Sowerby, Proc. Zool. Soc. London, p. 22, 1833.

A. cardiiformis Reeve, Conch. Icon., *Arca*, pl. 3, f. 17, 1844.

A. cardiiformis d'Orbigny, Voyage, Amér. Mérid. Moll., p. 634, 1846.

A. cardiiformis Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 310, 1857.

A. (Cunearca) cardiiformis Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

A. (Cunearca) cardiiformis Zetek, Los Moluscos de Panama, p. 52, 1918.

Not *Arca cardiiformis* Basterot, Desc. géol. bass. tert. du Sud-Ouest de la France, Mém. Soc. d'Hist. Nat., 2, p. 76, pl. 5, f. 7, 1825; Grateloup, Cat. Zool. Gironde, p. 60, 1836; d'Orbigny, Prod. Ill., p. 123, 1852; Benoist, Cat. Saucats, p. 64, 1873; Cossmann et Peyrot, Conch. Néogénique de l'Aquitaine, 2, p. 154, pl. 8, f. 17-21, 1914.

Not *Arca nodosa* Wood, Index Testacea Suppl., pl. 2 (*Arca*), f. 8, 1828, (no locality); Dall, Trans. Wagner Inst. Sci., p. 635, 1898.

Arca brasiliiana Reeve (*pars*), Conch. Icon., *Arca*, pl. 3, f. 17, 1844.

Not *Arca brasiliiana* Lamarck, Anim. s. Vert., 6, p. 44, 1819.

Arca bifrons Carpenter, Catalogue Reigen Coll. Mazatlan Moll. British Museum, p. 134, 1855-57.

Arca bifrons Carpenter, Rept. Brit. Assoc. Adv. Sci., pp. 249, 310, 1857.

Carpenter described *Arca bifrons* as subquadrate, ventricose, thin, very inequivalve, angulated posteriorly, beaks not distant. Color white, covered with a smooth, olivaceous epidermis. Ribs about thirty. On young shells all the ribs are tuberculate, but on the adult only the anterior eight or ten, the rest being smooth. Sculpture somewhat discrepant on the two valves, ventral ribs of the smaller valve small, rounded, not equalling the interspaces in width; on the larger valve ribs flat, subobsolete, interspaces narrow. Ligamentary area rhomboidal. Hinge line curved, teeth small. The basal margin of the smaller valve rests within that of the toothed larger valve. Length of type 1.55 inches. Sowerby's *A. cardiiformis* measured two inches in length, 1.7 in altitude and 1.5 of an inch in diameter.

The synonymy of this species is involved. Sowerby, in 1832, named a shell from an unknown locality, *Arca inæquivalvis*. This later proved identical with the *Arca cardiiformis*. But Bruguière, in 1792, had given the name *inæquivalvis* to an East Indian *Arca*, so that Sowerby's *inæquivalvis* could not stand.

In 1833, Sowerby gave the name *Arca cardiiformis* to the West coast shell. But this name had been applied eight years earlier by de Basterot to a fossil *Ark* from the Miocene of southern France.

Carpenter, in 1856, described *Arca bifrons*. This Dr. Dall pronounces identical with Sowerby's *cardiiformis* and *inæquivalvis*. Since both of Sowerby's names were preoccupied, Carpenter's *bifrons* holds. I am greatly indebted to Dr. Dall for this important information regarding the identity of *cardiiformis* and *bifrons*. Carpenter himself supposed them to be distinct species. From his description of *A. bifrons*, however, it is evident that his shell was very close to *cardiiformis*; but as *bifrons* was never figured and as the type is in the British Museum one could not be sure of their identity.

Reeve confused the East coast species, *Arca brasiliiana* Lamarck, which is the Southern form of the well-known *Cunearca incongrua* Say, with the West coast shell; and his figure 17 on plate 3 is an illustration of a West coast specimen. These Atlantic and Pacific forms are closely allied, but distinct species, as d'Orbigny pointed out many years ago.

Arca bifrons(*cardiiformis*) and (*A. æquatorialis*) seem to be very closely related and to vary within each species. Both may be stained with rusty red, but in the smaller species this may be quite striking, while Reeve says of *A. cardiiformis*; "very palely stained with light rusty red." *A. æquatorialis* is typically longer and more produced posteriorly, but our Panama specimens do not show any marked elongation. Reeve says that *A. cardiiformis* has fewer ribs, numbering only twenty-six, but Carpenter describes *bifrons* as having thirty, which is the same number as in the type of *æquatorialis*. Thus the number of ribs does not appear to be distinctive.

In the young of *bifrons* Carpenter says all the ribs are tuberculate,—this is true of our large valve which we take to be *bifrons*. On the other hand, many valves of *æqua-*

torialis have smooth central ribs nearly to the beak on both valves, although the ribs of the left valve are stronger than those on the right. But in other specimens nearly all the ribs of the left valve are nodular except at the distal ends. *A. æquatorialis* seems to vary greatly in this respect.

The discrepancy in the width of the ribs of the two valves seems to be greater in *A. bifrons* than in *æquatorialis*.

The chief distinguishing feature between adult specimens of *A. bifrons* and *A. æquatorialis* is the size. Our twenty-three valves of *æquatorialis* are consistently small while *bifrons* attains twice their size.

Sowerby's type of *Arca cardiiformis* was collected by Cuming on the sands at San Blas, Gulf of California. Specimens identified by d'Orbigny as this species were dredged by Fontaine at Paita, Peru.

Carpenter's type of *Arca bifrons* was collected by Cuming at Mazatlan, Gulf of California, and specimens were also in the Reigen collection from Mazatlan.

Apparently this species has not been recorded from Panama. Zetek merely states that it is to be expected there. We have a valve which may be the larger valve of *A. bifrons*. It is a *Cunearca* and is not *Cunearca æquatorialis*, and its measurements correspond with those given by Sowerby for *cardiiformis*. This valve, however, is not thin, and the smooth ribs of the left valve are not subobsolete, otherwise it agrees with *A. bifrons* and *A. cardiiformis*.

Locality.—Near the mouth of Río Chepo, Panama (Olsson coll.).

Scapharca (Cunearca) labiata Sowerby

Plate I, Figure 8

Arca labiata Sowerby, Proc. Zool. Soc. London, p. 21, 1833.

A. labiata Reeve, Conch. Icon., *Arca*, pl. 1, f. 7, 1844.

A. labiata Hanley, Descr. Cat. Rec. Sh., p. 160, 1845

A. labiata d'Orbigny, Voy. Amér. Mérid., Moll., p. 634, 1846.

A. labiata Carpenter, Cat. Reigen Coll. Mazatlan Moll., p. 134, 1855-57; Rept. Brit. Assoc. Adv. Sci., p. 310, 1857.

A. (Scapharca) labiata Stearns, Proc. U. S. Nat. Mus., 14, p. 310, 1891.

A. (Scapharca) labiata Dall, Proc. U. S. Nat. Mus., 37, pp. 155, 253, 1910.

Shell heart-shaped with very high, acute beaks, a wide hinge and long teeth. It is unusually heavy for a *Cunearca*. The marginal dentition within the valves is very strong. The sculpture on the valves is discrepant. On the left valve the ribs are prettily and conspicuously marked with transverse wrinkles, except distally on the posterior slope and close to the umbonal ridge. Thus more of the ribs are sculptured than in *æquatorialis* and *bifrons*.

On the right valve, which is slightly smaller the ribs are smooth except on the anterior slope and near the beaks. Cardinal area as in *Cunearca*. It is diamond-shaped

and entirely covered by the ligament which has no grooves. Length 40 mm., altitude 42, diameter 36 mm.

This species has a heavier shell than *Cunearca æquatorialis* or *A. bifrons* and is shorter and higher in form, with a wider hinge and longer teeth. The finely wrinkled ribs are also characteristic.

Cuming's specimens which Sowerby described as the type of *A. labiata* were dredged in sandy mud at seven fathoms at Real Llejos, Nicaragua, and at Tumbes, Peru. Carpenter stated it was very rare in Reigen's Mazatlan collection; Stearns listed it from Bahia (*Panguapi*) Ecuador, Lat. 3° North where it was collected by Dr. Jones of the U. S. S. *Wachusett* in 1884; and Dall recorded it from Capon, Peru, collected by Mr. Coker.

A. labiata appears to have never yet been found in Panama Bay. The specimen figured was kindly loaned by Dr. Dall from the National Museum, No. 23611, locality not given.

Section Argina Gray

Scapharca (Argina) brevifrons Sowerby

Arca brevifrons Sowerby, Proc. Zool. Soc. London, p. 22, 1833.

A. brevifrons Reeve, Conch. Icon., *Arca*, pl. 1, f. 6, 1844.

A. brevifrons? Carpenter, Rept. British Assoc. Adv. Sci., p. 249, 1857.

A. brevifrons Carpenter, Rept. Brit. Assoc. Adv. Sci., p. 310, 1857.

A. (Scapharca) brevifrons Dall, Proc. U. S. Nat. Mus., 37, p. 253, 1910.

The type of this species was dredged by Cuming at Tumbes, Peru, Lat. 3° 30' South, in soft mud at seven fathoms. It is said to range northward to the Gulf of California.

We have no typical specimens in our collection, although the following variety is abundantly represented.

Argina brevifrons variety *bucaruana* Sheldon and Maury, new variety

Plate II, Figure 16; Plate III, Figure 10

Shell oblong, inequivalve, beaks situated about the anterior fourth of the total length. Anterior end short, posterior end long and squarely expanded, with the posterior margin truncated. Color white, often with a black spot at the beak. Typical forms according to Reeve are stained elsewhere with light green, but our shells are white or tinged with fawn. Epidermis dark brown, bristly in the interspaces. Ribs smooth, closely-set, numbering in our specimens thirty-three to thirty-six. Sculpture of the ribs variable, in some cases all the ribs are entire, in others practically all are medially grooved. Usually the left valve shows more groovings than the right. Ligamentary area

present, not wanting as described by Sowerby. But since this species belongs to *Argina* the beaks are closely incurved at the anterior end of the area and the ligament occupies only a long, narrow furrow extending backward. When the two valves are together it is practically hidden. Teeth in two series, the posterior long, the anterior very short and the teeth of that series often irregular. Length of largest specimen 39 mm, altitude 27, diameter 19 mm.

Arca brevifrons is described by Reeve as having twenty-two or twenty-three ribs, only the central ones being grooved. The form also is longer and more ovate than in our shell.

In form and ribbing our Panama shells are almost identical with the figure and description of the shell from an unknown locality which Reeve used as an example of *Arca indica* Gmelin,—an obscure and much misunderstood species. Possibly Reeve's shell was really a specimen of this variety of *A. brevifrons* and not the Indian Ark.

Since our Panama Bay specimens, of which we have thirty valves, all differ from the typical *Arca brevifrons*, as described by Sowerby and figured by Reeve, in their squarer and less pointed posterior end, and in the presence of ten to twelve more ribs, which show more tendency to medial groovings, we suggest that this Panama shell be distinguished as variety *bucaruana*.

Locality.—Bucaru, the port of Tonosi, Los Santos Province, Panama (Olsson coll.).

Section Bathyarca Kobelt

Scapharca (Bathyarca) nucleator Dall

Scapharca (Bathyarca) nucleator Dall, Bull. Mus. Comp. Zool. Harvard Coll., 43, p. 397, pl. 18, f. 9, 1908; Bull. 112, U. S. Nat. Mus., p. 16, 1921.

Shell very small, subglobose, sculpture very finely reticulate, radial and concentric raised lines subequal and bearing long fringes of periostracum. Altitude 6mm., latitude 6, diameter 4 mm,

The type of *Bathyarca nucleator* was dredged by the U. S. S. *Albatross* in the Bay of Panama at 1270 fathoms, temperature 36° Fahrenheit. The northern limit of this abyssal species is San Diego, California.

Scapharca (Bathyarca) pompholyx Dall

Scapharca (Bathyarca) pompholyx Dall, Bull. Mus. Comp. Zool. Harv. Coll., 43, p. 398, 1908; Bull. 112, U. S. Nat. Mus., p. 17, 1921.
corpulenta Smith, variety? 1885.

This deep sea species has been dredged off the Galapagos Islands and may also be found in the abyssal fauna of Panama Bay.

Bathyarca prompholyx ranges westward from the Galapagos group into the mid-Pacific, and northward to Santa Barbara, California.

INCERTA SEDIS

Arca pernoides Carpenter

Byssosarca pernoides Carpenter, Proc. Zool. Soc. London, p. 202, 1856.

Byssosarca pernoides Carpenter, Rept. Brit. Assoc. Adv. Sci., pp. 283, 310, 351, 1857.

Carpenter remarked of this unfigured species that it somewhat resembled, "the fine variety of *Barbatia solida*, but is square and known at once by the teeth and ligament. This is (under the lens) in minute pits as in *Isoptomon*, but with an extra layer covering the whole area."

Possibly this description of the cardinal area might apply to a shell somewhat like *Noëtia olssoni* but the reference to *A. solida* implies a shell of very different general aspect.

Dr. Dall in a recent letter suggests that Carpenter's description might be explained as follows: "The resilium in the Arks is divided into strips which run in the grooves of the area covered by the ligamentary layer ("extra layer" of Carpenter) which is continuous. Usually these grooves are shallower and one does not notice the ends of the resiliary strips, but it is conceivable that in some specimens they might be abnormally developed by disease or something to give the effect Carpenter describes.

If *Arca pernoides* is a valid species it cannot belong to the same section as *A. solida* because of the cardinal characters. Only by an examination of the type can the relationship and validity of this doubtful species be determined. Carpenter's specimen was in Gould's collection. It was said to be from San Diego, California, collected by Lieutenant Webb. But it may be exotic. The Gould collection is now at the Albany Museum; but the Curator of the Mollusca in that Museum writes that since moving, the Mollusca have never been unpacked and are in twenty thousand separate bundles with no indication on the exterior as to what they contain.

Only the single valve constituting the type has ever been found.

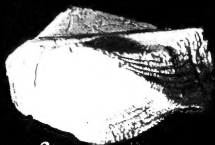
Plate 1 (XXIX)

Plate I (XXIX)

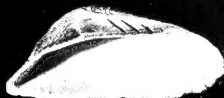
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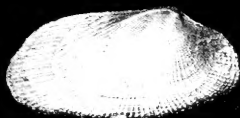
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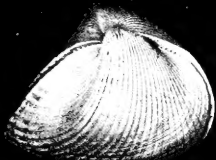
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Plate 2 (XXX)

Plate II (XXX)

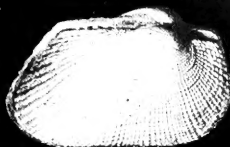
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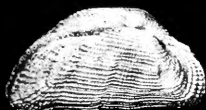
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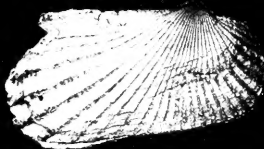
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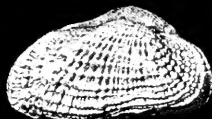
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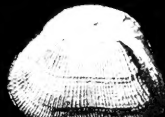
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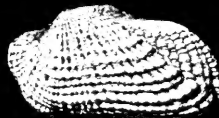
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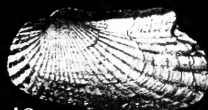
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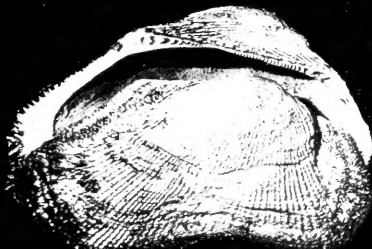
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PALÆONTOGRAPHICA AMERICANA

ILLUSTRATED CONTRIBUTIONS

TO THE

INVERTEBRATE PALEONTOLOGY

OF

AMERICA

VOL. I

No. 5. — The Veneridae of Eastern America, Cenozoic and Recent

(Pages 209 - 522 ; Plates 32 - 76)

(Presented to the Graduate School of Cornell University in partial fulfillment of the requirements for the degree of Doctor of Philosophy)

BY KATHERINE VAN WINKLE PALMER

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Katherine Van Winkle Palmer



PREFATORY REMARKS

The object of the work expressed on the following pages has been, primarily, to illustrate and describe all the known Cenozoic and Recent species of the molluscan family Veneridæ, from the Atlantic Slope of North America and South America excluding the region south of Brazil and including the province of the Caribbean Sea and the Gulf of Mexico. The determination of the generic classification of the species involved the search for specimens and illustrations of the type species of the genera and subgroups of which the family consists. In many cases, the illustrations of the type species are in publications that are inaccessible, and specimens are to be found only in the large museums. An additional purpose of the paper has been to illustrate and discuss as completely as possible the types of all the groups of the Veneridæ, under which, species of the region studied, have been classified. The original description has been included whenever it has been possible to gain access to a copy of the original publication.

In the study of a family of mollusca from a stratigraphic standpoint, one gains a perspective of the development of the genera which may be put to practical service in the determination of unknown material. Charts have been made on which all the species of a genus are listed in their proper stratigraphic position. Comparing the charts of the genera one is able to obtain the stratigraphic range of each genus as well as the range of each of the genera in relation to each other. These charts have been made for the region studied in this paper and do not include the range of the genera as they occur in other parts of the world. To conserve space, the author has placed the species of consecutive ages in the same horizontal line. This arrangement does not indicate stratigraphic development of species.

The investigation represents study at Cornell University of material in the Newcomb collection of recent shells; of extensive Tertiary collections from the East Coast and Gulf Coast of the United States; of the Harris Tertiary and Recent collections from Trinidad; of the Maury Miocene and Recent collections from Santo Domingo; of the Olsson Mio-

cene and Recent collections from Costa Rica and Panama, and of minor collections from various localities; also of type and duplicate collections at the Academy of Natural Sciences and at the Wagner Free Institute of Science in Philadelphia; of collections at the United States National Museum in Washington, and borrowed collections from the American Museum of Natural History. In addition work was done in the library of the Museum of Comparative Zoology at Harvard University, the library of the United States Geological Survey, the Library of Congress and the library of Cornell University.

The author wishes to express her thanks to all who have helped willingly in the use of museum and library material. Especially is she indebted for the use of material to Dr. S. F. Harmer of the Natural History Division, British Museum, to Dr. Roy Miner of the American Museum of Natural History, to Dr. W. H. Dall of the United States National Museum, to Dr. David White of the United States Geological Survey, to Dr. H. A. Pilsbry of the Academy of Natural Sciences, Philadelphia, to Dr. Carl O. Dunbar of Yale University, and to Prof. G. D. Harris of Cornell University.

To Prof. G. D. Harris, the writer owes much for his ever ready encouragement and his criticism, as well as for the privilege of publication.

The form used in writing the scientific names on the following pages is that of the International Rules of Zoological Nomenclature, 1913, Article 10. The subgeneric name is placed in parentheses between the generic name and the specific name. The name of the section precedes and appears only on the same page as the first discussed species which belongs to that section.

*Paleontological Laboratory,
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Ithaca, N. Y.
February 4, 1926*

THE VENERIDÆ OF EASTERN AMERICA; CENOZOIC AND RECENT

BY KATHERINE VAN WINKLE PALMER

Genus DOSINIOPSIS Conrad



Fig. 1. Hinge of type species of *Dosiniopsis*

Dosiniopsis Conrad, 1864, Proc. Acad. Nat. Sci. Phil., vol. 16, p. 213, fig. in text; Stoliczka, 1871, Pal. Indica, vol. III, p. 151; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 179; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 178; Fischer, 1887, Man. de Conch., p. 1079; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 345; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1225; Jukes-Browne, 1914, Proc. Mal. Lond., vol. 11, p. 65.
Aeora Conrad, 1870, Amer. Jour. Conch., vol. VI, p. 72, pl. 3, fig. 8; Whitfield, 1885, Mon. U. S. Geol. Sur., No. IX, p. 167, pl. 23, figs. 16, 17; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 346; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1226; Gardner, 1916, Md. Geol. Sur., Upper Cretaceous, p. 679 under *Meretrix*.

Equivalve, lentiform; hinge with three cardinal teeth in each valve; posterior tooth of right valve bifid; in the left valve a thick rugose lateral tooth fitting into a cavity in the opposite valve; under the apex is a pit or cavity; cartilage plate granulated; pallial sinus deep and angular.

Exteriorly the shells of this genus resemble *Dosinia*; and the pit under the apex and the form of the pallial impression are similar, but the anterior, thick, rugose cardinal tooth, the posterior hinge channel and tooth-like plate, and the muscular impressions ally it most nearly to *Venilia* and *Cyprina*.

Venus lineolatus, Sowerby, has a hinge character nearly allied to, if not identical with, this genus.—[Conrad, 1864.]

Genoholotype.—*Dosiniopsis lenticularis meeki* Conrad. Plate I, Figures 8, 10, 13, 14. Eocene of Maryland.

Shell large, orbicular or ovate; smooth except for growth lines; lunule large, faintly impressed; escutcheon not distinctly defined, bounded

by a sharp ridge; a thick, posterior lateral tooth in the right valve, hardly distinguished from the hinge margin except by means of a deep groove behind; a narrow socket in the left valve to receive the right, posterior lateral tooth; nymphs finely granulated.

The form which Conrad gave as the type of the genus *Dosiniopsis* is regarded now as a variety of the species *D. lenticularis* Rogers. The variety has been given in this discussion as the type of the genus since that is the particular shell Conrad had in mind when he typified the genus.

A study of the hinge of the type of the genus *Aeora* described by Conrad shows the same characters as those belonging to *Dosiniopsis*. Illustrations of the type specimens of *Aeora* are included so that the relationships may be seen. The figure of Conrad does not give all the elements of the hinge of the right valve as seen in the type specimen. The hinge is a duplicate of that of *Dosiniopsis* but is smaller and more delicate. The anterior cardinal in the left valve appears to be bifid but that is caused by being worn. The unworn tooth appears broad and corrugated and weathers to a bifid condition. The tooth is broader than that of *Dosiniopsis*. The pallial sinus is not seen on the co-types. Conrad described it as "deep, reaching to a point in a line with the posterior cardinal tooth; rounded and somewhat ascending." The type of *Aeora* is *A. cretacea* Conrad from the Cretaceous of Haddonfield, New Jersey, Plate I, figures 2, 9, 12.

Dosiniopsis is characteristic of Cretaceous and Eocene deposits. The type occurs in the Eocene of the East Coast and Gulf Coast of North America. *D. nebrascensis* Meek and Hayden is from the Cretaceous of the Western Plains region of the United States. *D. orbicularis* (Edw.), *D. bellovacensis* (Desh.) and *D. fallax* (Desh.) are species from the Eocene of the Paris Basin. *D. umzambiensis* (Woods), Ann. South African Museum, 1906, vol. IV, pt. VII, p. 304, pl. 36, figs. 4-6, shows the occurrence of this genus in the Cretaceous of Pondoland, Africa.

DOSINIOPSIS LENTICULARIS (Rogers)

Plate I, Figures 3, 11, 16

- Cytherea lenticularis* Rogers, 1839, Trans. Am. Phil. Soc., n. s., vol. 6, p. 372, pl. 28, fig. 1; Lea, 1848, Proc. Acad. Nat. Sci. Phil., vol. 4, p. 99.
Artenis lenticularis Conrad, 1853, Proc. Acad. Nat. Sci. Phil., vol. 6, p. 320.
Meretrix lenticularis Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 30.
Dosinia lenticularis Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 30.
Cytherea eversa Tuomey, 1858, 2nd Biennial Rept. Geol. Ala., p. 271.
Dosiniopsis lenticularis Conrad, 1864, Proc. Acad. Nat. Sci. Phil., vol. 16, p. 213; Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6; Conrad, 1866, Amer. Jour. Conch., vol. II, p. 100; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 6; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 178, pl. CXV, fig. 38; Aldrich, 1886, Geol. Sur. Ala., Bull. I, p. 57; Harris, 1894, Amer. Jour. Sci., vol. 47, p. 302; Clark, 1895, Johns Hopkins Univ. Cir., vol. XV, p. 5; Clark, 1896, U. S. Geol. Sur., Bull. 141, p. 78, pl. XVIII, fig. 1a-1g; Harris, 1897, Bull. Amer. Pal., vol. 2, No. 9, p. 64, pl. 12, fig. 13; Clark and Martin, 1901, N. d. Geol. Sur., Eocene, p. 171, pl. XXXV, fig. 1a-1g; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1225.

Shell large, depressed, discoidal, rather thick, length nearly equal to the breadth; transversely striated; lunule long, ovate, obscurely defined by a very faint impressed line; umbones rather depressed; beaks small, hardly recurved; teeth straight, divergent; cavity of the shell not deep; margin entire. Diameter about two inches.

Locality, eastern Virginia, in the eocene, where it is a common species.

Remarks.—From the extreme triability of this shell it has been impossible, hitherto, to procure a perfect specimen. It differs from all *Cythereæ* of our American eocene beds in its nearly orbicular form, and in its slight degree of inflation. The insulated tooth of the right valve is long, straight, and not much elevated. The anterior cardinal tooth in the same valve is slightly bifid. The striæ upon the surface of the disc are almost obsolete, where decay has not removed the external laminae. The small incurvation in the beaks distinguishes it from *C. Poulsonii* of Conrad (*C. globosa*, Lea), to which species it bears some resemblance.—[Rogers, 1839.]

Dimensions.—48 mm., length; 48 mm., height; 30 mm., thickness.

Holotype.—?

Occurrence.—Eocene. Virginia (type); Aquia Cr., Va.; Maryland (Md. Geol. Sur.); Fort Washington, Md.; Bell's Landing, Ala.; Ft. Gaines, Ga. (Cornell Univ. Pal. Lab.).

DOSINIOPSIS LENTICULARIS MEEKI Conrad

Plate I, Figures 8, 10, 13, 14

Dosiniopsis meeki Conrad, 1864, Proc. Acad. Nat. Sci. Phil., vol. 16, p. 213, figure in text; Conrad, 1865, Am. Jour. Conch., vol. I, p. 6; Conrad, 1866, Amer. Jour. Conch., vol. II, p. 100; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 6.

Dosiniopsis lenticularis var. *meeki* Harris, 1894, Amer. Jour. Sci., vol. 47, p. 302; Clark, 1895, Johns Hopkins Univ. Cir., vol. XV, p. 5; Clark, 1896, U. S. Geol. Sur., Bull. 141, p. 78.

Dosiniopsis meeki Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 345.

Short ovate, ventricose, moderately thick, inequilateral; anterior margin regularly rounded, posterior dorsal margin elongated, rounded, very oblique, the extremity subangulated; apex prominent; basal margin profoundly curved; lunule obsolete, or defined by an obscure line; surface without other lines than those of growth. Height $1\frac{1}{2}$ inch; length $1\frac{3}{4}$ inch.

Locality.—Six miles east of Washington, D. C. Meek.

Proportionally more elevated and convex than *D. (Cytherea) lenticularis*, Rogers.

A singular feature of this shell is a tuberculated callus under the anterior cardinal plate, which occurring in four valves must be characteristic of the species. It has the appearance of having grown up from the inner surface of the valve and folded over the under side of the hinge plate.

Mr. Meek found this species abundantly in a dark grey quartzose sand, six miles east of Washington, D. C., in company with other new univalves and bivalves. *Cytherea lenticularis*, Rogers, belongs to the genus *Dosiniopsis*, and more closely resembles *Dosinia* exteriorly. Both characterize the oldest portion of the American Eocene which has yet been observed.

This genus, like the preceding, is remarkable for uniting the characters of two families, *Cyprinidæ* and *Veneridæ*, which are obviously distinct in the recent shells.—[Conrad, 1864.]

Dosiniopsis lenticularis shows two phases of form. One with a flat and less elevated shape and the other with a more convex form. The more elevated and convex shell, Conrad named *D. meeki*. Comparing specimens of about the same length and height, the varietal form *meeki* is 3 mm. more in semidiameter. The posterior dorsal line is much more convex in *meeki*, the anterior end is shorter and the beaks are more elevated.

Dimensions.—49 mm. length; 47 mm. height; 30 mm. thickness.

Holotype.—?

Occurrence.—(Type) Six miles east of Washington, D. C.; mouth of Potomac Creek, Md. (Cornell Univ. Pal. Lab.); Md. localities see Md. Geol. Survey, Eocene.

Genus PITARIA¹ Römer (Dall)



Fig. 1. Hinge of type species of *Pitaria*

- Pitar* Römer, 1857, Krit. Unters. Art. Moll., *Venus*, p. 15; Römer, 1862, Mal. Blätt., Band 9, p. 58; Meek, 1876, U. S. Geol. Sur. Terr., Vol. IX, p. 179.
Caryatis Römer, 1862, Mal. Blätt., Band 9, p. 58; Römer, 1867, Mon. *Venus*, vol. I, p. 79; Stoliczka, 1871, Pal. Indica, vol. III, p. 151; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 178 not *Caryatis* Hübner, Lepidoptera, 1816.
Pitaria Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 353; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1264; Cossmann and Peyrot, 1910, Act. Soc. Linn. Bordeaux, vol. LXIV, p. 371; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 61.

Shell moderate in size, plump, inequilateral; umbones full; lunule large, elongate, bounded by a faint impressed line; no escutcheon; interior margins smooth; pallial sinus deep and narrowly rounded; anterior, left lateral fitting into a well developed socket in the right valve; middle, left cardinal large; posterior, right cardinal bifid; shell smooth, sculpture of concentric growth lines only. *Pitaria sensu stricto*.

Genoholotype.—*Venus tumens* Gmelin, Plate I, Figures 1, 4, 5, 6, 7. Recent, Western Africa, the Coast of Senegal and the Gulf of Guinea.

The genus constitutes one of the common and long-lived stocks of the Veneridæ. It, with the closely allied genus *Callista* include the greater number of the Eocene species of the family. The genus extends probably back into the Cretaceous since it is so well-developed in the Eocene. The genus occurs throughout the Tertiary on the East Coast and has numerous representative species living to-day.

¹ In defense of the change by Dr. Dall of the vernacular name *Pitar* to *Pitaria* we quote the following rules:

"Zoological nomenclature is the scientific language of systematic zoology, and vernacular names are not properly within its scope." Prin. II, Code, A. O. U., 1908.

"The scientific names of animals must be words which are either Latin or Latinized, or considered and treated as such in case they are not of classic origin." Art. 3, Int. Rules Zool. Nom., 1915.

Stratigraphic Range of *Pitaria* s. s.

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
nuttalliopsis and varieties	sincera	sincera	lordyi	subaresta	morrhuana
texacola var. tornadonis	nux	ammondea	sayana	sayana	albida
angelinae	riocollazica	sapotensis			fulminata
nuttali		sayana and varieties			aresta
poulsoni		catharinae			simpsoni
cornelli					penistoni
ovata					munda ?
pyga					
lenis ?					
liciata ?					
securiformis					
eversa					
ripleyana					

Genus PITARIA Römer

Subgenus PITARIA s. s.

? PITARIA RIPLEYANA (Gabb)

Plate III, Figures 14. 15

Venus riplejana Gabb, 1860, Jour. Acad. Nat. Sci. Phil., vol. IV, 2nd ser., p. 393, pl. 68, fig. 22.

Meretric riplejana Harris, 1896, Bull. Amer. Pal., vol. I, No. 4, p. 67, pl. 6, fig. 6. Inequilateral; beaks small, anterior; cardinal margin strongly curved, anterior semicircular, basal and posterior regularly rounded, surface marked by regular transverse ribs.

Dimensions.—Length .55 in., width .7 in., diameter .38 in.

Locality.—Ripley Group, Hardeman Co., Tenn.—[Prof. Safford.]

This species may be distinguished from *Dione Delawarensis*, Gabb, in its external appearance, by being shorter proportionally, and more pointed posteriorly. The surface markings are different, those of the latter species being finer and not so regular.—[Gabb, 1860.]

Nearly all the type specimens of this species were from a clay bank 2 miles S. S. E. of Middleton, Tenn. One specimen, however, is from 2 miles E. of Middleton, and another is from the limestone on Muddy creek. The specimen that Gabb used in his description and which he figured is probably the one now represented by the blue clay filling, the shell having been exfoliated. However, several other fairly well preserved specimens show the character of the species. One is figured herewith. This is perhaps not quite so elongated as the majority of the specimens; there seems to be considerable variability in this regard. The concentric rugæ are fairly strong and regular from the middle of the valve downwards, while upwards towards the beaks the shell is nearly smooth. All the specimens from Dr. Safford are approximately the same. The lunule is rather narrow and long, giving that margin of the shell an unusual straightness from the umbo to the anterior end.

In Georgia, casts of this species occur at the base of the Midway on the Chattahoochie river, and thence to the mouth of Sandy creek. Another slightly larger variety occurs in the cuts north of Snow Hill, off-set of the section p. 31.—[Harris, 1896.]

Prof. Harris studied the types of Gabb's species and since we have not been able to get further data on the specimens we quote his discussion of the species.

The genus is not determined with certainty. The appearance of the

specimens from the figures is like that of *Pitaria*. The species is described as having fairly, strong, concentric ribs. This character approaches the feature of *Lamelliconcha* but not having specimens for study we only suggest such a grouping.

Proterotypes.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Midway Eocene. Hardeman County, Tennessee.

PITARIA (PITARIA) EVERSA (Conrad)

Plate IV, Figures 10, 13, 21

Cytherea eversa Conrad, 1844, Proc. Acad. Nat. Sci. Phil., vol. 2, p. 174; Conrad, 1848,

Jour. Acad. Nat. Sci. Phil., 2nd. ser., vol. I, p. 130, pl. 14, fig. 21.

Dione eversa Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Suborbicular or lentiform, ventricose; surface with fine, closely arranged concentric lines; anterior and posterior extremity rounded; basal margin profoundly rounded, and forming a regular curve from the extremities; umbo broad, with a prominent apex; lunule ovate-acute, marked by a well defined impressed line; cardinal teeth robust. Length $1\frac{3}{4}$ inch. Height $1\frac{1}{2}$ inch.

Locality.—Marlbourne, Hanover county, Virginia.

This shell has much the exterior aspect of an *Artemis*. Mr. Ruffin has one specimen with both valves. It occurs at Marlbourne, the residence of Edmund Ruffin, Esq., who is making important investigations in the Eocene deposits of that locality. He has kindly sent me beautiful specimens of *Cardita planicosta* and *Cardium Nicolleti*, together with the new species of *Cytherea* above described.—[Conrad, 1844.]

The proterotype material at the Academy of Natural Sciences, Philadelphia, is represented by two right valves. One of these specimens is figured in this report. That specimen is broken so we have figured also a whole specimen from the Cornell collection.

Dimensions.—44 ? mm. length; 38 mm. height; 15 mm. semidiameter.

Holotype.—No. 4132. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Eocene. Marlbourne, Hanover county, Va. (Type).
Mouth of Potomac Creek, Va. (Cornell Univ. Pal. Lab.)

PITARIA (PITARIA) LENIS (Conrad)

Plate IV, Figure 7

Cytherea lenis Conrad, 1848, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. I, p. 130, pl. 14, fig. 19.

Dione lenis Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Meretrix lenis Clark and Martin, 1901, Md. Geol. Sur., Eocene, p. 168, pl. 33, fig. 4.

Longitudinally ovate, thin ventricose; anterior extremity acutely rounded; posterior end direct, subtruncated; disk with impressed concentric lines, distinct on the sides but obsolete in the middle of the valves; lunule long, cordate, defined by an impressed line; inner margin entire.

Locality.—Occurs with the preceding.—[Conrad, 1848.]

This species has not been found. Clark and Martin figure a specimen from Woodstock, Maryland, and give additional notes on the species. We include the original figure in this paper.

Occurrence.—Eocene. Marlbourne, Hanover county, Va. (Type.)

PITARIA (PITARIA) OVATA (Rogers)

Plate IV, Figures 3, 4, 20

Cytherea ovata Rogers, 1836, Trans. Amer. Phil. Soc., n. s., vol. 5, p. 340; Rogers, 1839, *ibid.*, vol. 6, pl. XXVII, fig. 2; Reprint, Geology of the Virginias, 1884, p. 668, pl. 11, fig. 2.

Meretrix ovata Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 30.

Dione ovata Conrad, 1865, Amer. Jour. Conch., vol. 1, p. 6; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

? *Cytherea liciata* Conrad, 1848, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. I, p. 130, pl. 14, fig. 20; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Meretrix ovata Clark and Martin, 1901, Md. Geol. Sur., Eocene, p. 168, pl. 34, fig. 1. Shell subovate, somewhat inflated, with concentric transverse stria, very fine near the umbones, but much coarser near the margin; beaks rather elevated; lunule very indistinct; teeth elevated and straight, the two posterior ones of the left valve small, much compressed, approximate, and nearly parallel; the anterior tooth large and grooved by a deep canal; cavity of shell deep; margin entire; posterior margin straight, and separated from the muscular impression by a fold or groove. Length, one inch and one-tenth; height, eighty-five hundredths of an inch.

Locality.—Coggins Point, in the Eocene green sand.—[Rogers, 1836.]

Specimens of *P. ovata* from the type locality, Coggins Point, Va., were not found at the Academy of Natural Sciences, at Philadelphia, but specimens were found in the Conrad collection from Pamunkey River, Va., and from Maryland. The specimen figured from the Cornell collection was compared with the Academy specimens which seem to be what Rogers had in mind. The Cornell collection contains material from Coggins Point but the specimens are in the form of casts. Several of these seem to be *P. ovata*.

It is difficult to separate *P. ovata* and young specimens of *P. pyga* and it may be that they are the same species. They both tend to have a broad posterior end and the dorsal line slightly straight. *P. pyga* becomes two times or more the size of *P. ovata*. Conrad described *Cytherea liciata* which has not been identified by specimens. The illustration by Conrad resembles somewhat *P. ovata*. The original figure of *P. liciata* has been included, pl. IV, fig. 6.

Holotype.—?

Occurrence.—St. Maurice Eocene. Coggins Point, Va. (Type); Newcastle, Va., Potomac Creek, Va., Fort Washington, Md. (Cornell Univ. Pal. Lab.)

PITARIA (PITARIA) PYGA (Conrad)

Plate IV, Figures 9, 11, 17

Cytherea pyga Conrad, 1844, Proc. Acad. Nat. Sci. Phil., vol. 2, p. 174; Conrad, 1848, Jour. Acad. Nat. Sci. Phil., n. s., vol. I, p. 131, pl. 14, fig. 18.

Meretrix pyga Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 30.

Dione pyga Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6.

Cytherea ovata Clark, 1895, Johns Hopkins Univ. Circ., XV, p. 5; (in part) Clark, 1896, U. S. Geol. Sur., Bull. 141, p. 76, pl. XVI, figs. 1a-1f.

Cytherea ovata var. *pyga* Clark and Martin, 1901, Md. Geol. Sur., Eocene, p. 169, pl. 34, figs. 2, 3, 4, 5.

Suboval, ventricose, thick, with closely arranged robust concentric lines; umbo wide, prominent above; dorsal margin very oblique, rounded; posterior extremity obtusely and obliquely rounded inwards; anterior extremity much narrower than the posterior, and acutely rounded; lunule lanceolate, defined by a distinct impressed line; cardinal teeth robust. Length $1\frac{3}{8}$ inch. Height $1\frac{1}{4}$ inch.

Locality.—Potomac river, Stafford county, Virginia.—[Mr. Bruff.]

I am indebted to Mr. Bruff, of Washington, for an opportunity to describe this species. The specimen is a right valve, very perfect, and in outline has some resemblance to *C. licata*, but is larger, thicker, more ventricose, with much wider umbones, &c.—[Conrad, 1844.]

This species is very common in the Virginia and Maryland Eocene Basin. In size it approaches *P. eversa* but it does not become as large as that species. It differs from *P. eversa* in being less oval and less high. The posterior end is subquadrate and the length is greater than the height. The height and length of *P. eversa* are nearly equal.

Metatypes.—Academy of Natural Sciences, Philadelphia, Pa.

Dimensions.—36 mm., length; 30 mm., height; 13 mm., semidiameter.

Occurrence.—St. Maurice Eocene. Potomac River, Va. (type): below City Point, Radcliff, Aquia Cr., Va., Marlboro, Fort Washington, Md. (Cornell Univ. Pal. Lab.)

PITARIA (PITARIA) NUTTALLIOPSIS (Heilprin)

Plate II, Figures 1, 3, 5, 6, 11, 17

Cytherea Nuttalliopsis Heilprin, 1880, Proc. Acad. Nat. Sci. Phil., vol. 32, p. 370, pl. 20, fig. 1; Aldrich, 1886, Bull. Ala. Geo. Sur., vol. 1, pp. 53, 57.

Meretrix nuttalliopsis Harris, 1897, Bull. Amer. Pal., vol. 2, No. 9, p. 61.

Meretrix cf. nuttalliopsis Maury, 1912, Jour. Acad. Nat. Sci., 2nd ser., XV, p. 55, pl. IX, fig. 8.

Shell sub-elliptical, moderately ventricose, its surface covered with fine concentric striae, which are apt to become roughly imbricate on the basal margin; umbones not very prominent, rather anterior; lunule cordate, deeply impressed at about its middle, its outline clearly pronounced by a sharply impressed line; posterior extremity regularly rounded, the anterior somewhat produced; margin entire; pallial sinus somewhat angular, pointing toward the centre of the shell.

Length, $1\frac{1}{2}$ inch. Knight's Branch, Clark Co., Ala.

This species most resembles among American species of *Cytherea* the *C. Nuttalli* Conr., from which it may be distinguished by the greater production forward of the anterior extremity, and by the median depression in the lunule. In this last character it agrees with *C. Poulsoni*, Conr., from which, however, it very materially differs in form, and in the much lesser development of the umbones.—[Heilprin, 1880.]

Specimens which Heilprin described of this species from Knight's Branch, Clarke County, Ala., seem to be intermediate in size considering the entire development of the species in the Sabine Eocene. Specimens from Gregg's Landing, Ala., show typical characters of *P. nuttalliopsis* but they are small in size while specimens from the upper part of the upper Sabine at Wood's Bluff attain the maximum dimensions of 50 mm. in length, height 38 mm. and semidiameter 15 mm. The posterior end in the Wood's Bluff forms tends to become truncate.

Pitaria nuttalliopsis represents a common and well developed stock of Eocene Veneridæ in the southern North American Basin. It is the recognizable initiation of the *nuttalliopsis-nuttalli* stock. Casts occur in

the Midway Eocene which are probably the progenitors of this species but the remains are too poor for one to be definite on such a point. Varietal forms of *nuttalliopsis* occur in the Sabine Eocene, while in the St. Maurice and Claiborne stages forms of *nuttali*, *cornelli*, *poulsoni* develop which show a maximum of size. In the Jackson Eocene the stock is represented by *securiformis* which in many cases resembles *nuttalliopsis* to a very marked degree.

Dimensions.—Holotype, 33 mm., length; 28 mm., height; 10 mm., semidiameter.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Sabine Eocene. (Type) Knight's Branch, Clarke Co., Ala. Gregg's Landing, Bell's Landing, near mouth of Bashi Creek, Ozark, Thomasville, 4 miles above Hamilton Bluff, Wood's Bluff, Ala. (Cornell Univ. Pal. Lab.)

PITARIA (PITARIA) NUTTALLIOPSIS GREGGI (Harris)

Plate II, Figures 2, 4, 10

Meretric nuttalliopsis Harris, 1896, Acad. Nat. Sci. Phil., vol. 48, p. 477, pl. 22, figs. 1, 2. Erroneously written *M. mortoniopsis* l. c. p. 477.

Meretric nuttalliopsis var. *greggi* Harris, 1897, Bull. Amer. Pal., vol. 2, No. 9, p. 62, pl. 13, figs. 1, 2.

The figures represent two well-preserved specimens of this species from the Lower Lignitic. It seems well to have them accurately figured, since their relationship to the species of this genus described by Rogers and Conrad from Virginia is still in an unsettled state.

Locality.—Bell's Landing, Ala.—[Harris, 1896.]

Descending in the geologic scale to Bell's and Gregg's landings and Lower Peach Tree, somewhat wider variations are met with. The forms more rotund posteriorly, probably females (pl. 13, fig. 1) have a close resemblance to *nuttalliopsis*, while the specimens more pointed posteriorly, probably males, (pl. 13, fig. 2) would not at first sight be placed under this species.—[Harris, 1897.]

The forms of this variety which Prof. Harris has suggested might be males, present characters which make them separated easily from typical *P. nuttalliopsis*. The posterior end is pointed markedly. The concentric striæ are heavier and they extend equally over the whole surface of the shell. This variety occurs in the higher sediments at Sabinetown, Texas. The ribs become even more regular, sharp and conspicuous which is an initial development of the sculpture of *Lamelliconcha*. Unless the relationship of shape to *nuttalliopsis* var. *greggi* had been noted in the lower beds one would be inclined to regard the specimens of specific rank, (plate II, figure 2).

The forms indicated as females in the original discussion are not distinguished so easily from *P. nuttalliopsis*. They are smaller. However, when compared with small or young specimens from the Wood's Bluff collection, the resemblance is very close (pl. II, figs. 1, 5). Therefore we have not included those forms under this variety.

Dimensions.—30 mm., length; 21 mm., height; 9 mm., semidiameter.

Holotype.—Lea Memorial Collection, Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Sabine Eocene. Bell's Landing, Gregg's Landing, Lower Peach Tree, Ala.; Sabinetown, Pendleton, Texas. (Cornell Univ. Pal. Lab.)

PITARIA (PITARIA) NUTTALLIOPSIS FULVA (Harris)

Plate II, Figures 9, 13

Meretrix nuttalliopsis Heilprin var. *fulva* Harris, 1897, Bull. Amer. Pal., vol. 2, No. 9, p. 62, pl. 12, figs. 8-10.

At Yellow Bluff on the Alabama, and at Ft. Gaines, Ga., a variety occurs still farther separated from the typical form. Here also two mutations are observable, probably owing to sex, one rounded posteriorly, the other more or less pointed. Fig. 10 shows the blunt form, young, fig. 9 the pointed form, young, fig. 8 an adult. This form is unusually developed anteriorly, and has a tendency to become inflated or bulged up along the umbonal ridge. The reason for not giving a new specific name to this marked variety is, that some of its phases are indistinguishable from certain forms of *greggi*, and the latter is certainly but a variety of *nuttalliopsis*. The intimate relationship, or perhaps specific identity of this species with *Meretrix ripleyana* Gabb, will doubtless be satisfactorily proven. Likewise its identity with *M. ovata* Rogers, and other Virginian forms will probably be shown.—[Harris, 1897.]

Dimensions.—34 mm., length; 30 mm., height; 11 mm., semidiameter.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Sabine Eocene, Yellow Bluff, Ala.; Ft. Gaines, Ga.

PITARIA (PITARIA) NUTTALLIOPSIS HEILPRINI n. var.

Plate II, Figure 8

Shell short, subovate with the umbones high and very full, otherwise as in the typical form. Were it not for the fact that there are several specimens of this variety in the collection it might be taken as a stunted shell. Typical specimens which measure the same in height as this variety are from 3 to 7 mm. more in length.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Upper Sabine Eocene. Wood's Bluff, Ala.

PITARIA (PITARIA) NUTTALI (Conrad)

Plate III, Figures 2, 7, 13

Cytherea Nuttali Conrad, 1834, Jour. Acad. Nat. Sci., Phil., vol. VII, p. 149.

Meretrix nuttali Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 60 not *Cytherea Nuttali* Conrad, 1857, Rept. U. S. Mex. Bound. Sur., vol. I, pt. 2, p. 162, pl. 4, fig. 5 = *P. trigoniata* var. *bastropensis* Harris.

Dione Nuttali Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7, in part.

Cytherea nuttali Heilprin, 1880, Proc. Acad. Nat. Sci., vol. 32, p. 370; Conrad, 1833, Fos. Sh. Tert. Form., Harris, Reprint, 1893, pl. 19, fig. 1; De Gregorio, 1890, Ann. de Geol. et de Pal., 7 et 8 liv., p. 219, pl. 34, fig. 23; Heilprin, 1890, Proc. Acad. Nat. Sci., vol. 42, p. 402; Harris, 1895, Bull. Amer. Pal., vol. I, No. 1, p. 30. *Meretrix nuttali* Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 143, pl. 45, fig. 4 (5-8 vars.).

Shell subcordate, ventricose, with crowded elevated acute concentric lines on the inferior portion, obsolete above; beaks prominent, lunule cordate, merely defined by an obscure impressed line; cavity of the umbo capacious.

Locality.—Claiborne, Alabama.

This species resembles *C. Poulsoni*, nobis, (*C. globosa*, Lea.) but differs in its striae and in the beaks which are not so greatly curved forwards. It is smaller than the *Poulsoni*. I dedicate it to Nuttall, the distinguished naturalist.—[Conrad, 1834.]

Conrad's figure of this species, pl. III, fig. 7, (pl. 19, fig. 1 of Harris Reprint Fos. Shells) does not show a socket for an anterior lateral tooth. The type specimen has an anterior lateral. The sculpture consists of fine, sharp, concentric ribs which are thicker and sharper ventrally.

Dimensions.—Holotype, 43 mm., length; 37 mm., height; 15 mm., semidiameter.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Claiborne Eocene. Claiborne, Ala.

PITARIA POULSONI (Conrad)

Plate III, Figures 9, 10, 11, 12

Cytherea Poulsoni Conrad, 1833, Foss. Sh. Ter. Form., p. 36 (*not* pl. 19, fig. 1), Harris, Reprint, 1893, pl. 20, fig. 7.

Cytherea globosa Lea, 1833, Cont. to Geol., p. 65, pl. 2, fig. 40.

Meretrix poulsoni Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 30.

Dione Poulsoni Conrad, 1865, Amer. Jour. Sci., vol. I, p. 6; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Cytherea Poulsoni De Gregorio, 1890, Ann. de Geol. et de Pal., 7 et 8 liv., p. 216, pl. 34, figs. 11-13.

Meretrix Poulsoni Cossmann, 1893, Ann. de Geol. et de Pal., 12 liv., p. 10.

Cytherea poulsoni Harris, 1895, Bull. Amer. Pal., vol. I, No. 1, p. 36.

Meretrix poulsoni Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 144, pl. 40, figs. 3-5.

Shell ventricose, cordate, with fine concentric striae; beaks prominent, curved towards the lunule, which is heart shaped; cavity of the beaks very deep. Diameter about 2 inches, the length and breadth being nearly equal.

The beaks are not unlike those of *Isocardia*, and the shell resembles *C. Sayana*, (*nobis*) but the latter wants the concentric striae. I dedicate this shell to my kind friend, Mr. Charles A. Poulson.

Locality.—Claiborne, Ala.

Cab. Acad. N. S.—[Conrad, 1833.]

The shell is short and high with large, recurved beaks; the lunule is very large and sunken beneath the beak.

Dimensions.—40 mm., length; 36 mm., height; 15 mm., semidiameter.

Proterotypes.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Claiborne Eocene. Claiborne, Ala. (Type); Shell Bluff, Ga. (Cornell Univ. Pal. Lab.)

PITARIA (PITARIA) TEXACOLA (Harris)

Plate II, Figures 18, 19

Meretrix texacola Harris, 1895, Proc. Acad. Nat. Sci. Phil., vol. 47, p. 50, pl. 2, fig. 5; Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 142, pl. 44, figs. 13-15.

Size and general forms as indicated by the figures; surface generally smooth about the umbones, but often more or less corrugated concentrically towards the base, especially posteriorly; lunule in the larger specimens, very indistinct in the smaller forms bordered by a well incised line.

The surface markings resemble somewhat those of *C. nuttalliopsis* Heilp., but the anterior and posterior are too pointed, the shell in general too inflated, and the umbonal angle too great for that species. The larger specimens resemble *M. californica* Con.—[Harris, 1895.]

(The part of the original description which is omitted here is the list of localities given below.)

Occasional specimens of medium size, referable to this species, seem to practically connect such nearly related forms as *nuttalliopsis*, *nuttali*, and varieties of *securiformis*; hence, in a sense, most of these designations might be regarded as varietal. In Texas, we formerly designated the smaller, longer forms (pl. 45, figs. 2, 3), as var. *tornadonis*. Another Texan form simulating in type of exterior marking the *mortoni* of Conrad is shown by fig. 1. It seems, however, to be simply a sport from the *texacola* stock.—[Harris, 1919.]

This species may be recognized easily by the increased production of the anterior end. Variation in the strength and amount of the concentric striae or growth lines occurs in most of the species of the *Pitaria* group, depending on conditions.

Holotype.—Texas State Museum, University of Texas, Austin, Texas.

Occurrence.—St. Maurice Eocene. Rio Grande at Webb-Zapata county line, Smithville, Bastrop Co.; 2 miles E. of Alto, Cherokee; Moseley's Ferry, Brazos Co.; Cedar Cr., Robertson Co.; Alum Bluff, Trinity River; Hurricane Bayou, Houston Co.; Collier's Ferry, Brazos River, Burleson Co., Texas; three miles S. E. of Negreet; Simpkin's Place, Clear Lake; Marble Quarry, Louisiana; Wautubbee, Mississippi; Hamilton Bluff, Lisbon, base of Claiborne Bluff, Claiborne, Alabama; Center Hill, South Carolina; Rocky Landing, Neuse River, North Carolina. (Cornell Univ. Pal. Lab.)

PITARIA (PITARIA) TEXACOLA TORNADONIS (Harris)

Plate II, Figures 7, 21

Meretrix texacola var. *tornadonis* Harris, 1919, Bull. Amer. Pal., vol. 6; No. 31, p. 142, pl. 45, figs. 2, 3.

The anterior production is as in *P. texacola*; the posterior end is narrower and more elongate; the dorsal line is less convex.

Holotype.—Texas State Museum, University of Texas, Austin, Texas.

Dimensions.—45 mm., length; 35 mm., height; 26 mm., thickness.

Occurrence.—St. Maurice Eocene. South Fork of Hurricane Bayou, Houston Co., Texas. (Type) Base of bluff at Claiborne, Ala.

PITARIA (PITARIA) CORNELLI (Harris)

Plate III, Figures 4, 5, 6, 8

Meretrix cornelli Harris, 1895, Bull. Amer. Pal., vol. 1, No. 1, p. 49, pl. 1, fig. 5; Harris, 1919, *ibid.*, vol. 6, No. 31, p. 144, pl. 46, figs. 1-2.

The specimen herewith figured is the second of the kind known to the writer; the first belongs to the U. S. National Museum and was collected by L. C. Johnson, formerly of the U. S. Geol. Survey. The species is characterized by its large size (natural in the figure), its rhomboidal form,—the obtuse angles at beak and base, the acute at either extremity,—the smooth exterior with lines only about the margins, and the plain V shaped pallial sinus.

Type.—Harris's collection.—[Harris, 1895.]

This species rivals in size *P. nuttali*. It differs from the latter in the

lower, smaller and less full umbones and in a greater production of the anterior end. In those characters it is like *texacola*, but differs from that species in size and shape.

A connected series showing variation in the size of the umbones is illustrated by figures 4, 6 and 8, plate III. Figure 8 is the type specimen with a full umbo, a more convex, dorsal line, a broader and more rounded posterior end than *P. nuttali*. Figure 4 is a specimen which has about the same posterior, dorsal convexity as the type but is slightly less full in the umbonal region. This gives the appearance of a more attenuated, anterior end. Figure 6 is a specimen which has a greater reduction in the umbonal region which increases the anterior production. The posterior end retains a close specific resemblance.

Dimensions.—59 mm., length; 52 mm., height; 16 mm., semidiameter.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Claiborne Eocene. Claiborne "sand," Claiborne, Ala.

PITARIA (PITARIA) ANGELINÆ (Harris)

Plate IV, Figures 16, 19

Meretrix angelinæ Harris, 1919, Bull. Amer. Pal., vol. 8, No. 33, p. 17, pl. 2, figs. 12, 13.

Shell large (65 x 54 x 15 mm.) and oblong, as indicated by the figures; anterior somewhat extended as *Cornelli* but posterior not with broad circular sweep of concentric lines; but with more or less of a rectilinear truncation; pallial sinus small, V-shaped; anterior muscular scar sharply defined, posterior scarcely visible; a few obscure radiating ridges internally and a few radiating lines.

This large species, (figures somewhat less than life size,) is found in the state of casts and impressions in sandy ironstone fragments gathered by A. C. Veatch along the Angelina River, Angelina County, Texas, 2 miles above Marion.

It seems very different from anything with which we are acquainted in the lower Eocene beds, and is here associated with an abundance of *Anomia*, (also *Plicatula filameatosa*, *Ostrea* var. *vermilla*, *Spaerella bulla* and *anteproducta*.) reminding one strongly of the St. Maurice beds of Louisiana; also a small, smooth *Pecten*; but most telling among its associates are *Haminea grandis*, *Pleurotoma creno-strinata* Heilp., of Jackson age; but one of the most abundant species is *Rimella* cf. *texana*, a St. Maurice form. A *Fusoficula* and an unusually large *Tornatina* are among the undescribed associates (—).

Types.—Deposited in the Paleont. Mus., Cornell Univ.—[Harris, 1919.]

Along the posterior, dorsal margin a small area of concentric ribs occurs but the shell appears to have been smooth over the remaining portions. The impression of the hinge is exposed in the cast showing the cardinals, anterior lateral and pallial sinus of *Pitaria*. Since it was probable that the greater portion of the shell was smooth we have placed the species in *Pitaria* s. s.

Occurrence.—Eocene.

PITARIA (PITARIA) SECURIFORMIS (Conrad)

Plate II, Figures 12, 14, 15

Dione securiformis (Conrad), 1865, Amer. Jour. Conch., vol. I, p. 137, pl. 10, fig. 1.

Subcordate, ventricose, with concentric recurved ribs; anterior margin acutely

rounded; posterior extremity subtruncated; lunule cordate, defined by a slightly impressed line; right valve-cardinal teeth approximate, curved, direct.—[Conrad, 1865.]

The majority of the specimens of this species have a slight truncation posteriorly. They resemble *P. nuttalliospsis* of the Sabine. *P. securiformis* may be distinguished from *nuttalliospsis* by the increase in the size of the beaks, as well as the beaks being more recurved. The anterior end in the lunular region is shortened. The differences between the two species are slight. The increase in the size of the umbo in the Jackson species is the only practical difference.

The type locality of the species is Garland's Creek, Miss. and not Enterprise as stated by Conrad (see Amer. Jour. Sci., vol. 30, p. 307, 1885).

Dimensions.—40 mm., length; 32 mm., height; 27 mm., semidiameter.

The name of *Cytherea profunda* has been used for this species by later authors in lists and on labels in the Academy of Natural Sciences collection. It, as far as we can find, is only a museum label name.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Jackson Eocene. Garland's Creek, Jackson, Miss.; Montgomery, Dansville Landing, 1/2 mile below Gibson's Landing, La. (Cornell Univ. Pal. Lab.)

A specimen occurs in the collection of Jackson Eocene from Montgomery, La., which appears to be a mutation. If it occurred in the middle Eocene it would be placed as a variety of *P. poulsoni* without question. The length is short and the shell is extremely high with an overproduction of the beaks. The latter character which is more than normal inclines one to believe the shell is a sport. 41 mm., length; 40 mm., height; 17 mm., semidiameter (plate II, figures 16, 20).

? PITARIA NUX (Dall)

Plate V, Figure 10

? *Callocardia nux* Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 147, pl. 18, fig. 3, not *Caryatis nux* Römer, 1869, = (*P. rudis*).

Shell small, equivalve, the beaks, near the anterior third, moderately convex, short-ovate, the surface smooth except for faint incremental lines; beaks low, pointed, prosocœlous, a large lanceolate lunule in front of them which is not impressed but circumscribed by a sharply incised line; there is no escutcheon; anterior slope roundly descending, ends of the shell evenly rounded, base prominently arcuate; anterior inaccessible. Height of shell 12, length 14, diameter 7 mm.

Tampa silex beds at Ballast Point, Tampa Bay, Florida. U. S. Nat. Mus. No. 166115.

This simple little shell has no pronounced characteristics but is distinct from any of the other Veneridæ known from this or adjacent formations.—[Dall, 1915.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Tampa silex beds, Ballast Point, Tampa Bay, Florida. (Dall.)

PITARIA (PITARIA) SINCERA (Dall)

Plate V, Figure 24

Callocardia (Agriopoma) sincera Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1260, pl. 55, fig. 12; Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 146, pl. 25, fig. 7.

Oligocene of the Chipola horizon at Alum Bluff and on the Chipola River, and probably at Ballast Point, Tampa Bay, in the siliceous beds.

Shell small, short, ovate, very slightly rostrate behind, with low, pointed, anteriorly directed beaks and a large lanceolate lunule defined by an incised line; surface finely, closely, concentrically wrinkled, with two obscure ridges radiating from the beaks behind, of which the anterior one forms a slight angle where it intersects the base; hinge solid, normal; posterior right cardinal bifid; posterior dorsal margin deeply grooved to receive the bevelled edge of the opposite valve; pallial sinus short, angular, ascending. Length 20.75, height 17.5, diameter 10.0 mm.

This species, though much smaller and with the sculpture more clean-cut, has the general features of *C. Sayana*, which succeeds it in the Miocene and of which it may be regarded as the precursor. The slightly pointed and rostrate posterior end is peculiar to it.—[Dall, 1903.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Probably, at Ballast Point, Tampa Bay, in the siliceous beds, Florida Miocene; Chipola horizon at Alum Bluff and on Chipola River, Florida. (Dall.)

PITARIA (PITARIA) RIOCOLLAZICA (Maury)

Plate VI, Figure 2

Callocardia riocollazica Maury, 1920, N. Y. Acad. Sci. Sur., Porto Rico and Virgin Is., vol. III, pt. 1, p. 40, pl. VI, fig. 9.

Shell rather small, cordate, moderately convex, beaks rather low and curving forward over the small lunule. Hinge characters concealed by the matrix, hence the reference of the shell to this genus is tentative. Surface sculpture of the very fine, even ridges barely seen without a lens. Length of shell 28 mm., altitude 20 mm., semidiameter 8 mm.

Callocardia gatunensis Dall from the Miocene of the Isthmus and of Santo Domingo, is larger and the curve of the anterior basal margin is quite unlike that of the Porto Rican shell.

Locality.—Rio Collazo near San Sebastian, Station 53.—[Maury, 1920.]

Holotype.—American Museum of Natural History. New York, N. Y.

Horizon.—Middle Oligocene. (Maury.)

PITARIA (PITARIA) SAPOTENSIS (Gabb)

Plate V, Figures 25, 26

Meretrix sapotensis Gabb, 1881, Acad. Nat. Sci. Phil., Jour., n. s., vol. VIII, p. 343, pl. 44, fig. 15.

Shell moderately large, convex, thin; inequilateral, the small strongly incurved beaks being about a third of the total length from the anterior end, which is narrow and produced, most prominent a little above the middle and sloping up nearly straight to the beaks with a very faint convexity in the lunular region. Posterior cardinal margin broadly curved and sloping to the end of the shell, which is broad and round; base forming almost a third of a circle, not perfect in outline however, being a little more prominent near the front edge of the pallial sinus, and also being markedly straightened as it slopes upwards in front. Surface marked by small concentric ribs, evidently polished when alive. The lunule, rather large, is bordered by an impressed line, so faint as only to be visible with a glass in certain directions of reflected light. Internal margin smooth; pallial sinus small and angular.

Figure.—Natural size.

Locality.—Sapote, Costa Rica, where I found only the specimen figured. The generic determination given above is, I believe, correct; although I cannot be positive. The shell is crystalline and imbedded in tough sandstone. I succeeded in uncovering a portion of the hinge, and the teeth, so far as I could see, warrant my determination.—[Gabb, 1881.]

Gabb's description and figure of this species is good. We have figured the holotype. The illustration of the anterior end of the shell, (pl. V, fig. 25) does not show the details of the shell but gives the relative convexity of the specimen.

Dimensions.—Holotype. 47 mm., length; 39 mm., height; 20 mm., semidiameter.

Holotype.—No. 3489, Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Miocene. Sapote, Costa Rica.

PITARIA (PITARIA) SAYANA (Conrad)

Plate IV, Figures 1, 2, 5, 8, 12, 14, 15, 18

Plate V, Figures 11, 15, 19, 23, 27, 28

Cytherea convexa Say, 1824, Jour. Acad. Nat. Sci. Phil., 1st ser., vol. IV, p. 149, pl. 12, fig. 3 (Harris Reprint, 1896, Bull. Am. Pal., vol. I, No. 5, p. 325) not of Brongniart, in Cuvier, "Ossemens fossiles," 1811, vol. 11, pl. 8, fig. 7.

Cytherea sayana Conrad, 1833, Amer. Jour. Sci., vol. 23, p. 345; Conrad, 1834, Jour. Acad. Nat. Sci. Phil., 1st ser., vol. VII, p. 124; Conrad, 1838, Fos. Med. Ter., p. 13, pl. VII, fig. 3, (Conrad's figure not the same as figure of Say).

Cytherea convexa Gould, 1841, Inv. Mass., p. 84; 2nd ed., 1870, p. 131.

Meretrix sayana Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. VII, p. 30.

Venus sayana Tuomey and Holmes, 1857, Pleiocene Fos. S. Car., p. 83, pl. 21, fig. 9.

Cytherea sayana Emmons, 1858, Geol. Rep. N. Car., p. 294, f. 221.

Dione sayana Conrad, 1862, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 10.

Cytherea convexa Conrad, 1870, Amer. Jour. Conch., vol. VI, p. 200.

not *Cytherea convexa* Guppy, 1874, Geol. Mag., vol. 11, p. 442.

?*Cytherea sayana* Heilprin, 1886, Trans. Wag. Inst. Sci., vol. I, p. 116.

?*Cytherea sayana* Heilprin, 1887, Proc. Acad. Nat. Sci. Phil., vol. 39, p. 401; Dall, 1892, Nautilus, vol. VI, p. 52.

Dione sayana Whitfield, 1894, U. S. Geol. Sur. Mon., No. 24, p. 75, pl. XII, f. 1 (Copy of Say's figure).

Caryatis plionema Conrad, 1868, Amer. Jour. Conch., vol. IV, p. 278, pl. 20, f. 3.

Culloccardia (Agriopoma) sayana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1262, pl. 54, fig. 16; Glenn, 1904, Md. Geol. Sur., Mic., p. 313, pl. 73, figs. 13a, 14; Gardner and Aldrich, 1919, Proc. Acad. Nat. Sci. Phil., vol. 71, p. 19.

Shell subcordate; elevated convex, concentrically wrinkled, inequilateral; posterior tooth and fosset not striated; edge not crenated; umbo rather prominent; lunule dilated, cordate, marked by a simple line.

Length one inch and a tenth, breadth more than one inch and three-tenths.

On the inner surface of the shell is a prominent line in one valve, proceeding from the extremity of the impression of the retractor muscle, and becoming obsolete behind the cavity of the umbo; on the opposite valve is an impressed line, occupying a similar position. Whether or not this line is characteristic, I am unable to determine, having seen but two valves.—[Say, 1824.]

Shell subovate, variable in shape; posterior more rounded on some shells and more produced on others; umbones moderate; ventral margin regularly rounded; anterior and posterior ends evenly rounded, slightly narrowed; lunule large, marked by a line; hinge and pallial sinus typical of the genus; surface of the shell smooth except for heavy, concentric lines of growth.

The line which Say mentions in his description, as occurring on the inner surface from the extremity of the retractor muscle becoming

obsolete behind the cavity of the umbo, is a raised line which occurs along the inner side of the anterior margin of the right valve in the region of the lunule or just in front of and below the anterior lateral tooth. In the opposite valve this ridge fits into a groove. This ridge and corresponding groove occur in many a *Pitaria*. It is not a specific character and is not constant. It may be seen distinctly or it may be obscure.

This species was one of the shells from a collection obtained and sent to Say by Mr. John Finch from Maryland. Say, in his description and notes, does not mention a definite locality.

In an essay with Cuvier in "Ossements fossiles" volume II, pt. 2, 1811, Alexander Brongniart had figured a *Cytherea convexa*, pl. 8, fig. 7. This was since identified as *Cyrena semistriata* of Deshayes. (Dall, Nautilus, 1892, p. 52.) It was this that Conrad had in mind when in 1883, he changed the name of *convexa* to *sayana* including also the recent species of the Atlantic coast. The fossil and recent shells at that time were considered to be the same. Later Conrad in his Medial Tertiary Fossils figured a shell of *sayana*, but his figure and that of Say do not represent the same variation in shape of this species. It may be true that Conrad's shell represents the most common form of the species and the most generalized shape, but since the species is very variable and Say's figure must always be used for true identification, it is that form which we use as the type of the species.

Comparing material from numerous localities throughout the Upper Miocene of the Chesapeake region this species appears to be inconstant in the character of shape. If the figures which the various authors have used to illustrate this species are compared the diversity is very well shown. Because of the variability it seems best to call them all the same species, designating for methods of convenience the more extreme forms as varieties. Although Say's figure does not represent the most common shape, nevertheless it must stand as the type of the species. *C. plionema* of Conrad is an adult form, slightly more triangular than the figure of *sayana* Conrad. For *C. subnasuta* Conrad we can not find more than varietal differences since gradations can be found to link it with other forms.

Occurrence.—LOWER MIOCENE. Oak Grove, Santa Rosa County, Fla. (Dall) ? Ballast Point, Fla. (Heilprin '86); UPPER MIOCENE. *Calvert Stage.* Calvert Cliffs, Md. (var. *subnasuta* Con.), Plum Point, Md. (var. *prunensis* Glenn); Walkertown, Va. (Va. Sur. Bull. IV, '12.) *Choptank Stage.* Jones Wharf, Choptank River near Easton, Md. (Cornell Univ. Pal. Lab.) Peach Blossom Cr., Md. *St. Mary's Stage.* Cove Point, St. Mary's River, Bowler's Wharf, Md., (Cornell Univ. Coll.) $\frac{1}{4}$ mile below Jones Point, Va. (Va. Sur. Bull. IV, '12.) *Murfreesboro Stage.*

Petersburg, Kingsmill, Va., Cornell Univ. Coll. *Yorktown Stage*. Yorktown, Bellefield, Chocowinity, Jenny's near Suffolk, Bluff at Standard Oil bank near Suffolk, Jacks' Bluff on Nansemond River, Va. (Cornell Univ. Coll.), Smithfield, Chuckatuck, Va. (Va. Sur. Bull., IV, '12); Tar Ferry, N. C. (Cornell Univ. Coll.) *Duplin Stage*. Natural Well, Wilmington, N. C., (Dall); Muldron Place, Sumter County, 5 miles southeast of Maysville, S. C. (Gardner and Aldrich). *PLIOCENE*. 5 miles below Newbern, at Moore's Farm on Neuse River. (Cornell Univ. Coll.), Nixon's marl bed on Waccanaw River, S. C.; Calooshatchee beds, south Florida. (Dall.) *PLEISTOCENE*. Dismal Swamp, Va. (Cornell Univ. Coll.), Wailes Bluff near Cornfield Harbor, Md. (Dall). Darlington Dist., S. C. (Tuomey and Holmes.)

PITARIA (PITARIA) SAYANA (Conrad)

Plate IV, Figures 5, 14

Cytherea convexa Say, 1824, Jour. Acad. Nat. Sci. Phil., vol. IV, p. 149, pl. 12, fig. 3, (Harris Reprint, Bull. Amer. Pal., vol. I, No. 5, p. 325, pl. 12, fig. 3, 1896).
in part *Cytherea Sayana* Conrad, 1833, Amer. Jour. Sci., vol. 23, p. 345.

See the original description under the preceding.

This form seems to be the least abundant of the varieties that are found in the series. The anterior end is straight and strongly produced; the dorsal and ventral margins are straighter with the posterior end less pointed and more rounded than most of the shells found. We figure a shell from Petersburg, Va., which appears to be the closest to Say's figure, (figure 5 on plate IV).

The shell figured by Say was described from Maryland.

Holotype.—Right valve. John Finch Collection, British Museum, Division of Natural History. (Newton, Geol. Mag., 1902, p. 304.)

PITARIA (PITARIA) SAYANA (Conrad) var.

Plate IV, Figure 18

Cytherea Sayana Conrad, 1833, Fos. Med. Tert., pl. 7, fig. 3.
Venus Sayana Tuomey and Holmes, 1857, Pleio. Fos. S. Car., p. 83, pl. 21, fig. 9.
Caryatis plionema Conrad, 1868, Amer. Jour. Conch., vol. IV, p. 278, pl. 20, fig. 3.
Callocardia (Agriopoma) Sayana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pl. 54, fig. 16; Glenn, 1904, Md. Geol. Sur., Mio., pl. 73, figs. 13, 14.

This group is characterized by having a shape much shorter and higher than the shell figured by Say. In many cases as in *plionema*, (pl. IV, fig. 18) and other extreme shells, the form becomes trigonal. In many specimens there appears at the posterior end, radiating from the umbones to the ventral margin, a shallow yet noticeable flexure. In the Cornell collections this is a common form at St. Mary's, Maryland, Petersburg, Yorktown and localities near Suffolk, Virginia, Tar Ferry, North Carolina, and in the Pliocene near Newbern, North Carolina. A form of this variety with an extremely rounded, dorsal region, from the

Pleistocene of Dismal Swamp, Virginia, is figured on Plate V, figure 28.

PITARIA (PITARIA) SAYANA SUBNASUTA (Conrad)

Plate V, Figure 23

Cytherea subnasuta Conrad, 1841, Proc. Acad. Nat. Sci. Phil., vol. I, p. 28; Conrad, 1842, Jour. Acad. Nat. Sci. Phil., vol. VIII, p. 183; Conrad, 1845, Fos. Med. Tert., p. 72, pl. 41, fig. 3.

? *Venus subnasuta* Tuomey and Holmes, 1857, Pleioc. Fos. S. Car., p. 80, pl. 21, fig. 3.
Dione subnasuta Conrad, 1862, Proc. Acad. Nat. Sci. Phil., vol. IV, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 10.

Callocardia (Agriopoma) subnasuta Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1264; Glenn, 1904, Md. Geol. Sur., Mio., p. 312, pl. 75, figs. 1-3.

Trigonal, thin, ventricose; anterior side narrowed, slightly produced and subangulated at the extremity; surface with rather prominent concentric wrinkles; posterior margin obliquely arched; beaks distant from anterior extremity, and not nearly central; length $1\frac{1}{2}$ inch. Allied to *C. sayana*, but is proportionately longer, less ventricose, narrowed, and more produced anteriorly.—[Conrad, 1841.]

This species was described from the Calvert Cliffs, Maryland. It appears to be intermediate between *sayana* and the shorter forms. It is more produced anteriorly and elongated posteriorly as in *sayana* but the posterior end is more pointed. In a few cases a slight flexure occurs on the posterior region. The Cornell collection contains specimens from St. Mary's, Maryland.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

PITARIA (PITARIA) SAYANA PRUNENSIS (Glenn)

Plate IV, Figures 1, 8

Callocardia (Agriopoma) prunensis Glenn, 1904, Md. Geol. Sur., Mio., p. 313, pl. 75, figs. 4, 5, 6.

Shell small, oval, convex or vaulted; beak elevated, projecting; anterior side nearly straight; anterior end regularly rounded; posterior side gently convex; posterior end somewhat more acutely rounded than the anterior end; base regularly arched; teeth normal; cardinal area rather broad; ligament impressions and pallial sinus distinct; exterior polished, with a few shallow, concentric growth striæ here and there.

It differs from *C. elevata* H. C. Lea in its shape, in being polished and in lacking the gentle, irregular undulations or slight ridges characteristic of the *elevata*.

Occurrence.—Calvert Formation. Plum Point.

Collection.—Maryland Geological Survey.—[Glenn, 1904.]

The mark of length indication by the original illustrations of this species shows this shell to be 8 mm. in length.

Proterotypes.—United States National Museum, Washington, D. C.

Occurrence.—Calvert stage, Upper Miocene. Plum Point, Md. (Glenn).

PITARIA (PITARIA) CATHARINÆ Maury

Plate XLIV, Figure 4

Pitaria catharinæ Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 148, pl. 27, fig. 4.

Shell small, suborbicular, very plump and chubby; anterior extremity rounded, posterior end very short, roundly subtruncate; posterior basal margin very slightly sinuate. Beaks very full but low, their acute apices curving over the broadly lanceolate lunule, which is large for the size of the shell, not much depressed and bordered by a delicate line. Escutcheon not present. Surface marked with very numerous, very closely set, concentric threads which not infrequently anastomose. Hinge characters concealed. Length of specimen 18, altitude 16, diameter 12 mm.

This pretty shell is named in honor of Mrs. Katherine Van Winkle Palmer, whose

fine Monograph on the *Veneridae* will soon appear.

The affinities of *Pitaria catharinae* are with the Pleistocene *P. subaresta* Dall, from Mt. Hope on the Isthmus, but the Trinidad fossil has very much coarser concentric lines, and the lunule, though large, is proportionately smaller than that of *subaresta*.

Locality.—Ravine on east side of road about $\frac{3}{4}$ mile south of Brasso.

Horizon.—Manzanilla Miocene.—[Maury, 1925.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

PITARIA (PITARIA) AMMONDEA (Woodring)

Plate XLIV, Figures 1, 2

Callocardia sp. indet. Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1261 (fide Woodring).

Callocardia (Callocardia) ammondea Woodring, 1925, Carnegie Inst. Wash., Pub. No. 366, p. 151, pl. 20, figs. 11, 12.

Shell small, strongly inflated, slightly inequilateral, rounded-trigonal or broadly ovate; lunule large, limited by a shallow groove; sculpture consisting of irregularly spaced concentric rugae; anterior left cardinal long and narrow; right anterior (3a) and posterior (3b) cardinals obscurely joined; posterior right and anterior left dorsal margins grooved; anterior dorsal margin of some right valves, and ventral margin of some left and right valves, similarly grooved.

Length 7.5 mm.; height 7 mm.; diameter (left valve) 2.2 mm.

Some shells are more ovate and have stronger and more regular sculpture than the holotype. Alternating opaque and partly translucent concentric bands are visible on some specimens. All the American Miocene *Callocardias* heretofore described belong to the subgenus *Agriopoma*, which is characterized by large heavy valves, obscure right anterior lateral lamellæ, and a deep angular pallial sinus.

Type material.—Holotype (left valve, U. S. Nat. Mus. No. 352830).—[Woodring, 1925.]

From the description and figures of this species the form appears to belong to *Pitaria* s. s. rather than to *Callocardia*. The left anterior lateral is developed too strongly for *Callocardia*. The pallial sinus is not described or illustrated.

Occurrence.—Miocene. Bowden, Jamaica.

PITARIA (PITARIA) LORDLYI (Gabb)

Plate V, Figure 18

Caryatis Lordlyi Gabb, 1881, Jour. Acad. Nat. Sci. Phil., vol. VIII, p. 373.

Shell trigonal, gibbous; beaks anterior; anterior end narrowly produced, most prominent a little above the middle; posterior end prominent, base regularly rounded. Surface marked by fine concentric striae, most distinct on the anterior end; lunule broad, bounded by a fine, elevated, thread-like line. Internal margin entire.

Length, one inch.

Nearest to *C. albida*, but differs in being more cuneate posteriorly and in the sculpture. Named after Dr. C. R. Lordly, formerly of Limon, now of Cartago, Costa Rica, who materially aided me in making this collection.—[Gabb, 1881.]

This species has not been figured heretofore. The holotype is represented by one specimen of two valves attached. The form is distinct.

Dimensions.—Holotype. 25 mm., length; 20 mm., height; 16 mm., thickness.

Holotype.—No. 3413. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Pliocene. Limon, Costa Rica.

PITARIA (PITARIA) SUBARESTA Dall

Plate V, Figures 13, 14

Pitaria subaresta Dall, 1912, Smith. Misc. Coll., vol. 59, No. 2, p. 2; Brown and Pilsbry, 1913, Proc. Acad. Nat. Sci. Phil., vol. 65, p. 496.

Shell thin, white, somewhat lozenge-shaped, with the prominent beaks at about the anterior fourth; the basal margin produced, anterior and posterior ends attenuated and roundedly pointed; lunule cordate, large, nearly smooth, defined by a feeble incised line; escutcheon none; surface sculptured with rather sharp, narrow, concentric wavelets, with narrower valleys between; posterior end a little compressed and tending to rostration. Hinge of the subgenus, the teeth well developed, the hinge-line short; pallial sinus ascending, pointed above; margin of the valve smooth. Length 28, height at the beaks 23, diameter 15 mm.

Station 5868, Type, U. S. Nat. Mus. 214352.

This species has most resemblance to *P. aresta* Dall, of Porto Rico, but is more trapezoid in form, with a relatively larger lunule, the hinge teeth are of a different shape, as is also the pallial sinus; the shell is more nearly equilateral with a shorter, less arcuate posterior dorsal slope.—[Dall, 1912.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Pleistocene. (Type) Toro Point Monkey Hill, Panama or Limon Bay, Costa Rica, (Sta. 5868), (Dall), Pleistocene, Oyster-shell layers from the Black Swamp near Mount Hope, Panama. (Brown and Pilsbry). Mt. Hope and Al Mirante, Panama, (Olsson Coll. Cornell Univ. Pal. Lab.).

PITARIA (PITARIA) ALBIDA (Gmelin)

Plate VI, Figures 17, 18, 20

Pectunculus albidus Lister, 1692, Hist. Conch., pl. 273, fig. 109.

Venus albida Gmelin, 1792, Systema Naturæ, VI, p. 3287.

Dione albida Deshayes, 1853, Cat. Conch. Brit. Mus., pt. I, Veneridæ, p. 68.

Dione albida Reeve, 1863, Icon. Conch., Mon., *Dione*, pl. X, fig. 39.

Cytherea albida Krebs, 1864, West Indian Marine Shells, p. 95.

Carystis albida Römer, 1869, Mon., *Venus*, p. 91, pl. 14, fig. 4.

Cytherea albida Dall, 1885, Bull. U. S. Geol. Sur., No. 24, p. 102; ? Dall, 1886, Bull. Mus. Comp. Zool. Har., vol. 12, No. 6, p. 276; Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 56.

Meretrix albida Dall and Simpson, 1901, U. S. Fish. Com. for 1900, vol. I, p. 485.

Pitaria albida Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 370.

V. testa orbiculari subcompressa æquilatera alba: striis transversis subtilibus.

List. Conch. t. 273 f. 109.

List. Conch. t. 274 f. 110.

Habitat in Jamaica.—[Gmelin, 1791.]

Shell large, rectangular, moderately thick; the dorsal and ventral margins are subparallel and rounded regularly to the posterior extremity; anterior end straight and oblique from the beaks in the lunular area, becoming rounded ventrally; shell moderately compressed; beaks small; lunule large, very elongate, line of the margin not impressed very deeply; surface smooth, the lines of growth become heavier toward the ventral region; teeth and pallial sinus typical of the genus; color of a chalky white, sometimes polished; shell of a milky white on the interior.

P. albida differs from *P. fulminata* in being less trigonal, more quadrate, in the more narrow and elongate lunule, usually more compressed shape and in the absence of the brown or yellow spots or markings. In shape *P. albida* approaches *P. morrhuana* more than *P. fulminata* but differs from *morrhuana* in being more attenuated anteriorly, less convex, larger, with a narrower and longer lunule and in the absence of the conspicuous coloration.

Dimensions.—49 mm., length; 40 mm., height; 24 mm., diameter.

Occurrence.—Recent. Florida Straits, Florida Keys, thru the West Indies to northern South America; Monti Cristi, Santo Domingo, (Maury Coll., Cornell Univ. Pal. Mus.).

PITARIA (PITARIA) SIMPSONI (Dall)

Plate V, Figures, 12, 16, 20.

Cytherea simpsoni Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 56.

Meretrix simpsoni Dall, 1895, Nautilus, vol. IX, No. 1, p. 10; Dall, 1902, Proc. U. S. Nat. Mus., vol. 24, No. 1264, p. 510, pl. 32, fig. 3.

Pitaria simpsoni Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 371; Vanatta, 1903, Proc. Acad. Nat. Sci. Phil., vol. 55, p. 757; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 70.

Shell small, plump, concentrically grooved, but somewhat irregular in sculpture, smoother toward the beaks; varying in color externally from pure white to livid bluish overlaid with streaks or zigzag brown lines, the interior from pure white to deep bluish purple; the most common color variety much resembles Sowerby's figure of *C. hebræa* Lam. (Thesaurus, pl. 134, figs. 143-4), but with the posterior end more rounded, the hinge teeth more compressed and smaller, and with a well-developed pallial sinus reaching to the vertical of the beaks; the lunule is smooth, long-ovate, marked off by an incised line, but not differentiated by color or otherwise from the adjacent parts of the shell; the escutcheon is obscure.

Alt. 15.0; lon. 18.0; long. of post-umbonal part 11.0; diam. 8.0 mm. Habitat from Curaçao to St. Thomas, West Indies, to Cedar Keys, Florida, from low water to 26 fathoms; Chas. T. Simpson and other collectors, in the U. S. Nat. Museum.

This is probably the species which has been identified by Antillean collectors with *Circe* (*Lioconcha*) *hebræa* (Lam.) Sowerby, but it is a smaller shell and a true *Meretrix*, represented by specimens from seven localities in the Museum collection and noted in Bull. 37, U. S. N. M., p. 56, No. 285 in 1889.—[Dall, 1895.]

Shell with narrow, slightly irregular and feeble concentric ridges, surface not polished except over the large ovate lunule which is smooth. Colors white or more or less suffused with purple which may be very dark internally, a zigzag pattern of yellowish brown frequently present; pallial sinus ascending, rather large and rounded in front; margins entire; escutcheon not delimited; Lon. 16.5; alt. 15; diam. 8.5 mm. The shell is rather solid and the periostracum thin and translucent.—[Dall, 1902.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Living. Curaçao and St. Thomas, West Indies to Cedar Keys, Florida, from low water to 26 fathoms. West Florida at Tampa and Sarasota Bay, low water to 26 fathoms. (Dall); St. Joseph's Bay and Crooked Isl., Florida (Vanatta).

PITARIA (PITARIA) MORRHUANA (Linsley)

Plate V, Figures 5, 8, 9, 17, 21, 22

Cytherea convexa Conrad, 1830, Acad. Nat. Sci. Phil. Jour., 1st ser., vol. 6, p. 261.

Cytherea Sayana Conrad, 1833, Amer. Jour. Sci., 2nd ser., vol. 23, p. 345; Conrad, 1838, Fos. Med. Tert., p. 13.

Cytherea convexa Gould, 1841, Inv. Mass., p. 84, pl. 3, fig. 49, 2nd ed., 1870, p. 131-132, fig. 444; Dekay, 1841, Nat. Hist. New York, Zool. vol. V, p. 84, pl. 3, fig. 49; Mighels, 1843, Jour. Bost. Soc. Nat. Hist., vol. 4, p. 320.

Cytherea morrhuana Linsley, 1845, Amer. Jour. Sci., 1st ser., vol. 48, p. 276 (not described); Gould, 1848, Amer. Jour. Sci., 2nd ser., vol. 23, p. 233; Kurtz, 1860, Cat. Recent Mar. Shells etc., Portland, p. 4.

Callista convexa H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 425; Willis, 1861, Proc. Bost. Soc. Nat. Hist., vol. 8, p. 61.

Dione convexa Reeve, 1863, Conch. Icon., *Dione*, pl. X, fig. 40.

Cytherea convexa Hub. and Smith, 1865, Ann. N. Y. Lyc. Nat. Hist., vol. 8, p. 15.

Cytherea morrhuana Perkins, 1869, Proc. Bost. Soc. Nat. Hist., vol. 13, p. 163.

Cytherea Sayii Perkins, op. cit., p. 147.

Callista convexa Dall, 1870, Proc. Bost. Soc. Nat. Hist., vol. 13, p. 252.

Cytherea convexa Smith and Prime, 1870, Ann. Lyc. Nat. Hist. N. Y., vol. 9, p. 388, var. *morrhuana*; Coues, 1871, Proc. Acad. Nat. Sci. Phil., vol. 23, p. 136.

- Callista convexa* Verrill, 1873, Proc. Amer. Ass. Adv. Sci., p. 368.
Callista Sayana Tryon, 1873, Amer. Mar. Conch., p. 160, pl. 29, fig. 398.
Cytherea convexa Dall, 1885, Bull. U. S. Geol. Sur., No. 24, p. 102; Dall, 1889, U. S. Nat. Mus. Bull. 37, p. 56; reprint, 1903, pl. 56, fig. 15 (not pl. 64, fig. 142a as listed on p. 56); Johnson, 1890, Nautilus, vol. IV, p. 60, not *Cytherea convexa* Guppy, 1874, Geol. Mag., vol. XI, p. 442.
Cytherea convexa Balch, 1901, Proc. Bost. Soc. Nat. Hist., vol. 29, p. 158; Dall, 1902, Nautilus, vol. VI, p. 53.
Callocardia (Agriopoma) morrhuana Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 370; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1262, pl. 54, fig. 14; Sumner, Osburn and Cole, 1913, Bull. Bur. Fish., vol. 31, pt. 1, pp. 692-3, pt. 2, pp. 146-7-50, chart 146; Johnson, 1915, Occ. Papers Bost. Soc. Nat. Hist., vol. VII, No. 13, p. 69; Jacot, 1919, Nautilus, vol. 22, No. 3, p. 92; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 69.

Previous to 1845 the names *convexa* and *sayana* of Conrad were used for the shells of this recent species. Linsley proposed the name *morrhuana* for a young specimen found in a codfish stomach at Stonington, Conn. He did not give a description of the shell and in 1848 Gould identified the form as *convexa* of Say. The name *convexa* was applied further to the recent shell, *sayana* being used for the fossil. In many cases each name was used for both or either, the fossil or the living species. By a mistake Perkins used the name *Sayii*. Dr. Dall, in 1902, revived the name *morrhuana* for the recent form, thus assigning definitely the name *sayana* to the fossil. The name *convexa* is preoccupied by Brongnart, in Cuvier, 1811. Although Conrad confounded originally the recent and fossil shells, the name *sayana* was proposed by him to take the place of *convexa* which had been used for the fossil form by Say. Hence *sayana* stands properly for the fossil species.

Shell medium; moderately thick; somewhat elongate; anterior end not produced greatly, posterior end nearly straight, rounded regularly at the dorsal and ventral margins; umbones wide; lunule large, elongate, impressed by an incised line; surface ornamented by prominent, concentric lines of growth only; color very often a bluish black, or an iron stain red.

This form differs from *sayana* and its varieties by a lesser production of the anterior end, a greater fullness of the umbones and a greater convexity of the posterior end.

The hinge is that of typical *Pitaria*.

Dimensions.—(Largest specimen) Length 40 mm.; height 31 mm.; diameter 22 mm.

Occurrence.—Miocene. York River, Virginia, Shell Branch near Darlington, South Carolina, (Dall). Pleistocene. Wailes Bluff, near Cornfield Harbor, Md., (Dall) (Cornell Univ. Pal. Lab.); Living from Prince Edward's Island to Cape Hatteras, North Carolina. The citations of local occurrences of this species are very numerous and may be found from the synonymy.

PITARIA (PITARIA) ARESTA (Dall and Simpson)

Plate VI, Figures 15, 16

Meretrix aresta Dall and Simpson, 1901, Bull. U. S. Fish. Com. for 1900, Vol. I, p. 485, pl. 56, figs. 1, 7.

Callocardium (Agriopoma) aresta Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 370.

Shell large, solid, inflated, white or yellowish, very inequilateral, with prominent much incurved prosogyrate umbones, rounded in front, arcuate and almost rostrate behind, the base arcuate; lunule cordiform, hardly defined by an obsolete impressed line, but there is no defined escutcheon; ligament deeply immersed, very little of it visible externally; surface sculptured with fine, somewhat irregular concentric sulci in harmony with the incremental lines, but coarser and more excavated, with often a few narrow undulations near basal margin; umbonal region somewhat smoother and often appears polished by attrition; interior dull white, not polished, with a short anteriorly rounded subtriangular pallial sinus; hinge normal with a subconic left anterior lateral fitting into a pit in the right valve.

Length, 51; height, 50; diameter, 28 mm.; a larger valve is 58 mm. long.

Mayaguez Harbor, Porto Rico, at stations 6061 and 6062, in 12 to 30 fathoms, abundant; a single young pair off Puerto Real at station 6074.

Nearest to *M. albidula*, but with a rougher surface, a different outline, and attaining a larger size.—[Dall and Simpson, 1901.]

Holotype.—United States National Museum, Washington, D. C.

PITARIA (PITARIA) PENISTONI (Heilprin)

Plate V, Figures 4, 6, 7

Cytherea Penistoni Heilprin, 1889, The Bermuda Islands, pp. 178, 190, pl. 17, fig. 4; Heilprin, 1889, Proc. Acad. Nat. Sci. Phil., vol. 41, p. 141, pl. 8, fig. 4.

Pitaria Penistoni Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 371.

Shell sub-trigonal, the beaks, prominently elevated; lunule cordiform; the dental characters normally those of the genus; anterior lateral tooth (left valve) triangular, lamellar.

Margin of shell even; pallial sinus broad, directed upwards, and not quite reaching the centre of the shell. Lines of growth closely set, and even. Shell covered with a chestnut epidermis; interior purplish.

Length, .6 inch; height, .5 inch.

It gives me pleasure to name this delicate, and abundantly represented, *Cytherea* after my friend Miss A. Peniston, of Peniston's, from whom I have received much valuable assistance in the preparation of my material illustrating the Bermudian fauna.—[Heilprin, 1889.]

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Living. Bermuda. (Heilprin) St. Thomas, West Indies. (U. S. National Museum).

PITARIA (PITARIA) MUNDA Römer

Plate V, Figures 1, 2, 3

Cytherea (Pitar) munda Römer, 1861, Malak. Blätt., Band 7, p. 150.

Cytherea (Caryatis) munda Römer, 1869, Mon. Moll., *Venus* Band L, Subgenus *Cytherea*, p. 120, pl. 32, fig. 6.

Pitaria munda, Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 371.

T. trigono-cordata, tenui, inæquilatera, tumidiuscula, antice brevis, curvata, postice obtuse subrostrata, alba, vix nitente per strias incrementi minutissimas, antice præsertim, rugulosa; umbonibus subacutis, antrorsum involutis, longitudinem in ratione 1:2 discludentibus; margine ventrali curvato, postice vix, antice magis adscendente, dorsali postice curvato valde descendente, antice brevis, declivi, subrecto; lunula lanceolato-cordata, magna, superficiali, medio elevata, obsolete circumscripta; area nulla, ligamento subimmerso, angustissimo; intus alba; sinu pallii mediocri, late aperto, in apice rotundato; dentibus cardinalibus tenuibus, elevatis, primo et secundo

in valva sinistra complicatis, dente laterali papilliformi. Long. 15, alt. 13, crass. 8 mill. Habitat ad insulam St. Thomas, Antillarum.

Diese niedliche Art aus der schwierigsten aller Venusgruppen erinnert einerseits an *Cyth. albina* Lam., andererseits an *Cyth. Kingii* Gray. Mit ersterer hat sie namentlich im Umriss Aehnlichkeit, unterscheidet sich aber durch grössere Ungleichseitigkeit, gewölbteren und tiefer herabsteigenden hinteren Rückenrand, längere und schmalere Lunula, viel breiter Mantelbucht. *C. Kingii* ist mehr querverlängert, hinten stumpf abgeschnitten, während unsere Art einen abgerundeten Schnabel zeigt, und hat eine engere, aber tiefere Mantelbucht. Auch *C. inconspicua* Sow. von Peru ist nahe verwandt, zeichnet sich jedoch durch ihre, für diese Gruppe ungewöhnlich grosse, bis über die Schalenmitte reichende, sehr schmale Mantelbucht aus.—[Römer, 1861.]

This is a small shell, undoubtedly *Pitaria*. Römer figured the species in color in his monograph of *Cytherea*. It has not been reported since Römer and specimens are not accessible hence we have made a reproduction of Römer's figure.

Occurrence.—Living. St. Thomas, West Indies. (Römer.)

PITARIA (PITARIA) FULMINATA (Menke)

Plate VI, Figures 5, 7, 10, 19

Cytherea hebræa Lam., 1818, An. s. Vert., vol. V, p. 568 (according to Krebs, fide Dall).

Cytherea fulminata Menke, 1830, Syn. Moll. Museo Menk., 2nd Ed., p. 150.

Circe hebræa Reeve, 1863, Conch. Icon., *Circe*, pl. VIII, fig. 34.

Circe varians Reeve, op. cit., pl. IX, fig. 39.

Cytherea (Dione) hebræa Dall, 1886, Bull. Mus. Comp. Zool. Har., vol. 12, No. 6, p. 275.

Cytherea hebræa Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 56; Dall, 1889, Proc. U. S. Nat. Mus., vol. XII, p. 271.

Meretrix hebræa Dall and Simpson, 1901, Bull. U. S. Fish. Com. for 1900, vol. 1, p. 485.

Pitaria fulminata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 371; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 70; Maury, 1925, *ibid.*, vol. 10, No. 42, p. 147, pl. 27, fig. 9.

C. testa-cordato trigona, inæquilatera, levi, albedo-fulva, lineis transversis angulibus, rufis cincta; umbonibus tumidis, angustis; ano impresso vulvaque perampla cordatis.

a. maior. alt. 1 poll. 10 lin.; lat. 2 poll.; diam. ventris 1 poll. 3 lin.

b. media. alt. 1 poll.; lat. 1 poll. 1 lin.; diam. ventr. 6½ lin. Hab ad Brasiliam, unde maiorem reportavit.

Serenissimus Princeps Wiedensis; mediam et minorem, ad Cabo Santo lectas, venales habuit C. H. Bescke, Hamburgensis.

Testa ventricosa, in maiore infra medium epidermide cinerascete, tenui vestita; valvis intus albis, in fornice macula longitudinali coerulea notatis, ad marginem integerrimis; dente cardinali lateris anterioris striato, crenato.—[Menke, 1830.]

Shell medium; plump; subtrigonal, umbones large and full; lunule very large, impressed by an incised line; anterior end broader than the posterior end; hinge and pallial sinus typical of the genus; shell smooth except for heavy, concentric lines of growth; color white with spots or zigzag markings of brown.

The adult shells are about the same size as that of *P. morrhuana*. *P. fulminata* differs from *morrhuana* in being more trigonal, in having a greater diameter of the shell, larger beaks and a larger lunule. It may be differentiated in color by the radial or zigzag markings or spots. The species differs from *P. albida* in being more trigonal, less attenuated posteriorly and in the presence of the coloration markings. The difference in shape distinguishes the two species if the valves of *fulminata* have been

bleached of their color.

Dimensions.—36 mm., length; 31 mm., height; 23 mm., thickness.

Occurrence.—Upper Pliocene. Matura, eastern coast, Trinidad. (Maury. Harris Coll. Cornell Univ. Pal. Lab.) Living from Cape Hatteras, North Carolina, to Bermuda, the Antilles and Brazil in depths from few feet to 170 fathoms. Living young were taken from the 170 fathoms. (Dall.)

? PITARIA EXIQUA (Conrad)

Plate III, Figure 1

Caryatis exiqua Conrad, 1871, Amer. Jour. Conch., vol. 6, p. 201, pl. 11, fig. 3; Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 150, pl. 47, fig. 7.

Subcordate, short and elevated, ventricose, thin in substance; summits prominent; posterior side truncated; lunule cordate, indistinctly defined.

Locality.—Claiborne, Alabama. Rare. Eocene.—[Conrad, 1871.]

Further data concerning this species has not been found. The original figure and description have been copied.

Holotype.—?

? PITARIA VESPERTINA (Conrad)

Plate III, Figure 3

Venus vespertina Conrad, 1857, U. S. Mex. Sur., vol. I, pt. 2, p. 162, pl. XIX, fig. 5a, b, not *Cytherea vespertina* Conrad, 1848, or *Dione vespertina* Conrad, 1865, or Meek, 1864.

Meretrix ? vespertina, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 144, pl. 46, fig. 6.

Subtriangular, inequilateral, convex; length and height equal; buccal end acutely rounded; anal end more obtuse; summit prominent.

A small Eocene species, with the external surface somewhat worn. It appears to have had concentric lines.

Locality.—Western Texas.—[Conrad, 1857.]

Prof. Harris did not find this species in his large collections of Eocene material. It does not seem to have been mentioned in literature since the original description. The holotype was not found at the U. S. National Museum.

The figure of Conrad indicates fairly strong, concentric ribs.

? PITARIA ASTARTOIDES (Gardner)

Plate XLIV, Figures 15, 16

Callocardia astartoides Gardner, 1923, Prof. Paper U. S. Geol. Sur., No. 131, p. 113, pl. 32, figs. 4-7.

Shell small for the genus, thick shelled, trigonal, ovate in outline, astartiform, moderately compressed; umbones not conspicuous, the tips proximate and prosogyrate, slightly anterior; lunule rather wide, cordate, slightly depressed, and delineated by an incised line; escutcheon not defined; anterior extremity bowed slightly in front of the lunule; posterior end of shell obliquely truncate and feebly arcuate from the umbones to the basal margin; base line arcuate, more abruptly rounded posteriorly than anteriorly; external surface finely and evenly threaded concentrically; resting stages conspicuous, usually one strongly defined near the umbones and several not quite so prominent toward the base; a fine and regular radial lineation visible upon weathered surfaces; external ligament mounted upon a rather heavy nymph produced more than one-third of the length of the posterior dorsal margin; dentition robust; the laminar anterior cardinal of the right valve broken away; medial cardinal rather slender, cuneate; posterior cardinal produced; left

anterior and medial cardinals united under the umbones to form an asymmetric V, the anterior cardinal slender, the medial cardinal relatively heavy and deltoid; posterior left cardinal broken away, doubtless very thin and laminar; a very short obtuse lateral tooth developed in the left valve, received in a corresponding socket in the right; adductor scars distinct, the anterior the more prominent; pallial sinus produced almost to the median vertical, obtusely trigonal; inner margins entire.

Dimensions: Right valve, altitude 16.0 millimeters, latitude 16.5 millimeters, semidiameter 7.4 millimeters; left valve, altitude 17.0 millimeters, latitude 17.3 millimeters, semidiameter 8.6 millimeters.

Type locality: Station 8833, about 7 miles up the Rio Grande from Laredo, at Knob Bluffs, a quarter of a mile above pump of Santa Barbara farm, Webb County, Tex.

Callocardia astartoides is a remarkable species, uniting the dentition and sinal characters of the Veneridae with the external outline and surface sculpture of certain of the Astartidae. The occurrence of so primitive a type of a highly specialized group in the early Tertiary beds is of unusual interest.

Callocardia astartoides is the dominant species at the type locality and common at a number of other localities in the Cook Mountain formation.

Stations in Cook Mountain formation

? 8850 (c). 500 yards southwest of Espejo ranch, 8 miles south of Laredo, Webb County.

8833 (a). About 7 miles up the Rio Grande from Laredo, in Knob Bluffs, a quarter of a mile above pump of Santa Barbara farm, Webb County.

8768 (c). 1½ miles north of and a trifle east of the third gate, 7 miles south-east of Velenzuela ranch house, Webb County.

8770 (c). 39.9 miles north of Rio Grande City, Starr County, on river road to Zapata, just north of Lopeño post office, Zapata County.—[Gardner, 1923.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Claiborne Eocene. Texas. (Trowbridge.)

PITARIA ? OBSCURATA (White)

Plate VI, Figures 1, 1a

Callista obscurata White, 1887, Arch. Museu Nac. Rio de Janeiro, vol. VII, p. 96, pl. VIII, figs. 10, 11, 12.

Shell transversely subovate in marginal outline; valves regularly convex, gibbous; umbones moderately prominent; beaks small, incurved and turned a little forward; front prominent; front margin regularly rounded; base also regularly convex and rounded up to both the anterior and posterior margins; posterior margin regularly and more broadly rounded than the anterior; postero-dorsal margin broadly convex, sloping backward and downward from the beaks. Surface marked only by concentric lines of growth.

Length of the largest example in the collection, 39 millimeters; height from base to umbones, 25 millimeters.

All the specimens in the collection are in the condition of natural casts, some of which show portions of the hinge, which appears to be that of true *Callista*. One of them shows a small sublunular tooth.—[White, 1887.]

This species is placed under *Pitaria* instead of *Callista* as determined by White. We have not been able to examine specimens and the illustrations are those of casts so one can not determine definitely the genus. The shape of the casts however suggest *Pitaria* rather than *Callista* in being more gibbous. *Callista* is more compressed than *Pitaria*. The small sublunular tooth described by White is characteristic of both genera. The pallial sinus is not described or illustrated.

Holotype.—National Museum, Rio de Janeiro, Brazil.

Occurrence.—Cretaceous. (Maury). Porto dos Barcos, Provincia de Sergipe. Miocene. (Maury). Rio Piabas, Provincia do Para.

Since the difference in age is so great between the localities which

White listed for the occurrence of the specimens, the species is probably mixed. One can not tell to which locality *P.?* *obscurata* belongs.

PITARIA TRYONIANA (Gabb)

Plate VII, Figure 2

Callista Tryoniana Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 250.

Pitar tryoniana Pilsbry, 1922, Proc. Acad. Nat. Sci. Phil., vol. 74, p. 422, pl. 47, fig. 11.

Shell rounded triangularly; beaks anterior; cardinal margin arched; base deeply convex; anterior end narrowly rounded, straight in the lunular region, lunule large not sunken, bordered by an impressed line; surface smooth in the young, in the old covered by numerous small, rounded concentric ribs.

A very little smaller than *M. juncea*, this shell differs markedly in its lunule and surfaces and slightly in outline. It is more produced in front and more narrowly rounded; in that species the lunular region is concave.—[Gabb, 1873.]

The line marking the lunule is faint; the concentric sculpture consists of fine, flattened ribs with interspaces half the width of the ribs; the ribs divaricate occasionally; the umbones are very full.

P. tryoniana is somewhat like *P. gatunensis* in general appearance. It differs in being smaller; the umbones are larger, the lunule is broader and the ribs flatter and more regular. In *P. gatunensis* the concentric lines or wrinkles are upright and they are not developed as definitely as they are in *P. tryoniana*. The figure of *P. tryoniana* does not show the character of the concentric lines.

This species may have the hinge of *Pitarella* and perhaps should be so classed. We have not been able to examine the hinge and so do not classify the species as to the subgroup.

Dimensions.—28 mm., length; 23.3 mm., alt.; 8.4 mm., semidiameter (type, from Pilsbry).

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Miocene. Santo Domingo, (Gabb Coll. Acad. Nat. Sci. Phil.).

PITARIA (PITARIA) ZONATA (Dall)

Plate VI, Figure 4

Cytherea? obovata Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 56.

Callocardia (Agriopoma) zonata Dall, 1903, *ibid*, Reprint, p. 207, pl. 89, fig. 4; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1512, pp. 370, 381, pl. 12, fig. 4; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 70.

Shell small, thin, arcuate, with a dull surface, whitish with concentric zones of yellow brown; surface concentrically striated or sulcate with wider interspaces, forming low riblets; beaks high, inflated, their apices small, anteriorly directed, lunule large, cordate, defined by a sulcus; no visible escutcheon; ends rounded, base prominently arcuate; interior porcellaneous, with a small ascending angular pallial sinus; hinge verging toward *Chionella*. Length 23; height 18.5; diameter 14 mm.

Type locality.—United States Fish Commission station 2608, in 22 fathoms, sand, off the coast of North Carolina. Cat. No. 92015, U. S. N. M.—[Dall, 1902.]

The hinge of this species approaches that of *P. vesica* (Dall). The pallial sinus is small but more distinct than in *P. vesica*. The shell is thicker than that species and the umbones are not as large and Isocardia-

like. The shell of *P. zonata* is more trigonal.

Subgenus AGRIOPOMA Dall



Fig. 3. Hinge of type species of *Agriopoma*

Agriopoma Dall, 1902, Proc. U. S. Nat. Mus., vol. 24, No. 1264, p. 509. (section of *Meretricis*).

Agriopoma Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 353. (subgenus *Callocardia*).

Agriopoma Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1269. (subgenus *Callocardia*).

Shell large, elongate, chalky; anterior end greatly produced; lunule large, circumscribed by an incised line; no escutcheon; hinge with three cardinals in each valve; a very small anterior lateral tooth in the left valve and situated at the extreme anterior point of the hinge plate; anterior cardinal of the left valve thin and sharp; the middle, left cardinal is very large, thick and extremely elongate; a minute pit is situated near the edge of the hinge plate in the right valve for the reception of the small lateral tooth; anterior and middle right cardinals thin and sharp; the anterior and middle left cardinals are of a continuous structure being hooked in the middle; in the right valve the anterior cardinal and the posterior cardinal are of a continuous formation; the right posterior cardinal is bifid and elongate; a deep pit occurs in each valve in front of the anterior cardinal; pallial sinus deep and pointed; margin smooth; exterior ornamented only by concentric growth lines, not heavy but conspicuous.

Genoholotype.—*Cytherea texasiana* Dall, Plate VII, Figures 5, 12, 13, 14.

Recent of the Gulf Coast of North America.

This group has a hinge peculiar to itself and seems to show a relationship between *Callocardia* Adams and *Pitaria* Römer. The elements of the hinge are those of *Pitaria* but they have been modified especially along three lines. One change has been in the extreme, anterior position of a very small, in many cases, minute, anterior lateral tooth. Another has been in the heavy, elongate left middle cardinal, and a third in the remote small socket in the right valve for the left anterior lateral. The characters of *Callocardia* seem to be developed less strongly. A comparison of the hinges of *Agriopoma* and *Callocardia* show a relationship, but the hinge of *Callocardia* is pronounced less and is obscure. It is known

only from one valve. The presence of a pallial sinus in the genus is a question. *Aagriopoma* has a well developed pallial sinus.

Pitaria is a well established stratigraphic genus. The stratigraphic history of *Callocardia* is not known definitely. Because of the fact that *Aagriopoma* shows well developed, but modified characters of *Pitaria*, it is placed as a subgenus of *Pitaria*, instead of a subgenus of *Callocardia*. *Callocardia* is also placed in subgeneric rank under *Pitaria*.

Aagriopoma is at present known from one species, *A. texasiana* which occurs in the Pleistocene and Recent of the Gulf Coast of the United States.

PITARIA (AGRIOPOMA) TEXASIANA (Dall)

Plate VII, Figures 5, 12, 13, 14

Cytherea ? *idonea* Dall, 1889, U. S. Nat. Mus. Bull. 37, p. 56.

Cytherea texasiana Dall, 1892, Nautilus, vol. V, No. 12, p. 134; Singley, 1892, 4th Ann. Report Texas Sur., p. 327.

Meretrix (*Aagriopoma*) *texasiana* Dall, 1902, Proc. U. S. Nat. Mus., vol. 24, No. 1264, p. 509, pl. 32, fig. 1.

Callocardia (*Aagriopoma*) *texasiana* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 353, 370; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1259; Vanatta, 1903, Proc. Acad. Nat. Sci. Phil., vol. 55, p. 757; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 69.

Shell resembling in general features *C. convexa* Say, but larger more elongate in proportion and with a more delicately sculptured surface. Shell moderately inflated, beaks not very prominent, surface white, the young nearly smooth but gradually becoming finely concentrically wrinkled toward the margin and the wrinkles wavy or more or less interrupted; lunule large, similarly sculptured, bounded by an impressed line but not depressed; there is no defined escutcheon; epidermis thin, pale, closely adherent and smooth; interior chalky white, polished; pallial sinus angular and deep; margins smooth; sockets of the hinge deep, hinge teeth normal, slender; the anterior tooth small but well defined.

Shape of the shell very nearly a true oval, the height greatest about midway between the two ends; base and ends evenly rounded. Lon. of shell 67.0; alt. 49.0; diam. 32.0; beaks behind the anterior end 20.0 mm.

This fine species is No. 291 of my list in Bull. 37, U. S. Nat. Mus., where it was referred with doubt to a fossil species which proved to be of a different character. It was first collected by Wurdeman during the earliest Coast Survey Work on the Texan coast (about 1856) and has since been sent to the National Museum from Galveston by R. R. Gurley of the U. S. Fish Commission and later by J. H. Singley of the Texas Geological Survey. It is a *Dione* of the section represented by *D. sayana* or *convexa* and must, when in really fine condition, be a very elegant species.—[Dall, 1892.]

This species differs from *Pitaria morrhuana* and *sayana* fundamentally in the hinge characters. *P. morrhuana* and *sayana* possess typical *Pitaria* hinges.

Holotype.—6056. United States National Museum, Washington, D. C.

Occurrence.—Living. Coast of Texas from Galveston to Indianola. (Dall). Cameron, Chenier, Point-au-Fer, La.; Galveston, Texas. (Cornell Univ. Pal. Lab.); Indian Pass, Apalachicola Bay, Florida (Vanatta); Pleistocene. Grand Chenier, Knapp's well, Terrebone Parish, No. 2 at 1542-1632, No. 3 at 570-700 ft., La. (Cornell Univ. Pal. Lab.)

¹ *Callocardia (Agriopoma) parkeria* Glenn in Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1262 is a *nomen nudum*.² Notes were made on the form by Dall and Glenn but the species was not described subsequently by Glenn. The type specimen should be in the United States National Museum.

Subgenus PITARELLA new subgenus

Shell large, inequilateral; umbones full and recurved; lunule large, defined by a faint line; escutcheon if present, very narrow, defined by an impressed line; hinge of the right valve consists of three cardinal teeth and a minute, anterior pit; the right, posterior cardinal tooth is long and bifid, the anterior and middle cardinal teeth are short and fit closely together; the pit into which the left, anterior lateral tooth fits is very small and is situated very close to the anterior cardinal tooth with but a small, sharp cavity between; the hinge of the left valve consists of three cardinal teeth and a very small, anterior lateral tooth, the posterior cardinal tooth is long and narrow; the anterior cardinal tooth is thin and sharp and the middle cardinal tooth is elongate and greatly thickened; the anterior lateral tooth is very small, pointed and situated very near the anterior cardinal tooth; pallial sinus medium in size and pointed; inner margin smooth; shell is smooth exteriorly or sculptured with heavy, concentric lines of growth.

Genoholotype.—*Pitaria gatunensis* (Dall) Plate VII, Figures 3, 7, 9, 10; Plate IX, Figures 3, 9. Miocene of Gatun, Panama.

Just as the hinge of *Agriopoma texasiana* shows a modification of the hinge of *Pitaria*, in the under or over development of the anterior, lateral tooth, resulting in a very small process, so the species of *Pitarella* represent a group with the anterior, lateral tooth much reduced. In *Agriopoma*, the lateral tooth has shifted to a position distant from the middle, cardinal teeth while in *Pitarella* it occupies a position extremely close to the cardinals. The two subgenera have the middle, left, cardinal tooth elongate and much enlarged. Typically, *Pitaria* has the middle, left, cardinal tooth enlarged but it is only slightly longer than the anterior, cardinal tooth.

The hinge of *Veneriglossa vesica* Dall is very close to that of *Pitarella*. *Veneriglossa* has but a slightly sinuated pallial line while the pallial sinus of *Pitarella* is well defined and of good size.

The species so far noted as belonging to this group are from the Miocene.

PITARIA (PITARELLA) GATUNENSIS (Dall)

Plate VII, Figures 3, 7, 9, 10; Plate IX, Figures 3, 9.

Callocardia (Agriopoma) gatunensis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt.

¹ The notes included are the result of correspondence with L. C. Glenn, E. W. Berry and Dr. Dall.

6, p. 1260, pl. 54, fig. 1; Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., vol. 63, p. 370; Olsson, 1922, Bull. Amer. Pal., vol. IX, No. 39, p. 235; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 146, pl. 27, figs. 5, 7.

Oligocene of the Gatun beds near Gatun, on the line of the Panama Canal, Rowell and Hill; near the line of the railway at Monkey Hill, Newberry and Hill; at Ponton, St. Domingo, and at Clairmont, St. Ann's Parish, Jamaica, West Indies.

Shell moderately large, thin, inflated, ovate; with low, incurved beaks over a large, cordate lunule, defined by a feebly impressed line; ligament narrow, the margins adjacent to it marked by a raised thread; anterior dorsal slope short, straight, the beaks being near the anterior fifth of the shell and the margins raised above the general surface, where they cross the lunule; anterior end rounded, base evenly arcuate, posterior end broadly rounded, posterior dorsal border moderately convex; hinge delicate, anterior lateral small and closely adjacent, posterior right cardinal bifid and rather widely separated from the middle cardinal; pallial sinus ascending, linguiform, extending through the posterior third of the shell; muscular impressions rather large. Length 38, height 31, diameter 21 mm.

This species appears to be abundant at Gatun and in St. Domingo. The sculpture is only of fine, feeble, close, concentric wrinkles, emphasized distally. It is remarkable for its inequilateral and inflated form. It differs from *C. sapotensis* Gabb, of the Costa Rica Oligocene, in its less triangular and more inflated form, the absence of any anterior projection, and the less equilateral valves.—[Dall, 1903.]

The shell is smooth on the middle and umbonal regions. The Cornell collections contain specimens from Costa Rica and from Panama. The outline of the shell and the size of the concentric lines varies among a number of specimens from a locality.

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Gatun Miocene. (Type). Gatun beds near Gatun on the line of the Panama Canal; near the line of the railway at Monkey Hill, Panama; Ponton, Santo Domingo; Clairmont, St. Ann's Parish, Jamaica, (Dall); Gatun and Mt. Hope Canal Zone, Panama; Hill No. 1, Banana River, Sousi Creek (Upper Hone Creek), Costa Rica, (Olsson Coll., Cornell Univ. Pal. Lab.); Province of Darien, Panama, (Yaekel Coll., Cornell Univ. Pal. Lab.); Brasso, Machapoorie Quarry, Trinidad, (Maury. Harris Coll., Cornell Univ. Pal. Lab.).

PITARIA (PITARELLA) GATUNENSIS MULTIFILOSA (Dall)

Plate VII, Figure 6

Callocardia (*gatunensis* variety) *multifilosa* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1261, pl. 54, fig. 15; Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., vol. 63, p. 370.

Callocardia gatunensis Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 325, pl. 32, fig. 1.

In the Oligocene with the last species near Gatun, Rowell; also 10.5 kilometers west of Colon Hill; and at Ponton, St. Domingo.

Shell of moderate size, cordate, inflated; the beaks high and incurved; the lunule large and feebly defined by an impressed line; form and other features essentially as in *C. gatunensis*, but the sculpture, which in the latter is polished and in the middle of the disk less pronounced, is in this variety nearly uniform over the surface and raised in small, crowded, thread-like ribs. This gives quite a different aspect to the shell, which seems to justify the application to it of a varietal name.—[Dall, 1903.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Gatun Miocene. Near Gatun, Panama; 10.5 km. west of Colon, Panama; Ponton, Santo Domingo, (Dall); Banana River, Costa Rica, (Olsson Coll., Cornell Univ. Pal. Lab.).

PITARIA (PITARELLA) CERCADICA Maury
Plate VII, Figure 8; Plate IX, Figure 4

Pitaria cercadica Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 380, pl. 37, fig. 10.

Shell rounded, inflated, umbones full, beaks incurved; lunule marked off by a single line hardly breaking the concentric sculpture; escutcheon not defined; umbonal region of both our shells smooth, perhaps worn so, entire remaining surface sculptured with close, fine, apparently uniform flattened ridges, but when examined with a lens they are seen to be somewhat irregular and occasionally divaricating; only one imperfect hinge is free from the matrix but it appears to be that of *Pitaria*. Our shell shows no radial sculpture whatever. Length 30, approximate altitude 25, semidiameter 10 mm.

Locality.—(Exp'd '16) Bluff 3, Cercado de Mao.—[Maury, 1917.]

The matrix was cleaned from the hinge of the right valve of this species and the teeth studied. They reveal the same characters as those of *P. gatunensis*. The sculpture is like that of a specimen of *P. gatunensis multiflora* from the Banana River, Costa Rica. This species seems to be broader posteriorly and the umbones are larger and more inflated. It is related to *P. gatunensis*. The species is known only by one valve and since it presents differences we have kept it distinct from *gatunensis*.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Lower Miocene. Bluff 3, Cercado de Mao, Santo Domingo.

Subgenus VENERIGLOSSA Dall

Veneriglossa Dall, 1886, Bull. Mus. Comp. Zool., Har. Col., vol. 12, No. 6, p. 275;

Dall, 1889, Bull. U. S. Nat. Mus., vol. 37, p. 56; Dall, 1889, Proc. U. S. Nat. Mus., vol. 12, p. 270.

For the description of the group see under *P. (Veneriglossa) vesica* (Dall).

Genoholotype.—*Veneriglossa vesica* Dall. Plate VI, Figures 3, 9. Recent. Gulf of Mexico to Barbados.

PITARIA (VENERIGLOSSA) VESICA (Dall)

Plate VI, Figures 3, 9

Cytherea (Veneriglossa) vesica Dall, 1886, Bull. Mus. Comp. Zool., Har. Col., vol. 12, No. 6, p. 275; Dall, 1889, Bull. U. S. Nat. Mus., vol. 37, p. 56.

Veneriglossa vesica Dall, 1889, Proc. U. S. Nat. Mus., vol. 12, p. 270, pl. XIV, fig. 8, 12. *Callocardia vesica* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 370.

Shell thin, inflated, rounded ovate, white, uniformly concentrically grooved, polished; no differentiated dorsal area; lunule wide, short, marked by a fine inscribed line; beaks tumid, involved, as in *Isocardia*, twisted away from the hinge-line so that their tips are widely separated; margins thin, simple; hinge with the teeth arranged much as in *Cytherea sayana* Conrad, but with the depressions prolonged into pits, the ends of the teeth sharp and pointed, and the ventral margin of the hinge-shelf upturned; ligament long, in a deep groove, passing away from the hinge line under the beaks as in *Isocardia*; muscular impressions small, near the margin; pallial line with a shallow wide wave just before the posterior adductor scar. Lon. of shell 22.0; alt. 21.0; diam. 17.0 mm.

Habitat, Station 36, 84 fms., in the Gulf of Mexico; Station 167, near Guadelupe, in 175 fms.; Barbados, 100 fms., by the "Hassler"; all dead valves.

This is a very singular shell. In the absence of the soft parts I am at a loss to place it. If it were not for the slight wave in the pallial line, I should, in spite of its Venerid teeth, have placed it in the *Isocardidae*. The very young shells, though

more elongated and less tumid, resemble *Vesicomya atlantica* Smith; the adults are more like it on a larger scale. The dentition is altogether different from *Ciree*, and those forms of *Cytherea* which have somewhat similar teeth have the beaks and ligament different, and an angular pallial sinus. It seems to be worthy of a section to itself.—[Dall, 1886.]

The teeth of this shell are like those of *Pitarella* in character and arrangement. The middle, left cardinal is slightly shorter. The lack of a well developed pallial sinus excludes the species from *Pitarella*. The shell of the form is very thin and the pallial line and sinus are difficult to determine. A slight, wavy indentation in the pallial line may be distinguished just anterior to the posterior adductor muscle.

Holotype.—? Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

Occurrence.—Recent. Gulf of Mexico to Barbados, 84 to 175 fathoms. (Dall.)

Subgenus CALLOCARDIA Adams

Callocardia A. Adams, 1864, Ann. and Mag. Nat. Hist., 3rd ser., vol. XIII, p. 307.

Caryatis Sowerby, 1888, Proc. Zool. Soc. Lond., p. 218.

Callocardia Dall, 1889, Proc. U. S. Nat. Mus., vol. 12, p. 266, pl. 10, fig. 5; E. A. Smith, 1900, Proc. Mal. Soc. Lond., vol. 4, p. 81, fig. in text; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 353 in part; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1259 in part; Jukes-Browne, 1913, Proc. Mal. Soc. Lond., vol. 10, pp. 340, 341, 346.

Testa cordata, tenuis, lævis, inflata; umbonibus parvis, subspiralibus, approximatis. Cardo (in valva sinistra) dentibus duobus inaequalibus, cum foveola angusta arcuata interposita, munitus; dente antico valde prominente, in medio angulatum flexo cum fossula antica et postica instructo, margine quadricuspidato; dente postico obliquo, arcuato, angusto, elongato, margine denticulis duobus vix elevatis instructo; dentibus lateralibus nullis. Pallii linea simplex; impressiones musculares semilunares.

This genus is proposed for the reception of a beautiful shell, of which, unfortunately, I possess but a single valve, which in general appearance most nearly resembles a *Bucardia*. The surface of the valve is simple, as in *B. cor*, but it is not covered with an epidermis. The complicated nature of what I have termed the anterior cardinal tooth, which is furnished with four prominent cusps, and is angularly bent on itself in the middle, with a triangular pit on each side, together with the absence of lateral teeth, will distinguish *Callocardia* from the *Isocardia* of Lamarck. The genus *Anisocardia* of M. Munier-Chalmas, founded on a fossil shell from the Kimmeridge Clay of Havre, appears to bear some resemblance to my proposed genus; but in that form the surface of the valves is radiately grooved, the anterior muscular scar projects as in *Cucullæa*, and the disposition of the hinge-teeth seems to be very different.—[Adams, 1864.]

Genoholotype.—*Callocardia guttata* A. Adams. Plate VII, Figures 1, 4, 11. Recent. Off Quelpaart Id., Korea, 48 fathoms.

The type of *Callocardia* is in the British Museum. There is a single left valve which has been broken. S. F. Harmer, Keeper of Zoology at the Natural History Division of the British Museum kindly sent the including drawing and photographs of the type specimen. Dr. Dall published previously a figure of a drawing made by E. A. Smith of the British Museum and Mr. Smith figured later the hinge. It is from the notes and figures of the authors mentioned, together with the original description that one may derive a conclusion as to the relationship of the genus.

A definite anterior lateral is not present. There is an intimation by the curvature of the hinge of the left valve in the region anterior to the cardinals that a slightly elevated area might occur. Smith, in his drawing of the restored right valve indicates a slight concavity in the corresponding region. The "anterior cardinal tooth" mentioned by Adams refers to the two united cardinals, beneath the beak in the left valve which are bent angularly a little anterior to the middle. The left, posterior tooth is long and free. The figure of the right valve as drawn by Smith shows a right, bifid, posterior cardinal which is continuous with an anterior cardinal. The middle, right cardinal is indicated as present. Adams gave the pallial line as simple. The later authors who have examined the shell, say that the pallial line is discernible poorly so that the degree to which the line may be sinuated can not be stated. The original description states that the anterior cardinal is furnished with four, prominent cusps. E. A. Smith mentions that three cusps may be seen instead of four. The actual nature of these cusps can not be determined from the illustrations or published notes. The character of the lunule is not given. A prominent flexure is seen on the posterior end of the shell.

Dr. Dall has pointed out a relationship of this form with *Agriopoma texasiana*. There is a strong resemblance between the hinges of the two. *Agriopoma* has a minute but distinct, anterior lateral which is distant from the cardinal teeth. Its hinge is that of *Pitaria* s. s. which is the result of an under or over development of the anterior, lateral tooth. *Callocardia* does not have the anterior lateral as well developed as *Agriopoma*. It also lacks a well developed pallial sinus. *Veneriglossa vesica* represents a group of *Pitaria* with a nearly simple pallial line. It, however, has a small but distinct, anterior lateral which is very close to the cardinal teeth. Since *Pitaria* represents the old stock, well developed in the Eocene and well represented thruout the Cenozoic and Recent, showing definite, well developed structures, we believe that the most satisfactory classification defines *Pitaria* as the genus and the modifications of the *Pitaria* characters, as subgroups under that genus. The characters of *Callocardia* are known too obscurely to include shells with well developed characters which are typical of the genus *Pitaria*.

Several eastern American species besides those listed or discussed in the present paper, have been referred to *Callocardia* and later changed to a genus of another family. For convenience the following list is cited:

Callocardia (*Vesicomya*) *pilula* Dall, 1881, Caribbean Sea.=*Vesicomya pilula*.

Callocardia (*Vesicomya*) *venusta* Dall, 1886, N. Carolina, Cuba.=*Vesicomya venusta*.

Callocardia albida Dall, 1889. Rio de Janeiro.=*Vesicomya albida*.

Callocardia Smithii Dall, 1889. Off Tobago.=*Vesicomya Smithii*
Callocardia (Callogonia) Leeana Dall, 1889. Off Tobago.=*Vesicomya Leeana*.

Subgenus LAMELLICONCHA Dall

Lamelliconcha Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 354; Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1265.
 Shell trigonal, subcompressed, concentrically ribbed or laminate, without spines; the edges of the nymphs smooth; otherwise like *Hysteroconcha*.
 Tropical seas, especially in America.—[Dall, 1902.]

Hinge of *Pitaria*; lunule small, defined by an incised line; escutcheon narrow, defined by an incised line; inner margins smooth; pallial sinus rounded, large, extending past the midline of the shell; shell moderate in size.

Genoholotype.—*Cytherea concinna* Sowerby, Plate VIII, Figures 5, 20, 29, 30. Recent. Magdalene Bay south to Payta, Peru.

The chief distinction between the shells belonging to the group *Lamelliconcha* and those belonging to *Hysteroconcha* is in the character of the concentric ribs. The concentric ribs in *Hysteroconcha* are more laminate and develop spines posteriorly. The size of the spines varies in different species. *Lamelliconcha* includes a large number of species which represent the group of *Pitaria* with concentric ribbing. Initial development of this variation from the smooth character of *Pitaria* s. s. is found on specimens in the Eocene where shells are partially ribbed. The subgroup begins in the Eocene. Since *Lamelliconcha* is the general group and has the greater geologic range, it has been made the subgenus with *Hysteroconcha* as the section instead of the reverse order as used formerly.

In eastern America the subgenus ranges from the Eocene and occurs in the Recent.

Stratigraphic Range of *Lamelliconcha* subgenus s. s.

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
macbeani	imitabilis	harrisi	labreana	circinata	eucymata
trigoniata	astartiformis	hilli	circinata		circinata
var. bastro-	perbrevis	var. muscanica			
pensis	siliciflvia	filosina			
yoakumi	calcanea	cora			
		casta			
		boucaaryensis			
		circinata			
		and varieties			
		elethusa			
		perarcana			
		baumanni			
		zertummi			

PITARIA (LAMELLICONCHA) YOAKUMI (Gabb)

Plate VIII, Figure 14

? *Meretrix Yoakumii* Gabb, 1861, Acad. Nat. Sci. Phil. Proc., vol. 13, p. 370; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Megetrix yoakumi Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 150.

Shell sub-quadrate; beaks prominent, placed one-third of the distance from the anterior extremity, which is regularly rounded. Posterior cardinal margin straight. Anal extremity subtruncated. Surface marked by numerous very regular concentric ribs, which are abrupt on the side towards the beak, and slope concavely on the other side. Crests of the ribs rounded or subangular. Interspaces a little wider than the ribs.

Length, 3 in.; width, 4; height of valve, .09 in.

From a brown, highly ferruginous sandstone, (Eocene). Caddo Peak, Texas. Collected by Prof. Yoakum.

The specimen being so imbedded that I could not obtain a view of the hinge, renders the determination of the genus somewhat doubtful; but since it presents the usual appearance of this genus more strongly than any other, I refer the species provisionally as above. The shallow valve, the abrupt posterior end, and the very distinct ribs (about thirty in number on the specimen before me), will serve to separate the species from all the other known species.—[Gabb, 1861.]

This species is represented by the type only which is a perfect specimen of one valve imbedded in a ferruginous sandstone.

The shell is small. The ribs are raised, very distinct, with interspaces about equal in width to the ribs. The form differs from *P. trigoniata* and the variety *bastropensis* in being truncated posteriorly. The concentric ribs are wider than on either of those two forms.

Dimensions.—(Holotype). 10 mm., length; 7.5 mm., height; 3 mm., semidiameter.

Holotype.—No. 3958. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Eocene. Caddo Peak, Texas.

PITARIA (LAMELLICONCHA) TRIGONIATA (Lea)

Plate VIII, Figures 27, 32

Cytherea trigoniata Lea, 1833, Cont. to Geol., p. 67, pl. 2, fig. 44.

Cytherea discoidalis Conrad, 1833, Foss. Sh. Tert. Form., vol. 1, No. 3, not description, p. 37, Harris Reprint, 1893, pl. 20, fig. 2.

Dione discoidalis Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6, in part; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Cytherea trigoniata De Gregorio, 1890, Ann. de Geol. et de Pal., 7 et 8 liv., p. 218, pl. 34, figs. 15-21.

Megetrix aquarea trigoniata Cossmann, 1893, Ann. de Geol. et de Pal., 12 liv., p. 10.

Megetrix trigoniata Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 146, pl. 47, figs. 1-3.

Shell somewhat inflated, triangular, concentrically and minutely striate; substance of the shell rather thick; beaks moderately elevated and recurved; lunule long, elliptical; teeth moderately large; excavation of the pallial impression deep and rounded; cavity of the shell deep, sub-angular; margin entire.

Diam. .6, Length .9, Breadth 1.1, of an inch.

Observations.—In outline the *trigoniata* resembles closely the *suberassa*. It is, however, less thick in the substance of the shell, has much finer striae, and is entirely without crenulations on the margin.—[Lea, 1833.]

As has been pointed out by De Gregorio and Prof. Harris, Conrad could not have had *trigoniata* in mind when he wrote his description of *discoidalis*, Fos. Sh. N. Amer., 1833, p. 37. His figure, pl. 20, fig. 2, Harris reprint labelled *discoidalis* is *trigoniata* Lea.

This species approaches the sculptural characteristics of *Lamelliconcha*. The concentric ribbing is definite, but very fine. It does not seem to have attained the development as shown in the later Tertiary and Recent species of *Lamelliconcha*. Possibly this and the following related Eocene species

should not be classed under the subgenus of *Pitaria*. However, the fine sculpture eliminates the forms from typical *Pitaria*. Initial development forms must, in many cases, be put arbitrarily under groups of which they have not developed fully the characters.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—St. Maurice Eocene. Base of Claiborne Bluff, Hamilton Bluff, Ala.; Ft. Gaines, Ga.; 5 miles N. of Orangeburg, S. C.; Claiborne Eocene. Sand bed of Claiborne Bluff, Ala. Jackson Eocene. Ark.

PITARIA (LAMELLICONCHA) TRIGONIATA BASTROPENSIS (Harris)

Plate VIII, Figures 13, 17, 21

Cytherea nuttali Conrad, 1857, U. S. and Mex. Bound. Sur., Geol. and Pal., p. 162, pl. 4, fig. 5.

Cytherea discoidalis Heilprin, 1890, Proc. Acad. Nat. Sci., vol. 42, p. 402.

Cytherea nuttali Heilprin, *ibid.*

Meretrix trigoniata var. *bastropensis* Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 148, pl. 47, figs. 4-6.

General form as figured: possessing two aspects according to the kind of matrix in which it is preserved: 1st, when preserved in clay or ferruginous sand,—Substance of shell thin; small; external surface with beautiful, evenly sculptured concentric striae; lunule large, long, defined by a very faintly impressed line; somewhat resembling *trigoniata* Lea, though too circular in outline (fig. 4). 2nd, when preserved in firm calcareous sandstone,—Shell comparatively larger, thicker, with less plainly marked, concentric striae on the umbones and much coarser lines or rugæ near the anterior, basal and posterior margins (fig. 6). This form is very similar to that described by Conrad as *Dosinia alta*, from Canyada de las Uvas, California. The figure he gives is exceedingly poor and misleading. The type specimen, or that marked as such and broken in the manner illustrated, is in the collection of the U. S. National Museum.

This species is generally characterized by the broad, circular form of its posterior margin. The form together with the character of the concentric striae or rugæ on the larger specimens found along the Rio Grande will serve to differentiate it from *trigoniata* or *nuttali*. In the last mentioned species the rugæ are sharp or lamellar, while in *bastropensis* they are rounded, or semicylindrical. The pallial sinus deeper than in *trigoniata*.

Type specimens.—Pl. 47, fig. 4, Mus. No. 407, Sta. 37; fig. 6, No. 1721, Sta. 11. Texas State Museum. Now at the Univ. of Texas.

Geological horizon.—St. Maurice Eocene.

Localities of form No. 1.—Devil's Eye, Colorado River, Bastrop Co.; Smithville, Bastrop Co.; Moseley's Ferry, Brazos R., Burl. Co.; Brazos R., 500 yards below the mouth of Little Brazos R., Brazos Co.; Cedar Cr., S. E. corner of Wheelock league, Robertson Co.; Campbell Cr., Gifford headright, Robertson Co.; Orrell's Crossing, Elm Cr., Lee Co.

Localities of form No. 2.—Rio Grande, six miles above Starr-Zapata Co. line; Rio Grande, Mexican side, one mile above the Starr-Zapata Co. line; Rio Grande, 15 miles below Carrizo; Rio Grande, 6 miles below Carrizo; Dr. Williams' quarry, on Robert Stephenson's headright, Brazos Co.; Hammett's Branch, Louisiana.—[Harris, 1919.]

PITARIA (LAMELLICONCHA) MACBEANI (Harris)

Plate VIII, Figures 7, 9.

Meretrix macbeani Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 140, pl. 44, figs. 7, 8.

Size and general appearance shown by fig. 8; substance of the shell rather thick; concentric lirations well-defined and smooth; neither escutcheon nor lunule sharply defined; pallial sinus V-shaped; anterior lateral tooth large and strong.

Dimensions of right valve. 21 x 12 x 5.5 mm.

This is but distantly related to any other Cytheroid shell known to the writer

from the Eocene of America. In many respects it approaches *Pitaria* s. s. as defined by Dall.

The type specimen (an only one known) is from McBean Creek, Burke Co., Ga. and is in the U. S. Nat. Mus. at Washington, D. C.—[Harris, 1919.]

Occurrence.—Eocene.

PITARIA (LAMELLICONCHA) IMITABILIS (Conrad)

Plate VIII, Figures 6, 15, 23, 33

Cytheræa imitabilis Conrad, 1847, Proc. Acad. Nat. Sci. Phil., vol. 3, p. 292; Conrad, 1848, Jour. Acad. Nat. Sci. Phil., 2nd Ser., vol. I, p. 123, pl. 13, fig. 14.

Meretrix imitabilis Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 30; *ibid*, 1855, vol. 7, p. 257.

Dione imitabilis Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6; Conrad, 1866, Smith. Misc. Coll., vol. VIII, No. 200, p. 28.

Pitaria (Lamelliconcha) imitabilis Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1268.

Cordate, inequilateral, plano-convex, with numerous concentric prominent acute ribs; extremities rounded; basal margin regularly curved; lunule ovate, defined by an impressed line. Length 1 7/10. Height 1 3/10. Common.—[Conrad, 1847.]

Shell medium in size; the interspaces are not quite as wide as the concentric ribs; hinge is typical.

Dimensions.—43 mm., length; 34 mm., height; 10 mm., semidiameter.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Oligocene. (Type) vicinity of Vicksburg, Miss. (Conrad) (Cornell Univ. Pal. Lab.); Moody's Branch and Dry Creek, Miss. (Moore in Hilgard '60); upper portion of marl on Chickasway River, Clarke County, Miss., at German Berry's S. 11, T. 4, R. 2E, Monterey P. O., Rankin County, Miss. (Hilgard); Johnson's sink, Levy County and Martin Station, Marion County, Florida. (Dall.)

PITARIA (LAMELLICONCHA) ASTARTIFORMIS (Conrad)

Plate VIII, Figures 2, 3, 24

Cytheræa astartiformis Conrad, 1847, Proc. Acad. Nat. Sci. Phil., vol. 3, p. 292; Conrad, 1848, Jour. Acad. Nat. Sci. Phil., vol. I, 2nd ser., p. 123, pl. 13, fig. 13.

Meretrix astartiformis Con., 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 29.

Dione astartiformis Conrad, 1865, Amer. Jour. Conch., vol. I, pp. 6, 190; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 28.

Pitaria (Lamelliconcha) astartiformis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1269.

Trigonal, elevated, ventricose, subequilateral, with numerous regular concentric grooves and obtuse ridges; lunule not defined; summits prominent; umbo flattened. Length 6/10; height 1/2.

This shell has a remarkable resemblance on the exterior to some species of *Astarte*. Rare.—[Conrad, 1847.]

Shell somewhat flattened; concentric ribs prominent, and undulating;

the paratypes of Conrad are worn in the lunular region so that probably shells in perfect condition would show the lunule defined faintly. The anterior lateral is large. This species differs from *P. silicifluvia* of Dall in being very much flatter, in having a more elongate, lunular region and in the ribs being broader. The concentric ribs of the two species are alike in being rounded and undulating.

P. astartiformis differs from *P. perbrevis* in being less elevated and having larger, concentric ribs with the interspaces wider.

Dimensions.—(Largest specimen) 15 mm., length; 13 mm., height; 4 mm., semidiameter.

Holotype and Paratype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Oligocene. (Type) Vicksburg, Miss.; Mint Spring Bayou, Layer N, Vicksburg, Miss. (Cornell Univ. Pal. Lab.). Lower Miocene. Chipola beds at Alum Bluff and on the Chipola River, Calhoun county, Florida. (Dall.)

PITARIA (LAMELLICONCHA) PERBREVIS (Conrad)

Plate VIII, Figure 16

Cytherea perbrevis Conrad, 1847, Acad. Nat. Sci. Phil. Proc., vol. 3, p. 293; Conrad, 1848, Acad. Nat. Sci. Phil. Jour., 2nd ser., vol. I, p. 123, pl. 13, fig. 18; Conrad, 1854, Proc. Acad. Nat. Sci., vol. 7, p. 30.

Dione perbrevis Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Pitaria perbrevis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1266.

Ovate-triangular, elevated, ventricose; the posterior and anterior margins equally declining and very oblique, the anterior one straight, the posterior slightly curved; beaks medial; surface with numerous regular impressed lines; basal margin rounded. Length and height 6–10.

It is of the size, and has somewhat the form of *V. Astartiformis*, but the greater elevation, convex umbo, numerous impressed lines, and more rounded base distinguish it from that species. Rare.—[Conrad, 1847.]

The specimens of the Conrad types of the Vicksburg species described as *Cytherea* have been mixed. The shells of *C. semipunctata* which Conrad figured but did not describe were labelled *C. perbrevis*. The holotype of *perbrevis* has been in the tray with the paratypes of *C. astartiformis*. *Pitaria perbrevis* is like *P. astartiformis* in being high and short but it is more elevated and the ribs are much smaller, flatter and closer together.

Dimensions.—(Holotype) 15 mm., length; 15 mm., height; 7 mm., semidiameter.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Vicksburg Oligocene. Vicinity of Vicksburg, Miss. (Type); (Cornell Univ. Pal. Lab.).

PITARIA (LAMELLICONCHA) CALCANEA Dall

Plate VIII, Figures 18, 25

Pitaria (Lamelliconcha) calcanca Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1270, pl. 55, fig. 19; Dall, 1916, Proc. U. S. Nat. Mus., vol. 51, No. 2162, p. 501. Oligocene of Vicksburg, Mississippi; Johnson and Crutcher.

Shell small, solid, subtriangular, elevated, with prominent anteriorly twisted beaks; lunule impressed, obscurely limited by an impressed line, rather large, cordate; an obscure ridge extends from the beaks backward and downward to the lower posterior end of the shell; anterior end attenuated, rounded; posterior end broader and more bluntly rounded; base arcuate; sculpture of thick, adjacent, low, rounded concentric ribs, smooth except for the ribbing; when partly eroded showing fine, thread-like, concentric structure; nymphs short; hinge solid, concentrated; the teeth entire, the

posterior left cardinal slender, the anterior lateral stout and prominent; internal margins entire; pallial sinus linguiform; slightly ascending, not reaching the middle of the shell. Length 17, height 15, diameter 10 mm.

This shell is somewhat rude and individuals differ somewhat in form, but all show the elevated and twisted beaks and the broad, low, thick ribs, differing from *P. astartiformis*, which has narrow ribs terminally acute, separated by deep channels.—[Dall, 1903.]

Holotype.—No. 136750, United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Vicksburg, Miss.; Station 7096, at Red Bluff, on the west bank of the Flint River, 7 miles above Bainbridge, Decatur County, Georgia. U. S. Nat. Mus. Cat. No. 166773 (Dall). Mint Spring Bayou, Vicksburg, Miss. (Cornell Univ. Pal. Lab.).

PITARIA (LAMELLICONCHA) SILICIFLUVIA Dall

Plate VIII, Figures 1, 4

Pitaria (Lamelliconcha) silicifluvia Dall, 1916, Proc. U. S. Nat. Mus., vol. 51, No. 2162, p. 500, pl. 85, figs. 2, 3.

Shell small, inflated, arcuate, moderately thick; valves slightly inequilateral, rounded in front and behind with a prominently arcuate base, the inner margins smooth; beaks prominent, inflated, small, conspicuously incurved and prosocoelous, with an impressed and broadly heart-shaped lunule bordered by an impressed line; sculpture of small concentric waves with narrower interspaces; the crests of the waves, at first rounded, become more sharp-edged and crowded toward the basal margin; in the left valve there is no escutcheon; pallial line obscure, but the sinus is apparently small and triangular; the hinge is strongly developed, the middle cardinal largest, the anterior left lateral strong and subconic. Height of valve, 16; length, 19; length behind the vertical from the beaks, 14; double diameter of left valve, 16 mm.—[Dall, 1916.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Station 7096, at Red Bluff, west bank of Flint River, 7 miles above Bainbridge, Decatur County, Georgia. U. S. Nat. Mus. Cat. No. 166718; Vicksburg, Miss. (Dall).

PITARIA (LAMELLICONCHA) HARRISI Maury

Plate VIII, Figure 22

Pitaria (Lamelliconcha) harrisi Maury, 1910, Bull. Amer. Pal., vol. 4, No. 21, p. 155, pl. IX, fig. 7.

Shell nearly orbicular, slightly compressed and inequilateral, with regular, close, concentric ribs; beaks not prominent; lunule rather small, well-defined, cordate; anterior end rounded; posterior bluntly angulated; base either rounded or in some specimens slightly angulated; hinge strong, the anterior laterals and the cardinals well developed; pallial sinus deep, ascending, triangular, reaching to the middle of the shell. Length of largest specimen 16.5; height 15; diameter of one valve 3 mm. The usual size is, however, much smaller.

This species resembles in general form and sculpture *P. imitabilis* Conrad, but the shell is smaller and the ribbing closer.

Chipola marls, Bailey's Ferry, Florida.
Cornell University collection.—[Maury, 1910.]

In the character of the ribbing and general outline of shape there seems to be a close relationship of the Bailey's Ferry form to the Vicksburg species. *P. harrisi* is more blunt, i. e., shorter and smaller than *P. imitabilis*. It is represented by the holotype only, and may be a young specimen.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Miocene. Chipola marls, Bailey's Ferry, Florida.

PITARIA (LAMELLICONCHA) BOUCARYENSIS Olsson

Plate VIII, Figure 12

Pitaria boucaryensis Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 239, pl. 31, fig. 10.

Shell rounded quadrate, thin and moderately convex; posterior and anterior extremities rounded, umbos rather large; lunule small and feebly defined by a faint, impressed line; surface of disk sculptured with about 40 even, distant, concentric lamellæ; interspaces generally smooth or irregularly sculptured with growth lines; interior shell concealed.

Length 31, height 22, diameter (right valve) 10 mm.

As the single type specimen is fragmentary and imbedded in a hard sandstone, the above measurements are but approximate. It is a very distinctive species, differing from the other fossil Costa Rican *Pitarias* by its more delicate and convex shell and more distant, even, concentric lamellæ.

Gatun Stage: *Boucary creek, C. R.*—[Olsson, 1922.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Boucary Creek, Costa Rica.

PITARIA ? (LAMELLICONCHA) HILLI (Dall)

Plate VIII, Figure 11

Pitaria (Lamelliconcha) Hilli Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1268, pl. 54, fig. 7; Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci., vol. 63, p. 370.

Oligocene of the vicinity of Gatun on the line of the Panama Canal, Colombia. Shell elongated, moderately convex, ovate inequilateral, the beaks within the anterior third, moderately prominent; lunule small, impressed, lanceolate; surface sculptured with narrow, low, roundish ribs with narrower deep sulci between them; an obscure ridge extends from the beaks to the lower posterior margin, which it almost angulates; anterior end rounded, base gently arcuate; posterior end blunt rather than truncate; hinge obscured by the matrix; pallial sinus deep, reaching beyond the middle line of the shell, rather narrow. Length about 36, height 22, diameter 13 mm.

This has somewhat the aspect of a *Paphia*, but until the hinge is better known in all probability it will be most suitably placed here. A larger, somewhat rudely concentrically striated species also occurs in the same beds but is represented by such inadequate material in our collection that I refrain from attempting to describe or name it.—[Dall, 1903.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Miocene. In the vicinity of Gatun on the line of the Panama Canal.

PITARIA (LAMELLICONCHA) HILLI MUSANICA Olsson

Plate VIII, Figure 31

Pitaria Hilli Dall var. *musanica* Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 237, pl. 31, fig. 5.

Shell elongate, moderately convex and rather solid; beaks situated at the anterior $\frac{1}{2}$, with the anterior extremity widely rounded but obtusely pointed posteriorly; lunule small, ridged in the middle and defined by a faint line; posterior-dorsal area broad and flat; surface of the shell sculptured with low, irregular, rounded, concentric ribs, which are persistent along the posterior-dorsal slope but lacking elsewhere near the ventral margin; interior of the shell unknown.

Length 42, height 27, thickness (left valve) 10.50 mm.

This species has a solid shell like that of *Macrocallista*. It differs from the true *Hilli* described by Dall from the Gatun of the Canal Zone, by its more rude and irregular concentric sculpture.

The *P. planivicta* Guppy, from the Miocene of Jamaica and Santo Domingo is a much shorter and more regularly sculptured shell.

Gatun Stage: Hill No. 2, Banana River, C. R.—[Olsson, 1922.]

This species is known only by one specimen. It is embedded in a hard sandstone so that the hinge has not been determined. The posterior, dorsal margin has been crushed so that the shell appears to be more pointed than it would be normally. The surface of the shell is not eroded along the ventral margin and shows that region to be smooth except posteriorly. The outer shell has been eroded on the umbonal region and beneath, are seen two layers of fine, concentric striæ. Along the beaks and the dorsal region, the surface appears to be smooth.

Holotype.—Paleontological Museum, Cornell University, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Hill No. 2, Banana River, Costa Rica.

PITARIA (LAMELLICONCHA) CASTA (Pilsbry and Brown)

Plate VIII, Figure 26

Pitaria (Hysteroconcha) casta Pilsbry and Brown, 1917, Proc. Acad. Nat. Sci. Phil., vol. 69, p. 38, pl. 6, fig. 4.

The shell is oblong with small, rather plump beaks. Sculpture of continuous, smooth, concentric ridges, their edges overhanging the succeeding intervals a little, smooth concentric ridges, their edges overhanging the succeeding intervals a little, and some of them broadened into lamellæ at the anterior end. They are not enlarged or interrupted posteriorly, and there are no spines. Between the concentric ridges there are fine growth-lines, some of them larger, thread-like. Lunule defined by a groove, radially striate. Interior not seen. Length about 26 mm.; height 19 mm.; semidiameter 6 mm.

The sole specimen is partially imbedded in material too hard to be removed, so that the internal characters and posterior end could not be examined. The sculpture, however, is very perfectly preserved and characteristic, and leaves very little doubt that the shell is related to the recent *P. dione* (L.). The absence of spines would be expected in an early member of the group. The concentric lamellæ are developed than in *P. dione*, and turn downwards at the edge. In contour *P. casta* stands nearer to *P. lupanaria*.—[Pilsbry and Brown, 1917.]

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Gatun Miocene. Near Cartegena, Colombia. (Pilsbry and Brown.)

PITARIA (LAMELLICONCHA) CORA Brown and Pilsbry

Plate VIII, Figure 8

Pitaria cora Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., vol. 63, p. 370, pl. 28, fig. 3.

The shell is extremely thin, oval, with prosogyrate beaks at the anterior fourth; rather plump; dorsal margin rather concave in front of, and slightly convex behind, the beaks. Sculpture of fine, nearly even concentric riblets, without radial striation. No defined lunule or escutcheon. Interior unknown, but the valve-margins are smooth inside.

Length 35, alt. 26.5, diam. 18.5 mm.

This species occurred as casts in a hard matrix retaining the shell in places. *P. hilli* Dall is a longer, lower shell.—[Brown and Pilsbry, 1911.]

Holotype.—Academy of Natural Science, Philadelphia, Pa.

Occurrence.—Gatun Miocene. From the excavations for the locks, Gatun, Panama. (Brown and Pilsbry.)

PITARIA (LAMELLICONCHA) FILOSINA Dall

Plate VIII, Figure 10

Pitaria (Lamelliconcha) filovina Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1270, pl. 57, fig. 1.

Pitaria filovina Gardner and Aldrich, 1919, Proc. Acad. Nat. Sci., vol. 71, p. 19.

Upper Miocene of North Carolina at the Natural well in Duplin County; Burns. Shell small, subcompressed, ovate-trigonal, with low, small, pointed beaks; lunule large, lanceolate, hardly differentiated from the rest of the surface by an obscure impressed line, the surface of the lunule sculptured like the rest of the shell and not impressed; surface with very fine, close, thread-like concentric ribs but no radial sculpture; hinge well developed but delicate; the anterior right, the posterior and anterior left cardinals entire, the others grooved or bifid; the anterior lateral inconspicuous; the anterior left and posterior right dorsal margins grooved to receive the edge of the opposite valve, the basal margins entire; the pallial sinus large, linguiform, ascending towards the umbo. Length 7.75, height 7.5, diameter 4.0 mm.

This odd little shell recalls *Gouldia* by its form and *Dosinia* by its sinus. Nothing very close to it in the Miocene has turned up.—[Dall, 1903.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Upper Miocene, Duplin stage. Natural Well, Duplin County, North Carolina. (Dall.) Muldrow Place, Sumter county, about 5 miles southeast of Maysville, South Carolina. (Gardner and Aldrich.)

PITARIA (LAMELLICONCHA) ELETHUSA (Woodring)

Plate IX, Figures 6, 6a

Callocardia (Callocardia) elethusa Woodring, 1925, Carnegie Inst. Wash. Pub. No. 366, p. 152, pl. 20, figs. 13, 14.

Shell small, strongly inflated, ovate; umbos high and full; lunule wide and long; sculpture consisting of closely and evenly spaced concentric rugae; hinge and inner edge of valve as in *Callocardia ammondea*.

Length 8.5 mm.; height 7.5 mm.; diameter (left valve) 2.5 mm.

The holotype is considerably larger than any other valve. This species is more inflated than *C. ammondea*, and has higher, fuller umbos, wider lunule, and more uniform sculpture.

Type material.—Holotype (left valve, U. S. Nat. Mus. No. 352831).—[Woodring, 1925.]

The hinge of this species is that of *Pitaria* rather than that of *Callocardia*. The left anterior lateral is developed too strongly for the species to be placed under *Callocardia*. The sculpture of the shell as magnified in the illustration of the species, is more pronounced and regular than *Pitaria* s. s. It is questionable whether the sculpture is typically that of *Lamelliconcha*.

Occurrence.—Miocene. Bowden, Jamaica.

PITARIA (LAMELLICONCHA) CIRCINATA (Born)

Plate IX, Figures 10, 11, 12, 15, 16, 19

Venus circinata Born, 1780, Test. Musei Cæsarei Vind., p. 61, tab. IV, fig. 8; Dillwyn, 1817, Cat. Recent Shells, I, p. 169.

Cytherea alternata Broderip, 1835, Proc. Zool. Soc. Lond., p. 45 (Pacific variety).

Dione circinata Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 77; Reeve, 1863, Conch. Icon., *Dione*, pl. VII, fig. 25a, b; (fig. 28a, b, *alternata* Broderip).

Callista circinata H. and A. Adams, 1857, Gen. Rec. Moll., p. 425.

Cytherea juncea Guppy, 1866, Quart. Jour. Geol. Soc. Lond., vol. 22, p. 582, pl. XXVI, fig. 13 variety.

Dione circinata Römer, 1869, Mon. *Venus* s. g. *Cytherea*, p. 135, pl. 36, fig. 1; (fig. 2, *alternata*).

- Chione circinata* Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 250.
Callista acuticostata Gabb, 1873, op. cit., p. 250.
Cytherea circinata Guppy, 1874, Geol. Mag., vol. 11, p. 442.
Cytherea juncea Guppy, 1874, op. cit., p. 442; Guppy, 1876, Quart. Jour. Geol. Soc. Lond., vol. 32, p. 531 variety.
Venus circinata D'Orbigny, 1878, Arango Fauna Mal. Cuba, p. 249.
Meretrix circinata Dall and Simpson, 1900, Bull. U. S. Fish. Com., vol. 1, p. 485.
Pitaria (Lamelliconcha) circinata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 377; var. *alternata* Dall, op. cit., p. 389; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1269; Dall, 1910, Proc. U. S. Nat. Mus., vol. 37, No. 1704, p. 266.
Cytherea juncea Guppy, 1911, Agr. Soc. Trinidad, No. 454, p. 5 variety.
Pitar circinata Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., vol. 63, p. 370.
Pitaria (Lamelliconcha) circinata Maury, 1912, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. XV, p. 56, pl. 9, fig. 12, 13 young.
Pitaria (Lamelliconcha) acuticostata Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 380, pl. 37, fig. 2.
Pitaria (Lamelliconcha) circinata Maury, 1917, op. cit., p. 379, pl. 37, fig. 1 = variety *mauryæ*.
Pitar (Lamelliconcha) acuticostatus Pilsbry, 1921, Proc. Acad. Nat. Sci. Phil., vol. 73, pt. 2, p. 422, pl. 47, fig. 10.
Pitaria (Lamelliconcha) circinata Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 236, pl. 31, figs. 3, 9; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 149, pl. 27, figs. 12, 13 and variety *juncea* p. 150, pl. 27, figs. 6, not fig. 10.
not *Pitaria* cf. *circinata* Maury, 1925, Ser. Geol. E. Min. do Brazil, p. 453, pl. 18, fig. 2 = *Anomalocardia brasiliana* (Gmelin).
Germ. Die gereiste Venus.

Testa subcordata, membranis transversis arctis, areola impressa ovata, limbo integro.

Testa habitu Veneris Dionis, subcordata, umbonata, membranis transversis elevatis imbricatis arctis cincta; Sinus utrinque labiatus, labiis inæqualibus; Areola cordata impressa; Limbus integerrimus; Color pallide roseus, radiis obsoletis albis. Long. l. poll. 2. lin. lat. 1. poll. 4. lin. Patria ignota.—[Born, 1780.]

Shell subtrigonal, ventral margin regularly rounded; posterior end with a slight tendency to become truncated; surface ornamented with prominent, equal or subequal, concentric ribs which are thin and lamellose in many cases; numerous, microscopic striæ occur between the ribs; lunule small, inequilateral, larger on the right valve, heart-shaped, bounded by an impressed line; escutcheon very narrow; beaks small and pointed; hinge and pallial sinus typical of the subgenus. The lunule and escutcheon have a deep, purple coloration. The shell is white with reddish or pinkish radiating bands.

The Pacific form of this species is *alternata* described by Broderip. A specimen is figured on plate IX, Figure 16. The interspaces between the concentric ribs are wider than the typical form. Some of the smaller shells as those from Panama are a little more pointed and slightly less broad posteriorly than *circinata* s. s. The shells from Panama of *alternata* are of a reddish purple, uniform color. The Miocene specimens which Mr. Olsson collected at Gatun, Panama and in Costa Rica are like *alternata* in the arrangement of the ribs.

Guppy described *C. juncea* and Gabb described *C. acuticostata*. Dr. Pilsbry figured the holotype of *acuticostata*. Comparing that figure with specimens of *circinata* of the same size one does not seem to find differences great enough for separation. The *C. acuticostata* of Dr. Maury has also been compared with the young of *circinata* i. e. specimen equal in size and

they seem to be the same. *C. juncea* Guppy might be regarded as a variety of *circinata*.

Dimensions.—33 mm., length; 29 mm., height; 20 mm., width.

The holotype of *acuticostata* Gabb is No. 2776, Academy of Natural Sciences, Philadelphia. 25.5 mm., length; 22 mm., height; 7.2 mm., semi-diameter.

Occurrence.—Lower Miocene. Cercado de Mao, Bluff 3, Santo Domingo, (Maury). Middle Miocene. Gatun, Panama (Dall and Olsson); Saury Creek, Zone E, Costa Rica, (Olsson); Cumana, Venezuela, (Guppy). Pliocene. Matura and Brighton, Trinidad, (Maury and Harris Coll., Cornell Univ. Pal. Lab.). Recent. West Indies, northern South America, south to Santa Caterina, Brazil. (Dall.)

PITARIA (LAMELLICONCHA) CIRCINATA JUNCEA (Guppy)

Plate IX, Figures 13, 14

Synonymy under *P. circinata* (Born).

Shell subtrigonal, rounded anteriorly, and somewhat angular and truncate behind, ornamented with numerous thin concentric lamellæ, alternately rather higher; posterior cardinal area slightly folded, rather indistinct; lunule impressed, striated; umbo small, incurved; hinge-teeth strong, the hinder (of the right valve) bifid, the two anterior ones compressed, close together, and having before them a deep oblong pit for the reception of the tooth of the opposite valve. Hinge-area with a long groove extending from the termination of the ligament nearly to the posterior angle. Upper Miocene, Cumana.—[Guppy, 1866.]

Dr. Maury found in material from Machapoorie Quarry, Trinidad, specimens which have the character of concentric ribs alternating in size as described by Guppy for *P. juncea*. The shell is about the shape of *P. circinata*. The variety of *circinata* called *mauryæ* has the concentric ribs alternating in size over a portion of the shell. That form, however, is elongated more conspicuously than *circinata* and *juncea*.

Dimensions.—Holotype. 30 mm., length; 26 mm., height; 10 mm., semi-diameter.

Holotype.—No. 115549, United States National Museum, Washington, D. C.

Occurrence.—Type. Miocene. Cumana, Venezuela. Machapoorie Quarry, Trinidad. (Maury. Harris Coll. Cornell Univ. Pal. Lab.).

PITARIA (LAMELLICONCHA) CIRCINATA MAURYÆ n. var.

Plate IX, Figures 8, 18, 21

Pitaria (Lamelliconcha) circinata Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 379, pl. 37, fig. 1.

Shell is elongate more conspicuously with the posterior tip broader than *P. circinata* Born; the valves are less convex. On the middle and lower portions of the shell, the ribs alternate in size. The microscopic

striae between the ribs are numerous. In the other characters, the forms are like *circinata*. The variation in shape and ribs is constant among the shells in the collection from Santo Domingo. The young shells are more rectangular than the adults and differ from the young of *circinata* s. s. in having a straighter, ventral line and being less convex.

Dimensions.—35 mm., length; 27 mm., height; 9 mm., semidiameter.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Lower Miocene. Zones H and I, Rio Cana at Caimito, Santo Domingo. One specimen from Bailey's Ferry, Florida.

PITARIA (LAMELLICONCHA) LABREANA Maury

Plate VIII, Figures 19, 28

Pitaria (Lamelliconcha) labreana Maury, 1912, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. XV, p. 57, pl. 9, figs. 14, 15; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 151, pl. 27, fig. 11.

Shell elongate-ovate, rather compressed, inequilateral, lunule small, well-defined, lanceolate; valve sculptured with narrow, round-edged lamellae, with much wider grooves between them; hinge characters shown in the figure; pallial sinus very deep, rounded, broad, extending beyond the center of the valve.

Length of shell 17, height 13, diameter 6 mm.

Remarks.—This species is akin to *P. hilli* Dall from the Oligocene of Gatun on the Panama Canal. It differs from the latter in having a bolder, more distally ribbed type of concentric sculpture, and, as far as shown, is much smaller.

Locality.—Along the shore 1000 feet west of the pier at Brighton, Trinidad, in an impure asphalt.

Geological horizon.—Upper Oligocene. Equivalent to the Chipolan stage of Florida.—[Maury, 1912.]

This species resembles, in the character of the concentric ribs and the attenuate posterior end, *P. concinna* Sowerby. It differs, however, from that species, in the absence of a posterior flexure and in the presence of a more truncated and less pointed, posterior end.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Upper Pliocene. Along the shore 1000 feet west of the pier at Brighton, Trinidad.

PITARIA (LAMELLICONCHA) EUCYMATA (Dall)

Plate IX, Figure 7

Cytherea sp. Dall, 1889, Bull. U. S. Nat. Mus., No. 37, p. 56, No. 290.

Cytherea eucymata Dall, 1889, Proc. U. S. Nat. Mus., vol. 12, p. 271, pl. 13, fig. 11.

Pitaria eucymata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 371; Vanatta, 1903, Proc. Acad. Nat. Sci. Phil., vol. 55, p. 757; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 70.

Shell thin, inflated, concentrically ribbed, waxen white or pale brown, with clouds and zigzag fluctuations of madder brown, polished; adult with about fifty rounded slightly flattened concentric waves with a short dorsal and long ventral slope, separated by narrow sharp grooves; these waves become fused in pairs or alternately obsolete and raised into more thin and elevated lamellae near the posterior dorsal margin; radiating sculpture none, except a narrow ridge bordering the ligamental furrow and the groove which circumscribes the lanceolate lunule; there is no esutcheon; margin elegantly rounded, a little straighter along the ligamental border, outline ovate; beaks full, not prominent; hinge of the genus; the lateral tooth conic in the young, compressed in the adult; margin rounded, smooth; pallial sinus not quite reaching the vertical from the beaks, rounded or subtruncate at its inner part. Adult, maximum longitude 40, altitude 32, diameter 26, vertical from the beaks

behind the anterior end 10; young, maximum longitude 14.5, altitude 11.5, diameter 7.5, vertical 4.5 mm.

Hab.—Station 2402, between the Mississippi delta and Cedar Keys, in 111 fathoms, muddy bottom; station 2604 and 2606, off Cape Hatteras, North Carolina, in 25 to 34 fathoms, sand; west of Florida, in 50 fathoms (U. S. S. *Bache*); station 2640 and 2646, off the southern part of Florida, in 56 to 85 fathoms, sand; and station 2758, 90 miles southeast from Cape San Roque, Brazil, in 20 fathoms, shelly bottom; temperatures 77° to 79.1° F.

This remarkable elegant species has about the form of *Dione Kingi* Gray as figured by Reeve (Conch. Icon. *Dione* Pl. IX, Fig. 36a) with somewhat the sculpture of *D. grata* and *D. erycina*. It recalls in its coloration *Tapes turgida* Lamarck and *T. lirata* Philippi, minus their dark radiating bands. It is like none other on the east coast of America and has been for several years recognized by me as undescribed from the specimens in the National Collection.—[Dall, 1889.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Living. Cape Hatteras, North Carolina, and southward to the Antilles, and Cape San Roque, Brazil in 20 to 111 fathoms. (Dall). Horn Island, Miss. (Vanatta).

Section HYSTEROCONCHA Fischer



Fig. 4. Hinge of type species of *Hysteroconcha*

Hysteroconcha Lang, 1722, (not binomial) fide Fischer.

Dione Gray, 1847, Proc. Zool. Soc. Lond., p. 183; not *Dione* Hübner, 1816, in *Insects*; not *Dione* Gray, 1851 = *Callista*.

Callista H. and A. Adams, 1857, Gen. Recent Moll., vol. II, p. 424, in part.

Dione Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 178; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 178.

Hysteroconcha Fischer, 1887, Man. de Conch., p. 1079, (in synonymy); Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 354; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1265.

In 1847, Gray gave the name *Dione* to the shells typified by *Venus dione* Linnæus. The name had been used in 1816 in *Insects* by Hübner. Gray again, in 1851, used the name *Dione* with *Venus chione* Linnæus as the type. *Venus chione* was already the type of the genus *Callista* Poli. For many years *Dione* was used by authors for *Venus dione* and related forms. In 1902, Dr. Dall revived the pre-Linnæan name of *Hysteroconcha* which Fischer had placed in synonymy with *Dione*. He gave the name with Fischer as authority, dating it from the publication of the *Manuel de Conchyliologie* instead of from the work of the original author, Lang. Lang was not a binomial author. Also he was pre-Linnæan.

Shell moderate, sub-trigonal, ornamented with concentric lamellations which on the posterior end develop spines; hinge as in *Pitaria*; lunule and escutcheon present, impressed and defined by an incised or sunken line; inner margins smooth; pallial sinus full and rounded; nymphs microscopically granulated.

Type.—*Venus dione* Linnæus, Plate IX, Figures 1, 2, 17, 20. Recent. East Coast of North America from Texas to Costa Rica, thru the Antilles and Trinidad.

The section is represented in the Miocene of Costa Rica and by a living species in the Gulf of Mexico and Caribbean Sea, thru the Trinidad region. Several living species occur on the western American coast.

Section HYSTEROCONCHA Dall

PITARIA (LAMELLICONCHA) DIONE. (Linnæus)

Plate IX, Figures 1, 2, 17, 20

Venus dione Linnæus, 1858, Systema Naturæ, 10 ed., p. 684; Bruguière, 1897, Ency. Meth., pl. 275, fig. 1, a, b.

Cytherea dione Lamarck, 1818, An. sans Vert., vol. V, p. 570; Jay, 1852, Cat. Shells, p. 36.

Dione veneris Deshayes, 1853, Cat. Conch. Brit. Mus., pt. I, p. 75; Reeve, 1863, Conch. Icon., *Dione*, pl. VI, fig. 23 (err. 24).

Dione dione H. and A. Adams, 1857, Gen. Recent Moll., pl. 108, figs. 1, a, b; Römer, 1869, Mon., *Venus*, p. 129, pl. 34, figs. 1, a, b; Fischer, 1887, Man. de Conch., p. 1080, pl. XX, fig. 8; Dall, 1889, U. S. Nat. Mus. Bull., 37, p. 56.

Cytherea dione Beau, 1858, Cat. Coq. Quadaloupe, p. 24; Woodward, 1880, Man. of Moll., 4th ed., p. 474, pl. 20, fig. 8; Singley, 1892, Geol. Sur. Texas, 4th Ann. Rept., p. 328.

Meretrix (Dione) dione Dall and Simpson, 1901, Bull. U. S. Fish Com., vol. I, p. 485, pl. 56, fig. 3, 10.

Pitaria (Hysteroconcha) dione Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 371; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 70; Maury, 1925, ibid., vol. 10, No. 42, p. 149, pl. 27, fig. 8.

V. testa subcordata transverse sulcata, pube spinosa.

List conch. t. 307. f. 146. Rumph. mus. t. 48. f. 4. Olear. mus. 29. f. 4. Pet. gaz t. 31. f. 9. Gualt. test. t. 76. f. D. Argenv. conch. t. 24. f. I.

Habitat in O. Americæ.

Venerem filiam Dionis s. e. Concha maris natam finxere Poëtæ; hujus Typus Præcipue determinabit Concharum partium mataphoricam denominationem.

Testa bivalvis, semicordata, rotundata, subincarnata, postice anticeque magis gibba, ventris lateribus undique exaratis striis transversis, distantibus, parallelis, marginatis, subrecurvatis, æqualibus: exterioribus obtusioribusque: posterioribus alternis altioribus acutioribusque, Alternisque abbreviatis minoribus. Intus levis, alba, sub umbonibus fornicata. Cardio sinistrae tridentatus: Dentibus approximatis, scrobiculo distinctis. Denticulo intermedio compresso, angustiore; lateralibus divergentibus, crassiusculis, obtusis. Dextrae cardio Denticulis duobus, approximatis, compressis inter scrobiculos duos. Margo ambitus obtusissimus, integerrimus: Nates recurvatae, obtusiusculæ, apice glabrae. Anus impressus, ovatus, lævis, incarnatus. Antice Pubes ciliare, utrinque e natibus ad fimum montis veneris, cingens vulvam Spinis e striis alternis tertissime testæ ortis, subulatis, depressis, ascendentibus, antrorsum arcuatis, subtus canaliculatis, superioribus semsim longioribus: longissimis longitudine ipsius rimæ. Vulvæ regio incarnata, oblique striata, sursum a rima ad pubem. Labia læviora incarnata, inclusa fascia pallida, armata, a natibus ad medium rimæ Aculeis utrinque quinque brevissimis; margo vulvæ supra rimam connivet sulco longitudinali, intra quem sinistrae margo gibbosior se insinuat. Rima lanceolata, hians labris prominulis, clausa hymene. Nymphæ cartilagineæ, retractoris, longitudine rimæ.—[Linnæus, 1758.]

Shell medium; subovate, posterior dorsal region sloping at an angle of about 60° from the beaks, decreasing to about 35° at the dorsal third; lunule small, sunken; anterior end produced; surface ornamented with concentric lamellæ, which are usually wider on the anterior end; the lamellations develop into two radiating rows of spines on the posterior

end, the anterior row bears the larger spines. In many cases, the spines may be broken or immature. The coloration is a beautiful violet becoming a deep purple in spots. The posterior, dorsal, marginal region above the escutcheon is smooth except for the concentric lines of growth.

Dr. Dall has explained in the introduction to his work on the Veneridæ in the Transactions of the Wagner Institute that this beautiful shell would be consistently the type of the genus *Venus* Linnæus. It was the first species which Linnæus cited in the *Systema Naturæ*, the only one cited in Murray, *Fundamenta testaceologica*, and it was the early species commonly known as the "true Venus shell." However usage, since Lamarck's *Prodrome*, 1799, has planted the common North American Atlantic Coast clam *Venus mercenaria* Linnæus too firmly as the type of the genus *Venus* (Linnæus) Lamarck, for any change in the nomenclature.

The Pacific analogue of this species is *Pitaria lupanaria* (Lesson) which occurs from Lower California to Payta, Peru.

Dimensions.—42 mm., length; 36 mm., height; 24 mm., diameter.

Occurrence.—Recent. Gulf of Mexico, Texas to Colon, Antilles and Trinidad. Aspinwall. (Newcomb Coll.); Monti Cristi, Santo Domingo. (Maury Exped.); Gulf of Paria between La Brea and San Fernando, sandy beach south of Brighton on shore of Gulf of Paria, Trinidad. (Veatch Coll.); Pt. Lune, Trinidad, (Harris Coll. Cornell Univ. Pal. Lab.); Fajardo, Mayaguez, Porto Rico, Wounta Haulover, La Cuba, Honduras, mouth of Atrato River, Cartegena, Colombia; Port Limon, Costa Rica, Tobago Light, Chiriqui Lagoon, Panama. (U. S. Nat. Mus. Coll.)

PITARIA (LAMELLICONCHA) VAN WINKLEÆ Olsson

Plate IX, Figure 5

Pitaria Van Winkleæ Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 238, pl. 32, figs. 2, 3.

Shell elongate, depressed; anterior extremity broadly rounded, posterior more acute; lunule small, lanceolate and defined by an impressed line; escutcheon long and very narrow; surface sculptured with narrow, closely spaced and reflected ribs; these ribs which number about 100 on the shell disk are even on the center of the shell, but generally uneven on the anterior extremity; the ribs are continuous from the edge of the escutcheon to the anterior dorsal margin; the rounded posterior slope carries two small, faint rows along which the concentric ribs are slightly higher and occasionally raised into small incipient spines.

Length 41.5, height 32, diameter (left valve) 10 mm.

This species is quite similar to the *P. rosea* Broderip and Sowerby of the West Coast in its depressed shell and general form. The concentric ribs are very regular, even and continuous across the entire surface of the shell. Where these ribs cross the posterior-dorsal slope, they occasionally become raised into two rows of incipient spines. In *P. rosea* there is only one row of incipient spines and the dorsal-posterior area is smooth.

This species is named for Miss Katherine Van Winkle of the Paleontological Department of Cornell University and who is at present engaged on a Monograph of the American species of *Veneridæ*.

Gatun Stage: Hill No. 3. Banana River, C. R.—[Olsson, 1922.]

Syntypes.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrences.—Gatun Miocene. Banana River, Costa Rica.

Subgenus HYPHANTOSOMA Dall

Hyphantosoma Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 354; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1265.

Shell with zigzag sculpture on the surface like *Textivenus* Cossmann, of the Venerine series.—[Dall, 1902.]

The shells have the general shape, hinge characters, pallial sinus, and smooth interior margin of *Pitaria*. The lunule is very large and bounded by an incised line; there may be a very narrow escutcheon.

Genoholotype.—*Cytherca carbacea* Guppy, Plate X, Figures 1, 4, 13, 14. Miocene of the Caribbean Region.

The subgroup is represented by species in the Oligocene, Miocene and Pliocene.

PITARIA (HYPHANTOSOMA) SEMIPUNCTATA (Conrad)

Plate X, Figures 5, 9

Cytherca semipunctata Conrad, 1848, Proc. Acad. Nat. Sci. Phil., vol. I, 2nd ser., exp. plate, p. 134, pl. 13, fig. 19.

Shell small, inequilateral, ovate; beaks small; posterior and anterior ends rounded nearly equally; lunule large for the size of the shell, elongate and bounded by an impressed line; teeth of *Pitaria*; pallial sinus rounded; margin entire; sculpture of fine but well developed concentric ribs with interspaces equal to the width of the rib; the concentric ribs are crossed by a series of punctations in zigzag formation. The punctations are best developed posteriorly and ventrally. The young shells do not show the punctated surface. This species represents a form in the initial stage of the character of *Hyphantosoma*.

Conrad figured this species and gave the name in the explanation of the plate but did not include the description in the text of the report on the Vicksburg fossils. The collection of the type specimens of Conrad, at the Academy of Natural Sciences at Philadelphia, contains a tray with specimens labelled *C. perbrevis*. The specimens are not *C. perbrevis* and on examination reveal the beautiful sculpture which we have determined that Conrad must have meant when he called the species *semipunctata*. The specimen of *perbrevis* is in the tray with the types of *C. astartiformis* which it resembles but from which it may be differentiated readily.

Dimensions.—14 mm., length; 12 mm., height; 4 mm., semidiameter.

Plesiotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Oligocene. Vicksburg, Miss. (Acad. Nat. Sci., Phil., Cornell Univ. Pal. Lab.)

PITARIA (HYPHANTOSOMA) FLORIDANA Dall

Plate X, Figure 6

Pitaria (Hyphantosoma) floridana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1267, pl. 54, fig. 10.

Oligocene marl of the Chipola horizon at Alum Bluff and on the Chipola River at McDonald's farm; Dall and Burns.

Shell subtrigonal, solid, nearly equilateral, sculptured with fine, close concentric wrinkles, over and upon which is imposed the faint, close zigzag sculpture of divaricate lines with numerous angles; anterior dorsal slope nearly straight, posterior gently arched, with one or two faint radial ridges indicated as extending from the umbo to the posterior margin; lunule long, rather narrow; hinge delicate, anterior lateral prominent, compressed; posterior right cardinal bifid near the dorsal end; grooves of the dorsal margin deep; anterior end rounded; posterior end obscurely truncate, base produced a little in the middle. Length 29.2, height 24.0, diameter 17.0 mm.

Young shells were abundant in the marl, full-grown ones comparatively scarce. —[Dall, 1903.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Lower Miocene. Chipola horizon at Alum Bluff and on the Chipola River at McDonald's farm, Florida. (Dall.)

PITARIA (HYPHANTOSOMA) CARBASEA (Guppy)

Plate X, Figures 1, 4, 13, 14

Cytherea (Circe) carbasea Guppy, 1866, Quart. Jour. Geol. Soc. Lond., vol. 22, p. 292, pl. 18, fig. 13.

Callista carbasea Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 250.

Cytherea carbasea Guppy, 1874, Geol. Mag., vol. II, p. 442; Guppy, 1876, Quart. Jour. Geol. Soc. Lond., vol. 32, p. 531.

Pitaria (Hyphantosoma) carbasea Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 354; Dall, 1903, Trans. Wag. Inst., Sci., vol. III, pt. 6, p. 1266; Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 380; Hubbard, 1920, N. Y. Acad. Sci., vol. III, pt. 2, p. 121, pl. XVI, fig. 2.

Pitar (Hyphantosoma) carbaseus Woodring, 1925, Carnegie Inst. Wash., No. 366, p. 153, pl. 20, figs. 15 to 19.

Shell rounded, rather inequilateral, tumid, sulcated by lines of growth decussating with numerous radiating striae, which divaricate on the anterior part of the disk, and become subrugose towards the posterior margin; lunule large, scarcely distinct; posterior margin rounded; anterior margin somewhat produced. The character of the ornamentation in this species approaches to that of *C. divaricata*, Chemn., and in general form it is related to that species and to several others of the same group inhabiting both the eastern and western seas, or found fossil in Tertiary formations. —[Guppy, 1866.]

The zigzag markings of ornamentation are broad and occur over the anterior and mid-region of the shell. Over the remaining surface of the shell, the lines are radiating.

Dimensions.—36 mm., length; 30 mm., height; 15 mm., semidiameter.

Holotype.—Natural History Division, British Museum.

Occurrence.—Miocene. (Type locality.) Bowden, Jamaica. (Guppy); (Cornell Univ. Pal. Lab., Hodson Coll.); Santo Domingo. (Gabb, '73.)

PITARIA (HYPHANTOSOMA) CENTANGULATA Brown and Pilsbry

Plate X, Figures 7, 8, 10, 12

Pitaria (Hyphantosoma) n. sp. Toula, 1909, Jahr. der K.-K., Geol. Reichsanstalt,

Band 58, p. 726, pl. 28, fig. 16.

Pitar centangulata Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., vol. 63, p. 369.

Nur eine Schalenbruchstück der rechten Klappe mit Wirbel und Vorderregion liegt mir vor, das die Skulptur der Oberfläche recht gut erkennen lässt. Die Oberfläche ist mit zahlreichen dicht stehenden Anwachslien bedeckt, die vonz etwas ungleicher Stärke sind und gekreuzt werden von bogig vom Wirbel bis zum Vorder- und Stirnrand verlaufenden, in der Mitte der Schalle aber winkelig im Zickzack gebrochenen, feinen, punktierten Linien von ziemlich gleicher Stärke, die als feine Furchen auftreten. Die Zickzacklinien erinnern an die farbigen Linien, wie sie etwa bei der rezenten *Venus gallina* L. auftreten. Die Lunula ist nur durch eine scharfe und schmale aber nicht sehr tiefe Furche von der übrigen Schale abgetrennt und trägt nur die Anwachslien.

Pitaria (*Hyphantosoma*) *opisthogrammata* Dall aus dem Pliocän von Florida (VI, Taf. LIV, Fig. 8) besitzt eine ähnliche Zickzackornamentierung, hat jedoch im übrigen wenig Ähnlichkeit, vor allem fehlt die bogige Streifung vorn. Noch ähnlicher ist die Streifung bei *Pitaria* (*Hyphantosoma*) *floridana* Dall aus dem Chipolaoberoligozän. Die bogige Streifung gegen den Vorderrand meines Stückes ist bei *Pitaria floridana* Dall nur gegen den Stirnrand leicht angedeutet. Die nicht eingesenkte Lunula und ihre Abgrenzung stimmt mit der von Dall gegebenen Charakterisierung (l. c. VI, pag. 1265). Die Zickzackskulptur gibt Dall (an gleicher Stelle) als bezeichnend für die "Sektion *Hyphantosoma*" an. Ich glaube nicht fehl zu gehen, wenn ich mein Stück etwa zwischen die beiden genannten Formen stelle.—[Toula, 1909.]

This species is closely related, as Toula has pointed out, to the above-named species of Dall. It differs from *P. floridana* (from the Chipola Oligocene) in the rotund-oval, not "subtrigonal" shape, and in the even rotundity of the valves, without trace of a flattening or sulcus running to the posterior base; but it agrees with *floridana* in the very fine, markedly zigzag sculpture, there being three to four lines to a millimeter. *P. opisthogrammata*, of the Floridan Pliocene, is a "rounded-quadrate" shell with "the zigzag sculpture nearly obsolete."—[Brown and Pilsbry, 1911.]

Since the illustration which Toula gave of this species is of a broken shell and since Brown and Pilsbry did not figure a specimen from their material it is hard to determine the exact characters of the species.

Material which Mr. Olsson collected in a "quarry on the west side of the Gatun locks," contains numerous specimens which are very probably this species. The shell is large; the umbones, very full and incurved. The lunule is large and bounded by a sharply incised line. The escutcheon is very narrow. The shape of the shell differs from *P. carbasea* in the flaring out of the ends of the shell anteriorly and posteriorly. It differs also from *carbasea* in the character of the external, zigzag lines. They are much finer in *centangulata* and do not occur over the umbonal region. The umbonal region from the midline dorsally is conspicuously smooth. This character is noted on all the specimens of the collection and is indicated on the figure of Toula. The lines on *carbasea*, whether zigzagging or radiating, are coarser and occur over the whole surface of the shell. The illustration of *P. floridana* indicates that the zigzag lines occur, in that species, on the dorsal half of the surface, the region where, on the Gatun specimens, the lines are obsolete. Some specimens are short posteriorly and others are more elongate in the posterior region. They are all, however, the same species.

Dimensions.—51 mm., length; 40 mm., height; 16 mm., semidiameter.

Occurrence.—Miocene. Excavations for Gatun locks, Canal Zone, Panama. (Toula, Brown and Pilsbry); Quarry on west side of Gatun locks, Canal Zone, Panama. (Olsson Coll., Cornell Univ. Pal. Lab.).

PITARIA (HYPHANTOSOMA) OPISTHOGRAMMATA Dall

Plate X, Figure 2

Pitaria (Hyphantosoma) opisthogrammata Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1267, pl. 54, fig. 8.

Pliocene marl of Shell Creek and Alligator Creek, near Charlotte Harbor, Florida; Wilcox and Burns.

Shell rounded quadrate, produced and attenuated in front, subtruncate behind, with a well-marked, wide, shallow sulcus extending from the beaks backward and downward to the middle of the truncation; beaks inflated, anteriorly twisted; lunule deeply impressed, subcordate, defined by a sharply incised line, with a second impressed but less conspicuous and regular line in harmony with the lunular boundary and dividing the lunule into two subequal parts; surface concentrically striate, feebly on the middle of the disk and more emphatically towards the ends of the shell; the zigzag sculpture nearly obsolete but usually discernible on the smoother basal parts of the shell, and stronger in some specimens than in others; pallial sinus ample, linguiform, reaching the middle of the shell, with the upper border nearly on a level with the bases of the adductor scars; the hinge well developed, the anterior lateral prominent, compressed, triangular. Length 39, height 32, diameter 22 mm.

The impressed lunule is more conspicuously depressed in the adult than in the partly grown shell and differs also in different specimens.—[Dall, 1903.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Pliocene. Marl of Shell Creek and Alligator Creek, near Charlotte Harbor, Florida. (Dall.)

Genus PELECYORA Dall



Fig. 5. Hinge of type species of *Pelecyora*

Pelecyora Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 346; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1226; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 65.

Shell orbicular, with rugose nymphs, simple anterior lateral and socket; no posterior lateral; the pallial sinus narrow, angular, ascending; the cardinals entire except the right posterior one, which is bifid; otherwise as in *Dosiniopsis*, though the only known species is very much smaller than the known species of *Dosiniopsis*.

This group differs from *Dosiniopsis* by its smooth lateral and socket, and by the absence of the posterior lateral and socket, and by its relatively deeper pallial sinus. From *Æora* the same characters, as well as the nonbifid left cardinals and orbicular form, suffice to distinguish it. The rugosity of the nymphs is more like the semiradial rugæ in *Tivela* than the fine granulations of the type of *Dosiniopsis*.—[Dall, 1902.]

Genoholotype.—*Cytherea hatchetigbeensis* Aldrich. Plate VI, Figures 6, 8, 13, 14. Sabine Eocene of Alabama.

The genus, in eastern America, is known only from the type species.

PELECYORA HATCHETIGBEENSIS (Aldrich)

Plate VI, Figures 6, 8, 13, 14

Cytherea hatchetigbeensis Aldrich, 1886, Geol. Sur. Ala., Bull. I, p. 39, pl. 4, fig. 1;

De Gregorio, 1890, Ann. de Geol. et Pal., 7 et 8 liv., p. 220, pl. 34, fig. 14.

Meretrix hatchetigbeensis Harris, 1897, Bull. Amer. Pal., vol. 2, No. 9, p. 255, pl. 12, figs. 11, 12.

Pelcyora hatchetigbeensis Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 346; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1226.

Shell rather thick, inflated, subrotund, transversely striate—the different periods of growth marked by a dropping down of the concentric lamina, giving a ridge-like appearance; umbones swollen; beaks elevated; lateral tooth in left valve transverse, conical and strong; ligament short-curved; excavation of the pallial impression angular; margin of the shell entire, thickened in some specimens.

Locality.—Hatchetigbee Bluff, Ala., beneath the Buhrstone.

Prof. A. Heilprin considers this shell as *C. discoidalis*, Con., but that is described as having the inner margin crenulate, while this is smooth. Conrad's species has never been figured.—[Aldrich, 1886.]

Holotype.—Aldrich collection, Johns Hopkins University, Baltimore, Md.

Occurrence.—Sabine Eocene. Hatchetigbee Bluff, Ala.

Although it has not been the purpose of the paper to include Cretaceous species, in some cases where the characters of the genus may be described definitely by the type species, a description and illustration of the genus have been given. The Cretaceous species of the genus described, with the exception of the type, are not included in the report. There is the possibility that some of the genera may occur in the Eocene.

Genus APHRODINA¹ Conrad

Aphrodina Conrad, 1868, Amer. Jour. Conch., vol. IV, p. 246, pl. 18, fig. 5; Conrad, 1875, Kerr, Geol. N. Car., vol. I, App. A, p. 7; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 179; Stoliezka, 1879, Pal. Indica, vol. III, p. 150; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 177; Fischer, 1887, Man. de Conch., p. 1079; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 355; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1272.

Meretrix Weller, 1907, Geol. Sur. N. J., vol. IV, p. 607, pl. 68, figs. 1-3.

Aphrodina Gardner, 1916, Md. Geol. Sur., Upper Cretaceous, p. 681; Stephenson, 1923, N. C. Geol. and Ec. Sur., vol. V, pt. I, p. 311.

Shell rounded or suboval, striated or sulcated; hinge in the left valve with three diverging cardinal teeth, the anterior tooth as thick as the middle one or thicker, and a straight, compressed, transversely rugose lateral tooth parallel with the margin of the shell above it; pallial sinus deep, and similar to that in *Caryatis* Roemer.

The type of this genus is *Meretrix Tippiana*, Conrad, of which we have one valve only, the left, which shows the hinge, and that is nearly as perfect as if the valve were a recent specimen.—[Conrad, 1869.]

Lunule elongate, bounded by an incised line; no escutcheon; anterior, lateral tooth elongate and corrugated; left, anterior cardinal thick and sharply pointed, larger than the middle left cardinal; posterior left cardinal not definitely bifid or grooved; nymphs very finely crenate; shell smooth.

Upper Cretaceous. Mississippi, Maryland, New Jersey and the Carolinas.

¹ *Aphrodina* Conrad has been taken out of the *Antigona* group (*Cytherea* s. g. *Aphrodina* Dall, Synopsis of Veneridæ, 1902, p. 355; Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1272, because the shell characters are not as closely related to *Antigona* as they are to *Pitaria* and because of its stratigraphic origin. *Aphrodina* is a Cretaceous genus. The *Antigonas* did not develop before the Oligocene in eastern America. Conrad points out the similarity of the sinus of *Aphrodina* with that of *Pitaria* (*Caryatis*).

Genoholotype.—*Meretrix tippana* Conrad, Plate VI, Figures 11, 12. Upper Cretaceous. Gulf and eastern Coast of the United States.

Genus DOSINIA Scopoli

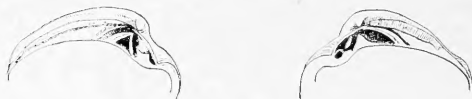


Fig. 6. Hinge of type species of *Dosinia*

- Dosinia* Scopoli, 1777, *Introd. ad Hist. Nat.*, p. 399.
Cytherea Lamarck, 1818, *An. sans Vert.*, V, pp. 572, 573.
Artemis Conrad, 1832, *Fos. Tert. Form.*, p. 20; Reeve, 1850, *Conch. Icon.*, Mon., *Artemis*.
Dosinia Deshayes, 1853, *Cat. Conch. Brit. Mus.*, pt. I, p. 5; Römer, 1862, *Mon., Dosinia*; H. and A. Adams, 1857, *Gen. Rec. Moll.*, vol. II, p. 430; Tryon, 1884, *Struct. and Syst. Conch.*, vol. III, p. 180; Fischer, 1887, *Man. de Conch.*, p. 1082; Dall, 1902, *Proc. U. S. Nat. Mus.*, vol. 26, No. 1312, p. 346; Dall, 1903, *Trans. Wag. Inst., Sci.*, vol. III, pt. 6, p. 1226; Jukes-Browne, 1912, *Proc. Mal. Soc. Lond.*, vol. 10, p. 95; Jukes-Browne, 1914, *ibid.*, vol. 11, p. 63.
 not *Dosina* Gray, 1838, *Analyst.*, vol. VIII, No. 24, p. 308; not Gray, 1847, *Proc. Zool. Soc. Lond.*, pt. XV, p. 183, *Venus verrucosa* L.

Shell orbicular, medium in size; beaks small; lunule small, deeply impressed, heart-shaped; interior margin smooth; pallial sinus long, narrow, bluntly rounded, upper margin extending practically straight and at right angles to the line of the height of the shell; escutcheon long, narrow, bordered by a sharp ridge or keel at which the concentric sculpture of the shell tends to terminate and become lamellose; small, anterior left lateral; anterior left cardinal thin and sharp; middle, left cardinal heavy, bifid or grooved; posterior left cardinal thin and curved; small pit in the right valve to receive the anterior left lateral; right anterior cardinal small, pointed and sharp; middle right cardinal broad, bifid or grooved; a wide groove between the middle right cardinal and the posterior right cardinal; posterior right cardinal bifid, narrow, sharp; shell sculptured by fine but distinct, concentric, flattish ridges; shell white exteriorly, the interior may be colorless or reddish brown in the area of the pallial sinus and along the pallial line below.

Genoholotype.—*Dosinia africana* Hanley (Le Dosin Adanson, 1757). Plate XVII, Figures 5, 8, 13, 14. Recent of western Africa.

As yet *Dosinia* has not been found below the Oligocene in the eastern American Tertiary. On the western Coast of America, *D. mathewsonii* Gabb occurs in the Oligocene. Many Cretaceous and Eocene shells of

orbicular shape and known only from casts have been referred to the genus *Dosinia*. Some of these have proved to belong to *Dosiniopsis*, *Cyprimeria* or Lucinoid forms. Others have never revealed the hinge structure so that they can be placed definitely. In Europe the genus does not occur below the Miocene, as stated by Jukes-Browne, (Proc. Mal. Soc. Lon., vol. 11, 1914, p. 59). It is of interest to note that Conrad early made the determination that the so-called *Dosinias* of the Cretaceous and lower Tertiary were not true *Dosinias*. He¹ states that *Dosinia* originated in the Miocene. The range has been extended to the Oligocene.

Section DOSINIDIA Dall



Fig. 7. Hinge of type species of *Dosinidia*

Dosinidia Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 347; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1229; Jukes-Browne, 1912, Proc. Mal. Soc. Lond., vol. 10, p. 97; Jukes-Browne, 1914, *ibid.*, vol. 11, p. 64.

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.]

Type.—*Venus concentrica* Born, plate XVIII, Figures 2, 5, 10; Plate XX, Figure 4. Pleistocene and Recent. Florida Keys south thru West Indies to Rio de Janeiro, Brazil.

The section occurs from the Oligocene and in the Recent fauna of eastern America.

Stratigraphic Range of *Dosinia*, Section *Dosinidia*

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
	chipolana	chipolana elegans grandis delicatissima acetabulum var. obliqua braziliensis azuana liogona	elegans discus	elegans discus concentrica	elegans discus concentrica

¹ Conrad, T. A., 1866, Amer. Jour. Conch., vol. II, p. 98.

Section DOSINIDIA Dall

DOSINIA CHIPOLANA Dall

Plate XVII, Figures 4, 10, 15

Dosinia (Dosinidia) chipolana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1229, pl. 54, fig. 4; Dall, 1915, U. S. Nat. Mus. Bull., No. 90, p. 145, pl. 24, fig. 10.

Oligocene of the Chipola horizon on the Chipola River, Calhoun County, Florida, at Alum Bluff and the silex at Ballast Point, Tampa Bay.

Shell rather small and thin, suborbicular, moderately convex, with full, pointed beaks, with fine, sharp concentric grooves having the distal side more abrupt, the interspaces flattish and hardly raised towards the ends of the shell; lunule lanceolate, impressed; beaks sculptured like the rest of the shell; anterior dorsal margin convexly arched; hinge-plate rather short and wide; teeth normal; the adductor scars large; the pallial sinus ample, ascending, acute in front, terminating two-thirds the distance forward from the posterior to the anterior adductor. Height 37.5, length 40.0, diameter 17.0 mm.

The nepionic young of this species have very much the form of the adult and are usually sculptured in much the same way.—[Dall, 1903.]

Holotype.—United States Museum, Washington, D. C.

Occurrence.—Oligocene. Silex beds at Ballast Point, Tampa Bay, Florida. Lower Miocene. Alum Bluff, Chipola River, Florida. (Dall); Bailey's Ferry, Florida. (Cornell Univ. Pal. Lab.)

DOSINIA ELEGANS (Conrad)

Plate XVIII, Figures 3, 4, 8, 9; Plate XX, Figure 2

Artemis elegans Conrad, 1843, Proc. Acad. Nat. Sci. Phil., vol. 1, p. 325; Conrad, 1845, Fos. Med. Ter., p. 67, pl. 38, fig. 1; Conrad, 1846, Am. Jour. Sci., 2nd Ser., vol. I, p. 404; Conrad, 1846, *ibid.*, vol. 11 p. 393.

Artemis concentrica Reeve, 1850, Conch. Icon., Mon. *Artemis*, pl. II, fig. 8, not of Born, 1780.

Dosinia concentrica Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 29.

Dosinia concentrica Tuomey and Holmes, 1855, Pleioc. Fos. S. Car., p. 82, pl. 21, fig. 7.

Dosinia obovata Bush, 1885, Trans. Conn. Acad. Sci., vol. VI, p. 477 (young).

Dosinia elegans Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 10; Dall, 1889, U. S. Nat. Mus. Bull. 37, p. 56; ed. of 1903, pl. 89, fig. 6; pl. 90, fig. 7; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 366, 379, pl. 12, fig. 6; pl. 13, fig. 7; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1231; not *D. elegans* Dall and Simpson, 1900, Bull. U. S. Fish Com., vol. I, p. 486.

? *Dosinia elegans* B&se, 1906, Boll. de Inst. Geol. de Mexico, numero 22, p. 80, pl. XI, fig. 6.

Artemis transversus Emmons, 1858, Geol. Rep. N. Car., p. 295, figs. 223, 224.

Dosinia intermedia Conrad, 1862, Proc. Nat. Acad. Sci. Phil., vol. 14, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 200, p. 10.

Dosinia elegans Maury, 1919, Bull. Amer. Pal., vol. 8, No. 34, p. 67.

Lentiform, regularly convex, with strongly marked rather distant impressed concentric lines; on the posterior side these are closely arranged and profound, forming prominent recurved lines, which become acute or lamelliform towards the posterior margin; posterior hinge margin elongated, slightly convex, oblique; lunule cordate, deeply impressed. Height, two and a half inches; length, two inches and seven-eighths.

A. elegans. Fossils of Tertiary Formations, p. 30.

Locality.—Neuse river, below Newbern, North Carolina, 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*.

I found this and the kindred species recent on Mullet Key, at the entrance of

Tampa Bay, and, fortunately, specimens of the young of both, which show a marked difference in specific character.—[Conrad, 1843.]

The discussion of the differences between *D. elegans* and *D. concentrica* is given under the description of *D. concentrica*. The two species are confused very easily.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Upper Miocene. Alum Bluff, Fla.; Sumter District, South Carolina. Pliocene. Caloosahatchie beds on Caloosahatchie River, Shell Creek and Alligator Creek Fla. (Dall); Acme, N. C. (Cornell Univ. Pal. Lab.). Pleistocene. North Creek, near Osprey, Fla. (Dall), Labelle, Fla. (Maury). Recent. Cape Hatteras, N. C.; Charleston, S. C.; West mouth of St. John's River, East Florida, West Florida; Tortugas, Texas and south to Yucatan and St. Thomas. (Dall)

DOSINIA DELICATISSIMA Brown and Pilsbry

Plate XVII, Figures 1, 9

Dosinia delicatissima Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. Phil., vol. 64, No. 516, pl. 26, fig. 1; ? Spieker, 1922, Johns Hopkins Univ. Studies Geol., No. 3, p. 140.

Specimens from the Spillway agree well with Dall's account and figures of *D. biogona* Dall (Trans. Wagner Inst. III, p. 1230, pl. 53, figs. 4, 7; pl. 54, fig. 11), except that the shell is remarkably thin for a bivalve of this genus. A valve at least 60 mm. in length is only 1.3 mm. thick in the thickest part. Moreover, the sculpture does not rise in "sharp fine lamellæ towards the ends of the shell," as described for that species. Towards the ends of the shell the concentric ridges between the grooves are more raised than in the middle of the valves, but they are rather too thick and blunt to be called lamellæ. The specimens are all in poor condition so that the sculpture of the beaks is a little in doubt, but from a small area exposed in one specimen the very young shell would appear to be smooth.

Length 48, alt. 46, semidiameter about 11 mm. Less perfect specimens than that figured are larger, up to 55 to 60 mm., or even more.

Very plentiful in the Gatun Formation at Tower N.

It occurs also in the Pecten bed at Tower N.

The Miocene *D. acetabulum* Conr. is a decidedly more solid shell, noticeably differing from *D. delicatissima* in sculpture.—[Brown and Pilsbry, 1912.]

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Miocene. Gatun formation. Gatun, Panama. ?Zorritos formation. Head of Quebrada Zapotal, Peru. (Spieker)

DOSINIA ACETABULUM (Conrad)

Plate XIX, Figures 1, 2, 3, 5, 6, 7, 9

Cytherea concentrica Say, 1824, Acad. Nat. Sci. Phil., Jour., 1st ser., vol. IV, p. 150; Harris Reprint, 1896, Bull. Amer. Pal., vol. I, No. 5, p. 326; Conrad, 1830, Jour. Acad. Nat. Sci. Phil., vol. VI, p. 212.

Artemis acetabulum Conrad, 1832, Shells Tert. Form., p. 20, pl. 6, fig. 1.

Cytherea obovata Conrad, 1834, Jour. Acad. Nat. Sci. Phil., ser. I, vol. VII, p. 132 (young); Conrad, 1838, Fos. Med. Ter., p. 32, pl. 8, fig. 4.

Artemis acetabulum Conrad, 1838, Fos. Med. Tert., p. 47, pl. 16, fig. 1; Conrad, 1846, Amer. Jour. Sci., 2nd ser., vol. I, p. 404, in part; Lea, 1848, Acad. Nat. Sci. Proc. Phil., vol. IV, p. 96.

Artemis concentrica Conrad, 1853, Acad. Nat. Sci. Phil., Proc. VI, p. 320 in part.

Dosinia acetabulum Conrad, 1854, Acad. Nat. Sci. Phil., Proc. VII, p. 30; Conrad, 1862, Acad. Nat. Sci. Phil., Proc. 14, p. 575.

- Dione obovata* Conrad, 1862, *ibid.*, p. 575; Meek, 1864, *Smith. Misc. Coll.*, vol. VII, No. 183, p. 9.
- Dosinia obovata* Conrad, 1870, *Amer. Jour. Conch.*, vol. VI, p. 77; not *Dosinia obovata* Bush, 1855, (= young of *D. elegans*).
- Dosinia acetabulum* Meek, 1864, *l. c.*, p. 10; p. 442; Heilprin, 1888, *Acad. Nat. Sci. Phil.*, vol. 39, p. 401-3; Whitfield, 1894, *U. S. Geol. Sur. Mon.*, No. 24, p. 73, pl. XIII, fig. 2.
- Dosinia* (*Dosimidia*) *acetabulum* Dall, 1903, *Trans. Wag. Inst. Sci.*, vol. III, pt. 6, p. 1230; var. *obliqua* Dall, *ibid.*, p. 1231, pl. 54, fig. 13.
- Dosinia acetabulum* Glenn, 1904, *Md. Geol. Sur., Mio.*, p. 315, pl. 83, fig. 1; pl. 84, fig. 1; Böse, 1906, *Boll. de Inst. Geol. Mex.*, numero 22, p. 81, pl. 11, figs. 7, 11.
- Dosinia* (*Artemis*) cf. *acetabulum* Toulou, 1908, *Jahrb. der K. K. Geol. Reich.*, Wein, vol. 58, p. 727, pl. 27, figs. 8, 8a.
- Dosinia acetabulum* Clark and Miller, 1912, *Va. Geol. Sur., Bull. IV*, pp. 173-174; Olsson, 1922, *Bull. Amer. Pal.*, vol. 9, No. 39, p. 403, pl. 31, fig. 1.
- Lentiform, with numerous concentric striae, which are rather sharp and elevated on the anterior and posterior sides; cardinal fosses large, oblong, profound; with age, almost obliterating the posterior tooth; right valve with three teeth, the posterior one long and sulcated longitudinally; two anterior teeth approximate; left valve with four teeth, three of them distant; the anterior tooth somewhat pyramidal and entering a groove formed by two slight elevations in the opposite valve.
- Localities.*—St. Mary's River, and Easton, Md.; James River, near Smithfield, and Suffolk, Va. Upper Tertiary. This shell has been confounded with *Artemis concentrica*, (*Cytherea concentrica*) of our coast.
- The species of this genus are still referred to *Cytherea* by many authors, but the hinge differs essentially, and has more the character of *Lucina*, which also has frequently the fosses under the apex. *Orbiculus*, Megerle, *Lentillaria*, Schumacher, *Eoleta*, Brown, are synonyms of the present genus which is very different from *Artemis* of Oken, an example of which is *Venus pectinata* of Chemnitz. I adopt the name given by Poli, on the authority of Blainville, as I have not seen the work in which it was originally described.—[Conrad, 1832.]

Conrad gives localities from two different horizons of the Chesapeake Miocene at which specimens were obtained. The holotype figured is from the higher or Yorktown stage.

An examination of specimens from localities in Maryland and Virginia which represent the Calvert, Choptank, St. Mary's, Murfreesboro and Yorktown stages of the upper Miocene reveals slight variations in the shells. These variations appear to be constant for the locality and in general for the horizon. The shells from the Choptank, are higher, the anterior end is less attenuated and slopes at a smaller angle from the lunular area, the posterior, dorsal margin is less extended which gives the higher appearance to the shell than to the typical forms. The specimens resemble somewhat var. *obliqua* Dall from Alum Bluff, Florida, but they appear obliquely to the basal margin.

Specimens from St. Mary's, Miocene are more rounded in shape and are characteristically smooth on the central portion of the shell. Along the midline of the shell from the beaks to the ventral margin the concentric ribs die out, leaving a narrow, smooth strip except for the fine lines of growth.

The shells from the higher horizons all display the sculpture described as typical. They seem to increase in size in the younger sediments, averaging from 80 mm. to 100 mm. in length while the Choptank specimens do not increase beyond 80 mm.

The young of *acetabulum* show strong, concentric ribs and pointed

umbo as well as corrugations on the posterior cardinal tooth. Conrad gave the name of *obovata* to the young specimens.

In early literature, the species was confused with the recent *D. concentrica* Born. *D. acetabulum* as known so far is confined to the Miocene. Although limited in vertical range its geographical extent is fairly wide.

Dimensions.—Holotype. 90 mm., length; 86 mm., height; 39 mm., thickness.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—UPPER MIOCENE. Artesian boring at Atlantic City, N. J.; Maryland. *Calvert Formation*. 3 miles south of Chesapeake Beach, Plum Point, White's Landing, Lyon Creek, Reed's. (Glenn). *Choptank Formation*. Governor Run, 2 miles south of Governor Run, Flag Pond, Jones Wharf, Turner, Pawpaw Point, St. Leonard Creek, Sand Hill, Cordova, Greensboro, Trappe Landing, Peach Blossom Creek, Dover Bridge (Glenn). *St. Mary's Formation*. Little Cove Point, St. Mary's River, near Easton on St. Mary's River, Maryland. (Cornell Univ. Pal. Lab.); Langley's Bluff, St. Mary's River. (Glenn). *Murfreesboro Formation*. Claremont Wharf, James River, Petersburg, Ruffins, Virginia (Cornell Univ. Pal. Lab.). *Yorktown Formation*. Suffolk, James River near Smithfield, Bellfield, Kingsmil, Greensville, Yorktown, Virginia (Cornell Univ. Pal. Lab.); marl below peat of Great Dismal Swamp (Dall). Alum Bluff, Chattahoochee River, Florida (Dall) (Cornell Univ. Pal. Lab.). GATUN MIOCENE. Gatun, Canal Zone; Hotel and Hone Creek, Pumbri Creek, Hill No. 3, Banana River, Coll. 6, Estrella River, Costa Rica. (Olsson Coll., Cornell Univ. Pal. Lab.); Panama (Toula). (? PLIOCENE.) Mexico (Böse).

DOSINIA ACETABULUM OBLIQUA Dall

Plate XIX, Figure 4

Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1231, pl. 54, fig. 13.

This variety is described as being "more compressed and higher, with the basal margin obliquely produced." "Alt., 49.0 mm."

Chesapeake Miocene horizon at Alum Bluff on the Chattahoochee River. (Dall).

Holotype.—No. 115722. United States National Museum, Washington, D. C.

DOSINIA BRASILIENSIS White

Plate XVII, Figure 6

Dosinia brasiliensis White, 1887, Arch. Museu Nac. Rio de Janeiro, vol. VII, p. 97, pl. VIII, figs. 13, 14, 15.

Dosinia brasiliensis Katzer, 1903, Grundzüge der Geologie, etc., pl. II, fig. 25.

not *Dosinia braziliensis* Pervinquieré, 1912, Etudes Pal. Tunisienne, vol. II, p. 272, listed as synonymous with *D. elegans* (Sharpe).
Dosinia (*Dosinidia*) *braziliensis* Maury, 1925, Ser. Geol. Min. Brazil, Mon. N. IV, p. 319, pl. 17, fig. 17.

Loc. Porto dos Barcos, Trapiche das Pedras Velho, Coqueiro, Riacho da Aroeira e Engenho Pamona, Provincia de Sergipe; Rio Piabas, Provincia do Para.

Shell lenticular, almost circular in marginal outline, the anterior-posterior diameter being only a little greater than the height; beaks small, not very prominent, directed forward; free margins forming a continuous and almost circular curve from a point just behind the beaks, to one a little in front of them, where the margin has a short, deep lunule; convexity of the valves nearly uniform from side to side, and also nearly regular from base to beaks; cardinal teeth comparatively strong; sublunular tooth also strong. Surface marked by numerous, sharply impressed, very regular, concentric lines, the interspaces between which are of about the same width as the lines upon the umbones, but they increase in width towards the borders, upon which they are from two to four times as wide as the lines; the surface of these interspaces is flat, or gently convex, and plain.

Antero-posterior diameter of the most perfect example in the collection, 35 millimeters; height from base to beaks, 35 millimeters; thickness, both valves together, 17 millimeters.—[White, 1887.]

Dr. Maury, in her recent Monograph on the Tertiary of Brazil has figured the species from material from Rio Pirabas. She discussed further the species and gave measurements of the specimens which she had in her collection. White listed originally the localities at which his specimens were found, as Cretaceous. The determination by Dr. Maury of the Miocene age of the Rio Pirabas beds reaffirms the established, stratigraphic range of the genus *Dosinia*. The Sergipe localities are of Cretaceous age, Maury, 1924. The illustration of the species by White, identifies the specimen as *Dosinia*. Since part of the material listed by White came from a locality of Miocene age, and since Maury rediscovered specimens in Rio Pirabas material, the Miocene specimens should stand as *Dosinia braziliensis* and the type locality, Rio Pirabas. What the forms were which White included from the other localities, can not be determined from his description.

Holotype.—National Museum, Rio de Janeiro, Brazil.

Occurrence.—Lower Miocene. Rio Pirabas, Provincia do Para, Brazil. (Maury)

DOSINIA AZUANA Pilsbry and Johnson

Plate XVII, Figure 2

Dosinia azuana Pilsbry and Johnson, 1917, Proc. Acad. Nat. Sci. Phil., vol. 69, p. 200; Pilsbry, 1921, *ibid.*, vol. 73, pt. II, p. 424, pl. 47, fig. 9.

The shell resembles *D. elegans*, but is somewhat plumper, with the concentric grooves more widely spaced, strong throughout. The sculpture is not laminar at the ends. Lunule as in *D. elegans*.

Length 39, alt. 38, diam. 20 mm.

West of Azua, collected by Mr. L. B. Smith.

Type No. 2685, A. N. S. P.—[Pilsbry and Johnson, 1917.]

Occurrence.—Miocene. Santo Domingo.

DOSINIA LIOGONA Dall

Plate XVII, Figures 3, 7, 11

Dosinia (Dosinidia) liogona Dall, 1903, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1230, pl. 53, figs. 4, 7; pl. 54, fig. 11.

Uppermost Oligocene at Oak Grove, Santa Rosa County, Florida; Burns.

Shell much resembling the last, from which it differs by the less convex posterior dorsal margin; smooth or feebly sculptured beaks, sculpture rising into a sharp, fine lamellæ towards the ends of the shell, smaller adductor scars, narrower hinge-plate, and different form of the nepionic young. Height 45, length 48, diameter 18 mm.

The young shells are proportionately more elevated and shorter than the adult and most of them are smooth or very sparsely concentrically grooved. At first sight they would hardly be recognized as the same as the adults. The posterior cardinals are elegantly crenate. In the adult the anterior left and posterior right cardinals are grooved on the distal edge.—[Dall, 1903.]

This species has larger, concentric ribs than *D. chipolana* Dall. It is related closely to *D. delicatissima* Brown and Pilsbry but the concentric ribs are larger in *D. liogona*. The concentric ribs are not as large in *D. liogona* as in *D. elegans* Conrad.

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Lower Miocene. Oak Grove, Santa Rosa County, Florida.

DOSINIA GRANDIS Nelson

Plate XVII, Figure 12; Plate XIX, Figure 8;

Plate XX, Figure 14; Plate XLV, Figures 1, 2, 3, 4

Dosinia grandis Nelson, 1871, Trans. Conn. Acad., vol. 2, p. 201; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1233.

Dosinia (Dosinidia) grandis Spieker, 1922, Johns Hopkins Studies in Geol., No. 3, p. 138, pl. VIII, fig. 4.

Dosinia (Dosinidia) titan Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 139, pl. 24, figs. 1, 2; pl. 25, fig. 3.

Shell large, solid, subequilateral; length and breadth nearly equal, broadest just above middle line. Beaks elevated, nearly central, curved inward and forward. Lunule heart-shaped, very deeply impressed, two-thirds as wide as long, marked by striations which become finer as they pass into it. Anterior end short. Anterior and posterior ends nearly equally rounded. Ligament large; scar long, striated longitudinally. Surface covered by a thick epidermis, and marked by broad, flat concentric ribs, which become larger and smoother over the middle of the shell, but not wholly obsolete. With the epidermis removed the shell still shows the striations, especially about the beaks. Hinge line nearly straight, very broad. The median tooth (cardinal) of the right valve is large and pointed; the posterior cardinal deeply bifid. Lateral tooth large, nearly as long as the posterior cardinal, and parallel with it. In the left valve the median cardinal is bifid throughout the upper half of its length. Hinge area forming a very obtuse angle with the ligament area. Muscular scars and pallial impression not observed. A young and full-grown specimen give the following measurements: Young, Length, 46.05 mm., Breadth, 47.1 mm., Height, 22.6 mm.; Mature, Length, 95.6 mm., Breadth, 95.2 mm., Height, 47.2 mm.

This is the most common bivalve in the collection. The species is peculiar in that the young specimens are proportionately wider than long, while full grown specimens are slightly longer than wide. The species most nearly resembles *D. ponderosa* Gray, but is much thicker and stouter, more elongated, and has the sulcations more distinct. *D. grandis* is much larger, also, than *D. Dunkeri* Phil., and more elongated, and the ribs are coarser and flatter.—[Nelson, 1871.]

This species was described from Peru. Shells occur in the Miocene of Springvale, Trinidad, which are so close to *D. grandis* that we include them under the same species. The species occurs abundantly in the

Springvale beds and reaches a size larger than those of measurements given by Nelson.

Dr. Carl O. Dunbar of the Peabody Museum, Yale University sent very kindly the included photograph of the best specimen of Nelson's material. It is the same specimen figured by Spieker in the Johns Hopkins University Studies in Geology although it is not stated in his report. The measurements for this lectotype are 9.5 cm., length, 8.8 cm., height and 4.5 cm., greatest thickness, showing that the length exceeds the height as it does on the Trinidad specimens in about the same proportion. Nelson's figures are misleading. In young specimens the form is more quadrate and the height may equal or exceed the length.

Two specimens of the Trinidad material were sent to Dr. Dunbar for comparison with the type material of *D. grandis*. The notes which he sent are very valuable for a comparison of the two species so that we quote them in full. He says

a comparison of your specimens with Nelson's types of *Dosinia grandis* and although they are very much alike, there appear to be certain minor differences. Your shells are rather more orbicular in outline, the arched hinge-line rounding into the evenly convex posterior margin with a curvature that continues almost uniform around both posterior and anterior portions of the ventral margin. On the contrary, Nelson's type is slightly trapezoidal, the hinge line being relatively less arched while the middle of the posterior margin is less convex than the postero-dorsal and postero-ventral portions and the ventral margin curves gradually upward into the anterior so that the posterior half of the shell is higher than the anterior. In your larger and more perfect specimen, the concavity of the anterior margin below the beaks is shallower and longer than in the holotype but this appears to be a variable character since your second specimen agrees closely with Nelson's specimen whereas some of his co-types agree closely with your first specimen. The lunule in your specimen appears to be slightly larger and more elongated than in Nelson's, though the difference is slight and may have no significance.

The greatest difference appears to be in the surface ornamentation. As Speiker points out, of course, the shells of *Dosinia grandis* present great differences in surface appearance due to partial exfoliation, but I refer to differences where the shell is intact. In contrast to the regularity displayed in your shells where adjacent concentric ribs are of approximately equal width, all being broad and nearly flat-topped and separated by much narrower and flat-bottomed grooves, Nelson's types show much irregularity due to the fact that the concentric ribs frequently and often incompletely bifurcate in passing from the margins toward the middle of the shell, so that the ribs here appear fasciculate and adjacent ribs differ much in width at the same time that the same rib varies in width due to sub-division. The broader ribs in Nelson's specimens frequently bear small angular ribs, or striations, upon them as a result of the incomplete bifurcation. The transverse profile of the ribs tend to differ also in that in Nelson's specimens the upper margin of the rib is highest and from it there is a more gradual slope into the next groove beyond, whereas in your specimen the ribs are more nearly flat-topped and the intervening grooves more distinctly defined, especially at their upper edges. I believe these differences are pronounced enough and constant enough so that I would be able to readily separate your specimens from Nelson's.

The Trinidad specimens present great variability in shape and strength of development of the concentric ribbing. The immature specimens as seen by figure 8, plate XIX, have a nearly straight hinge line, giving a more quadrate shape and the concentric ribs are equally developed over the whole surface. Two specimens have been figured on plate XLV, which are mature but which have a less orbicular shape than the specimens compared with the types of *D. grandis*.

The concentric ribs seem to be developed more strongly and regularly in the specimens from Trinidad than those from the locality of Nelson in Peru. The ribs die out ventrally in older specimens. A few adult shells of the Trinidad specimens have the ribs developed along the ventral border but the majority have the ribs smoothed out and bifurcated as in *D. grandis* s.s. but not over such a large area. It is the greater irregularity of ribbing which inclines one to feel that the specimens from the different localities might not be the same species. The difference might be due to a difference in stratigraphic age.

The resemblance between the forms seems to us to be too great for a separation of species. If the two species should be thought to be distinct the name of *Dosinia titan* by Dr. Maury stands for the specimens from Trinidad.

Dimensions.—Lectotype. 95 mm., length; 88 mm., height; 45 mm., greatest thickness. Trinidad. Average. 91 mm., length; 86 mm., height; 42 mm., thickness.

Lectotype.—Peabody Museum, Yale University, New Haven, Conn.

Occurrence.—Type. Miocene. Zorritos, Peru. (Nelson). Zorritos Formation. South of Quebrada Boca Ban, Peru. (Spieker). Upper Miocene. Springvale, Trinidad. (Harris Coll. Maury. Cornell Univ. Pal. Lab.)

DOSINIA DISCUS (Reeve)

Plate XVIII, Figures 1, 6, 7; Plate XX, Figure 1

- Artemis concentrica* Conrad, 1831, Am. Marine Conch., p. 55, pl. xii; Conrad, 1846, Am. Jour. Sci., 2nd Ser., vol. II, p. 393; not *Venus concentrica* Born, 1780.
Cytherea concentrica DeKay, 1843, Nat. Hist. N. Y., Zool., vol. V, p. 216.
Artemis discus Reeve, 1850, Cnch. Icon., *Artemis*, pl. II, fig. 9; Conrad, 1853, Acad. Nat. Sci. Phil., Proc., vol. VI, p. 320.
Dosinia discus Deshayes, 1853, Cat. Conch. Brit. Mus., pt. I, p. 10.
Dosinia discus Conrad, 1854, Acad. Nat. Sci. Phil. Proc., vol. VII, p. 30; H. and A. Adams, 1857, Gen. Recent Mol., vol. II, p. 431; Römer, 1862, Mon., *Dosinia*, p. 10, pl. 1, figs. 1.a, b.
Dosinia concentrica Holmes, 1860, Post-Plio., Fos. S. Car. p. 137 pl. VII fig. 4.
Dosinia discus Conrad, 1871, Acad. Nat. Sci. Phil., vol. 23, p. 137; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 180, pl. 114, fig. 32; Dall, 1889, U. S. Nat. Mus. Bull., No. 37, p. 56, l. c. ed. 1903, pl. 89, fig. 1; pl. 90, fig. 1.
Dosinia (*Dosinidia*) *discus* Dall, 1902, U. S. Nat. Mus., Proc., vol. 26, No. 1312, p. 366, pl. XII, fig. 1; pl. XIII, fig. 1; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1232.
Dosinia discus Hinckley, 1907, Nautilus, vol. 21, p. 70; Maury, 1920, Bull. Am. Pal., vol. 8, No. 34, p. 66.

Art. testa tenuicula, transverse ovata postice subquadrata, latiore quam alta, valde compressa, concentricè subtilissime inciso-striata liris intermediis ad latera subobsoletis et numero decrescentibus, area ligamenti simplici, lunula rotundato-cordata; albidum, fasciis pallide ferrugineis, interdum autem obscure tincta, epidermidate tenui cornea induta.

The quoit *Artemis*. Shell rather thin, transversely ovate, posteriorly somewhat square, broader than high, very compressed, concentrically very finely engraved with striae, intermediate ridges rather obsolete and decreasing in number at the sides, area of the ligament simple, lunule rotundately heart-shaped; whitish, sometimes, but obscurely stained with light rust bands, and covered with a thin horny epidermis.

Hab.—United States.

This fine species is chiefly distinguished by its compressed growth and fine sculpture.—[Reeve, 1850.]

Occurrence.—Pliocene. Brunswick Canal, Georgia, H. J. H. Couper (Dall); Caloosahatchie beds, Myakka and Caloosahatchie Rivers and Shell Creek, Florida (Dall). Pleistocene. Simmon's Bluff, South Carolina, very common. (Cornell Univ. Pal. Lab.); Osprey, Fla.; Grand Chenier?, New Orleans, artesian well of 1856 at 546 feet, Lake Borgne borings, New Orleans puping station No. 7, New Orleans Gymnasium well at 1200 feet, Knapp's wells, Terrebonne Parish, No. 1, (?), 1600–1700 feet, No. 2, 1519–1542, No. 3 at 570–700, 880–900, 1330–1375, 1400–1440, 1700–1712 feet. (Maury. Cornell Univ. Pal. Lab.). Living. Cape May, New Jersey south along the coast to Vera Cruz, Mexico; Ft. Barrance, Point au Fer, Chandeleur, La.; Galveston, Corpus Christi, Texas. (Cornell Univ. Pal. Lab.). St. Joseph's Bay, Crooked Island, Alligator H, Franklin Co., Fla.; Horn Island, Miss. (Vanatta)

DOSINIA CONCENTRICA (Born)

Plate XVIII, Figures 2, 5, 10;

Plate XX, Figure 4

Venus concentrica Born, 1780, Test. Musei Cæsarei Vind., p. 71, pl. V, fig. 5.

Cytherea concentrica Lamarck, 1818, An. sans Vert., V, p. 573.

Venus Philippi D'Orbigny, 1847, Voy. Am. Merid., p. 553.

Artemis Patagonica Reeve, 1850, Conch. Icon. *Artemis*, pl. VII, fig. 40, not *Artemis concentrica* Reeve, 1850.

Dosinia concentrica Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 6.

Dosinia concentrica Römer, 1862, Mon. *Dosinia*, p. 8.

Dosinia floridana Conrad, 1866, Amer. Jour. Conch., vol. II, p. 280, pl. 15, fig. 4.

Dosinia elegans Dall and Simpson, 1900, Rep. U. S. Fish. Com., vol. I, p. 486.

Dosinia concentrica Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 366; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1232; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 141, pl. 25, fig. 2.

Germ. Die Gürtelvenus. Angl. The girtled Heart cockle *Petiver*.

Testa orbiculata laevi, sulcis transversis concentricis, areola impressa, cordata.—[Born, 1780.]

Shell large, orbicular, moderately convex; surface covered with medium wide, flat, regular concentric ribs, over the whole surface of the shell; lunule impressed, deep and sunken; pallial sinus large and pointed; shells white with irregular bluish or yellow patches.

D. concentrica differs from *D. elegans* with which it may be confused easily, by being more convex in the umbonal and mid-region of the shell. Usually the concentric ribs are narrower than in *D. elegans*. *D. d'seus* is the most compressed and has the finest concentric ribbing. *D. elegans* is more compressed than *D. concentrica* but the concentric ribbing is coarser.

The young of *D. concentrica* are plumper. The concentric ribs are more regular in the young than in the adults.

Occurrence.—Pleistocene of Cuba, D'Orbigny (fide Dall). Recent. Florida Keys (Conrad); Martinique, Porto Rico, Guadeloupe, Virgin Islands, Santa Cruz and St. Thomas, West Indies; Colon; Maracaibo to Rio de Janeiro, Brazil.

CALLISTA (POLI) Mörch¹Fig. 8. Hinge of type species of *Callista*

- Callista* Poli, 1791, Testacea Utriusque Siciliae, I, p. 30 not binomial.
Chione Gray, 1838, The Analyst, VIII, p. 305; *Venus chione* Linné not *Chione* Megerle von Mühlfeld, 1811; Gray, 1847, Proc. Zool. Soc. Lond., p. 183, not *Chione* Gray, 1851.
Dione Gray, 1851, List An. Brit. Mus., p. 6 fide Dall *Venus chione* Linné, not *Dione* Gray, 1847, or *Dione* Hübner, 1816, Lepidoptera.
 not *Callista* Leach, 1852, Syn. Moll. Gt. Brit., p. 302 edited by Gray *Venus verrucosa* Linné, fide Dall.
Callista Mörch, 1853, Cat. Yoldii, II, p. 27. *Venus chione* Linné, no type designated; first species *C. ergyina* Linné.
Callista Römer, 1857, Krit. Unters., p. 15; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 424 example *V. chione* Linné, no type designated; Römer, 1866, Mon., *Venus*, p. 43, *Venus chione*; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 178, *Venus chione* Linné as type; Stoliczka, 1871, Pal. Indica, vol. III, p. 150; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 177; Fischer, 1887, Man. de Conch., p. 1079.
Macrocallista Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 351 in part; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1251 in part; not all of *Macrocallista* Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 179.
Callista Cossmann and Peyrot, Act. Soc. Linn. Bordeaux, vol. LXIV, p. 384; Jukes-Browne, 1908, Proc. Mal. Soc. Lond., vol. 8, p. 99; Jukes-Browne, 1913, l. c., vol. 10, p. 335; Jukes-Browne, 1914, l. c., vol. 11, p. 60.
 in part *Chionella* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 369; in part Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1255; not *Chionella* Cossmann, 1886; Fischer, 1887, *Meretrix ovalina* Deshayes, not *Chionella* (Jeffreys) Swainson, 1840, Mal., p. 335.
Paradione Dall, 1909, Proc. Mal. Soc. Lond., vol. 8, p. 197 to replace *Chionella* Cossmann, 1886; Dall, 1909, U. S. Geol. Sur., Prof. Paper, No. 59, p. 120; Dall, 1915, U. S. Nat. Mus., Bull. 90, p. 146.

The name *Callista* can not be used in a rigid interpretation of zoological rules. It is here used in hope that it may be placed on the list of zoological excepted names of genera. A discussion of the non-binomial application of names by Poli has been given in detail by Dr. Dall and Jukes-Browne. The name if used must date from some later author than Poli. *Venus chione* Linné was the first name of Poli's list of the shell of *Venus*.²

The species was used later by several authors but for genera which had been proposed previously with different type species. Gray published in 1852 the application of Leach for *Callista* which was that of *Venus verrucosa* L. which had been used by Brown in 1827 for *Clausina*. Mörch in 1853 used *Callista* but did not designate a type. H. and A.

¹ Art. 30, g., Int. Rules Zool. Nom., 1916. Type fixed by Meek, 1876. Type by subsequent designation.

² Jukes-Browne, 1908, Proc. Mal. Soc. Lond., vol. 8, p. 100.

Adams in 1857 used *Callista* but did not cite *Venus chione* as type, only as an example. However, Meek, in 1876 designates definitely *Venus chione* Linné as the type of *Callista* Poli. This, according to the rules of zoological nomenclature fixes the type of *Callista* with the author as Mörch instead of Poli. The unfortunate use of the name by Leach and published by Gray makes the use questionable.

Venus chione Linné typifies a group of shells of the Veneridæ which cannot be placed consistently under groups which represent only modifications of the normal form. The classification of the genus according to the strict rules makes the relationships as designated by generic and sub-generic rank mean very little and is confusing as to the true relationship of the genus *Callista* as a group. *Venus chione* represents the normal form,—exterior, smooth and the length medium. *Macrocallista* represents the elongate form with a smooth exterior. *Costacallista* represents the shell with typical characters but with a costate exterior. *Paradione* Dall, (*Chionella* Cossmann, 1886) was applied to a very small species of the Paris Basin Eocene and does not represent the typical *Callista* shell of American Tertiary and Recent. A comparison of *C. marylandica* (Conrad), pl. XI, figs. 2, 3; pl. XII, fig. 10, with *Venus chione* Linné, pl. XI, figs. 1, 4, 5, 6, will show what is meant by *Venus chione* representing typically an eastern American group.

Shell large, heavy; obovate or elongate, slightly compressed; posterior and anterior ends rounded; beaks low and broad; inner margins smooth; teeth consist of three cardinals in each valve, middle cardinal in each valve the largest; nymphs of genus sensu stricto smooth; posterior, right cardinal bifid; posterior, left cardinal thin and elongate; anterior lateral in the left valve, large and high; pallial sinus large, typically biangulate; lunule large, impressed, bounded by an incised line, inequilateral, right side the larger; no escutcheon; exterior smooth with porcelaneous glaze or with flat, medium, concentric ribs.

Callista and *Pitaria* represent the old stocks of the eastern American Veneridæ and include the greater portion of the Eocene species. The two genera are related closely and may be confused easily in the fossil form. The noncostate *Callista* differs from the noncostate *Pitaria* in having a smooth porcelaneous shell, with a polished glaze while the exterior of *Pitaria* s. s. is rough and the growth lines are conspicuous. Typically, *Callista* has a biangulate pallial sinus although the sinus may become rounded but the pallial sinus of *Pitaria* is always rounded and does not show the characteristic biangulation seen in *Callista*. The *Callistas* are usually more compressed than the *Pitarias* and the umbones less full. *Callista* has often an inequilateral lunule. The ribs in the costate *Callistas* have a tendency to be more flattened and the shell more compressed than the species of *Pitaria* which are ribbed.

Genolectotype.—*Venus chione* Linnæus, Plate XI, Figures 1, 4, 5, 6. Recent. Northwestern European Seas and the Mediterranean Sea.

The genus ranges from the Eocene thru Recent and is represented by abundant species thruout its range.

Genus CALLISTA Mörch s. s.

Subgenus Callista s. s.

Characters as described under the general head; shell obovate; smooth.

Genolectotype.—*Venus chione* Linnæus.

Section MACROCALLISTA Meek

Characters of genus; shell smooth, elongate in shape.

Type.—*Venus nimbose* Solander (*V. gigantea* Gmelin).

Subgenus COSTACALLISTA n. s. g.

Characters of genus; shell with numerous flat, medium, concentric ribs; obovate in shape.

Genoholotype.—*Venus erycina* Linnæus.

Stratigraphic Range of *Callista* s. s.

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
<i>annexa</i>	<i>sobrina</i>	<i>pirabica</i>	<i>maculata</i>	<i>maculata</i>	<i>maculata</i>
<i>veatchi</i>	<i>neusensis</i>	<i>marylandica</i>			
<i>perovata</i>		<i>maculata</i>			
<i>var. lisbonensis</i>					
<i>var. subvitrea</i>					

CALLISTA (CALLISTA) VEATCHI (Van Winkle)

Plate X, Figures 3

Macrocallista? veatchi Van Winkle, 1919, Bull. Amer. Pal., vol. 8, No. 23, p. 21, pl. 3, figs. 6, 7.

Size and shape of shell as indicated by the figures; high compared with the size of the shell; beaks situated nearly centrally, swollen; surface sculpture consists of numerous, moderate in size, radiating ribs with very narrow interspaces, less than one-half the width of the ribs. The first cardinal of the right valve differs from the type of *Macrocallista* in being a very large, heavy tooth, the posterior ligamental groove in this form is not as deep or external as in most species of *Macrocallista*. These characteristics, with the shortness of form probably make the species of sectional rank. Longitude of shell 22 mm., altitude 19 mm.

Type and specimens figures.—Pal. Museum, Cornell Univ.

Geological horizon.—Midway Eocene.

Locality.—"Bed No. 2, Soldado Rock, Gulf of Paria, Trinidad."

Collected by A. C. Veatch in 1912, then of the General Asphalt Company of Philadelphia.—[Van Winkle, 1919.]

CALLISTA (CALLISTA) NEUSENSIS (Harris)

Plate XIV, Figures 13, 14, 16

Meretric neusensis Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 136, pl. 43, figs.

4-7, 10.

General appearance as figured; nearly smooth centrally, somewhat undulate peripherally; rather longish, at some localities, with exceedingly thick shell in the umbonal regions, but thin basally; interior of the shell not capacious; hinge heavy, broad.

This shell has the appearance of having been filled up with shell matter from within, leaving the muscular scars and pallial sinus very deeply sunken in the shell mass. In casts of the interior, these features appear very prominent. The greatest depth of the shell is at the anterior curve or angulation of the pallial sinus. The complete filling of the umbonal region with shell matter is somewhat unusual.

Variety *lisbonensis* (described under *perovata*), if larger and thicker would appear exceedingly close to this form. The outline of the shell is often very much like that of *pearlensis*. It is difficult to say whether this species is more closely related to *lisbonensis* or *subimpressa*. Some specimens could very well be referred to mutations of either. The pallial line is somewhat distant from the basal margin of the shell, reminding one of *Crassitellites*; this is especially true in the very much shortened varieties of the species.

Casts of this species are exceedingly abundant in the coarse silicious limestone about Newbern. Occasionally other species are found. At first we are astonished at the great amount of variation this species shows. But, still, *perovata* in the Claiborne shows just as much. Rarely we find pseudomorph which assists greatly in determining the exterior characteristics (fig. 7, a). Though the shell matter is often very thick, the diameter of the valves is never proportionally so great as in typical *perovata*. In fact, this seems to be a less specialized form, an overgrown *lisbonensis*. —[Harris, 1919.]

This form is one of several of the *Callistas*, the shape of which is between typical *Callista* and typical *Macrocallista*.

Syntypes.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Oligocene. Correlated with the Tampa beds. In the "Trent formation" near Newbern, Rocky Landing on the Neuse River above Newbern, 16-17 miles above Newbern, on Neuse River, N. C. (Harris Coll., Cornell Univ. Pal Lab.)

CALLISTA (CALLISTA) PEROVATA (Conrad)

Plate XIV, Figures 9a, 11, 15, 21, 22

Cytherea perovata Conrad, 1852, Fos. Sh. N. Am., vol. I, No. 3, p. 37 not pl. 19, fig. 5, Harris Reprint, 1893, pl. 20, fig. 4.

Cytherea comis Lea, 1833, Cont. to Geol., p. 66, pl. 2, fig. 41.

Cytherea perovata Conrad, 1842, 2nd. Bull. Proc. Nat. Inst., p. 179.

Meretrix perovata Conrad, 1854, Acad. Nat. Sci. Phil. Proc., vol. 7, p. 30.

Dione perovata Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Cytherea perovata Heilprin, 1880, Acad. Nat. Sci. Phil. Proc., vol. 32, p. 364.

Cytherea comis Meyer, 1885, Amer. Jour. Sci., vol. 29, p. 467.

Cytherea perovata Aldrich, 1885, Amer. Jour. Sci., vol. 30, p. 306.

Cytherea aquorea var. *comis* De Gregorio, 1890, Ann. de Geol. et Pal., 7 et 8 liv., p. 217, pl. 33, fig. 23-25; var. *cominduta* DeGregorio, 1890, *ibid.*, p. 217, pl. 34, fig. 6-7 in part.

Meretrix perovata Cossmann, 1893, Ann. de Geol. et Pal., 12 liv., p. 10; Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 138, pl. 43, fig. 12-14.

Shell cuneiform-ovate, convex, smooth, and polished, slightly sulcated on the inferior half of the valves; posterior side slightly compressed and cuneate; umbo tumid, beaks almost anterior; two anterior cardinal teeth in the right valve, approximate and parallel; lunule cordate and defined by a simple compressed line. Length 1½ inches. Breadth 1 inch.

Locality.—Claiborne, Alab.

Cab. Acad. N. S.—[Conrad, 1832.]

Typically this species has a thick shell with large, tumid umbones. The surface is smooth. The adults have the posterior side slightly com-

pressed and cuneate. The young are developed more evenly anteriorly and posteriorly. The sculpture varies from the forms which have practically no trace of concentric liræ to forms which have concentric ribs present on the umbonal region, on the posterior dorsal margin and anteriorly along the margin of the lunule. The shape remains the same in general aspect but may shorten in length. A variety of this species which develops regular, concentric ribs over the greater portion of the shell is *aldrichi* Harris. That form does not become as tumid as *perovata*.

Dimensions.—43 mm., length; 31 mm., height; 24 mm., thickness.

Holotype.—? Academy of Natural Science, Philadelphia, Pa.

Occurrence.—St. Maurice and Claiborne Eocene. Claiborne and Lisbon, Ala. Shell Bluff, Ga. (Cornell Univ. Pal. Lab.)

CALLISTA (CALLISTA) PEROVATA LISBONENSIS (Harris)

Plate XIV, Figures 2, 7, 8

Meretrix perovata var. *lisbonensis* Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 137, pl. 43, figs. 8-9.

General features as figured, appearing in some elongate forms singularly like *sylærupis*, but without the long anterior, and concave lunular margin of that species, therefore approaching in outline *subimpressa* Con., but with deeper valves and passing gradually through shorter forms (fig. 10 and var. *subvitrea* de Greg., fig. 11) into typical *perovata*.—[Harris, 1919.]

Syntypes.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—St. Maurice and Claiborne Eocene. Lisbon and base of bluff at Claiborne, Ala.; 3 and 6 miles W. N. W. of Orangeburg, S. C.

CALLISTA (CALLISTA) PEROVATA SUBVITREA (De Gregorio)

Plate XIV, Figures 6

Cythera aequorea mut. *subvitrea* De Gregorio, 1890, Ann. de Geol. et Pal., 7 et 8 liv., p. 217, pl. 33, figs. 16-22.

Meretrix perovata var. *subvitrea* Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 138, pl. 43, fig. 11.

Similis præcedenti [*Cythera hydii*] sed laevigata.—[De Gregorio, 1890.]

This variety is less tumid and shorter in shape than the type species.

The form in the Jackson Eocene of this is *C. annexa* Conrad.

Occurrence.—St. Maurice and Claiborne Eocene. Lisbon and Claiborne, Ala. (Cornell Univ. Pal. Coll.)

CALLISTA (CALLISTA) ANNEXA (Conrad)

Plate XIV, Figures 17, 20

Dione annexa Conrad, 1865, Amer. Jour. Conch., vol. I, p. 137, pl. 10, fig. 5.

Meretrix annexa Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 138.

Ovate, convex; posteriorly cuneate, abruptly rounded at the extremity; sub-stance thick; anterior side short, obtusely rounded; ventral margin rounded; umbo broad; anterior cardinal tooth robust in the left valve, pyramidal.

One valve only is in the collection, and is water-worn, but otherwise entire. It differs from *D. perovata* in being a smaller species, less in diameter through the umbones, and less produced posteriorly. It has some resemblance to *D. silicea*, C., but is shorter anteriorly, and proportionally longer in outline.—[Conrad, 1865.]

Dimensions.—36 mm., length; 26 mm., height; 20 mm., thickness.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Jackson Eocene. (Type), Garland's Cr., Miss. (not Enterprise, Miss., as stated by Conrad. See Am. Jour. Sci., vol. XXX, 1885, p. 307.) Bunker Hill Landing and Montgomery, La. (Cornell Univ. Pal. Lab.)

CALLISTA (CALLISTA) SOBRINA (Conrad)

Plate XII, Figures 4, 5, 13

Cytherea sobrina Conrad, 1847, Proc. Acad. Nat. Sci. Phil., vol. 3, p. 293; Conrad, 1848, Jour. Acad. Nat. Sci., 2nd ser., vol. I, p. 123, pl. 13, fig. 17.

Meretrix sobrina Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 30; Conrad, 1855, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 257.

Dione sobrina Conrad, 1865, Amer. Jour. Conch., vol. I, p. 6; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 28.

Macrocallista (Chionella) sobrina Dall, 1903, Trans. Wag. Inst. Sci., vol. III, p. 1279.

Subovate, ventricose, polished; with rather obtuse irregular, distant, concentric, impressed lines; umbo entire; extremities rounded; base regularly curved. Length 1 1-10; Height 9-10.

Very abundant. Almost always with disunited valves. It is quite thick on the anterior side towards the summit.—[Conrad, 1847.]

This species presents variability in shape. In all, the umbones are very full. Some individuals shorten posteriorly until the shell is only about two-thirds of the average length. The anterior and posterior ends are almost blunt. The shell is thick, but thin specimens are found in the collection and other specimens are found which have an excess of material in the mid-region of the valve. The species differs from *C. annexa* of the Jackson in being shorter, the posterior end not pointed and the umbones much fuller. This species may have come from the stock of *C. perovata* of the St. Maurice—Claiborne Eocene thru var. *subvitrea* and *C. annexa*.

Dimensions.—30 mm., length; 28 mm., height; 9 mm., semidiameter.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Vicksburg Oligocene. (Type), Vicksburg, Miss.; Mint Spring Bayou and Cemetery Road, Vicksburg, Miss. (Cornell Univ. Pal. Lab.)

CALLISTA (CALLISTA) MARYLANDICA (Conrad)

Plate XI, Figures 2, 3; Plate XII, Figures 10, 11

Cytherea marylandica Conrad, 1833, Am. Jour. Sci., 1st. Ser., vol. 23, p. 343; Conrad, 1838, Fos. Sh. Med. Ter., p. 15, pl. IX, fig. 1; Conrad, 1842, Bull. Nat. Inst., vol. II, pp. 183, 185.

Dione marylandica Conrad, 1863, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9; Whitfield, 1894, U. S. Geol. Sur., Mon. 24, p. 74, pl. 13, fig. 1.

Macrocallista (Chionella) marylandica Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1255.

Macrocallista marylandica Glenn, 1904, Md. Geol. Sur., Mio., p. 311, pl. 74, figs. 1, 2.

Shell obtusely ovate, smooth, thick; umbo obtusely rounded posteriorly; lunule ovate-acute and slightly impressed; hinge with the anterior tooth very robust. This shell is from the upper marine formation; it is about the size and shape of *Venus mercenaria*, and is vastly abundant in the bank of the Choptank river, about four miles

from Easton, Md., and occurs in no locality which I have visited.—[Conrad, 1833.]

This species is typical of the genus *Callista* represented by *Venus chione* Linnæus. The characters are so typical that it does not seem fit to follow the rigid rule of nomenclature to place the species in a related subgroup to which it does not belong so appropriately.

The shell is thick and the hinge heavy. Many specimens show an additional thickening in the region of the anterior teeth and middle cardinal, back of the anterior adductor scar, extending to the pallial line. This thickening does not extend beyond the mid-portion of the shell posteriorly, but leaves that area as a more or less deep concavity. The posterior edge of the anterior adductor scar is set deeply in the thickened portion.

The rugose edge of the fan-shaped, anterior right cardinal mentioned by Dr. Dall occurs also in the specimens of *C. albaria* and *reposita*. The beaks are small but the umbonal region is wide and very convex, giving the appearance of the dorsal region being rolled under. The posterior end varies from rounded to pointed. Young specimens are thin, the umbonal region is not so convex and the posterior and anterior ends are more nearly equal in the degree of roundness. The anterior right cardinal shows the rugose edge in the young. The young of *marylandica* is like *C. albaria* in shape.

Dimensions.—Aver. Adult, 114 mm., length; 90 mm., height; 61 mm., thickness.

Holotype.—? Academy of Natural Science, Philadelphia, Pa.

Occurrence.—Calvert Miocene. Chesapeake Ld., Plum Point, Md. Choptank Miocene. (Type.) Near Easton and on the Puxtuxent River, Jones Wharf, Md. (Cornell Univ. Pal. Lab.)

CALLISTA (CALLISTA) MACULATA (Linnæus)

Plate X, Figure 11; Plate XII, Figures 1, 2, 3, 8, 9;

Plate XIV, Figure 4

Venus maculata Linnæus, 1758, *Systema Naturæ*, ed. X, p. 686; Linnæus, 1767, *ibid*, ed. XII, p. 1132.

Cytherea maculata Lamarck, 1818, *Hist. des An. sans Vert.*, vol. V, p. 566; Jay, 1852, *Jay's Catalog*, p. 36.

Meretrix dariena Conrad, 1855, *App. Blake's Geol.*, Rep. House Doc., 129, p. 18.

Cytherea ? (*Meretrix*) *dariena* ? Conrad, 1857, *Pac. R. R. Repts.*, vol. VI, p. 72, pl. V, fig. 21 not Conrad, 1856, *Pac. R. R. Repts.*, vol. V, p. 328, pl. VI, fig. 55 = *Clementia*.

Dione maculata Reeve, 1863, *Mon.*, *Dione*, *Conch. Icon.*, pl. III, fig. 11.

Callista maculata Gabb, 1881, *Jour. Acad. Nat. Sci. Phil.*, 2nd ser., vol. VIII, p. 344; Dall, 1889, *U. S. Nat. Mus.*, Bull. 37, p. 56; Singley, 1892, *Geol. Sur. Texas*, 4th Ann. Rept., p. 327.

Meretrix maculata Dall and Simpson, 1900, *Bull. U. S. Fish. Com.*, vol. I, p. 485.

Macrocallista (*Chionella*) *maculata* Dall, 1902, *Proc. U. S. Nat. Mus.*, vol. 26, No. 1312, p. 369; Dall, 1903, *Trans. Wag. Inst. Sci.*, vol. III, pt. 6, p. 1256; Pilsbry, 1921, *Proc. Acad. Nat. Sci. Phil.*, vol. 73, pt. II, p. 422.

- ? *Cytherea planivieta* Guppy, 1911, Agr. Soc. Trinidad, No. 440, Harris Reprint, 1921, vol. 8, No. 35, pp. 149, 154, pl. 8, fig. 2.
- Macrocallista (Pavadione) maculata* Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 68; Maury, 1925, Ser. Geol. e Min. do Brazil, Mon., No. IV, p. 321, pl. 18, figs. 8, 9.
- Macrocallista (Chionella) maculata* Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 234, pl. 31, fig. 6, 7; Maury, 1925, Bull. Amer. Pal., vol. 25, No. 42, p. 145, pl. 25, figs. 1, 4, 5.
- V. testa cordato lævi: maculis exoletis sparsis.
Gualt. test. t. 86, f. I. *Argenv. conch. t. 24, f. H. Kratzenst. Regenf. t. 8, f. 16.*
Habitat in O. Americano.—[Linnaeus, 1758.]

Shell large, obovate; anterior end rounded; posterior end subtruncate; beaks low, small; inner margins smooth; three cardinals in each valve; middle teeth high and sharp; posterior cardinal in the right valve bifid; posterior cardinal in the left valve long and thin; anterior lateral in the left valve high and pointed; pallial sinus medium, angulate, typically bi-angulate in the mid-region; ligament external; lunule inequilateral, larger side on the right valve, marked only by a faint line; no escutcheon; shell smooth; color white or pinkish, with a pattern of darker rose or brown checks or blotches; some with darker radiating rows; shell covered with a brown periostracum.

Gabb, 1881, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. VIII, p. 372, differentiated a variety of this species which he called *cuneata*. The difference given was in the posterior slope, i. e., the posterior dorsal margin is sloped regularly in a nearly straight line instead of bearing the truncation of *maculata*. We did not see the specimens which Gabb had in mind. This variety was described from the Pliocene of Costa Rica.

Dimensions.—73 mm., length; 53 mm., height; 32 mm., thickness.

Occurrence.—MIOCENE. Rio Pirabas, Provincia do Parà, Brazil. (Maury). LOWER MIOCENE. Chipola River, Alum Bluff, Chattahoochee River, Oak Grove, Shoal River, Walton County, Fla. GATUN MIOCENE. Headwaters of Middle Creek, Rio Blanco, Costa Rica. (Olsson). SPRINGVALE MIOCENE. Springvale, Trinidad. (Maury. Harris Coll., Cornell Univ. Pal. Lab.). PLIOCENE. Caloosahatchie, Shell Creek, Alligator Creek, Fla.; Limon, Costa Rica. (Gabb). RECENT. Cape Hatteras south to West Indies, Gulf of Mexico, west to Texas, thru the Antilles, south to Cap San Roque, Brazil. (U. S. Nat. Museum, Cornell Univ. Pal. Lab.).

CALLISTA (CALLISTA) SILICEA (Conrad)

Plate XII, Figure 6, 7

Dione silicea Conrad, 1865, Amer. Jour. Conch., vol. I, p. 137 (reference). (No description.)

Shell ovate; beaks small; anterior end short; posterior end slightly truncated; lunule long and narrow; hinge with three cardinals in each valve and an anterior lateral in the left valve; exterior smooth; inner margin smooth; interior of the shell filled with a sandy siliceous matrix.

The shape of the shell is like that of *C. maculata* but the posterior end is less angulated and more produced anteriorly. It is probably a variety of *maculata*. The true identity of this species cannot be determined since the only specimens are without a locality label. Conrad mentions the species in his description of *Callista annexa*. Two specimens are in the collection of the Academy of Natural Sciences at Philadelphia, but there is no indication as to the locality from which they came. The shells are worn and filled partly with a siliceous matrix with fragments of extraneous shell attached firmly.

Dimensions.—44 mm., length; 33 mm., height; 12 mm., semidiameter, left valve; 37 mm., length; 29 mm., height; 10 mm., semidiameter, right valve.

Lectotype.—No. 965 of Academy of Natural Sciences, Philadelphia, Pa.

Section MACROCALLISTA Meek



Fig. 9. Hinge of type species of *Macrocallista*

Macrocallista Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 179; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 178; Fischer, 1887, Man. de Conch., p. 1079; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 351; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1251; Jukes-Browne, 1913, Proc. Mal. Soc. Lond., vol. 11, p. 60.

Shell transversely elongate-oval, with surface smooth; pallial sinus and hinge nearly typical, excepting that the sublunular or anterior lateral tooth is generally more compressed, more oblique, and more remote from the cardinal, and the posterior lateral much more elongated, and nearly horizontal.—[Meek, 1876.]

Shell elongate; lunule narrow, elongate, defined, slightly unequal, the right side the broader; escutcheon not defined; inner margins smooth; three cardinals in each valve, right posterior cardinal bifid; anterior lateral in the left valve, large and pointed; pallial sinus large, broad and typically not rounded but biangulate, pointed in front; shell smooth.

Comparing the types of *Callista* s. s. and *Macrocallista*, one finds that the character of the elongation of the shell in *Macrocallista* appears to differentiate the two groups. In Recent and later Tertiary species that character may be used. Examining more species, especially in the Eocene, one finds that there are many species which it is difficult to say whether they are too elongate to be placed in *Callista* s. s. or not elongate enough to be placed in *Macrocallista*. *C. neusensis* (Harris) is an example of this. When species do not fall naturally into the group and the merging is so complete, *Macrocallista* does not seem to be of more than sectional value.

Type.—*Venus nimbosa* Solander (*V. gigantea* Gmelin), Plate X; Figure 15; Plate XIII, Figures 1, 4; Plate XIV, Figure 18. Recent. North Carolina south to Cuba and the Gulf Coast of the United States

The section ranges from the Eocene to the present time.

Stratigraphic Range of *Macrocallista* section

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
<i>sylværupis</i>	floridana	floridana	nimbosa	nimbosa	nimbosa
<i>subimpressa</i>		reposita			
<i>golftotristensis</i>		albaria			

Section MACROCALLISTA Meek

CALLISTA (CALLISTA) SYLVÆRUPIS (Harris)

Plate XIII, Figures 7, 9, 11

Cytherea perovata? Aldrich, 1886, Bull. Geol. Sur. Ala., vol. I, p. 53.

Meretrix subimpressa var. Harris, 1897, Bull. Amer. Pal., vol. 2, No. 9, p. 255, pl. 12, figs. 6, 7.

Meretrix sylværupis Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 136, pl. 43, fig. 1.

The variety here referred to has some resemblance to *M. pearlensis* Har., but has no indications of such markings. From *subimpressa* typical it differs in having its upper and basal margins more rectilinear, its posterior very prolonged, but finally abruptly truncated, its anterior more produced and circular, its beaks slightly more prominent. The moderately deep truncated pallial sinus is the same in both.

Many specimens are scarcely distinguishable from young *M. levigata* Lam., though the beaks are always a little pronounced and there are no signs of radiating lines.—[Harris, 1897.]

The general characteristics of this form have already been discussed. With a much greater amount of material containing all stages of growth of *subimpressa* it is evident that the two species are quite distinct. Figures of *subimpressa* (figs. 2 and 3), from Pope's Creek, Md., are here introduced for comparison with this Woods Bluff, Sabine, form. It is also clear that this merges, through the St. Maurice var. *lisbonensis* into *perovata* of the Claiborne sands.—[Harris, 1919.]

Dimensions.—21 mm., length; 13 mm., height; 45 mm., semidiameter.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Upper Sabine Eocene. Woods Bluff, Ala. (Cornell Univ. Pal. Lab.)

CALLISTA (CALLISTA) SUBIMPRESSA (Conrad)

Plate XIII, Figures 2, 3, 8

Cytherea subimpressa Conrad, 1844, Acad. Nat. Sci. Phil. Proc., vol. 2, p. 173; Conrad, 1848, Acad. Nat. Sci. Phil. Jour., 2nd ser., vol. I, p. 130, pl. 14, fig. 26; H. C. Lea, 1848, *ibid.*, vol. IV, p. 99.

Meretrix subimpressa Conrad, 1854, l. c., Proc., p. 30.

Dione subimpressa Conrad, 1865, Amer. Jour. Conch., vol. I, p. 7; Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 28.

Cytherea subimpressa Clark, 1895, Johns Hopkins Univ. Circle, vol. XV, p. 5; Clark, 1896, U. S. Geol. Sur. Bull. No. 141, pp. 40, 43.

Meretrix subimpressa Clark and Martin, 1901, Report Md. Geol. Sur. Eocene, p. 170, pl. XXXIII, figs. 5-9; Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 136, pl. 43, figs. 2, 3.

Ovate, slightly ventricose, smooth and polished, with concentric slightly impressed lines on the anterior side; anterior side short, rather acutely rounded; posterior side produced, acutely rounded at the extremity; dorsal margin long, oblique, slightly curved; beaks prominent; lunule lanceolate, defined by a slightly impressed line.

Length $1\frac{1}{4}$ inch. Height $\frac{8}{10}$ inch.

Locality.—Marlbourne, Hanover county, Virginia. Mr. Ruffin.

This species may be distinguished from *C. æquorea*, by its greater comparative length, smaller size, and in wanting the strong furrows of that species. Mr. Ruffin obtained several entire specimens.—[Conrad, 1844.]

C. subimpressa is broader posteriorly than *C. sylværupis*. It is also a more delicate shell than *sylværupis*. It shows the characteristic bi-angulate pallial sinus of the genus. The species has a tendency to develop flat, broad, concentric ribs anteriorly. The middle and posterior regions of the shell are smooth. *Sylværupis* is smooth over the whole surface of the shell.

Dimensions.—(Large.) 29 mm., length; 20 mm., height; 8 mm., thickness.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Nanjemoy Formation. Eocene. Marlbourne, Hanover County, Piping Tree, Newcastle, below City Point, Va.; Popes Creek, Woodstock, 1 mile southeast of Piscataway, Md. (Cornell Univ. Pal. Lab. Md. Geol. Sur.)

CALLISTA (CALLISTA) GOLFOTRISTENSIS (Maury)

Plate XIII, Figure 6

Meretrix subimpressa var. *golfotristensis* Maury, 1912, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. XV, p. 56, pl. IX, fig. 9.

A number of shells of a *Meretrix* were found in bed No. 8, Soldado Rock, which recall the varietal form of Conrad's *subimpressa* found by Professor Harris in the Lignitic Eocene of Wood's Bluff, Alabama. But the Soldado shells when compared with the Museum specimens from Wood's Bluff are seen to be smaller, less convex, more sculptured with concentric lines, and with the posterior margins still more prolonged, giving the general outline of the valve a more elliptical form.

The largest specimen measures in length 20, height 10, thickness of one valve 3 mm.

Locality.—Bed No. 8, Soldado Rock, Gulf of Paria (Golfo Triste of the early navigators).

Geological horizon.—Lignitic Eocene. Equivalent to the Lignitic of Alabama.—[Maury, 1912.]

Since this species was described, the differences between *Callista subimpressa* (Conrad) and the species from Woods Bluff, Alabama, have been illustrated well and pointed out by Prof. Harris. The forms from Alabama were named *sylværupis* by him. The specimens from Soldado Rock, Trinidad, seem to warrant specific rank from *subimpressa*. In addition to the differences between the two forms, brought out by Dr. Maury, the Trinidad shell is much more slender, beaks lower and the anterior end is more produced than either *subimpressa* or *sylværupis*.

Holotype.—Paleontological Museum, Cornell University, Ithaca, N. Y.

Occurrence.—Sabine Eocene. Bed No. 8, Soldado Rock, Gulf of Paria, Trinidad.

CALLISTA (CALLISTA) FLORIDANA (Conrad)

Plate XIV, Figures 1, 3, 5, 9, 10, 12, 19

Cytherea floridana Conrad, 1846, Amer. Jour. Sci., 2nd ser., vol. II, p. 400, text figure.*Dione floridana* Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.*Macrocallista floridana* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1257.*Macrocallista acuminata* Dall, 1903, l. c., p. 1255, pl. 57, fig. 3.*Macrocallista (Paradione) acuminata* Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 146, pl. 20, figs. 8, 9, 10; pl. 24, fig. 2.

Oval, inequilateral, rounded at the ends; ligament margin slightly curved; basal margin rounded.

Occurs with the preceding.

This seems to have been a smooth and polished species, but none of the shell remains.—[Conrad, 1846.]

Specimens were found at the Academy of Natural Sciences, Philadelphia, of *Cytherea floridana* Conrad from Ballast Point, Florida. We have figured a specimen since Conrad's original figure is poor for identification purposes. The hinge is that of *Callista*. The shape of the shell is somewhat like *C. subimpressa* and *C. sylværupis* of the Eocene but differs from both of those species in being more pointed posteriorly. Dr. Dall has named a *Callista* from Ballast Point, *acuminata*, which is probably the species of Conrad. The drawing of 1903 of *acuminata* shows the shell to be more pointed than Conrad's shell but the photographs of *acuminata* which were published later in 1915, shows the specimens to be like *C. floridana* Conrad. Copies of the figures of *acuminata* have been included for comparison. The dimensions of *acuminata* are greater than those of the specimen figured of *floridana*.

Dimensions.—17 mm., length; 12 mm., height; 4 mm., semidiameter.*Specimen figured* of *C. floridana* no. 10612. Academy of Natural Sciences, Philadelphia, Pa.*Holotype*.—*C. acuminata* no. 114631. United States National Museum, Washington, D. C.*Occurrence*.—Oligocene. Ballast Point, Florida. (Conrad); Lower Miocene. Chipola beds at Alum Bluff, Chattahoochee River, Florida. (Dall, *C. acuminata*).

CALLISTA (CALLISTA) REPOSTA (Conrad)

Plate XIII, Figures 5, 10

Cytherea reposta Conrad, 1834, Jour. Acad. Nat. Sci. Phil., vol. VII, p. 132; Conrad, 1838, Fos. Medial Tert., p. 15, pl. IX, fig. 2.? *Cytherea pandata* Conrad, 1834, Jour. Acad. Sci. Phil., vol. VII, p. 132.*Cytherea reposta* Emmons, 1858, Geol. Rep. N. Car., p. 294, fig. 223a.*Dione reposta* Conrad, 1863, Proc. Acad. Nat. Sci. for 1862, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 10.*Macrocallista reposta* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1252.

Shell large, ovate, moderately thick, and convex; beaks prominent; dorsal margin depressed, slightly arcuated; posterior extremity obtusely rounded; lunule large, lanceolate, defined by a slightly impressed line; two anterior cardinal teeth united above; posterior cardinal tooth laminar, slightly prominent; anterior tooth thick, subpyramidal. Length five inches; height, three inches and three-quarters.

Locality.—Suffolk, Va.—[Conrad, 1834.]Shell elongate, the shape is shorter and broader than *C. nimbose* of the same size, the umbones are higher and the lunular region is more concave; the lunule is larger; a slight flexure extends from the beaks, in the

mid-region of the shell, to the ventral margin.

Dimensions.—123 mm., length; 72 mm., height; 18 mm., semi-diameter.

Holotype.—? Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Upper Miocene. (Type) Suffolk, Va., Newbern, Wilmington, Magnolia, N. C.; sixteen miles southwest of Tallahassee, Fla.; Natural Well, N. C. (Cornell Univ. Pal. Lab.)

CALLISTA (CALLISTA) ALBARIA (Say)

Plate XII, Figure 12; Plate XIII, Figures 12, 13

Cytherea albaria Say, 1830, Am. Conch., pl. 59, fig. 1-2; Binney's Reprint, 1858, p. 219, pl. 59; Conrad, 1838, Fos. Med. Tert., p. 13, pl. 8, fig. 2.

Dione albaria Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.

Dione densata Conrad, 1863, Proc. Acad. Nat. Sci. Phil., vol. 15, p. 586; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.

Callista densata Conrad, 1868, Amer. Jour. Conch., vol. IV, p. 278, pl. 19, fig. 2.

Callista virginiana Conrad, 1869, Amer. Jour. Conch., vol. V, p. 39, pl. 2, fig. 1.

Dione virginiana Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.

Dione idonea Conrad, 1863, Proc., Acad. Nat. Sci. Phil., vol. 15, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.

Macrocallista albaria Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1253.

Shell transversely oblong-ovate, inequilateral, wrinkles of growth more obvious towards the margin, somewhat polished, with a slight appearance of rather broad, numerous radii; *beaks* a little prominent in consequence of the concave curvature of the posterior dorsal margin; *hinge* rather large, impressed, distinct, oblong-cordate; *posterior side* prominent; *anterior dorsal margin* slightly arquated, depressed, towards the beak obtusely carinated on the sub-margin; *anterior tip* narrowed and rounded; *within*, margin simple; *fosset of the posterior tooth* simple.

Observations.

This fossil shell was sent to me by the late Stephen Elliot who informed me that it was found on the banks of the Santee River, below the confluence of the Congaree and Wateree rivers in South Carolina. It is proportionally broader than *C. lilacina*, Lam., and much less broad than *C. gigantea*, Gm., of Florida. The specimen is very much thickened within on the inner side of the palleal impression, which is deeply sinuous anteriorly.—[Say, 1830.]

This species is intermediate between the obovate form of *C. marylandica* and the elongate form of *C. nimbosea*. It is closer to *marylandica*. The umbonal region has the appearance as in *C. marylandica* of being turned over dorsally. The shell of *albaria* is much flatter. The full grown specimens represented by Conrad's *virginiana* are difficult in some cases to separate from *marylandica*. They are, however, not as heavy in proportion to their size and are flatter, i.e., not as convex thru the umbonal region. This species has the character at certain localities of thickening the shell to about twice the original thickness of the valves. The additional material is deposited over the whole interior of the shell and not as in *marylandica* in the mid-anterior region.

Dimensions.—Adult. 132 mm., length; 114 mm., height; 24 mm., semidiameter; *densata* holotype. 60 mm., length; 40 mm., height; 23 mm., thickness.

Holotype and Paratypes.—*C. densata*. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Murfreeshoro Miocene. Petersburg, Va.; Yorktown Miocene. Chocowinity, N. C. (Cornell Univ. Pal. Lab.). (For Virginia localities see Bull. IV, Va. Geol. Sur., 1912, p. 173.)

CALLISTA (CALLISTA) NIMBOSA (Solander)

Plate X, Figure 15; Plate XIII, Figures 1, 4;

Plate XIV, Figure 18

- Venus nimbosa* Solander, 1786, Portland Cat., No. 3761, p. 175.
Venus gigantea Chemnitz, 1788, Conch. Cab., vol. X, p. 345, pl. clxxi, fig. 1661; Gmelin, 1792, Systema Naturæ, Tome VI, p. 3282; Encyc. Meth., 1797, pl. celxxx, fig. 3; Dillwyn, 1817, Descr. Cat. Rec. Sh., I, p. 202.
Cytherea gigantea Lamarck, 1818, Hist. des An. sans Vert., vol. V, p. 564; Conrad, 1834, Tert. Sh., in Morton, Syn. Org. Rem. App., I, p. 2; Conrad, 1846, Am. Jour. Sci., 2nd ser., vol. 11, p. 44.
Dione gigantea Deshayes, 1853, Cat. Conch. Brit. Mus., pt. I, p. 80; Reeve, 1863, Conch. Icon., *Dione*, pl. V, fig. 17.
Callista gigantea H. and A. Adams, 1857, Gen. Recent Moll., vol. II, p. 245; Holmes, 1860, P. Pl. Fos. S. Car., p. 36, pl. VII, fig. 3; Römer, 1866, Mon., *Venus*, Band I, subgenus *Cytherea*, p. 54, pl. XV, fig. I.
Cytherea gigantea Coues, 1871, Proc. Acad. Nat. Sci. Phil., vol. 23, p. 136.
Callista (Macrocallista) gigantea Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 179.
Callista gigantea Dall, 1889, Bull., U. S. Nat. Mus., No. 37, pp. 56-57.
Callista nimbosa Whitfield and Hovey, 1901, Bull. Am. Mus. N. Hist., vol. XI, p. 462.
Macrocallista nimbosa Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 351, 369; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1254; Vanatta, 1903, Proc., Acad. Nat. Sci., Phil., vol. 55, p. 757; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 67.

Shell large, very elongate, narrow and thin; anterior and posterior ends slightly pointed; beaks small and low; inner margins smooth; three cardinals in each valve, the two central teeth in each valve large and sharp; the posterior tooth in each valve elongate and thin, anterior lateral in left valve large, pointed; pallial sinus moderate in size, angulate typically with two angles in the mid-region; ligament external; lunule narrow, elongate, bounded faintly by a line; no escutcheon; shell smooth externally, white color with beautiful radiating rays of purple; shell covered with a brownish periostracum; lunular area purple; interior white with brown.

Dimensions.—130 mm., length; 63 mm., height; 32 mm., thickness.

Occurrence.—Pliocene. Caloosahatchie beds, Shell Creek, Alligator Creek, Myakka River and on the Caloosahatchie River, Florida. (Dall). Pleistocene. Simmons Bluff, South Carolina, North Creek, near Osprey, Florida. (Dall). Living from Cape Hatteras, North Carolina to Florida Keys and possibly Cuba. West along Gulf Coast to Matagorda Bay, Texas (Dall). (Cornell Univ. Pal. Lab.)

Subgenus COSTACALLISTA n. s. g.

Plate XV, Figures 17, 18, 21

Shell obovate, medium in length, sub-compressed; beaks low and full; hinge and pallial sinus typical of the genus; no escutcheon; lunule large, impressed, bounded by an incised line, usually inequilateral, right side the

wider; surface with large, flat, wide, concentric ribs with narrow interspaces.

The character of prominent, concentric ribbing distinguishes a large group of *Callistas* from the smooth type of the genus *sensu stricto*. The well known *C. erycina* of the Orient represents this group. A comparison of the species of the eastern American fauna on plate XV, shows the close resemblance of the American species to the species chosen as type. Some of the species show the costæ in partial development. This subgenus is to *Callista* as *Lamelliconcha* is to *Pitaria*. The subgenus is conspicuous in the eastern American fauna thruout the Tertiary but is not represented among the living species within the region of the present paper.

Genoholotype.—*Callista erycina* Linnæus. Plate XV, Figures 17, 18, 21. Recent. Indian Ocean and China Sea.

Stratigraphic Range of *Costacallista* s. g.

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
rathbunensis		olssoni	guppyana		
pearlensis		planivieta			
perovata var.					
aldrichi					
mortoni					
æquorea					
mcgrathiana					

CALLISTA (COSTACALLISTA) RATHBUNENSIS Maury

Plate XV, Figures 4, 8

Callista mcgrathiana Maury, 1912, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. XV, p. 57, pl. 1, fig. 10; var. *rathbunensis* Maury, l. c., p. 58, pl. IX, fig. 11.

Shell similar to a large specimen of *Callista mcgrathiana*; but characterized by the sudden cessation of the concentric groovings over the lower, central portion of the valve. Elsewhere the concentric sculpturing is beautifully regular, then it abruptly becomes obsolete.

Length of shell 21, height 15 mm.

Locality.—Bed No. 2, Soldado Rock, near the Serpent's Mouth, Gulf of Paria.

Geological horizon.—Midway Eocene. Equivalent to the Midway of Alabama and to that of the Rio Maria Farinha beds, State of Pernambuco, Brazil.

This variety is named in honor of Dr. Rathbun, of the United States National Museum, who was the first to describe shells from the Rio Maria Farinha beds, Brazil. —[Maury, 1912.]

This species is peculiar in that that umbonal half of the shell is sculptured regularly with wide, flat, concentric ribs with linear interspaces while the basal half of the shell from the anterior to the posterior ends is smooth.

Rathbun's species was not figured and only known from casts. The specimens figured by White cannot be placed definitely in relationship to *C. mcgrathiana*. The specimens from Trinidad differ from the figures of White in shape and in the size of the ribs. Both the type specimens of the species *C. Mcgrathiana* Maury and the variety *rathbunensis* Maury show

exactly the same type of sculpture. The hard, surrounding matrix covers portions of the shells and gives them a slight difference in the appearance of shape.

Dimensions.—Holotype.—21 mm., length; 17 mm., height; 6 mm., semidiameter. Paratype.—24 mm., length; 19 mm., height; 9 mm., semidiameter.

Holotype.—Paleontological Museum, Cornell University, Ithaca, N. Y.

Occurrence.—Midway Eocene. Bed No. 2, Soldado Rock, Serpent's Mouth, Gulf of Paria, Trinidad. (Maury)

? CALLISTA (COSTACALLISTA) MCGRATHIANA Rathbun

Callista Mcgrathiana Rathbun, 1874, Proc. Bost. Soc. Nat. Hist., vol. 17, p. 255.

? *Callista mcgrathiana* White, 1887, Arch. Museu Nac. Rio de Janeiro, VII, p. 95, pl. V, figs. 36, 37, 38.

not *Callista mcgrathiana* Maury, 1912, Jour., Acad. Nat. Sci. Phil., 2nd ser., vol. XV, p. 57, pl. IX, fig. 10.

Shell small, elongate, and with the valves moderately convex; length somewhat greater than the height; outline subelliptical.

The beaks are situated a little in advance of the middle, are prominent and incline rather strongly forward. Their internal moulds are sharply pointed and incurve slightly. The hinge margin descends quite rapidly from the beaks posteriorly, and is moderately curved, nearly the same curve being continued in the larger part of the posterior margin, while the ventral margin is also very regularly, but more gradually, rounded.

The point of greatest convexity of the valves is just above the middle, though the curvature of the surface from the beaks to the ventral margin is usually quite regular. The curvature along the antero-posterior diameter is moderate and more or less regular. The slope towards the posterior and hinge margins is usually quite rapid, and increases in strength near the beaks; it is always well rounded.

The surface of the shell is marked with numerous small, rounded, concentric raised-lines, separated by similar interspaces of slightly greater width. They are quite equally disposed, sometimes, however, differing in width and placed nearer together. They round up strongly in front.

The muscular imprints are of moderate size, slightly excavated, and are situated just above the antero-posterior axis. Of the cardinal teeth, the anterior is nearly perpendicular, bending slightly forward below, while the posterior, which is the longer, extends backward, bending a little downward. The dental prominence in front of the cardinal teeth is somewhat elevated.

This small form, not represented by any perfect impression of the exterior, seems to be a true *Callista*, as indicated by shape and hinge-markings. Size: length, 14 mm.; height, 11 mm.; depth of two valves, 6 mm.

Moderately abundant in the cretaceous beds at Pt. Nova Cruz and Sao José, Prov. of Pernambuco, Brazil. Respectfully dedicated to Dr. McGrath of Pernambuco to whom Prof. Hartt and his party are indebted for many favors and valuable information regarding the geology of the vicinity of Pernambuco.—[Rathbun, 1874.]

Search has been made in the several laboratories where the types of the species that Rathbun described from Brazil, might be found. As yet they have not been located so that we are unable to figure the species. The specimens which White called the same species as that of Rathbun are to be questioned. Without a figure one cannot be sure what the original species was since the material was that of casts. White listed material under his species from both Eocene and Miocene localities. His Eocene material, from Maria Farinha, Provincia do Pernambuco, Brazil, may be the same as that of Rathbun. The illustrations which White gave of his material are not listed as to locality so we can not be sure of what age

each may be. The figures of White are included for completeness, pl. XVI, figures 5, 11. The specimens of White may be new but since we have not the material to study we only call attention to the species.

Holotype.—?

Occurrence.—Eocene. Pt. Nova Cruz and Sao José, Province of Pernambuco, Brazil.

CALLISTA (COSTACALLISTA) PEROVATA ALDRICHI (Harris)

Plate XV, Figures 7, 13

Meretrix perovata var. *aldrichi* Harris, 1895, Bull. Amer. Pal., vol. I, No. 1, p. 48, pl. 1, fig. 1; Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 138, pl. 44, figs. 1-2. In collecting large quantities of this species at Claiborne, one finds that it is subject to rather wide variations both as to form and surface markings. The typical and most abundant form is that figured on pl. 20 of Harris's republication of Fossil Shells etc. (*Cytherea comis* Lea). This is comparatively small, smooth, gibbous about the umbones, and cuneate posteriorly. The variety above named is on the other hand large, elliptical, and with strong concentric rugæ on the anterior and posterior but not the middle.

In the collection of the Phil. Ac. Nat. Sci., some specimens of this variety are included under "*Cytherea perovata* Con." while others are among "*C. mortoni* Con."

That *aldrichi* is only a variety of *perovata* is proven by the abundance of connecting forms.—[Harris, 1895.]

In keeping this species as a variety of *perovata* and placing the form under the subgenus *Costacallista* one appears to be mixing relationships. Such forms as *perovata*, *aldrichi*, *pearlensis* and *æquorea* which have characters in the initial or in the dying out stages do not fall readily into an artificial classification. Some individuals of *perovata* show concentric ribs in certain regions, but that character is not developed enough to place the species under the group of *Costacallista*. *Aldrichi* is *perovata* in a more strongly developed stage of concentric liræ. Although the ribs do not cover the whole surface of the shell but leave a pronounced smooth area in the mid-region, the shell shows that it belongs to the group of *Costacallista*. *C. pearlensis* is in the same category.

Dimensions.—45 mm., length; 32 mm., height; 13 mm., semidiameter.

Holotype.—State Museum, University of Texas, Austin, Texas.

Occurrence.—Claiborne Eocene. Claiborne, Ala. (Cornell Univ. Pal. Lab.)

CALLISTA (COSTACALLISTA) PEARLENSIS (Harris)

Plate XV, Figures 10, 12, 15

Meretrix pearlensis Harris, 1896, Proc. Acad. Nat. Sci. Phil., vol. 48, p. 470, pl. XVIII, figs. 4, 5.

The general characters of the species are shown by the figures. The concentric striation is precisely that of *Meretrix perovata* var. *aldrichi* (Bull. Amer. Pal., No. 1, p. 48, pl. 1, fig. 1) and the young of these two forms sometimes approach each other closely in outline, yet there is always noticeable in *pearlensis* a tendency to become elongate, like *M. levigata* of the Paris basin.

Instead of making this a new species, we might speak of it as a marked variety of *aldrichi*, which itself is a variety of *perovata* Con. It seems to us, however, better

to designate it by a new name. A variety of this species shows concentric liræ over its entire outer surface.

Locality, Jackson, Miss.—[Harris, 1896.]

This species like *aldrichi* has been put in the subgroup of *Callista* because, although the concentric liræ do not completely cover the shell, they are developed enough to show the relationship of the species. The form varies in the amount of concentric ribbing which it possesses. Usually the ribbing is complete over the umbonal region. Some individuals are very smooth while others have the concentric ribs developed more completely, pl. XV, fig. 10. This species, as Prof. Harris has pointed out, is like *C. aldrichi*. It is more pointed and elongated posteriorly than *aldrichi* but retains the same character of rib arrangement.

Dimensions.—39 mm., length; 28 mm., height; 10 mm., semidiameter.

Syntypes.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Jackson Eocene. (Type.) Jackson, Miss.; Montgomery, La. (Cornell Univ. Pal. Lab.)

CALLISTA (COSTACALLISTA) MORTONI (Conrad)

Plate XV, Figures 11, 19, 20

Cytherea Mortoni Conrad, 1834, Acad. Nat. Sci. Phil., Jour., vol. VII, p. 150; Conrad, 1893, Harris Reprint. Fos. Shells, pl. 20, fig. 1.

Meretrix mortoni Conrad, 1854, Acad. Nat. Sci. Phil., Proc., vol. 7, p. 30.

Dione Mortoni Conrad, 1865, Amer. Jour. Conch., vol. 1, p. 6.

Cytherea mortoni Heilprin, 1879, Acad. Nat. Sci. Phil., Proc., vol. 31, p. 222.

Dione Mortoni Conrad, 1886, Smith. Misc. Coll., vol. VII, No. 200, p. 7.

Cytherea mortoni De Gregorio, 1890, Ann. de Geol. et Pal., 7 et 8 liv., p. 220.

Cytherea æquorea var. *cominduta* De Gregorio, partim, *ibid.*, p. 217, pl. 34, fig. 5.

Meretrix æquorea var. *Mortoni* Cossmann, 1893, Ann. de Geol. et Pal., 12 liv., p. 10.

Meretrix mortoni Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 139, pl. 43, figs. 14, 15.

Shell ovate, convex, with numerous regular impressed lines; lunule cordate, defined by an impressed line. Length, two inches, height, one and a half inches.

Locality.—Claiborne, Ala.

Allied to *C. æquorea, nobis*, (*C. Hydi* Lea) but is a much larger species, with more regular sulci. It is not uncommon at Claiborne, and I could readily distinguish it from *C. æquorea* in every stage of growth. I give it the name of my friend, Dr. S. G. Morton, through whose kind assistance I was enabled to visit the most remarkable tertiary deposits in the southern states.—[Conrad, 1834.]

This species attains a size larger than two inches in length. Even young specimens 10 mm. and smaller (one specimen 2 mm.) show the large, regular sulci developed over the whole shell. *C. mortoni* is more compressed and less convex than *C. aldrichi*. In some cases *aldrichi* has the concentric ribs developed over the whole surface of the shell and the species might be confused with *mortoni* but the two may be separated by the difference in shape.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Claiborne Eocene. Claiborne, Ala. (Cornell Univ. Pal. Lab.)

CALLISTA (COSTACALLISTA) ÆQUOREA (Conrad)

Plate XV, Figures 3, 9, 14

- Cytherea æquorea* Conrad, 1833, Fos. Shells N. Am., p. 36, Harris Reprint, 1893, pl. 20, fig. 5.
Cytherea Hydii Lea, 1833, Cont. Geol., p. 66, pl. 2, fig. 42.
Cytherea æquorea Conrad, 1842, Proc. Nat. Inst., 2nd Bull., p. 175.
Meretrix æquorea Conrad, 1854, Acad. Nat. Sci. Phil. Proc., vol. 7, p. 29; Conrad, 1855, Acad. Nat. Sci. Phil. Proc., vol. 7, p. 257.
Dione æquorea Conrad, 1865, Amer. Jour. Conch., vol. 1, p. 6.
Cytherea æquorea Smith, 1885, Amer. Jour. Sci., vol. 30, p. 274; Aldrich, 1885, *ibid.*, p. 306; Langdon, 1886, *ibid.*, vol. 31, p. 208.
Dione æquorea Conrad, 1886, Smith. Misc. Coll., vol. VII, No. 200, p. 7.
Cytherea æquorea var. *Hydii* de Gregorio, 1890, Ann. de Geol. et Pal., 7 et 8 liv., p. 216, pl. 33, fig. 18-15.
Meretrix æquorea Cossmann, 1893, Ann. de Geol. et Pal., 12 liv., p. 6; Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 140, pl. 44, fig. 3-6.
 Shell subovate, inequilateral, compressed, with regular, distinct concentric sulci; lunule cordiform, two cardinal teeth in the right valve, parallel and approximate. Length $1\frac{1}{4}$ inch. Breadth $1\frac{1}{4}$ inch.
Locality, Claiborne, Ala.
Cab. Acad. N. S.—[Conrad, 1833.]

This species bears the concentric costæ, but except on the umbonal region they are not developed regularly and uniformly. Parts of the surface become smooth. The ribbing of the umbones is like that of *mortoni* but the adult shells are quite different. *C. æquorea* is more elliptical and the shell tends to become thicker than *C. mortoni*.

Dimensions.—32 mm., length; 25 mm., height; 14 mm., thickness.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Claiborne Eocene. Claiborne, Ala. (Cornell Univ. Pal. Lab.)

CALLISTA (COSTACALLISTA) PLANIVIETA Guppy

Plate XV, Figures 1, 2, 5, 6, 16

- Cytherea (Callista) planivieta* Guppy, 1866, Quart. Journ. Geol. Soc. Lond., vol. 22, p. 292, pl. 18, fig. 3.
Callista planivieta Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 250.
Cytherea planivieta Guppy, 1874, Geol. Mag., N. S., Decade II, vol. I, p. 442; Guppy, 1876, Quart. Journ. Geol. Soc. Lond., vol. 32, p. 531; ? Grzybowski, 1899, Neues Jahrb. für Min. Beilage Bd., 12, p. 639, pl. 19, fig. 3.
Pitaria (Lamelliconcha) planivieta Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1268.
 not *Cytherea planivieta* Guppy, 1911, Agr. Soc. Trinidad, No. 440; Harris Reprint, 1921, Bull. Amer. Pal., vol. 8, No. 35., pp. 149, 154, pl. 8, fig. 2 = ? *C. maculata* (L.).
Pitaria (Lamelliconcha) planivieta Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 380, pl. 37, fig. 3; ? Spieker, 1922, Johns Hopkins Univ. Studies Geol., No. 3, p. 147, pl. X, fig. 6.
Macrocallista (Chionella) planivieta Pilsbry, 1921, Proc. Acad. Nat. Sci. Phil., vol. 73, p. 422.
Pitar (Hysteroconcha) planivietus Woodring, 1925, Carnegie Inst. Wash. Pub., No. 366, p. 155, pl. 21, figs. 1 to 4.
 Shell inequilateral, transverse, oval, compressed; valves polished, ornamented with numerous flat, slightly irregular, concentric ribs, which are much closer than their interstices; umbones prominent, approximated; lunule scarcely impressed.
 This bivalve approaches closely to *C. erycina* of the Eastern seas. It is also

allied to *C. striatella* of the Belgian Tertiaries, and even more closely to *C. erycinoides* of the Bordeaux beds.—[Guppy, 1866.]

The nymphs are granulated microscopically. The young has the granules on the nymphs well developed.

The specimens from Jamaica have the posterior end subtruncate, adult or large specimens from Santo Domingo are more rounded on the posterior dorsal slope and the ribs have a tendency to die out on the ventral margin leaving the surface smooth. Young and smaller specimens of the Santo Domingo shells show the angulate posterior slope of typical *planivieta* and the ribs are constant on the ventral region.

As Guppy pointed out originally the affinities of this species are with the group of shells typified by *Callista erycina* Linn. *C. planivieta* has the shape, hinge and typical sinus of the *Callista* group.

Dimensions.—38 mm., length; 29 mm., height; 9 mm., semidiameter; 41 mm., height of large broken specimen

Holotype.—Geological Dept. No. 64085. British Museum. Natural History Division, fide Woodring.

Occurrence.—Miocene. Bowden, Jamaica. (Type.); Bluff 2 and 3 Cercado de Mao, Zone G, Rio Gurabo at Los Quemados, Zone 1, Rio Cana at Caimito, Santo Domingo. (Maury Coll. Cornell Univ. Pal. Lab.); White Beach near Osprey, Florida. (Dall)

CALLISTA (COSTACALLISTA) OLSSONI n. sp.

Plate XLIV, Figure 5

Pitaria Guppyana Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 237, pl. 31, fig. 11 not *Caryatis Guppyana* Gabb, 1881.

Shell small, ovate, moderately convex and porcellaneous; dorsal side straight; ventral side gently convex; posterior extremity sub-truncate but wide, meeting the dorsal side nearly at right angles; anterior extremity much narrower, produced and rounded; lunule narrowly lanceolate, sculptured with the continuation of the concentric ribs and separated from the shell disk by an impressed line; surface of disk sculptured with rather wide, low or appressed ribs formed between incised lines, but the shell as a whole is porcellaneous and smooth; as the ribs pass over the dorsal-posterior area towards the dorsal margin they decrease in number through fusion; interior concealed in a hard matrix.

Length 32, height 18, diameter (right valve) 5 mm.

A small species of the coralline limestone and marls of the Limon Peninsula, from which it was described by Gabb. It approaches the *P. planivieta* Guppy of the Miocene of Jamaica and Santo Domingo but is smaller and more rectangular in outlines. It is rather convex with a smooth and polished surface and with regular, even, concentric ribs.

Geological Stage: Port Limon.—[Olsson, 1922.]

This species differs from *C. guppyana* Gabb in having a nearly straight dorsal line and a truncated, posterior end. The posterior line in *C. olssoni* is nearly straight, meeting the dorsal line at almost a right angle. This species is much flatter, lunule narrower and the umbones less convex. *C. guppyana* Gabb is a much more ovate, convex form. For specimens of the same size as *C. olssoni*, the concentric ribs are not so wide in *C. guppyana*.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.
Occurrence.—Gatun Miocene. Port Limon, Costa Rica.

CALLISTA (COSTACALLISTA) GUPPYANA (Gabb)

Plate XLIV, Figures 3, 8, 12, 13, 14

Caryatis Guppyana Gabb, 1881, Acad. Nat. Sci. Phil. Jour., 2nd ser., vol. VIII, p. 373, pl. 47, fig. 73.
 not *Pitaria Guppyana* Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 236, pl. 31, fig. 11.

Shell moderate in size, thin, convex, short, and almost subtriangular when young, growing more oval as it increases in size. Beaks prominent; anterior end broadly rounded, curving with an unbroken curve across the lunule to the beaks. Posterior end broad and round; base regularly convex. Surface polished and ornamented by numerous small, regular, concentric ribs. Lunule large, and bordered by a sharply impressed line.

Figure. Natural size; drawn from the largest specimen, which is unfortunately broken. Four others of smaller size confirm the above diagnosis.

From *C. Lordlyi* this shell can be distinguished by being slightly less convex; by the anterior end of this being nearly semicircular, the curve only ending at the beaks; while in *Lordlyi*, from the most prominent part of the anterior end, over the lunular region, the outline is nearly a straight line. In *Lordlyi* the posterior end, though rounded, is very narrow, here it is unusually broad. Again, at all ages this shell is regularly costate, while in the other, the ribs are smaller, more irregular, and seem rather like somewhat confused lines of growth; and finally, in this the lunule is bounded by an incised line, while in that it is strongly bordered by a thread-like rib.

From *Cytherea planivicta*, Guppy, with which it is congeneric, the differences are only those of outline. In that, the lunular region is very slightly concave, but the great difference is in the posterior end. That species is cuneiform posteriorly, while this is broadly rounded. There is a very slight difference in the teeth, but only of specific value. The anterior tooth is placed in a slightly different position, and the cardinals vary a little in the distance they are placed apart.—[Gabb, 1881.]

On the largest of Gabb's specimens, the ribs are wide with very narrow interspaces. On the young specimens the interspaces are wider.

Dimensions.—*Holotype*, adult, Approx. 40 mm., length; 33 mm., height; 11 mm., semidiameter; paratype, young, 17 mm., length; 15 mm., height; 6 mm., semidiameter.

Holotype.—No. 3454. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Pliocene. Limon, Costa Rica.

Genus TRANSENNELLA Dall



Fig. 10. Hinge of type species of *Transennella*

Transennella Dall, 1883, Proc. U. S. Nat. Mus., vol. 6, p. 341; Fischer, 1887, Man. de Conch., p. 1080; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 348; Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1240; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 60.

Original description of the genus is included with that of the genotype.

Shell small, trigonal; three cardinals in each valve; left anterior lateral fitting into a socket in the right valve; lunule large for the shell, defined; pallial sinus moderate, angular; sculpture consisting of fine, con-

centric ridges; internal margins obliquely grooved with numerous sulci over the entire margin.

Genoholotype.—*T. conradiana* Dall. Plate XVI, Figures 4, 8, 10. Recent. Coasts of Florida.

The distinctive character of this genus is the internal grooving of the margins of the shell. The genus ranges from the Miocene thru Recent with numerous species thruout its range.

Stratigraphic Range of *Transennella*

Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
		<i>carolinensis</i>	<i>caloosana</i>	<i>caloosana</i>	<i>conradiana</i>
		<i>utica</i>		<i>conradiana</i>	<i>culebrana</i>
		<i>santarosana</i>			<i>stimpsoni</i>
		<i>chipolana</i>			<i>cubaniana</i>
		<i>caloosana</i>			

TRANSENNELLA CAROLINENSIS Dall

Plate XVI, Figures 6, 7, 9, 15

Cytherea carolinensis Conrad, 1841, Amer. Jour. Sci., vol. 41, p. 343; H. C. Lea, 1848, Acad. Nat. Sci. Phil. Proc., vol. IV, p. 98.

Dione carolinensis Conrad, 1862, *ibid*, vol. 14, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.

Transennella carolinensis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1242, pl. 55, fig. 4.

Miocene of North Carolina at Magnolia and the Natural Well of Duplin County, Burns, Hodge, etc.

Shell small, subequilateral, cythereæform, rather solid and thick for its size; plump, with low, slightly anteriorly directed beaks; polished, nearly smooth in the middle, towards the ends having somewhat irregularly concentric bevelled sulci; lunule impressed, lanceolate, bounded by an incised line, striated; hinge normal, the middle left cardinal bifid; marginal sulcations strong; pallial sinus short, nearly horizontal, rounded in front. Length 11, height 9, diameter 6 mm.

This species was obtained by Hodge in North Carolina more than sixty years ago and was listed as *Cytherea carolinensis* in several papers and checklists by Conrad and Meek, but never figured or described. A specimen named by Conrad and collected by Hodge in North Carolina was presented by the latter to the National Institute and subsequently became a part of the collection of the National Museum, thus enabling me to recognize the nude name, which I now adopt, as it may have some currency in collections. The species has also been called *Dione carolinensis*. It is more heavy and trigonal than the following species, more equilateral and smoother. It is much larger than any of the species antedating the Miocene.—[Dall, 1903.]

Holotype.—No. 115165 United States National Museum, Washington, D. C.

Occurrence.—Upper Miocene. Duplin Stage. Magnolia and Natural Well, North Carolina. (Dall) (Cornell Univ. Pal. Lab.)

TRANSENNELLA UTICA Dall

Plate XVI, Figure 17

Transennella utica Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1240, pl. 57, fig. 12.

Oligocene of the Chipola horizon at Alum Bluff, Florida, and on the Chipola River; Dall and Burns.

Shell small, only moderately convex, subtrigonal, inequilateral, polished, with shallow, concentric sulci, less marked in the centre of the disk, diminishing in number and increasing in strength towards the anterior end of the shell; beaks small, erect, acute at the anterior third; lunule narrow, lanceolate, as long as the anterior dorsal slope, slightly impressed, smooth, defined by an impressed line; escutcheon not de-

fined; hinge compact, the anterior left cardinal bifid; the sulcations of the margin well marked but not as dense as in the larger species; the sinus deep, narrow, rounded in front. Length 7.0, height 5.0, diameter 2.5 mm., but usually smaller.

This is the earliest and smallest species, notable for its acute beaks. These shells vary, some being shorter and higher, others more beaked and elongate. All the species vary in much the same way, but, in spite of the difference in outline, there is a recognizable facies to each. Only one or two species occur in any single horizon.—[Dall, 1903.]

Holotype.—No. 1145900. United States National Museum, Washington, D. C.

Occurrence.—Miocene. Chipola horizon Alum Bluff, and on Chipola River, Florida. (Dall)

TRANSENNELLA SANTAROSANA Dall

Plate XVI, Figure 18

Transennella santarosana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1241, pl. 57, fig. 13.

Oligocene sands of Oak Grove, Santa Rosa County, Florida; Burns.

Shell small, plump, subtrigonal, polished, and sculptured with numerous slightly irregular concentric sulci; beaks small, subcentral, slightly anteriorly directed; lunule cordate, narrow, bounded by an impressed line, striated; hinge with the middle cardinals and the anterior lateral large and conspicuous; pallial sinus wide, short, rounded, not reaching the middle of the valve. Length 6.5, height 5.5, diameter 3.8 mm.

This is easily distinguished from *T. chipolana* by its less sharp and crowded sculpture and its more convex valves.—[Dall, 1903.]

Holotype.—No. 135890. United States National Museum, Washington, D. C.

Occurrence.—Miocene. Oak Grove sands, Santa Rosa county, Florida. (Dall)

TRANSENNELLA CHIPOLANA Dall

Plate XVI, Figure 12

Transennella chipolana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1241, pl. 57, fig. 6.

Oligocene of the Chipola River, Florida, at McDonald's Ranch; Dall.

Shell small, short, ovate-trigonal; beaks low, anteriorly directed, near the anterior third; anterior dorsal slope short, straight, with a narrow, cordate, slightly impressed lunule; posterior slope convexly arcuate, posterior end rounded, base evenly arcuate; surface covered uniformly with fine, close, sharp, concentric grooves; hinge and margins normal; pallial sinus ample, deep, rounded in front. Length 5.0, height 4.2, diameter 2.0 mm.

Only a single valve of this species was obtained, but it is well distinguished by its fine, even sculpture, *Chionella*-like outline, and ample sinus.—[Dall, 1903.]

Holotype.—No. 109230. United States National Museum, Washington, D. C.

Occurrence.—Miocene. McDonald's ranch, Chipola River, Florida. (Dall)

TRANSENNELLA CALOOSANA Dall

Plate XVI, Figure 14

Transennella caloosana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1242, pl. 57, fig. 2.

Upper Miocene of Jackson Bluff, south of Tallahassee, Florida, Vaughan, Pliocene of the Caloosahatchie, Shell Creek, and the Myakka River, south Florida, Dall, Burns and Wilcox; Pleistocene of North Creek, near Osprey, Florida, Dall.

Shell elongate-ovate, inequilateral, with small, acute beaks, anteriorly directed and situated at the anterior third; surface polished, smooth in the middle of the disk; towards each end irregularly concentrically sulcate with rather close, somewhat bevelled sulci; the middle of the disk is often crossed by obscure radial threads, which are sometimes strong enough to crenulate the outer margin; lunule impressed, very narrow, lanceolate, bounded by a sulcate line; hinge with the posterior right and middle left cardinals bifid, margins strongly sulcate, pallial sinus small, linguiform. Length, 13.5, height 10.0, diameter 5.5 mm.

This species is nearest to *T. cubaniana* Orbnigny of the recent species, but is larger, with less uniform sulcation and shorter pallial sinus. It is more inequilateral, more oval and elongate, and with more pronounced sculpture than *T. carolinensis*.—[Dall, 1903.]

Holotype.—No. 109231. United States National Museum, Washington, D. C.

TRANSENNELLA CONRADIANA (Dall)

Plate XVI, Figures 4, 8, 10

Cytherea (*Transennella*?) *conradiana* Dall, 1883, Proc. U. S. Nat. Mus., vol. 6, p. 340. *Transennella conradiana* Dall, 1889, Bull. U. S. Nat. Mus. 37, p. 56 in part; ed. 1903, pl. xc, fig. 6.

Meretrix (*Transennella*) *conradiana* Dall, 1902, Proc. U. S. Nat. Mus., vol. 24, No. 1264, p. 509 in part, not figures 5, 7, pl. 31.

Transennella conradiana Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 348, 367, 379, pl. 13, fig. 6; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 67.

Shell of much the same general form of *C. cuneimeris* Conrad, but without the radiating sculpture and the strong sculpture on the ribs. The color is nearly white with fine zigzag markings of yellow; a touch of pink internally in some valves; exterior smooth, or concentrically grooved; lunule marked by a strongly impressed line, proportionately large; escutcheon not distinguishable; shell moderately inflated, beaks not very prominent, recalling *Cyrena floridana* in shape but more rounded off; interior smooth, pallial sinus moderate, angular; beaks subcentral; margin internally grooved at right angles to the hypothetical radii of growth. Long., 8.0 mm.; altitude, 5.7 mm.; diameter, 3.5 mm.

Habitat.—Rare at Cedar Keys, in mud between tides.

The most remarkable feature of this shell is the internal grooving of the margins. The ventral margin is deeply scored parallel to the long axis of the beaks, the margin is closely and deeply grooved in a direction nearly parallel to the anterior and posterior slopes. I have seen nothing like it in any other bivalve. The grooves are not, as might be supposed, parallel with the lines of growth but invariably, except at the center of the base, form a more or less acute angle with them. The only analogue to such sculpture known to me occurs on the outside of such *Lucinidæ* as the Lamarckian *L. divaricata*, *Woodia*, and some *Nuculidæ* and *Yoldias*. But on the inside of any shell such sculpture has not, so far as I am aware, been reported, apart from structures appertaining to the hinge. Several gentlemen to whom the form in question has been submitted are unanimous in considering it worthy of more than specific rank, and while I am yet in doubt as to the systematic value of the structure described, I would suggest for it, in case it be deemed worthy of separation, the name of *Transennella*.—[Dall, 1883.]

Transennella conradiana is the most pointed posteriorly of the recent species of *Transennella*. *T. cubaniana* is trigonal in shape but not as pointed posteriorly as *conradiana*. The two species are ribbed concentrically. *T. cubaniana* has the ribs over all of the surface while *T. conradiana* has the mid-region smooth. *T. stimpsoni* is smooth except for irregular, concentric ribbing. *T. culebrana* is smooth. It is somewhat like *T. stimpsoni* but is more convex than that species. *T. stimpsoni* is light in color with brown and violet rays. *T. culebrana* is brown in color.

Holotype.—No. 35889. United States National Museum, Washington, D. C.

Occurrence.—Pleistocene. Osprey, Fla. (Maury). Recent. St. Andrews Bay, western Florida, south to Florida Keys and north along eastern coast of Florida to Palm Beach, near low-water mark. (Dall)

TRANSENNELLA CULEBRANA (Dall and Simpson)

Plate XVI, Figure 19

Meretrix culebrana Dall and Simpson, 1901, Bull. U. S. Fish. Com., vol. 1, p. 486, pl. 55, fig. 5.

Transennella culebrana Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 367.

Shell small, solid, subtrigonal, with elevated beaks, nearly equilateral, moderately convex; periostracum rather thick, yellowish brown, paler on the umbones and posterior dorsal area; surface obsoletely minutely concentrically undulated, with a rather large ovate-cordate, somewhat depressed lunule defined by a well-impressed line, but no perceptible escutcheon; form as figured; interior white; hinge strong, normal, a prominent, anterior lateral in each valve; pallial sinus subtriangular, rounded in front; marginal grooving well marked.

Length, 7; height, 5.7; diameter, 3.8 mm.

At station 6087, in 14 to 18 fathoms, coral sand, off Culebra Island, Porto Rico.

A very pretty and characteristic species of this peculiar group, which can not be confounded with either of the other described species.—[Dall and Simpson, 1901.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Recent. Culebra Island, Porto Rico. (Dall and Simpson)

TRANSENNELLA STIMPSONI Dall

Plate XVI, Figures 13, 16

Transennella conradiana Dall, 1902, Proc. U. S. Nat. Mus., vol. 24, No. 1264, p. 509, pl. 31, figs. 5, 7.

Transennella stimpsoni Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 367, 379.

Shell small, rounded trigonal, rather plump, polished, painted with purple-brown on a white ground externally, the lunule, and central portion of the disk internally usually purplish; beaks prominent, incurved, small; lunule defined by a sulcus, elongate, narrow; escutcheon not defined; beaks five-fourteenths of the length from the anterior end, which is rounded, with the dorsal slope rather flat; posterior end attenuated; hinge normal, the posterior left cardinal obscure, thin, consolidated with the nymph; internal margins tangentially sulcate; pallial sinus deep, narrow, somewhat rounded in front. Length 14; height 10.5; diameter 7 mm.

Type locality.—Egmont Key, Florida. Cat. No. 54100, U. S. N. M.

The shell is marked by fine, concentric lines of growth, and by a few, irregularly distributed, stronger concentric sulci, which become evanescent toward the middle of the disk.—[Dall, 1902, vol. 26.]

Holotype.—United States National Museum, Washington, D. C.

TRANSENNELLA CUBANIANA (D'Orbigny)

Plate XVI, Figure 2

Venus cubaniana D'Orbigny, 1845, Moll. Cuba in Sagra Hist. de l'île de Cuba, p. 320, pl. 26, figs. 45-46.

Gouldia cubaniana Dall, 1881, Mus. Comp. Zool., Har. Col., vol. IX, p. 130.

Transennella cubaniana Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 56, ed. 1903, pl. xc, fig. 4.

Meretrix cubaniana Dall and Simpson, 1901, Bull. U. S. Fish. Com., vol. 1, p. 486.

Transennella cubaniana Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 367, 379, pl. 13, fig. 4.

Venus testa ovato-trigona, compressa, albida, concentric striata; latere buccali

brevi, angulato; latere anali elongato, obtuse angulato; lunula lanceolata.

Dimension. Longitud. . . . 10 millim. . . . 5 lineas. Es vecina por su forma de la anterior, pero diferente por no tener estrias radiales; es propia de Cuba, la Martinica y las Floridas.—[D'Orbigny, 1845.]

Shell rather small, triangular-ovate, solid, rather compressed, inequilateral, with high beaks, slightly turned forward over a large, well-defined lunule; surface covered with low, irregular, concentric ridges; left valve with three cardinals, the central tooth strong, and a high compressed anterior lateral; right valve having the two anterior cardinals separated by a narrow fissure and two small anterior laterals with a deep pit between them; pallial sinus deep. Color white, generally with a few irregular brown markings.

Length, 8; height, 6; diameter, 4 mm.

Mayaguez, Porto Rico, a few worn valves.

The internal margins of the valves are sharply grooved, but not in harmony with the lines of growth, which is the characteristic of this subgenus, of which the species are all small shells.—[Dall, 1901.]

Occurrence.—Living. Florida to St. Croix, West Indies. (U. S. Nat. Mus.)

Genus AMIANTIS Carpenter

Amiantis Carpenter, 1863, Report to Brit. Ass., p. 126; Carpenter, 1865, Ann. and Mag. Hist., 3rd ser., vol. XV, p. 279; Reprint, 1872, Smith. Misc. Coll., No. 252, p. 279; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 352; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1257; Jukes-Browne, 1913, Proc. Mal. Soc. Lond., vol. II, p. 60.

Amyantis Stoliezka, 1871, Pal. Indica, vol. III, p. 151.

Subgenus of *Callista*: hinge-plate roughened as in *Mercenaria*.

Mantle-bend as in *Dosinia*. L. W. comp. *Cp.*—[Carpenter, 1863.]

Callista: dente postico utraque valva ruguloso.

Type: *Amiantis callosa*, = *Cytherea callosa*, Conr., = *Dosinia callosa*, Brit. Assoc. Rep. 1857 (from fragments); non *Venus callosa* (as of Conr.), Sow., Rve., Desh.

Hab.—Sta. Barbara (*Nuttall* Jewett); S. Pedro (*Cooper*); Cape St. Lucas (*Xantus*).

This section differs from the typical *Callistæ* as does *Mercenaria* from *Venus*. Whether the other peculiarities of the species (re-described by Reeve as *Cytherea nobilis*) are coordinate, cannot yet be stated, as it stands alone. In sculpture and colour it resembles *Dosinia*; in its ponderous growth, *Pachydesma*.—[Carpenter, 1865.]

Shell large, ovate, heavy; lunule large, sunken, defined by an impressed line, escutcheon narrow; inner margins smooth; hinge with three, heavy, cardinals in each valve; left valve with a large anterior lateral and a corresponding socket in the right valve; middle cardinals largest; right posterior cardinal bifid; posterior left cardinal and the nymph of the right valve rugose; pallial sinus large, pointed, ornamentation consisting of wide, flat-topped, concentric ribs which bifurcate irregularly; inter-spaces equal to the width of the ribs. The species *A. callosa* which typifies the genus is thickened greatly thruout the mid-region of the shell and develops two radiating ridges internally on the thickening.

Genoholotypes.—*Amiantis callosa* (Conrad). Plate XVI, Figures 22, 23, 24. Pleistocene to Recent. California. Living from San Pedro, Cal., to Gulf of Tehuantepec.

This genus has been found in the San Pablo Miocene of California.

Section EUCALLISTA Dall



Fig. 11. Hinge of type species of *Eucallista*

Eucallista Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 352; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, p. 1257.

Shell with the posterior cardinals short; the opposite faces of the nymphs with interlocking rugosities; the teeth smooth; interior without radial ridges.—[Dall, 1902.]

The pallial sinus is large and pointed, similarly shaped as *Amiantis* s. s. The teeth are as in the genus except the posterior cardinal is much smaller and shorter. The interior thickening of the shell does not occur. That character in *A. callosa* may be due to local conditions.

Type.—*Cytherea purpurata* Lamarck, Plate XVI, Figures 1, 3, 20, 21. Living Cuba and south to Brazil.

The section is known from the living species, *Cytherea purpurata* Lamarck which occurs from Cuba south to Brazil.

Section EUCALLISTA Dall

AMIANTIS PURPURATA (Lamarck)

Plate XVI, Figures 1, 3, 20, 21

Cytherea purpurata Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 563, not *Venus purpurata* Gmelin, 1792.

Dione purpurata Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 60.

Dione purpurata Reeve, 1863, Conch. Icon., *Dione*, pl. 8, fig. 32.

Amiantis (Eucallista) purpurata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 370.

C. testa rotundato-cordata, purpurea, albido fasciata; sulcis transversis inæqualibus: superioribus posticisque eminentioribus; intus alba.

Habite. . . . Belle coquille, renflée, pourprée, à crochets grands et bombés, ayant la dent cardinale antérieure denteleé, granuleuse. Mus. n.^o Largeur, 52 millimètres. Je la crois des mers du Brésil on d'Amérique.—[Lamarck, 1818.]

Shell medium in size, inequilateral, ovate; beaks low; anterior end rounded; posterior end rounded, only slightly pointed; inner margins smooth; hinge and pallial sinus described under the section.

The adult shell is smooth except on the umbones and on the anterior and posterior dorsal margins. On the young shells flat, regular, concentric ribs with narrow interspaces cover the whole surface of the exterior.

The shells are of a beautiful, pinkish purple or rose color. There is a light brown periostracum.

Dimensions.—46 mm., length; 36 mm., height; 24 mm., diameter.

Occurrence.—Cuba south to Brazil. (U. S. Nat. Mus. Coll., Newcomb Coll., No. 16298. Cornell Univ. Pal. Mus.)

Genus MERETRIX Lamarck

Fig. 12. Hinge of type species of *Meretrix*

Meretrix Lamarck, 1799, Prodrome in Soc. d'histoire naturelle de Paris, p. 85, *Venus meretrix* Linné; Lamarck, 1801, Syst. des An. sans Vert., p. 122; Blainville, 1825, Man. Mal., p. 556; Gray, 1847, Proc. Zool. Soc. Lond., p. 183; Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 34; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 423; Römer, 1869, Mon., *Venus*, p. 25; Fischer, 1887, Man. de Conch., p. 1079.

Citherea Roissy, 1805, Moll., vol. VI, pp. 329, 336, fide Dall, *V. meretrix* L.
Cytherea Roissy, 1805, *ibid.*, p. 399, *C. lusoria*; Lamarck, 1806, Ann. du Museum, VII, p. 133; Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 562; Stoliczka, 1871, Pal. India, vol. III, p. 150; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 1777; not *Cytherea* Bolten, 1798 = *Antigona*.

Meretrix Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 352; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1258; Cossmann and Peyrot, 1910, Actes Soc. Linn. Bordeaux, LXIV, p. 369; Jukes-Browne, 1913, Proc. Mal. Soc. Lond., vol. II, p. 68.

Coq. sutransverse ou orbiculaire; trois dents cardinales rapprochées, et une dente isolée située sous las lunule.

Venus meretrix. Lin.—[Lamarck, 1799.]

Shell large, trigonal, plump, nearly equilateral; posterior end slightly longer and more pointed; ventral margin regularly rounded; shell smooth, porcelainous; lunule and escutcheon only faintly impressed, not circumscribed; inner margins smooth; pallial sinus large, broad, shallow with an extended tip ventrally; left anterior lateral fitting into a well developed, right anterior socket; cardinals large, sharp; posterior cardinal very elongate; anterior left and posterior right cardinal bifid or grooved; right nymph and posterior left cardinal corrugated; anterior left and posterior right margins grooved; umbones broad.

Genoholotype.—*Venus meretrix* Linné, Plate XX, Figures 3, 5, 7, 8, 9. Recent. China and Philippine Islands.

Meretrix does not occur living or fossil in the eastern American region. Illustrations and a detailed description of the type of the genus have been included for the benefit of those who wish to know what characters constitute this genus. In the past, authors have used the names *Meretrix* and *Cytherea* to designate shells, belonging to the Veneridæ, the characters of which were too obscure for exact classification. Those names were used also as general terms for any Venerid.

Genus GAFRARIUM Bolten

Fig. 13. Hinge of type species of *Gafrarium*

- Gafrarium* Bolten, 1798, Mus. Boltenianum, p. 176, no figure or description, type by elimination *Venus pectinata* Linné.
Crista Römer, 1857, Krit. Unters., *Venus*, p. 15; Stoliczka, 1871, Pal. Indica, vol. III, p. 152; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 279; Fischer, 1887, Man. de Conch., p. 1080.
Gafrarium Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 350; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1246; Jukes-Browne, 1910, Proc. Mal. Soc. Lond., vol. 9, p. 247.
Crista Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 67.

Shell medium in size, heavy, thick; inequilateral; anterior end short; posterior end moderately pointed; beaks minute, pointed; lunule large, bounded by an impressed line, smooth except for lines of growth; umbonal region compressed; escutcheon narrow not well defined; adductor scars impressed; anterior retractor scar small but distinct, deeply impressed; inner margin coarsely crenate; left anterior lateral large, pointed fitting into a deep, narrow socket in the right valve; three left and two right cardinals, long and narrow; anterior right cardinal small; right posterior cardinal faintly grooved; ligamental area sunken; shell sculptured by heavy, nodose, radiating ribs which medially are dichotomous; interspaces wide; posteriorly the ribs extend obliquely to the medial ribs; pallial line simple or with only a slightly indented sinus.

Genoholotype.—*Venus pectinata* Linnæus, Plate XX, Figures 6, 10, 11, 12, 13. Living. Red Sea, Indian Ocean and Philippine Islands.

Subgenus GOULDIA C. B. Adams



Fig. 14. Hinge of type species of *Gouldia*

- Thetis* C. B. Adams, 1845, Proc. Bost. Soc. Nat. Hist., vol. II, p. 9; not *Thetis* Oken, 1815, nor *Thetis*, Sowerby, 1826.
Gouldia C. B. Adams, 1847, Cat. Coll. Adams, p. 29; Woodward, 1851, Man. Moll., p. 465 not Carpenter, 1857, Cat. Mazatlan Shells Brit. Mus.; H. and A. Adams, 1857, Gen. Recent Moll., vol. II, p. 484 in part; Carpenter, 1864, Suppl. Rep. Brit. Ass., p. 544; not Gould, 1870, Invert. Mass., p. 128; Stoliczka, 1871, Pal. Indica, vol. III, p. 279 in part; Dall, 1879, Proc. Zool. Soc. Lond., p. 131 in part; Dall, 1881, Bull. Mus. Comp. Zool., Har. Col., vol. IX, p. 128; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 179; Dall, 1886, Bull. Mus. Comp. Zool., Har. Col., vol. XI, p. 261; Fischer, 1887, Man. de Conch., p. 1080; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 350; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1247; Cossmann and Peyrot, 1910, Actes Soc. Linn. Bordeaux, Tome 64, p. 429; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 67.
Circe E. A. Smith, 1885, Challenger Rept., p. 221 in part; not *Circe* Dall, 1902; Dall, 1903.
 G. T. *Astarte* affini, sed dente laterali remota anteriore in utraque valva-instructa; pallii impressione vix vel haud sinuata.—[C. B. Adams, 1845.]

Shell small, beaks minute; lunule long, bounded by an impressed line; no escutcheon; pallial line simple or with a slight sinus; ornamented with fine concentric or reticulate sculpture.

Genoholotype.—*Gouldia cerina* (Adams). Plate XXI, Figures 1, 5, 9, 11, 21. Living from Cape Hatteras, thru the Antilles to Brazil.

Since *Gafrarium* Bolten, 1798 is an older name than *Circe* Schu-

macher, 1817, we are following Dr. Dall in the use of *Gafrarium* for the genus with *Circe* and *Gouldia* as subgenera. *Circe* is like *Gafrarium* in the presence of a thick shell but it lacks the coarse, radiating sculpture. *Gouldia* differs from both of those groups in being small and in having a thinner shell. The concentric and radiating sculpture in *Gouldia* is usually of nearly equal importance.

Gouldia occurs in the eastern American fauna from the Miocene with several living species.

Stratigraphic Range of *Gouldia*

Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
		metastrata	metastrata		insularis
		insularis	cancellata		cerina
		alta			bermudensis
		erosa			
		limonensis			
		alta var.			
		costaricensis			

GAFRARIUM (GOULDIA) METASTRIATUM (Conrad)

Plate XXI, Figures 7a, 19

- Cytherca metastrata* Conrad, 1838, Fos. Med. Tert., p. 14, pl. VIII, fig. 5.
Venus metastrata Conrad, 1846, Amer. Jour. Sci., 2nd ser., vol. I, p. 404; D'Orbigny, 1852, Prodome Pal., III, p. 108; Tuomey and Holmes, 1857, Pleioc. Fos. S. Car., p. 79, pl. 21, figs. 1, 2.
Circe metastrata Conrad, 1862, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 10.
Gafrarium (Gouldia) metastratum Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1249; Gardner and Aldrich, 1919, Proc. Acad. Nat. Sci. Phil. vol. 71, p. 19. Shell equilateral, triangular; disks with unequal concentric rounded prominent striae, and radiating lines, obsolete in the middle, but distinct near the anterior and posterior extremities, which are regularly and nearly equally rounded; inner margin entire; lateral tooth prominent, compressed.

Locality. Suffolk, Virginia.

Observations. A small species, much less than the figure; the posterior extremity is somewhat less obtuse than the anterior, and the concentric ribs, though generally very unequal, sometimes occur nearly uniform in size. It occurs in the Upper Tertiary near Newbern, North Carolina, and recent, in the Gulf of Mexico, near Mobile Point.—[Conrad, 1838.]

The specimens referred to as recent by Conrad were *G. cerina* Adams.

Dimensions.—Average. 8 mm., length; 6 mm., height; 1.5 mm., semidiameter. Dr. Dall gives measurements of large specimens as twice this size.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Yorktown Miocene. (Type). Suffolk, Va.; Yorktown, Va. (Dall); Kingsmill, Va. (Cornell Univ. Pal. Lab.); Duplin Miocene. Magnolia, Natural Well, Wilmington, N. C. (Dall); Muldrow Place, Sumter County, S. C. (Gardner and Aldrich). Upper Miocene of Jackson Bluff and localities south of Tallahassee, Fla. (Dall). Pliocene. Waccamaw district, S. C.; Caloosahatchie and Shell Creek, Fla. (Dall).

GAFRARIUM (GOULDIA) EROSUM Dall

Plate XXI, Figure 10

Gafrarium (Gouldia) erosum Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1248, pl. 57, fig. 10.

Oligocene of the Chipola River, Calhoun County, Florida; Burns.

Shell rounded trigonal, rather thin, subcompressed, the surface finely, evenly, closely, concentrically sulcate, with a few almost microscopically minute radial striae sometimes visible under a lens in the sulci near the ends of the shell; most of the specimens appear to be without radial sculpture; beaks small, pointed, slightly anteriorly directed over a lanceolate lunule bounded by an incised line; hinge normal; pallial sinus barely indicated; inner margins smooth, the right posterior dorsal margin grooved to receive the beveled edge of the margin of the opposite valve. Length 8.3, height 7.2, diameter 4.0 mm.

This species is especially characterized by its fine, even, concentric sculpture and nearly total absence of radial striae.—[Dall, 1903.]

Holotype.—No. 114721. United States National Museum, Washington, D. C.

Occurrence.—Miocene. Chipola River, Calhoun County, Florida.

GAFRARIUM (GOULDIA) ALTUM Dall

Plate XXI, Figure 25

Gafrarium (Gouldia) altum Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1249, pl. 57, fig. 5.

Oligocene sands of Oak Grove, Santa Rosa County, Florida; Burns.

Shell small, high, rounded trigonal, the beaks small but prominent and rather pustular than pointed; surface with faint, irregular, concentric striae and wrinkles; towards the base and ends the sculpture is more regular, and, near the ends, cut by faint radial striae; lunule lanceolate, impressed; pallial line with a broad, shallow wave posteriorly; right posterior dorsal margin deeply grooved, the other portions of the margin smooth. Length 4.5, height 4.5, diameter 3.0 mm.

This species is characterized chiefly by its small size, irregular and feeble sculpture, and wide situation of the pallial line.—[Dall, 1903.]

Holotype.—No. 135892. United States National Museum, Washington, D. C.

Occurrence.—Miocene. Oak Grove sands, Santa Rosa County, Florida.

GAFRARIUM (GOULDIA) ALTUM COSTARICENSIS Olsson

Plate XXI, Figure 14

Gafrarium altum Dall var. *costaricensis* Olsson, 1922, Bull. Amer. Pal., vol. IX, No. 39, p. 234, pl. 32, figs. 19, 22.

Shell small, high, rounded trigonal, moderately convex; beaks small and pointed slightly forward, in young shell nearly central but becoming with maturity slightly anterior; anterior and posterior extremities nearly similar and evenly rounded; surface with fine, concentric lines, most distinct and even towards the ventral margin, and with faint, radial striae on the anterior and posterior slopes; lunule large, lanceolate, defined by an impressed line; interior of shell deep, with a concentrically grooved margin.

Length 4.85, height 4.75, diameter of right valve 1.50 mm.

The Costa Rican shells differ from the typical *altum*, described by Dall from the Oak Grove sands of Florida, in being more trigonal in form and with higher beaks. The sculpture of its surface is mainly concentric, the radials showing only as very faint striae on the posterior and anterior extremities.

Gatun Stage: Middle creek

Coll. 6, Estrella River.—[Olsson, 1922.]

Syntypes.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Costa Rica.

GAFRARIUM (GOULDIA) LIMONENSIS Olsson

Plate XXI, Figure 2

Gafrarium limonensis Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 233, pl. 32, fig. 18.

Shell small, subcircular, moderately convex, umbos inflated, beaks anterior to the middle; surface finely sculptured with even, concentric riblets, more or less cancellated by fine, radial threads which are strongest on the anterior and posterior extremities, while the concentric riblets predominate on the middle of the shell; lunule distinct, narrowly lanceolate; interior of the shell deep, the hinge of both valves with 3 cardinal teeth and an anterior lateral; ventral margin concentrically grooved but not tangentially as in *Transcennella*.

Length 4.75, height 4.25, diameter of the left valve 1.50 mm.

This small *Gouldia*, is fairly abundant in the Miocene coral limestones of Port Limon, and is characterized by its small, convex shell and subcircular form. Gabb has described a small *Gouldia* from the Pliocene beds of the Limon Peninsula, but that species is more depressed, less circular and more trigonal in outline. Gabb's species may prove to be a small form of the recent West Indian *G. cerina* C. B. Adams.

Gatun Stage: Port Limon.

Old Man Sam creek, 1 mile south of the beach.—[Olsson, 1922.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Costa Rica.

GAFRARIUM (GOULDIA) CANCELLATUM (Gabb)

Plate XXI, Figures 4, 8, 22

Psephis cancellata Gabb, 1881, Jour., Acad. Nat. Sci. Phil., vol. VIII, p. 373, pl. 47, fig. 74.

Gouldia cancellata Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1250.

Shell small, subtrigonal, compact; beaks acute and prominent, base regularly rounded; surface marked by fine concentric ribs, crossed by others of an equal size radiating from the beaks; lunule long and slender; inner margin entire. Of about the same size and shape as the West Coast *P. tantilla*, Gld.; this species can be at once distinguished by its minute cross sculpture. *P. tantilla* is marked only by a few concentric lines.—[Gabb, 1881.]

The shells figured are the proterotypes of Gabb. They show the true characters of the shells somewhat better than the original drawings. In the original drawing of the hinge, the anterior teeth are not situated in quite the proper relationship. The uppermost of the two very small teeth drawn anteriorly is the small, anterior cardinal. It is slightly more parallel to the middle cardinal than drawn. The lower, small, anterior tooth drawn is the anterior projection of the pit into which the anterior lateral of the left valve fits. The photograph of the right valve, pl. XXI, fig. 8, shows the hinge in its normal relationship. The radiating striae are more conspicuous than shown on the original figure.

The species differs from *G. cerina* in being less high and in having the radial ribs more prominent on the anterior and posterior regions with the central portion not being marked conspicuously with the radials. *G. cerina* has usually the radial sculpture developed over all the shell but very fine and delicate in strength. *G. cancellata* is related most nearly to *G. bermudensis* and *G. metastriata*, in that those species have the strong development of the radial ribs anteriorly and posteriorly with the mid-region

free from radials. *G. cancellata* differs from *G. bermudensis* in being slightly higher and the ventral margin more convex. It differs from *G. metastriata* in being more convex, in having finer sculpture and possibly the radial sculpture developed more conspicuously.

Dimensions.—5 mm., 6.5 mm., 4 mm. length, respectively.

Lectotype.—Left valve. No. 3425. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Pliocene. Between Limon and Moen, Costa Rica. (Gabb)

GAFRARIUM (GOULDIA) INSULARIS (Dall and Simpson)

Plate XXI, Figure 15

Circe insularis Dall and Simpson, 1901, Bull. U. S. Fish. Com., vol. I, p. 487, pl. 55, fig. 2.

Gafrarium (Gouldia) insularis Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 396; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1248; Woodring, 1925, Carnegie Inst. Wash., No. 366, p. 150, pl. 20, figs. 8 to 10.

Shell small, yellowish white, quite inequilateral, moderately convex, with a prominent, rather anterior, beak; sculpture of small, close-set, subequal, concentric undulations, with narrower interspaces and less pronounced on the umbones, crossed by fine radial striae, which are stonger toward the ends of the valves, where the interspaces sometimes become threadlike; lunule small, sharply defined, rather long and narrow; escutcheon absent; interior white, the margin in many specimens with a fine sulcus, parallel to it around the shell; hinge normal; pallial line entire, but slightly truncate behind.

Length, 5.5; height, 5; diameter, 3 mm.

San Juan and Mayaquez harbors, Porto Rico; in the latter abundantly at station 6061, in 30 fathoms, coral sand, but no living specimens were taken.

Well distinguished from the other American species by its form and size.—[Dall and Simpson, 1901.]

This species differs in shape from the other species of *Gouldia*. It has a more convex and inequilateral shape, like that of *Pitaria*. The sculpture is finer but typical of *Gouldia*.

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Miocene. Bowden marl, Bowden, Jamaica. (Dall, Woodring). Living. San Juan and Mayaquez Harbors, Porto Rico. (Dall and Simpson).

GAFRARIUM (GOULDIA) CERINA (C. B. Adams)

Plate XXI, Figures 1, 5, 9, 11, 21

Thetis cerina C. B. Adams, 1845, Proc. Bost. Soc. Nat. Hist., vol. II, p. 9.

Gouldia cerina C. B. Adams, 1847, Cat. Coll. Adams, p. 29.

? *Venus cerina* Reeve, 1864, Conch. Icon., *Venus*, pl. 26, fig. 140.

Gouldia cerina Dall, 1881, Bull. Mus. Comp. Zool., Har. Col., vol. IX, p. 128.

Circe (Gouldia) cerina Dall, 1886, Bull. Mus. Comp. Zool., Har. Col., vol. XI, p. 263, pl. VII, fig. 4a, 4b; Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 48, ed. 1903, pl. 7, figs. 4a, 4b; Dall and Simpson, 1901, U. S. Fish. Com. Bull., vol. 1, p. 487.

Gafrarium (Gouldia) cerina Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 369; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 67.

T. t. parva, lineis elevatis concentricis distantibus et striis radiantibus ornata, cerina; lunula vulvaeque transversim rubro lineatis; umbonibus minimis, acutis, pallide virentibus; margine supra angulato, alibi rotundato; pallii impressione subsinuata. Long. .42 poll.; alt. .39 poll.; lat. .21 poll.—[Adams, 1845.]

Shell small, nearly equilateral, beaks high, minute; lunule long, bounded by an impressed line; no escutcheon; pallial line simple or only slightly indented; shell ornamented with reticulate sculpture of which fine, concentric ribs predominate, the radial ribs are most conspicuous anteriorly; shell white.

Mina L. Winslow, Curator of Mollusca at the University of Michigan Museum of Zoology, is working on the illustration and determination of the Amherst Adams collection of shells. She writes that the type collection of *Gouldia cerina* C. B. Adams consists of the following lots:

1. From Jamaica. var. s. Large series of specimens. C. B. Adams donor!

2. From St. Thomas. Two shells. Thomas Bland donor!

3. From Jamaica. One shell. C. B. Adams donor.

Adams did not select a type. Miss Winslow will probably select the lectotype from lot 1.

Dimensions.—9 mm., length; 8.5 mm., height; 5 mm., thickness.

Lectotype.—Amherst College Museum, Amherst, Mass.

Occurrence.—Living. Cape Hatteras, North Carolina south to Bermuda, Antilles and to 90 miles southwest of Cape San Rogue, Brazil. Low water to 95 fathoms. (Dall). Charlotte Harbor, Fla. 13 fathoms. (Maury)

GAFRARIUM (GOULDIA) BERMUDENSIS (E. A. Smith)

Plate XXI, Figures 3, 6, 7

Circe bermudensis E. A. Smith, 1885, Challenger Exped., Zoology, Lamellibranchiata, p. 143, pl. II, figs. 1-1b.

Gafrarium (Gouldia) bermudensis Dall, 1902, Proc. U. S., Nat. Mus., vol. 26, No. 1312, p. 369.

Testa parva, trigono-rotundato, paulo inequilateralis, albida (?), mediciter convexa, utrinque rotundata, liris radiantibus et concentricis tenuibus cancellata. Margo dorsi utrinque valde declivis, postice leviter arcuatus, antice rectiusculus, ventralis parum curvatus. Umbones mediocres, aliquanto ante medium siti, acuti, incurvati. Lunula impressa, late lanceolata. Dentes cardinales normales, postico valve dextræ et mediano sinistræ maximis. Sinus pallii indistinctus.

This species is longer than high, and becomes proportionately longer as it increases. It is a little inequilateral, the anterior end, as is usually the case in the Veneridae, being shorter than the posterior. It is beautifully ornamented with fine concentric lire, which are crossed by others equally slender radiating from the apices, the points of intersection being somewhat granular. It is probably whitish, but I am unable to speak with certainty upon this point, as all the valves before me are more or less worn. It is rather rounded when very young, but becomes more trigonal in older shells, the umbones being more elevated, and thus producing this appearance. The dorsal margin descends considerably on both sides, is rather longer and a trifle arcuate behind, in front being nearly rectilinear. The two ends are subequal, the posterior, if anything, rather narrower than the anterior, the reverse being the case in the earlier stages of growth. The ventral margin ascends, more in front than behind, and is not very much curved at the middle. The lunule is broadly lanceolate, faintly sunken, defined, and exhibits lines of growth. The hinge is normal in construction, the hinder tooth in the right valve and the central one in the left being rather larger than the others. The muscular impressions and the pallial line are too distinct for description.

Length 7 mm., height 6½, diameter 4½.

Habitat.—Station 33, off Bermuda, at a depth of 435 fathoms; coral mud.—

[Smith, 1885.]

Holotype.—British Museum, Natural History Division, London.

Occurrence.—Bermuda (type), Smith; Barbados and Curaçao in 5 to 100 fathoms. (Dall)

Gouldia lunulata Conrad, 1862, is *Crassinella lunulata*.

Gouldia martinicensis Gabb, 1873, is *Crassinella Guppyi* Dall, 1896.

Gouldia pygmaea Conrad, 1865, is *Crassinella pygmaea*.

Genus GRATELOUPIA Desmoulin

Donax Basterot, 1825, Mem. Soc. Hist. Paris, Tome 2, p. 84.

Grateloupia Desmoulin, 1828, Bull., Soc. Linn. de Bordeaux, Tome II, p. 243, figs. 1-5; Hoernes, 1870, Fos. Moll. Tert., Wien, II, p. 148; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 179; Fischer, 1887, Man. de Conch., p. 1081; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 348; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1238; Cossmann and Peyrot, 1910, Actes Soc. Linn., Bordeaux, Tome LXIV, p. 423; Jukes-Browne, 1913, Proc. Mal. Soc. Lond., vol. 10, p. 266; Jukes-Browne, 1914, *ibid.*, vol. 11, p. 69.

Charact. gener.—Animal *ignotum*; *sed verisimiliter ut in Donacis speciebus Veneriformibus*.

Testa transversa, subtrigona, æquivalvis, ferè æquilatera; latere postico (Blainville) *subattenuato et subcuneato, leviter (ut in Tellina) undato*.

Dentes cardinales primarii (ut in Cytherea) divaricati, tres in quibus accedunt in valvis ambabus dentes cardini-seriales 3-6 lamellosi, paralleli ad natem convergentes, oblique rugosi, margineque denticulati, sub ligamento ad latus testæ posticam instructi.

Dens lateralis unicus, anticus, sub ano (ut in Cytherea) in valva sinistra positus; fovea in valva dextra, alterius valvæ dentem lateralem excipiente.

Ligamentum externum, subturgidum, prælongum, ultra dentes cardini-seriales porrectum.

Nutes exique, viz prominulæ, virque ad anum vergentes.

Impressiones musculares subæquales, rotundatæ.

Impressio pallialis postice profunde sinuata sinu adversus dentem lunularem terminato.

Caract. génér.—Animal inconnu, mais probablement analogue à celui des Donaces Vénéiformes.

Coquille transverse, subtrigone, équivalve, presque équilatérale. Coté postérieur (Blainville) un peu atténué en coin, et margué d'un léger pli flexueux analogue à celui des *Tellines*.

Dents cardinales au nombre de trois principales, divergentes, a la manière de celles des *Cytherees*, sur chaque valve, accompagnées aussi sur chaque valve, de 3-6 dents *cardini-seriales*, lamelleuses parallèles, convergentes vers le crochet, obliquement rugueuses et dentelées en leur bord. Ces dents sont situées au coté postérieur de la coquille, sous le ligament.

Une seule dent latérale, antérieure, placée sous la lunule, analogue à celles des *Cytherees*, sur la valve gauche; une fossette correspondante sur la valve droite.

Ligament extérieur, bombé, très-long, dépassant les dents cardini seriales.

Crochets très-petits, peu saillans, à peine inclinés vers la lunule.

Impressions musculaires subgales, arrondies.

Impression palléale fortement enchançrée postérieurement, l'enchançrure se prolongeant jusque vis-à-vis la dent lunulaire.

Obs. Ce genre se distingue des Donaces par deux caractères important: 1.° la présence des dents que j'appelle *cardini-seriales*; 2.° la grande longueur du ligament, lequel est toujours excessivement court dans les Donaces. J'ai pu observer ce ligament parfaitement conservé, à l'état de chaux très-blanche et friable, ayant l'aspect fibreux, sur les individus *complets* qu'on trouve à Saucats, et dont M. l'abbé Laborde, curé de cette paroisse, a bien voulu me donner un. Il a fallu sacrifier ce beau ligament, rare à trouver, pour pouvoir étudier la charnière dans son plus grand état de fraîcheur; mais la planche, que je dois au talent et à la complaisance de mon ami M. Raug, le représente parfaitement. Ce ligament s'enfonçe un peu sous les crochets, à la manière de celui des *Cyprines*, au moyen d'une fossette oblongue, extrêmement petite, creusée dans la nymphe. Cette fossette existe aussi dans quelques Donaces, peut-être dans

toutes, mais elle est presque imperceptible dans les spices ou je l'ai observée.

L'excavation de l'impression palliale est beaucoup plus profonde que dans les Donacés Veneriformes.—[Desmoulin, 1828.]

Genoholotypes.—*G. irregularis* (Basterot) (*G. donaciformis* Desmoulin). Plate XXI; Figures 20, 24, 28, 29, 30. Miocene of the Bordeaux Basin, France, and the Vienna Basin, Austria.

The genus is European and is included here to show relationships with subgroups which occur in the American region.

Subgenus CYTHERIOPSIS Conrad



Fig 15. Hinge of type species of *Cytheriopsis*

Cytheriopsis Conrad, 1865, Amer. Jour. Conch., vol. I, p. 146; Conrad, 1867, *ibid.* vol. III, p. 14; Stoliczka, 1871, Pal. Indica, vol. III, p. 154; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 179; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 348; Dall, 1903, Trans., Wag. Inst. Sci., vol. III, pt. 6, p. 1239; Jukes-Browne, 1913, Proc. Mal. Soc. Lond., vol. 10, p. 272.

Grateloupina Dall, 1902, l. c., p. 348; Cossmann and Peyrot, 1910, Actes Soc. Linn., Bordeaux, vol. LXIV, p. 424.

Grateloupia Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 69 in part.

Triangular; hinge composed of two compressed or linear teeth under the apex, and two oblique teeth anterior to them; in the left valve are four diverging teeth, the posterior one linear; and a lateral pyramidal compressed tooth anteriorly; cartilage area rugose pallial line with a shallow, rounded sinus.

C. Hydana, Conrad

This very distinct genus has been usually referred to *Grateloupia*, Desmoulin; but it has one more cardinal in each valve, and a slight pallial sinus, which in *Grateloupia* is very profound. It is at present represented by this one species, and peculiar to the Eocene.—[Conrad, 1865.]

Three cardinals in each valve; left, posterior cardinal fused with rugosities of the nymph; right, posterior cardinal slender, narrowly bifid; nymphs prominently rugose; left valve with a large pointed, anterior lateral which fits into a good sized socket in the right valve; posterior margin of the right valve grooved; lunule large and elongated, defined by an incised line; pallial sinus small, rounded.

Genoholotype.—*Cytheriopsis hydana* Conrad. Plate XXI, Figures 17, 18, 23, 26, 27. Eocene of Alabama.

Since Conrad described this subgenus from a single Eocene species, Dall has described a species from the Chipola Miocene horizon at Alum Bluff, Florida.

Dr. Dall suggested, 1902, that if the name of this group is too close to *Cytheropsis* McCoy, 1849, *Grateloupina* might be substituted.

GRATELOUPIA (CYTHERIOPSIS) HYDANA (Conrad)

Plate XXI, Figures 17, 18, 23, 26, 27

Cytherea hydana Conrad, 1833, Aug., Fos. Shells Ter. For., p. 36; Harris Reprint, 1893, pl. XX, fig. 3.

Grateloupia moulinsi Lea, 1833, Nov., Cont. to Geol., p. 59, pl. 2, fig. 33.
Cytheriopsis Hydana Conrad, 1865, Am. Jour. Conch., vol. I, pp. 7, 146; Conrad, 1867, ibid., vol. 3, p. 14.

Grateloupia moulinsi De Gregorio, 1890, Ann. de Geol. et Pal., 7 et 8 liv., p. 221, pl. 34, figs. 28-33.

Meretrix dalli Cossmann, 1893, Ann. de Geol. et Pal., 12 liv., p. 11, pl. 1, figs. 9, 10. not *Meretrix dalli* Dickerson, 1914.

Grateloupia (Cytheriopsis) hydana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1239; Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 152, pl. 47, figs. 12, 13. Shell subtriangular, inequilateral; posterior side slightly channelled; posterior end cuneiform; lunule lanceolate, elliptical.

I gladly name this fine species in compliment to Mr. William Hyde, one of the most successful and zealous cultivators of American Conchology. Length 2 inches. Breadth 1½ inches.

Locality, Claiborne, Alab.

Cab. Acad. N. S.—[Conrad, 1833.]

In the young specimens, the rugose nymphs are still traceable but very narrow. The posterior end is rounded in the young while in the adult it becomes attenuated and pointed with the anterior end broader and more rounded. Half grown specimens are often symmetrical, more equilateral with the ends less pointed. This stage, De Gregorio named variety *symetrica*. The shells are smooth, except for growth lines.

Dimensions.—56 mm., length; 39 mm., height; 27 mm., thickness.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Claiborne stage. Mid-Eocene. Claiborne, Ala.

GRATELOUPIA (CYTHERIOPSIS) ALUMENSIS Dall

Plate XXI, Figures 12, 13 16

Grateloupia (Cytheriopsis) alumensis Dall, 1902, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1239, pl. 52, fig. 14.

Oligocene of the Chipola horizon at Alum Bluff, Florida; Burns.

Shell smooth or faintly concentrically striated, subequilateral, trigonal, moderately thick, base somewhat produced in the middle; beaks pointed, low, subcentral; lunule impressed, bounded by a very delicate incised line, lanceolate; a raised thread borders the dorsal margin at the side of the ligament; valves moderately convex, the posterior slightly more attenuated than the anterior end, base prominently arcuate; hinge hardly differing from that of *G. hydana*, but the pallial sinus wider and more rounded in front. Length of adult valve, about 38 mm., of the younger but better preserved valve figured 15, height 12.5, diameter 8.0 mm.; diameter of adult 20.0, height 32.0 mm.

This species is easily distinguished from *G. hydana* by its more equilateral, trigonal form, smoother surface, and more ample sinus.—[Dall, 1903.]

Holotype.—No. 114609 United States National Museum, Washington, D. C.

Occurrence.—Miocene. Chipola horizon at Alum Bluff, Florida.

Genus TIVELA Link



Fig 16. Hinge of type species of *Tivela*

Tivela Link, 1807, Besch. Nat. Samml. Rostock., II, p. 152.

Trigona Megerle von Mühlfeld, 1811, Entw. neu. Syst. Schälth., p. 55; Schumacher, 1817, Essai d'un Nouv. Syst., p. 153; Gray, 1838, Analyst, VIII, No. 24, p. 304; Deshayes, 1853, Cat. Conch., pt. I, p. 45 not *Trigona* Jurine, 1807, Hymenoptera.
Tivela Mörch, 1843, Cat. Yoldi, II, p. 28; Römer, 1864, Mon., *Venus*, vol. I, p. 1; Stoliczka, 1871, Pal. Indica, vol. III, p. 150; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 177; Fischer, 1887, Man. de Conch., p. 1079; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 349; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1243; Cossmann and Peyrot, 1910, Actes Soc. Linn., Bordeaux, LXIV, p. 424; Jukes-Browne, 1913, Proc. Mal. Soc. Lond., vol. 10, p. 266; Jukes-Browne, 1914, *ibid.*, vol. 11, p. 69.

Shell large, trigonal, subequilateral and smooth; umbones usually very full; lunule large bounded by an incised line; escutcheon not defined; inner margin smooth except in the section *Eutivela*; ligament short, posterior, but extending forward over the upper margin of the cardinals; pallial sinus short, wide and rounded markedly in front; hinge with a large, anterior lateral in the left valve and a large socket in the right valve into which the anterior lateral fits; the number of cardinals varies in different species; in *T. mactroides* there are at least three cardinals in each valve and in addition a split and heavily, rugose nymph plate; the posterior edge of the left, posterior cardinal is also corrugated; the exact terms applied to the posterior portion of the hinge of *Tivela* vary with the individual interpretation; the nymph plate of the right valve might be defined as a rugose, posterior cardinal with a smaller rugose nymph, in place of, as stated, a split and rugose nymph plate. It is a splitting of the posterior portion of the hinge plate which allows the greater number of cardinals in the species of the genus. The inner margin of the posterior end is grooved to receive the bevelled edge of the opposite valve; the shell is covered with a brownish or greenish periostracum which is often of a velvety texture.

Genoholotype.—*T. mactroides* (Born) = (*T. corbicula* Gmelin). Plate XXII, Figures 1, 4, 6, 15, 20, 21. Recent. West Indies south to Brazil.

The genus extends from the Miocene in eastern America with numerous species to-day.

Stratigraphic Range of *Tivela* s.s.

Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
		jamaicensis	nasuta var. austeniana var. maturensis		nasuta mactroides brazilliana abaconis trigonella fulminata ventricosa

TIVELA JAMAICENSIS Dall

Plate XXII, Figure 16

Tivela jamaicensis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1244, pl. 57, fig. 9; Woodring, 1925, Carnegie Inst. Wash., Pub., 366, p. 149, pl. 20, figs. 6, 7. Oligocene of the Bowden marl at Bowden, Jamaica, rare; collected by Henderson and Simpson.

Shell small, thin, plump, smooth, or faintly concentrically striated; beaks nearly

central, low pointed, turgid; lunule large, lanceolate, smooth, defined by an impressed line; nymphs short and elevated, dorsal slopes nearly straight, ends bluntly rounded, base slightly arcuate; hinge delicate with three small cardinals and a rather long, slender anterior left lateral; margins thin, smooth; pallial sinus small, rounded. Length 6.0, height 5.5, diameter 4.9 mm.

This, the only fossil *Tivela* yet obtained in the Atlantic Tertiaries, is small and delicate, belonging to the group of *T. trigonella* Lamarck and *T. abaconis* Dall, of the recent fauna.—[Dall, 1903.]

Holotype.—No. 135675. United States National Museum, Washington, D. C.

Occurrence.—Miocene. Bowden marl at Bowden, Jamaica. (Dall)

TIVELA NASUTA AUSTENIANA (Maury)

Plate XXII, Figures 5, 12

Maetra austeniana Maury, 1912, Jour., Acad. Nat. Sci. Phil., vol. 15, p. 61, pl. IX, figs. 22, 23.

Tivela austeniana Maury, 1925, Bull. Amer. Pal., vol. 25, No. 42, p. 144, pl. 27, fig. 2.

Shell of moderate size; triangular, rather thin, moderately convex; beaks low, approximate; surface sculptured only by concentric lines of growth; pallial sinus small, rounded; hinge of right valve with a short double anterior lateral tooth, a strong bifid or reversed V-shaped cardinal, a triangular chondrophore (about equalling in size the bifid tooth), and a double elongated posterior lateral tooth; the narrow, lanceolate ligament area is separated from the chondrophore by a shelly plate.

Length of largest specimen 27, height 21, diameter 14 mm.

Remarks.—Small individuals of this species superficially recall *Mulinia lateralis* in their general outline; but the hinge characters are very different,—the shelly plate lying between the ligament and the chondrophore separating this shell at once from *Mulinia*.

The writer takes great pleasure in naming this shell in honor of Mr. Austen, Librarian of Cornell University. His kind help in matters of bibliography has greatly facilitated our researches.—[Maury, 1912.]

This species has the typical hinge of *Tivela*. The hinge of the type is known only from the right valve. The form differs from *T. mactroides* in the shell being less elevated, the umbones not as full and the posterior end more produced. In shape, the shells are identical practically with specimens of *T. nasuta* Dall from the Gulf of Venezuela.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Late Pliocene. (Type) Along the shore 1000 feet west of Brighton pier, Trinidad, in an impure asphalt. (Maury coll.)

TIVELA NASUTA MATURENSIS Maury

Plate XXII, Figure 5a

Trigona mactroides Guppy, 1864, Trans. Sci. Ass. Trinidad, Harris Reprint, 1921, Bull. Amer. Pal., vol. 8, No. 35, p. 16.

Tivela austeniana var. *maturensis* Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 144, pl. 27, fig. 1.

We have a number of *Tivelas* from the Matura beds which are intermediate in form between the Pliocene *austeniana* and young shells of the Recent *mactroides*.

They are about the size of *austeniana* and resemble it in the form of the umbo and degree of convexity, but the posterior end is shorter, as in young *mactroides* which the base of the shell approaches in form. The hinge is heavy for the size of the shell, much more so than in *austeniana*. The largest specimen measures in length 25, altitude 24, semidiameter 7 mm.

Locality.—Matura, northeastern Trinidad.

Horizon.—Upper Pliocene.—[Maury, 1925.]

Guppy referred this species in his list of the Matura fauna to *T. mactroides*. The species differs from *T. mactroides* by the same characters as does *T. nasuta austeniana*. The Matura shells are shorter than *T. austeniana* as Dr. Maury has pointed out.

Guppy noted that the fauna of the Matura beds contained many of the recent species which do not attain the size of the living shells. Since there is a noticeable difference in the shells of this form we leave the species with a varietal distinction between it and the recent *T. nasuta* and *T. austeniana* from Brighton.

TIVELA NASUTA Dall

Plate XXII, Figures 7, 13, 19

Tivela nasuta Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 368, 380, pl. 12, fig. 2; Dall, 1903, ed. U. S. Nat. Mus. Bull., 37, pl. 89, fig. 2.

Shell of moderate size, solid, nearly equilateral, somewhat rudely concentrically striated, with a reddish-brown polished periostracum; shell substance white, with numerous pale purple radii, the dorsal posterior margin near the end dark brown within and without; beaks pointed, dorsal slopes nearly straight; lunule impressed, defined by a distinct incised line; anterior end rounded, posterior end narrower, almost rostrate; hinge solid, with four cardinals, the anterior lateral lamelliform, prominent; pallial line with a short, small, rounded sinus. Length, 32.5; height, 25; diameter, 17 mm.

Type locality.—Santa Marta, Colombia; Baker. Cat. No. 143377, U. S. N. M.

By its rudely striated surface and produced posterior end, this seems to differ from the other Antillean forms.—[Dall, 1902.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Recent. Santa Marta, Colombia. (Dall). Gulf of Venezuela. (Wiesbord Coll., Cornell Univ. Pal. Lab.)

TIVELA TRIGONELLA (Lamarck)

Plate XXII, Figures 2, 3

Cytherea trigonella Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 567.

Trigona angulifera Gray, 1838, The Analyst, VIII, No. 24, p. 305.

Trigona trigonella Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 50.

Cytherea trigonella Sowerby, 1853, Thes. Conch., p. 617, pl. 128, fig. 16; Reeve, 1864, Conch. Icon., *Cytherea*, pl. X, fig. 41.

Tivela trigonella Römer, 1869, Mon. Venus, p. 18, pl. 5, fig. 5.

Tivela trigonella Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 368.

C. testa parvula, trigona, levigata, albido fulvo purpureoque varia; lineis rufis angulato-flexuosis; intus maculata.

Habite l'Océan des Antilles. Cabinet de M. Dufresne. Largeur, 15 ou 16 millimètres. Elle est quelquefois trèsvivement colorée et assez jolie.—[Lamarck, 1818.]

The umbones of this species are not as plump as *abaconis* Dall. The ventral margin is nearly straight.

The figures which we include are from the beautiful monograph on the Veneridæ by Römer. There is in the Newcomb collection a specimen of both valves, which is probably this species. The only doubt which one may have is that the label accompanying the specimen gives the locality as "Cape of Good Hope." The identification of the species on the label is erroneous and the locality given is probably also.

Dimensions.—14 mm., length; 11 mm., height; 8 mm., thickness. (U.

S. Nat. Mus. specimen.)

Occurrence.—West Indies and Gulf of Paria (Dall, U. S. Nat. Mus.).

TIVELA ABACONIS Dall

Plate XXII, Figure 17

Tivela abaconis Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 367, 380, pl. 13, fig. 3; Dall, 1903, ed. U. S. Nat. Mus. Bull., 37, pl. XC, fig. 3.

Shell small, subtranslucent, deep rose color at the beaks and in the middle of the disk, becoming paler toward the margins; beaks high, pointed, subcentral; shell moderately inflated, the ends rounded, the base gently arcuate; surface polished; hinge delicate; the teeth small, three cardinals in each valve, the anterior lateral elongate, thin, distant; pallial sinus short, wide, rounded; length, 11; height, 8.2; diameter, 6 mm.

Type locality.—Abaco, Bahamas, I. Greegor. Cat. No. 103551, U. S. N. M.

The shell is smaller, more delicate, more equilateral, and of a different color and texture from *T. trigonella* Lamarck, which is the only species comparable with it and which is white and opaque with a conspicuous periostracum.—[Dall, 1902.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Recent. Abaco, Bahamas and Vera Cruz, Mexico.

(Dall)

TIVELA FULMINATA (Valenciennes)

Plate XXII, Figures 8, 9, 11, 14, 18

Venus fulminata Valenciennes, 1827, Ency. Meth., pl. 268, fig. 2 fide Dall.

Cytherea fulminata Philippi, 1844, Abbild. und Besch. Conch., p. 198, pl. 3, f. 4.

Trigona fulminata Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 50.

Cytherea fulminata Reeve, 1864, Conch. Icon., *Cytherea*, p. IX, p. 40.

Tivela fulminata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 368.

Shell large, broadly trigonal; umbones medium, almost equilateral; posterior portion slightly longer than the anterior; posterior end more pointed than the anterior end; ventral margin rounded regularly; lunule large, bounded by a very faint line; ligament short, exposed; no esutcheon; teeth consist of three cardinals in each valve with a posterior rugosity; large, anterior lateral tooth in the left valve fitting into a deep socket with upper and lower projections, in the right valve; pallial sinus medium, rounded; shell white with a yellow periostracum.

The species differs from *T. ventricosa* in being more equilateral, less high and in lacking a distinct posterior ridge; the lunular area is not so sunken.

Dimensions.—47 mm., length; 39 mm., height; 25 mm., thickness. (Medium size).

Occurrence.—Coast of southern Brazil at Rio and Santa Caterina. Recent. (Dall, U. S. Nat. Mus.)

TIVELA MACTROIDES (Born)

Plate XXII, Figures 1, 4, 6, 15, 20, 21

Venus mactroides Born, 1778, Index rerum nat. musei Cæsari Vind. Test. fide Dall; Born, 1780, Test. Mus. Cæs. Vind., p. 65.

Venus corbicula Gmelin, 1792, Systema Naturæ, VI; Bruguière, 1797, Enc. Meth., p. 269, fig. 3.

Tivela vulgaris Link, 1807, Besch. Nat. Rostock. Samm. fide Dall.

Trigona radiata Megerle von Mühlfeld, 1811, Mag. Gesell. Nat. Freunde, Berlin fide Dall.

Venus turgens (Solander MS.) Dillwyn, 1817, Desc. Cat. Shells, I fide Dall.

Trigona fasciata Schumacher, 1817, Essais Nouv. Syst. hab. vers. test. fide Dall.

Cytherea corbicula Lamarck, 1818, Hist. des Ann. sans vert., Tome V, p. 563.

not *Cytherea mactroides* Lamarck, 1818, *ibid.*, p. 567 = *C. planulata* Sowerby.

Trigona corbicula Gray, 1838, The Analyst, VIII, No. 24, p. 304.

Trigona mactroides Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 51.

Cytherea mactroides Reeve, 1864, Conch. Icon., *Cytherea*, pl. V, fig. 18.

Tivela mactroides Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 56; Dall, 1902, Proc. U. S.

Nat. Mus., vol. 26, No. 1312, p. 367; Maury, 1925, Bull. Amer. Pal., vol. 10, No.

42, p. 143, pl. 26, fig. 8, pl. 27, fig. 3.

Germ. Die Korbvenus. Belg. Gestraalde Kwaker. Gall. Quacre rayonné.

Testa triangula, umbonata, lævi, utrinque complanata, cardinis dente laterali remoto.

Lister. Hist. Conch. tab. 251, f. 85.

Knorr. Vergn. V. tab. 15, f. 2

VI. tab. 10, f. 5.

Testa similis *Mactrae stultorum*, triangula, subæquilatera, lævis, transversim tenuissime striata, utrinque prope apices complanata; Apices incurvi; Dentes primores tres, structura congenerum, quibus accedit postice lateralis remotus; Color testæ fulvus radiis albis, apicum violaceus.

Long. 11 lin. lat. 1. poll. 1. lin.

Patria ignota.—[Born, 1780.]

Shell variable in shape; large, triangular; adults with umbones swollen and posterior end pointed; shell heavy; young nearly equilateral, base and apex parallel; surface smooth; color white or yellow with dark rays of brown or purple. Anterior and posterior ends of some shells violet or purplish blue.

Occurrence.—Recent. Bahama Islands, thru the West Indies and shores of adjacent continents south to Santa Caterina, Brazil. (Dall). St. Thomas, and southern shore of Gulf of Venezuela. (Cornell Univ. Pal. Lab.)

TIVELA BRASILIANA Dall

Plate XXII, Figure 10

Tivela brasiliana Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 368, 381, pl. 12, fig. 3; Dall, 1903, ed. U. S. Nat. Mus. Bull., 37, pl. 89, fig. 3.

Shell subtriangular, flattish, with high, pointed, opisthogyrate beaks; cream color with darker yellowish zones; surface smooth; lunular region impressed; lunule narrow, elongate, pouting a little at the junction of the valve margins; posterior slope straight, flattened, with a short ligament; interior pale yellow brown; hinge with five right cardinals, the posterior pair rugose; the anterior lateral adjacent, strong; the pallial sinus rounded, about as large as the posterior adductor scar. Length 40; height 34; diameter 20 mm.

Type locality.—Santa Caterina, Brazil. Cat. No. 125468, U. S. N. M.

This peculiarly flat and triangular form recalls the *T. planulata* Sowerby, of the Pacific Coast.—[Dall, 1902.]

This species has been referred in lists of recent shells from Brazil to *T. bicolor* Gray.

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Recent. West Indies; Santa Caterina, Brazil. (Dall)

TIVELA VENTRICOSA (Gray)

Plate XXIII, Figures 2, 7, 8, 9, 10, 11, 12

Trigona ventricosa Gray, 1838, The Analyst, vol. VIII, No. 24, p. 304; Deshayes, 1853,

Cat. Conch. Brit. Mus., pt. 1, p. 53.

Cytherea ventricosa Reeve, 1864, Conch. Icon., *Cytherea*, pl. V, fig. 17.

Tivela ventricosa Römer, 1869, Mon., *Venus*, I, p. 21, pl. VII, fig. 3.

Tivela (Pachydesma) ventricosa Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 368.

Shell ovate, trigonal, ventricose, pale brown. Hinder slope flattened, very broad. —[Gray, 1838.]

Shell very large, smooth, triangular; umbones very large and full; a high, sharp posterior ridge extends from the beaks to the ventral margin; lunule is very large, sunken, bounded by an incised line; ligament large, external; anterior end produced, rounded; pallial sinus rounded; hinge typical of the genus; a small, anterior, external cartilage which measures 5.5 mm. in length and 4 mm. across both valves; shell white with a yellow, dehiscent periostracum.

An examination of *Tivela mactroides*, as well as other species of the genus, shows that there is an area of an anterior cartilage but that it is located internally, between the two valves instead of wholly externally as is the case in *T. ventricosa*. In the genoholotype species the area is located directly beneath and anterior to the beaks and spreads over the base of the two anterior cardinals, terminating at the middle cardinal. The same condition is true in *T. stultorum* (Mawe) (*T. crassatelloides* Conrad), the type of the section, *Pachydesma* Conrad. In that species the area is of fairly good size but confined to the interior of the shell. *T. ventricosa* is striking in presenting a change in the location of an apparently primitive character. This character has been shown in the photograph, plate XXIII, figure 2.

A comparison of the hinges of *T. mactroides*, genoholotype, *T. stultorum* and *T. ventricosa* shows that the hinge of the last is more typical of the genus, *Tivela* s. s. The cardinals number the same, their position is the same and the two left, posterior cardinals or projections show the same amount of rugosity in the same relationship. The middle or second left, anterior lateral in each species, *T. ventricosa* and *mactroides*, is finely split, while in *stultorum* it is larger and definitely bifid. The rugose, left, posterior cardinal in *stultorum* does not present two moderately separated, rugose parts as in *mactroides* and *ventricosa*; the anterior portion is thin and sharp and projects as a knob ventrally, while the posterior part is rugose and close to the anterior portion. The right posterior tooth of *stultorum* is rugose but single. In *ventricosa* and *mactroides* it is rugose and divided. The hinges of the species may be compared on plate XXII, figures 1, 4 and plate XXIII, figures 4, 5, 7, 8, 9.

Dimensions.—78 mm., length; 67 mm., height; 48 mm., diameter. U. S. Nat. Mus. specimen No. 122469. Dr. Dall speaks of specimens in the United States National Museum measuring 105 mm. in length, 90 mm., in height and 70 mm. in diameter.

Occurrence.—Southern Brazil. Recent. Reeve, Römer, Deshayes and

other early writers list the species from China but that distribution seems to be an error.

Section EUTIVELA Dall

Eutivela Dall, 1891, Nautilus, vol. V, p. 27; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 349; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1244; Cossmann and Peyrot, 1910, Actes Soc. Linn., Bordeaux, LXIV, p. 425; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. II, p. 69.

On the southeastern coast of South America there seems to be a group hitherto unrecognized which to the general characters of *Tivela* in regard to form, pallial sinus and hinge, unites the crenulated margin of *Sunetta*. To this section the name of *Eutivela* may be applied.—[Dall, 1891.]

Shell small, elongate-trigonal, with crenulate interior margins, thin, polished periostracum, three left and four right cardinal teeth.

This type points the way toward *Sunetta*.—[Dall, 1902.]

Type.—*Eutivela perplexa* Stearns. Plate XXIII, Figure 6. Recent. Argentine coast and off Rio La Plata.

The section as yet is known from two species both of which are recent and occur off the coast of Argentine and Brazil, respectively.

TIVELA IHERINGI Dall

Plate XXIII, Figure 3

Meretrix (Eutivela) Iheringi Dall, 1891, Nautilus, vol. V, No. 3, p. 29, fig. in text. *Tivela (Eutivela) Iheringi* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 369.

Shell thinner, more equilateral and more elongate than *E. perplexa*, waxen-white with more or less interrupted rays of brown extending from the beaks toward the margin, modified by whitish zigzags. The exterior is smooth, with a well marked epidermis and faint, obscure radiations corresponding to the interior marginal crenulations. The interior of the beaks and the cardinal region on both sides of them below the margin more or less marked with purplish brown. The lunule is narrow lanceolate and faintly impressed. The figure illustrates the characters of the single valve upon which the species is founded, which measures 41 mm. long, 27 high, while the double diameter would be about 18 mm.

It is named in honor of Dr. H. von Ihering, from whom it was received, and by whom it was collected on the beach near Santa Caterina in southeastern Brazil in about latitude 26° south.—[Dall, 1891.]

Holotype.—United States National Museum, Washington, D. C.

Occurrences.—Recent. Sao Paulo and Santa Caterina, Brazil. (Dall)

TIVELA PERPLEXA Stearns

Plate XXIII, Figure 6

Meretrix (Eutivela) perplexa Stearns, 1891, Nautilus, vol. V, No. 3, p. 28, fig. in text. *Tivela (Eutivela) perplexa* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 349, 368.

Shell waxen-white, porcellaneous, covered with a greenish-yellow epidermis recalling that of *Iphigenia brasiliensis* or *Mactra ponderosa* Jan. The surface under the epidermis is smooth or marked with lines of growth only. The figure sufficiently illustrates the other characters of the shell. The specimen figured measures 45 mm. long by 33 in height and 23 in diameter. There is an impressed lanceolate lunule 15 mm. long and about 4.5 mm. in greatest width. As in *Tivela* there is a prolongation forward, between the beaks, of the dark epidermal coating of the ligament; forming a blackish lanceolate area in front of the beaks about 5 mm. long, resembling the dark area in *Arca*. This and the rugose subligamentary ridge are reminiscences of the period when the ancestors of *Tivela* had a more archaic type of hinge. There is no defined escutcheon.

The soft parts in alcohol present several differences when compared with *Tivela crassatelloides*.

The gills are double, as in that species, but proportionately much larger and broader; the edges of the mantle are double with a groove between them; in both species they are open from the sinus to the anterior adductor; there are no papillæ or granulations in *E. Iheringi*; the foot is elongated, linguiform, and sharp-edged, without sulci or granulations; the palpi are large and distinctly paired on each side instead of being fused; the siphons are extremely short but rather large, the incurvent with several ranks of rather elongate tentacular processes, the excurrent with a single row of obvious papillæ; the siphons have blackish maculations toward their ends and are joined for most of their length on the adjacent sides. From the dark color of the tissues in alcohol, they were probably reddish or, at least, not white in life.

On a single shell of many, are two small brown maculæ, so that the species may sometimes be colored with brown markings. But the differences of proportion and of solidity which seem to be very constant, forbid us to unite the present species with *E. Iheringi*.

This species was dredged by the U. S. S. Albatross in several places off the mouth of the Rio La Plata in 10-15 fathoms, muddy bottom, associated with *Pectunculus* and sundry *Nuculidæ*.—[Stearns, 1891.]

Holotype.—United States National Museum, Washington, D. C.

Genus OMNIVENUS new genus

Shell suborbicular; beaks small and full; lunule large; escutcheon very narrow; inner margin crenulated distinctly; three cardinals in each valve; a prominent, anterior lateral in the left valve; nymphs rugose prominently; pallial sinus large and somewhat pointed; exterior with irregular, concentric ribs.

This species is of interest for it has a combination of the two distinct groups of the Veneridæ. It has the anterior lateral of the *Pitaria-Callista* group and the crenulated margin and rugose nymph of the *Venus-Chione* group. The genus is known only by the type species from the Claiborne Eocene.

Holotype.—*Cytherea discoidalis* Conrad (*Cytherea subcrassa* Lea). Plate XXIV, Figures 10, 19. Eocene of Alabama.

OMNIVENUS DISCOIDALIS (Conrad)

Plate XXIV, Figures 10, 19

Cytherea discoidalis Conrad, 1833, Aug., Fos. Sh. Tert. Form., p. 37, descrip. not pl. 19, fig. 4 = *Corbula nasuta* Conrad, (Harris Reprint, 1892), not Conrad, *ibid*, pl. 20, fig. 2 = *C. trigoniata* Lea.

Cytherea subcrassa Lea, 1833, Nov., Cont. to Geol., p. 67, pl. 2, fig. 43; Conrad, 1833, Fos. Sh. Tert. Form., Harris Reprint, 1892, pl. 20, fig. 6.

Cytherea trigoniata subcrassa De Gregorio, 1890, Ann. de Geol. et Pal., 7 et 8 liv., p. 219, pl. 34, fig. 24.

Cytherea subcrassa Harris, 1895, Bull. Amed. Pal., vol. I, No. 1, p. 43.

Meretrix subcrassa Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 149, p. 46, fig. 7.

Shell ventricose, thick, suborbicular, gradually narrowed to the beaks, with concentric striae rather deeply impressed, giving the rough exterior; beaks anterior to the middle; inner margin crenulated; lunule cordate, not very distinct. Diameter 1 inch.

Locality, Claiborne, Alab.

Cab. Acad. N. S.—[Conrad, 1833.]

Beaks small; umbones large and full; lunule large; escutcheon very narrow; inner margin crenulated distinctly; three cardinals in each valve; a prominent, anterior lateral in the left valve; nymphs rugose prominently; pallial sinus large and somewhat pointed; exterior with irregular, concentric ribs.

In the collection of the Academy of Natural Sciences at Philadelphia two specimens were found, labelled *Cytherea discoidalis* Lea by T. A. Conrad.

By a comparison with the figures of Conrad those specimens are seen to be what Conrad figured as *C. subcrassa* Lea on pl. 20, fig. 6 of his Fossil Shells, etc. (Harris Reprint).

Since Conrad's description was published several months before that of Lea, we hold the name of *discoidalis* for the species although the figures listed by Conrad are badly mixed. The number given by Conrad with his original description is that for *Corbula nasuta* and the fig. on pl. 20, Harris Reprint, labelled *C. discoidalis* does not correspond to the description of that species. It is an illustration of *C. trigoniata* Lea. Since the museum label of Conrad given as *C. discoidalis* Lea, is with specimens which Conrad figured as *C. subcrassa* Lea and since the descriptions given by the two authors are general but correspond, we take it that they had in mind similar shells. The figure of Conrad shows the shell slightly more orbicular than that of Lea.

The two specimens in the museum at present, vary. One shell is fuller and higher than the other.

This species is of very great interest in the characters which it exhibits. A discussion of those characters is given under *Omnivenus* new genus.

Dimensions.—25 mm., 27 mm., length; 24 mm., 25 mm., height; 9 mm., 11 mm., semidiameter respectively.

Specimens.—(Labelled by Conrad). Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Claiborne Eocene. Claiborne, Ala.

Genus ANTIGONA Schumacher



Fig. 17. Hinge of type species of *Antigona*

not *Antigonus* Hübner, 1816, Lepidoptera.

Antigona Schumacher, 1817, Essais d'un nouveau système des habitations des vers testaces, p. 154. *A. lamellaris* Schumacher.

Dosina Gray, 1838, The Analyst, VIII, No. 24, p. 308, *D. Lamarekii*.

in part *Venus* Deshayes, 1853, Cat. Conch. Bivalve Shells Brit. Mus., pt. I, p. 97; H. and A. Adams, 1857, Gen. Recent Moll., vol. II, p. 417; Reeve, 1863, Conch. Icon., *Venus*, pl. XII, fig. 39; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 176.

Venus (*Antigona*) Smith, 1885, Challenger Rept., Zoology, vol. XIII, p. 121.

Chione (*Omphalocathrum*) Fischer, 1887, Man. de Conch., p. 1084.

Cytherea Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 354; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1271. *V. puerpera* Linne. not *Cytherea* Lamarck, 1818.

Antigona Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 355; Dall, 1903, Trans.

Wag. Inst. Sci., vol. III, pt. 6, p. 1273; Dall, 1915, U. S. Nat. Mus. Bull., 90, p. 148, *A. lamellaris* Schumacher.
Chione (*Omphaloclathrum*) Cossman and Peyrot, 1910, Actes Soc. Linn., Bordeaux, Tome LXIV, p. 325, *V. puerpera* Linne.
Antigona Jukes-Browne, 1914, Proc. Mal. Soc. Lond., 11, p. 70, *A. lamellaris* Schumacher.

Testa cordiformis, æquivalvis, ventricosa.

Cardo: in valva sinistra dentes cardinales quatuor, quorum anterior crassus, antice versus obliquus; secundus subconicus, compressiusculus; posteriores duo lamellares, semilunares, transversales; superior minor; fossa intermedia perangusta et profunda; dens analis subobsoletus, approximatus, obtusus cum fossa parva. In valva dextra dentes cardinales tres, quorum anterior lamellaris, obliquus; intermedius perpendicularis, compressus, apice bifido; posterior lamellaris, semilunaris, transversalis, supraconcavus, infra convexus; dens analis parvulus, conicus, approximatus.

Antigona lamellaris.—[Schumacher, 1817.]

Shell medium in size; subtrigonal; posterior end truncate; lunule large, deep, cordate, marked by an incised line; escutcheon not bounded by an incised line, carinated above; valves plump; inner margins crenulate; three cardinal teeth in each valve; the right, posterior cardinal and the left, middle cardinal bifid; a very small but well defined, anterior lateral tooth in the left valve with a corresponding very small socket in the right valve; pallial sinus small, triangular; the ornamentation consists of prominent, raised, concentric lamellations which are underlaid by radiating ribs; the radiating ribs on the umbonal region are single and wide, with interspaces about equal to the ribs in width; anteriorly and ventrally the radiating ribs bifurcate and an intervening, small rib may occur in the interspaces. Specimens of the genoholotype may be recognized by a beautiful, rose colored interior.

ANTIGONA SENSU STRICTO

Genoholotype.—*Antigona lamellaris* Schumacher (= *Dosina lamarekii* Gray). Plate XXVII, Figures 6, 8, 15, 18. Recent Seas of Japan, China and Australia.

The genus *Antigona* in general, includes large or moderate sized shells, usually with prominent, concentric sculpture, with or without radial lines. The character peculiar to the genus is the small or minute anterior tooth. Whether the pustule-like tooth is in an atrophied condition or in an initial stage of development, is difficult to say. The presence of the tooth combined with the type of sculpture which the shells possess, places the forms in a separate, large group in the family. The species have the crenulated margin of *Chione* and *Venus*, with the coarse sculpture of *Chione*. *Chione* and *Venus* do not have any trace of an anterior lateral. The other, larger division of the Veneridæ, is that represented by *Pitaria* and *Callista* which have a well developed, anterior lateral. *Antigona* has a heavier shell with coarser sculpture than the *Pitaria* and *Callista* groups.

Early authors regarded shells of *Antigona* as belonging to the genus *Venus*. The shells were classed also under *Chione*. That classification

is used still by some European authors. Dr. Dall, in 1902 revived the name *Cytherea* of Bolten, not of Lamarck 1818, for the shells of this group. By elimination of the species listed by Bolten, Dr. Dall took *Venus puerpera* Linnæus as the type of the genus *Cytherea* sensu stricto. He took *Venus verrucosa* Linnæus, *Venus rugosa* Gmelin, *Cytherea lamellaris* Schumacher, *Venus staminea* Conrad, *Venus plicata* Gmelin, *Meretrix tippiana* Conrad and *Chione floridella* Gray as the types of the subgenera and the sections, *Clausina* Brown, *Ventricola* Römer, *Antigona* Schumacher, *Artena* Conrad, *Circomphalus* Mörch, *Aphrodina* Conrad and *Lepidocardia* Dall, respectively.

The name *Cytherea* was found later by Dr. Dall, in 1915, to be preoccupied by Fabricius in *Diptera*, 1795. The next oldest name to have been applied to any of the species of this group of shells was *Antigona* by Schumacher in 1817. *Antigona* was raised from subgeneric rank to that of genus and the species which are typified by *Venus puerpera* Linnæus (*Cytherea* Bolten) were without a generic name.

Jukes-Browne in 1914 proposed a new name, *Periglypta*, for the shells of *Venus puerpera* Linnæus. But in reviewing the synonymy of the group, one finds that there are older names which can stand for the shells. A discussion of the name used for the group of the shells like *Venus puerpera* Linnæus and *Venus reticulata* Linnæus is given under the subgenus *Dosina* Gray.

Stratigraphic Range of *Antigona*

Oligocene	Miocene	Pliocene	Pleistocene	Recent
<i>Artena shepardii</i>	<i>A. staminea</i>	<i>V. rigida</i>	<i>V. rigida</i>	<i>V. rigida</i>
<i>A. glyptoconcha</i>	<i>A. undulata</i>	<i>D. wilcoxi</i>	<i>V. rugatina</i>	<i>D. listeri</i>
<i>Dosina berkeii</i>	<i>D. caesarina</i>	<i>V. rugatina</i>		<i>V. rugatina</i>
<i>D. caesarina</i>	<i>D. tarquinia</i>			<i>V. callimorpha</i>
var. <i>anquillana</i>	var. <i>antillica</i>			<i>V. strigillana</i>
<i>D. tarquinia</i>	<i>D. dominica</i>			
<i>Ventricola</i>	<i>D. proserpinæ</i>			
ucuttana	<i>V. rigida</i>			
	<i>V. blandiana</i>			
	<i>V. harrissiana</i>			
	<i>V. thalestris</i>			
	var. <i>amazoniana</i>			
	<i>V. sanctæ-noctis</i>			

Genus ANTIGONA Schumacher, 1817

Subgenus *Antigona* s. s.

Section *Antigona* s. s.

Section *Artena* Conrad, 1870

Subgenus *Clausina* Brown, 1827

Section *Clausina* s. s.

Subgenus *Dosina* Gray, 1838

Subgenus *Circomphalus* Mörch, 1853

Section *Ventricola* Römer, 1857

Dichotomous Key to the genus *Antigona* Schumacher

Shells with three cardinal teeth in each valve and a small or minute, anterior lateral in the left valve, with a small or minute corresponding socket in the right valve.

I. Anterior lateral small but well marked.

1. Surface with prominent, concentric lamellæ with underlying, radiating lines

Section *Antigona* s. s.

Genoholotype.—*Antigona lamellaris* Schumacher.

1. Surface with prominent, concentric lamellæ with fine, intervening lines; no radiating lines

Section *Artena* Conrad

Type.—*Cytherea staminea* Conrad

I. Anterior lateral minute, often obscure.

1. Exterior sculpture consists of concentric ribs only

- a. Shell rotund; lunule broader than long; concentric ribs not expanded posteriorly

Section (of subgenus *Circomphalus*) *Ventricola* Römer

Type.—*Venus rugosa* Gmelin (= *V. rigida* Dillwyn)

- a. Shell compressed; lunule longer than broad; concentric ribs expanded posteriorly

Subgenus *Circomphalus* Mörch

Genolectotype.—*Venus plicata* Gmelin

1. Exterior sculpture consists of concentric and radial ribs; lunule longer than broad

- a. Radial ribs underlie the concentric ribs and occur over the whole of the shell

Subgenus *Dosina* Gray

Genolectotype.—*Venus reticulata* Linnæus

- a. Radial ribs cut the concentric ribs and occur only over a portion of the shell

Subgenus *Clausina* Brown

Genoholotype.—*Venus verrucosa* Linnæus

Section ARTENA Conrad



Fig. 18. Hinge of type species of *Artena*

- Artena* Conrad, 1870, Amer. Jour. Conch., vol. VI, p. 76; Fischer, 1887, Man. de Conch., p. 1084, *Cytherea staminea* Conrad type.
Artena Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 178.
Ventriculoidea Sacco, 1900, 1, Moll. Terz. Piem., p. 30, *Cytherea multilamella* Lam.; Cossmann and Peyrot, 1910, Actes Soc. Linn., Bordeaux, LXIV, p. 328.
Artena Dall, 1902, Proc. U. S. Nat. Mus. 26, No. 1312, p. 356; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1273; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 72; Dall, 1915, U. S. Nat. Mus. Bull., 90, p. 148.
 Triangular, thick; surface with acute, concentric, prominent ribs; hinge with three cardinal teeth in the right valve, two of them diverging, distant, the anterior one under the apex, robust, direct, curved; left valve with three diverging distant teeth; lateral tooth very small, pyramidal; pallial sinus very small and angular.

Cytherea staminea, Conrad, Miocene Foss., pl. 21, fig. 1.

This genus is readily distinguished from the other genera of the family by one thick anterior tooth in the right valve instead of the two approximate teeth of *Meretrix*, *Caryatis*, etc., and by the two distant, thick, nearly equal teeth of the opposite valve, and also by the very small pallial sinus, the exterior ribs, etc.

The species is triangular, very ventricose, slightly contracted posteriorly, and between the ribs are close, minute, rugose, concentric lines umbonal slope terminal, angular; posterior slope depressed, lunule cordate. . . . *Venus Lamarckii* is a recent species of this genus.—[Conrad, 1870.]

Type.—*Cytherea staminea* Conrad. Plate XXVII, Figures 2, 4, 5, 9, 10, 11, 14. Upper Miocene of Maryland.

Species of this section in eastern America occur in the Oligocene and Miocene.

Section ARTENA Conrad

ANTIGONA (ANTIGONA) SHEPARDI (Dall)

Plate XXVII, Figure 7

Cytherea (Artena) Shepardi Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1278, pl. 55, fig. 16.

Antigona (Artena) Shepardi Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 148, pl. 25, fig. 4. Oligocene of Hillsboro Bay and Ballast Point, near Tampa, Florida; J. Shepard, Willcox, Post, and Dall.

Shell small, solid, subtrigonal, concentrically feebly waved, the waves more distinct near the beaks, the whole surface minutely, closely, concentrically striated; lunule narrow, lanceolate, defined by a sharp incised line, but feebly impressed; escutcheon narrow, striated, defined by a sharp radial keel beyond which the concentric waves do not pass; beaks small, pointed, prosogyrate; hinge normal, anterior lateral well developed; inner margins finely crenulate; pallial sinus small, triangular. Length 2.0, height 18.5, diameter 12.0 mm.

This species recalls *C. ucuttana* in its sculpture, but it has the *Chione*-shape of *Artena* and an almost rostrate posterior end. It is nearest to *C. glytococoncha*, but is less produced and wants the prominent ribbing.—[Dall, 1903.]

Holotype.—No. 109236. United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Hillsboro' Bay and Ballast Point, near Tampa, Florida. (Dall)

ANTIGONA (ANTIGONA) GLYTOCOCONCHA (Dall)

Plate XXVII, Figure 3

Cytherea staminea Heilprin, 1887, Trans. Wag. Inst. Sci., vol. I, p. 116, not of Conrad, 1839.

Cytherea (Artena) glytococoncha Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1277, pl. 55, fig. 24.

Antigona glytococoncha Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 148, pl. 25, fig. 1.

Oligocene of the silex beds at Ballast Point, Tampa Bay, Florida; Willcox, Burns, and Dall.

Shell variable in form from short to rather produced, trigonal with the posterior slope longer and the posterior end subrostrate; beaks (normally) pointed, moderately high, subcentral; lunule cordate, striated, impressed; anterior end below the lunule rounded; posterior slope nearly straight; a striated narrow area representing the

escutcheon is bounded by a rapidly widening radial ridge, in front of which is a shallow sulcus, the whole forming at its intersection with the posterior border a short rostrum; sculpture of heavy, slightly recurved concentric ribs, somewhat expanded on the rostrum and covered with a fine secondary close, concentric striation; base arcuate; hinge heavy, normal, the anterior lateral small but distinct; basal margin minutely crenulate; pallial sinus small, triangular. Dimensions of varying forms:

Elongate.....	length 22.0,	height 15.0,	diameter 11.0 mm.
Normal.....	length 26.5,	" 20.5,	" 13.0 mm.
Short.....	length 18.0,	" 16.5,	" 13.0 mm.

A few specimens show faint radial striation on the ventral side of the ribs nearest the base of the shell.

This interesting species has the general aspect of *Lirophora*, the minute sculpture and hinge of *Artena*. It is one of the more abundant species in the siliceous beds.—[Dall, 1903.]

Holotype.—No. 163337 United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Siliceous beds at Ballast Point, Tampa Bay, Florida. (Dall)

ANTIGONA (ANTIGONA) STAMINEA (Conrad)

Plate XXVII, Figures 2, 4, 5, 9, 10, 11, 14

Cytherea staminea Conrad, 1839, Fos. Med. Tert., back cover No. 1, pl. 21, fig. 1, not

Cytherea staminea Heilprin, 1887 = *A. glyptoconcha* Dall.

Artena staminea Conrad, 1870, Amer. Jour. Conch., vol. VI, p. 76; Whitfield, 1894, Mon., U. S. Geol. Sur., vol. 24, p. 71, pl. XIII, figs. 3-10.

Cytherea (Artena) staminea Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1279.

Cytherea (Antigona) staminea Glenn, 1904, Md. Geol. Sur., Mio., p. 314, pl. 76, figs. 6-8.

Shell subtriangular, thick, with about ten very prominent acute slightly reflected concentric ribs, with an intermediate carina, and crowded minute lamellar striæ; anterior tooth very small; margin crenulate. Length 1 inch. *Locality*, Calvert county, Md.—[Conrad, 1839.]

The shell of the young is flatter and the escutcheon smaller and less keeled. Eroded specimens will reveal an underlying structure of radiating ribs. The general characters are described under the discussion of the section.

Dimensions.—26 mm., length; 24 mm., height; 18 mm., thickness.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Calvert Miocene. Calvert county, Md. (type), Plum Point, Md. (Cornell Univ. Pal. Lab.); Chesapeake Beach, 3 miles south of Chesapeake Beach, Lyon's Creek, Reed's Creek, Church Hill, Md. (Md. Survey)

ANTIGONA (ANTIGONA) UNDULATA (Conrad)

Plate XXVII, Figure 1

Artena undulata Conrad, 1870, Amer. Jour. Conch., vol. VI, p. 76.

Cytherea (Artena) undulata Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1278; not *Cytherea undulata* Sowerby, 1855, Thes. Conch., vol. II, p. 618.

Subtriangular, profoundly ventricose; disk undulated slightly and having four thick concentric ribs and numerous prominent lines; inner margin crenulate.

Locality.—South Carolina. Cast, in the phosphate deposits. Miocene?

These casts are so well defined that the hinge and external character of the shell can readily be studied by making moulds in wax or plaster.

The ventricose disks, which are common in the hard or coherent phosphate rock, usually show a somewhat undulated surface. The generic character perfectly agrees

with that of the preceding. *Venus Lamarckii* is a recent species of this genus.—[Conrad, 1870.]

This species is figured from a guttapercha cast sent by Dr. Dall from the collection in the United States National Museum. Conrad did not figure the species. The cast studied did not reveal the hinge. Conrad and Dall determine the hinge as that of *Artena*. The adult form is very high and narrow in length. The ventral margin is thickened greatly and rolled back. The margin is crenulated. The outer surface seems to be ornamented only with heavy, concentric lines of growth. The eroded surface reveals an underlying layer of radiating growth.

Dimensions.—23 mm., height; 18 mm., length; 10 mm., semidiameter.

Occurrence.—Miocene. Phosphatic rock of the Ashley River, South Carolina.

Subgenus CLAUSINA Brown

Venusarius Dumeril, Froriep's translation, 1806, Zool. Analyt., p. 169, *Venus verrucosa* Linnæus non-Linnæan fide Dall.

Clausina Brown, 1827, Illus. Rec. Conch. Great Britain, 1 ed., expl. pls. XIX-XX *Venus verrucosa* Linnæus not *Clausina* Römer, 1857, Krit. Unters., p. 16 fide Dall.

Callista Fischer, 1887, Man. de Conch., p. 1084 not Mörch 1853.

Clausina Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 355; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1272; Cossmann and Peyrot, 1910, Actes Soc. Linn. Bordeaux, Tome LXIV, p. 326; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 73.

Shell large, ovate; lunule and escutcheon well defined; lunule impressed, longer than broad; escutcheon unequal, left side much broader without sculpture, except lines of growth; inner margins crenate; anterior lateral minute with the socket in the right valve obsolete; pallial sinus small, narrowly rounded; sculpture consists of prominent concentric ribs crossed by irregular radial ribs which may become nodular.

Genoholotype.—*Venus verrucosa* Linnæus. Plate XXVII, Figures 12, 13, 16, 17. Recent Mediterranean Sea, Canary Islands to Senegal.

This subgroup sensu stricto, under the present classification does not include any of the eastern American species.

Subgenus DOSINA Gray

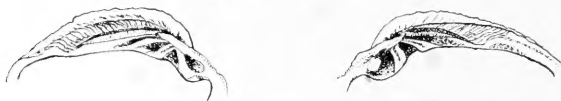


Fig. 19. Hinge of the type species of *Dosina*

Cytherea Bolten 1798, Mus. Boltenianum, p. 177, Type by elimination *Venus puerpera* L., *Venus rugosa* Gmelin and *Venus verrucosa* L.; not *Cytherea* Fabricius, 1795, Ent. Syst., IV, p. 143 *Diptera* or Oken, 1815, not *Cytherea* Lamarck, 1818.

Dosina, 1838, Gray, The Analyst, VIII, p. 308, type by elimination *D. reticulata* L.

Omphaloclathrum (Klein) Mörch, 1853, Cat. Yoldii, II, p. 25, *V. reticulata* L. type of Klein (fide Dall); Römer, 1867, Mal. Blatt., XIV, p. 29; Fischer, 1887, Man. de Conch, p. 1084.

Cytherca Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 354; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1271.

Omphaloclathrum Cossmann and Peyrot, 1910, Actes Soc. Linn., Bordeaux, Tome LXIV, p. 325.

Cytherca Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. IX, pt. 14, p. 246.

Periglypta Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. XI, p. 72.

Dosina (Gray)

Shell ovate; hinder hinge tooth entire; anterior lateral teeth small, rudimentary sphenal inflection small.

* Anterior lateral tooth in left valves large.

Dosina Lamarckii . . .

** Anterior lateral tooth small sometimes obliterated.

Dosina verrucosa L.

reticulata L.

puerpera Gmelin

Dosina Listeri, *V. puerpera* var., Linn. Sow. Gen. f. Ency. Meth. t. 278, f. 2.— [Gray, 1838.]

Shell large, very inequilateral; rotund; umbones low and full; lunule large, heart-shaped, longer than broad and bounded by a well impressed line; escutcheon well marked, long, narrow and bounded by a distinct line, unequal; the right side is larger and overlaps that of the left valve; interior margin crenate; pallial sinus large, broad and rounded; teeth consist of three large cardinals in each valve; the middle right, posterior right and middle left cardinals bifid; a very minute pustule anteriorly in the left valve, very close to the anterior cardinal; small dent for the reception of the pustule not seen in the right valve; ligament deep seated; shell reticulately sculptured with the concentric ribs slightly more prominent; the presence of the radiating ribs causes the concentric ribs to have a crenulated appearance.

Genolectotype.—*Venus reticulata* Linnæus. Plate XXVIII, Figures 4, 5, 7, 10. Recent, Red Sea, Indian Ocean, Philippine and Hawaiian Islands.

The subgenus occurs from the Oligocene thru to the present.

Since the change of *Antigona* Schumacher from subgeneric to generic rank and the subsequent change in the classification of the genus *Cytherca* Bolten, the classification of the various subgroups of the genus has become very difficult. The change in the name of the genus from *Cytherca* to *Antigona* has been discussed under the general discussion of *Antigona*.

A group of the *Antigonas* which present more than specific differences from *Antigona* s. s. and *Artena* are typified by *Venus verrucosa* Linnæus, *Venus reticulata* Linnæus or *Venus puerpera* Linnæus, *Venus plicata* Gmelin and *Venus rugosa* Gmelin respectively. The first generic name to be applied to any of those species was *Clausina* by Brown in 1827.

The first name for *V. puerpera* L. was *Cytherca* Bolten but that was preoccupied in Insects. The next name used was *Dosina* Gray in 1838. Dr. Dall wrote kindly that the authorities on nomenclature believe that the term *Dosina* can stand in spite of *Dosinia* Scopoli, 1777.¹ From that

suggestion I am presenting that which seems to be the most proper and clearest solution of the name for the shells like *Venus puerpera* Linnæus.

To make the matter of the use of the name *Dosina* clearer and the selection of *Venus reticulata* Linnæus as the type, I am quoting Gray's description of the genus in full.

The first group as divided by Gray is that of *D. Lamarekii* Gray = *A. Lamellaris* Schumacher which is *Antigona* s. s. The first species listed under the second group is *V. verrucosa* which had already been used for *Clausina* Brown, 1827. The next two species, *V. reticulata* and *V. puerpera* differ only specifically and so represent the same section, see figures 1, 3, 4, 5, 6, 7, 8, 9, 10, plate XXVIII. I am taking therefore *V. reticulata* as the type since it was listed first. *V. reticulata* was also the shell of Klein which would be the type of the next name used, that of *Omphaloclathrum* (Klein) Mörch 1853, if the name of Gray, *Dosina*, could not be used.

ANTIGONA (DOSINA) BERKEYI (Hubbard)

Plate XXX, Figures 1, 2

Cytherea Berkeyi Hubbard, 1920, N. Y. Acad. Sci., vol. III, pt. 2, p. 120, pl. XX, fig. 1, 2, 3.

Shell large, convex, very inequilateral; right valve with two posterior bifid and one anterior simple cardinal teeth; left valve with one middle bifid and anterior and posterior simple cardinals; left anterior papilliform small but distinct; adductor scars and pallial line strongly impressed, the latter granulose; pallial sinus large, broad, rounded, ascending; inner margins minutely crenulate; small auxiliary adductor scars, situated close to dorsal margin between beaks and principal anterior adductor scars, and nearer to the latter; obscure, irregular impressed line in interior of each valve, descends vertically from anterior end of beak and dies out midway between beak and vertical margin; surface of valves marked by numerous small radial ribs, somewhat wavy, evenly spaced, and fairly uniform in size, but becoming coarser over the posterior third of the shell, where they alternate in strength, with occasionally two or three small ribs alternating with one larger one; the whole cut by fine, low, sharp, raised concentric lamellae, evenly spaced near the beaks; but gradually increasing to 2, 3, or 4 mm. apart towards the ventral margin, where they suddenly become irregularly spaced or crowded, apparently a geronic character. These concentric lamellae are delicately fluted by the radials in the umbonal region. Minute growth lines cross the sculpture between the lamellae. The concentric sculpture is nowhere as prominent as the radial which increases in coarseness ventrally. The largest specimen, an internal mold collected by Dr. Berkey, measures in length 85 mm., height 68 mm., diameter 48 mm.

A large shell of the same type as *C. tarquinia* Dall and also resembles *C. lacerata* Hanley, a recent shell from China, and *C. antiqua* King, recent, from Chile and Patagonia. It differs from all of these in having the radial sculpture predominate over the concentric sculpture.

Localities.—318, 41, 78, 98 (Berkey). Bayamon and Ponce. (Lobeck).

Horizon.—Quebradillas limestone Ponce limestone.—[Hubbard, 1920.]

Holotype.—American Museum Natural History, New York, N. Y.

Occurrence.—Upper Oligocene. Porto Rico.

¹ Recommendation. Art. 36. "It is well to avoid the introduction of new generic names which differ from generic names already in use only in termination or in slight variation of spelling which might lead to confusion. But when once introduced, such names are not to be rejected on this account." Int. Rules Zool. Nomen., 1913.

ANTIGONA (DOSINA) TARQUINIA (Dall)

Plate XXIX, Figures 5, 9

Venus magnifica Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 249 (? var. *antillica*); Heilprin, 1886, Trans. Wag. Inst. Sci., vol. I, p. 116 not of Sowerby, 1853.

Venus tarquinia Dall, 1900, Trans. Wag. Inst. Sci., vol. III, p. 1194, pl. 38, figs. 2, 2a. *Cytherea tarquinia* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1274.

Antigona tarquinia Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 147, pl. 26, figs. 1, 2; Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 381, pl. 37, fig. 4 (var. *antillica*); Maury, 1920, N. Y. Acad. Sci., vol. III, pt. 1, p. 38; Pilsbry, 1921, Proc. Acad. Nat. Sci. Phil., vol. 73, p. 423 (? var. *antillica*); Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 240, pl. 30, fig. 10.

Oligocene of the Tampa silex beds at Ballast Point, Tampa Bay, Florida, Willcox and Dall; St. Domingo, Gabb.

Shell short-ovate, moderately convex, with low, inconspicuous beaks; sculptured with numerous, even, regular, thread-like radial riblets, separated by narrower interspaces, and with rather distant, slightly elevated, thin crenulate concentric lamellæ; lunule lanceolate, small and narrow; escutcheon defined by a deep sulcus, on the left valve almost linear, on the right wider but usually defective in the fossils; hinge normal, anterior lateral small and pustular; pallial sinus small, short, ascending, rounded in front; basal inner margin minutely crenulate. Length 49, height 41, diameter 26 mm.

This species, though similar in a general way to the young of the large species like *C. listeri* Gray, of which it is the precursor, never attains a large size, the measurements given being taken from a fully adult specimen. It is not uncommon at Ballast Point and is chiefly notable for the regularity of its radial sculpture and the thin and distant concentric lamellæ.—[Dall, 1903.]

Holotype.—No. 109233. United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Tampa silex beds at Ballast Point, Florida. (type). Rio Collazo near San Sebastian, Station 46, Station 63. Limestone near Aquada, Station 117. Porto Rico. (Maury. Amer. Mus. Nat. Hist.). Miocene. Gatun Stage. Zone E, Saury Creek, near Cahuita, Costa Rica. (Olsson. Cornell Univ. Pal. Lab.)

ANTIGONA (DOSINA) TARQUINIA ANTILICA Maury

Plate XXX, Figure 9

Venus magnifica Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 249, not of Sowerby, 1853.

Antigona tarquinia Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 217, pl. 37, fig. 4. *Antigona tarquinia antillica* Maury, 1920, N. Y. Acad. Sci., vol. III, pt. 1, p. 39.

? *Cytherea (Antigona) tarquinia* Pilsbry, 1921, Proc. Acad. Nat. Sci. Phil., vol. 73, p. 423.

Shell of medium size, roundly trigonal, with the posterior dorsal margin sloping rapidly; beaks low; surface sculptured with narrow, concentric ridges between which are conspicuous radial threads. Length of shell 36 mm., altitude 33 mm., semi-diameter 10 mm. Collected by my party at Zone H, Rio Cana, Santo Domingo, in 1916.

In describing this Dominican shell I noted that more material might prove it worthy of varietal rank.

The Porto Rican collection made by Dr. Reeds includes a single external mold in the limestone which strikingly resembles the Dominican valve. The umbro is broken away, but the mold agrees in its sloping posterior margin and in size and general aspect with the valve from the neighboring island.

This form appears to constitute a variety.

Locality.—Near Quebradillas, Station 130.—[Maury, 1920.]

The specimens collected by Mr. Olsson in Costa Rica from the Miocene seem to be more like the typical *tarquinia*.

Holotype.—Cornell University Paleontological Museum, Cornell Uni-

versity, Ithaca, N. Y. *Idiotype*.—American Museum of Natural History, New York City.

Occurrence.—Miocene. Zone H, Rio Cana at Caimito, Santo Domingo. (Maury coll., Cornell Univ. Pal. Lab.); near Quebradillas, Station 130, Porto Rico. (Maury. Amer. Mus. Nat. Hist.)

ANTIGONA (DOSINA) CÆSARINA (Dall)

Plate XXIX, Figures 1, 1a, 8

Cytherca cæsarina Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1275, pl. 53, fig. 5.

Oligocene of the Chipola marl, Calhoun County, Florida, Burns; and of White Beach near Osprey, Florida, Dall.

Shell ovate, inequilateral, the beaks being in or at the anterior fourth; lunule hardly impressed, concentrically striate, cordate, small; escutcheon long and narrow, wider in the right valve, bordered on each valve with a strong sulcus, the ligament hidden by the right-hand portion; sculpture of numerous narrow, elevated, thickened, concentric lamellæ, somewhat reflected and with narrower concentrically striate interspaces; these cross fine radial riblets, which are distinct and uniform on the young shell but rapidly become obsolete, though the broad tops of the concentric sculpture are crenulate or, more strictly speaking, articulated by the development on them of channels or sulci corresponding to those of the obsolete riblets; hinge strong, the larger cardinals deeply bifid, the anterior lateral small and pustular; pallial sinus small, ample, short, rounded in front, inner basal margins minutely crenulate. Length of figured valve 66, height 58, double diameter 40 mm.; length of an internal cast from White Beach 75, height 60, diameter 42 mm.

This fine species is quite distinct from any of the others; the radial sculpture, contrary to usage, is more distinct in the middle of the disk than on the distal portions of the shell. It much more nearly resembles the recent West American *C. multicostrata* Sowerby than any species now living on the Atlantic side, and adds in this way an interesting item to the list of those which indicate more or less clearly a tolerably close connection between the two faunas in Oligocene times.—[Dall, 1903.]

Holotype.—No. 114754. United States National Museum, Washington, D. C.

Occurrence.—Lower Miocene. Chipola near Calhoun County and White Beach near Osprey, Florida (Dall); Bailey's Ferry, Florida. (Cornell Univ. Pal. Lab.). Bowden Miocene. Bowden, Jamaica. (Hodson Coll., Cornell Univ. Pal. Lab.)

ANTIGONA (DOSINA) CÆSARINA ANGUILLANA Cooke

Plate XXIX, Figures 2, 3

Antigona (aff.) *cæsarina* Dall, 1916, Proc. U. S. Nat. Mus., vol. 51, No. 2162, p. 500 fide Cooke.

Antigona cæsarina var. *anguillana* Cooke, 1919, Carnegie Inst. Pub., No. 291, p. 150, pl. 16, figs. 4a, b.

Shell orbicular, convex; sculpture of numerous low, flat, narrow, radial riblets, separated by slightly wider interspaces and of elevated, reflexed, crenulated, concentric lamellæ; lunule broad, cordate, extended anteriorly; escutcheon long, wider in the right valve, defined on each valve by a deep sulcus.

Length of the specimen figured (broken at the posterior end), 53 mm.; height, 52 mm.; diameter of joined valves, 30.5 mm.

The radial riblets are more prominent in the variety *anguillana* than in the typical *A. cæsarina* and the lunule is more extended in front. Perfect specimens might show other distinguishing characters.

Antigona anguillana resembles *A. tarquinia* (Dall) from the Tampa "silex" bed, from which it may readily be distinguished by its more orbicular shape, greater inflation of the umbones, closer concentric lamellæ, and much broader, cordate lunule. Its sculpture as well as can be determined from the specimens at hand is like that

of the Recent and Pleistocene *A. listeri* (Gray), from which it differs in the greater inflation of the posterior dorsal slopes, which, in the latter species, are flat or even slightly concave. A very closely related, perhaps identical, form from the base of the Chattahoochee formation near Bainbridge, Georgia, has been listed as *A. (aff.) cesarina* by Dall.

Localities.—Crocus Bay, Anguilla, station 6893; Blizzard Mill, Antigua, station 6874; Vaughan. A fragment with similar sculpture is from the chert interbedded with tuffs at St. Johns, Antigua, station 6855. The type of *A. cesarina* is from the Chipola Miocene at station 2212, Ten Mile Creek, Calhoun County, Florida.

Geologic Horizon.—Oligocene.

Type of *A. cesarina* Dall.—U. S. Nat. Mus. No. 114754.

Type of variety of *anguillana* Cooke.—U. S. Nat. Mus. 167192.—[Cooke, 1919.]

Dr. Dall found affinities between specimens from Oligocene localities in Georgia with *cesarina* but the poor preservation of the specimens did not allow exact identifications. The localities he listed are as follows:

Station 3381, at the base of the bluff at Little Horseshoe Bend, on the east bank of the Flint River, 4 miles below Bainbridge, Decatur County, Georgia, just below the mouth of Blue (or Russell) Spring branch; T. W. Vaughan, 1900. Also at station 7074, on the west bank of the Flint River, 7 miles southeast of Bainbridge at Hale landing, station 7078, near lower end of Smith's Reach, about a quarter of a mile below Hale landing; station 7079, at Mascot Point, near station 3381; and at station 7096 on the west bank of Flint River at Red Bluff, 7 miles above Bainbridge; Vaughan, Cooke, and Mansfield, 1914. U. S. Nat. Mus. Cat. No. 166772.

ANTIGONA (DOSINA) DOMINICÁ n. sp.

Plate XXIX, Figures 4, 7; Plate XXXI, Figure 15

Antigona multicostrata Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 239, pl. 30, fig. 1 not *A. multicostrata* Sowerby, 1835.

Shell large, ponderous; beaks low and full; dorsal margin arcuate; posterior margin nearly straight; shell very inequilateral; a concave area extends from the umbones to the posterior, ventral margin; the lunule is large and marked by a deeply incised line; the teeth are very heavy with hardly a noticeable indentation anteriorly for the receipt of the minute pustule of the left valve; teeth typical of the subgenus; pallial sinus, rounded, broad, typical of the subgenus; the ornamentation of the shell is strong and composed of thick, flat-topped, concentric ribs with very inconspicuous, underlying, radiating ribs; the concentric ribs are thin and sharp on the umbonal region but become from 1 to 2 mm. in thickness on the central and ventral portions; the interspaces are broad and irregular, usually one and one-half times the width of the concentric ribs; the concentric ribs become more lamellose and crowded posteriorly; the radiating under-structure which is conspicuous on the other West Indian species of the subgenus *Dosina* of *Antigona* has become obsolete in this species and does not cause the greater portion of the concentric ribs to become crenulated. The radiating ribs appear as fine, ripple-like lines. They are most prominent on the umbonal region and crenulate delicately the concentric ribs.

An examination and comparison of the specimen of this species from Santo Domingo with the specimen identified as *A. multicostrata* Sowerby by Olsson from Costa Rica show the identity of the two forms. The

Costa Rican specimen differs markedly from *multicostata* of the recent western coast fauna in the character of the ribs, as well as in the shape. The ribs are square-topped, erect and separated by interspaces equal to or twice the width of the rib. This is one of the distinctive characters of *dominica*. The concentric ribs in *multicostata* are much narrower, crowded, and rolled over until the interspace is hidden practically except on the umbonal region. This is a constant character, as shown by specimens from different collections. The dorsal line of *multicostata* is slightly rounded, the dorsal line of *dominica* in both the Santo Dominican specimen and the Costa Rican is more rounded with a slightly angulated point in the mid region of the shell. The specimen of *dominica* from Santo Domingo is more mature than the one from Costa Rica, for the concentric ribs are smoother and show fewer crenulations. *Multicostata* has the concentric ribs heavily crenulated, plate XXX, figure 11.

Dimensions.—105 + mm., length; 97 mm., approx. height; 33 mm., semidiameter.

Holotype and Paratype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Middle Miocene. Zone F, Rio Gurabo, Santo Domingo. Specimen from the material of the expedition of Dr. C. J. Maury to Santo Domingo in 1916; Water Cay, Costa Rica. (Olsson Coll. Cornell Univ. Pal. Lab.)

ANTIGONA (DOSINA) WILCOXI (Dall)

Plate XXIX, Figure 6

Cytherea Wilcoxi Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1276, pl. 53, fig. 3.

Pliocene marl of the Caloosahatchie River, near the site of old Fort Thompson; Willcox and Dall.

Shell large, capacious, with well-rounded, somewhat anteriorly twisted beaks; a cordate lunule unequally divided and larger in the right valve; escutcheon long, bordered by a wide, shallow sulcus and more emphatic in the left valve; sculpture of very numerous concentric lamellæ widened and flattened at the top so that nearly (and sometimes quite) join over the interspaces, especially towards the base; these lamellæ, though sharper distally, do not rise into wide, thin lamina, as in the well-developed individuals of *C. listeri*, but remain of nearly the same height over the whole shell; near the beaks fine radial striation is notable in the interspaces, faintly crenulating the concentric lamellæ but becoming almost wholly obsolete as the shell approaches maturity; hinge solid, the two posterior cardinals in each valve deeply bifid; the anterior lateral reduced to a low pustule; inner margins minutely crenulate; adductor scars very large; pallial sinus ample, linguiform, rising above a line joining the bases of the scars. Length 102, height 87, diameter 60 mm.

Shell somewhat resembling the recent *C. listeri* Gray of the Florida Keys, but differing from it by larger size, much closer and more uniform concentric lamellation, proportionally larger lunule and escutcheon, heavier hinge, proportionately larger adductor scars, and more ascending pallial sinus.

I take great pleasure in naming this splendid shell after Mr. Joseph Willcox, to whom we are indebted for so much in connection with the explorations of the Pliocene and Oligocene of Florida, and for the discovery of this and many other of their finest fossil remains.—[Dall, 1903.]

Holotype.—No. 109234. United States National Museum, Washington, D. C.

ANTIGONA (DOSINA) LISTERI (Gray)

Plate XXVIII, Figures 2, 11

Dosina Listeri Gray, 1838, The Analyst, VIII, No. 24, p. 308.

Venus Listeri Deshayes, 1853, Cat. Conch. Biv. Shells Brit. Mus., pt. 1, p. 106, distribution erroneous.

Venus Listeri Reeve, 1863, Conch. Icon., Mon. *Venus*, pl. V, fig. 14.

Venus (Chione) Listeri Römer, 1867, Mal. Blätt., 14 Bd. in part.

Venus crispata Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54, not of Deshayes, 1853.

Cytherea listeri Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 372; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 71.

Shell large, subquadrate, inequilateral; beaks low, full; dorsal margin nearly straight, becoming bowed or oblique with age; posterior margin slightly truncate; a broad, concave area extends from the umbones to the posterior, ventral margin; lunule heart-shaped, deeply incised; escutcheon pronounced, causing the posterior, dorsal margin to be wrinkled and the line of the escutcheon to extend beyond the dorsal margin, the latter projecting as a flare forward and above; hinge typical; pallial sinus ample, rounded, sometimes with a slight point; exterior ornamented with low, radiating ribs, the interspaces on the umbonal region $\frac{1}{3}$ to $\frac{1}{2}$ the width of the ribs, increasing in size toward the ventral region where they are nearly equal in width to the ribs; the radiating ribs are crossed by prominent, concentric laminae which increase in height on the posterior end; the radiating ribs cause the concentric ridges to have a crenulated appearance.

Coloration is whitish to yellowish brown in irregular blotches.

Gray did not describe this species but merely listed it under *Dosina*.

For the original description of that group see under the subgenus *Dosina* of the genus *Antigona*.

Dimensions.—55 mm., length; 46 mm., height; 16 mm., semidiameter.

Occurrence.—Recent. Lake Worth, Florida; Florida Keys, thru the Antilles, as far as Tortola and Virgin Island (Dall '92); Monti Cristi, Santo Domingo. (Cornell Univ. Pal. Lab.)

Subgenus CIRCOMPHALUS Mörch

Circumphalus (sp.) Herrmannsen, 1847, Index Gen. Mal., I, p. 237, fide Dall; Mörch, 1853, Cat. Yoldi, p. 23; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 422.

Anaitis Römer, 1857, Krit. Unters., p. 16, fide Jukes-Browne, not of Duponchiel, 1829, Lepidoptera.

Chione Römer, 1857, Krit. Unters., p. 16 not of Mörch, 1853, fide Dall.

Circumphalus Sacco, 1900, I. Moll. Terz. Piem., pt. XXVIII, selected *Venus plicata* as type, fide Jukes-Browne; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 356; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1273; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 73.

Shell large, compressed; lunule and escutcheon well defined; lunule unequal, irregular and deeply impressed; escutcheon large, unequal, the left side being larger, without sculpture except the lines of growth; inner margins finely crenate; anterior lateral very small with the indentation to

receive it in the right valve minute; pallial sinus medium, pointed, sculpture consists of prominent, thin, concentric lamellæ which become expanded posteriorly.

Genolectotype.—*Venus plicata* Gmelin (not *V. plicata* Barbut, 1788). Plate XXX, Figures 4, 8, 10, 12. Recent. Senegal, Africa.

The subgenus in eastern America is represented by the species of the section *Ventricola*. They range from the Oligocene thru Recent.

Section VENTRICOLA Römer

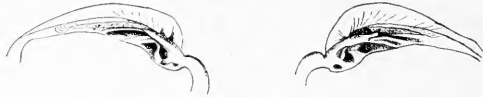


Fig. 20. Hinge of the type species of *Ventricola*

Ventricola Römer, 1857, Krit. Unt., Moll. Venus; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 176; Fischer, 1887, Man. de Conch., p. 1084; Sacco, 1900, Moll. terz. Piem. e Lig., p. 27; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 355; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1272.

Clausina Cossmann and Peyrot, 1910, Actes Soc. Linn. Bordeaux, vol. LXIV, p. 326 in part.

Ventricola Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 73.

Shell large, very convex; beaks large and full; lunule deeply impressed, large, cordate, broader than long; escutcheon present only on the left side, broad; inner margin crenulate; pallial sinus small, rounded; hinge of *Antigona*, with the right, middle cardinal very robust; sculpture consists of heavy, evenly spaced, concentric lamellæ with fine, intervening, concentric threads.

Type.—*Venus rugosa* Gmelin = *V. rigida* Dillwyn. Plate XXX, Figures 3, 7; Plate XXXI, Figures 13, 14. Recent Atlantic Ocean, Florida Keys to Rio Janeiro, thru the West Indies; Gulf of California, Pacific Ocean.

Species of this section occur from the Oligocene to the present time.

Section VENTRICOLA Römer

ANTIGONA (CIRCOMPHALUS) UCUTTANA (Dall)

Plate XXX, Figure 5

Cytherea (Ventricola) ucuttana Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1276, pl. 57, fig. 14.

Red Bluff horizon of the lower Oligocene of Mississippi on Ucutta Creek, Clarke County; Carson's Creek, and at Red Bluff, Wayne County; Johnson, Burns, and others.

Shell small, moderately convex, rotund, with low, inconspicuous, prosogyrate beaks; lunule small, slightly impressed, bounded by an impressed line; escutcheon very narrow, defined by a radial ridge sharper in the left valve; surface sculptured with numerous low, even, gently rounded, wavelike concentric ridges and by fine, close, regular, low, concentric threads which cover the whole surface; hinge solid, normal, well developed, the anterior lateral distinct; inner margins, except the posterior margin, finely crenulate; pallial sinus very small, triangular outer edges of the adductor scars usually a little raised. Length 19.0, height 16.5, diameter 8.0 mm.

This neat little shell grows to a somewhat larger size, as fragments indicating

individuals one-third larger than the measurements given are in the collection. It is from this stem that the upper Oligocene and Miocene *Artena* seems to be derived. —[Dall, 1903.]

Holotype.—No. 136468. United States National Museum, Washington, D. C.

ANTIGONA (CIRCOMPHALUS) HARRISIANA Olsson

Plate XXX, Figure 6; Plate XXXI, Figures 1, 3

Antigona Harrisiana Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 241, pl. 30, fig. 3.

Shell small, convex and nearly circular in outline; umbos full with the beaks situated a short distance in front of the middle; lunule small but broadly cordate and sculptured with the continuation of the concentric ribs and lamellæ; escutcheon lanceolate, bordered by an angled ridge from the shell disk; disk sculptured with about 28 even, concentric ribs which appear as close undulations of the shell surface; the ribs and interspaces are in addition sculptured with fine lamellæ-like threads, each finely crenulated or radially striated; these lamellæ vary in size, those of the interspaces or troughs between the ribs are fine and 5 in number, with 2 large ones forming the tops of the ribs themselves, so that the ribs appear as if mesially divided; the radially striated character of the ribs and lamellæ is much stronger on the anterior and posterior submargins; interior of the shell deep but concealed by matrix in the type specimens.

Length 21.5, height 19.5, diameter 6.25 mm. (right valve).

This elegant species occurs in the coralline phase of the Gatun formation in Costa Rica. Its relations are with the *A. Blandiana* Guppy and the recent *A. strigillina* Dall, but it differs from both in its more elegant sculpture. This sculpture consists of close, regular, wave-like undulations or ribs, the crests of which carry 2, low laminae, the troughs or interspaces, 5 or 6 finer threads. These fine thread-like laminae are delicately etched with fine radial striations.

It is named for Professor G. D. Harris of the Paleontological Department of Cornell University.

Gatun Stage: Port Limon.—[Olsson, 1922.]

The sculpture of the type specimen of this species is preserved perfectly. Very rarely is the extreme outer surface of the sculpture of the related species *A. blandiana*, preserved so entirely. It is difficult therefore to compare the fine details of sculpture. In *A. harrisiana* the number of fine, interstitial threads remains about uniform over the whole surface. In *A. blandiana* a greater number of the intervening, concentric threads occurs over the umbonal region than over the lower portion. On the umbonal region there are 3 or 4 more threads than on *A. harrisiana*. *A. harrisiana* is quadrate in form. The adult *blandiana* is not. The posterior end in that species is narrower, and more pointed. Even in the young where the form is more quadrate, the dorso-ventral line of the posterior end is rounded. In *A. harrisiana* that line is straight.

A specimen from Bailey's Ferry, Fla., which is much larger than the type of Mr. Olsson is figured. It has been identified as *A. harrisiana*.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Chipola Miocene. Bailey's Ferry, Fla.; Gatun Miocene. Port Limon, Costa Rica. (Type). (Cornell Univ. Pal. Lab.)

ANTIGONA (CIRCOMPHALUS) BLANDIANA (Guppy)

Plate XXXI, Figures 2, 3a, 6, 7, 9, 10, 11, 12

Venus blandiana Guppy, 1873, Proc. Sci. Assoc. Trin., vol. 3, p. 85, Harris Reprint, 1921, Bull. Amer. Pal., vol. 8, No. 35, p. 217.

- Venus Blandiana* Guppy, 1874, Geol. Mag., n. s., Decade II, vol. 1, pp. 436, 442, pl. XVII, fig. 8; Guppy, 1876, Quart. Jour. Geol. Soc. Lond., vol. 32, p. 530.
- Cytherea (Ventricola) Blandiana* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1277.
- Antigona (Ventricola) Blandiana* Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 217, pl. 37, fig. 5; Olsson, 1922, l. c., No. 9, No. 39, p. 241, pl. 30, figs. 5, 6; Woodring, 1925, Carnegie Inst. Wash. Pub., No. 366, p. 155, pl. 21, figs. 5 to 9.
- Cytherea (Ventricola) Blandiana* Pilsbry, 1921, Proc. Acad. Nat. Sci. Phil., vol. 73, p. 423.

Suborbicular, subequilateral, moderately convex, adorned with numerous equidistant concentric lamellæ, between each of which there are about seven or eight concentric striæ; somewhat angulate in front and subtruncate behind; margins crenate. Lunule smooth, impressed. Posterior dorsal area not defined, striate, continuously with the lamellæ of the disk. Umbones small. Cardinal teeth two under the lunule; lateral tooth one, nearly halfway down the posterior slope.

Referred to hitherto in papers on West Indian fossils as *Venus rugosa*, var., to young specimens of which species it bears a somewhat close resemblance. The Jamaican examples are smaller than those from Haiti. A specimen in the British Museum from the latter place is labelled *V. circinnaria*, but it is not *Cytherea circinnata*, nor even nearly allied to it.

When describing *Cytherea juncea* from Cumana, I omitted to point out the close kinship between that fossil and *C. circinnata*.—[Guppy, 1873.]

The concentric lamellæ remain fairly widespread as they approach the ventral margin and do not thicken and overturn dorsally to the exclusion of the striæ as do the ribs in *V. rugosa*. The number of fine, concentric striæ between the lamellæ varies on different parts of the shell. Specimens from Bowden show a range in number from three to eight, the larger number occurring usually between the lamellæ on the umbonal slope and on young specimens. Four is the average number which occurs on the middle and lower portions of the shell, although the striæ may crowd along the ventral margin. The distance between the concentric lamellæ is also wider on the umbonal slope and on young shells. The adult forms are less rounded. The young shells up to 25 mm. in length are quadrate in form. The specimens in the Maury collection from Santo Domingo show practically the same characters as those from Bowden. The shells from Costa Rica collected by A. Olsson have the concentric lamellæ spread strikingly wider and the number of the intervening striæ is increased. The number varies from nine to twelve.

The type material in the U. S. Nat. Mus. includes a specimen from Haiti and one from Jamaica. The Jamaican shell is more rounded and less truncated posteriorly than the specimen from Haiti.

Dimensions.—No. 115548. Holotype, Jamaica, 25 mm., length; 21 mm., height; 9 mm., semidiameter. No. 115547. Guppy specimen, Haiti, 39 mm., length; 32 mm., height; 14 mm., semidiameter.

The largest specimen from Bowden measures 50 mm. in length and about 43 mm. in height. The largest from Santo Domingo measures 43 mm., length (Pilsbry). 42 mm., length, 36 mm., width and 25 mm., in height, are measurements of specimens from the Maury collection. Those from Costa Rica as measured by Mr. Olsson range smaller, length 30; 24 mm.; height 24; 23 mm.; diameter 9; 8.5 mm. respectively.

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—LOWER MIOCENE. White Beach near Osprey, and Chippola River, Calhoun County, Florida. (Dall). MIDDLE and UPPER MIOCENE. Bowden, Jamaica (Guppy), (Hodson Coll., Olsson Coll., Cornell Univ. Pal. Lab.); Bluff I, Cercado de Mao, Zones A, B, F, Rio Gurabo, at Los Quemados; Quayubin to Mao Road, Rio Cana, Santo Domingo. (Maury Coll., Cornell Univ. Pal. Lab.); Comandre Creek near Cahuita, and Port Limon, Costa Rica. (Olsson Coll., Cornell Univ. Pal. Lab.).

ANTIGONA (CIRCOMPHALUS) RIGIDA (Dillwyn)

Plate XXX, Figures 3, 7; Plate XXXI, Figures 13, 14

- Venus rugosa* Gmelin, 1792, Systema Naturæ, Tome 1, pt. 6, p. 3276 not *Venus rugosa* Linnæus, 1777 fide Dall.
Venus rigida Dillwyn, 1817, Descript. Cat.
Venus rugosa Lamarck, 1818, Hist. des. An. sans Vert., Tome V, p. 587; not Gould, 1850, Proc. Bost. Soc. Nat. Hist., vol. III, p. 177; Gould, 1850, U. S. Expl. Exp. Moll., p. 420, f. 532.
Venus rugosa Deshayes, 1853, Cat. Conch. Brit., pt. 1, p. 102; Reeve, 1863, Conch. Icon., Mon. *Venus*, pl. VII, f. 23.
Venus rugosa Arango, 1878, Cont. fauna Mal., Cuba, p. 251; Gabb, 1881, Acad. Nat. Sci. Phil. Jour., 2nd ser., vol. 8; Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54 in part.
Venus rugosa Guppy, 1894, Proc. Victorian Inst., p. 146.
Cytherea (Ventricola) rigida Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 372, 390. Atlantic and Pacific.
Venus rugosa Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 240, pl. 30, fig. 4.
V. testæ gibbæ striis transversis membranaceis arcuatis, ano cordato, margine crenulato. Mant. 2, p. 545.
Chem. Conch. 6, t. 29, f. 303.
Habitat rarior in India, testa crassa ultra 2 pollices longa et lata, ex cinero alba, maculis oblongis spadicis varia; valva oblonga subimpressa, in sinistra valva glabra fusca alboque varia; rima oblonga ampla hiante.—[Gmelin, 1791.]

Shell large, oval-quadrate; umbones large, full; numerous, prominent, concentric ribs, recurved with fine intervening striæ; when the concentric ribs are worn or broken away, fine, radiating threads are visible. The concentric ridges on the right valve extend over the area of the escutcheon to the ligamental attachment, while on the left valve the ribs end at the escutcheon and continue to the ligamental area only as lines; the lunule is heart-shaped, deeply impressed and it may or may not be equilateral; color of brownish white, spotted with dark brown blotches. The area of the escutcheon on the left valve has reddish brown bars or spots.

Dimensions.—71 mm., length; 62 mm., height; 51 mm., thickness.

Occurrence.—Upper Gatun Miocene. 2 miles west of Limon, Costa Rica. (Olsson Coll. Cornell Univ. Pal. Lab.) Recent. Florida Keys, including the West Indies south to Rio de Janeiro. Gulf of California (Dall); Santo Domingo. (Maury Coll. Cornell Univ. Pal. Lab.)

ANTIGONA (CIRCOMPHALUS) RUGATINA (Heilprin)

Plate XXXI, Figure 4

- Venus rugatina* Heilprin, 1887, Trans. Wag. Inst., vol. I, p. 92, pl. 11, fig. 24.
Venus rugosa Dall var. *rugatina* Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54.

Venus rugatina Dall and Simpson, 1901, Bull. U. S. Fish Com., vol. I, p. 483.
Cytherea (Ventricola) rugatina Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 372; Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1277.
Antigona (Ventricola) rugatina Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 71.
 Shell ventricose, subcircular, appearing on its inner aspect much like *Isocardia*, with a prominent anterior projection, corresponding to the lower boundary of the deeply-impressed lunule; hinge-line in each valve with two prominent, transversely projecting, cardinal teeth, and a third (posterior) oblique one, which, in the left valve, is separated from the median tooth by a deep, obliquely directed, dental sulcus; the anterior tooth in the left valve deeply grooved above, and preceded by a d-natal papilla; posterior lateral tooth not prominent; surface covered with very numerous, sharply-defined, imbricated lines of growth, which at nearly regular intervals are marked off by lines of special prominence, immediately below which the normal lines are least closely crowded; number of prominent lines twenty-five and upward; number of normal lines between these from six to eight; border crenulated, the crenulation extending over the lunule.

Length 2.5 inches; height 2.1 inches.

Abundant in the banks below Fort Thompson.

Closely resembles the recent *Venus rugosa*, but may be readily distinguished by the greater interval separating the more prominent lines.—[Heilprin, 1887.]

This species differs from *A. rigida*, as Heilprin points out, in the concentric ribs being spaced much wider.

Holotype.—No. 923. Wagner Free Institute of Science, Philadelphia, Pa.

Occurrence.—Pliocene. Caloosahatchie, Fla. (Type), Shell Creek, Florida. Recent. Cape Hatteras, North Carolina, Gulf of Mexico and southeast to Porto Rico, 26 to 85 fathoms. (Dall)

ANTIGONA (CIRCOMPHALUS) CALLIMORPHA (Dall)

Plate XXXI Figure 5

Venus pilula Dall, 1886, Bull. Mus. Comp. Zool., Har. Col., vol. XII, p. 276; Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54, ed. 1903, pl. XC, fig. 5; not *Venus pilula* Reeve, 1863, Conch. Icon., Mon. *Venus*, pl. XV, fig. 58.

Cytherea (Ventricola) callimorpha Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 372, 382, pl. 13, fig. 5; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 71.

Shell small, globose, covered with a thin yellowish periostracum over a white shell with a salmon-colored flush internally; beaks full, prominent, the apices turned forward; lunule cordate, circumscribed, evenly striated; surface with about 27 primary concentric lamellæ having a T-rail section, to flat interspaces having 6-8 extremely fine low concentric threads, crossed by fine radial striation; escutcheon limited by an obscure ridge, ending in a subangular projection of the margin; in front of the ridge is a wide shallow radial depression; hinge well developed; posterior right cardinal long, distant from the others and bifid; middle right cardinal deeply bifid; anterior lateral small, papilliform; interior surface polished, with a salmon-colored flush behind the beaks; pallial sinus small, sharply angular, ascending; inner margins finely crenulate. Length 16; height 14.5; diameter 12 mm.

Station 272, in 76 fathoms, at Barbados, West Indies, United States Coast Survey steamer *Blake*. Cat. No. 64292 U. S. N. M.

The peculiar form of the primary lamellæ renders them very liable to fracture, and if broken off they leave no visible trace, and the surface appears uniformly concentrically threaded, since the basal attachment of the primaries is no wider than the normal width of the secondary threads. [p.382.]

This species was identified doubtfully with Reeve's *Venus pilula* in the *Blake* report, but I am now confident that it is distinct. The sculpture resembles that of *C. strigillina*, but is less dense and prominent.—[Dall, p. 373, 1902.]

This species resembles *A. strigillina* Dall in shape but it is more quadrate than that species. The primary, concentric ribs are wider in

A. callimorpha than in *A. strigillina*. The secondary, concentric striæ in this species are very minute.

Holotype.—No. 64292. United States National Museum, Washington, D. C.

ANTIGONA (CIRCOMPALLUS) STRIGILLINA (Dall)

Plate XXXI, Figure 8

Cytherea (Ventricola) strigillina Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 372, 381, pl. 12, fig. 5; Dall, 1903, ed., Bull. U. S. Nat. Mus. 37, pl. 89, fig. 5.

Shell rotund, inflated, grayish white; beaks prominent, their apices anteriorly directed; lunule deeply impressed, cordate, striated; disk covered with low, uniform, slightly recurved thin primary concentric lamellæ, about 1 millimeter apart, the interspaces with much finer and smaller secondary lamellæ; there is no defined esutcheon, but the posterior dorsal slope, as usual, is less prominently lamellose; hinge strong, with large teeth, the anterior lateral large, and the posterior cardinal on the right valve bifid; pallial sinus very small, wide, and angular; internal margins of the valves finely crenulate. Length 45; height 39; diameter 32 mm.

Type locality.—United States Fish Commission station 2317 in 45 fathoms, cor.-l. off Key West, bottom temperature 75° F. Cat. No. 95668, U. S. N. M.—[p. 381.]

Shell entirely white, much smaller than the preceding species, (*A. ruçatina* Heilprin) and with very much finer, though similar sculpture. The lunule is proportionately larger.—[Dall, 1902, p. 372.]

Occurrence.—Living from Key West, Florida to Barbados, and 90 miles southwest of Cape San Roque, Brazil, in 20 to 100 fathoms. (Dall)

Genus MARCIA H. and A. Adams

Marcia H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 423, not of Chenu, 1862, or Tryon, 1884; Fischer, 1887, Man. de Conchyl., p. 1086; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 360; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1318; Jukes-Browne, 1909, Proc. Mal. Soc. Lond., vol. 8, p. 233; Cossmann and Peyrot, 1911, Actes Soc. Linn. Bordeaux, Tome LXIV, p. 318; Jukes-Browne, 1914, l. c., vol. 11, p. 87.

Shell with the surface of the valves smooth.—[H. and A. Adams, 1857.]

Shell large, subquadrate; three cardinals in the left valve and four cardinals in the right valve, the posterior right cardinal is very thin, the two middle, right cardinals are bifid; the pallial sinus is medium in size and pointed; the lunule is large, sunken and is bounded by an incised line; the surface of the shell is concentrically lamellose; inner margins smooth. This description was written from specimens in the U. S. Nat. Mus.

Genolectotype.—*Venus exalbida* (Chemn.) Dillwyn. Living. Shores of Argentine, Patagonia and Straits of Magellan.

Subgenus KATELYSIA Römer

Katelysia Römer, 1857, Krit. Unters. Moll., *Venus*, p. 16; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 177.

Katelysia Fischer, 1887, Man. de Conchyl., p. 1086.

Katelysia Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 360; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1318; Jukes-Browne, 1909, Proc. Mal. Soc. Lond., vol. 8, pp. 240, 245; Jukes-Browne, 1914, *ibid*, vol. 11, p. 88.

Shell medium, inequilateral, elongate; umbones small; three cardinals in each valve; teeth small; middle and posterior right cardinals bifid;

middle and anterior left cardinals slightly bifid; lunule narrow, elongate and circumscribed; inner margins smooth; pallial sinus medium and rounded in front; no escutcheon; exterior with prominent, concentric ridges.

Genolectotype.—*Venus scalarina* Lamarck. Plate XXVI, Figures 9, 10, 12. Living. Australia.

This subgenus appears to occur in the Eocene of Trinidad.

MARCIA (KATELYSIA) PARIENSIS Van Winkle

Plate XXVI, Figures 5, 7

Marcia pariensis Van Winkle, 1919, Bull. Amer. Pal., vol. 8, No. 33, p. 20, pl. 3, figs. 4, 5.

Size and shape of shell as indicated by the figures; a slight umbonal ridge extends from the beaks to the posterior, ventral margin; surface ornamented with prominent, concentric lamellæ which are much more pronounced and heavier on the anterior and central portion of the valve, decreasing in size from the posterior umbonal ridge backward. Longitude of shell 16 mm.; altitude 13 mm.

Type and specimens figured.—Pal. Museum, Cornell Univ.

Geologic horizon.—Midway Eocene.

Locality.—"Bed No. 2, Soldado Rock, Gulf of Paria, Trinidad."

Collected by A. C. Veatch in 1912, then of the General Asphalt Company of Philadelphia.—[Van Winkle, 1919.]

Section TEXTIVENUS Cossmann

Textivenus Cossmann, 1886, Cat. Illus. Cog. Fos. Env., Paris, I, p. 97; Fischer, 1887, Man. de Conchyl., p. 1087; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 361; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1321; Cossmann and Peyrot, 1911, Actes Soc. Linn. Bordeaux, Tome LXIV, p. 320; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 84.

Shell small, ovate; teeth and pallial sinus as of subgenus; inner margins smooth; lunule medium, impressed and bounded by an incised line; surface sculptured with fine, reticulate, radiating and zigzag threads which cut the surface into fine punctations.

Type.—*Venus texta* Lamarck. Plate XXVI, Figures 8, 11. Eocene of Paris Basin.

The section is represented in the eastern American Eocene.

Section TEXTIVENUS Cossmann

MARCIA (KATELYSIA) RETISCVLPTA (Meyer)

Plate XXVI, Figures 1, 2, 3, 4

Venus reticulata Meyer, 1886, Geol. Surv. Ala., vol. I, p. 84, pl. 1, figs. 27, 27a.

Marcia reticulata Harris, 1919, Amer. Pal. Bull., vol. 6, No. 31, p. 153, pl. 47, figs. 16-19.

Rhombically circular; convex; covered with broad, flat, and somewhat irregular concentric lines, crossed by similar radiating ones; the sculpture indistinct near the umbo; an impressed line separates a long lunule; pallial sinus large; margin entire.

Locality.—Claiborne, Ala.

The sculpture makes the surface appear as if reticulated with small rounded holes, especially in worn shells; the figured specimen shows the complete hinge, otherwise it is not the largest or best sculptured one.—[Meyer, 1886.]

This small species shows typical *Textivenus* characters. The sculpture is more radiating and divaricating than shown in Meyer's illustra-

tion. The specimens are slightly worn so that the real sharpness of the sculpture is not visible.

Dimensions.—6 mm., length; 5 mm., height; 4 mm., thickness.

Occurrence.—Claiborne stage. Eocene. Claiborne sand, at Claiborne Bluff, Ala.

Subgenus MERCIMONIA Dall

Mercenaria Cossmann, 1886, Cat. Illus. Coq. Env., Paris, I, p. 94 not of Schumacher, 1817, = *Venus*.

Mercimonia Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 361; Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1320; Jukes-Browne, 1908, Proc. Mal. Soc. Lond., vol. 8, p. 169; Jukes-Browne, 1914, *ibid*, vol. 11, p. 84.

Shell oval; tumid; prominent umbones; lunule large and defined feebly by a faint line; no escutcheon; three teeth in each valve; right posterior cardinal bifid; inner margins smooth; pallial sinus nearly obsolete in type, large or medium in species listed under the group; exterior with concentric striæ.

Genoholotype.—*Venus bernayi* Cossmann. Plate XXIV, Figures 6, 15. Eocene of the Paris Basin.

The above description of the subgenus has been taken from the descriptions of Dall and Jukes-Browne and from the figures as given by Cossmann in the *Iconographie des Coquilles Fossiles de L'Eocene*. The type of the group is *Venus bernayi* which is stated to have only a very small pallial sinus. Several species from the Paris Eocene which have a well developed pallial sinus are listed under the subgenus by the European scholars of the forms. We do not separate those forms from the subgenus since the data would be from the literature only. Hence we include the American species under the subgenus from its great similarity with the sinuated species of the Paris Basin. Dr. Dall (1902) states that the species with the pallial sinus might be referred to *Venerella* Cossmann. *Venerella* is stated not to have a bifid, right posterior cardinal. (Jukes-Browne 1908, 1914). The lack of that character is seen also in the illustration of *V. bernayi* by Cossmann in the *Iconographie*.

MARCIA (MERCIMONIA) MERCENAROIDEA (Aldrich)

Plate XXIV, Figures 11, 15a, 16

Dosinia mercenaroidea Aldrich, 1887, Jour. Cinn. Soc. Nat. Hist., p. 82; Aldrich, 1897, Bull. Amer. Pal., vol. 2, No. 8, p. 172, pl. 2, fig. 10.

Mercetrix mercenaroidea Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1234.

Clementia mercenaroidea Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 151.

Shell orbicular, moderately compressed, concentrically finely striated, nearly smooth upon the umbo. Substance of the shell thin, thickening towards the margins; lunule rather long and narrow, beak curved towards lunule, small and anterior to the centre; hinge line rather long. Teeth in left valve rather prominent, erect, central one subtriangular. Ventral margin smooth.

Length 1.4, Breadth 1.15, Thickness .6 inch.

Locality: Upper landing at base of Claiborne Bluff. (My No. 9 bed Claiborne Section).

This species is more rotund than the recent *D. concentrica* Gmel. and much thicker

through the umbones. Only two specimens found.—[Aldrich, 1887.]

This form is distinct in the eastern American Eocene. It has been placed in the subgenus *Mercimonia* because it bears a close resemblance to *Venus cytheræformis* Deshayes. *V. cytheræformis* is placed by Europeans in the subgenus *Mercimonia* although in regard to the pallial sinus it differs from the type of the subgenus. A large pallial sinus is present in *V. cytheræformis*. Having only the literature of the Paris Basin species to go by, we have left the classification as given. *M. mercenaroidea* bears resemblances to species of the Cretaceous genus *Flaventia*. That section has a well developed lunule. The species has also hinge characters and a pallial sinus like the Cretaceous group *Cyclorisma* Dall. That subgenus is orbicular and it as well as *Flaventia* is not known later than the Cretaceous.

M. mercenaroidea has a large, pointed pallial sinus; the lunule is bounded only faintly; the form is more quadrate than orbicular with the dorsal line nearly straight, bowed slightly; the hinge known from the right valve; right valve with three cardinal teeth, anterior and middle cardinal close; the posterior cardinal long and bifid; the concentric striæ are conspicuous and well developed, giving the surface a rough appearance.

Dimensions.—36 mm., length; 31 mm., height; 20 mm., thickness.

Occurrence.—St. Maurice stage, Mid-Eocene. Base of Bluff just opposite the "Upper Landing," Claiborne, Ala. (Type locality). (Harris coll. Cornell Univ. Pal. Lab.)

Genus CHIONE Megerle von Mühlfeld



Fig. 21. Hinge of type species of *Chione*

Chione Megerle von Mühlfeld, 1811, Mag. Ges. Naturf. Freunde zu Berlin, V, p. 51 not *Chione* Desvoidy, 1830, Diptera.
not *Chione* Gray, 1838, The Analyst, VIII, No. 24, p. 305; not Gray, 1847, P. oc. Zool. Soc., Lond., p. 183.

Chiona Mörch, 1853, Cat. Yoldi, p. 24, fide Dall.

Chione Deshayes, 1853, Cat. Conch. Brit. Mus., pt. I, p. 118; H. and A. Adams, 1857, Gen. Recent Moll., vol. II, p. 420; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 176; Fischer, 1887, Man. de Conch., p. 1083; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 357; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1286; in part Cossmann and Peyrot, 1910, Actes Soc. Linn. de Bordeaux, Tome LXIV, p. 325; Jukes-Browne, 1915, Proc. Mal. Soc. Lond., vol. 11, p. 79.

Die Schale ist zwey—und fast gleichklappig, etwas herzförmig, am Randgekerbt; die Vulva und der After sind deutlich, und die Lippen auf dem Vorderrand auffliegend.

Das Schloss lieget fast im Mittel, ist sockszähmig, und hat keine Seitenzähne. Der Bewohner ist eine Calliste.

a. mit vorne dorniger oder stachelicher Schale.

Die *Dünnribbige Spielmuschel*. *Chione Dysera*.

Die fast herzförmige, strahlig gestreite und bogig blättrig gegürtelte Schale; hat von einander abstehende Gürtel, die über die Vulvaränder hinaustreten, und eine braune Vulva und Aftergegend.

Linn. Syst. Nat. Gen. 309. Sp. 4a:

Chemn. Conch. 6. t. 28. f. 287-290.

b. mit vorne unbewaffneter Schale.

Die *gemeine Spielmuschel*. *Chione gallina*.

Die fast herzförmige, etwas zusammengedrückte, weisse, ungleich bogig und schwach geribbte Schale, hat äusserst sein gelbroth punctirte Rippen, und die herzförmige Vulva und den After wie beschrieben.

Linn. Syst. Nat. Gen. 309. Sp. 9

β et 114 ♂

Chemn. Conch. 6. t. 30. f. 308.-310.

Man kennet noch 21. hierher gehörige Arten.—[Megerle, 1811.]

Shells trigonal or ovate; thick; three cardinals in each valve; no anterior lateral; pallial sinus small and triangular; inner margin crenulated except in *Gomphina*; lunule impressed bounded by an incised line; escutcheon usually bounded by a ridge and smooth except for lines of growth, not bounded by a line; in some subgroups the nymph is finely rugose; ornamented with concentric ribs and radiating ribs, either or both, or smooth.

Chione sensu stricto.

Nymphs smooth; ornamentation consists of prominent, concentric ribs with underlying, radiating sculpture; inner margins crenulated.

Genolectotype.—*Chione cancellata* (Linnæus) = *C. dysera* Chemn. fide Dall. Plate XXXVII, Figures 1, 2, 3, 4, 5, 6, 6a, 7, 8, 11, 15. Miocene, Pliocene, Pleistocene of southeastern Coast and Gulf Coast of United States and Recent from Cape Hatteras, N. C., thru the West Indies.

The genus is known from the Oligocene in the eastern American fauna with numerous species among the recent.

Synopsis of *Chione* Megerle

Subgenus *Chione* s. s. Megerle, 1811.

Right nymph and left posterior cardinal smooth; ornamentation consists of prominent, concentric ribs with underlying, radiating sculpture.

Section *Timoclea* Brown, 1827.

Right nymph and left, posterior cardinal smooth; ornamentation consists of predominate, radiating ribs.

Section *Clausinella* Gray, 1851.

Right nymph and left, posterior cardinal smooth; ornamentation consists of heavy, broad, concentric ribs with fine concentric lines between; no radiating sculpture.

Section *Chamelea* Mörch, 1853.

Right nymph and left, posterior cardinal smooth; ornamentation consists of small, close, concentric ribs only.

Subgenus *Anomalocardia* Schumacher, 1817.

Section *Anomalocardia* Schumacher, 1817.

Right nymph and left posterior cardinal rugose; valves rostrate; ornamentation variable, if any the concentric ribs predominate; radial sculpture when present fine, obscure.

Subgenus *Gomphina* Mörch, 1853.

Right nymph and left, posterior cardinal rugose; shell smooth; inner margins smooth. Not known definitely in the eastern American province.

Subgenus *Lirophora* Conrad, 1864.

Right nymph and left, posterior cardinal rugose; ornamentation consists of heavy, broad, concentric ribs with only discontinuous faint, radial striations; concentric ribs flaring often posteriorly.

		Stratigraphic Range of <i>Chione</i> s. s.				
<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>	
	bainbridgensis	socia	cancellata	cancellata	cancellata	
	spenceri	erosa	cribraria	intapurpurea	subrostrata	
		tegulum	dalliana		pubera	
		cancellata	intapurpurea		intapurpurea	
		subrostrata			mazyckii	
		pubera				
		cribraria				
		cortinaria				
		costaricensis				
		quebradillensis				
		var. guajatica				
		rowleei				
		chipolana				
		santodomingensis				
		guppyana				
		paraensis				
		walli				
		sawkinsi				
		woodwardi				
		primigenia				

CHIONE (CHIONE) BAINBRIDGENSIS Dall

Plate XL, Figures 6, 9

Chione bainbridgensis Dall, 1916, Proc. U. S. Nat. Mus., vol. 51, No. 2162, p. 499, pl. 84, figs. 5, 6.

Shell small, slightly inequilateral, moderately inflated, thin; beaks small, rather prominent, prosocœlous, with a short lanceolate impressed lunule below them; the escutcheon narrow and more elongated; sculpture of numerous sharp recurved lamellæ, somewhat sparser on the beaks but elsewhere uniformly distributed, and more elevated near the anterior end; radial sculpture of numerous fine threads evenly distributed, with narrower interspaces, strong on the front surface of the lamellæ and in the interspaces, but wanting on the back or concave side of the lamellæ; inner margin of the valves finely crenulated; anterior end of the valves rounded, the base prominently arcuate, the posterior end more pointed; hinge as usual in the genus. Height of somewhat defective valve, about 25; length, 35; diameter (double), 18 mm.

Localities. Station 7095, on the east bank of Flint River, at the bend near the "Old Factory," about three-fourths of a mile northeast of the railway station at Bainbridge, Georgia. Also at station 7131, at Cherry Chute, 2¾ miles below Bainbridge, in hard, residual blocks of limestone; and stations 3381, 7074, 7075, 7078, 7079, 7095, 7096 and 7131, at various points on Flint River above and below Bainbridge and within a dozen miles of that town; Cooke and Mansfield, 1914, U. S. Nat. Mus. Cat. No. 166717.

Each horizon from the Chattahoochee to the recent fauna contains a species of *Chione* of this general type, but distinguished by minor differences from the species in

the zones above or below.

Chione woodwardi Guppy, from the Oligocene of Bowden, Jamaica, is an example of the group.—[Dall, 1916.]

Syntypes.—United States National Museum, Washington, D. C.

Occurrence.—Oligocene.

CHIONE (CHIONE) SPENCERI Cooke

Plate XXXIX, Figures 17, 21

Chione spenceri Cooke, 1919, Carnegie Inst. Wash., Pub. 291, p. 150, pl. 15, figs. 1a, b.

Shell ovate, moderately convex, with low, prosogyrate beaks and a sharply defined, lozenge-shaped lunule with imbricating growth-lamellæ; escutcheon lanceolate, flat or slightly concave, and with fine growth-lines; radial sculpture of minute, close, low, rounded ridges becoming obsolete at the anterior and posterior ends; concentric sculpture of erect, evenly spaced lamellæ, 24 on the type specimen, smooth on the dorsal surface and on the upper part of the ventral surface, but with a row of beads, contiguous to the radial ribbing, at the base of the ventral surface.

Length, 26 mm.; height, 23 mm.; diameter of joined valves, 15.5 mm.

Localities.—Antigua, Spencer (type); Willoughby Bay, Antigua, station 6881; Vaughan.

Geologic horizon.—Oligocene.

Type.—U. S. Nat. Mus. No. 163352.—[Cooke, 1919.]

CHIONE (CHIONE) PUBERA (Valenciennes)

Plate XXXVIII, Figures 2, 5, 6, 12

Venus pubera Valenciennes, 1827, Bory St. Vincent, Expl. Plates, Ency. Meth., p. 152, pl. 267, fig. 4a, b.

Venus crenulata Reeve, 1863, Conch. Icon. *Venus*, pl. X, fig. 33; not *V. crenata* Gmelin, 1792; not *V. crenulata* Lamarck, 1818.

Venus superba Guppy, 1873, Proc. Sci. Ass. Trinidad, vol. 2, p. 91, pl. 3, fig. 2, Harris reprint, 1921, Bull. Amer. Pal., vol. 8, No. 35, p. 73, pl. 1, fig. 2; Guppy, 1875, Ann. Mag. Hist., Ser. 4, vol. 15, p. 49, pl. VII, fig. 2; not *Cytherea superba* D'Eichwald, 1853.

Venus halidona Guppy, 1910, Agr. Soc. Trinidad and Tobago, No. 440, p. 11; Harris reprint, l. c., p. 154.

Chione (Chione) pubera Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 374; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 160, pl. 29, figs. 12, 13.

Shell moderately large, inequilateral, umbones full; posterior end angulated, rounded ventrally, ventral region regularly rounded; surface ornamented with numerous, fine, radial ribs which are crossed by concentric ribbing which is thin, distinct and crenulated by the under sculpture of radiating ridges; the crenulation is more marked on the lower surface of each concentric rib than above; lunule heart-shaped, large, impressed and sharply defined by a surrounding groove, the concentric ribbing of the shell continues over the lunule; escutcheon long, narrow, wider and larger on the left valve, very narrow on the right, bounded by an impressed line, sculptured only by prominent lines of growth; posterior, dorsal margin of the shell with a slightly, sunken area running from the beaks to the posterior tip making a ridge along the lower side, this groove is not so distinguishable on the recent shells where the sculpture has not been broken or worn from that region. On specimens from Springvale, Trinidad, the outer layer of the shell has usually been stripped so that on the larger forms the groove is plainly developed. The species is highly

colored with brown zigzag markings or spots on a white background.

Dimensions.—Recent. 60 mm., length; 51 mm., height; 36 mm., width (medium size); specimen, U. S. Nat. Mus., 81 mm., length; 60 mm., height; 43 mm., thickness; Springvale specimen—largest—74 mm., length; 65 mm., height; 40 mm., width.

Occurrence.—Miocene. Cumana, Venezuela. (Guppy); Mt. Pleasant Quarry, Springvale. Trinidad. (Maury. Harris coll. Cornell Univ. Pal. Lab.). Recent. West Indies and northern South America. (Dall)

CHIONE (CHIONE) CORTINARIA (Rogers)

Plate XXXVIII, Figures 4, 11, 13;

Plate XL, Figures 8, 37

Venus cortinaria Rogers, 1835, Trans. Am. Phil. Soc. N. S., vol. V, p. 333; Rogers, 1839, *ibid.*, vol. VI, pl. 36, fig. 7; Conrad, 1838, Fos. Med. Tert., p. 11, pl. 8, fig. 1. *Dione (Chamelea) cortinaria* Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9. *Chione cortinaria* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1292.

Shell sub-cordate, inflated, with very regular concentric, closely approximate and very prominent imbricated ridges, which incline towards the beak, except the portion opposite the anterior, basal, and posterior margins, where they decline outwards towards 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 sub-bifid; lunule wide, cordate; basal margin crenate within; posterior margin short, straight and especially at the lunule finely crenate. Length, one inch; height, nine-tenths of an inch.

Locality, Williamsburg, Miocene. This beautiful shell rarely shows the concentric ridges perfect, from their prominence and thinness.—[Rogers, 1835.]

This species is like *C. cribraria*, but it is shorter in proportion to the height. The concentric ribs flatten dorsally, making the tops smooth. The lower portion of the ribs is crenulated. Specimens from Jackson Bluff, Fla., are like specimens of *C. cortinaria* in the Academy of Natural Sciences, Philadelphia, in sculpture but they are much more elongate. They are more elongate than the original figure.

Dimensions.—Specimen from Jackson Bluff. 34 mm., length; 27 mm., height; 8 mm., semidiameter.

Holotype.—Boston Society Natural History. (Lost)

Occurrence.—Lower Miocene, Jackson Bluff, Fla. (Dall), (Cornell Univ. Pal. Lab.); Upper Miocene, Murfreesboro stage. Williamsburg, Va. (type); Kingsmill, Va. (Cornell Univ. Pal. Lab.); Grove Wharf, Va. (Dall)

CHIONE (CHIONE) CRIBRARIA (Conrad)

Plate XXXVIII, Figures 1, 8, 9;

Plate XXXIX, Figures 3, 24

Venus cribraria Conrad, 1843, Proc. Acad. Nat. Sci. Phil., vol. I, p. 310; Conrad, 1845, Fos. Med. Tert., No. 3, p. 67, pl. 38, fig. 2; in part Emmons, 1858, Geol. N. Car., p. 293, fig. 218; Tuomey and Holmes, 1857, Pliocene, Fos. S. Car., p. 83, pl. 21, fig. 10.

Dione (Chamelea) cribraria Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9. *Chione cribraria* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1292; Gardner and Aldrich, 1919, Proc. Acad. Nat. Sci., Phil., vol. 71, p. 19.

Subtriangular, slightly ventricose, with about 25 concentric elevated recurved lamelliform ribs, on the inferior side of which are elevated transverse lines; lunule

cordate, laminated, suture profound; inner margin profoundly crenulated. Length one and a quarter inch. Height one and one-eighth nearly.

Locality. Wilmington, N. C.; Neuse river below Newbern, N. C.

Resembles somewhat *V. punctulata*, Val. (Enc. Method, t. 267, p. 4) of Florida, but has much more prominent, narrow and more remote ribs. In this respect it differs from *V. cortinaria*, Rodgers.—[Conrad, 1843.]

The shell varies in the convexity of the posterior end, some specimens are more trigonal than others, the concentric ribs vary from 25 to 30 or more in number, they are erect, lamellose and fluted on the posterior and anterior ends.

Conrad had specimens from older and from younger beds.

Dimensions.—Largest specimens, 43 mm., length; 38 mm., height; 13 mm., semi-diameter.

Occurrence.—LOWER MIOCENE. Alum Bluff, Bailey's Ferry, Fla. (Cornell Univ. Pal. Lab.). UPPER MIOCENE. *Duplin Stage*. Wilmington, N. C. (Conrad) Natural well, Strickland's marl pit, 1½ miles northwest of Magnolia, N. C. (Cornell Univ. Pal. Lab.); Darlington, S. C. (Tuomey and Holmes); Muldrow Place, Sumter county, 5 miles southeast of Maysville, S. C. (Gardner and Aldrich). PLIOCENE. Acme, Moores Farm, 5 miles below Newbern, Neuse River, Keith marl pit, Neill's Eddy Landing, N. C. (Cornell Univ. Pal. Lab.) Waccamaw, S. C. (Tuomey and Holmes)

CHIONE (CHIONE) INTAPURPUREA (Conrad)

Plate XXXVIII, Figure 3; Plate XXXIX, Figures 4, 5;

Plate XL, Figures 34, 35, 36

Venus punctulata Conrad, 1843, Proc. Acad. Nat. Sci. Phil., vol. I, p. 311, not *Venus punctulata* Valenciennes.

Venus intapurpurea Conrad, 1849, Jour. Acad. Nat. Sci., Phil, 2nd Ser., vol. I, p. 209, pl. 39, fig. 9.

Chione cribraria Holmes, 1860, Post-Pliocene Fos. S. C., p. 35, pl. VI, fig. 15.

Venus cribraria Dall, 1889, U. S. Nat. Mus., Bull. 37, p. 54; Vanatta, 1903, Proc. Acad. Nat. Sci. Phil., vol. 55, p. 757.

Chione intapurpurea Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 374; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1293; Mau, y, 1921, Bull. Amer. Pal., vol. VIII, No. 34, p. 73.

Ovate-triangular, thick, ventricose, with about thirty concentric somewhat reflected ribs, becoming laminated and waved towards the anterior and posterior margins; the laminae alternately elevated; radiating striae distant; lunule cordate; basal margin rounded and somewhat tumid in the middle, subtruncated posteriorly; color white with irregular, angular fulvous spots; interior white with a very large triangular purple stain; margin crenulated. 1½. 1.

Locality. Egmont Key, Tampa Bay.

Resembles the Miocene fossil *Venus cribraria*, nob. but is very distinct.—[Conrad, 1849.]

C. intapurpurea differs from *C. cribraria* in being proportionately longer than high. The concentric ribs on the central region tend to become smooth and flare posteriorly and anteriorly. In *cribraria*, the concentric ribs are more uniformly crenulated over the whole surface of the shell and lack the smoothness of the ribs centrally. On recent specimens of *intapurpurea*, the purple spot mentioned by Conrad is conspicuous.

Dimensions.—38 mm., length; 32 mm., height; 23 mm., thickness.

Type.—?

Occurrence.—PLIOCENE. Florida (Dall). PLEISTOCENE. New Orleans artesian well of 1856, at 41 and 225 ft., New Orleans Gymnasium Club well at 1200 feet; Lake Borgne borings, New Orleans pumping station No. 7, Knapp's wells, Terrebonne Parish, No. 2, 1050–1190; No. 3, 700–780, 790–830; 1040–1043 feet, (Maury—Cornell Univ. Pal. Lab.) RECENT. Cape Hatteras, N. C., south to Florida and Keys along the Gulf Coast to Honduras. Ft. Barranca, St. Joseph's Bay, Crooked Island off St. Andrews Sound, Calhoun county, Florida. Horn Island, Miss. (Cornell Univ. Pal. Lab.) (Vanatta)

CHIONE (CHIONE) PARAENSIS (White)

Plate XLIII, Figures 19, 38

Venus (Chione) paraensis White, 1888, Arch. Mus. Nac. Rio de Janeiro, vol. VII, p. 94, pl. V, figs. 34, 35; Katzer, 1903, Geol. des unteren Amaz., p. 132, pl. 1, fig. 12, copy of White.

Not *Chione paraensis* var. Maury, 1912, Jour. Acad. Nat. Sci., XV, p. 60.

Chione (Chione) paraensis Maury, 1925, Ser. Geol. e Min. do Brazil, Mon. vol. IV, p. 345, pl. 19, fig. 8.

Shell rather small, gibbous, transversely subelliptical in marginal outline; lunule moderately large, cordiform, prominent, distinctly defined by a narrow, sharply impressed groove; escutcheon long, lanceolate, concave from side to side, bounded on each side by a distinct ridge which extends from the beak by a gentle outward curve, to the posterior border; umbones slightly elevated; beaks small, closely incurved upon the cardinal margin and turned forward; cardinal margin broadly and regularly convex; anterior and posterior margins regularly and almost equally rounded; basal margin broadly and regularly convex; cardinal teeth well developed; sublunular tooth comparatively strong. Surface marked by numerous sharply raised, finely crenulate, concentric lamellæ which cover the whole surface including the lunule but not including the narrow escutcheon. These lamellæ consist of merely close-set raised striae upon the beaks, but they become stronger and wider apart towards the free margins. Length, 21 millimeters; height from base to umbones, 18 millimeters.

This species is represented in the collections by natural casts and moulds. An artificial cast from one of the latter shows the surface characters with great clearness.—[White, 1887.]

Dr. Maury discovered specimens in her material which came from Rio Pirabas which she determined as the same species that White had found. The shape of the specimens is close to that of White. The molds which Dr. Maury had, show very fine, radiating, crenulations over the concentric ribs. The original description and illustration of the species do not show fine, radial striations. It may be that the original specimens were younger although the measurements of material of both collections are almost the same. The presence of the fine, radiating lines places the species in *Chione* s. s. as Dr. Maury has done.

Holotype.—National Museum Rio de Janeiro, Brazil.

Occurrence.—Lower Miocene. (Maury). Rio Piabas, Provincia do Pará, Brazil.

CHIONE (CHIONE) SAWKINSI Woodring

Plate XL, Figures 26, 32

Chione sawkinsi Woodring, 1925, Carnegie Inst. Wash., Pub. No. 366, p. 159, pl. 21,

figs. 12 to 14, in part *Venus woodwardi* Guppy, 1866, and 1874, in part *Chione woodwardi* Dall, 1903.

Shell medium-sized, ovate-trigonal, moderately inequilateral, strongly inflated; lower part of posterior margin obliquely truncate; lunule limited by a deep groove; escutcheon relatively narrow, bounded by a rounded ridge; margin of left valve adjacent to ligament raised along proximal two-thirds of its length; a short distance from this ridge lies a second lower ridge, which disappears toward the umbo, area between the two ridges slightly excavated and forming at margins the truncation; sculpture consisting of numerous concentric lamellæ; over more than anterior half of shell their edges are thickened and turned toward the umbo, except near the lunule; on their ventral sides are low radial ribs, separated by interspaces of varying width; the ribs fail to extend across the interspaces, but alternate with broader and less distinct ribs on the shorter dorsal side of the lamellæ; behind a radial line near middle of shell the edge of the lamellæ is turned toward the ventral margin and is finely frilled; from the ends of each frill narrow low radials extend across at least the dorsal half of the interspaces; right anterior cardinal (3a) heavy, right middle cardinal (1) slender, right posterior cardinal (3b) distinctly bifid; left middle cardinal (2b) distinctly bifid; flutings of inner margin fine.

Length 25.5 mm.; height 22 mm.; diameter (right valve) 8 mm.

This species is one of the most abundant veneroids. Young shells are more rounded and their concentric lamellæ may be frilled over the entire shell. The slight posterior truncation and the expanding and frilling of the concentric lamellæ on the posterior half of the shell are characteristic features. The largest specimen has the following dimensions: length 33.8 mm.; height 28 mm.; diameter (right valve) 8.5 mm.

Although the type of *Venus woodwardi* is in the British Museum, 7 specimens in the Guppy collection (U. S. Nat. Mus. No. 115545) are labelled "types." All these shells represent the species here described as *Chione sawkinsi*. The same species is represented by a few specimens from the Cercado formation of the Dominican Republic that have fewer and coarser lamellæ. *C. walli* (Guppy), from Trinidad, and *C. guppyana* Gabb, from the Dominican Republic, have more ribs on the ventral face of the lamellæ than in the interspaces.

Other localities.—Cercado formation (lower Miocene), Dominican Republic.

Type material.—Holotype (U. S. Nat. Mus. No. 352836).—[Woodring 1925.]

This species belongs to the *cribraria* group. It differs from that species in having the concentric ribs more crowded, less flaring, and in the shape being less ovate. The ribs resemble *intapurpurca* but *sawkinsi* is plumper and less compressed than that species.

Occurrence.—Miocene. Bowden, Jamaica. (Type.) (Woodring). (Hodson and Olsson Colls. Cornell Univ. Pal. Lab.). Cercado formation. Dominican Republic. (Woodring)

CHIONE (CHIONE) WOODWARDI (Guppy)

Plate XXXIX, Figures 1, 2, 6, 7, 8, 9, 10, 11, 12, 25;

Plate XL, Figures 22, 24, 25

Venus woodwardi Guppy, 1866, Quart. Jour. Geol. Soc. Lon., vol. 22, p. 292, pl. 18, fig. 1; Guppy, 1874, Geol. Mag., decade II, vol. I, No. X, p. 442; Guppy, 1876, Quart. Jour. Geol. Soc. Lon., vol. 32, p. 530.

Chione woodwardi Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1291; Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 218, pl. 37, fig. 6.

Chione cf. walli Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 218, pl. 37, fig. 7.

Chione woodwardi Maury, 1920, N. Y. Acad. Nat. Sci., vol. III pt. I, p. 40; Hubbard, 1920, *ibid.*, vol. III, pt. 2, p. 122, pl. 13, fig. 7; Woodring, 1925, Carnegie Inst. Wash. Pub., No. 366, p. 160, pl. 22, figs. 1 to 4.

Shell subtrigonal, somewhat inequilateral, anteriorly rounded, posteriorly somewhat angulated; ornamented with numerous fine radiating costellæ, interrupted by equidistant concentric crenulate ridges, which are continued across the large lunule; margin beneath the lunule internally obsolete toothed.

A form allied to *V. cancellata*, Linn., abundant in the Caribbean Sea.—[Guppy, 1866.]

Shell small, trigonal or subtrigonal; the concentric ribs pre-

dominate but beneath the concentric sculpture are the conspicuous, radiating ribs of a single nature. The interspaces between the ribs are equal or slightly narrower than the width of the rib. Posteriorly there is a wide area where the radiating ribs are present but not developed as strongly. Some specimens show the radiating ribs developed equally over the whole surface. Specimens from Bowden show a flexure near the posterior end with the posterior ventral point produced and pointed. The specimens from Santo Domingo have the posterior end more rounded.

Some of the very large specimens from Santo Domingo show a doubling of the anterior ribs. This character was noticed by Dr. Maury. The type material of Dr. Maury's has been figured, plate XXXIX, figures 8, 10, to show this character. The shells are *woodwardi* in all other characters and seem to have developed the splitting of the ribs as an extreme character. They may be differentiated from *walli* by their plumper shape, less pointed posteriorly and by the greater development of the single ribs of *woodwardi*. *Walli* has all the radiating ribs doubled, except posteriorly, and as has been pointed out under the discussion of that species, typical of all stages of its development.

Dimensions.—22 mm., length; 20 mm., height; 8 mm., semidiameter.

Holotype.—British Museum, Natural History Division. No. 640884 fide Woodring.

Specimens.—No. 115545. United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Porto Rico. (Maury. Amer. Mus. Nat. Hist. Hubbard. Columbia Univ. Pal. Mus.) MIOCENE. Bowden, Jamaica. (Type), Bluffs 2 and 3, Cercado de Mao, Zone G, Rio Gurabo at Los Quemados, Zone I, Rio Cana at Caimito, Santo Domingo. (Maury Exp'd, '16. Cornell Univ. Pal. Lab.); Cumana, Venezuela and Yaqui Valley, Haiti (Guppy).

CHIONE (CHIONE) TEGULUM Brown and Pilsbry
Plate XXXIX, Figure 20

Chione tegulum Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci., Phil., vol. 63, p. 368, pl. 28, fig. 8.

Shell plump, the altitude almost equal to the length, with prominent prosogyrate beaks near the anterior third. Sculpture of rounded, tilelike radial ribs (their summits 1 mm. apart near the basal margin, in the median part of a shell 19 mm. in alt.); these are interrupted by narrow, concentric, machiolated ridges, curved downwards in the intervals, upward where they cross the radial ribs. There are 26 of the concentric ridges in a shell 19 mm. in altitude. The wide, cordate lunule has radial lamellae only, and is defined by a deep groove. The lanceolate escutcheon is concave, with sculpture of smooth raised lines continued from the concentric lamellae. The basal and anterior valve margins are crenulated inside, as is also the margin along the lunule.

Length 19.5, alt. 19, semidiameter 8 mm.

This species resembles *C. woodwardi* Guppy, from the Bowden Oligocene, but differs by having a smaller lunule, and in details of sculpture, as shown in the figure. —[Brown and Pilsbry, 1911.]

Holotype.—Academy Natural Sciences, Philadelphia, Pa.

Occurrence.—Gatun Miocene. Gatun Locks, Panama. (Brown and Pilsbry).

CHIONE (CHIONE) WALLI (Guppy)

Plate XXXIX, Figures 13, 14, 16, 19

Venus walli Guppy, 1866, Quart. Jour. Geol. Soc., vol. 22, p. 581, pl. 26, fig. 16; Guppy, 1874, Geol. Mag., decade II, vol. 1, No. X, p. 442.

Chione walli Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1291; not *Chione* cf. *walli* Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 382, pl. 37, fig. 7; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 159, pl. 28, figs. 2, 11, 15.

Shell subtrigonal, somewhat inequilateral, anteriorly rounded, posteriorly somewhat angular, ornamented with numerous small and fine, close radiating costellæ, interrupted by high concentric crenulated ridges, which are higher and closer towards the ventral margin; umbones small, prominent; lunule impressed, sinuately striated, circumscribed by a sharp groove; posterior cardinal area distinct, striate.

On the disk the costellæ are distinctly paired, with a smaller intermediate costella between each pair; but near the keel which runs from the umbo to the posterior angle, separating the striate posterior margin, the costellæ are larger and single, and the concentric ridges die away into the striations.

This species is related to the recent *V. cancellata*.

Lower Miocene, Manzanilla, Trinidad.—[Guppy, 1866.]

Specimens from the type locality, Manzanilla, Trinidad, show the distinct characters of this species to be the doubling of the radiating ribs over the greater portion of the shell and the reflecting of the concentric ribs, which on the ventral region become crowded together and dominate over the radiating lines; the latter give the appearance of crenulation to the concentric ribs. This species attains considerable size compared with its relative *C. woodwardi*.

C. walli differs from *C. woodwardi* in the characters described. Specimens 19 or 20 mm. in length of the two species will show a close resemblance. See pl. XXXIX, figures 10, 19.

In both species, the posterior area of radial ribbing consists of larger, single ribs and both have the concentric, crenulated ribs with wide interspaces. On a shell of the size stated there may be the doubling of the radial ribs, anteriorly and ventrally. In *C. woodwardi* there occurs only the beginning of such development and that character represents a fully mature shell. In *C. walli* this doubling is developed to such a degree that the ribs anteriorly have again become single, differing from the original single rib as seen in *C. woodwardi* by being finer and more numerous. The beaks in *C. woodwardi* are fuller than in *C. walli*.

The differences which are intimated between the two species in smaller specimens are accentuated in larger and older shells of *C. walli* until both the anterior and posterior ends of that species become pointed, the shell becomes more trigonal in shape and the concentric ribs become crowded conspicuously medially and ventrally. The ribs are reflected dorsally, revealing the crenulated lower margin of each rib. This, together with the total divarication of the ribs give the greater surface of the shell a crenulated appearance.

Dimensions.—29 mm., length; 25 mm., height; 10 mm., semidiameter. Specimen U. S. Nat. Mus.

Holotype.—? British Museum, Natural History Division. Specimens No. 115544, United States National Museum, Washington, D. C.

Occurrence.—Miocene. Manzanilla, Trinidad (type) (Guppy) (Harris coll. Cornell Univ. Pal. Lab.)

CHIONE (CHIONE) COSTARICENSIS Olsson

Plate XL, Figure 10

Chione costaricensis Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 245, pl. 32, fig. 4.

Shell of moderate size, convex, ovate-trigonal; the dorsal portion of the type specimen is lacking; the surface is sculptured with fine, subregular, concentric lamellæ spaced on the center of the disk about .75 mm. apart; the interspaces and the ventral surfaces of the lamellæ are marked with regular, incised lines forming radial bands of an average width of .40 mm.; a faint radial sinus extends from the beaks to the posterior; ventral margin of the shell is slightly arcuate at its posterior end; interior of the ventral margin is finely crenulated.

Length 34, height 29, diameter of the right valve 10 mm.

This shell will be distinguished from the other Costa Rican Chiones by its more crowded, concentric lamellæ and the regular, radial striae. The striae occur on the ventral facies of the lamellæ and on their interspaces.

Gatun Stage: Hill No. 3, Banana River.—[Olsson, 1922.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Hill No. 3, Banana River, Costa Rica.

CHIONE (CHIONE) GUPPYANA Gabb

Plate XXXIX, Figures 15, 23

Chione guppyana Gabb, 1873, Trans. Amer. Phil. Soc., new series, vol. XV, p. 249;

not *C. guppyana* Maury, 1912, Jour. Acad. Nat. Sci., vol. 15, p. 59, pl. 9, fig. 19;

Pilsbry, 1921, Proc. Acad. Sci., Phil., vol. 73, pt. II, p. 423, pl. 47, figs. 3, 4, 5.

Shell sub-circular, swollen beaks anterior, base and extremities regularly rounded; posterior cardinal margin arched and bordered by a narrow flat space; lunule surrounded by an impressed groove; surface sculptured by numerous equal radiating ribs, crossed by rather closely placed concentric waved lamellæ.

The form of this shell is nearest *V. toreuma*. In its sculpture it resembles *C. Walli*, and *C. Woodwardi* of Guppy, but can be at once distinguished from them by its round form.—[Gabb, 1873.]

A peculiarity of this species is that the ventral facies of some or all of the concentric lamellæ have about twice as many ribs as there are in the intervals. This is shown in the detail photographed in fig. 4. It is a rather plump, rounded shell, related to *C. woodwardi* Guppy.

Length 31.3, alt. 30 mm. Type no. 2773.

Length 32.5, alt. 29, diam. 22.3 mm.—[Pilsbry, 1921.]

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Miocene. Santo Domingo. (Wm. M. Gabb Coll. Acad. Nat. Sci., Phil.)

CHIONE (CHIONE) SOCIA Pilsbry and Johnson

Plate XXXVIII, Figures 7, 10

Chione socia Pilsbry and Johnson, 1917, Proc. Acad. Nat. Sci. Phil., vol. 69, p. 199.

Chione socia Pilsbry, 1921, *ibid.*, vol. 73, p. 423, pl. 47, fig. 12, 13.

The shell resembles *C. woodwardi* Guppy in size and shape, as well as in the lunule, over which the concentric lamellæ run. It differs by the radial sculpture. In

C. woodwardi the radial ribs run to the basal border, gradually enlarging. In *C. socia* these ribs, at first similar, soon become smaller, low and slender, and towards the margin they split, so that there are very many more, and smaller ribs. Crenulations of the internal basal margin are smaller and twinned.

Length 21, alt. 19, diam. 14 mm.

Type No. 2778, A. N. S. P.

This form shows a particular sculpture not found in the common *C. woodwardi* of the Bowden bed, which appears not to occur in Santo Domingo. In *C. santodomingensis* the concentric lamellæ are much more widely spaced.—[Pilsbry and Johnson, 1917.]

Occurrence.—Miocene of Santo Domingo. (Wm. M. Gabb Coll. Acad. Nat. Sci., Phil.)

CHIONE (CHIONE) ROWLEEI Olsson

Plate XXXIX, Figure 22

Chione Rowleei Olsson, 1922, Bull. Am. Pal., vol. 9, No. 39, p. 244, pl. 30, fig. 2.

Shell rather large, convex, ovate; lunule broadly cordate and concentrically sculptured; escutcheon long, narrow, smooth and defined by a small cord-like ridge; surface of the disk with about 30 slightly elevated concentric ribs which on the umbos are thin and lamellar but lower on the shell disk are wide and triangular at the base, but with thin zigzag or fluted lamellar ridge on top; the interspaces, much wider on the umbos is sculptured with even rib-like cords which also flute in harmony with the dorsal face of the concentric ribs; the ventral face of the ribs are finely striated by radial incised lines which form cord-like ridges about $\frac{1}{2}$ as wide as the radial cord of the interspaces; interior of the shell deep, with a small pallial sinus and subequal adductor scars; basal margin finely crenulated as well as the lunular margin and the extreme posterior extremity.

Length 42, height 37.5, thickness (right valve) 17 mm.

This large, elegant *Chione* is quite common in the Gatun beds of Costa Rica. It also occurs in the lower Gatun at Gatun, usually in the form of casts. It recalls in a general way, the recent West Coast *C. amathusia* Philippi, but differs in its heavier shell, higher and fuller umbos and difference in details of its spiral and radial sculpture. In the Costa Rican shell, the radial cords are simple, relating it more closely with the small *C. Woodwardi* Guppy of the Miocene of Jamaica and Santo Domingo, while in *C. amathusia*, they are double and alternating.

The *C. tegulum* Brown and Pilsbry we have not seen. It is a smaller shell, related to the *C. Woodwardi*. In *C. tegulum* the concentric lamellæ are much closer and the wide cordate lunule is sculptured only with radial lamellæ.

It is named for Professor W. W. Rowlee, who collected a few specimens from the Banana River in the course of botanical investigation of the Balsa tree (*Genus Ochroma*), a very light wood used in the construction of life-buoys, etc.

Gatun Stage: Gatun, C. Z.

Banana River.

Coll. 6, Estrella River.—[Olsson, 1922.]

From the midportion of the shell to the ventral margin this shell displays the characteristic sculpture of *C. walli* Guppy from the Manzanilla beds of Trinidad, on which the concentric ribs are crowded closely and are reflected backward strongly with a pronounced, crenulated appearance caused by the radiating ribs. In *C. rowleei* this character in the sculpture covers a greater portion of the shell than in *C. walli*. In *C. walli* and in *C. woodwardi* this is a wide area extending from the umbos ventrally on the posterior end where the radial ribs are single, finer with wider interspaces, than on the body of the shell, with the concentric ribs less fluted and less conspicuous in the details of the sculpture. This area in *rowleei* is more limited and occurs only slightly beyond the region of the escutcheon.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Gatun, Canal Zone. Banana River, Costa Rica. (Olsson Coll., Cornell Univ. Pal. Lab.)

CHIONE (CHIONE) SUBROSTRATA (Lamarck)

Plate XL, Figures 3, 4, 19, 29, 30

Plate XLIV, Figure 20

- Venus subrostrata* Lamarck, 1818, Hist. Nat. An. sans Vert., Tome V, p. 588, not Ency. Meth., pl. 267, fig. 7a, b.
Venus portesiana D'Orbigny, 1846, Voy. dans Amer. Merid., p. 556, pl. 83, figs. 1, 2.
Venus Beauï Recluz, 1852, Jour. de Conch., Tome III, p. 412, pl. 12, fig. 15.
Venus crenifera Sowerby, 1835, Proc. Zool. Soc. Lond., p. 43; Sowerby, 1853, Thes. Conch., vol. II, p. 714, pl. 165, figs. 73-74.
 not *Venus subrostrata* Reeve, 1863, Conch. Icon., *Venus*, pl. 14, fig. 54.
Venus beauï Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54.
Venus subrostrata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 273, 393; Dall, 1910, Proc. U. S. Nat. Mus., vol. 37, No. 1704, p. 268; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 154.
Venus portesiana Maury, *ibid*, p. 155, pl. 28, fig. 3; var. *beauï* Maury, *ibid*, p. 155, pl. 28, fig. 7.
V. testa cordata, striis longitudinalibus transversisque cancellata, albida, radiatim rufo maculata; ano cordato.
 Encycl. pl. 267, f. 7. a. b. ?
 Habite les mers des Antilles, à l'île St. Jean. *Richard*. Elle est très-voisine de la précédente; mais ses stries transverses sont fréquentes, régulièrement espacées; et à l'intérieur, elle est toute blanche. Largeur, 30 millimètres.—[Lamarck, 1818.]

Shell inequilateral and moderately thin; posterior end slightly pointed, rounded ventrad, ventral margin well rounded; anterior end flaring; sculpture consists of radiating and concentric ribs which are about equal in prominence; the radiating ribs are fine with interspaces equal to the width of the rib; they are arranged in groups of three equal ribs, with a wider interspace between each group, in the anterior region the interspaces become larger making the ribal grouping more conspicuous; the radiating ribs occur over the entire surface of the shell including the area of the lunule; on the umbo and posterior end they become finer; the concentric ribbing is lamellated delicately and developed equally over the whole surface; lunule large, heartshaped, deeply impressed and ornamented with radial ribbing, sometimes the concentric sculpture is slightly conspicuous in this area.

The color of the shell is brown or whitish and brown, blotched or streaked, the interior is sometimes purplish.

Lamarck referred the species to figures in the Encyclopédie Méthodique but questioned the identity. The figures referred to in the Encyclopédie Méthodique are not of the common species of the West Indies which was figured by D'Orbigny as *V. portesiana*. The figures referred to by Lamarck are of *Antigona lamellaris* Schumacher (*Dosina lamarekii* Gray) a foreign species. There are many cases where figure references of Lamarck to the Encyclopédie are incorrect so we take it that a confusion was made in the case of *C. subrostrata*. The illustration of Reeve for the species is very poor or erroneous.

The *Venus beauii* of Récluz is a very convex *C. subrostrata* and perhaps should be regarded as a variety. It seems to be a local development at Quadeloupe. Specimens were collected from the Bowden Miocene, Jamaica which also might be regarded as a variety. They are intermediate in convexity between *subrostrata* s. s. and *beauii*. In the other characters they are typical of the species.

Dimensions.—27 mm., length; 22 mm., height; 9 mm., semidiameter.

Occurrence.—MIOCENE. Bowden, Jamaica. (Hodson Coll. Cornell Univ. Pal. Lab.) RECENT. Miami, Florida, Florida Keys south to Albrohlos Island, off Brazilian coast and Rio de Janeiro; Mazatlan, Mexico to Paita, Peru. (Dall. U. S. Nat. Mus.) Trinidad. (Harris Coll. Cornell Univ. Pal. Lab.)

CHIONE (CHIONE) CANCELLATA (Linnæus)

Plate XXXVII, Figures 1, 2, 3, 4, 5, 6, 6a, 7, 8, 11, 15

Venus cancellata Linnæus, 1767, *Systema Naturæ*, XII, p. 1130; *Ency. Meth.*, pl. 268, fig. 1, a, b; Lamarck, 1818, *Hist. des An. sans Vert.*, Tome V, p. 588; D'Orbigny, 1842, *Voy. l'Amer. Merid.*, V, p. 554; Tuomey and Holmes, 1857, *Pleioc. Fos. S. C.*, p. 84, pl. 21, fig. 11; Reeve, 1863, *Conch. Icon.*, *Venus*, pl. XIX, fig. 88; not *Venus cancellata* Sowerby, 1840.

Venus elevata Say, 1822, *Jour. Acad. Nat. Sci., Phil.*, vol. 11, p. 272.

? *Venus inequalis* Say, 1822, *ibid.*, p. 273 fide Dall.

Chione cancellata Deshayes, 1853, *Cat. Conch. Brit. Mus.*, pt. 1, p. 134.

Chione cancellata Holmes, 1860, *Post-Pleioc. Fos.*, p. 35, pl. 6, fig. 14.

Venus cancellata Dall, 1889, *Bull. U. S. Nat. Mus.*, 37, p. 54; Singley, 1893, *Geol. Sur. Tex. from 1892 4th Ann. Rept.*, *Tex. Geol. Sur.*, p. 327; Harris, 1895, *Bull. Amer. Pal.*, vol. 1, No 3, p. 10; Dall and Simpson, 1901, *U. S. Fish. Com. Bull.* for 1900, vol. 1, p. 483.

Dione (Chamellea) cancellata Meek, 1864, *Smith. Misc. Coll.*, vol. VII, No. 183, p. 9.

Chione cancellata Dall, 1902, *Proc. U. S. Nat. Mus.*, vol. 26, No. 1312, p. 373; Dall, 1903, *Trans. Wag. Inst. Sci.*, vol. III, pt. 6, p. 1290; Maury, 1920, *Bull. Amer. Pal.*, vol. 8, No. 34, p. 72; Maury, 1925, *Bull. Amer. Pal.*, vol. 10, No. 42, p. 153, pl. 28, figs. 1, 5.

V. subcordata, striis transversis membranaceis remotis, ano cordato. M. L. U. 506, n. 71.

Gualt. test. t. 88 f. D.

Habitat in Oceano Africano.

Testa cinerea, leviter striata a natibus ad marginem; Striae transversae, remotae, elevatae, membranaceae, erecto-patentes. Anus cordatus. Margo subcrenulatus. Variat striis longitudinalibus & absque his striis.—[Linnaeus, 1767.]

The shell is thick, triangular and variable in shape; posterior end often produced; lunule impressed, heartshaped, escutcheon prominent, large and usually inequilateral; surface with large lamellated, remote, concentric ribs which cross well developed, radiating, rounded ribs; on young specimens and on the umbonal region of adults the radiating ribs are single with equal or nearly equal interspaces; with age these ribs become irregular, bifurcating or more frequently trifurcating with the mid-rib in the triple grouping, the strongest and sometimes very much enlarged; the division of the radiating ribs is characteristic of the middle portion of the shell and the anterior end; those ribs on the posterior end are large and single with wider interspaces; on the extreme posterior end the ribs occur diagonally to the other radiating ribs.

The recent shells are blotched with brown on the exterior, with the interior often colored reddish brown.

Dimensions.—Average, 33 mm., length; 30 mm., height; 10 mm., semidiameter.

Occurrence.—MIOCENE. Galveston well, Texas, 1550 to 2871 ft. (Harris). PLIOCENE. Caloosahatchee beds of the Caloosahatchee River, Alligator Creek and Shell Creek, Fla. (Dall). Matura, Trinidad. (Maury). Neill's Eddy Landing, Keith marl pit, Cape Fear River, N. C. (Cornell Univ. Pal. Lab.) PLEISTOCENE. Osprey, North Creek and in the Quarternary beds generally throughout the state, Florida (Dall). Simmon's Bluff, S. C. New Orleans artesian well of 1856, Lake Borgne borings, New Orleans pumping station, no. 7, New Orleans Gymnasium well, 1200 ft. Knapp's well, Terrebonne Parish, no. 1, 2250-2450; no. 2, 1731-1739; no. 3, 570-700; 1150-1200, 1200-1300, 1330-1375, 1400-1440-1443; 2470, 1500-1525 ft. (Maury. Cornell Univ. Pal. Lab.). RECENT. Cape Hatteras, N. C., south to Brazil, including Bermuda, West Indies, the Gulf of Mexico, Beaufort, N. C., Monte Christi, Santo Domingo, Trinidad, Ft. Barranca, St. Joseph's Bay, Crooked Island, Cedar Keys, Fla., Horn Isl., Miss., Galveston, Corpus Christi and Pt. Isabel, Texas. (Vanatta.) (Cornell Univ. Pal. Lab.), Aspinwall, Panama, (Newcomb Coll. Cornell Univ. Pal. Lab.)

CHIONE (CHIONE) MAZYCKII Dall

Plate XXXVII, Figure 9

Venus Lamarckii Dall, 1889, U. S. Nat. Mus., Bull. 37, p. 54, not *Venus Lamarckii* Gray.

Chione Mazyckii Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, pp. 373, 382, pl. XIII, fig. 2.

Shell small, subrostrate, with low distant concentric lamellæ crossing flat radial ribs, those radials in front of the middle later becoming double, while the ribs behind the middle remain single; all the ribs are separated by subequal smooth interspaces except near the anterior margin, where interstitial threads appear, the concentric lamellæ become laminate, especially on the right valve, near the posterior end; lunule distinct, lanceolate, striated; escutcheon defined by a keel, striated, the right half somewhat overlapping the other, painted with brown streaks or entirely brown; disk white with pale-brown or rose-colored radial bands and occasional darker-brown flecks; interior rose-color with white near the end and basal margins; hinge normal, with a rose-colored ray below a very short ligament; pallial sinus very small and blunt, inner margins crenulated. Length, 14.2; height, 11.2; diameter 8, mm.

Type locality.—United States Fish Commission, station 2616, off Cape Fear, North Carolina, in 17 fathoms, sand. Cat. No. 92022, U. S. N. M.

This pretty little species is easily discriminated by its form and color from *C. cancellata* at any stage of growth. It is named in honor of Mr. W. G. Mazyck, of Charleston, South Carolina.—[Dall, 1902.]

Occurrence.—Recent. Cape Hatteras, North Carolina, southward to vicinity of Cape San Roque, Brazil, 15 to 127 fathoms. (Dall)

CHIONE (CHIONE) QUEBRADILLENIS (Maury)

Plate XXXVII, Figure 10

Chione quebradillensis Maury, 1920, N. Y. Acad. Sci., vol. III, pt. 1, p. 41, pl. 8, fig. 4.

Shell subtrigonal, anterior end rounded, posterior end somewhat pointed. The surface is handsomely sculptured by about fifteen concentric, crenulated ridges which are cut by the deeply impressed lines defining the lunule, and then continue on over the lunule itself. Over the anterior and posterior areas of the valves the radial sculpture consists of very fine and close-set riblets more or less uniform, only the posterior

somewhat finer and closer. Upon the central portion of the valves the radial ribs are less crowded, although still close, and usually show a definite alternation of a comparatively broad, unpaired, rib with a very fine, linear rib. Length of shell 21 mm., height 16 mm., semi-diameter 9 mm.

This species is related to *Chione walli* Guppy, from the Manzanilla beds of Trinidad and also recorded from Bowden, Jamaica; but that shell has a great many more concentric ridges, and the central riblets, alternating with the small intermediate ribs are paired. Lately Pilsbry and Johnson have briefly described, but not figured a Dominican shell, *Chione santodomingensis*, which is apparently of the same group. The Floridan analogue is *C. chipolana* Dall. The Porto Rican collection afforded a single but very perfect external mold of this shell imprinted in the limestone.

Locality.—Near Quebradillas on Rio Guajataca, Station 134.—[Maury, 1920.]

This shell from the illustration is apparently related to *C. cancellata*. The remoteness of the concentric ribs, the general shape and the manner of the splitting of the radial ribs are characteristic of *cancellata*.

Holotype.—American Museum of Natural History, New York, N. Y.

Occurrence.—Miocene of Porto Rico (Maury).

CHIONE (CHIONE) QUEBRADILLENSIS GUAJATICA Maury

Plate XXXVII, Figure 12

Chione quebradillensis guajatica Maury, 1920, N. Y. Acad. Sci., vol. III, pt. 1, p. 40, pl. VII, fig. 5.

A fragmentary external mold was collected by Reeds which resembles the species described as *Chione quebradillensis*, but the ribs over the central area of the valves are paired and alternate with the fine, intermediate rib. This character is as in Guppy's *Chione walli*, but in the Porto Rican shell the concentric crenulated ridges are distant, while in *C. walli* they are very close, almost crowded.

Locality.—Near Quebradillas, Station 133.—[Maury, 1920.]

Holotype.—American Museum of Natural History, New York, N. Y.

Occurrence.—Miocene of Porto Rico. (Maury.)

CHIONE (CHIONE) CHIPOLANA Dall

Plate XXXVII, Figures 13, 14, 18, 19, 21

Chione chipolana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1290, pl. 55, fig. 20.

Oligocene of the Chipola horizon at Alum Bluff and on the Chipola River, Calhoun County, Florida; Dall and Burns.

Shell moderately convex, in general much resembling *C. cancellata*, but smaller, with the radial sculpture finer, the radii more numerous, the concentric lamellæ more regularly, evenly, and distinctly fluted on the ventral side, the lunule larger, and the pallial sinus more sharply angular. The mutations of the individuals pass through about the same range as in *C. cancellata*, but modified by the differences above noted. Length of a fully adult specimen 32.0, height 25.5, diameter 18.0 mm.—[Dall, 1903.]

The young of this species and of *cancellata* are very much alike and may be confused easily. Both have the radial ribs single, with the concentric ribs thin, sharp and separated widely. The young of both species are figured on plate XXXVII.

Holotype.—No. 114739. United States National Museum, Washington, D. C.

Occurrence.—Lower Miocene. Alum Bluff and on the Chipola River, Calhoun County, Florida (Dall); Bailey's Ferry, Fla. (Cornell Univ.

Pal. Lab.)

CHIONE (CHIONE) SANTODOMINGENSIS Pilsbry and Johnson

Plate XXXVIII, Figures 15, 16

Chione santodomingensis Pilsbry and Johnson, 1917, Proc. Acad. Nat. Sci., Phil., vol. 69, p. 199; Pilsbry, 1921, Proc. Acad. Nat. Sci., Phil., vol. 73, pt. II, p. 423, pl. 47, figs. 1, 2.

The shell resembles *C. chipolana*, but differs as follows. It is shorter and higher, the dorsal and anterior slopes forming a smaller angle. The concentric laminae are widely spaced, and continue over the lunule. The radial sculpture produced by splitting of the ribs is less even. There are fewer concentric ribs than in *C. chipolana* of the same size.

Length 17.4, alt. 16.4, semidiameter 5.7 mm.

Type No. 2777, A. N. S. P.

We have compared this with a long series of *C. chipolana* from the type locality and have no doubt of its distinction, though there is a general similarity.—[Pilsbry and Johnson, 1917.]

Occurrence.—Miocene of Santo Domingo. (Gabb coll. Acad. Nat. Sci. Phil.)

CHIONE PRIMIGENIA Pilsbry and Johnson

Plate XXXVIII, Figures 14, 17

Chione primigenia Pilsbry and Johnson, 1917, Acad. Nat. Sci. Phil., vol. 69, p. 199;

C. primigenia Pilsbry, 1921, *ibid.*, vol. 73, pt. II, p. 423, pl. 47, figs. 6, 7.

Related to *C. cancellata* and *C. chipolana*. The radial sculpture is coarser than in *chipolana*, the beaks are nearer the anterior end, and the tooth-plate is decidedly broader. The posterior end is more prolonged and cuneate than in *C. cancellata*, the concentric ribs are more delicate, the lunule far wider than *cancellata* of equal size and the beaks more anterior.

Length 26, alt. 21.6, semidiameter 8.2 mm.

Type, a right valve No. 2782. A. N. S. P.—[Pilsbry and Johnson, 1917.]

The form has a peculiar twist to the posterior end.

Occurrence.—Miocene of Santo Domingo. (Gabb Coll. Acad. Nat. Sci. Phil.)

CHIONE (CHIONE) EROSA Dall

Plate XXXVII, Figures 16, 17, 20, 22

Chione erosa Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1290, pl. 55, figs. 5, 8.

Miocene of Florida, sixteen miles southwest of Tallahassee near and at Jackson Bluff (upper bed); Vaughan.

Shell rather large, compressed, the sculpture behind the middle of the disk obsolete, the radial feebly defined, the concentric lamellae little elevated and distant; hinge normal, the teeth entire; anterior adductor scar elongated, posterior shorter and smaller; pallial sinus nearly obsolete; lunule slightly larger and proportionately narrower than in *C. cancellata*. Length 35, height 32, diameter 17 mm.

Many of the specimens have the sculpture almost entirely obsolete.—[Dall, 1903.]

Holotype.—No. 109237 United States National Museum, Washington, D. C.

Occurrence.—Lower Miocene. 16 miles southwest of Tallahassee and Jackson Bluff—(Dall). Upper Miocene. Upper beds at Jackson Bluff and Alum Bluff, Fla. (Cornell Univ. Pal. Lab.)

CHIONE (CHIONE) DALLIANA Maury

Plate XL, Figures 2, 7, 14, 15, 23

Chione veatchiana Maury, 1912, Jour. Acad. Nat. Sci., Phil., vol. 15, p. 58, pl. 9, figs. 17, 18.

Chione dalliana Maury, 1912, l. c., p. 59, pl. 9, fig. 16; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 158, pl. 28, fig. 10.
Chione guppyana Maury, 1912, l. c., p. 59, pl. 9, fig. 19; not *Chione guppyana* Gabb, 1873.
Chione dalliana var. *veatchiana* Maury, 1925, l. c., p. 158, pl. 28, fig. 14; var. *guppyana* l. c., p. 158, pl. 28, figs. 4, 13.

Shell subtriangular, with the posterior end rostrated; the amount of rostration varies; the sculpture consists of concentric and radiating ribs of equal prominence; the radiating ribs are fine and equal in width, closely set with only a very slight interspace; the space between the concentric ribs is about three times the width of the rib; on the anterior end there are from six to eight conspicuous, radiating plications formed by the grouping of the radiating ribs.

The figures given are of the type specimens from Trinidad. *C. guppyana* was described as differing from the other species described as *C. dalliana* and *V. veatchiana* in the lack of the radial plications. The removal of matrix from the anterior region of the type specimen of *C. guppyana* reveals the presence of the plications. The three holotypes have been figured (plate XL, figure 15) in juxtaposition in such a manner as to show the anterior end of each specimen.

It would seem that *C. veatchiana* should be differentiated from the other two shells because of the greater production of the posterior end but the peculiar characteristic sculpture is common to all the shells and more specimens of this species show that the longer or shorter shapes are not constant. This species is related very closely to the recent *Chione*, *C. subrostrata* (Lam.) (*Venus portesiana* D'Orb.). It might be a variety of the recent.

The name *Chione guppyana* was used by Gabb in 1873.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Late Pliocene or Pleistocene. Along the shore 1000 ft. west of the pier at Brighton, Trinidad, in an impure asphalt. Matura, Trinidad. (Maury). Collection made by A. C. Veatch in 1912 and G. D. Harris in 1920.

Section TIMOCLEA Brown, 1827



Fig. 22. Hinge of the type species of *Timoclea*

Timoclea Brown, 1827, Ill. Conch. Gt. Brit., 1st. ed. expl. pl. XIX, fig. 11; Brown, 1844, l. c., 2nd ed., p. 91, pl. 37, fig. 11, *Venus ovata* Pennant; *Pasiphaë* Leach, 1852, Syn. Moll. Gt. Brit., p. 30; not *Pasiphaë Spinola* 1851, Hymenoptera or Risso, 1826, Crustacea fide Dall; H. and A. Adams, 1857, Gen. Recent Moll., vol. II, p. 422; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 176; Fisher, 1887, Man. de Conch., p. 1084; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 358; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1286; Jukes-

Browne, 1914, Proc. Mal. Soc. Lon., vol. 11, p. 80.

Shell subovate, subcompressed, oblique, nearly equilateral; pale brown or yellowish, frequently mottled with rusty-brown; with strong, longitudinal, divergent ribs, crossed by fine, transverse striae, which produce tubercular elevations on the ribs, and give a beautifully cancellated appearance to the surface; umbones almost central, slightly inflated, with a subcordiform lunule under them, which is somewhat elevated in the centre; inside glossy, white, sometimes of a pale flesh-color, being frequently pale purple in the centre of the valves; margins slightly crenated. Length varying from half an inch to three-quarters.

Found on most of the British and Irish coasts. We met with a variety of this species in the estuary of the Clyde, in which the longitudinal ribs were set in pairs.—[Brown, 1844.]

Shell with predominant, radiating sculpture; concentric sculpture obscure; lunule narrow, impressed, elongate; three cardinals in each valve, left middle tooth, and right middle and right posterior teeth bifid or grooved, pallial sinus small; inner margin crenate.

Type.—*Venus ovata* Pennant. Plate XL, Figures 1, 5, 11, 31. Recent. Seas of England, Norway and the Mediterranean.

Numerous species from Miocene to Recent represent this section of *Chione*.

Stratigraphic Range of *Timoclea* section

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
		grus	grus	grus	grus
		retugida			pectorina
		præpectorina			pygmæa
		granulata			granulata

Section TIMOCLEA Brown

CHIONE (CHIONE) GRUS (Holmes)

Plate XL, Figures 13, 18, 21

Tapes grus Holmes, 1858, Post-Pl. Fos. S. Car., p. 37, pl. 7, fig. 5.

Venus trapezoidalis Kurtz, 1860, Cat. Sh. N. and S. Car., p. 5, fide Dall.

Venus pygmæa Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54, in part.

Chione (Timoclea) grus Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 375; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1299; Gardner and Aldrich, 1919, Proc. Acad. Nat. Sci., Phil., vol. 71, p. 10; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 106; var. Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 248, pl. 26, fig. 21.

Shell small, convex, transversely oblong, sub-rhomboidal, inequilateral, with twenty-five or twenty-six 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 sub-truncated, anterior margin shorter, regularly rounded; pallial margin crenated; pallial sinus deep; muscular impressions large.

This shell is now living on the coast of South-Carolina.

Plate VII. Fig. 5.

Locality. Simmons'.

Cabinet F. S. H.—[Holmes, 1858.]

The shell figured by Holmes as holotype is 5 mm. long. Specimens get to be twice that size. This species is like *T. pygmæa* in its rectangular shape but differs in the character of the radiating ribs. They are much finer in *grus* and tend to be in pairs. In *pygmæa* the ribs are single, larger with wider interspaces. The two species were confused formerly. They do not, however, have the same distribution; *pygmæa* is thought not to extend beyond Florida to the north.

Holotype.—?

Occurrence.—MIOCENE. Jackson Bluff, Ocklocknee River, Florida. (Vaughan in Dall). GATUN MIOCENE. Var. Coll. 4, Red Cliff Creek, Costa Rica (Olsson. Cornell Univ. Pal. Lab.). UPPER MIOCENE. *Duplin Stage*. Natural Well and Magnolia, Duplin county, N. C. (Dall) Curry, N. C. (Cornell Univ. Pal. Lab.). PLEISTOCENE. Caloosahatchee and Shell Creek, Florida. (Dall). PLEISTOCENE. Simmon's Bluff, S. C. (type, Holmes); New Orleans pumping station no. 7; New Orleans Gymnasium well at 1200 ft., Knapp's no. 2 well, Terrebonne Parish, 1434–1519, 1542–1632, 1780–1790, 1791–1842 ft., La. Bush-Johnson well at Logtown, Miss., at 280 ft. (Maury. Cornell Univ. Pal. Lab.). RECENT. Cape Hatteras, N. C., to Yucatan, 12–63 fathoms. (Dall)

CHIONE (CHIONE) PECTORINA (Lamarck)

Plate XL, Figures 20, 33

Venus pectorina Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 589.
Venus pectorina D'Orbigny, 1842, Voy. Merid. Amer., p. 555; not *Venus pectorina* Reeve, 1863, Conch. Icon., *Venus*, pl. VIII, fig. 25.

Chione pectorina Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 139.
Chione (Timoclea) pectorina Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 374; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 164, pl. 28, figs. 6, 8.
 V. testa ovato-cordata, longitudinaliter radiatimque sulcata, striis transversis decussata, pallide fulva, intus immaculata; pube litturis fuscis ornata.

Habite . . . les mers d'Amerique? Très voisine de la précédente. Elle est plus élégamment sillonnée, n'est tachée au dehors que par les litturations de son corselet. Lunule grande, en cœur, incolore. Largeur, 36 millimètres. Mon cabinet.—[Lamarck, 1818.]

Shell medium in size, quadrate, plump; sculpture intense and fine, radiating ribs more strongly developed, crossed by concentric lines which give the whole surface a fine, crenulated appearance; interspaces of the radials wide as the rib and bear a thread-like interstitial, this is developed from the mid-region of the shell ventrally and is not present on the umbonal area. It is developed best anteriorly and on the immediate, posterior portion, occurring rarely in an area between the central line and the extreme posterior border; lunule very large, impressed; radials prominent; escutcheon not impressed, marked only by a sharp, dorsal ridge and the absence of sculpture except the lines of growth; right side the larger with the growth lines finer. Color white, sometimes maculated anteriorly and posteriorly with brown; shell has a light brownish cast from remains of the epidermal covering. The following dimensions are those of the common size of the shell. The species attains a larger size. Specimens measure 38 mm. in length.

Dimensions.—32 mm., length; 29 mm., height; 21 mm., thickness.

Occurrence.—Antilles and south to Sao Paula, Brazil. Gulf of Paria between La Brea and San Fernando, Trinidad. (Cornell Univ. Pal. Lab.).

CHIONE (CHIONE) PYGMÆA (Lamarck)

Plate XL, Figures 16, 27, 28

- Venus pygmæa* Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 585.
Venus inequivalvis D'Orbigny, 1845, in Sagras, Hist. de La Isla de Cuba, Molluscos, p. 319, pl. 26, figs. 38-40.
Chione pygmæa Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 129.
Venus pygmæa Reeve, 1864, Conch. Icon., *Venus*, pl. 26, figs. 138, a, b, c; Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54, in part; Dall and Simpson, 1900, Bull. U. S. Fish. Com., vol. 1, p. 484.
Chione (Timoclea) pygmæa Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 375.
 V. testa ovata, depressiuscula, subdepressata, albida, rufo aut fusco maculata; lamellis transversis undato-crispis; pube lamellosa, natibus roseis.
 Cabinet de M. Valenciennes.
 Habite la mer des Antilles, a l'île de St.-Thomas. Coquille extremement petite, jolie, qui tient à la précédente par ses lames transverses, quoique plus couchées; et à la *V. marica*, par les lames qui bordent son corselet. Largeur, 10 millim.—[Lamarck, 1818.]

Shell small, rectangular, slightly compressed; inequivalved, left valve the larger; beaks small, situated one-fifth the distance from the anterior end; posterior dorsal line straight, sloping; posterior end nearly straight, rounded ventrally; surface decorated with radiating and concentric ribs, both well and equally developed; the radials are single with equal and subequal interspaces; lunule lanceolate, small; escutcheon narrow, sunken; color white with brown spots and streaks most prominent in the posterior dorsal region; the beaks with a beautiful pink spot.

Dimensions.—11 mm., length; 7.5 mm., height; 5 mm., thickness.

Occurrence.—Living on the Florida reefs and Antilles.

CHIONE (CHIONE) GRANULATA (Gmelin)

Plate XL, Figures 12, 17

- Venus granulata* Gmelin, 1792, Systema Naturæ, Tome I, pt. 6, p. 3277; 1797, Ency. Meth., pl. 272, f. 3 a, b; Dillwyn, 1817, Cat. Rec. Sh., p. 171; Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 589; D'Orbigny, 1845, in Sagras, Hist. de la Isla de Cuba, Molluscos, p. 318; Reeve, 1863, Conch. Icon., *Venus*, pl. 16, f. 62.
Chione granulata Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 138.
Venus plumbea Reeve, 1863, Conch. Icon., *Venus*, pl. 16, f. 65.
Venus granulata Dall, Bull. U. S. Nat. Mus., 37, p. 54; Dall and Simpson, 1900, U. S. Fish. Com. Bull., vol. 1, p. 484.
Chione (Timoclea) granulata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 374.
 V. testa rotundata desuccatim striata anterieus et margine crenulato violacea.
 Born. Mus. Cæs. Vind. test. t. 4, f. 5, 6.
 Chemn. Conch. 6, t. 30, f. 313.
 Habitat in Oceano americano, maricæ affinis, et vulva glabra nunc livida nunc albo et cærulescents varia, testa ipsa alba maculis lineisque angularibus lividis aut nigris varia, ano cordato impresso nigricante aut cærulescente.—[Gmelin, 1792.]

Shell medium in size, subquadrate; beaks small, low, full; sculpture of coarse predominate, radiating ribs crossed by obscure concentric lines which give the ribs a fine wavy or beaded character most distinct posteriorly; interspaces about half the width of the rib, increasing on the anterior and posterior regions; lunule well-defined, the radiating ribs continuing in the lunular space; escutcheon smooth, limited by a dorsal

ridge; the number and size of the radiating ribs is not constant.

Shell spotted with brown or purple, the deepest colors occurring on the posterior portion; surface of the interior is deeply colored with dark or light purple occurring on the anterior and posterior regions of the adductor scars, centrally beneath the hinge and over the hinge plate.

Specimens occur in the Bowden material that differ only slightly from the recent shells. They seem to be plumper and have a greater number of radiating ribs. The number of radiating ribs on the recent forms varies and may be as large a number as occurs on the Miocene specimens, but the usual number is less. The Bowden form might be described as a variety.

Dimensions.—26 mm., length; 22 mm. height; 8 mm., semidiameter.

Occurrence.—MIOCENE. Bowden, Jamaica. (Hodson Coll. Cornell Univ. Pal. Lab.). RECENT. Belize, West Indies south to Brazil. (Dall West Indies. (Newcomb coll. Cornell Univ. Pal. Lab.).

CHIONE (CHIONE) RETUGIDA Woodring

Plate XL, Figure 6a

Chione retugida Woodring, 1925, Carnegie Inst. Wash., Pub. No. 366, p. 161, pl. 22, figs. 5, 6.

Shell small, moderately inflated, elongate-ovate; groove bounding lunule shallow; escutcheon long and broad for size of shell, proximal half of its margin adjacent to ligament slightly raised; in front of ridge limiting escutcheon surface of shell slightly depressed toward ventral margin, but not enough to affect margin; sculpture consisting of a moderate number of concentric lamellæ and prominent rounded radials crossing the interspaces; near the lunule the edge of the concentric lamellæ are turned toward the ventral margin and slightly frilled, but over remained of anterior two-thirds of shell the edge is turned toward the umbo, thickened toward the ventral margin and frilled; obscure continuations of lamellæ extend across the lunule; right (3a) and left (2a) anterior cardinal parallel to dorsal margin of shell; left middle cardinal (2b) obscurely bifid.

Length 7 mm.; height 5.5 mm.; diameter (left valve) 1.5 mm.

Most of the valves are larger than the holotype, but are somewhat worn. The largest has the following dimensions: length 9.8 mm.; height 7 mm.; diameter 2.1 mm. The concentric sculpture resembles that of *C. sawkinsi*. As in *C. sawkinsi*, on small valves all the lamellæ are frilled. On adult valves they are thickened and smooth over most of the anterior two-thirds. The radial ribs are similar to those of *C. woodwardi*.

Type material.—Holotype (left valve, U. S. Nat. Mus. No. 352837).—[Woodring, 1925.]

Occurrence.—Miocene. Bowden, Jamaica.

Section CLAUDINELLA Gray



Fig. 23. Hinge of the type species of *Clausinella*

Clausinella Gray, 1851, List Brit. An. Brit. Mus., p. 12; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 358; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1288; Jukes-Browne, 1914, Proc. Mal. Soc. Lon., vol. 11, pt. 1, p. 80.

Shell small; ovate; thick, hinge of *Chione* s. s.; sinus of the genus; inner margin very finely crenate; sculpture of broad, concentric, undulating ribs with wide interspaces; concentric ribs continuous over the whole shell; radial sculpture absent.

Type *Venus fasciata* Da Costa. Plate XLI, Figures 4, 11, 16, 17. Recent. Europe.

Specimens of *Chione* have been seen in collections or reported in literature, from the eastern American Tertiary which might belong to the section *Clausinella*. The specimens have usually been few and worn so that the data as yet is not definite.

Section CLAUSINELLA Gray

CHIONE (CHIONE) SANCTI-DAVIDIS Maury

Plate XLIV, Figure 10

Chione (*Clausinella* ?) *sancti-davidis* Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 161, pl. 28, fig. 12.

In the collection is a single worn valve of a *Chione* which is of special interest since it appears to be a representative of the section *Clausinella* which is not now living in the North American or the Antillean seas.

The shell is small, oblong-trigonal, very flat. The surface is sculpture with very round, concentric ribs, the interspaces about equalling the ribs in width. Both on the ribs and on the posterior region are distinct traces of concentric striae. These may possibly be a deception due to wearing, but seem rather to be the fine concentric lines characteristic of the section *Clausinella*, of which the European shell, *Chione fasciata* Donovan, is the type. The Trinidad shell is much longer, with the posterior end far more produced than in *C. fasciata*, and the beak is lower and less curving. But it is quite probable that our fossil is a member of the same section. This can only be proved by more perfect specimens. Length of shell 13, altitude 11, semidiameter 3 mm.

A species of *Clausinella* is also listed by Drs. Vaughan and Woodring from the Province of Barabona, Dominican Republic.

Locality.—Matura.

Horizon.—Upper Pliocene.—[Maury, 1925.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Section CHAMELEA Mörch



Fig. 24. Hinge of the type species of *Chamelea*

Chamelea Mörch, 1853, Cat. Yoldi, II, p. 23; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 422; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 176; Fischer, 1887, Man. de Conch., p. 1084; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 359; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1289; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 81.
in part *Clausinella* Cossmann and Peyrot, 1911, Actes Soc. Linn. Bordeaux, Tome LXIV, p. 327.

Shell medium, inequilateral; anterior end short; beaks high; lunule impressed, cordate, smooth; escutcheon not well marked, smooth, bounded only by a ridge; inner margins crenate; pallial sinus small; ligament ex-

posed; teeth consist of three cardinals in each valve; right posterior lateral bifid; sculpture of close, concentric ribs.

Type.—*Venus gallina* Linnæus. Plate XLIII, Figures 21, 29, 30, 34. Living. Mediterranean Sea.

The eastern American species occur in the Oligocene and Miocene.

Stratigraphic Range of *Chamelea* section

<i>Eocene</i>	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
	<i>spada</i>	<i>dalli</i>			
	<i>rhodia</i>				
	<i>nuciformis</i>				
	<i>craspedonia</i>				

Section CHAMELEA Mörch

CHIONE (CHIONE) SPADA Dall

Plate XLIII, Figure 37

Chione (Chamelea) spada Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1301, pl. 55, fig. 13; Dall, 1903, U. S. Nat. Mus., Bull. 90, p. 149, pl. 24, fig. 5.

Oligocene of the siliceous beds of Ballast Point, Tampa Bay, Burns, Dall and Crosby; and of Bailey's Mill Creek Sink, Florida, L. C. Johnson.

Shell resembling *C. nuciformis* but more produced and pointed behind, with a distinct keel bordering the escutcheon, which is flat and smooth in the left valve; hinge normal, adductor scars subequal, pallial sinus small, angular; there is usually no radial striation, but the inner margins of both species are minutely crenulate. Length (elongate specimen) 29, height 23, diameter 14 mm.; of a short specimen, length 26, height 24, diameter 16 mm. Some specimens reach a length of 33 mm., and one of these shows a few obsolete radial striae on the anterior portion of the disk, but as these appear only on one valve they are probably pathological. Among some fifty other valves no other shows any radial sculpture.—[Dall, 1903.]

Holotype.—163371. United States National Museum, Washington, D. C.

CHIONE (CHIONE) RHODIA Dall

Plate XLIII, Figure 23

Chione (Chamelea) rhodia Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1301, pl. 55, fig. 10; Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 149, pl. 25, fig. 6.

Oligocene of the Ballast Point siliceous beds near Tampa, Florida, Dall; and of the Oak Grove sands, Santa Rosa County, Florida, Burns.

Shell small, solid, inequilateral, the beaks at the anterior sixth, high, pointed, decurved, over an impressed, cordate, striate lunule of moderate size; escutcheon elongated, large, smooth in the left valve, bordered by a keel at which the concentric sculpture ceases; anterior slope short, concave, posterior arcuate, both ends bluntly rounded, base evenly arcuate; sculpture of concentric lamellae more elevated on the posterior slope, with wide concentric striated interspaces and no radial sculpture; hinge well developed, pallial sinus angular, nearly reaching the middle of the disk, adductor scars subequal; inner margins minutely crenulate. Length 18, height 17, diameter 10 mm.

Though this species is only represented by a small amount of material, it seems a well-characterized form.—[Dall, 1903.]

Holotype.—109229. United States National Museum, Washington, D. C.

CHIONE (CHIONE) NUCIFORMIS (Heilprin)

Plate XLIII, Figure 35

Cytherea nuciformis Heilprin, 1887, Trans. Wag. Inst. Sci., vol. I, p. 116, pl. 16, fig. 61.

Chione (Chamelea) nuciformis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6,

p. 1300, pl. 55, fig. 9; Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 148, pl. 25, fig. 5. Shell erect, sub-trigonal, moderately convex; base evenly rounded, posterior slope rapidly declining; beaks elevated; surface covered with fine concentric lines of growth, disposed in a somewhat interrupted series; teeth.

Length .8 inch; height .7 inch.

Several specimens which can be readily identified by their small size and erect outline.—[Heilprin, 1887.]

The original illustration of this species is not distinct. Dr. Dall further illustrated the shell by a drawing in the Transactions of the Wagner Free Institute, a copy of which is given on plate XLIII. Size, 24 mm., length; 21 mm., height; 13 mm., diameter. (Dall).

The type locality for the species is the Tampa silex beds at Ballast Point, Tampa Bay, Florida, and Dr. Dall speaks of the shell as being one of the common species at that locality.

Holotype.—Wagner Free Institute of Science, Philadelphia, Pa.

CHIONE (CHIONE) CRASPEDONIA Dall

Plate XLIII, Figures 28, 36

Chione (? *Chamelea*) *craspedonia* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1300, pl. 55, fig. 2.

Lower Oligocene of Vicksburg and Eocene of Red Bluff, Mississippi; Burns, Schuchert, and Johnson.

Shell short-ovate or rounded-trigonal, inequilateral, the beaks nearly smooth, low, prosogyrate, situated slightly behind the anterior third; lunule cordate, sharply defined by an incised line, not impressed, nearly smooth; escutcheon elongate, sharply defined by a keel, which is more pronounced on the left valve; surface sculptured with small, regular, even concentric lamellæ, separated by wider interspaces which are concentrically striated; the lamellæ on the anterior two-thirds of the shell frequently show obsolete cross-striation which does not affect the interspaces; anterior slope nearly straight, posterior slope somewhat convex, ends rounded, base convexly arcuate; hinge well developed, the larger cardinals sometimes faintly grooved; adductor scars nearly equal; pallial sinus small, angular; basal and anterior margins minutely crenulate. Length 28, height 24, diameter 14 mm.

I thought at first that this attractive species might be referred to *Chione* s. s., but finally decided to put it in this section with a mark of doubt. It is certainly on the border line between the two sections. There is some variation in the closeness of the lamellation, though very little in the general form. The figure given by Conrad of the *Chione mississippiensis* is so remarkably different in outline that, unless Conrad's type was entirely abnormal, no question of their identity could arise.—[Dall, 1903.]

A single specimen from Vicksburg occurs in the Cornell collection. This we have figured under this species, pl. 43, fig. 36. The general shape and the sculpture is so like the figure of Dall for *C. craspedonia* that we hesitate to separate the form. The anterior end of the holotype is more produced than the Cornell specimen and hence perhaps the latter ought to be made a variety. We leave the specimen for further comparison with type material.

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Oligocene. Vicksburg and Red Bluff, Miss. (Dall); Mint Spring Bayou, Vicksburg, Miss. (Cornell Univ. Pal. Lab.)

CHIONE (CHIONE) DALLI Olsson

Plate XLI, Figures 1, 2, 6

cf. *Chione* sp. indet. Dall, 1903, Trans. Wag. Inst. Sci., vol. II, pt. 6, p. 1290.

Chione dalli Olsson, 1914, Bull. Amer. Pal., vol. 5, No. 24, p. 19, pl. 3, figs. 7-9.

Shell ovate to triangular, slightly convex, very solid; beaks prominent, approximate, sub-acute; lunule lanceolate, defined by an impressed line, smooth or with lines or growth; escutcheon long and narrow, smooth; surface of shell with thick, flattened, concentric lamellæ, fairly regularly arranged on the umbo, later becoming irregular and coalescing towards the basal margin; no radial sculpture present; hinge fairly heavy, with three cardinal teeth in each valve; pallial sinus merely a small notch; margin minutely crenulated.

Type. Length 23, height 20, thickness 6 mm.

Larger shell. Length 25, height 21, thickness 6 mm.

On page 1290 Dr. Dall, in his Tertiary Geology of Florida, vol. 3, pt. 6, briefly describes without naming a *Chione* from Petersburg, Virginia, which appears to belong to this species. This species bears some resemblance to *C. cortinaria* Rogers but may be distinguished by its irregular concentric lamellæ and the entire absence of the radial sculpture. At Claremont wharf the species occurs in the blue clays of the St. Mary's formation, accompanied by several unusual species. *Arca virginia* Wagner is very common here, and a small triangular *Glycymeris* like *Pectunculus virginia* Wagner showing relationship with *G. subovata* Say, of which it is probably a mutation.

St. Mary's formation; James River at Claremont wharf, Va.—[Olsson, 1914.]

Syntypes.—Cornell University Paleontological Museum, Ithaca, N. Y.

Subgenus ANOMALOCARDIA Schumacher



Fig. 25. Hinge of the type species of *Anomalocardia*

Anomalocardia Schumacher, 1817, Essai Meth., p. 134, pl. 20, fig. 4; Deshayes, 1853,

Cat. Conch. Brit. Mus., pt. I, p. 115.

Triquetre Blainville, 1818, Dict. Sci. Nat., X, Tableau; Blainville, 1825, Man. Mal. et Conch., p. 557; not *Triquetra* Conrad, 1846.

Cryptogramma Mörch, 1853, Cat. Yoldi, II, p. 22; H. and A. Adams, 1857, Gen. Rec.

Moll., vol. II, p. 420; Chemnitz, 1862, Man. de Conch., p. 83; Tryon, 1884,

Struct. and Syst. Conch., vol. III, p. 176; Fischer, 1887, Man. de Conch., p. 1083.

Anomalocardia Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 359; Dall, 1903,

Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1301; Jukes-Browne, 1914, Proc. Mal.

Soc. Lond., vol. 11, p. 80.

Anomalocardia Klein.

Pl. XX fig. 4.

Testa triangularis, antice elongata-rostrata, æquivalvis, ventricosa.

Cardo: in valva sinistra dentes duo cardinales; posterior conico-triangularis, acutus, subrecurvus; anterior linearis, subnympha parallelus. In valva dextra dentes duo cardinales; posterior compressiuscula, erectus, obtusus, anterior triangularis, decumbens.

Nympha parvæ interne crenulata.

Anomalocardia rugosa.

Pl. XX, fig. 4. *Venus flexuosa* Lin. Chemn. 6. pag 332. Tab. 3.—[Schumacher, 1817.]

Shell thick, valves rostrate; umbones moderate; escutcheon small; lunule large, impressed; three cardinals in each valve; middle left cardinal large, posterior left cardinal long and thin; right nymph and left, posterior cardinal rugose; pallial sinus very small; inner margins crenate; ligament short and exposed.

Genoholotype.—*Venus flexuosa* Linnæus. Plate XXXVI, Figures 10,

13. Recent. West Africa.

The eastern American species of the subgenus s. s. range from the

Oligocene with several species in the recent fauna.

Stratigraphic Range of <i>Anomalocardia</i> subgenus s. s.					
Eocene.	<i>Oligocene</i>	<i>Miocene</i>	<i>Pliocene</i>	<i>Pleistocene</i>	<i>Recent</i>
	<i>floridana</i>	<i>chipolana</i>		<i>brasiliana</i>	<i>brasiliana</i>
	<i>penita</i> ?	<i>brasiliana</i>	<i>caloosana</i>	<i>caloosana</i>	<i>cuneimeris</i>
		<i>dupliniana</i>			<i>leptalea</i>
					<i>membranula</i>
					<i>puella</i>

Section ANOMALODISCUS Dall

Anomalodiscus Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 359; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1303; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 80.
Surface with reticulate subequal sculpture, a dull papery periostracum, and the hinge without rugosities. Indo-China.—[Dall, 1902.]

Type.—*Cytherea squamosa* Lamarck. Recent. Indian Ocean.

This section has not been found as yet in the Eastern American fauna.

Section ANOMALOCARDIA

CHIONE (ANOMALOCARDIA) FLORIDANA (Conrad)

Plate XLIII, Figures 5, 16, 18, 24, 25, 26

Venus floridana Conrad, 1846, Am. Jour. Sci., 2nd ser., vol. II, p. 400, text figure.
Cryptogramma floridana Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 7.
Venus penita Heilprin, 1887, Trans. Wag. Inst. Sci., vol. I, p. 116.
Anomalocardia floridana Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1303, pl. 55, figs. 14, 15; Dall, 1915, Bull. U. S. Nat. Mus., 90, p. 150, pl. 23, figs. 4, 5.
Triangular, with concentric distant ribs; umbo broad, elevated; ligament margin oblique, straight; valves slightly flattened or compressed posteriorly, extremity angulated.

Occurs with the preceding.—[Conrad, 1846.]

Specimens labelled *A. penita* were found in the collection of the Academy of Sciences at Philadelphia but since the specimens are more nearly like the *A. floridana* Conrad and are what Dr. Dall has identified as *A. floridana*, the labels of the collection were probably those of Heilprin. Conrad's figure of the species is not very good. Dr. Dall reillustrated the species and we have included figures of specimens from the Academy collection. The specimens vary greatly in size as may be seen by the illustration herein and the table of measurements given by Dr. Dall. (1903.) The lunule is deep. A sharp ridge extends along the posterior ridge from the umbo to the ventral margin. The ventral margin is rounded and the posterior end is pointed.

Dimensions.—Average. 32 mm., length; 22 mm., height; 18 mm., thickness.

Occurrence.—Oligocene. Siliceous beds, Ballast Point, Tampa Bay, Sopchoppy limestone, Bailey's Mill Creek Sink and Tampa limestone overlying the siliceous beds at Ballast Point, Florida. (Dall)

CHIONE (ANOMALOCARDIA) PENITA (Conrad)

Plate XLIV, Figure 11

In the Amer. Jour. Sci., 2nd ser., II, p. 399, 1846, Conrad described

from Tampa Bay another species besides *A. floridana*, which he called *Venus penita*. The illustrations of both species are not good and *V. penita* has not since been identified. The following is Conrad's description:

Cuneiform, concentrically striated, the lines strong anteriorly, posteriorly less distant, posterior side produced, compressed, extremity angulated; ligament margin very oblique and straight from umbo to extremity; summits very prominent; cardinal teeth very robust; basal margin slightly arched posteriorly; inner margin crenulated. Ballast Point, Tampa Bay.

Little of the shell remains, which exhibits those radiating furrows common to all the chalky specimens of the genus in a fossil state. A cast of the hinge shews the form of the teeth, and an impression in the rock copies the exterior characters of the shell.

In the Eocene and Oligocene Checklist of 1866, Conrad questioned *Cryptogramma penita*.

Dr. Dall, 1903, was not able to reidentify the species.

CHIONE (ANOMALOCARDIA) CHIPOLANA Dall

Plate XLIII, Figure 32

Anomalocardia chipolana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1304, pl. 55, fig. 1.

Oligocene of the Chipola horizon at Alum Bluff, Calhoun County, Florida; Burns. Shell small, trigonal, produced behind, sculptured with elevated concentric lines, more crowded towards the base; both lunule and escutcheon feebly defined, beaks low and pointed; hinge very delicate, normal, the internal margin faintly crenulate; both ends of the shell rounded, the base with hardly any flexuosity. Length 6.5, height 5.0, diameter 3.0 mm.

A single valve, perhaps young, was obtained and is named to fix the presence of the genus in these beds, from which it has been otherwise, so far, unknown.—[Dall, 1903.]

Holotype.—No. 114592. United States National Museum, Washington, D. C.

Occurrence.—Lower Miocene. Chipola horizon. Alum Bluff, Fla.

CHIONE (ANOMALOCARDIA) CUNEIMERIS (Conrad)

Plate XXXVI, Figures 11, 12, 14

Venus cuneimeris Conrad, 1846, Proc. Acad. Nat. Sci., Phil., vol. 3, p. 24, pl. I, fig. 13.

Venus macrodon Reeve, 1863, Conch. Icon., *Venus*, pl. XXI, fig. 98a, not *Cythera macrodon* Lamarck, 1818.

Anomalocardia rostrata Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54.

Anomalocardia cuneimeris Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 376;

Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 107.

Inequilateral, triangular; ventricose anteriorly; flexuous and compressed posteriorly; posterior side cuneiform; surface with obtuse concentric ribs, profound on the umbo, and with minute radiating raised lines; color yellowish, varied with fulvous or brown, sometimes in spots, in other specimens with rays; within purple and white, with a whitish margin.

Locality. Tampa Bay.—[Conrad, 1846.]

This species is small, the concentric ridges are strong for the size of the shell. The radiating lines are obscure or may not be noted; a large number of the specimens will have nearly the whole of the interior of a deep purple or reddish color with a very narrow, white border along the ventral margin. Some are pure white on the interior with an intense, dark area along the posterior margin.

Dimensions.—18 mm., length; 13 mm., height; 10 mm., width.

Holotype.—?

Occurrence.—Recent. Tampa, Fla. (type) From Florida to Colombia. Not reported from the Antilles. (Dall)

CHIONE (ANOMALOCARDIA) LEPTALEA Dall

Plate XXXVI, Figure 22

Venus (Anomalocardia) leptalea Dall, 1894, Bull. Mus. Comp. Zool., Har. Col., vol. XXV, p. 114, fig. 5.

Anomalocardia leptalea Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 376. This is another form strictly confined to the lagoons. It is closely related to *V. (A.) rostrata* Sby., which is its open-sea representative, and which was first described by Conrad from Florida under the name of *Venus cuneimeris* (Proc. Acad. Phila., III, 24, Plate I, Fig. 13, 1845). From the latter *V. leptalea* differs by its smaller size (13–16 mm.), paper thinness, less impressed dorsal areas, its concentric ribs represented by elevated lamellæ, instead of rounded wavelets, and its color by zigzag lines, rather than radiating bands. The variations in outline are about the same in both; there are no traces in *V. leptalea* of radiating sculpture, the dorsal areas are usually dark, even if the rest of the valve is pale; the hinge is very feeble and the pallial sinus obsolete. The group is also known as *Cryptogramma* Mörch. —[Dall, 1894.]

Holotype.—No. 127527. United States National Museum, Washington, D. C.

Occurrence.—Living, Watling Island, Bahamas. Very abundant.

CHIONE (ANOMALOCARDIA) CALOOSANA Dall

Plate XXXVI, Figures 1, 2, 3, 4, 9

Venus (Anomalocardia) caloosana Dall, 1900, Trans. Wag. Inst. Sci., vol. III, pt. 5, p. 1198, pl. 42, fig. 10.

Anomalocardia caloosana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1305. Pliocene of the Caloosahatchie beds, on the Caloosahatchie and Myakka Rivers and Shell Creek, Florida; Pleistocene of North Creek, near Osprey, Florida.

Shell elongate, with low, pointed beaks, the anterior end rounded and swollen, the posterior end compressed, attenuated, and rostrate; the posterior dorsal slope long and straight; the base convex and slightly flexuous behind; sculpture of concentric waves, not coincident with the lines of growth and steeper on their dorsal slopes; these frequently become enfeebled or obsolete between the middle of the shell and the radial ridge bounding the escutcheon; lunule defined by an impressed line, lanceolate and narrow; escutcheon striated, impressed, bounded by a radial ridge which extends from the beaks to the rostrum; hinge delicate, normal, the rugosities distinct when adult; basal margin crenulate; pallial sinus obsolete, not passing in front of the posterior adductor scar. Length 28, height 20, diameter 14 mm.

While this species has its range of variation like others, its most prominent characteristic is the presence and persistence of the concentric sculpture, which in the great majority of specimens is continuous across the disk.—[Dall, 1900.]

Holotype.—No. 109242. United States National Museum, Washington, D. C.

CHIONE (ANOMALOCARDIA) DUPLINIANA Dall

Plate XLIII, Figure 27

Anomalocardia dupliniana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1305, pl. 55, fig. II.

Upper Miocene of the Natural Well, Duplin County, North Carolina; Burns.

Shell small, trigonal, high, with high, quite anterior beaks, the lunule and escutcheon not defined; anterior end rounded; posterior end produced, blunt; base moderately arcuate, not flexuous; surface smooth with feeble concentric striation, stronger posteriorly; hinge normal, feeble; inner margins entire; pallial sinus small, angular. Length 5.0, height 4.2, diameter 2.5 mm.

In this case also a single juvenile valve represents the genus in this horizon. In the older Miocene of Virginia and Maryland conditions were so much colder that it seems improbable that *Anomalocardia*, which is a tropical or subtropical genus, will

ever be found.—[Dall, 1903.]

Holotype.—115169. United States National Museum, Washington, D. C.

CHIONE (ANOMALOCARDIA) BRASILIANA (Gmelin)

Plate XXXVI, Figures 5, 6, 7, 8, 15, 16, 17, 17a, 18

Venus flexuosa Born, 1780, Test. Mus. Cæs. Vind., p. 62, pl. IV, fig. 10, not of Linnaeus, 1767.

Venus brasiliانا Gmelin, 1791, Systema Naturæ, Tome VI, p. 3289.

Cytherca macrondon Lamarek, 1818, Hist. des An. sans Vert., Tome V, p. 580.

Anomalocardia flexuosa Deshayes, 1853, Cat. Conch. Brit. Mus., pt. I, p. 116.

Venus macrondon Sowerby, 1855, Thes. Conch., II, p. 717, pl. 156, figs. 88, 89, 90.

Venus flexuosa Dall, 1883, Proc. U. S. Nat. Mus., vol. 6, p. 341; Dall and Simpson, 1900, Bull. U. S. Fish. Com., vol. 1, p. 484.

Anomalocardia brasiliانا Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 375;

Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1306; Maury, 1920, Bull.

Amer. Pal., vol. 8, No. 34, p. 106; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 165, pl. 29, figs. 10, 11.

Pitaria cf. *circinata* Maury, 1925, Ser. Geol. e Min. do Brazil, Mon., vol. IV, p. 453, pl. 18, fig. 2.

V. testa lentiform fusco lutea: striis transversis tenerioribus distantibus, ano cordata vulvaque latis caerulescentibus.

Bonnann. recr. 3 f. 345.

mus. Kirch. 2 f. 102

Habitat frequens in Brasiliæ littore, natibus versus inflexis.

β *Bonnann. recr.* 3, f. 380

mus. Kirch. 2 f. 114.—[Gmelin, 1791.]

Shell medium in size; variable in shape and ornamentation; commonly the posterior end is much produced with a pronounced umbonal ridge extending along the posterior slope from the beak to the posterior, ventral margin; the sculpture consists of prominent, concentric ribs which are developed best anteriorly and over the posterior ridge as well as on the umbonal region. Many large specimens have the area just anterior to the posterior ridge and the ventral region smooth. Some shells have the sculpture developed over the whole surface of the shell. These, when compared with the sculpture on the umbonal region of the partially smooth specimens are seen to be of the same species. Very fine, radiating striations are present. Some specimens are shortened posteriorly and the posterior end is more rounded. The color is light mottled with blackish or reddish, zigzag lines. The subgeneric characters are typical.

Dimensions.—40 mm., length; 28 mm., height; 21 mm., semidiameter.

Occurrence.—Upper Miocene. Freeport—Todd's Rd. (with *Arca patricia*), Trinidad. Upper Pliocene. Matura, Trinidad. (Maury, Harris Coll. Cornell Univ. Pal. Lab.). Pliocene or Pleistocene. Bahia de Turv, Brazil. (Maury). Recent. Wilmington, North Carolina, thru the West Indies and south to Rio de Janeiro, Brazil. (Dall) (Newcomb coll., Maury coll., Harris coll. Cornell Univ. Pal. Lab.)

CHIONE (ANOMALOCARDIA) MEMBRANULA Römer

Anomalocardia membranula Römer, 1860, Mak. Blätter, VII, July, pp. 163-165; Dall,

1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 376.

T. parva, tenui, fragili, diaphana, cordato-trigona, transversa, valde inequilateralata compressiuscula, antice fere circulariter curvata, postice producta, rostrataque intus extusque albidoferruginea, nitente; lamellis transversis parvum elevatis, filiformibus (c. 25), postice fere evanescentibus sen in strias subtiles conversis; longitudinis positis; margine ventrali antice medioque valve curvato, postice extenso, dorsali antice rotundato, valde descendente, postice subrecto, vix declivi, producto; lunula aegre conspicua, medio elevata, compressa, area sen tota declivitate postica lanceolato-ovata, medio convexa, per marginem subacutum, ab umbonibus decurrentem notabiliter limitata, sinu pallii latissimo, minuto, curvato; dentibus cardinalibus tenuibus, maxime divaricatis tertio in utraque valve cum nympha confluyente; margine interno subtilissime crenulato. Long. II, alt. 7.5. crass. 5 mill.

Habitat ad Insulam St. Thomas, Antillarum.

Der Habitus dieser kleinen und zierlichen Art erinnert eher an eine *Maetra* als an eine *Venus*; aber Schloss, Ligament, Mantel bucht weisen sie entschieden zur letzt genannten Gattung und zwar zur oben angegebenen Abtheilung derselben. In dieser entfernt sie sich ziemlich weit von den andern Arten und schliesst sich an *A. puella* Pfeiff. (Phil. Abbild. II p. 108. 18. N. 4. t. 5. f. 4.) an. Diese hat fast ebenso dünne Schalen, besitzt eine ähnlich querverlängerte, dreieckig-herzförmige Gestalt mit kurzer Vorder-, lang vorgezogener Hinterseite und sehr kleiner, abgerundeter Mantelbucht. Aber in unser Art sind die fadenförmigen Querlamellen reicher (23 gegen dort 13) und verschwinden hinten fast ganz, während dieselben bei *A. puella* hier selbst nur niedrigen werden; in dieser sind eine lanzett förmige Area und Lunula vorhanden und ihr mangelt die von den Wirbeln zum Hinterrande gehende, eine grosse, mitten erhabene, lanzett-eiförmige Area abgrenzende Kaute. Die Färbung der *A. puella* ist gelblich, hinten bläulich, mit unterbrochenen braunen Strichelchen, während die *A. membranula* hellrothfarbig ist mit weissen Stellen.—[Römer, 1861.]

CHIONE (ANOMALOCARDIA) PUELLA (Pfeiffer)

Venus puella Pfeiffer, 1846, in Philippi Abb. and Besch. Conch., II, pt. 18, p. 108, pl. 5, fig. 4.

Chione puella Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 125.

Anomalocardia puella Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 376.

V. testa parva, tenui, oblonga, valde inaequilatera, postice rostrata, albida, lineolis radiantibus, interruptis, fuscis picta; lamellis transversis parvum elevatis, subfiliformibus (circa 13); area lunulaque lanceolatis fuscis; margine interno crenulato. Long 5 3/4 ''''; alt 4 ''''; crass. 2 ''''.

Patria: Cuba, Punta de Maya sinus Matanzani.

Eine kleine, dünnchalige, zierliche Art. Die Wirbel liegen im dritten Theil der Länge, die beiden Rückenrände sind schwach gewölbt, fast gerade; der Bauchrand vorn stärker gewölbt als hinten, so dass die hintere Extremität geschnebelt wird. Etwa 13 seine, kurze, daher beinahe fadenförmige Querlamellen gehen ohne alle Unterbrechung von einer Seite zur andern sind aber auf der hintern Extremität niederliegend. Area und Lunula sind beide schmal letztere etwas gestreift; das Schloss hat drei Zähne wie gewöhnlich; die Mantelbucht ist gang klein, abgerundet und bildet auch mit dem dem Bauchrande parallelen Theil des Mantelindrucks ebenfalls eine Abrundung, keine Winkel. Die Färbung ist aussen gelblich, an der hinteren Extremität bläulich mit unterbrochen braunen, senkrecht auf die Querlamellen stehenden Strichelchen; Area und Lunula sind bräunlich dunkleren Linien. Innen ist das Gehäus bräunlich. Der Rand ist sehr fein gekerbt, namentlich auch am Schlosse. Ich fand die zierliche Muschel spärlich in einem Brachwassersumpf auf der Punta de Maya am Eingange der Bai von Mantanzas.—[Pfeiffer, 1846.]

Anomalocardia bowdeniana Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1304, pl. 57, fig. 7, is *Pliocardia bowdeniana* (Dall), the genoholotype of *Pliocardia* Woodring, 1925, Carnegie Inst. Wash., Proc., No. 366, p. 147, pl. 20, figs. 1-5 and is placed in the family Pliocardiidae. The species is from the Miocene of Bowden, Jamaica.

Subgenus GOMPHINA Mörch

Fig. 26. Hinge of the type species of *Gomphina*

Gomphina Mörch, 1853, Cat. Yoldii, p. 19; not H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 424; Stoliczka, 1871, Pal. Indica, vol. III, p. 149; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 177; Fischer, 1887, Man. de Conch., p. 1086; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 359; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1289; not Jukes-Browne, 1909, Proc. Mal. Soc. Lond., vol. 8, p. 233; not Jukes-Browne, 1914, *ibid.*, vol. 11, p. 85.

Shell trigonal, smooth; umbos small; inner margins smooth; lunule large, elongate, not deeply impressed but bounded by an incised line; no escutcheon; teeth as in the genus; right nymph and left, posterior cardinal rugose; pallial sinus short, and rounded in front.

Genolectotype.—*Venus undulosa* Lamarck. Plate XLI, Figures 23, 29, 30, 35, 39. Recent. New Holland.

This subgenus is not known definitely in the fauna of the region studied.

Dr. Dall listed a single species of *Chione* (*Gomphina*) *Kochii* Philippi, 1843, from the Caribbean coast at Belize, British Honduras. See Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 375, 1902. A single valve was found of which the origin is uncertain. The species was described from Mozambique. Sowerby lists also Zanzibar. We thus have not included the species with the list of eastern American *Chiones*.

Subgenus LIROPHORA Conrad

Fig. 27. Hinge of the type species of *Lirophora*

Lirophora Conrad, 1863 for 1862, Proc. Acad. Nat. Sci. Phil., vol. 15, pp. 575, 586; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 358; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, pp. 1288, 1293; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 81.

Triangular, thick in substance, with eight, broad prominent recurved ribs, striated at the base; ribs without posterior laminae; lunule cordate.

V. latilirata, Tuomey & Holmes (not Conrad).

Locality.—Virginia.

Distinguished from *latilirata* by its more numerous and narrow ribs and larger size. The marginal crenulations are much less distinct and the umbo broader.

The subgenus is characterized by broad, thick, recurved ribs. The following recent species belong to it. *Venus tiara*, Dill.; *V. paphia*, L.; *V. kelletii*, Hinds; *V. varicoso*, Sowerby; *V. fasciata*, Don.—[Conrad, 1863.]

Shell heavy; lunule sunken; teeth as of the genus; surface with broad.

concentric, lamellose ribs; right nymph and left, posterior cardinal with a narrow rugose area.

Genoholotype.—*Venus athleta* Conrad (= *C. latilirata* Conrad). Plate XLI, Figures 7, 12, 13, 21, 31, 32, 33, 34; Plate XLII, Figure 19. Miocene to Recent, Maryland to Florida. Living from Cape Hatteras to Rio Grande do Sul, Brazil.

The subgenus in eastern America is represented from the Oligocene thru the recent fauna.

Stratigraphic Range of *Lirophora* subgenus

Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
	ballista	alveata	latilirata	latilirata	paphia
	victoria	chiriquiensis	riomaturensis		latilirata
		burnsi			
		parkeria			
		caroniana			
		mactropsis			
		glyptocyma			
		ebergenyi			
		hotelensis			
		ballista			
		xesta			
		ulocyma			
		holocyma			
		carlottæ			
		victoria			
		hendersoni			
		latilirata			
		thalassopora			
		præpaphia			
		penthesilæ			

CHIONE (LIROPHORA) BALLISTA Dall

Plate XLII, Figure 25

Chione (Lirophora) ballista Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1295, pl. 55, fig. 23; Dall, 1915, U. S. Nat. Mus. Bull., 90, p. 149.

Oligocene silex beds at Ballast Point, Tampa Bay, Florida; Crosby, Burns and Dall.

Shell rather small, arcuate-trigonal, with small, acute umbones, and from eight to ten heavy concentric recurved ribs, not confluent but bent backward and attenuated near the posterior dorsal border; lunule narrow, striated, small; also the escutcheon; obsolete radial striation sometimes visible on the ventral side of the larger ribs, but not in the interspaces; anterior and posterior ends often but not always pointed; base and posterior dorsal border arcuate; interior normal. Length 24.0, height 19.5, diameter 12.0 mm.

This species is apt to be confounded with *Artena glyptoconcha* of the same horizon, unless attention is called to the absence of the minute anterior lateral on the hinge, and of the fine concentric striation in the *Chione*. It considerably resembles the next species [*C. hendersoni*] which, however, has more numerous and basally punctate ribs, which are pinched off at about the posterior third of the shell, while in this species the attenuation is less and is close to the dorsal margin.—[Dall, 1903.]

Holotype.—No. 109238. United States National Museum, Washington, D. C.

CHIONE (LIROPHORA) VICTORIA Dall

Plate XLII, Figure 35

Chione (Lirophora) victoria Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1293, pl. 55, fig. 17.

Lower Oligocene of Vicksburg, Mississippi; P. Crutcher and F. Burns.

Shell ovate, moderately convex, with low, prosogyrate beaks and a small, cordate,

striated lunule; the escutcheon is flattened and finely striated; surface sculpture of twenty or more elevated recurved lamellæ, more or less depressed and thickened anteriorly, more erect, distant, and higher behind; the only radial sculpture is of faint striation on the ventral side of the lamellæ, insufficient to flute them; hinge as usual, the two anterior left and posterior right cardinals grooved distally, the posterior adductor scar larger than the anterior one; the pallial sinus small, sharply angular; interior marginal crenulation fine and regular. Length 24.5, height 20.5, diameter 14.0 mm.

This interesting species is, as it were, just launched on its career towards the typical *Lirophora*; a trifle might have given it the same impetus towards *Chamelea*.—[Dall, 1903.]

Holotype.—No. 155311. United States National Museum, Washington, D. C.

CHIONE (LIROPHORA) ALVEATA (Conrad)

Plate XLI, Figures 5, 8, 9, 20, 24, 36, 40

Venus alveata Conrad, 1831, Jour. Acad. Nat. Sci., Phil., vol. VI, p. 264, pl. XI, figs.

14, 15; Conrad, 1838, Fos. Med. Tert., p. 9, pl. V, fig. 2.

Circumphalus (Lirophora) alveatus Conrad, 1862, Proc. Acad. Nat. Sci., Phil., vol. 14, p. 575; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.

Chione (Lirophora) alveatus Meek, 1864, *ibid.*, p. 9; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1298; Glenn, 1904, Md. Geol. Sur. Mio., p. 310, pl. 76, figs. 1, 2, 3.

Shell subtriangular, thick, with about six, much elevated, very thick and profoundly reflected concentric ribs, remote, and becoming smaller towards the posterior end; margin crenulated. *Syn. V. paphia* Lam.

Inhabits—. Fossil from Maryland.

Cab. Academy.

This shell is related to *V. paphia*, with which species it appears to be confounded by Lamarck, as his description of *V. paphia* was drawn from a fossil from Wilmington, N. C. My shell is a fossil from St. Mary's River, Maryland, where it is by no means rare; it may be distinguished from *V. paphia* by its shape, which is shorter in proportion to its height; and by the remote and recurved ribs, which do not abruptly, and in a regular line, become much smaller towards the posterior end.—[Conrad, 1831.]

Dimensions.—30 mm., length; 27 mm., height; 11 mm., semidiameter.

Syntypes.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—St. Mary's Stage. Miocene. St. Mary's River, Md. (*Type*). Miocene. Windmill Point, James River, Va. (Meek in Dall)

CHIONE (LIROPHORA) PARKERIA Glenn

Plate XLI, Figures 10, 22, 28

Chione parkeria Glenn, 1904, Md. Geol. Sur. Miocene, p. 310, pl. 76, figs. 9, 10, 11.

Shell triangular, depressed, posteriorly somewhat cuneiform, anteriorly rounded; beaks projecting, acute, approximate; lunule distinct, cordate; base posteriorly emarginate; dorsal surface with about five to eight concentric ribs perfectly flattened and closely appressed to the valve and each other as to become almost obsolete and be marked only by faint indulations and fine concentric impressed or laminated lines; ribs crossed from beak to base by numerous distinct, regular, radiating lines; cardinal teeth three in each valve; laterals none; muscle impressions deep; pallial sinus a slight notch; margin minutely crenulated. This species seems to be closely related to *C. ulocyma* Dall.

Length, 29 mm.; height, 23 mm.; diameter, 8 mm.—[Glenn, 1904.]

Syntypes.—U. S. National Museum, Washington, D. C.

Occurrence.—Miocene. Calvert Stage. Parker Creek, 2 miles south of Parker Creek, Md. (Glenn)

CHIONE (LIROPHORA) GLYPTOCYMA Dall

Plate XLII, Figures 9, 14, 20a, 22, 29, 31

Chione (Lirophora) glyptocyma Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6,

p. 1296, pl. 55, fig. 21.

Oligocene of the Oak Grove sands, at Oak Grove, Santa Rosa County, Florida; Smith, Burns, and Aldrich.

This species is very close to the ribbed variety of *C. Burnsii*, from which it is best distinguished by a differential description.

In *C. Burnsii* there is a slight inflection of the posterior base in front of the posterior dorsal area which gives the hinder end of the shell a look as if it were slightly bent down; in the present species the base is evenly arcuate and the rostration points backward. In *C. Burnsii* there are but three or four concentric lamellae on a young shell five millimeters in height; in the present species eight or nine. By looking at the beaks the two can be at once separated. In *C. glyptocyma* there are from sixteen to twenty-three ribs, in *C. Burnsii* when the ribs are not confluent there are nine to eleven. The surface of *C. glyptocyma* is more polished; the radial striation on the ventral aspect of the ribs stops at their base in *C. Burnsii*; in the present species it continues over the interspace to the base of the rib below. In *C. glyptocyma* the ribs are apparently never normally confluent, but in *C. Burnsii* confluence is the rule. An average specimen measures: length 33, height 24, diameter 16 mm., but the form may be longer or more trigonal, as in all these species I have figured a youngish valve 26.5 mm. long, because it shows remains of the foliations which in adult specimens are always broken off. The pallial sinus is very small and angular, the adductor scars subequal, and the teeth are entire.—[Dall, 1903.]

Holotype.—No. 135887. United States National Museum, Washington, D. C.

Occurrence.—Lower Miocene. Oak Grove, Santa Rosa County, Florida.

CHIONE (LIROPHORA) EBERGENYI Böse

Plate XLII, Figures 1, 2, 5, 6, 16

Venus (Chione) Ebergenyi Böse, 1906, Inst. Geol. Mex. Bol., Núm. 22, p. 28, pl. II, figs. 4-17; Böse, 1906, *ibid.*, p. 82, pl. XI, figs. 8, 9.

Concha medianamente grande, subtriangular, moderadamente convexa, con umbones encorvados hacia delante, bajos y elegantes sobre una lunula cordiforme alargada que está limitada por un borde marcado; la lunula está cubierta de estrias finas. Los umbones están cubiertos por numerosas costillas concéntricas, en la concha misma son las costillas anchos y de número variado; están reunidas de varias lamelas, las que se reconocen en las estrias concéntricas que se encuentran en toda la longitud de cada costilla, y además, en las hojas en las cuales las costillas se disuelven hacia los lados posterior y anterior.

Estas hojas se elevan en la parte posterior en una faja triangular, muy alargada, que comienza casi en la punta del umbón y que acaba en el margen inferior; en el margen posterior se encuentra al lado de esta faja de lamelas, un área; limitada de un borde bastante marcado, que forma una especie de corselete, y que está cubierto de estrias sencillas. En la parte anterior encontramos al lado y abajo de la lunula una faja semejante de lamelas pero menos bien limitada; parece que en la parte posterior las láminas se pliegan en lo general hacia abajo, en la anterior hacia arriba. El número de costillas es entre 20 y 23. Como las costillas se componen de lamelas, los intersticios vienen a ser verdaderos surcos, sólo en algunos ejemplares se ven intersticios anchos. Las costillas están cruzadas por estrias débiles radiales que están visibles también generalmente en los intersticios. La curva del margen inferior está plegada muy poco hacia abajo allí donde la toca la faja posterior de lamelas. El borde interior está dentado, en el lado posterior hasta el margen lateral, en el borde anterior hasta el umbón, estando dentada también la lunula. La charnela es normal, consiste de tre dientes cardinales fuertes y divergentes, las impresiones de los músculos son subiguales, el seno pallial es triangular y corto.

Las dimensiones son:

	I	II	III	IV	V	VI
Altura	25	27	30	19	25	22
Ancho	32	34	38	26	30.5	29
Grueso	9 (18)	9 (18)	11.5 (23)	7 (14)	9 (18)	7 (14)

Esta especie pertenece a la sección *Lirophora*, Conr. y especialmente al grupo de la *V. Burnsii* Dall. Es un tipo que pertenece principalmente al Terciario antiguo y que parece desaparecer en los depósitos más modernos. De la variedad acostillada de *V. Burnsii* Dall, se distingue nuestra especie por las numerosas costillas en el umbón, de la *V. glyptocyma*, Dall por el margen inferior encorvado posteriormente pare abajo y el mayor número de costillas, también hay una diferencia en la forma de

¹ Las cifras en paréntesis se refieren a la concha completa de dos valvas.

los intersticios. Los otras formas de la misma seccion se distinguen todavía mas.

Nuestra especie es la más importante de la fauna de Tuxtepec, he podido recoger unos 150 ejemplares; de otras partes de Mexico me las es conocida sólo de Santo Maria Tatetlan Ver.

La dedico al Sr. Emilio Ebergényi que descubrió la localidad fosilifera de Tuxtepec.—[Böse, 1906.]

Age.—? Pliocene. Stated as Pliocene by Böse.

This species, from a study of the illustrations given by Böse, bears a very close resemblance to *C. glyptocyma* Dall. It perhaps should be grouped as a variety of or as the same species as that of Dall. Copies of the illustrations and description of Böse have been included so that the species may be compared. A slight difference in shape may be noted as well as narrower interspaces between the concentric lamellæ. The figures by Böse of young specimens resemble the young of *glyptocyma*, cf. figures 16 and 22 of plate XLII. From a study of the illustrations only, *C. ebergényi* has not been put in synonymy.

CHIONE (LIROPHORA) CARONIANA Maury

Plate XLIV, Figure 18

Venus glyptocyma Guppy, 1910, Agr. Soc. Trinidad and Tobago, Paper No. 440, p. 11;

Harris' Reprint, 1921, Bull. Amer. Pal., vol. 8, No. 35, p. 153.

Not *Chione* (*Lirophora*) *glyptocyma* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1296, pl. 55, fig. 21.

Chione (*Lirophora*) *caroniana* Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 163, pl. 29, figs. 5, 7, 8.

Shell of medium size, roundly trigonal, solid, becoming robust with age, moderately convex; beaks low, acute, curving towards the striated lunule, escutcheon long, striated with growth lines, discs typically sculptured with broad, flat, irregular, concentric ribs which extend over the central portion of the valves, but anteriorly and posteriorly, on nearing the lunule and escutcheon, tend to alter suddenly into thin lamellæ. The striking feature is the coarse, broad, irregular ribbing, seemingly due to fusion. Occasionally the ribs are obsolete. Even on the beaks, the ribs are low and broad, but become wider over the discs where they vary from three to five, six or even eight millimeters in width. The largest shell measures in length 38 mm., height 30, diameter 19. An average adult is 30 x 24 x 16 mm.

This was a very common shell on the Miocene beach of Springvale.

A comparison with specimens of *Chione glyptocyma* Dall, from Oak Grove, Florida, shows a decided difference of sculpture, the Floridian shells have more abundant and narrower ribs. In the confluence of the ribs the Trinidad species approaches more nearly to *C. burnsi* Dall, from Bailey's Ferry, Florida, but that has characteristically radial striations, as shown on our shells and Dr. Dall's figure 4 of his type. The Trinidad specimens show no trace of radial markings.

This species is related to the Miocene to Recent shell *Chione utilivata* Conrad; but the ribbing is lower, more irregular, confluent and occasionally obsolete. Our shell also is allied to the recent *Chione paphia* Linn. (*vetula* Da Costa) but in that species the broad ribs are high and recurved.

Chione chiriquiensis Olsson from the Gatun formation of Costa Rica is a miniature relative of this group which is typified by *utilivata*.

Chione ebergényi Böse from Tuxtepec, Mexico, and *C. hendersoni* Dall from Bowden, Jamaica, are much more finely ribbed.

Locality.—Springvale, Trinidad. Very abundant.

Horizon.—Upper Miocene.—[Maury, 1925.]

Syntypes.—Cornell University Paleontological Museum, Ithaca, N. Y.

CHIONE (LIROPHORA) ULOCYMA Dall

Plate XLII, Figures 4, 26, 33, 36;

Plate XLV, Figure 5

Chione ulocyma (Dall MS.) Harris, 1895, Bull. Amer. Pal., vol. I, No. 3, p. 9.

Venus (*Anaitis*) *ulocyma* Dall, 1900, Trans. Wag. Inst. Sci., vol. III., pt. 5, p. 1198,

pl. 42, fig. 5 not 5a.

Chione (Lirophora) ulocyma Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1296; not *Chione ulocyma* Toulou, 1908, Jah. Geol. Reich., 58, p. 724, pl. 25 (1) figs. 20-22.

Miocene of Alum Bluff, Calhoun County, Florida, Dall and Burns; of Jackson Bluff and other localities nine to sixteen miles southwest of Tallahassee, Vaughan; and between 2236 and 2650 feet in the artesian well at Galveston, Texas, Texas Geological Survey.

Shell elongate-ovate, subcompressed, produced distally, inequilateral beaks low, prosogyrate, closely concentrically sculptured; lunule impressed, finely striated, cordate in the young, lanceolate in the full-grown; escutcheon large, striated, defined by a carina; sculpture of the disk foliate in front and behind, the middle portion with (normally) numerous thick, depressed, recurved concentric ribs which conceal the interspaces; exceptionally these ribs may be separated or coalescent, but it is rare that the interspaces are not indicated by sulci; these are crossed by shallow radial grooves, which, when the interspaces are visible, also cross them; anteriorly the ribs are convex ventrally, but behind the middle of the shell they show a moderate dorsal convexity, giving a flexuous aspect to the shell; distally the ribs are compressed and elevated, but the foliations are rarely preserved; internally the hinge is delicate but normal, the teeth entire, the anterior and basal margins crenulate, the adductor scars subequal, the pallial sinus very small but sharply angular. Length 45, height 32, diameter 18 mm.

The figure of the young shell of *C. burnsi* was by an accidental transposition referred to this species in the explanation of plate XLII. This is the largest of the *Lirophora* group in the Florida Tertiary and runs the gamut of variation, like the others. It is more like the Panama Oligocene species than any of the others, but that is smaller, less foliaceous, and relatively more plump and ovate.—[Dall, 1903.]

This species shows great variation in the shape of the shell and in the number and size of the concentric ribs. The form has a tendency to lengthen posteriorly giving the shape a narrow, attenuated appearance, plate XLV, figure 5. It is less plump in thickness, less convex along the postero-dorsal line and less in height than *C. mactropsis* (Conrad). The concentric ribs vary in size but they do not become as small or coalesce as much as the ribs in *C. mactropsis*. The young differ from *C. xesta* Dall with which it is associated by having larger, flatter concentric ribs and being overturned and marked over all the ribs by radial striations. Specimens of equal size of *C. xesta* have the ventral, concentric ribs sharp and straight or only slightly marked by radial striae.

Holotype.—No. 114848. United States National Museum, Washington, D. C.

CHIONE (LIROPHORA) HOLOCYMA Brown and Pilsbry
Plate XLI, Figure 27; Plate XLII, Figures 23, 34

Chione ulocyma Toulou, 1909, Jah. Geol. Reich., 58, pl. 25 (1), figs. 21-22.
Chione (Lirophora) ulocyma holocyma Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., vol. 63, p. 369.
Chione (Lirophora) holocyma Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 247, pl. 30, fig. 9.

There seem to be two forms: one agreeing with the type figure of *ulocyma* in having coarse concentric sculpture; the other having much finer, more numerous wrinkles. In the former the beaks appear to be smooth, but possibly as the result of wear. In the finely sculptured forms the beaks have about five thin concentric widely spaced laminae, preceding the corrugated stage, such as are described for *C. burnsi* Dall. This race may be called *C. ulocyma holocyma*. In this race, as well as in the coarse form, the radial grooves are very strongly developed.—[Brown and Pilsbry, 1911.]

This form appears to be more nearly related to *C. mactropsis* than to

C. ulocyma. They all, however, belong to the same group of *Lirophora*. This shell represents the type having the concentric and the radial sculpture of nearly equal importance. The concentric ribs do not stand out as in *ulocyma* and are finer than either *ulocyma* or *mactropsis*.

Specimens have been found in the Alum Bluff material which are so close to this species that they are so identified. The specimens are not as mature as those from Gatun.

Average specimen measures 37 mm. in length, 33 mm. in height and 20 mm. in thickness.

Compared with specimens of *C. burnsi* Dall in the same stage of growth, the coalescence of the concentric ribs is very much alike. On *C. burnsi* the concentric ribs on the umbonal region are regular with very wide interspaces of at least four times the width of the rib. On *C. holocyma* that character is true only on the extreme portion of the beak, as is the case in *C. ulocyma*, *C. mactropsis* and *C. xesta*. Posteriorly where the coalescence of concentric ribs is absent, the fluted lamellæ have very wide interspaces in *C. burnsi*. In *C. holocyma*, *C. ulocyma* and *C. mactropsis* the corresponding interspaces are only one-third or one-half the width of the lamellæ. A series of specimens of the respective species listed are figured on plate XLII and plate XLI for comparison.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Gatun Miocene. Gatun, Panama. (Brown and Pilsbry); Mt. Hope, Panama. (Olsson. Cornell Univ. Pal. Lab.). Chesapeake Miocene. Upper Alum Bluff beds, Fla. (Cornell Univ. Pal. Lab.)

CHIONE (LIROPHORA) MACTROPSIS (Conrad)

Plate XLII, Figures 3, 12, 17

Gratelupia ? *mactropsis* Conrad, 1855, House Ex. Doc., 129, Rept. W. P. Blake App., p. 18, July; Conrad, 1856, Pac. R. R. Repts., V, p. 328, pl. VI, fig. 54.

Chione (Lirophora) mactropsis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1294.

cf. *Chione ulocyma* Toulou, 1908, Jahr. Geol. Reich., 58, p. 724, pl. 25, (I), fig. 20.

Chione (Lirophora) mactropsis Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci., Phil., vol. 63, p. 369.

C. (Lirophora) ulocyma Brown and Pilsbry, 1911, *ibid.*, p. 369 in part; Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 245, pl. 30, figs. 7, 8.

Triangular, inequilateral; dorsal margins equally oblique, straight; basal margin rounded anteriorly, lightly curved, posteriorly, posterior extremity truncated, direct, considerably above the line of the base.

Locality.—Isthmus of Darien.—[Conrad, 1855-56.]

Conrad's description was made from a cast. A copy of his illustration of the species is given herein, pl. XLII, fig. 12. Hence the exact sculpture of the shell is not known. Later explorations in the zone of the Panama Canal and in Costa Rica have yielded many specimens of this species as well as species or varieties closely related, showing it to be very abundant and characteristic of the Gatun stage, Miocene, of that region.

Mr. Olsson's collections from Panama and Costa Rica are perhaps the most complete from which the best idea as to the characters of the

form may be obtained.

The *Lirophora mactropsis* described by Conrad from an internal cast as *Gratelupia*?, is one of the most abundant fossils in the Gatun beds of the Canal Zone, associated with the smaller and more finely sculptured *holocyma* Brown and Pilsbry. *L. mactropsis* is a species of variable size, but moderately convex, longer posteriorly and usually with the basal margin more or less arcuated about the posterior extremity. The sculpture consists of irregular more or less confluent concentric lamellæ, which are overrun by fine radial lines. These radial lines may remain strong or become obsolete as usual with specimens from the Canal Zone. A narrow foliaceous band is developed on each side of the escutcheon and another about the anterior extremity below the lunule. The Costa Rican examples are often very much larger than those of the Canal Zone, the concentric lamellæ are finer and less confluent and with more persistent radial lines. The following measurements will illustrate the range in size:

Length 30,	height 28,	thickness 15 mm.,	Central Zone		
37,	28,	19	" "		
41.5,	32,	9.5	(right valve)	Old Man Sam Creek,	
			C. R.		
51.5,	38,	21.5	Sousi, C. R.—	[Olsson, 1922.]	

This species apparently belongs to the group including *C. ulocyma* and *C. burnsii*, being related closer to *C. ulocyma*. *Burnsii* has the concentric ribs flattened out with the radial sculpture predominating. It has fewer fluted, lamellæ posteriorly, with wider interspaces. Traces of radial ornamentation are seen in *C. ulocyma* but are secondary to the concentric ribs. In *C. mactropsis* the concentric ribs have the heaviest and greatest development of any of the species in the group. *C. mactropsis*'s Olsson shows the concentric sculpture nearly as heavy as *C. ulocyma* but a flattening and smoothing out of the ribs is conspicuous so that in many specimens the central portion of the shell is practically smooth. *C. holocyma* Brown and Pilsbry the radial and concentric sculpture are more equal in prominence with the concentric slightly stronger. The posterior, fluted area is also less developed than in the other species.

Holotype.—No. 1843. United States National Museum, Washington, D. C.

Occurrence.—Gatun Miocene. Isthmus of Darien. (Conrad. type); Gatun and Vamos-a-Vamos, Panama Canal. (Agassiz.) 10.5 km. west of Colon, Hill, Chiriqui, (Dr. John Evans (Gabb) fide Dall.) Gatun and Mt. Hope, Canal Zone, Old Man Sam Creek, Sousi Creek, Upper Hone Creek and Banana River, Costa Rica. (Olsson, Cornell Univ. Pal. Lab.)

CHIONE (LIROPHORA) BURNSII (Dall)

Plate XLI, Figures 3, 14, 15, 18, 19, 26, 38;

Plate XLII, Figure 3a

Venus (Anaitis) Burnsii Dall, 1900, Trans. Wag. Inst. Sci., vol. III, pt. 5, p. 1198, pl. 42, figs. 4, 5a, 11.

Chione (Lirophora) Burnsii Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1294; Maury, 1919, Bull. Amer. Pal., vol. 8, No. 34, p. 105.

Oligocene of the Chipola horizon at Alum Bluff and on the Chipola River; Burns and Dall.

Shell subtrigonal, heavy, moderately convex, with low prosogyrate beaks over a striated cordate lunule, with the escutcheon elongate, nearly smooth, bounded by a well-marked keel; beaks with a few distant, low, concentric lamellæ; later the ribs become greatly thickened and recurved with narrower interspaces or more commonly confluent, suddenly pinched out behind, where they rise in thin, elevated foliations,

and below the lunule in front are somewhat similar but more crowded; these ribs are crossed by faint radial striations sharper towards the beaks but not visible in the interspaces; hinge normal, teeth entire, adductor scars subequal; pallial sinus angular, small. Length 34, height 26, diameter 16 mm.

Except in the radial striation this species recalls the recent *C. Kelletii* Hinds of the Pacific coast fauna. The ribbed form is close to *C. glyptocyma* of the Oak Grove sands, but may be distinguished by the sculpture of the beaks.—[Dall, 1903.]

See dimensions under *C. ulocyma*.

Holotype.—No. 114755. United States National Museum, Washington, D. C.

Occurrence.—Chipola Miocene of Alum Bluff and Chipola River (Dall).

CHIONE (LIROPHORA) XESTA Dall

Plate XLII, Figures 7, 10, 13, 24, 32

Chione (Lirophora) xesta Dall, 1903, Trans Wag. Inst. Sci., vol. III, pt. 6, p. 1297, pl. 55, fig. 18.

Miocene of Alum Bluff, Calhoun County, Florida: Burns and Dall.

Shell small, rounded-trigonal, with low, usually sparsely sculptured beaks, a striated cordate lunule, and feebly defined striated escutcheon; sculpture in general resembling that of the other species, but with the ribs high and sharp, or only slightly thickened, clear across the disk, though more elevated distally; the radial striation appears on the ventral side of the ribs, is not emphatic, and does not cross the interspaces, which are concentrically striated; there are about twenty ribs; interior as in the *C. ulocyma* the base evenly arcuate and not flexuous. Length 30, height 25, diameter 16 mm.

This species recalls the Vicksburgian *C. victoria*, which has a smaller lunule, larger pallial sinus, and denser and more elevated concentric lamellation.—[Dall, 1903.]

See discussion under *C. holocyma*.

Holotype.—No. 115720a. United States National Museum, Washington, D. C.

CHIONE (LIROPHORA) CHIRIQUIENSIS Olsson

Plate XLI, Figures 12a, 25

Chione chiriquiensis Olsson 1922, Bull. Am. Pal., vol. 9, No. 39, p. 248, pl. 32, figs. 9, 10.

Shell small, solid, depressed; lunule rather large, cordate, smooth; escutcheon large, smooth and defined by an angled ridge; surface of the disk sculptured with about 8, large, irregular ribs, like those of *Chione latilirata*; these ribs do not extend to the edge of the escutcheon, but commence a short distance in front leaving a narrow band which is smooth and sculptureless; the ribs are of variable size, flat-topped and smooth; they are rounded on their ventral side, but shelving or recurved backwards on the dorsal face; interspaces smooth or only sculptured with fine growth-lines; interior of shell of moderate depth, with a small pallial sinus and a slightly larger posterior adductor scar; basal margin finely crenulated.

Length 13.75, height 12.50, diameter 9.50 mm.

The few specimens which we have from Water Cay, are probably immature, but they possess such distinctive characters that the species cannot be mistaken.

The heavy, irregular concentric ribs recall certain varieties of *Chione latilirata* Conrad. They differ in being abruptly cut off or flattened a short distance behind the dorsal-posterior angle leaving a band as in *C. paphia* Linnaeus, but smooth and sculptureless. The interspaces are smooth.

Gatun Stage: Water Cay.—[Olsson, 1922.]

Syntypes.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Water Cay, Costa, Rica.

CHIONE (LIROPHORA) HOTELENSIS Olsson

Plate XLII, Figures 8, 20

Chione (Lirophora) hotelensis Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 247,

pl. 32, fig. 7.

Shell small, subtrigonal, heavy, but slightly convex; sculpture of about 15, thick, rounded and evenly spaced concentric lamellæ; on the posterior-dorsal slope, the ends of the lamellæ become attenuate, thin and somewhat appressed as in *glyptocyma* Dall of the Floridian Miocene; the lamellæ themselves are smooth and rounded but with their interspaces finely radially incised by small lines; escutcheon rather large, smooth; lunule small, cordate and smooth except for the growth lines.

Length 23, height 19, thickness 12.5 mm.

This elegant little species is distantly related to the *C. glyptocyma* Dall from the Oak Grove sands of Florida, but it is a smaller and more compact shell. The radial striations commence on the ventral surface of the lamellæ and are continued across the interspaces to the base of the next rib.

All of our specimens were collected in a hard sandstone in the lower Gatun of Hotel Creek near Old Harbor, Costa Rica.

Uscari Stage: Hotel Creek, C. R.—[Olsson, 1922.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Lower Miocene. Uscari formation. Hotel Creek, Costa Rica.

CHIONE (LIROPHORA) HENDERSONI Dall

Plate XLII, Figures 21, 27, 28, 30

Venus paphia Guppy, 1866, Quart Journ. Geol. Soc. Lond., vol. 22, p. 292 not of Linnaeus.

Chione paphia Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 249.

Venus paphia Guppy, 1874, Geol. Mag., Decade 2, vol. I, p. 450; Guppy, 1876, Quart. Journ. Geol. Soc. Lond., vol. 32, p. 530.

Chione (*Lirophora*) *Hendersoni* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1295, pl. 55, fig. 22; not Maury, 1919, Bull. Amer. Pal., vol. 5, No. 29, p. 219, pl. 37, figs. 8, 9; not Hubbard, 1920, N. Y. Acad. Sci., vol. III, pt. 2, p. 122; ? Spieker, 1922, Johns Hopkins Univ. Studies Geol., No. 3, p. 154.

Chione (*Lirophora*) *paphia* Pilsbry, 1921, Proc. Acad. Nat. Sci., Phil., vol. 73, pt. 2, p. 423.

Chione (*Lirophora*) *Hendersoni* Woodring, 1925, Carnegie Inst. Wash., No. 366, p. 163, pl. 22, figs. 7 to 10.

Oligocene of the Bowden marl at Bowden, Jamaica, Henderson and Simpson, and of Haiti, Guppy.

Shell resembling the last species, *C. ballista*, but with about fifteen ribs on the ventral bases, of which the radial sculpture is represented by a series of punctations which are rarely drawn out into striae; the ribs are closer together, sometimes obscuring the interspaces; the imaginary line at which the thick ribs suddenly become very thin and elevated marks off the posterior third of the shell, more than in any other species noted; the foliations are very thin and were presumably elevated, but are destroyed in all the specimens examined. In harmony with this arrangement of the sculpture the posterior end of the shell is somewhat rostrate; the lunule and escutcheon are wider than in *C. ballista*; the hinge normal, the teeth entire, the pallial sinus small and angular, and the adductor scars subequal. Length of an average specimen 27.5, height 20.5, diameter 14.0 mm.

The Bowden species was confused with others and with the recent *C. paphia* by Guppy, as above cited. Only a comparison is needed to prove their distinctness.—[Dall, 1903.]

C. hendersoni is intermediate between *C. carlottæ* and *C. paphia* in the character of the ribs. There are more ribs on the adult shells and the ribs are closer than on either of the other two species even on the young specimens. The ribs are not as erect as on *hendersoni* and not as overturned or flattened as on the adult *paphia*. The shape of the shell is much shorter and higher than *hendersoni* or *paphia*. *Hendersoni* presents the appearance of being produced the most posteriorly.

Holotype.—No. 135668. United States National Museum, Washington, D. C.

Occurrence.—Bowden Miocene. Bowden marl at Bowden, Jamaica. (Dall) (Cornell Univ. Pal. Lab. Hodson Coll.) ? Zorritos formation. Quebrada Heath, Peru. (Spieker)

CHIONE (LIROPHORA) CARLOTTÆ n. sp.

Plate XLII, Figures 11, 15, 18

Chione paphia Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 249.*Chione (Lirophora) Hendersoni* Maury, 1917, Bull. Amer. Pal., vol. 5, No. 29, p. 219, pl. 37, figs. 8, 9; Hubbard, 1920, N. Y. Acad. Sci., vol. III, pt. 2, p. 122.

Shell medium in size, thick; posterior end produced, pointed; lunule sunken, bounded by an incised line; teeth and pallial sinus typical of the subgenus including the rugose area of the right nymph and left, posterior cardinal; ornamentation consisting of heavy, lamellose, concentric ribs which flare outward, posterior to the midline of the shell and die out posteriorly; base of the ribs is pitted thickly exteriorly. There are from eight to eleven large, concentric ribs according to size and age of the shell.

Since the Maury Expedition of 1916 to Santo Domingo this species has been compared with specimens of *C. hendersoni* from the Bowden beds. It is found to differ constantly in shape and number and character of the ribs. The shells are more produced posteriorly. They are produced also posteriorly more than *C. paphia* which in turn is slightly more produced than *C. hendersoni*. The ribs are spaced more widely, the interspaces are about twice as wide as those of *C. hendersoni*. Except in the largest shells the ribs do not overturn but remain elevated. Even in adult shells where the ribs are overturned slightly the interspaces are still wider than those of *C. hendersoni*. The character of the ribs is more like the young of *C. paphia*. In adult forms of *C. paphia* the ribs are very much overturned and flattened.

Named in honor of Dr. C. J. Maury, on whose expedition the proterotype material of this species was collected.

Dimensions.—31 mm., length; 25 mm., height; 11 mm., semidiameter.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Miocene. Bluff 1, Cercado de Mao, Zone G, Rio Gurabo at Los Quemados, (Exped. 16, Maury). Lares l.s. to Los Puertos l.s. (Hubbard. N. Y. Acad. Sci.)

CHIONE (LIROPHORA) LATILIRATA (Conrad)

Plate XLI, Figures 7, 12, 13, 31, 32, 33, 34;

Plate XLII, Figure 19

Venus latilirata Conrad, 1841, Proc. Acad. Nat. Sci., Phil., vol. I, p. 28; Conrad, 1845,Fos. Med. Tert., p. 68, pl. 38, fig. 3; Tuomey and Holmes, 1857, not *V. latilirata*

Sowerby, 1897, Marine Sh. S. Afr., App. to.

Circomphalus (Lirophora) latilirata Conrad, 1862, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 575.*Circomphalus (Lirophora) athleta* Conrad, 1862, *ibid.*, pp. 575, 586.*Chione (Lirophora) athleta* Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, pp. 9, 30;*Chione (Lirophora) latilirata* Meek, 1864, *ibid.*, pp. 9, 30.*Venus varicosa* Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54.*Anatis varicosa* Dall, 1889, Proc. U. S. Nat. Mus., vol. 12, p. 271.

Venus latilirata Dall and Simpson, 1900, Bull. U. S. Fish. Com., vol. I, p. 484.
Chione (Livophora) latilirata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 375; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1298, pl. 42, fig. 3; Glenn, 1904, Md. Geol. Sur. Miocene, p. 309, pl. 77, figs. 3, 4, 5, 6; Gardner and Aldrich, 1919, Proc. Acad. Nat. Sci. Phil., vol. 71, p. 19; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 73; Spieker, 1922, Johns Hopkins Univ. Studies Geol., No. 3, p. 155; Maury, 1925, *ibid.*, vol. 10, No. 42, p. 161, pl. 29, figs. 1, 2, 9. Trigonal, convex, depressed, ribs concentric, about 5 or 6 in number, flattened, reflected, irregular, one of them generally very wide; ribs irregularly sulcated on the posterior slope; inner margin finely crenulated. Smaller than *V. alveata*, and with broader, less prominent ribs, which do not diminish in size on the posterior margin.—[Conrad, 1841.]

The shell is thick and heavy; the concentric ribs are wide and strongly recurved; the specimens from the typical localities are small with from 5 to 6 concentric ribs in the adult. On the smallest specimens measuring from approximately 9 to 13 mm., the ribs are often only 2 or 4 in number, each rib is very broad and smooth. This is true also of many irregular, adult shells from later horizons. Figure 31, plate XLI, is given of a Pliocene form showing the coalescence of the ribs. The younger stratigraphic specimens are larger in size, with heavier and with a greater number of concentric ribs, varying from 8 to 11 in number. The lunule is sunken, heart-shaped and defined by a sharp line beyond which in the lunular area the concentric ribs do not pass; escutcheon large, defined only by a pronounced ridge along the dorsal region at which the concentric ribs stop posteriorly; nymphs of right valve and edge of left, posterior, cardinal with a narrow rugose area.

In 1841 Conrad described *C. latilirata* from the Calvert Cliffs, Maryland. This is the form from the oldest horizon and is characterized by the lesser number of concentric ribs. The shell which Conrad called *C. athleta* citing it as the type of the new subgenus *Livophora*, was from Miocene of Virginia. It was described with a greater number (8) of concentric ribs. This is found to be true of shells from younger horizons.

Holotype.—Academy of Natural Science, Philadelphia, Pa.

Occurrence.—UPPER MIOCENE. *Calvert Stage*. Calvert Cliffs, (*type*) Fairhaven, Chesapeake Beach, 3 miles south of Chesapeake Beach, Plum Point, Lyon's Creek, Reed's, Jewel, Md. (Glenn. Johns Hopkins University.). *Choptank Stage*. Greensboro, Md. (Glenn Md. Geol. Sur.). *Yorktown Stage*. Yorktown, Va. (Dall). *Duplin Stage*. Magnolia and Natural Well, Duplin county, Wilmington, N. C. (Dall). *Zorritos formation*. Quebrada Zapotal, Peru. (Spieker). Jackson Bluff, Ochlochnee River, Fla. PLIOCENE. Acme, Neill's Eddy Landing, Cape Fear River, N. C., Tilly's Lake, Lake Waccamaw, S. C. (Cornell Univ. Pal. Lab.), Matura, Trinidad. (Maury. Harris Coll. Cornell Univ. Pal. Lab.) PLEISTOCENE. Caloosahatchie beds on the Caloosahatchie River, Shell Creek and Alligator Creek, Fla. (Dall). New Orleans well of 1856 at 480 ft., Lake Borgne borings, New Orleans Gymnasium well at 1200 ft. (Maury, C. U. Museum). RECENT. Cape Hatteras, N. C., to Rio Grande

do Sul, Brazil, 10–124 fathoms (U. S. Fish. Com.), West. Fla., Cameron, La., Galveston, Tex. (Cornell Univ. Pal. Lab.)

CHIONE (LIROPHORA) RIOMATURENSIS Maury

Plate XLIV, Figure 9

Chione (Lirophora) riomaturensis Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 162, pl. 29, fig. 4.

We have several imperfect but interesting shells of a *Chione* which is intermediate in characters between *C. latilirata* Conrad and *C. paphia* Linnæus.

The shell is of medium size, trigonal, flat, with about four heavy, broad, flat, concentric ribs over the main part of the disc, with a number of increasingly fine riblets extending to the apex of the beak. In the broad, heavy ribbing the shell resembles *latilirata*. But posteriorly the thick ribs suddenly thin out and are continued over the posterior dorsal area as narrow, elevated ridges which extend to the border of the escutcheon.

This thinning out of the ribs is a characteristic of *C. paphia*; the ribs in *latilirata* extending in their full width as far as the escutcheon. When entire this Trinidad form would measure about 31 mm. in length, 26 in height, and 10 in semidiameter.

These specimens are not dwarfed but of normal size. The fauna of which they were members is quite independent of, and earlier than the dwarfed, late Pliocene fauna of Matura.

Locality.—400 feet north of the Matura River, eastern Trinidad.

Horizon.—Lower Pliocene.—[Maury, 1925.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

CHIONE (LIROPHORA) PAPHIA (Linnæus)

Plate XLI, Figures 37, 41, 42

Venus paphia Linnæus, 1767, Systema Naturæ, 12 ed., p. 1129; not *Venus paphia* Lamarck, 1818.

Chione paphia Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 126.

Venus paphia Reeve, 1863, Icon. Conch., *Venus*, pl. XIX, f. 89; not *Venus paphia* Guppy, 1866.

Venus paphia Dall and Simpson, 1901, Bull. U. S. Fish. Com., vol. I, p. 484.

Chione (Lirophora) paphia Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 375.

V. testa subcordata, rugis incrassatis, pube rugis attenuatis, labris complicatis.

Bonan. recr. f. 2. 75.

Rumph. Mus. t. 48 f. 5.

Qualt. test. t. 85 f. A

Argenv. conch. t. 7. f. B

Regenf. conch. t. 7. f. II

Habitat in O. Lusitanico

Affinis adeo Dyseræ, ut multis examinatis specimenibus vix ac vix limites dentur.

—[Linnæus, 1767.]

Shell thick with heavy sculpture; trigonal in shape; posterior and anterior ends produced and subpointed ventrally; ventral margin well rounded; shell marked with broad, overturned, concentric folds, on the umbonal region and on young shells these ribs are thin and less folded back but stand more erect and are sharper. Between each rib there is an interspace in which the growth lines on the lower portion of the shell are fine but not conspicuous; posteriorly the concentric ribs become pinched and thin, flaring out with very wide spaces between each lamellation and forming a definite area of a change in sculpture; lunule sunken, defined by an incised line and ornamented only with lines of growth; escutcheon not defined but limited by a sharp ridge which extends from the beak to the posterior tip; inner margin finely crenulate; left, posterior cardinal and right nymph rugose. The shell is white marked by spots of brown or

purplish, yellowish on the heavy rib area and by lines and streaks of brown over the area of lamellose ribbing and over the escutcheon. On the interior there is an area of light purple, coloring beautifully the middle and posterior half of the shell and extending over the posterior adductor scar and region of the sinus.

Dimensions.—40 mm., length; 32 mm., height; 28 mm., thickness.

Occurrence.—Recent. West Indies south to Brazil, from shallow water to 30 fathoms on sandy bottom. Fide Dall. Monti Cristi, Santo Domingo. St. Thomas Island. (Cornell Univ. Pal. Lab.)

Chione paraensis White var. Maury 1912, Jour. Acad. Nat. Sci., vol. 15, p. 60, pl. IX, fig. 20, from Soldado Rock, Trinidad, is not a *Chione*. It has the hinge of *Astarte*. It is *Astarte mauriana* Van Winkle, 1919, Bull. Amer. Pal., vol. 8, No. 33. It is not *Chione paraensis* White, 1888 or Maury, 1925.

Genus VENUS (Linnaeus) Lamarck



Fig. 28. Hinge of the type species of *Venus* *

- Venus* Linnaeus, 1758, Systema Naturæ, ed. X, p. 684; Linnaeus, 1767, ed. XII, p. 1128; Gmelin, 1792, Systema Naturæ, Tome VI, p. 3266; Lamarck, 1799, Prodrome, p. 84.
Merccenaria Schumacher, 1817, Essai d'une Meth., p. 135; Gray, 1847, Proc. Zool. Soc. Lond., p. 183; Deshayes, 1853, Cat. Conch. Biv. Sh. Brit. Mus., pt. I, p. 113; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 418; Stoliczka, 1871, Pal. Indica, vol. III, p. 153; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 176 not Cossmann, 1887, Cat. Illus.
Venus Fischer, 1887, Man. de Conch., p. 1083 not *Venus* H. and A. Adams, 1857.
Crassivenus Perkins, 1869, Proc. Bost. Soc. Nat. Hist., vol. XIII, p. 147.
Venus Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 360; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1307; Cossmann and Peyrot, 1911, Actes Soc. Linn. Bordeaux, Tome LXIV, p. 322; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 79.
Animal Tethys.
Testa bivalvis, labiis margine antico incumbentibus.
Cavdo dentibus 3; omnibus approximatis; lateralibus apice divergentibus.
Vulva & *Anus* distincta.—[Linnaeus, 1758.]

Shell large, inequilateral and thick; lunule is large, cordate and bounded by an incised line; escutcheon defined by a high ridge which varies in sharpness; inner margin crenulate; pallial sinus medium in size, pointed; three cardinals in each valve; anterior cardinals of both valves simple; left, middle cardinal bifid; left, anterior cardinal high and pointed; right middle and posterior cardinal bifid; left, posterior cardinal very thin and hardly differentiated from the nymph plate; no laterals in either valve; the nymphs of both valves very coarsely rugose; exterior usually smooth or with concentric ribs or striations.

Genolectotype.—*Venus mercenaria* Linnæus. Plate XXXII, Figures 2, 3, 4, 7. Miocene to Recent and living. Atlantic Coast and Gulf Coast of United States.

The species of this genus as represented in the eastern American fauna show great variation. The genus begins in the Oligocene.

Chione and *Venus* are very closely related genera. *Chione* is regarded by some Europeans as a subgenus of *Venus*. The relationships point that way. *Venus* when developed typically in the adult has the heavy, rugose area on the nymphs. *Chione* s. s. does not have that character but the subgroups *Lirophora*, *Anomalocardia* and *Gomphina* do have narrow but distinct rugosities on the area of the nymph. Some of the teeth of *Venus* show a distinct bifurcation. The teeth of *Chione* show indistinct grooving.

Stratigraphic Range of *Venus*

Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
	mississippiensis	mercenaria	mercenaria	mercenaria	mercenaria
	halidona	submercenaria	campechiensis	campechiensis	and vars.
		campechiensis	(rileyi)	var. mortoni	campechiensis
		var. capax			and vars.
		var. tetrica			
		var. cuneata			
		var. mortoni			
		var. carolinensis			
		ducatelli			
		langdoni			
		tridacnoides			
		(rileyi)			
		plena			
		prototypa			
		alumbuffensis			

VENUS MISSISSIPPIENSIS (Conrad)

Plate XXXV, Figures 2, 4, 10;

Plate XXXVI, Figure 20

Cytherea mississippiensis Conrad, 1848, Acad. Nat. Sci. Phil. Jour., vol. I, 2nd ser., p. 123, pl. 13, fig. 16.

Chione mississippiensis Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 200, p. 28; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1300.

Subtriangular, ventricose, elevated, with prominent concentric acute ribs, rather distant, and with irregular intervals and fine intermediate lines; posterior margin somewhat curved; basal margin profoundly rounded; summits prominent; inner margin entire. Length $1\frac{1}{4}$. Height the same nearly. Rare.—[Conrad, 1848.]

In the Cornell Paleontological laboratory there are two specimens in the Vicksburg collection which apparently belong to this species. They represent a young and an adult shell. The shape and sculpture is like that described and figured by Conrad. One specimen is older than that of Conrad and shows the concentric ribs more crowded along the ventral region. The concentric ribs are large and widely spaced. There are fine lines between the ribs. The lunule is large and bounded by a deep impressed line; the inner margin is crenate. Conrad described the inner

margin as entire. He may have had a worn specimen. The pallial sinus is narrow and sharply pointed. There are three cardinals, the middle left cardinal is bifid. The rugose area of the nymphs is very narrow and more distinct in the young shell. The adult shell is pointed posteriorly while the young is more rounded. Conrad referred the species to *Chione*. I have placed the species in *Venus* on account of the left, middle bifid cardinal which is characteristic of *Venus* and not *Chione*, as well as the heavy rugose area of the nymph. Several subgenera of *Chione* have the area of the nymph rugose but they do not have the combination of characters as presented by this form. The corrugations on the specimens figured are worn. The young shell is very close to the young of *V. campechiensis*.

Dimensions.—(Adult.) 45 mm. length; 37 mm. height; 13 mm. semi-diameter; (young) 17 mm. length; 15 mm. height; 4 mm. semidiameter.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Oligocene. Vicksburg, Miss. (Cornell Univ. Pal. Lab.)

VENUS HALIDONA Dall
Plate XXXV, Figures 3, 9

Venus halidona Dall, 1900, Trans. Wag. Inst. Sci., vol. III, pt. 5, p. 1194, pl. 38, figs. 1, 1a; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1307.

Oligocene silex beds of Hillsboro' Bay and Ballast Point near Tampa, Florida; Dall, Burns and Willcox.

Shell small for the genus, subovate, slightly truncate behind; beaks low, anteriorly directed over a rather large lanceolate lunule; posterior dorsal area narrow, nearly smooth, elongate, laterally keeled; sculpture of sharp, thin, elevated, concentric lamellæ, slightly produced at their intersections with the posterior dorsal keels, the interspaces slightly striated by lines of growth without radial sculpture; hinge with three cardinals in each valve, the posterior right and middle left grooved or bifid; the rugose area narrow and inconspicuous but definitely present; pallial line with a short angular sinus; the inner border of the valves finely crenate. Height of a short and an elongate specimen respectively 32.5 and 34.0, length 34.0 and 40.0, diameter 22.0 and 20.0 mm. concentric lamellæ 6 to 14 on a radial centimetre.

This small species appears fully adult and differs from the young of *V. Langdoni* in its more numerous, less prominent, and thinner lamellæ, which are not bent down and broadened on the posterior slope; the shell is also less trigonal. From an examination of numerous valves it appears to have much such a series of mutations in form as the larger species, though less pronounced. There seems to be no tendency to effacement of the lamellæ of the large species of the Miocene.—[Dall, 1903.]

Holotype.—No. 109244. United States National Museum, Washington, D. C.

VENUS MERCENARIA Linnæus
Plate XXXII, Figures 2, 3, 4, 7

Venus mercenaria Linnæus, 1758, Systema Naturæ, ed. X, p. 686; 1767, Systema Naturæ, ed. XII, p. 1131; Gmelin, 1792, Systema Naturæ, Tome VI, p. 3271; Lamarck, 1799, Prodrome, p. 84; Dillwyn, 1817, Cat. Rec. Sh., p. 176; Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 591; Say, 1822, Jour. Acad. Nat. Sci. Phil., vol. II, p. 271; Conrad, 1830, Jour. l. c., vol. VI, p. 209; Deshayes, 1832, Ency. Meth., III, p. 1117, pl. 273; Gould, 1841, Inv. Mass., p. 85, f. 67; Mighels, 1843, Bost. Soc. Nat. Hist., Jour., vol. IV, p. 320; Stimpson, 1851, Shells of N. Eng., p. 19; DeKay, 1843, Zool. of New York, vol. V, p. 217, pl. 27, fig. 276; Reeve, 1863, Conch. Icon., XIV, Mon. Venus, pl. ii, fig. 4; Binney, 1870, Gould's Inv. Mass., p. 133, f. 52; Verrill, 1873, Inv. An. Viney Ld., p. 681, pl. 26, fig. 184; Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 54, pl. 55, pl. 7; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 376; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1311; Johnson, 1915, Occ. Papers Boston Soc. Nat. Hist., VII, No. 13, p. 70; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 76.

- Mercenaria violacea* Schumacher, 1817, Essai d' une Meth., p. 135, pl. X, fig. 3; De-shayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 113; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 419; Holmes, 1858, Post-Pli. Fos. S. Car., p. 33, p. VI, fig. 11; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.
- Mercenaria mercenaria* Tryon, 1874, Am. Mar. Conch., p. 158, figs. 388-90.
- Crassivenus mercenaria* Perkins, 1869, Proc. Bos. Sec. Nat. Hist., vol. 13, p. 147.
- Venus mercenaria* var. *antiqua* Verrill, 1875, Am. Jour. Sci., 3rd Ser., vol. X, p. 371 not *Venus antiqua* King, 1831 nor *Venus antiqua* Münster.
- V. testa cordata solida transverse substriata lævi, margine crenulato, intus violacea, ano ovato.
- List. angl. 229 t. 8. f. 33.
- Habitat in Pennsylvania. P. Kalm: e qua *Sylvestrium* Nummi parantur. In montibus Sveciæ fossilis.
- Testa præ reliquis crassa est & ponderosa. Limbus tantum testæ interne violaceus est.—[Linnæus, 1758.]

Shell large, ovate-trigonal, and thick; rounded anteriorly and pointed posteriorly with a well-defined shallow dorsal groove extending from the umbones to the posterior ventral margin; ventral margin regularly rounded; middle of the exterior surface characteristically smooth, remainder of the shell with the growth lines thickly corrugated; the umbones, as on the young shells, are with widely spaced, prominent concentric ribs between which are fine lines of growth; lunule large, cordate, deeply impressed; escutcheon not well defined, marked by a concave elongate area which is bounded by a dorsal ridge; the area of the left valve larger than the right; hinge as described for the genus. The young shells are more rounded, subquadrate and do not have the pointed, posterior end and dorsal groove of the adult. The sculpture is evenly developed over all of the shell consisting of concentric ridges with wide interspaces. The left posterior cardinal and right nymph though small are rugose.

The exterior of the shell is typically yellowish brown or in black; on the interior there is a characteristic purple spot on the posterior tip sometimes including the sinus and posterior adductor scar, usually extending dorsally along the hinge margin.

This species is the common edible clam of the Atlantic Coast. It is spoken of as the quahog.

The above description is taken from the recent specimens. The species extends back into the Miocene and includes many variations and mutations. Specimens from the Pleistocene of Wailes Bluff, Maryland, have the anterior end much more produced and the posterior end more broadly pointed than the recent, the shell has however the smooth middle region on the exterior as the typical forms. Among shells from the Pleistocene north of Maryland, Verrill named a variety from Nantucket, *antiqua*. Dall reports shell from New Jersey. Figure 32, plate 6 is of a specimen from New York City. These forms have the concentric sculpture very coarse and fully developed over the entire surface of the shell. The posterior end is moderately broad and the dorsal groove is partially developed. The name *Venus antiqua* is preoccupied and if the form warranted varietal rank it should be renamed.

The variations of the typical *mercenaria* shell which have been named are listed under separated headings.

Dimensions.—Recent. 94 mm., length; 82 mm., height; 53 mm., thickness.

Occurrence.—UPPER MIOCENE. Choptank River, Md., Gay Head, Martha's Vineyard, Massachusetts, Virginia and Florida (Dall). PLEIOCENE. Carolinas and Florida (Dall). PLEISTOCENE. Sankoty head, Nantucket, Mass. var. *antiqua* Verril; Wailes Bluff near Cornfield Harbor. Maryland. (Cornell Univ. Pal. Lab.) Simmons Bluff, S. C. (Dall) RECENT. From Bay of Chaleurs, Gulf of St. Lawrence and Sable Island, south to Florida Keys and west to Corpus Christ, Texas. New Orleans well of 1856, 41 ft., Lake Borgne borings, Grand Chenier, Knapp's wells, Terrebonne Parish, No. 2, at 1050–1190, 1542–1632, 1791–1839, No. 3 at 570–700, 1400–1550 feet. (Maury. Cornell Pal. Lab.)

VENUS SUBMERCENARIA n.n.

Plate XXXII, Figure 1

Mercenaria cancellata Gabb, 1860, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. IV, p. 376, pl. 67, fig. 25; Conrad, 1863, Proc. ibid., vol. 14, p. 574; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9; Whitfield, 1895, Mon. U. S. Geol. Surv., 24, p. 68, pl. 12, figs. 2, 3.

Venus mercenaria cancellata Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 377; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1314 not *Venus cancellata* Linnaeus, 1767, 12 ed. Systema Naturæ (= *Chione cancellata* Linn.) Convex, beaks inclined anteriorly; umbones prominent and rounded; cardinal margin slightly curved, anterior extremity and basal margin rounded, posterior extremity subangular at its junction, both with the basal and cardinal margin; surface marked by numerous small angular ribs crossed by fine, radiating, impressed lines; anterior muscular impression semi-lunar, posterior larger and irregular; pallial sinus small and angular.

Dimensions.—1¾ in., width 2¾ in., depth of valve .7 in.

Locality and position.—With the above.

Collection of the Academy. One valve.—[Gabb, 1860.]

This form is rare in the Miocene from which it was described. Dr. Dall states that it is found living occasionally. Since the form seems to present fairly striking differences with *mercenaria* the species has been left as distinct. Larger collections however may warrant it as a subspecies of *mercenaria*.

Holotype.—No. 4137. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Miocene. Shiloh, Cumberland County, N. J. (Type). Recent. (Dall)

VENUS MERCENARIA NOTATA Say

Plate XXXII, Figure 5

Venus notata Say, 1822, Jour. Acad. Nat. Sci. Phil., vol. II, p. 271.

Venus obliqua Anton, 1837, Archiv fur Naturg., I, p. 284, fide Sowerby.

Venus cyprinoides Anton, 1839, Verz. Conch., p. 9 fide Sowerby.

Venus notata DeKay, 1843, Zool. N. Y., vol. V, p. 218, pl. 26, fig. 278; Mighels, 1843, Bost. Soc. Nat. Hist., vol. IV, p. 320; Philippi, 1844, Abb. u. Besch. Conch., I, p. 128, pl. II, fig. 3.

Mercenaria notata Deshayes, 1853, Cat. Conch. Brit. Mus., pt. I, p. 114.

Venus mercenaria Sowerby, 1855, Thes. Conch., II, p. 732, pl. 162, fig. 206.

- Mercenaria notata* H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 419; Holmes, 1858, Post-Pl. Fos. S. Car., p. 33, pl. 6, fig. II.
Venus notata Reeve, 1863, Conch. Icon., XIV, *Venus*, pl. 2, fig. 4a; Binney, 1870, Gould's Inv. Mass., p. 135, fig. 446 not of Gould, 1841, Inv. Mass., pl. IV, fig. 67 lower.
Venus mercenaria var. *notata* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 376; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1312; Johnson, 1915, Occ. Papers Bost. Soc. Nat. Hist., VII, No. 13, p. 70.

This variety differs from typical *mercenaria* in being more rounded and broader posteriorly, in having a narrower lunule, in lacking the purple interior coloration and in having brown, zigzag blotches or lines over the exterior.

Occurrence.—Living in New England to Florida. (U. S. Nat. Mus. coll.).

VENUS MERCENARIA SUBRADIATA n.n.

- Venus mercenaria* var. *radiata* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 377; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1314 not *Venus radiata* Dillwyn, 1817, Cat. Rec. Sh., p. 189.
 Similar to the last, [*V. submercenaria*] except that the smooth medial area is not concentrically sulcate.—[Dall, 1902.]

Occurrence.—Recent.

VENUS MERCENARIA ALBA Dall

- Venus mercenaria* var. *alba* Dall, 1902, Proc. U. S. Nat. Mus. 26., no. 1312, p. 377; Dall, 1903, Trans. Wag. Inst. Sci., III, pt. 6, p. 1314.
 In this form the interior is like *notata*, and the exterior destitute of colored lineation.—[Dall, 1902.]

Occurrence.—Recent.

VENUS CAMPECHIENSIS Gmelin

Plate XXXIV, Figures 1, 5, 6

- Venus campechiensis* Gmelin, 1791, Systema Naturæ, Tome. I, pt. 6, p. 3287; Lister, 1692, Hist. Conch., pl. 283, fig. 121.
Venus praprarca Say, 1822, Jour. Acad. Nat. Sci. Phil., vol. ii, p. 271; DeKay, 1843, Zool. N. Y., vol. V, p. 219.
Venus mortoni Conrad, 1837, Jour. Acad. Nat. Sci. Phil., vol. VII, p. 251; DeKay, 1843, Zool. N. Y., vol. V, p. 219, Conrad, 1846, Amer. Jour. Sci., 2nd ser., vol. ii, p. 42; Reeve, 1864, Conch. Icon. Mon. *Venus*, pl. III, fig. 7, in errata as *Venus alboradiata*.
Mercenaria Mortoni Conrad, 1854, Proc. Acad. Nat. Sci. Phil., vol. VII, p. 29; Holmes, 1858, Post Pl. Fos. S. Car., p. 34, pl. VI, f. 12.
Mercenaria fulgurans Tiyon, 1865, Am. Jour. Conch., 1, p. 297, pl. 26, figs. 1-3.
Venus tetrica Conrad, 1838, Fos. Med. Ter., p. 7, pl. IV, f. 1.
Mercenaria tetrica Conrad, 1863, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 574.
Venus permagna Conrad, 1838, Fos. Med. Tert., p. 9; Conrad, 1844, Proc. Acad. Nat. Sci. Phil., vol. I, p. 324; Twomey and Holmes, 1865, Pleioc. Fos. S. Car., p. 86, pl. 22, f. 2.
Mercenaria permagna Conrad, 1863, Proc. Acad. Nat. Sci., vol. 14, p. 574; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.
Venus capax Conrad, 1843, Proc. Acad. Nat. Sci. Phil., n. s., vol. I, p. 324; Conrad, 1845, Fos. Med. Tert., p. 68, pl. 38, f. 4.
Mercenaria submortoni Conrad, 1863, *ibid.*, p. 574.
Mercenaria obtusa Conrad, 1866, Amer. Jour. Conch., vol. II, p. 104, pl. 8, f. 3, not *Venus obtusa* Sedgwick and Murchison, 1844.
Mercenaria cuneata Conrad, 1868, Amer. Jour. Conch., vol. IV, p. 278, pl. XX, fig. 1.
Mercenaria carolinensis Conrad, in Kerr, 1875, Geol. Rep. N. Car., App., p. 20.
Venus campechiensis Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 377; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 77.
 V. testa orbiculari inæquilateri: striis transversis confertis acutes.

List. Conch. t. 283 f. 121

Habitat in sinus Campechiensi, testa $2\frac{1}{4}$ pollices longa.—[Gmelin, 1791.]

Adult very large, heavy, very convex; umbones large, very plump; lunule large, cordate, deeply impressed and bounded by a deeply incised line; anterior end very short; ventral margin regularly rounded. Surface with close, heavy, coarse, concentric lamellate lines of growth, smoother ventrally.

The adult differs from the adult *mercenaria* in being heavier, shorter, more trigonal, higher, and the concentric lines coarser and occurring over all the shell. It lacks the smooth central area of *mercenaria*. The lunule is wider and the internal coloration is white wholly.

The young is longer in proportion to the height than the adult and the lower mid-region of the shell is smooth. The young shells approach the shape of *mercenaria*. Medium stages are more graduate and compressed than the adults. Some have a coloration of zigzag lines over the exterior surface. This variety was called *V. fulgurans* by Tryon. The variety of *mercenaria* which reveals the zigzag coloration is *notata*. As Dr. Dall has pointed out, the zigzag markings in the case of *notata* is that of blotches instead of lines.

The fossil and recent variations of this species are very numerous. The most striking of the forms have been named. Those forms are discussed and figured.

Dimensions.—152 mm., length; 136 mm., height; 48 mm., semidiameter (large specimen).

Occurrence.—Miocene. (Listed under varieties). Pliocene. Shell Creek, Fla. Pleistocene. Labelle and Osprey, West Fla. Recent. Chesapeake Bay, south to Cuba and west to Yucatan.

VENUS CAMPECHIENSIS CUNEATA Conrad
Plate XXXIV, Figures 2, 3

Mercenaria cuneata Conrad, 1867, Proc. Acad. Nat. Sci., vol. 19, p. 139; Conrad, 1868, Amer. Jour. Conch., vol. IV, p. 278, pl. 20, fig. 1.

Venus campechiensis var. *cuneata* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1318; Glenn, 1904, Md. Geol. Sur. Mio., p. 308, pl. 82, fig. 3; pl. 83, fig. 2.

This variety is more trigonal than typical *campechiensis*. It is about of the same convexity but the anterior end is more produced. The concentric laminae have a tendency to flatten out.

The collection of this form at the Academy of Natural Sciences includes several specimens. One is labelled "Cope" which is probably the holotype since Conrad mentions Cope as having collected the specimen which he described. That shell measures 82 mm., in length, 70 mm., in height and 25 mm., semidiameter. Another specimen measured 115 mm., in length, 95 mm., height, and 39 mm., semidiameter. The specimen in the Cornell collection which is figured pl. 34, fig. 2 is like the shell just mentioned. The Cornell specimen figured pl. 34, fig. 3 is like one of the specimens in the Academy collection so hence is figured here.

Occurrence.—Choptank Miocene. Jones Wharf, Md. (Cornell Univ. Pal. Lab.) St. Mary's Miocene. St. Mary's River, Md. (Cornell Univ. Pal. Lab.). The type specimen was from Charles county, Maryland. The age of the sediments is given as Calvert ? by Glenn in the Maryland Miocene report.

VENUS CAMPECHIENSIS CAPAX Conrad

Plate XXXIII, Figures 2, 4, 5

Venus capax Conrad, 1843, Proc. Acad. Nat. Sci. Phil., n. s., vol. 1, p. 324; Conrad, 1845, Fos. Med. Tert., p. 68, pl. 38, fig. 4.
Mercenaria capax Conrad, 1863, Proc. Acad. Nat. Sci., Phil., vol. 4, p. 574; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.
Venus campechiensis var. *capax* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1317; Glenn, 1904, Md. Geol. Sur. Mio., p. 308, pl. 80, fig. 1; pl. 81, fig. 1.

This variety is rounded more regularly and pointed less posteriorly than typical *campechiensis*. The pallial sinus is small and sharply pointed.

Dimensions.—50 mm., length; 44 mm., height; 35 mm., thickness.

Holotype.—No. 4131. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Upper Miocene. Type. Pamunkey River, Kent co., Va.; Choptank Miocene. Various localities of Md. Geol. Sur. (Glenn)

VENUS CAMPECHIENSIS TETRICA Conrad

Plate XXXV, Figures 6, 8

Venus tetrica Conrad, 1838, Fos. Med. Tert., p. 7, pl. IV, fig. 1.
Mercenaria tetrica Conrad, 1863, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 574; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.
Venus campechiensis var. *tetrica* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 378; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1317; Glenn, 1904, Md. Geol. Sur. Mio., p. 307, pl. 80, fig. 2; pl. 81, fig. 2.

This variety differs from typical *campechiensis* in being less convex, longer in proportion to the height, lunule slightly narrower and the sculpture of the close, prominent laminæ over the whole portion of the shell.

The specimen in the Academy of Natural Sciences at Philadelphia measures 90 mm., in length, 75 mm., in height and 54 mm., in thickness. The Cornell specimen which is larger is like the figure of Conrad but is more pointed posteriorly than the specimen in the Academy collection.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—St. Mary's Miocene. St. Mary's River, Maryland.

VENUS CAMPECHIENSIS MORTONI Conrad

Plate XXXII, Figure 8

Venus mortoni Conrad, 1837, Jour. Acad. Nat. Sci., vol. VII, p. 251; Conrad, 1838, Fos. Med. Tert., p. 8, pl. 5, fig. 1.
Venus submortoni D Orbigny, 1852 Prodrome, III, p. 108.
Mercenaria mortoni Holmes, 1860, Post.-Plioc. Fos. S. Car., p. 34, pl. VI, fig. 12.
Venus alboradiata Reeve, 1863, Mon. *Venus*, Conch. Icon., pl. III, fig. 7, *mortoni* in errata.
Mercenaria submortoni Conrad, 1863, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 574; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9.
 ? *Venus campechiensis* var. *mortoni* Glenn, 1904, Md. Geol. Sur. Mio., p. 307, pl. 77,

figs. 1, 2.

This variety is more elongate than typical *campechiensis*. It is not as pointed posteriorly as *mercenaria* and the umbonal region is much larger. The posterior end is broader and rounder than the variety *tetrica*. The concentric ribs in *mortoni* are developed over the whole surface of the shell but are not lamellar over the whole surface as in *tetrica*.

Conrad states that his original description of this variety was derived from a recent specimen from Charleston Harbour. The specimen which he figured later was from St. Mary's River, Maryland. The forms from upper Tertiary of North and South Carolina which were called *permagna* are very large but they are typical *campechiensis*.

Dimensions.—115 mm., length; 95 mm., height; 32 mm., semi-diameter.

Holotype.—? Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—St. Mary's Miocene. St. Mary's River, Md. (Conrad). Pleistocene. New Orleans pumping station No. 7, La. (Maury. Cornell Univ. Pal. Lab.). Recent. South Carolina. (Conrad.)

VENUS CAMPECHIENSIS CAROLINENSIS (Conrad)

Mercenaria carolinensis Conrad, 1875, in Kerr Geol. N. Car., I, App. p. 20.

Venus campechiensis var. *carolinensis* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 378; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1318.

Shell subtriangular, elongated, very inequilateral, slightly ventricose, disk with coarse, flattened, uneven, imbricated ridges on the middle and posterior side, the lines disposed to be ramose; on the anterior side and posterior slope they are sharp, prominent, rugose, imbricated lines; lunule large, cordate. Length 5 inches; height 4 inches.

Locality. Cape Fear river.—[Conrad, 1875.]

Conrad did not figure this form. Dr. Dall regards the form as a variety of *campechiensis* and states that it occurs in the recent fauna as well as fossil.

Occurrence.—Miocene. Cape Fear, North Carolina. (Conrad). Recent. (Dall)

VENUS CAMPECHIENSIS ALBO-RADIATA Sowerby

Plate XLIV, Figure 21

Venus albo-radiata Sowerby, 1855, Thes. Conch., II, p. 732, pl. 161, fig. 199.

Venus campechiensis var. *albo-radiata* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 377.

V. testa ovata, ventricosa, fulva grisescente albo biradiata, costellis concentricis numerosis lævibus integris ad latera et prope marginem erecto-laminatis prope marginem ventralem crebrisculis depressis obtusis cincta; latera postico elongato, ad terminum obtuse triangulato; margine ventrali intus crenulato.

In shape and sculpture resembling *V. oblonga*, but the concentric laminae smoother, and becoming more close and rounded near the ventral margin; the hinder side has three obscure angles at the extremity, and the dorsal margin is angularly depressed. The lunule is dark brown.

Gulf of Mexico. In Mr. Cuming's collection.—[Sowerby, 1855.]

VENUS CAMPECHIENSIS SUBCAMPECHIENSIS n.n.

Venus campechiensis var. *quadrata* Dall, 1902, Proc. U. S. Nat. Mus., vol. 2, No. 1312, p. 377 not *Venus quadrata* Deshayes, 1858, Descript. An. sans Vert. fos. env. Paris, Tome I, p. 428.

Shell small, quadrate, thin, compressed, and unicolorate, usually yellowish white.
—[Dall, 1902.]

Occurrence.—Recent.

VENUS CAMPECHIENSIS TEXANA Dall

Venus campechiensis var. *texana* Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 378.

Texas coast.

Shell suborbicular, inflated, with the concentric lamellæ toward the middle of the disk coalescent, forming broad, more or less inosculating, low, flat-topped ribs with polished tops, sometimes showing the brown lineations of the younger stages.
—[Dall, 1902.]

The interspaces on the shell are about three times the width of the ribs. The shell is more convex than *subcampechiensis*.

Dimensions.—(Type). 62 mm., length; 52 mm., height; 37 mm., diameter.

Holotype.—United States National Museum, Washington, D. C.

VENUS TRIDACNOIDES (Lamarck)

Plate XXXIII, Figures 1, 3, 6

Cyprina tridacnoides Lamarck, 1818, Hist. des An. sans Vert., Tome V, p. 558; after Lister, 1692, Conch. pl. 499, fig. 53.

Venus deformis Say, 1824, Jour. Acad. Nat. Sci. Phil., 1st ser., vol. IV, p. 148, pl. XII, fig. 2.

Venus tridacnoides Deshayes, 1835, An. sans Vert., ed. II, VI, p. 591 fige Dall; Conrad, 1838, Fos. Shells Med. Ter., p. 10, pl. 7, fig. 2; Twomey and Holmes, 1857, Pleioc. Fos. S. Car., p. 85, pl. 22, fig. 1.

Venus Rileyi Conrad, 1838, Fos. Med. Tert., p. 9, pl. 6, fig. 1; Twomey and Holmes, 1857, Pleioc. Fos. S. Car., p. 78, pl. 21, fig. 8; Glenn, 1904, Md. Geol. Sur., p. 304, pl. 76, fig. 4, 5.

Mercenaria tridacnoides Conrad, 1863, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 574; Meek, 1864, Smith. Misc. Coll. VII, No. 183, p. 9.

Mercenaria Rileyi Conrad, l. c., p. 574; Meek, 1864, l. c., p. 9.

Mercenaria percerassa Conrad, 1867, Amer. Jour. Conch., vol. III, p. 13; Conrad, 1868, l. c., IV, p. 278, pl. 19, fig. 1.

Venus tridacnoides Dall, 1903, Trans. Wag. Inst., vol. III, pt. 6, p. 1310.

C. testa transversim ovata, corrugata; striis verticalibus; limbo superiore udatim plicato.

Mon. cabinet. List. Conch. t. 499. f. 53.

Habite . . . Fossile d'Italie, Largeur, 11 centimètres. Coquille singulière, grande, plissée, en son limbe, comme dans les tridacnes, ayant dans les interstices de ses sillons des stries verticales.—[Lamarck, 1818. *V. tridacnoides*.]

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, Virginia.

Observations. 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 planoconvex. 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. *V. rileyi*.]

The normal form *V. rileyi* of this species, varies in the thickness of the shell, some are very thin compared to the size of the shell; the form is more compressed than *V. mercenaria*, the umbones less full and they are smaller; the lunule is elongate, which is the type of *mercenaria* instead of

campechiensis. It is deeply impressed and bounded by a prominent line; the ornamentation is heavy and coarse, consisting of close, crowded, concentric lines. The shells are usually much eroded. The eroded surface reveals beneath, a layer of radiating striae.

The name *tridacnoides* by which the species is known does not represent the normal form. At Virginia localities, a heavy, extremely thickened, pathological form of the species occurs which is found to be abundant at numerous localities. The names *deformis* and *pererassa* were also given to specimens of that type. The shell besides being irregular and ponderous has several large, radiating flexures on the mid-region, from the umbones to the ventral margin. Various stages in development between *V. rileyi* and *V. tridacnoides* may be found in a collection which show differences in flexure and thickness of the shell.

Dimensions.—93 mm., length; 70 mm., height; 21 mm., semidiameter. (medium)

Occurrence.—(*V. tridacnoides*). *St. Mary's Miocene*. Evergreen, Va. *Murfreesboro Miocene*. Petersburg, Kingsmill, Va.; *Yorktown Miocene*. Yorktown, James River, Bellefield, Grove Landing, Va. (*V. rileyi*). LOWER MIOCENE. Alum Bluff, Fla. UPPER MIOCENE. *Calvert Stage*. Plum Point, Md. (Glenn); *St. Mary's Stage*. Evergreen, Va. *Murfreesboro Stage*. Petersburg, Kingsville, Va. *Yorktown Stage*. Yorktown, James River, (*type*). Bellefield, Jack's Bluff, Suffolk, James River above Smithfield, Va. Chocowinity, Tar Ferry, N. C. *Duplin Stage*. Natural Well, N. C. (Cornell Univ. Pal. Lab.) Magnolia, N. C. (Dall). PLEIO-CENE. Waccamaw River, S. C., Caloosahatchie and Shell Creek, Fla. (Dall)

VENUS DUCATELLI Conrad
Plate XXXV, Figures 5, 7

Venus Ducatelli Conrad, 1838, Fös. Med. Tert., p. 8, pl. IV, fig. 2; Conrad, 1863, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 574; Meek, 1864, Smith. Misc. Coll., vol. VII, No. 183, p. 9; Whitfield, 1895, Mon. U. S. Geol. Sur., 24, p. 67, pl. XI, figs. 1, 2, 3 only; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1309; Glenn, 1904, Md. Geol. Surv. Mio., p. 304, pl. 75, figs. 7, 8.

Shell suborbicular, convex, thick; disks with numerous approximate, recurved ribs, laminar and much elevated towards the posterior margin; extremity obtuse; beaks distant from the anterior margin; umbo not inflated; lunule defined by an impressed line, not very profound; posterior margin rectilinear; two of the cardinal teeth in the left valve remote, thick, bifid; anterior tooth much compressed.

Locality.—Cumberland county, New Jersey.

Observations. This shell is related to *V. Mortoni*, but is much smaller, less ventricose, and has more prominent ribs. It is obtained in fragments only, but those are abundant. It is named in compliment to the State Geologist of Maryland, Professor Ducatel.—[Conrad, 1838.]

This species differs from the other species of *Venus*, except *alum-bluffensis* n. sp. in being orbicular. It is elevated and flat. The concentric ribs on the middle portion of the shell where they are the most regular have interspaces equal to the width of the ribs. On the ventral region the ribs crowd together. The rugose area of the hinge is narrow.

We figure herein the type of the species. Conrad's figure does not

show the true shape of the shell.

Diameter.—60 mm., length; 53 mm., height; 17 mm., semidiameter.
(*Holotype*.)

Holotype.—Academy Natural Sciences, Philadelphia, Pa.

Occurrence.—Miocene. Cumberland County, New Jersey; Calvert Miocene. Near Church Hill, Maryland. (Glenn)

VENUS ALUMBLUFFENSIS n. sp.

Plate XXXIV, Figures 4, 7

Shell medium in size, orbicular; posterior end pointed; shape plump, convex; inner shell characters those of the genus; lunule deeply impressed, heart-shaped, wide; umbones small; surface sculptured with prominent, concentric lamellæ which are developed over the whole surface of the shell; the ribs are thick at the base and thinner above, they overturn dorsally which causes them to appear thicker when viewed from above.

This shell is nearest to *V. ducatelli* Conrad. It differs from that species in being less rounded posteriorly and in being less compressed. The character of the ribs in the two species are much alike. They are more crowded in *V. alumbuffensis*. That character may be due to a difference in the stage of growth and may not be of specific value.

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Chesapeake Miocene. Upper beds at Alum Bluff, Fla. (Cornell Univ. Pal. Lab.)

VENUS LANGDONI Dall

Plate XXXVI, Figures 19, 21, 23, 24

Venus Langdoni Dall, 1900, Trans. Wag. Inst. Sci. Phil., vol. III, pt. V, p. 1198, pl. 42, figs. 2, 7, 12; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1308.

Oligocene of the Chipola formation at Alum Bluff, Calhoun County, Florida; Dall and Burns.

Shell of moderate size, subtrigonal, inflated, with prominent decurved beaks and a large cordate lunule; posterior dorsal area large, laterally keeled, with coarse concentric striation, the dorsal margin of the right valve somewhat overlapping that of the left; sculpture of numerous rather distant, thick, elevated, concentric recurved ribs, which on the posterior part of the disk are bent downward and expanded; the interspaces are closely, sharply, deeply concentrically striated, so that the interspaces of the striæ are almost lamellose; owing to the general slight decortication the internal radial structure of the shell is usually more or less visible, though in a perfectly intact specimen it would be completely hidden; hinge as in the other species, the rugose area in the adult large and prominent; pallial line with a short angular sinus; the inner anterior and basal margins of the valves finely crenulate. Height 70, length 88, diameter 50 mm.

This fine species is named in honor of D. W. Langdon, Jr., who has done much work on our Southern Tertiary.

The species is distinguished by its heavy, prominent, recurved concentric ribbing from any of the other species of the genus, recalling in this respect some of the forms of *Chione*. It has so far been obtained only from the lower or Chipolan bed at Alum Bluff, where it is rather abundant.—[Dall, 1903.]

Syntypes.—United States National Museum, Washington, D. C.

Occurrence.—Miocene. Chipola formation at Alum Bluff, Calhoun

County, Fla. (Dall)

VENUS PLENA (Conrad)
Plate XLIV, Figure 22

Mercenaria plena Conrad, 1869, Amer. Jour. Conch., vol. V, p. 100; Whitfield, 1895, U. S. Geol. Sur., Mon. 24, p. 69, 12, figs. 4-6.

Venus Ducatelli Whitfield, 1895, op. cit., p. 67, pl. 11, figs. 4-7.

Venus plena Heilprin, 1887, Proc. Acad. Nat. Sci. Phil., vol. 39, pp. 397, 403; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1309; Glenn, 1904, Md. Geol. Sur. Mio., p. 306, pl. 79, figs. 1, 2.

Cordate, inequilateral, ventricose, oblique, with close concentric rugose lines; posterior side subuneiform; lunule ovate; inner margin densely crenulated.

Locality.—Eastern Shore, Md. Prof. Cope, Miocene.

I am indebted to Mr. Gabb for this species. It approximates *M. capax*, Conrad, but is shorter, less ventricose, more oblique; the hinge character differs, and the pallial sinus is deeper and more angular.—[Conrad, 1869.]

The holotype of this species was examined in the Academy of Natural Sciences at Philadelphia. It is moderately thin; the umbonal region is worn showing fine, radiating lines beneath; the shape is not as triangular as *cuneata* but more trigonal than *mortoni*. Other specimens in the Academy collection from the Patuxent River, Md., show the characters more completely. The posterior dorsal line is peculiar and appears as though it was deformed. It extends almost straight from the umbo, then slopes obliquely to half the distance from the beak to the posterior tip and then slopes downward at about an angle of 45°. Some specimens are more angulated than others. The ornamentation is that of very close, lamellar, concentric ribbing.

Dr. Dall suggests two varieties of this species. A form from Bellefield, Va., which is very trigonal and measures 60 mm. in length, 55 mm. in height and 36 mm. in diameter he refers to as *inflata*. A form from the same locality which is more rounded, thick, subtruncate behind and has obsolete lamellations. It measures 33 mm. in length, 29 mm. in height and 16 mm. in diameter. It is referred to as *nucca*.

Dimensions.—Holotype. 53 mm., length; 45 mm., height; 17 mm., semidiameter (right valve).

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Choptank Miocene. Maryland Survey localities. (Glenn.) Calvert Miocene. Plum Point, Md. (Dall). Yorktown Miocene. Bellefield, on York River, Va., Yorktown, Va., Wilmington, N. C. (Dall). Older Miocene. Shiloh and Jericho, Cumberland, N. J. (Whitfield)

VENUS ALTILAMINATA Conrad
Plate XXXIII, Figures 7, 8;
Plate XXXV, Figure 1

In the collections at the Academy of Natural Sciences, Philadelphia, there are four specimens of a *Venus* labelled *Venus altilaminata* Conrad. No locality is given for the specimens but the cards are labelled Miocene. We have not found a reference to such a species described by Conrad in

literature. The species is a true *Venus* so it belongs properly to the fauna of eastern America. We figure and describe the species in hope that more data may be learned of the form.

Shell subquadrate, dorsal and posterior lines nearly straight; anterior end slightly rounded; surface is sculptured with heavy, prominent, high lamellar, concentric ribs; on the umbonal and middle regions of the shell the interspaces are wide; pallial sinus is narrow and pointed; nymph coarsely rugose.

The species resembles somewhat *V. ducatelli* Conrad. The character of the concentric ribbing of the two is much alike but *V. altilaminata* is more quadrate in shape and the umbos are larger.

Dimensions.—77 mm., length; 65 mm., height; 47 mm., semidiameter.

Holotype.—Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—Miocene. Locality ?

Venus ascia H. C. Lea, 1845, is stated by Dall, 1900, to have the appearance of a worn *Felaniella*. The type specimen is in too poor a condition for identification.

Venus castanea Say, 1822, Jour. Acad. Nat. Sci. Phil., ser. 1, vol. 2, p. 273, is an *Astarte*.

Venus latisulcata Conrad, 1840, is *Euloxa latisulcata* (Conrad) Dall.

Venus jacksonensis Meyer, 1887, Bericht. Seuckbergische naturforsch. Gesellschaft Frankfurt a. M., p. 12, pl. 11, fig. 4, generic identity is still a question. It belongs to the subdivision of the Veneridæ with a small pallial sinus, no anterior lateral and crenulated margin. It is allied to *Venus* and *Chione*. A copy of Meyer's figure is given on pl. XXXIII, fig. 9.

Genus CYPRIMERIA Conrad



Fig. 29. Hinge of the type species of *Cyprimeria*

Cyprimeria Conrad, 1864, Proc. Acad. Nat. Sci. Phil., vol. 16, p. 212; Conrad, 1866, Amer. Jour. Conch., vol. II, p. 102; Stoliczka, 1871, Pal. Indica, vol. III, p. 157; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 180, pl. 115, figs. 39, 40, 42; Fischer, 1887, Man. de Conch., p. 1082; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 357; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1282; Jukes-Browne, 1908, Proc. Mal. Soc. Lond., vol. 11, p. 165; Gardner, 1916, Upper Cret. Md. Geol. Sur., p. 687; Stephenson, 1923, N. C. Geol. & Ec. Sur., V, pt. 1, p. 304.

Lentiform; hinge of right valve broad, with a bifid oblique cardinal tooth under the apex, and two oblique acute anterior teeth, with an intermediate pit for the reception of the tooth in the opposite valve.—[Conrad, 1864.]

Teeth three in each valve; right, posterior cardinal bifid; middle and posterior left cardinals grooved; middle, right cardinal very large; nar-

row, elongate, rugose nymphs; lunule absent; inner margin smooth; pal-
lial line hardly sinuated; exterior smooth except for lines of growth.

Genoholotype.—*Cytherea excavata* Morton. Plate XXIV, Figures 8,
17. Cretaceous.

Genus CYCLINA Deshayes



Fig. 30. Hinge of the type species of *Cyclina*

Cyclina Deshayes, 1849, *Traite Elem.*, I, pl. 15, figs. 20–22; Deshayes, 1853, *Cat. Conch. Brit. Mus.*, pt. 1, p. 29; Mörch, 1853, *Cat. Yoldi*, II, p. 29; H. and A. Adams, 1857, *Gen. Rec. Moll.*, vol. II, p. 432; Römer, 1862, *Mon. Dosinia*, p. 4; Stoliezka, 1871, *Pal. Indica*, vol. III, p. 157; Tryon, 1884, *Struct. and Syst. Conch.*, vol. III, p. 180; Fischer, 1887, *Man. de Conch.*, p. 1082; Dall, 1902, *Proc. U. S. Nat. Mus.*, vol. 26, No. 1312, p. 348; Dall, 1903, *Trans. Wag. Inst. Sci.*, vol. III, pt. 6, p. 1234; Jukes-Browne, 1914, *Proc. Mal. Soc. Lond.*, vol. 11, p. 86 not *Cyclinus* Kirby, 1837, *Coleoptera*; not *Cyclinella* Gray, 1857.

Eocyclina Dall, 1908, *Bull. Mus. Comp. Zool. Har. Col.*, 43, p. 241.
"Animal *Dosinia* simile," Gray.

Test circularis, tenuis, inflata, inæquilateralis, transversim striata, area lunulaque nullis; umbones parvi, approximati; margines simplices, aliquantisper crenulati; cardo latus, planus, tridentatus, alter bidentatus; impressio muscularis postica ab extremitate marginis cardinalis remota; sinus pallii triangularis, obliquus, sæpius ascendens; ligamentum externum margine rimæ subtectum.—[Deshayes, 1853.]

Genoholotype.—*Venus sinensis* Gmelin. Plate XXIV, Figures 9, 13,
14, 20. Living in the China Sea.

Dr. Dall suggested *Eocyclina* for the genus if the name *Cyclina* is too
near *Cyclinus* of Kirby in 1837.

Typical *Cyclina* has not been found as yet in the eastern American
sediments. It is here included to show the relation in similar and dis-
similar characters with *Cyclinella*.

Cyclina parva Gardner, 1916, of the Upper Cretaceous is not a true
Cyclina.

Genus CYCLINELLA Dall



Fig. 31. Hinge of the type species of *Cyclinella*

Cyclinella Dall, 1902, *Nautilus*, vol. XVI, No. 4, p. 44; Dall, 1902, *Proc. U. S. Nat. Mus.*, vol. 26, No. 1312, p. 357; Dall, 1903, *Trans. Wag. Inst. Sci.*, vol. III, pt. 6, p. 1284; Jukes-Browne, 1914, *Proc. Mal. Soc. Lond.*, vol. 11, p. 86.

The European genus *Mysia* (Leach) Lamarck, of which the type is *Lucinopsis undata* Forbes and Hanley, has two right and three left cardinal teeth. A very similar type is found in American waters, represented in the Antilles by *Artemis tenuis* Recluz, and on the Pacific coast by *Dosima subquadrata* Hanley. These forms, however, differ from *Mysia* by having three cardinal teeth in each valve. For this American type I propose the name of *Cyclinella*, and add the following new species to the

fauna of the Pacific coast.—[Dall, 1902.]

Shell thin; orbicular; umbones small; lunule elongate, circumscribed by a faint line; no escutcheon; ligament large, internal; three cardinals in each valve, thin and sharp; right, posterior cardinal bifid; margins entire; pallial sinus directed, in many cases, at nearly a vertical attitude, this character is not true in all cases, even among individuals of the same species; exterior smooth or with undulating, fine lines of growth more or less conspicuous.

Cyclinella differs from *Cyclina* in having a thinner shell, a smoother inner margin, a faintly marked lunule, finer lines of growth and thinner teeth. The hinge of the two genera is similar except that *Cyclina* has much heavier teeth.

Genolectotype.—*Cyclinella tenuis* Recluz. Plate XXIV, Figures 3, 5, 18. Recent. West Florida to Brazil, thru West Indies.

Eastern American species range from the Miocene thru Recent.

Stratigraphic Range of *Cyclinella*

Eocene	Oligocene	Miocene	Pliocene	Pleistocene	Recent
		<i>gatunensis</i>	<i>tenuis</i>		<i>tenuis</i>
		<i>cyclica</i>			
		var. <i>domingensis</i>			
		<i>subquadrata</i>			
		var. <i>quitana</i>			
		<i>plasiatenuis</i>			
		<i>beteyensis</i>			
		<i>harrisi</i>			

CYCLINELLA GATUNENSIS Dall

Plate XXV, Figures 7, 15, 16

Cyclinella gatunensis Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1285, pl. 52, fig. 18.

Eocene of the Gatun beds on the line of the Panama Canal at Gatun, Colombia; R. T. Hill.

Shell thin, suborbicular, nearly equilateral, with inconspicuous beaks; moderately convex; sculptured with fine, concentric, scarcely elevated lines, near the beaks and on the middle of the disk nearly smooth; lunule elongate, lanceolate, defined by an incised line, not impressed; interior inaccessible. Height 44, breadth 43, diameter about 15 mm.

This species differs from *C. cyclica* in form, in its finer and less elevated sculpture, and in being a more thin and delicate shell. The lunule is also narrower and proportionately smaller.—[Dall, 1903.]

Specimens from the Darien region, Panama, which might be compared with *gatunensis* show a variation in shape. Two specimens are figured. Figure 7, plate XXV, compares very closely with *cyclica* but it does not have the more conspicuous, concentric lines as in *cyclica*. The specimen was compared with the specimens of *cyclica* in the U. S. Nat. Mus. The shape of *cyclica* is more subquadrate and less obliquely orbicular than the figure of Guppy.

The holotype of *C. gatunensis* is crushed. The specimen figured on plate XXV, figure 16 has been compared with and is typical of *gatunensis*.

It is crushed slightly also along the ventral margin. The posterior dorsal margin is well extended and the anterior end well produced.

The specimen, figure 7, which approaches *cyclica* more in shape, has a more quadrate form with the posterior, dorsal margin shortened and the anterior end less produced.

Holotype.—? No. 135257. United States National Museum, Washington, D. C.

Occurrence.—Miocene. Gatun Stage. Gatun beds on the line of the Panama Canal at Gatun. (Dall). Province of Darien, Panama. (Yaekel Coll. Cornell Univ. Pal. Lab.)

Cyclinella cyclica (Guppy)

Plate XXIV, Figures 2, 7, 12

Dosinia cyclica Guppy, 1866, Quart. Jour. Geol. Soc. Lond., vol. 22, p. 582, pl. 26, fig. 15.

Cyclina cyclica Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 250.

Luciniopsis cyclicus Dall, 1896, Proc. U. S. Nat. Mus., vol. 19, p. 329.

Cyclinella cyclica Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1285; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 151, pl. 26, fig. 4.

Shell nearly orbicular, thick, subinequilateral, scarcely swollen, finely and regularly concentrically striated, with occasional deeper subrugose lines of growth towards the ventral margin; umbones small, compressed, and closely approximate; lunule entirely wanting; margins plain. Hinge consisting of a broad flat plate circumscribed by the raised dorsal margin; teeth three, large; the central and largest one placed immediately under the umbo; the other two lamellar and divergent, the posterior one largest.

This shell has the general shape of *Dosinia discus*. It is also allied to *D. orbicularis* of the Bordeaux deposits. It wants the lunule and the small anterior tooth ascribed to the genus *Dosinia*, and I thought at first of referring it to *Cyclina*. The general character of the hinge, as well as of the exterior, however, resembles that of *D. orbicularis* so closely that I have decided to place it under the same generic name as that species. It is evidently intermediate in some respects to the two genera mentioned. It is readily distinguished from *D. acetabulum*, another species to which it bears some resemblance, by the very different arrangement of the hinge-teeth, by the total absence of a lunule, and by the umbo being less incurved.—[Guppy, 1866.]

The lunule is present in this species. It is large and lanceolate and defined by an impressed line. The exterior surface is marked with conspicuous, concentric lines which are fine and sharp. They are not as large as those which occur on *Dosinia* but are developed more than any of the recent species of *Cyclinella* of the American fauna. The specimens of the species except worn specimens are more quadrate than the figure of Guppy. The dorsal line is straighter. The hinge of the right valve has been seen on one specimen. It is that of *Cyclinella*. The figure of Guppy of the left hinge shows jagged edges between the teeth. Those protuberances do not represent any accessory features of the hinge. The specimens of this species are usually in the form of casts so that the figure of a cast is given.

Dimensions.—(Paratype. Medium specimen) 40 mm., length; 36 mm., height; 21 mm., diameter.

Holotype.—? No. 115541. United States National Museum, Washington, D. C.

Occurrence.—Miocene. Manzanilla, Trinidad. (Guppy); Cornell Univ. Pal. Lab.)

CYCLINELLA CYCLICA DOMINGENSIS Pilsbry and Johnson

Plate XXV, Figure 6

Cyclina cyclica Gabb, 1873, Trans. Amer. Phil. Soc., vol. 15, p. 250.

Cyclinella cyclica domingensis Pilsbry and Johnson, 1917, Proc. Acad. Nat. Sci. Phil., vol. 69, p. 200; Pilsbry, 1921, l. c., vol. 73, p. 424, pl. 47, fig. 8.

According to Guppy, the lunule is entirely wanting in his species, but Dall, who has examined the types, states that it is large and lanceolate, and there is "a close concentric sculpture of fine, sharp, somewhat elevated lines." (Wagn. Trans. III, 1285). In the Santo Domingo specimen (No. 2755) an excessively faint impressed lines defines the lunule, which is about 7 mm. long, 3 wide. The sculpture consists of unequal, unevenly developed flat growth-ripples, which on the posterior dorsal slope become fine but not much elevated threads.

Length 28.7, alt. 26.5, diam. 14 mm.

As the single specimen seems to differ somewhat from the account of Guppy's species, we prefer to treat it as a variety.

Dall stated that the type of *D. cyclica* Guppy was a *Lucinopsis* (Proc. U. S. Nat. Mus. XIX, 329), but later (Trans. Wagn. Inst. III, 1285) he placed it in *Cyclinella*. Type No. 2755.—[Pilsbry and Johnson, 1917.]

Occurrence.—Miocene. Santo Domingo. (Coll. Acad. Nat. Sci. Phil.)

CYCLINELLA BETEYENSIS Olsson

Plate XXV, Figure 8

Cyclinella beteyensis Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 243, pl. 31, fig. 2.

Shell thin, dosinoid or sub-circular in form, the margins of the shell nearly a perfect circle; slightly convex; beaks small but distinct, situated at the anterior $\frac{1}{3}$ of the shell; sculpture with very fine, concentric threads, which are a little elevated and strongest on the anterior end, nearly smooth on the middle; lunule small, lanceolate and defined by a small, incised line; hinge normal, the left valve with 3, narrow, cardinal teeth and a wide ligament.

Height 39, length 38?, diameter 5 mm. left valve.

Represented by a single, imperfect specimen from the Gatun of Rio Betey. It is but slightly convex, and in form approaches very closely a species in the Newcomb collection from the Bay of Fonseca, which is probably the *C. Kroeyeri Philipp*. The fossil shell is more perfectly circular in form.

Gatun Stage: Rio Betey.—[Olsson, 1922.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Costa Rica.

CYCLINELLA HARRISI n. sp.

Plate XLV, Figures 6, 7

Shell large, flat for the size of the form; dorsal line nearly straight; posterior and ventral margins rounded; umbones very small; lunule elongate, defined by a faint incised line; surface covered with regular, concentric lines, coarse for the genus.

This species is conspicuous for its large size, comparative flatness and regular, concentric liræ. It differs from *C. gatunensis* in being very much flatter and in having coarser, concentric lines over the surface. The dorsal line of *C. cyclica* is shorter than this species. *C. cyclica* is plumper for the size of the shell. The two species have the concentric liræ about of equal prominence. *C. harrisi* resembles *C. beteyensis* more closely than it does any of the other species. It is slightly thicker than that species and the concentric liræ are coarser and more regular than on *C. beteyensis*.

The species is named in honor of Prof. G. D. Harris who collected the specimens in Trinidad.

Dimensions.—62 mm., length; 57 mm., height; 20 mm., thickness.

Holotype and Paratype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Springvale Miocene. Springvale, Trinidad.

CYCLINELLA PLASIATENUIS Woodring

Plate XXIV, Figures 1, 4

Cyclinella plasiatenuis Woodring, 1925, Carnegie Inst. Wash. Pub., No. 366, p. 158, pl. 21, figs. 10, 11.

Shell medium-sized, thin, suborbicular, subequilateral, moderately inflated; dorsal margins rounding evenly into lateral margins; anterior end slightly more extended than posterior; umbo full, strongly incurved, moderately high; sculpture consisting of irregular incrementals.

Length 24 mm.; height 24 mm.; diameter (left valve) 8 mm.

C. plasiatenuis is known only from the holotype, an incomplete left valve. Only part of the lunule is preserved, but it apparently is relatively large and limited by a shallow groove. This species closely resembles the larger living *C. tenuis* (Recluz), but is more orbicular and has slightly more compressed teeth. *C. cyclica* (Guppy), a Miocene (?) species from Manzanilla, Trinidad, and *C. gatunensis* Dall, from the Gatun formation, are larger and less orbicular. *C. plasiatenuis* more closely resembles *C. beteyensis* Olsson, a Miocene species from Costa Rica, but is smaller and more inflated.

Type material.—Holotype (left valve, U. S. Nat. Mus. No. 353834).—[Woodring, 1925.]

Occurrence.—Miocene. Bowden, Jamaica.

CYCLINELLA SUBQUADRATA QUITANA Olsson

Plate XXV, Figure 3

Cyclinella subquadrata Hanley var. *quitana* Olsson, 1922, Bull. Amer. Pal., vol. 8, No. 39, p. 243, pl. 31, fig. 8.

Shell small, thin, convex and subcircular in form; beaks small but distinct, with inflated umbo and small beak situated at the anterior $\frac{1}{3}$; the anterior end is narrow and slightly produced, while the posterior end is wide and with the hinge-margin is subquadrate in form; the surface is sculptured with fine irregular, concentric growth-lines, which are strongest and more regular on the posterior dorsal submargin; the interior is concealed.

Height 28, length 31, diameter of the right valve 7 mm.

This is a smaller and more convex species than the *beteyensis* and like that species, it seems to find its recent analogue on the Pacific side, in this case the *C. subquadrata* Hanley. On the Pearl Islands in the Bay of Panama I collected a few small valves which are probably the *C. subquadrata* Hanley, but they are not so produced anteriorly as is shown in Reeve's figure. These Pearl Island shells are very similar to the Costa Rican fossil, differing mainly in their more inflated umbos and in slight difference in form.

From the Gatun beds of the Canal Zone, Dall has described *C. gatunensis*, but that species is very distinct from the two Costa Rican *Cyclinellas*.

Gatun Stage; Quitana creek.—[Olsson, 1922.]

Holotype.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occurrence.—Gatun Miocene. Quitana Creek, Costa Rica. (Olsson Coll. Cornell Univ. Pal. Lab.)

CYCLINELLA TENUIS (Recluz)

Plate XXIV, Figures 3, 5, 18

Dosinia (Artemis) tenuis Recluz, 1852, Jour. de Conch., vol. III, p. 250, pl. X, fig. 1;

Petit, 1853, ibid IV, p. 415, not *Artemis tenuis* Sowerby.

Cyclina tenuis Deshayes, 1853, Cat. Conch. Bivalve Shells Brit. Mus., pt. 1, p. 33;

Beau, 1858, Cat. Coq. Guadeloupe, p. 24.

Lucinopsis tenuis Petit, 1856, Journ. de Conch., vol. V, p. 155.

Mysia tenuis Dall and Simpson, 1901, Bull. U. S. Fish. Com., vol. 1, p. 487.

Cyclinella tenuis Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 373; Dall,

1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1285; Maury, 1920, Bull. Amer. Pal., vol. 8, No. 34, p. 71.

Testa orbiculari, æquilatera, convexo-depressa, tenui, squalide alba, antice rotundata, postice subrotunda; imbonibus prominentibus, antice inflexis, castaneo tinctis; area fere obsoleta, cordato-lanceolata; margine dorsali subrecto, declivi, antico submarginato; intus albidâ; impressione musculari antiqua, angusta, elongata, arcuata; postica ovato-rotundata, ac inferiore; impressione palliali trigona ascendente; margine valvarum integerrimo.

Habite la Baie de la Pointe-à-Pitre (Guadeloupe).

Coquille orbiculaire, mince, d'un blanc sale, équilatérale, convexe, déprimée, légèrement striée concentriquement; montrant des lignes longitudinales, rapprochées, obsolètes: ses sommets sont saillants, ordinairement teinte de marron clair: lunule peu apparente, cordiforme, lancéolée: intérieur blanchâtre, terne.

Charnière formée de trois dents sur chaque valve: deux dents cardinales antérieures geminées sur la valve droite, et une autre bifide postérieure sur la même valve; valve gauche, deux dents cardinales, divergentes, antérieures, avec une dent étroite, lamelleuse et postérieure: toutes ces dents sont si rapprochées, qu'on pourrait, à l'exemple de Lamarck, les considérer comme cardinales: néanmoins, avec un peu d'attention, on s'aperçoit que les postérieures sont bien des dents latérales.

Les chondrophores sont ceux du genre.

Impressions musculaires antérieures allongées, arquées, étroites, ne descendant pas jusque vers le milieu de la valve: impressions musculaires postérieures arrondies, placées sur la ligne médiane des valves, et touchant à l'excavation palliale: celle-ci est triangulaire, ascendante, et se termine sur le milieu de la valve.

Hauteur, 34 mill.

Largeur, 35 mill.

Épaisseur, 16 mill.

Il paraît, toutefois, que cette coquille atteint de plus grandes dimensions, d'après M. Beau, qui a envoyé cette espèce à M. Petit.—[Recluz, 1852.]

A larger size than the dimensions given is noted by Recluz. The species attains a size twice that of the original dimensions.

Occurrence.—Pliocene. Calcosahatchie River, Florida (Dall). Living. Cedar Keys, Florida thru the West Indies to San Paulo, Brazil.

Genus CLEMENTIA Gray



Fig. 32. Hinge of the type species of *Clementia*

Clementia Gray, 1842, Syn. Brit. Mus., p. 74; Gray, 1847, Proc. Zool. Soc., p. 184; Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 197; H. and A. Adams, 1857, Gen. Rec. Moll. vol. II, p. 433, pl. 109, fig. 1; Stolozka, 1871, Pal. Indica, vol. III, p. 157; Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 181; Fischer, 1887, Man. de Conch., p. 1084; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 348; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1234; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. 11, p. 85.

Blainvillia Hupé, 1854, Rev. de Zool., p. 219; not *Blainvillia* Desvoidy, 1830, Diptera fide Dall.

Shell thin, transversely ovate; beaks full; no lunule or escutcheon; three cardinals in each valve, no laterals; right, posterior cardinal bifid; pallial sinus large; margins entire; exterior concentrically undulate or wrinkled with prominent growth lines; shell white.

Genoholotype.—*Venus papyracea* Gray. Plate XXV, Figures 2, 5, 9, 11, 14. Recent. Philippine Islands and East Indies.

The recent species are inhabitants of the Australian and Philippine

regions. One species *C. solida* Dall is reported living from western America. The genus was common but with few species in the Oligocene and Miocene on the eastern shores of America and in the region of Central America. As yet the genus on the eastern coast has not been found below the Oligocene. It occurs in the Jackson Eocene of Peru.¹

CLEMENTIA DARIENA (Conrad)

Plate XXVI, Figures 6, 13, 14, 15, 16, 17, 18, 19, 20

Meretrix dariena Conrad, 1856, Pacific R. R. Repts., V, p. 328, pl. VI, fig. 55, not *Cytherea*? (*Meretrix*) *Dariena*? Conrad, 1857, *ibid.*, VI, p. 72, pl. V, fig. 21 = *Callista maculata* Linn.

Clementia dariena Gabb, 1881, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. VIII, p. 344, pl. 44, fig. 16, 16a; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1235; Toulou, 1908, *Jahr. der K. K. Reich.*, 58, p. 725, pl. 27, figs. 9, 10; Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phil., vol. 63, p. 371, pl. 28, fig. 1.

Clementia rabelli Maury, 1920, N. Y. Acad. Sci., vol. III, pt. 1, p. 37, pl. VI, figs. 2, 3.

Clementia dariena Hubbard, 1920, N. Y. Acad. Sci., vol. III, pt. 2, p. 118, pl. XIX, figs. 10, 11, 12; Woods, 1922, in Bosworth Geology of North-West Peru, p. 113, pl. XX, 4; Olsson, 1922, Bull. Amer. Pal., vol. 9, No. 39, p. 232, pl. 31, fig. 4; Spieker, 1922, Johns Hopkins Univ. Studies Geol., No. 3, p. 141, pl. VIII, fig. 5; Maury, 1925, Bull. Amer. Pal., vol. 10, No. 42, p. 141, pl. 26, figs. 1, 3, 5, 6, 7; Harris, 1926, Johns Hopkins Univ. Stud. Geol., No. 7, p. 110, pl. XX, fig. 8.

Clementia brasiliana Maury, 1924, Ser. Geol. e Min. do Brazil, Mon. vol. IV, p. 423, pl. 24, fig. 3.

Obtusely and obliquely subovate; ventricose; inequilateral; anterior extremity angulated, and situated much nearer the beak than the base; anterior dorsal line and oblique; beak not prominent; basal and posterior margins profoundly rounded.

Locality.—Occurs with the preceding.—[Conrad, 1856.]

Shell large, plump and thin; hinge of *Clementia*; lunular area sunken but not impressed or bounded by an incised line; the surface of the shell ornamented with large, prominent, concentric, undulating ridges which on the large, adult shells diminish in size ventrally and in many cases will not be present along the ventral margin; young shells, 30 mm. or so in length, have the ribs large, and high over the whole surface of the shell. The shape of the shell also varies with age. The young are more quadrate. On typical adult specimens the dorsal line is nearly straight. It curves slightly. The figure of the specimen of *rabelli* Maury from Porto Rico shows the dorsal line more curved than any specimens figured from other localities. *C. dariena* is collected most abundantly in the form of casts. The shell is very thin and the specimens from certain localities where abundant cast material is found are deformed very often. A specimen is figured from the Venezuelan material in the Cornell University Paleontological laboratory, which is worn and shows the curved dorsal line. There is no doubt as to its identity with *C. dariena*. Other specimens might be figured showing the same condition. This species has been found to occur more abundantly and over a wider range than was thought formerly. Large collections have been made from the Miocene and what is at present determined as Oligocene, of Venezuela. Specimens from the same and from different localities show the characters mentioned. The

¹ A. Olsson has in a collection from the Jackson Eocene, Saman formation, Chira Valley, Peru, a species of *Clementia*. The material contains specimens of *Venericardia planicosta* Lam.

best character to identify the species is that of the conspicuous, undulating ribs. Slight differences in shape, since there is a great chance for deformation and attrition, do not seem to be of value enough for the separation of species or varieties.

Gabb mentions that Conrad and he discussed the identity of Gabb's specimens with that of *C. dariena*.

Dimensions.—62 mm., length; 52 mm., height; 33 mm., thickness. (average adult).

Occurrence.—OLIGOCENE. Rio Collazo near San Sebastian, Stations 23, 53, 54, 60, 61, 62, Porto Rico. (Maury). San Sebastian shale, Juan Diaz shale, 232 (b), 233, Collazo Falls, 83, 84, Juan Diaz, Porto Rico. (Hubbard). Facon, Venezuela. (Williston Coll. Cornell Univ. Pal. Lab.). Venezuela. (Hodson Coll. Cornell Univ. Pal. Lab.). MIOCENE. Isthmus of Darien, Panama. (type. Conrad.) Province of Darien, Panama. (Yaekel Coll. Cornell Univ. Pal. Lab.). Gatun, Canal Zone, Panama. Nancy's Cay, Province of Bocas del Toro, Upper Hone Creek, Souis Creek, Costa Rica. (Olsson Coll. Cornell Univ. Pal. Lab.); Quaico-Tamana Road at 7¾ mile post, Manzanilla, Trinidad. (Maury. Harris Coll. Cornell Univ. Pal. Lab.); Zorritos formation. Quebrada Charan, 1 mile n. e. Boca Pan village, Peru. (Woods); Zorritos formation. South of Quebrada de las Alturas, Peru. (Spieker. Johns Hopkins Univ. Pal. Lab.); Venezuela (Williston and Hodson Coll. Cornell Univ. Pal. Lab.) Lower Miocene. Estação Agronomica bed n. 8, Brazil. (Maury).

CLEMENTIA INOCERIFORMIS (Wagner)

Plate XXV, Figure 10, 13;

Plate XXVI, Figure 13a

Venus inoceriformis Wagner, 1839, Journ. Acad. Nat. Sci. Phil., vol. VIII, p. 51, pl. 1, fig. 1; extra copies, p. 2, pl. 2, fig. 2 fide Dall, 1897, Trans. Wag. Inst. Sci., vol. 5, p. 7.

Venus (Egesta) inoceriformis Conrad, 1845, Fos. Med. Tert., p. 70, pl. XL, fig. 1.

Clementia inoceriformis Conrad, 1862, Proc. Acad. Nat. Sci., vol. 14, p. 575; Meek, 1864, Smith. Misc. Col., vol. VII, No. 183, p. 10; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1235; Glenn, 1904, Md. Geol. Sur. Miocene, p. 315, pl. 82, figs. 1, 2.

Shell oblique, suborbicular, thin and fragile, ventricos; disks with unequal, concentric undulations, forming prominent angulated carinae; concentric striae numerous, prominent; beaks prominent; no distinct lunule; cardinal teeth lamellar.

Locality.—Banks of St. Mary's River, Maryland. This beautiful *Venus* is very similar in the exterior to some species of *Inoceramus* which character has suggested the name. One specimen alone has hitherto been found; this I obtained on a visit to Porto Bello, St. Mary's River, Maryland.—[Wagner, 1839.]

Shell large; hinge prominent with a large pit extending from the beak down the posterior cardinal and ligamental area.

Dimensions.—75 mm., length; 72 mm., height; 16 mm., semidiameter.

Holotype.—No. 5415. Wagner Free Institute of Science, Philadelphia, Pa.

Occurrence.—Calvert, Choptank and St. Mary's Miocene, Maryland.

(Dall, Glenn and Cornell Univ. Pal. Lab.); Shiloh, N. J. (Acad. Nat. Sci. Phil.)

CLEMENTIA GRAYI Dall

Plate XXV, Figure 12

Clementia grayi Dall, 1900, Trans. Wag. Inst. Sci., vol. III, pt. 5, p. 1193, pl. 37, fig. 12; Dall, 1903, *ibid.*, vol. III, pt. 6, p. 1236.

Uppermost Oligocene at Oak Grove, Santa Rosa County, Florida; Burns.

Shell thin, convex, rude, concentrically coarsely and irregularly striated, near the beaks concentrically undulated, without lunule or es-cutcheon; internal margins smooth, adductor scars large, pallial line with a long, narrow, acute sinus extending forward more than two-thirds the way from the posterior to the anterior adductor; cardinal teeth entire, the middle cardinal strongest. Height 55, length 63, diameter 32 mm.

This fine species is not unlike the *C. Vatheletii* Mabille, living in Korea.—[Dall, 1903.]

Holotype.—United States National Museum, Washington, D. C.

Occurrence.—Miocene. Oak Grove, Santa Rosa county, Florida.

Clementia taeniosa Guppy and Dall, 1896, Proc. U. S. Nat. Mus., vol. 19, p. 327, p. XX, fig. 8 and Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1235 from the illustration does not show the aspects of a *Clementia*. The figure of a cast looks more like a *Racta* or *Harvella*. The type specimen was not to be found at the United States National Museum. The number is given in U. S. Nat. Mus. Catalogue, Bull. No. 53, pt. 1, p. 151 as 107106. Guppy described the species from Saveneta, Trinidad. The Harris collection from Trinidad did not reveal specimens of the species. Specimens of *C. dariona* occur in the Montserrat beds, Trinidad.

Genus GEMMA Deshayes



Fig. 33. Hinge of the type species of *Gemma*

Gemma Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 112; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 419.

Totteniana Perkins, 1869, Proc. Bost. Soc. Nat. Hist., vol. XIII, p. 148.

Tottenia Perkins, 1869, op. cit. in errata.

Gemma Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 180; Fischer, 1887, Man. de Conch., p. 1083; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 365; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1329; Jukes-Browne, 1913, Ann. Nat. Hist., ser. 8, vol. XII, p. 473; Jukes-Browne, 1914, Proc. Mal. Soc. Lond., vol. XI, p. 86.
Animal ignotum.

Testa rotundato-trigona, subæquilaterielis, lævigata, cardo brevis, angustus, dentes cardinales tres in valva sinistra, mediarus conicus, triangularis, parum arcuatus, duo in valva dextra dive gntes, fossula lata interposita; impressiones musculares marginales inferiores extremitatibus approximatae; impressio pallii marginalis, sinus angustus, excavatus, longissimus, perpendiculariter ascendens; ligamentum externum.—[Deshayes, 1853.]

Shell small, oval or subtrigonal; lunule large, faintly impressed; no escutcheon; two large teeth in the left valve with a large, median socket between the two; a very thin ridge which might be termed a tooth occurs posteriorly beneath the ligament, in the left valve; three teeth in the right valve, the middle tooth is large, the posterior tooth is long and narrow and the anterior is slight and feeble; the posterior, dorsal margin of the right valve and the anterior, dorsal margin of the left valve have a long, narrow groove to receive the ridge of the opposite valve; pallial sinus small, triangular; inner, ventral margin crenulate; exterior smooth or sculptured concentrically.

Various authors who have described the characters of the hinge of this genus interpret the small, anterior and posterior teeth or ridges of the two valves, differently, in regard into what category of teeth they should be classed. It is a question of the interpretation of the slight dental ridge in each valve.

Genoholotype.—*Gemma gemma* Totten, Plate XLIII, Figures 9, 13, 31. Pleistocene of Massachusetts Bay and living from Labrador to New York Bay.

The genus was known only from the Atlantic coast of North America until it was introduced on the Pacific coast of North America. It is known from the Eocene thru Recent on the eastern American coast.

GEMMA SANCTI-MAURICENSIS Harris

Plate XLIII, Figures 3, 7

Gemma sancti-mauricensis Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 152, pl. 47, figs. 14, 15.

Shell small, somewhat *Astarte*-like exteriorly as figured; increments of growth well-defined, rounded, becoming much less conspicuous on the anterior and posterior margins which fall off rather abruptly; lunule rather long, striate, and defined by a faint channel, not a sharply incised line; interior porcellanous, giving the shell a slightly thickish appearance for so small a specimen; anterior adductor scar apparent but not so deeply impressed, posterior and pallial sinus excessively faintly defined; margin faintly crenate anteriorly; in the right valve (the only one obtained) there is a faint trace of a long posterior lateral tooth, but a corresponding anterior channel, if ever present, is entirely eroded away.

This single specimen was found among some St. Maurice material marked Saline River?, La. Its exact provenance is therefore undetermined at present.

At this early date this genus seems not to have developed all the marked characteristics shown later on in the Oligocene and higher beds.

The external ligament was very short. As the shelly matter decayed there was a slight pit-like cavity formed just under the beak, reminding one of the extensive expansion seen under the beak of *Dosinia*, *Dosiniopsis*, etc.—[Harris, 1919.]

Type.—Cornell University Paleontological Museum, Ithaca, N. Y.

Occur. ence.—St. Maurice Eocene.

GEMMA TRIGONA DELANDENSIS Mansfield

Plate XLIII, Figures 1, 14

Gemma trigona Dall var. *delandensis* Mansfield, 1918, Fla. Geol. Sur. 11th Ann. Rep., p. 121, fig. 9, nos. 2-3.

The size of this form and the strength of the cardinal teeth are like the type of the species, *Gemma trigona* Dall; but it differs from the latter in having a rounded basal margin and a well defined concentric surface sculpture.

It is smaller than *Gemma magna* Dall, more equilateral, has larger and stronger cardinal teeth, and coarser concentric surface sculpture.

The type (Cat. No. 168211 U. S. N. M.) measures: right valve, length 4 mm.; height 3.7 mm.; diameter (double) 2.2 mm.

Type locality—Upper marl bed about one mile south of De Land, Volusia County, Florida. Dr. E. H. Sellards, collector.

At localities $\frac{1}{2}$ mile north and south of Orange City, Fla., there are forms with nearly smooth surface sculpture, but otherwise similar to those at De Land; these, I believe, represent only local variations of the same subspecies.—[Mansfield, 1918.]

Occurrence.—Pliocene.

GEMMA MAGNA VIRGINIANA Dall

Gemma magna variety *virginiana* Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1330.

Shell smaller, shorter, more delicate. Length 3.8, height 3.6, diameter 1.6 mm. From the Miocene of Yorktown, Virginia, in the middle portion of the series; Harris.

This form is the earliest *Gemma* known, and if I felt sure that it was an 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.]

The comparison in the description refers to *G. magna*.

Holotype.—No. 144643. United States National Museum, Washington, D. C.

GEMMA MAGNA Dall

Plate XLIII, Figure 22

Gemma magna Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1330, pl. 57, fig. 4.

Shell trigonal, moderately convex, the anterior end slightly shorter, rounded; the posterior end longer; more pointed; beaks high, pointed; lunule lightly flattened, bounded by an incised line often feeble, lanceolate, about half as long as the anterior dorsal slope; esutcheon not defined; surface sculptured with numerous regular, even, concentric sulci, with w'der 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 mm.

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.]

Holotype.—No. 115174. United States National Museum, Washington, D. C.

Occurrence.—Upper Miocene. Natural Well and Magnolia, Duplin County, N. C. Pliocene. Todd's Ferry, Waccamaw River, S. C.; Caloosahatchie and Shell Creek, Fla. Pleistocene. North Creek, near Osprey, Little Sarasota Bay, Fla. (Dall).

GEMMA TRIGONA Dall

Plate XLIII, Figure 8

Gemma trigona Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1330, pl. 57, fig. 8.

Shell small, rather acutely trigonal, nearly equilateral; beaks high, lunule three-fourths as long as the dorsal slope; surface smooth or with faint incremental lines, or rarely a few concentric sulci visible near the ends of the valve or indicating resting stages, when they may cross the disk; hinge very heavy and well developed; basal margins faintly crenulate; pallial sinus small, distinct. Length 4.25, height 4.0, diameter 2.6 mm.

This species is nearly as common as *G. magna* but much smaller and much heavier than *G. magna* of the same size, from which it is further distinguished by its smooth surface.—[Dall, 1903.]

Holotype.—No. 114915. United States National Museum, Washington, D. C.

Occurrence.—Upper Miocene. Natural Well and Magnolia, Duplin County, N. C.; one mile east of Darlington, S. C. Pliocene. Todd's Ferry, on the Waccamaw River, S. C.; Caloosahatchie River, Fla. (Dall).

GEMMA GEMMA (Totten)

Plate XLIII, Figures 9, 13, 31

- Venus gemma* Totten, 1834, Amer. Jour. Sci., 1st ser., vol. 26, p. 366, pl. I, fig. 2; Gould, 1841, Inv. Mass., p. 88, fig. 51.
Gemma gemma Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 113; H. and A. Adams, 1857, Gen. Rec. Moll., vol. II, p. 419, pl. CVII, fig. 3.
 ? *Venus manhattanensis* Prime, 1852, Jay's Cat., 4th ed. Suppl., p. 466 (fide Dall); 1862, Ann. Lyc. Nat. Hist. N. Y., vol. VII, p. 482.
Gemma totteni Stimpson, 1860, Smith. Misc. Coll., vol. II, No. 3, p. 3; Prime, 1862, loc. cit., p. 483 fide Dall.
Tottenia gemma Perkins, 1869, Proc. Bost. Soc. Nat. Hist., vol. 13, p. 148 see errata; Verrill, 1873, Invert. An. Vineyard Id., p. 682, pl. XXX, fig. 220.
Gemma purpurea Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 56.
Gemma purpurea var. *Totteni* Dall, 1898, Trans. Wag. Inst. Sci., vol. III, p. 919, pl. XXIV, figs. 1, 3.
Gemma gemma subsp. *Totteni* Dall, 1902, Jour. Conch. Manch., vol. X, No. 8, p. 241.
Gemma gemma Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 378; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1331, pl. 24, fig. 1, 3; Johnson, 1915, Occ. Papers Bost. Soc. Nat. Hist., VII, p. 70; Dall, 1921, U. S. Nat. Mus. Bull. 112, p. 44.

Shell sub-rotund, nearly equilateral, concentrically furrowed, glossy; anterior portion and basal margin, both within and without, white or pale reddish-violet, remainder reddish purple, darker at and near the superior and posterior margins; no *hinge*; *beaks* small, incurved, separate, generally eroded; *teeth* divergent, the medial tooth of each valve stout triangular, the anterior tooth of the right, and the posterior of the left valve, thin and not easily distinguished; inner margin crenulate.

Length, 0.15 of an inch.

The length being represented by 13
 the breadth will be 12
 and the diameter 6.

Inhabits the coast of Massachusetts and Rhode Island.

I found this beautiful little shell, first, on the beach at Provincetown, Cape Cod (Mass.); it has since been found in Newport harbor. The largest specimen I have seen among many hundreds, is barely 3/20 of an inch in length; the more common length being about 1/10 (of) an inch.

It is often much eroded on the disks, and then the color is bluish white.—[Totten, 1834.]

Shell ovate with coarse, concentric lines. The coloration varies. Many shells are white with spots of violet. The violet color is deeper on the posterior end and covers the greater portion of that end.

D. mensions.—(Average). 4.5 mm., length; 4 mm., height; 2 mm., thickness.

Occurrence.—Pleistocene. Massachusetts Bay at Point Shirley (Dall). Recent. Labrador south to New York Bay and Long Island Sound. San Juan Islands to San Francisco Bay. Introduced from the Atlantic coast with "seed" oysters. (Dall) The Pacific shells have been identified as the variety *purpurea* by Packard.

GEMMA GEMMA PURPUREA (H. C. Lea)

Plate XLIII, Figures 6, 10, 15, 17

- Cyrena purpurea* H. C. Lea, 1842, Amer. Jour. Sci., 1st ser., vol. 42, p. 106, pl. 1, fig. 1.
Tottenia manhattanensis Verrill, 1873, Inv. An. Vineyard Id., p. 682.
Parastarte concentrica Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 48, name only, fide Dall.

Gemma purpurea Dall, 1898, Trans. Wag. Inst. Sci., vol. III, p. 24, figs. 2, 4, 4b.
Gemma gemma subsp. *purpurea* Dall, 1902, Jour. Conch. Manch., vol. X, No. 8, p. 421;
 Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 378; Dall, 1903, Trans.
 Wag. Inst. Sci., vol. III, pt. 6, p. 1332, pl. 24, figs. 2, 4, 4b; Johnson, 1915, Occ.
 Papers Bost. Soc. Nat. Hist., VII, p. 71; Packard, 1918, Univ. Cal. Pub. Zool.,
 vol. 14, No. 2, p. 273.

C. testa rotundato-triangulari, æquilaterali, sub-inflata, subcrassa, diaphana, et
 purpurea et alba, polita, striis transversis; natibus prominentibus; margine non
 crenulato.

Shell rounded-triangular, equilateral, sub-inflated, somewhat thick, partly purple
 and partly white, with transverse striæ; beaks prominent; margin not crenulated.

Length .07. Breadth .07. Diam. .04 of an inch.

Hab. Delaware Bay. Cabinet of I. Lea.

Remarks.—This beautiful little species of *Cyrena*, has much resemblance to the
Venus gemma of Totten. Indeed I considered it as such for some time, until I was
 able to obtain a view of the teeth, which prove it to be a *Cyrena*. It may be a *Cyrena*.
 It may, however, be also distinguished from the *Venus gemma*, by its equilateral form,
 and want of crenulations on the margin. The beaks are rounded at the summit. It has
 usually a dark purple mark along the posterior margin, which gradually fades off,
 and the anterior portion of the shell is whitish. Occasionally, however, it is nearly all
 purple, but darker towards the posterior margin, and I have one specimen which is
 pinkish. The striæ are perfectly regular, and at even distances. It is, I believe, the
 smallest *Cyrena* yet noticed.—[Lea, 1842.]

Dr. Dall, 1903, gave excellent drawings of *G. gemma* and the sub-
 species *purpurea*. Those figures have been copied in this paper to illus-
 trate the differences between the two forms. *Gemma gemma* is more
 ovate and compressed but may be told more readily by the conspicuous,
 for the size of the shell, regular, concentric ribs. *G. purpurea* is more
 trigonal and plumper and the surface is smooth except for lines of growth
 and for concentric ribs on the anterior end. Both the species and the
 variety have the same coloration and occur abundantly together at certain
 northern localities. Lea was mistaken in describing the inner margins
 without crenulations.

Syntypes.—United States National Museum, Washington, D. C.

Dimensions.—(Average). 4 mm., length; 3.5 mm., height; 2 mm.,
 thickness.

Occurrence.—Pleistocene. Corpus Christi, Texas. (Dall); Recent.
 South side of Cape Cod to the Bahamas and west to Texas. (Dall) San
 Francisco Bay, Cal. Introduced. (Packard)

Subgenus PARASTARTE Conrad



Fig. 31. Hinge of the type species of *Parastarte*

Parastarte Conrad, 1862, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 288; Dall, 1883, Proc.

U. S. Nat. Mus., vol. 6, p. 339.

Callisstronia Dall, 1883, Science, II, p. 447.

Goodallia Tryon, 1884, Struct. and Syst. Conch., vol. III, p. 227 not of Turton.

Parastarte Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 365; Dall, 1903,

Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1332; Jukes-Browne, Proc. Mal. Soc.

London, vol. 11, p. 87.

Elevated, triangular, equilateral, ventricose; epidermis pale and shining; hinge

of right valve with one thick nearly direct tooth, and deep and rather long channel in the hinge plate anterior to the tooth; left valve with two equally diverging teeth; posterior submargin of both valves channelled above.

Astarte triquetra, C., Tampa Bay, is the type of this new genus, which differs essentially from *Erycinella* whilst the exterior is much like the latter. (Recent.)—[Conrad, 1862.]

Shell very small; lunule is large not sunken, defined by a very faint line; ligament broad, situated centrally beneath the beak; inner, ventral margins crenate; inner, right posterior and left anterior margins grooved with the corresponding margins in the opposite valve ridged; a narrow ridge occurs in the left valve posteriorly on the inner side of the ligamental area. It may be the raised edge of the margin or it may be termed a feeble tooth.

In comparing the characters of the genera *Gemma* Deshayes and *Parastarte* Conrad, a striking similarity is seen between the two. The differences between the two do not seem great enough to make them two distinct genera. See figures 31 and 32 in text.

Both hinges have in the right valve, one large, middle cardinal with a socket on each side, a definite small cardinal posteriorly and a feeble cardinal anteriorly. In the left valve both genera have a large central socket with a cardinal tooth on either side of the socket and a ridge along the posterior region of the hinge beneath the ligamental groove. In *Gemma* the ridge is longer and broader than in *Parastarte*. The crenulation of the inner margin covers only the ventral region in both forms. The lateral edges are grooved the same. In *Parastarte* the ligament is high and situated beneath the beak, occupying a very high and broad area. In *Gemma* the ligament is very narrow and elongated, extending posteriorly. The region between the beak and the upper margin of the hinge is conspicuously narrower in *Gemma* than in *Parastarte*. The pallial sinus is larger and better developed in *Gemma*.

Genoholotype.—*Parastarte triquetra* (Conrad). Plate XLIII, Figures 2, 4. Miocene to Recent of Floridian region. The subgenus extends from the Miocene thru Recent.

GEMMA (PARASTARTE) TRIQUETRA (Conrad)

Plate XLIII, Figures 2, 4

Astarte triquetra Conrad, 1845, Proc. Acad. Nat. Sci. Phil., vol. 3, p. 24, pl. 1, fig. 6.
Parastarte triquetra Conrad, 1862, Proc. Acad. Nat. Sci. Phil., vol. 14, p. 288; Dall, 1883, Proc. U. S. Nat. Mus., vol. 6, p. 339, pl. X, fig. 1-3; Dall, 1889, Bull. U. S. Nat. Mus., 37, p. 48, pl. 49, figs. 6, 7, 8; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, p. 379; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1333.

Callistronia triquetra Dall, 1883, Science, II, p. 447, Sept. 28.
 Very triangular, elevated, equilateral and symmetrical, ventricose, polished, white, sometimes brown or purple on the disk in form of a broad ray.

Locality. Tampa Bay.—[Conrad, 1845.]

The inner margin is crenate and the exterior of the shell is smooth except for fine lines of growth.

Dimensions.—3 mm. length; 3 mm. height; 1 mm. semidiameter.

Holotype.—No. 52589. Academy of Natural Sciences, Philadelphia, Pa.

Occurrence.—MIOCENE. Jackson Bluff, Ocklockonne River, Fla. (Dall) PLEIOCENE. Caloosahatchie, Alligator Creek and Myakka River, Fla. (Dall). Shell Creek, Fla. (Cornell Univ. Pal. Lab.). PLEISTOCENE. North Creek, near Osprey, Fla. (Dall) RECENT. (Type) Tampa Bay, Fla. Hillsboro' Inlet, East Florida south to Florida Keys and north to Cedar Keys. (Dall).

GEMMA (PARASTARTE) ANTILENSIS Woodring

Plate XLIV, Figures 6, 7

Parastarte antillensis Woodring, 1925, Carnegie Inst. Wash., No. 366, p. 164, pl. 22, figs. 11, 12.

Shell small, narrow, high, trigonal, strongly inflated, subequilateral, anterior end slightly more extended; umbo high, full, slightly prosogyrate; sculpture consisting of incrementals; hinge of left valve consisting of 2 strong faintly bifid cardinals (2 and 4b), separated by a relatively broad and deep socket; inner margin of valve finely fluted, right valve not known.

Length 3.5 mm.; height 3.8 mm.; diameter (left valve) 1.5 mm.

Parastarte antillensis closely resembles *P. triquetra* Conrad, but is slightly larger and broader, and the apex of its umbo is narrower. It is known only from the holotype. There is a possibility that it is not a Bowden shell.

Type material. Holotype (left valve, U. S. Nat. Mus. No. 352839).—[Woodring, 1925.]

Occurrence.—Miocene. Bowden, Jamaica.

Genus LIOCYMA Dall



Fig. 35. Hinge of the type species of *Liocyma*

Liocyma Dall, 1870, Proc. Bos. Soc. Nat. Hist., vol. 13, p. 256; Dall, 1871, Am. Jour. Conch., vol. VII, p. 145; Fischer, 1887, Man. de Conch., p. 1080.

Lyocima Barrois, 1887, in Zittel Traite de Pal., II, p. 109.

Liocyma Dall, 1902, Proc. U. S. Nat. Mus., vol. 26 No. 1312, p. 364; Dall, 1903, Trans. Wag. Inst. Sci., vol. III, pt. 6, p. 1327; Jukes-Browne, 1908, Proc. Mal. Soc. Lond., vol. 8, p. 244.

(Λιόσις, smooth and κύμα, wave) Shell trigonal or elongate-ovate, small, thin, smooth; furnished with concentric undulations and occasionally fine radiating lines; provided with a polished epidermis; pallial sinus small, rounded triangular; hinge teeth three in each valve, divaricate; middle tooth largest, grooved on the upper edge. Lunule faint, no areola, ligament set in below the exterior surface. Soft parts:—siphons equal, short, provided with numerous cylindrical papillae around the apertures, no valve in either siphon, both closely united, to their tips. Branchiae; inner layer extending from the posterior to the anterior adductor, broadly triangular, pointed behind; outer layer short, united around the siphons and before the foot; the latter is elongate-rhomboidal, with the edges sharply compressed, anterior extremity pointed, lanceolate. Palpi four; upper pair slender, narrow, pointed, smooth; lower pair stouter, dextrally spiral, with two turns. Type, *Venus fluctuosa* Gould, Inv. Mass., 1841, p. 47, pl. III, fig. 50. Binney, Inv. Mass., 2d ed., p. 136, fig. 447 (young).

The type of this genus was referred to *Venus* and *Tapes* by Gould, to *Chione* and *Tapes* by Deshayes, and finally to *Anatilis* by Roemer. The latter name is preoccupied in Lepidoptera as well as Botany, and must therefore be dropped. This species, moreover, does not agree with the types of Roemer's genus. Dr. Gould's original figure and description refer to one of two species which appear to have been confounded under the same name. . . . [Dall, 1870.]

Eastern American species are Recent. The genus occurs in the

Pleistocene of Alaska.

Genoholotype.—*Venus fluctuosa* Gould. Plate XLIII, Figures 12, 20.
Recent Arctic, northern Atlantic south to Maine.

LIOCYMA FLUCTUOSA (Gould)

Plate XLIII, Figures 12, 20

Venus fluctuosa Gould, 1841, Inv. Mass., 1st ed., p. 87, fig. 50.

Tapes fluctuosa Deshayes, 1853, Cat. Conch. Brit. Mus., pt. 1, p. 176; Jukes-Browne, 1908, Proc. Mal. Soc. Lond., vol. 8, p. 244, pl. X, fig. 2; Gould, 1870, Inv. Mass., p. 136, fig. 447.

Liocyma fluctuosa Dall, 1870, Proc. Bos. Soc. Nat. Hist. vol. 13, p. 256; Dall, 1871, Amer. Jour. Conch., VII, p. 145; Dall, 1902, Proc. U. S. Nat. Mus., vol. 26, No. 1312, p. 378; Johnson, 1915, Occ. Papers Bos. Soc. Nat. Hist., VII, p. 70.

Shell transversely-ovate, lenticular, white, with a yellowish epidermis; surface with recurved, concentric waves vanishing at the sides; areola none.

Figure 50, State Coll., No. 193. Soc. Cab., No. 2333.

Shell oblong-ovate, lenticular, rather thin, nearly equilateral; white, beneath a glossy, thin, straw-colored epidermis; anterior side shortest and broadest; both ends widely rounded; beaks slightly elevated with a smooth, heart-shaped space before them, not distinctly defined by any boundary; surface with from twenty to twenty-five concentric waves, not quite extending to the margin, especially anteriorly, so that the marginal edges are plain; when closely examined, these waves or ridges are found to be compressed, thin, and inclined towards the beaks; cardinal teeth three in each valve, the middle one cleft in both valves; muscular and pallial impressions very superficial, the latter with a deep sinus. Length $\frac{4}{5}$ inch, height $\frac{3}{4}$ inch, breadth $\frac{9}{40}$ inch.

Of this shell I have three specimens brought from the Bank fisheries. The largest specimen is proportionately more convex than the others, and the grooves of the surface are like those of *V. papilionacea*.

I know of no species very closely approaching this. Most of those allied to it have the posterior extremity more or less angular; this is always accurately rounded. *Venus anca* of Turton, small specimens of *V. gallina*, and of those Indian species allied to *V. papilionacea*, may be mentioned as allied to it.—[Gould, 1841.]

Lunule small and narrow, "when the epidermis is scraped away the lunule is seen to be bounded by a faint line. Dr. Dall notes a variety *brunnea* which is a rich chestnut or yellow brown. It is from the Gulf of St. Lawrence.

Dimensions.—21 mm., length; 15 mm., height; 7 mm., thickness.
U. S. Nat. Mus. specimen No. 51996.

Holotype.—? Not at Boston Society of Natural History, Boston, Mass.

Occurrence.—Recent. Arctic, Spitzbergen, Greenland and Sea of Okhotsk, south to Gulf of Saint Lawrence and Nova Scotia. (Dall).
Frenchman's Bay, Maine. 35 fathoms. (Johnson)

Genus PITARIA

RHABDOPITARIA new subgenus

Shell robust; lunule rather wide, cordate, slightly depressed, bounded by an incised line; escutcheon not defined; nymphs heavy; three cardinal teeth in each valve; a short, anterior lateral in the left valve, with a corresponding socket in the right valve; pallial sinus trigonal; inner margins entire. The outer surface of the shell smooth except for strongly defined resting stages; when worn the shell reveals an underlying structure of radiating lines.

The description of the subgenus is taken from the description by

Dr. J. Gardner for *Callocardia astartoides*. For further details of the form see the description of that species. On page 30 of this monograph we referred the species to *Pitaria* with a question. We hesitate to describe a group without having the type species at hand but in working out the subgeneric identity of a related but more puzzling form, *Meretrix winnensis* Harris, the best plan seems to be to describe the two forms as belonging to a new subgenus of *Pitaria*. The hinge of *Rhabdopitaria winnensis* is not known so that we use *Rhabdopitaria astartoides* as the genoholotype.

The conspicuous character of the subgenus is the radiating, under-layer. This is not characteristic of the *Pitaria-Callista* groups to which the hinge seems to approach most closely. Genera which reveal such a structure do not have the hinge characters of this form.

Genoholotype.—*Pitaria (Rhabdopitaria) astartoides* (Gardner). Plate XLIV, Figures 15, 16. Eocene. Texas.

The species occur in the Eocene.

PITARIA (RHABDOPITARIA) WINNENSIS (Harris)

Plate XLIV, Figures 17, 19

Meretrix trigoniata var. *winnensis* Harris, 1919, Bull. Amer. Pal., vol. 6, No. 31, p. 147, pl. 46, figs. 9-13.

General form somewhat trigonal and very inflated, as shown by the figures; surface with concentric lines and undulations, stronger near the anterior and basal margins, and with exceedingly fine concentric striae superimposed; apparently when slightly eroded, showing radii crossing the lines of growth at right angles, hence turning upwards posteriorly (*Camptnectes*-like) recalling in this region the markings on some species of *Civice*; as in *trigoniata*, a trace of an obsolete channel radiating from beak to base just anterior to the umbonal ridge; lunule as broad, but shorter than in *trigoniata*; anterior tooth comparatively longer but less pronounced than in *trigoniata*, pallial sinus not deep, pointed; lines of growth not so even, regular and deeply incised as in *trigoniata*; substance of the shell thinner, margin often crenulate; some forms as in figs. 11, 12 and 13 exceedingly inflated, reminding one of *Sphaevella*.

In the most inflated forms there is not a trace of radii nor of marginal crenulations but we are inclined to regard this as a minor variation from the typical forms.

The outline of this variety is much more triangular than that of *hatchitigbeensis*, the shell is much thinner and the teeth are different. The globose form, shorter lunule and exterior markings serve to differentiate it from *trigoniata*, s. s.

The specimens we have, though numerous, are all in the form of casts and impressions in a red, finegrained, hard, sandy matrix, derived evidently from weathering of glauconitic, sandy clays. The exact locality in Winn Parish, Louisiana, from which the material was obtained is not given but it appears to be exactly the same as we have collected along the St. Maurice road leading past the "Marble Quarry" west of Winnfield. Specimens deposited by Harris in the Pal. Museum, Cornell University.—[Harris, 1919.]

Dimensions—33 mm., length; 31 mm., height; 6 mm., semidiameter.

Occurrence—St. Maurice Eocene. Winn Parish, La.

In external appearance this species resembles *R. astartoides* (Gardner). Both are smooth with heavy, concentric resting stages. When worn the species reveal the underlying, radiating structures. *R. winnensis* varies in outline from an elongate shape to a higher, more convex, ovate form.

SYNOPSIS

OF GENERA WHICH OCCUR IN THE TERTIARY AND RECENT
OF EASTERN AMERICA

The genera are in LARGE AND SMALL CAPITALS, the subgenera are in *italics* and the sections are in Roman type only.

	DOSINIOPSIS p. 5	
	PITARIA p. 8	
<i>Agriopoma</i> p. 33	<i>Veneriglossa</i> p. 37	<i>Pitarella</i> p. 35
	<i>Rhabdopitaria</i> p. 211	
	<i>Lamelliconcha</i> p. 40	
Hysteroconcha p. 52	<i>Hyphantosoma</i> p. 55	
	PELECYORA p. 58	
	DOSINIA p. 60	
Dosinidia p. 61		
	CALLISTA p. 71	
<i>Callista</i>	<i>Costacallista</i> p. 73	Macrocallista p. 73
	TRANSENNELLA p. 91	
	AMIAN'TIS p. 96	
Eucallista p. 97		
	GRAFRARIUM p. 98	
	<i>Gouldia</i> p. 99	
GRATELOUPIA p. 105		TIVELA p. 107
<i>Cytheriopsis</i> p. 106		Eutivela, p. 114
	OMNIVENUS p. 115	
	ANTIGONA p. 116	
Artena p. 119		
<i>Dosinfa</i> p. 122		<i>Circomphalus</i> p. 129
		Ventricola p. 130
	MARCIA p. 135	
<i>Katclysia</i> p. 135		<i>Mercimonia</i> p. 137
Textivenus p. 136		
	CHIONE p. 138	
Timoclea p. 155	Clausinella p. 159	Chamelea p. 160
<i>Anomalocardia</i> p. 163		<i>Lirophora</i> p. 169
	VENUS p. 182	
	CYCLINELLA p. 196	
	CLEMENTIA p. 201	
	GEMMA p. 204	
<i>Parastarte</i> p. 208		
	LIOCYMA p. 210	

Since this publication has been in press, I have gained access to the "Catalogue Illustré de la Collection Lamarck," Fossiles by J. Favre, Geneva, 1918. The following type species of Lamarck from the eastern American fauna are illustrated:

Cyprina corrugata Lam., An. sans Vert., V, p. 558, consists of two species. Pl. 16, pt. Cd of the Cat. Illus. is of *V. mortoni* Conrad. Pl. 17 is *Venus rileyi* Conrad.

Cyprina tridacnoides Lam., An. sans Vert., V, p. 558, is figured Cat. Illus., part Cd, pl. 18, pl. 19, fig. 93. It is *Venus tridacnoides*.

Venus paphia Lam., An. sans Vert., V, p. 608, is figured pl. 22, fig. 119, a, b, c, Cat. Illus., pt. Cd. It is *Chione lätilirata* Con.

Cytherea occulta Say, 1822, Proc. Acad. Nat. Sci. Phil., vol. 11, p. 274, was not figured. It is difficult to say from the original description, to what genus it belongs properly.

Cytherea elevata Conrad in Conrad, 1846, Amer. Jour. Sci., 2nd ser., vol. 11, p. 404 is a nomen nudum not *Cytherea elevata*, H. C. Lea, 1845, Trans. Amer. Phil. Soc., vol. 9, p. 241, pl. 34, fig. 21. The latter species, Lea compared with *C. convexa* Say = *P. sayana* Conrad.

Cytherea spherica H. C. Lea, 1845, is *Diplodonta nucleiformis* Wagner, 1838. Conrad, 1866, Smith. Misc. Coll., vol. VII, No. 183, p. 10 referred the species to *Gemma*.

Cytherea minima Lea, 1833, Cont. Geol., p. 68, pl. 2, fig. 45, is probably the young of one of the Claiborne Pitarias or Callistas. Lea thought it might be the young of *P. trigoniata* Lea.

Cytherea jacksonensis Meyer, 1855, Amer. Jour. Sci., 3rd ser., vol. 29, p. 461, 467, is a nomen nudum.

Diplodonta discoidea (Gabb) plate XXV, figures 1, 4 = *Meretrix discoidea* Gabb, 1881, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. VIII, p. 372, pl. 47, fig. 75. The syntypes of this species have been examined and the species is figured herein. Gabb figured the species very well. The material consists of numerous specimens with both valves attached. One specimen is that of the hinge of the right valve and shows the species to be a *Diplodonta*. The species is figured again so that it will not be confused with genera of the Veneridæ. The hinge of the right valve consists of two cardinal teeth. What appears in the picture to be a posterior tooth is the edge of the ligamental plate. The right, anterior cardinal is entire. The middle or posterior cardinal is large and bifid. The ligament is very narrow. There is no lunule, but a minute constriction occurs beneath the beak in the upper lunular area. Anterior end is short and very narrow. When the surface is eroded the shell appears to be minutely punctate.

Venerupis Lamarck has not been found to occur as yet in the eastern American fauna. *Venerupis atlantica* Maury has the hinge destroyed

totally so that the generic characters cannot be determined definitely. *Venerupis subvexa* Conrad, 1833, Amer. Jour. Sci., 1st ser., vol. 23, p. 342 from the Miocene, Smithfield, Va., was not figured. It does not seem to have been located since.

Since the manuscript of this paper went to press a copy of Dr. C. J. Maury's fine monograph on the "Fosseis Terciarios do Brazil com Descripcao de Novas Formas Cretaceas" Ser. Geol. e Min. do Brazil, n. IV, 1925, has been received. Dr. Maury has described numerous Venerid species from the Tertiary of Brazil. This monograph is very valuable and helps to explain many of the species of White, 1887, the specimens of which appear to be mixed. The new species of Maury are listed below under the classification as given in the present work. The holotypes and duplicate material are in the Museum of the Geological Survey, Rio de Janeiro. The following species are from the Lower Miocene, Rio Parabas, State of Parà, Brazil.

Callista pirabica (Maury), p. 323, pl. 18, fig. 14 as *Macrocallista* (*Paradione*) *pirabica*.

Pitaria hartti (Maury), p. 327, pl. 17, fig. 8 as *Callocardia* (*Agriopoma*) *hartti*.

Pitaria euglypta (Maury), p. 329, pl. 17, fig. 7 as *Callocardia* (*Agriopoma*) *euglypta*.

? *Pitaria obscurata* (White), p. 326, pl. 17, fig. 2 as *Callocardia* (*Agriopoma*) *obscurata*. Dr. Maury found material which she identified with the species of White. She selected figure 10 of White as the lectotype.

Pitaria recondita (Maury), p. 331, pl. 17, fig. 4 as *Callocardia recondita*.

Pitaria ? cordeliae (Maury), p. 353, pl. 18, fig. 1 as *Chione ? cordeliae* Maury.

Pitaria (*Lamelliconcha*) *perarcana* Maury, p. 333, pl. 18, fig. 6.

Pitaria (*Lamelliconcha*) *baumanni* Maury, p. 333, pl. 19, fig. 4.

Antigona (*Circomphalus*) *thalestris* Maury, Section *Ventricola*, p. 337, pl. 18, figs. 7, 15 as *Antigona* (*Ventricola*) *thalestris*.

Antigona (*Circomphalus*) *thalestris amazoniana* Maury, p. 339, pl. 16, as *Antigona* (*Ventricola*) *thalestris* var. *amazoniana*.

Antigona (*Circomphalus*) *sanctae-noctis* Maury, Section *Ventricola* p. 339, pl. 18, fig. 13 as *Antigona* (*Ventricola*) *sanctae-noctis*.

Chione (*Lirophora*) *thalassopora* Maury, p. 345, pl. 18, fig. 11, as *Chione thalassopora* Maury.

Chione (*Lirophora*) *praepaphia* Maury, p. 351, pl. 19, fig. 12.

Chione (Lirophora) penthesileae Maury, p. 353, fig. 13.

Venus prototypa Maury, p. 355, pl. 18, fig. 10.

Chione agraria (White) in Maury, p. 347, pl. 18, fig. 12. Dr. Maury found molds which look very much like *Astarte agraria* White, 1887, Arch. Museu Nac., Rio de Janeiro, vol. VII, pp. 77, 427, pl. 5, fig. 31. The molds of Maury show the dentition of *Chione*. Also from Estacao Agronomica. (Maury).

The following species are from the Lower Miocene at Estacao Agronomica, Brazil:

Pitaria (Lamelliconcha) vertumni Maury, p. 425, pl. 18, fig. 4, as *Pitaria vertumni*.

Antigona (Dosina) prosperpinae Maury, p. 425, pl. 18, fig. 5 as *Antigona prosperpinae*.

The following species is from Bahia de Tury:

Chione (Timoclea) praepectorina Maury, p. 453, pl. 18, fig. 2.

Several papers on the Veneridæ or including species of the Veneridæ of eastern America have appeared since the writing of additional notes. It is not feasible now to include references to further publications. Attention is drawn to two species new at the time of printing, now pre-occupied.

Antigona dominica, p. 127, pl. XXIX, figs. 4, 7; pl. XXXI, fig. 15, is *Antigona caribbeana* Anderson, 1927, Cal. Acad. Sci., Proc., 4th ser., vol. XVI, No. 3, p. 90, pls. 2, 3.

Venus alumblyffensis, p. 193, pl. XXXIV, figs. 4, 7, is *Venus nannodes* Gardner, 1926, U. S. Geol. Sur., Prof. Paper No. 142-D, p. 175, pl. XXVIII, figs. 6, 7.

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EXPLANATION OF PLATES

NOTE.—Unless otherwise stated the specimens figured are from the collections in the Cornell University Paleontological Laboratory.

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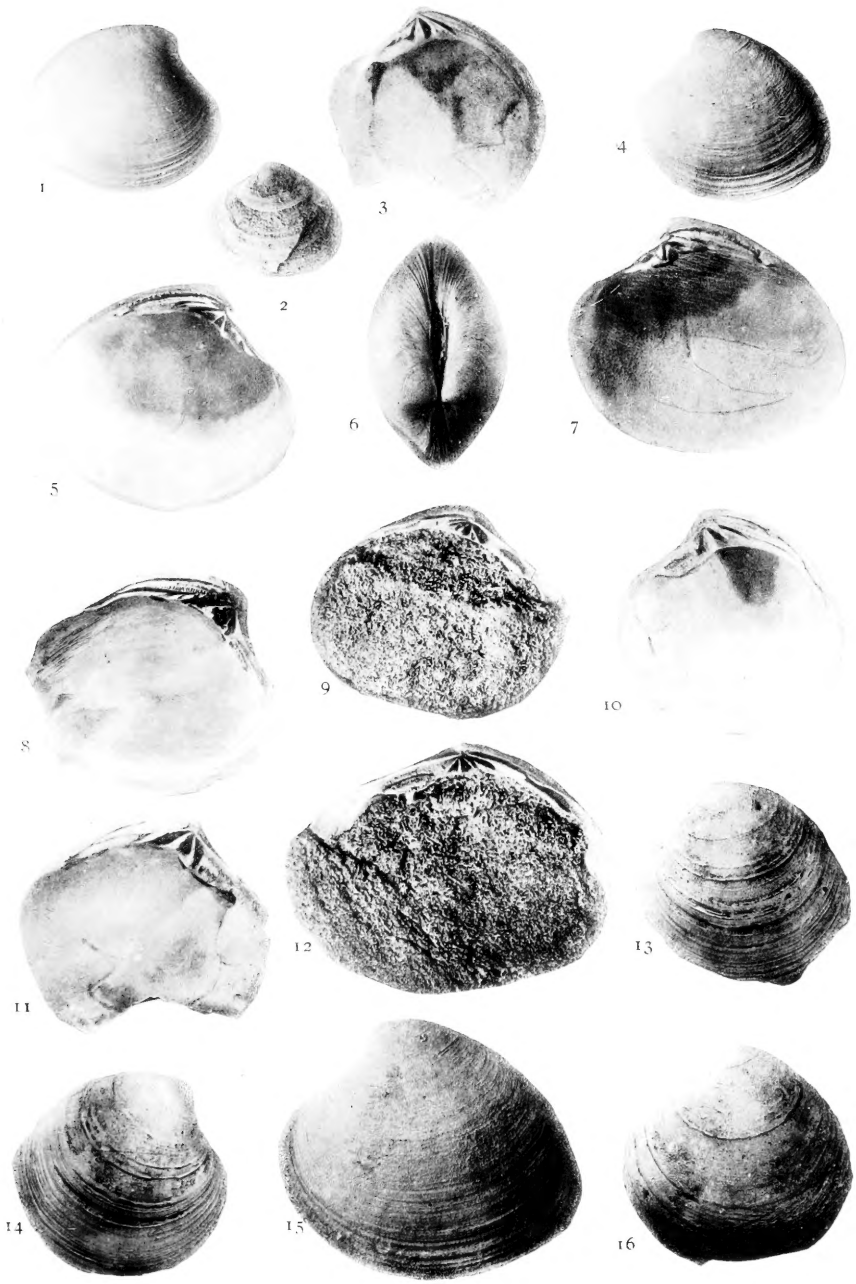


PLATE II

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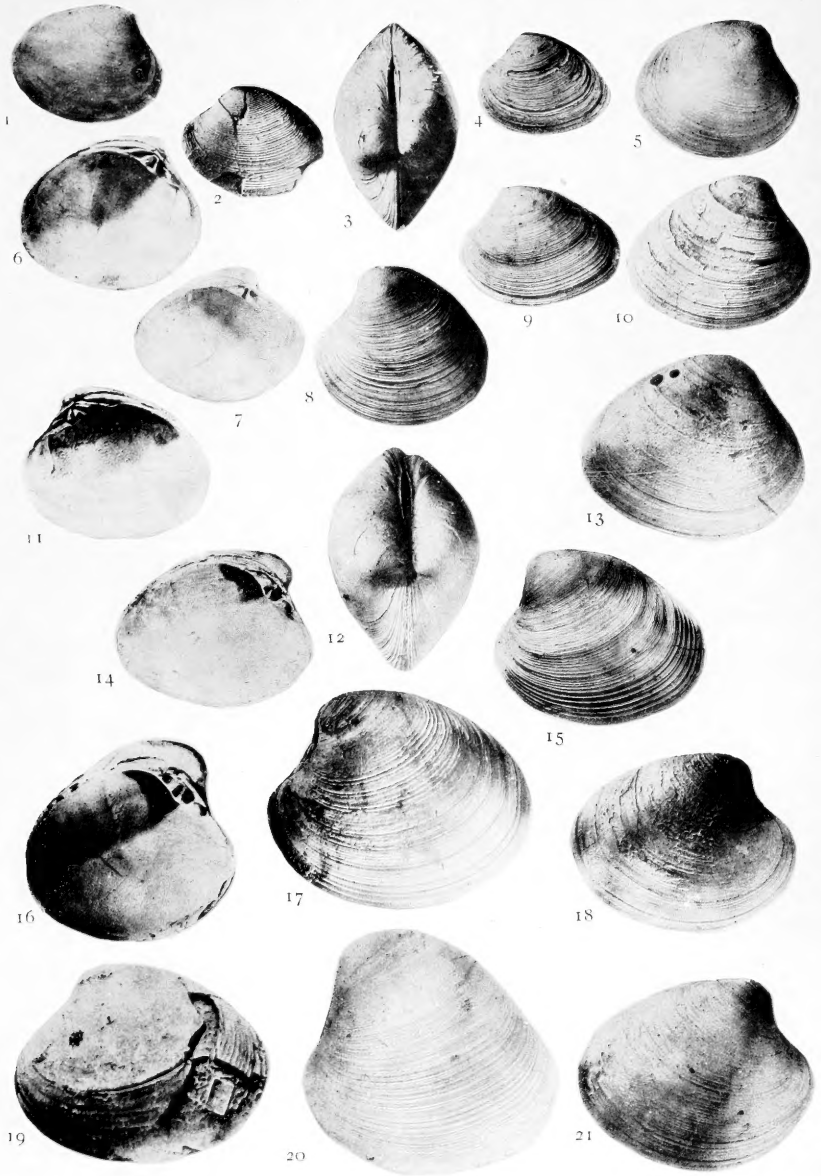




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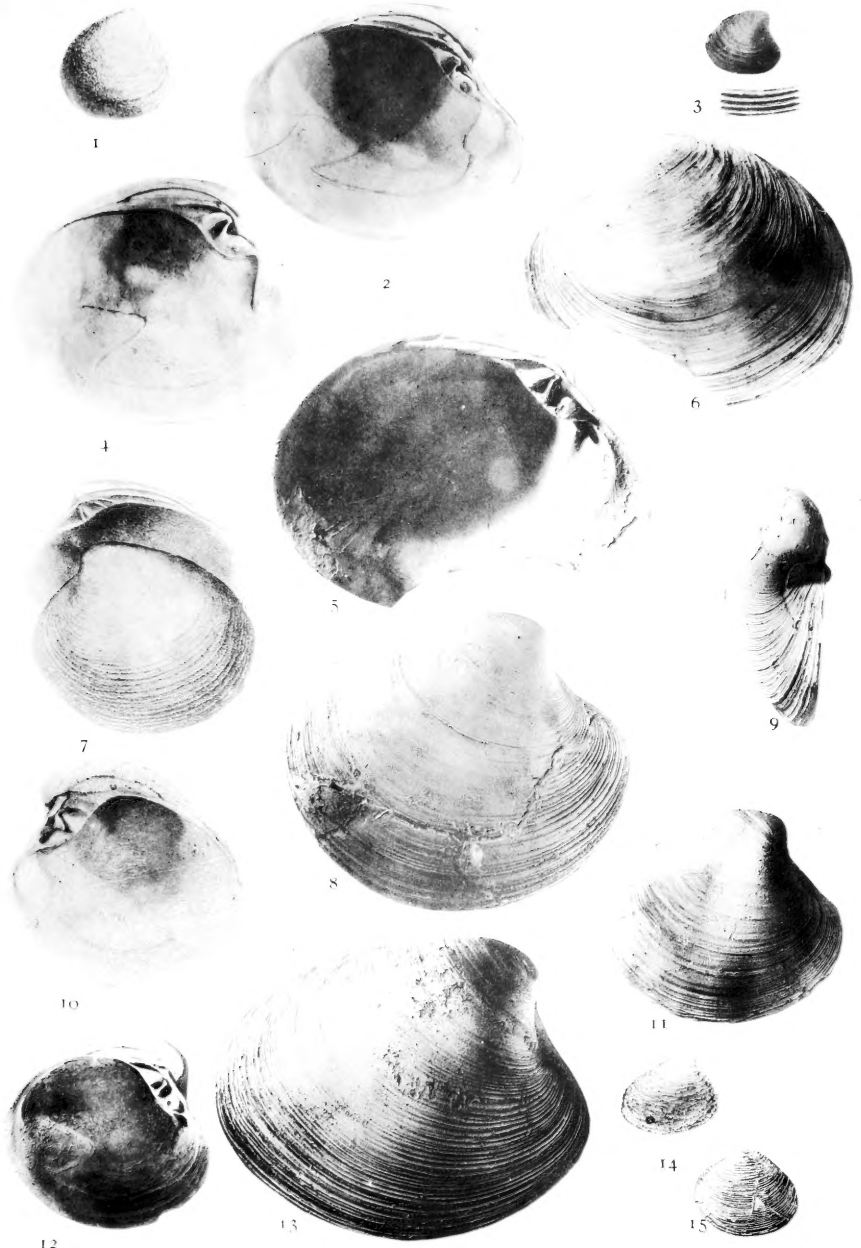




PLATE IV

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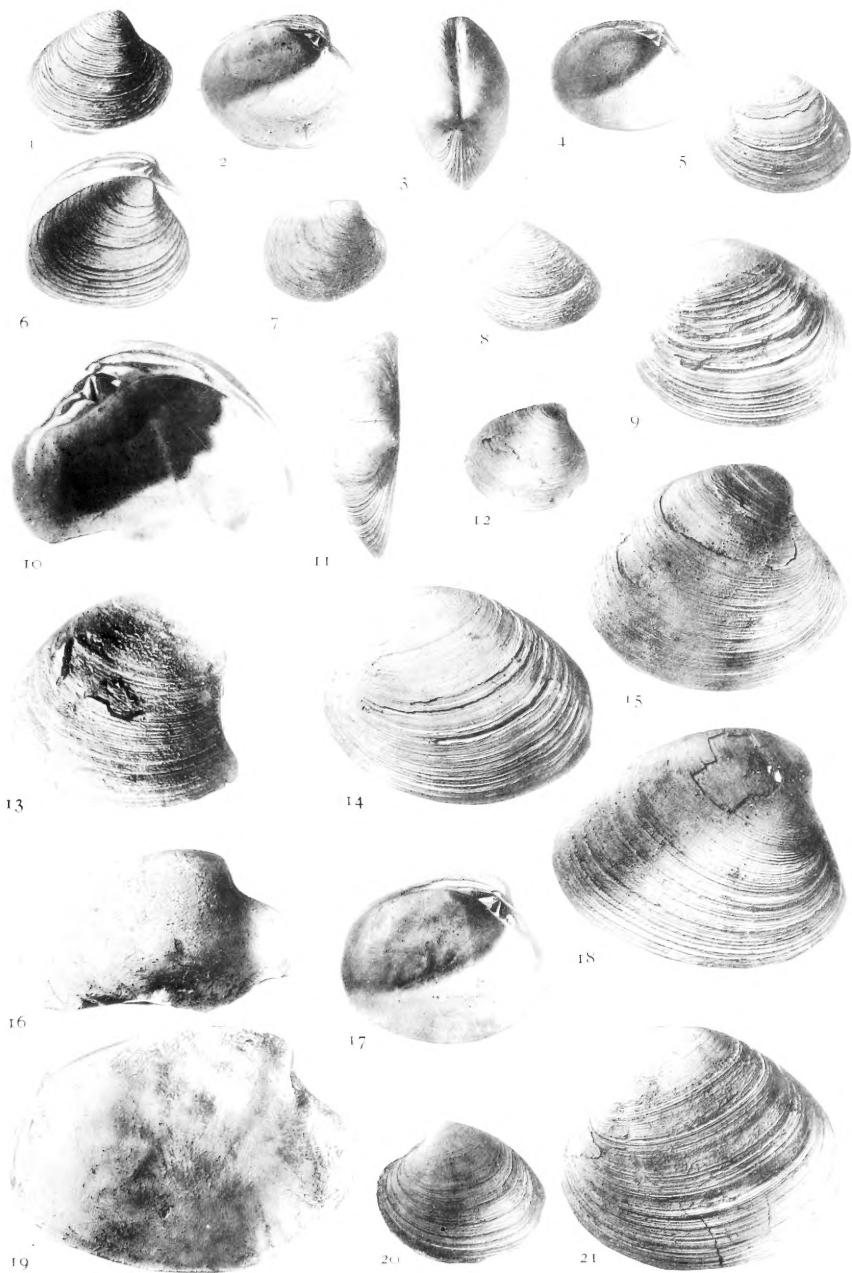




PLATE V

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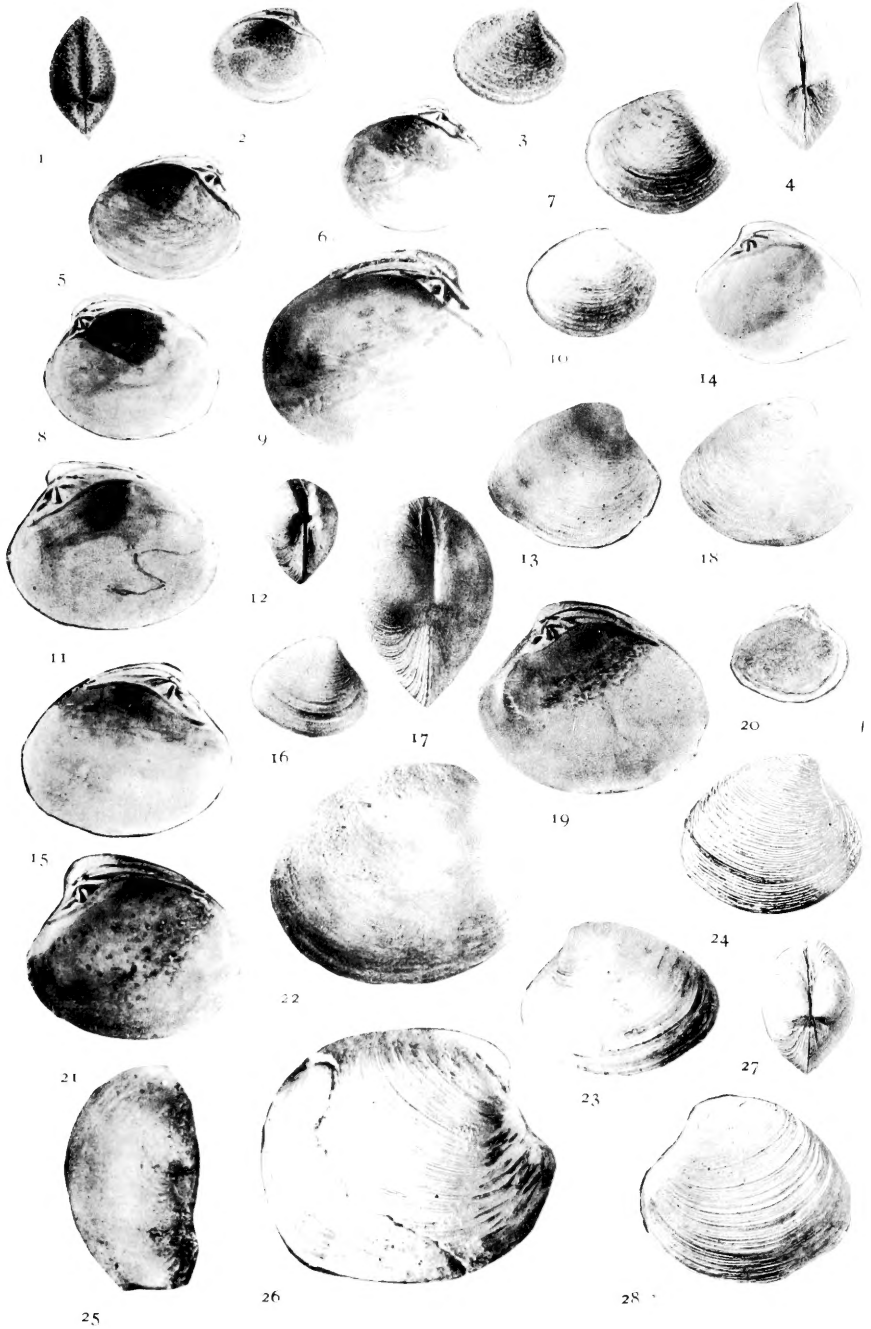


PLATE VI

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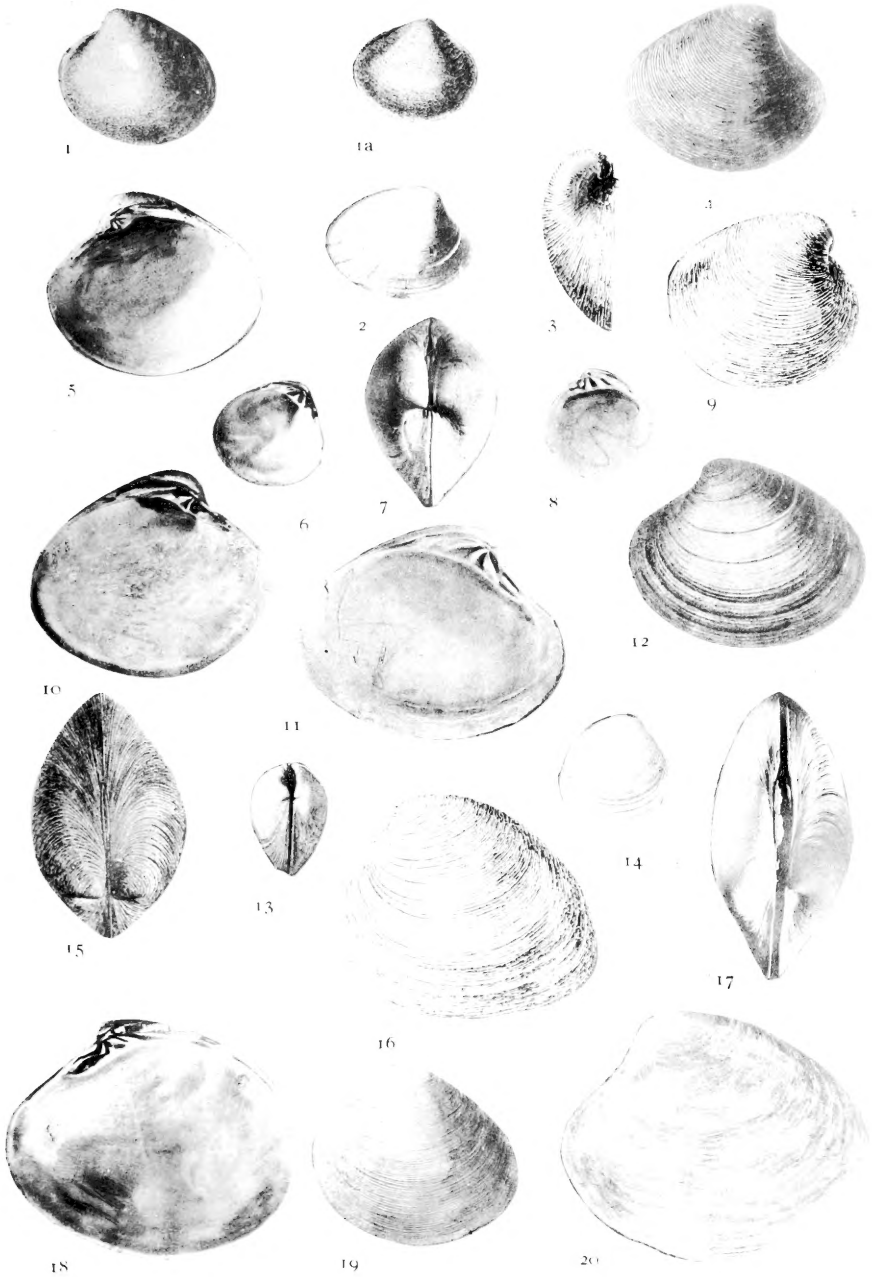


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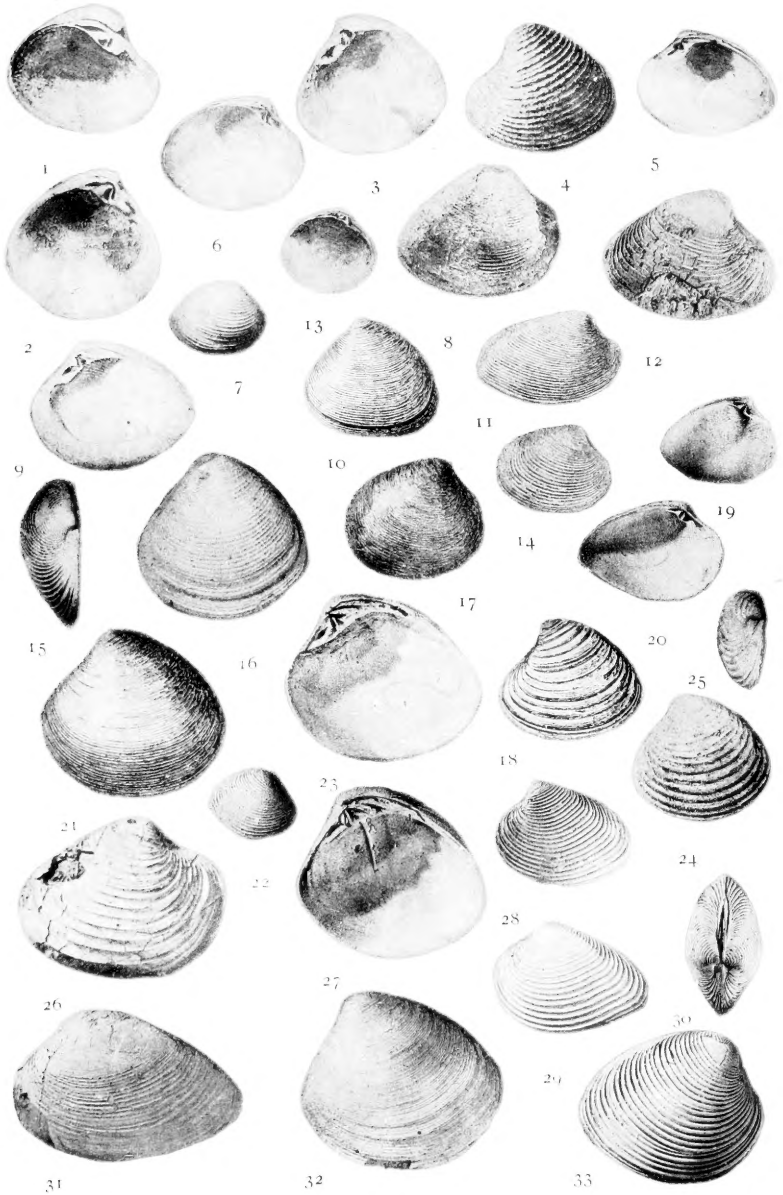


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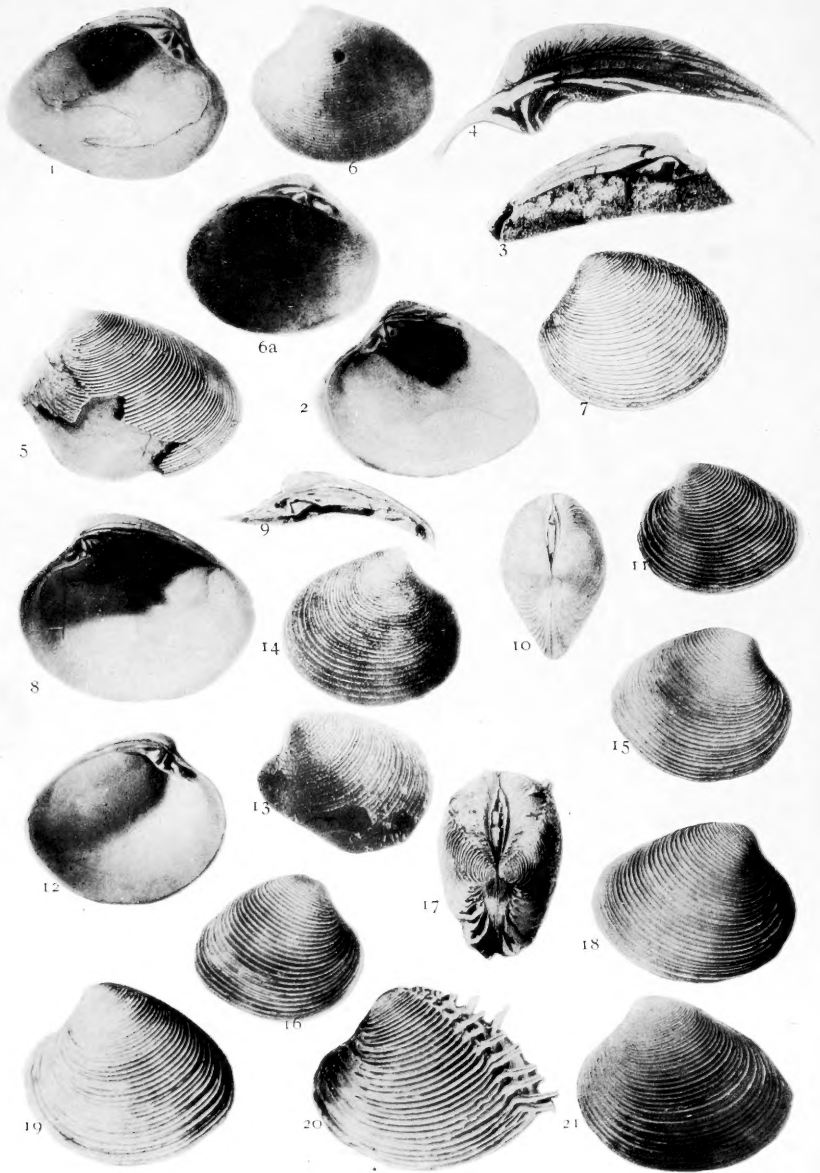


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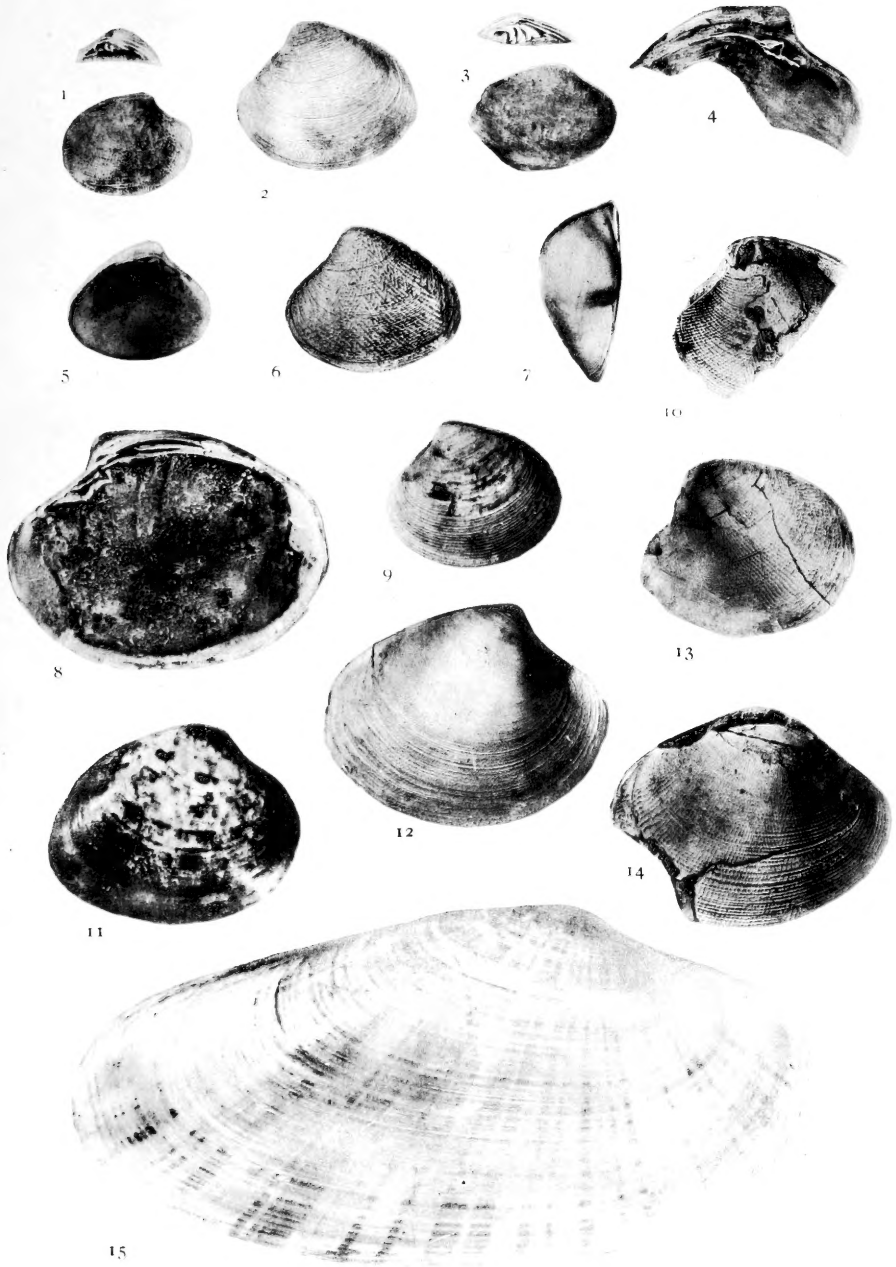


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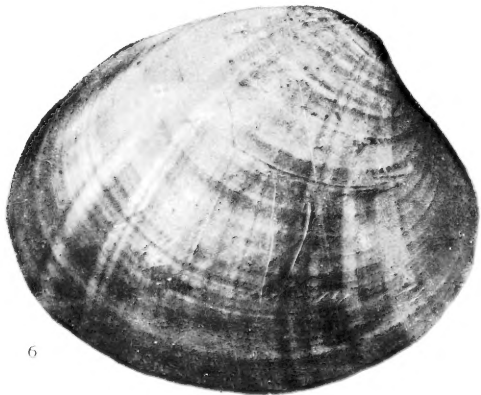
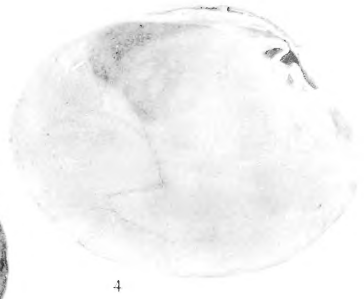
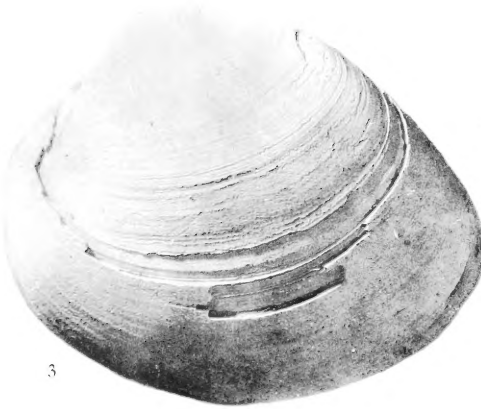
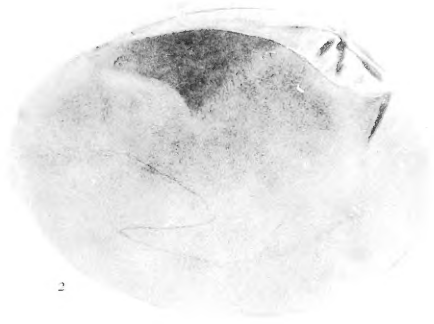


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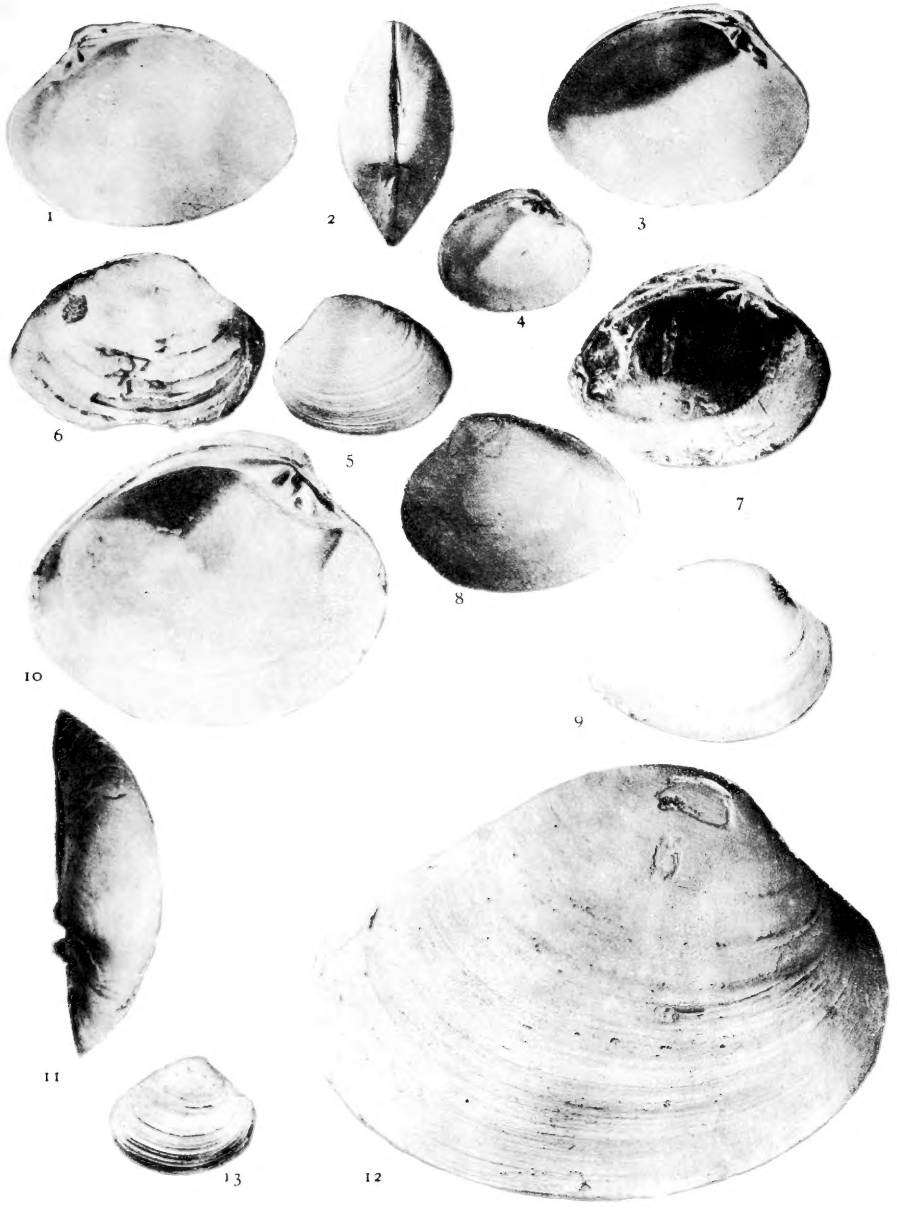


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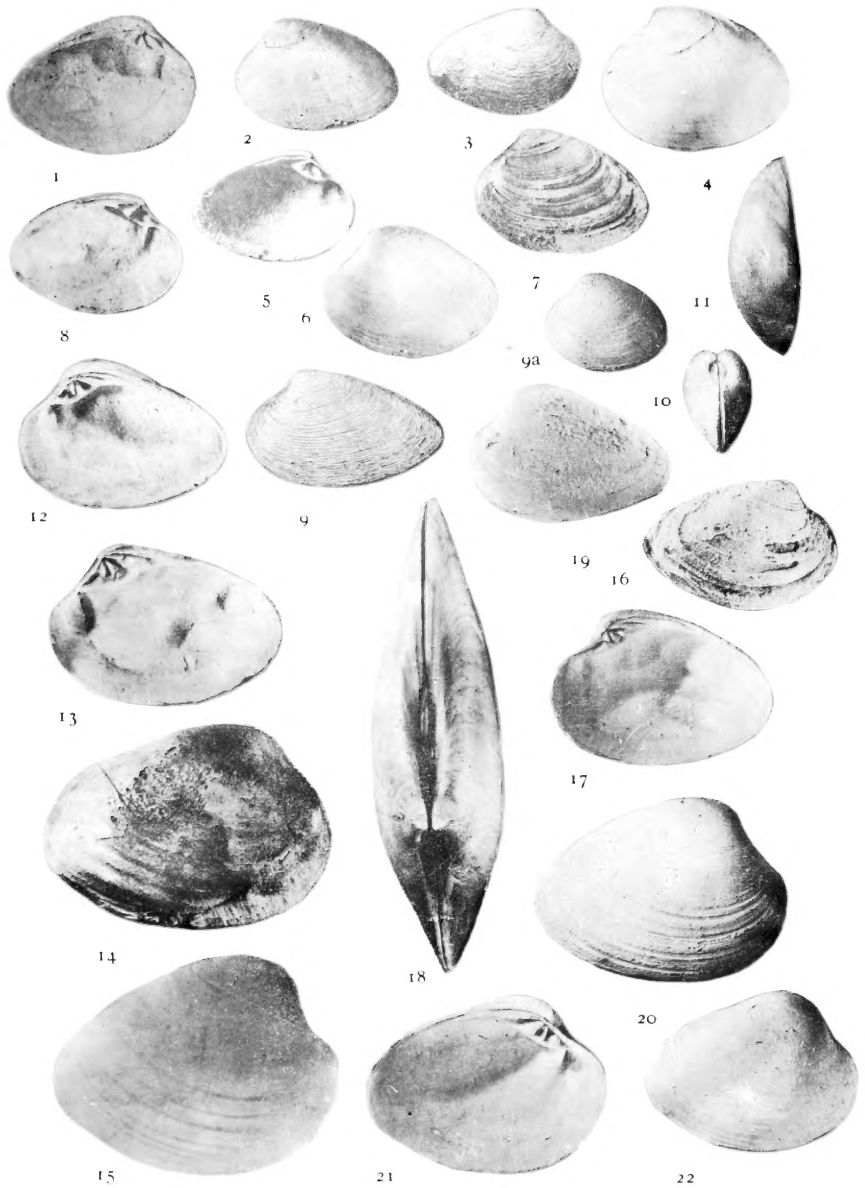


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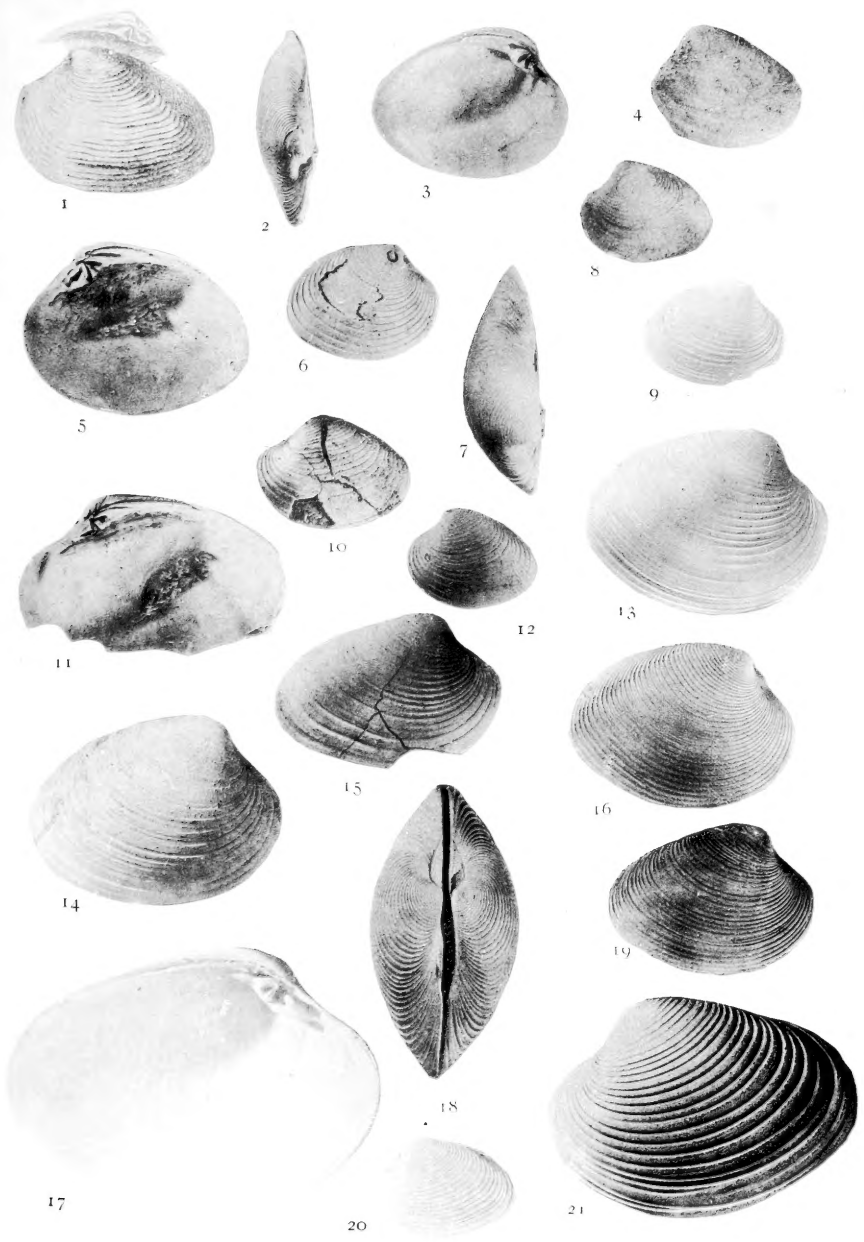




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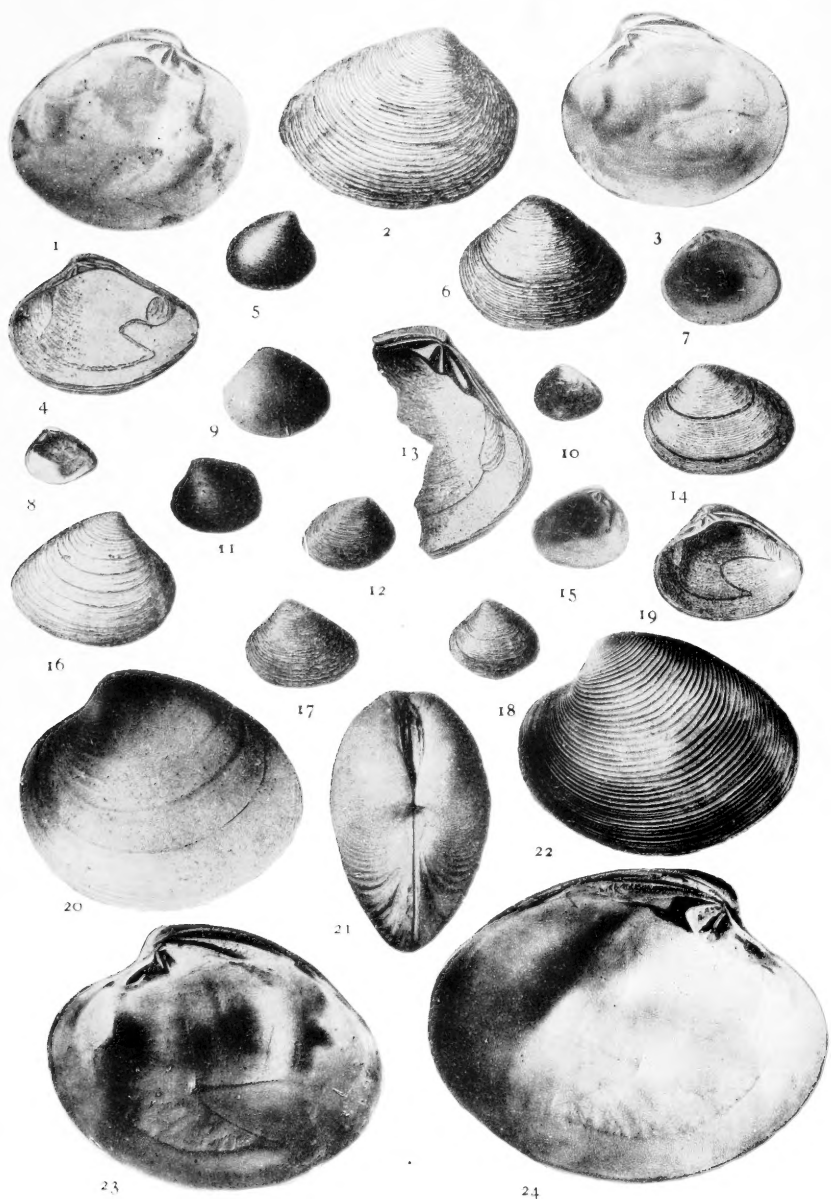


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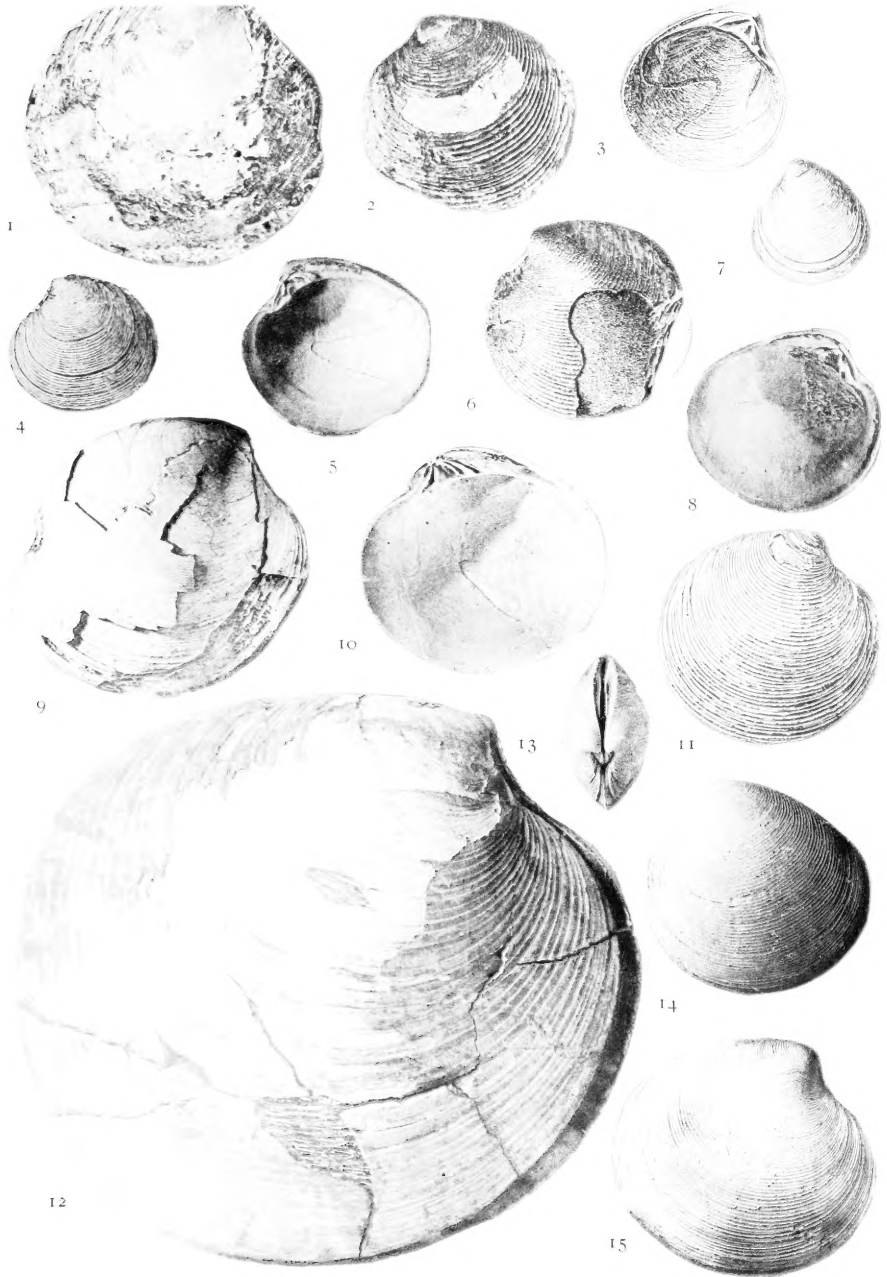


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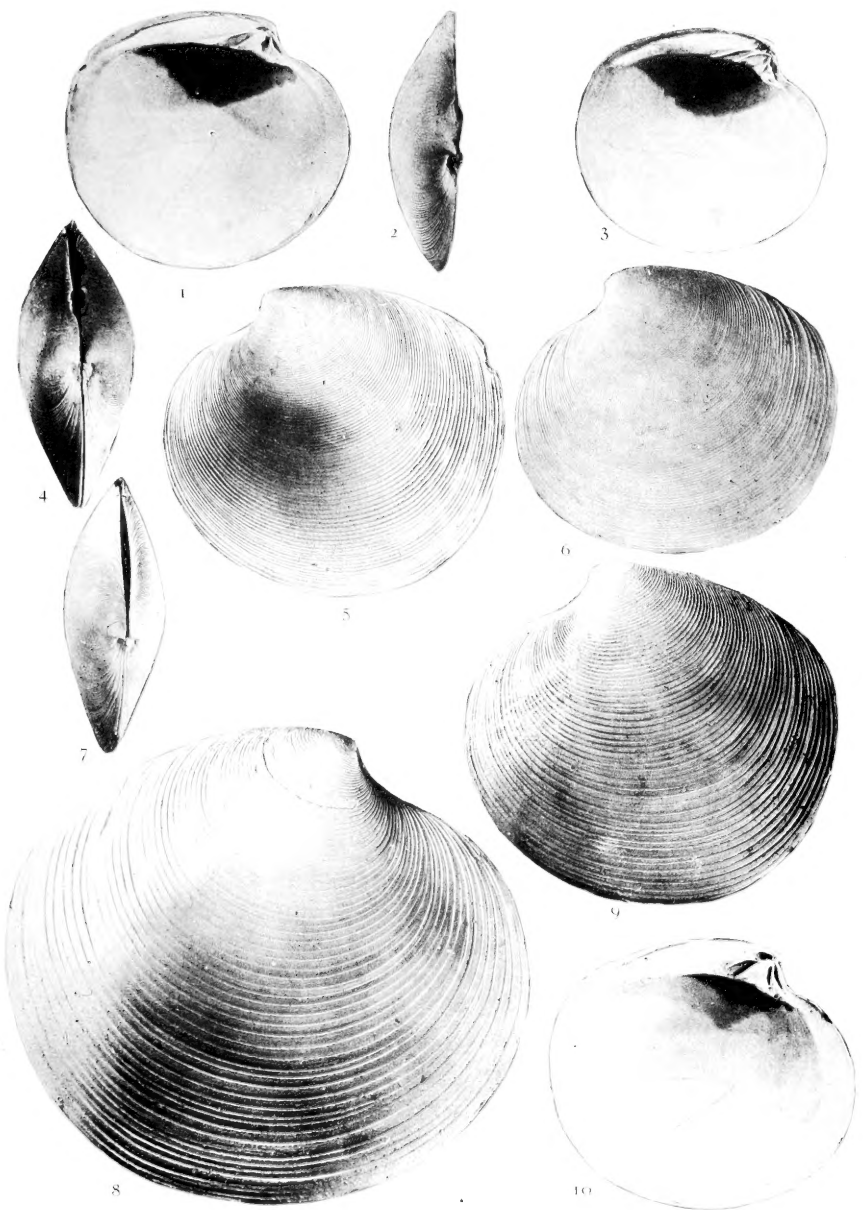


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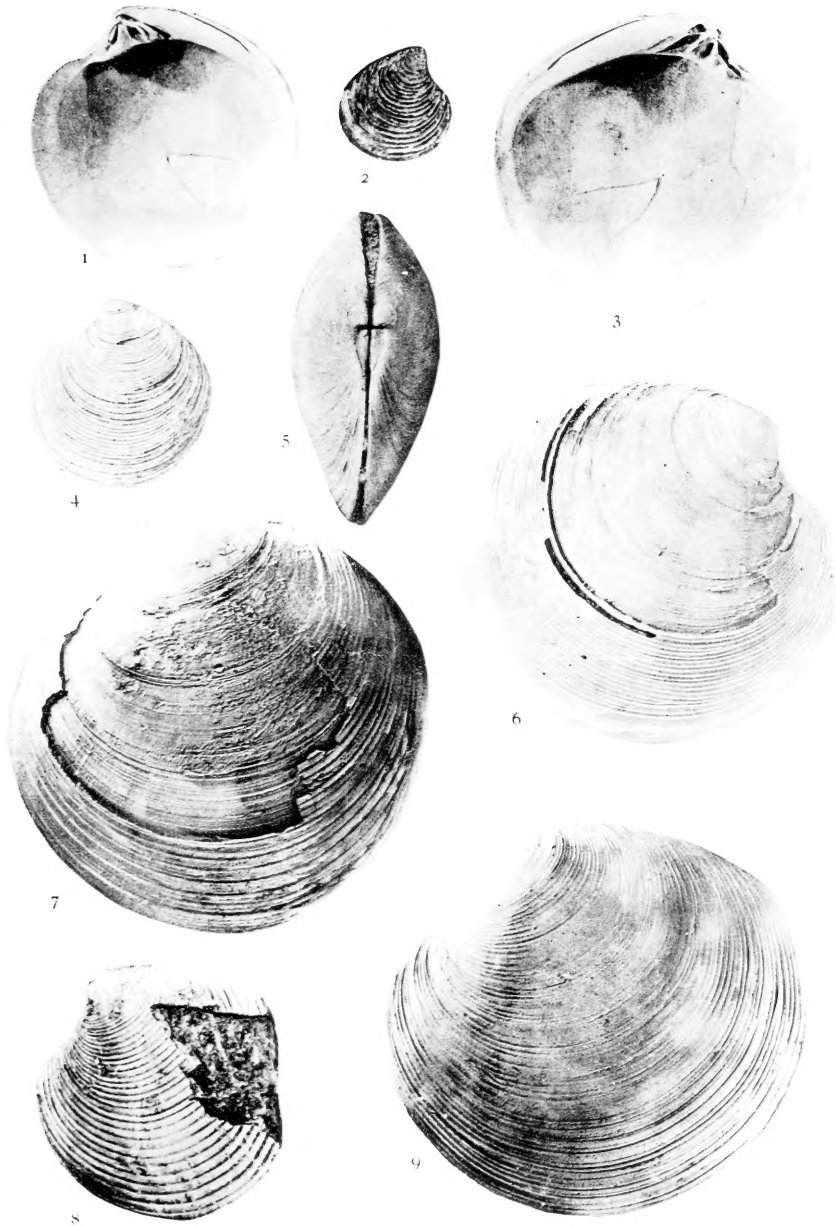


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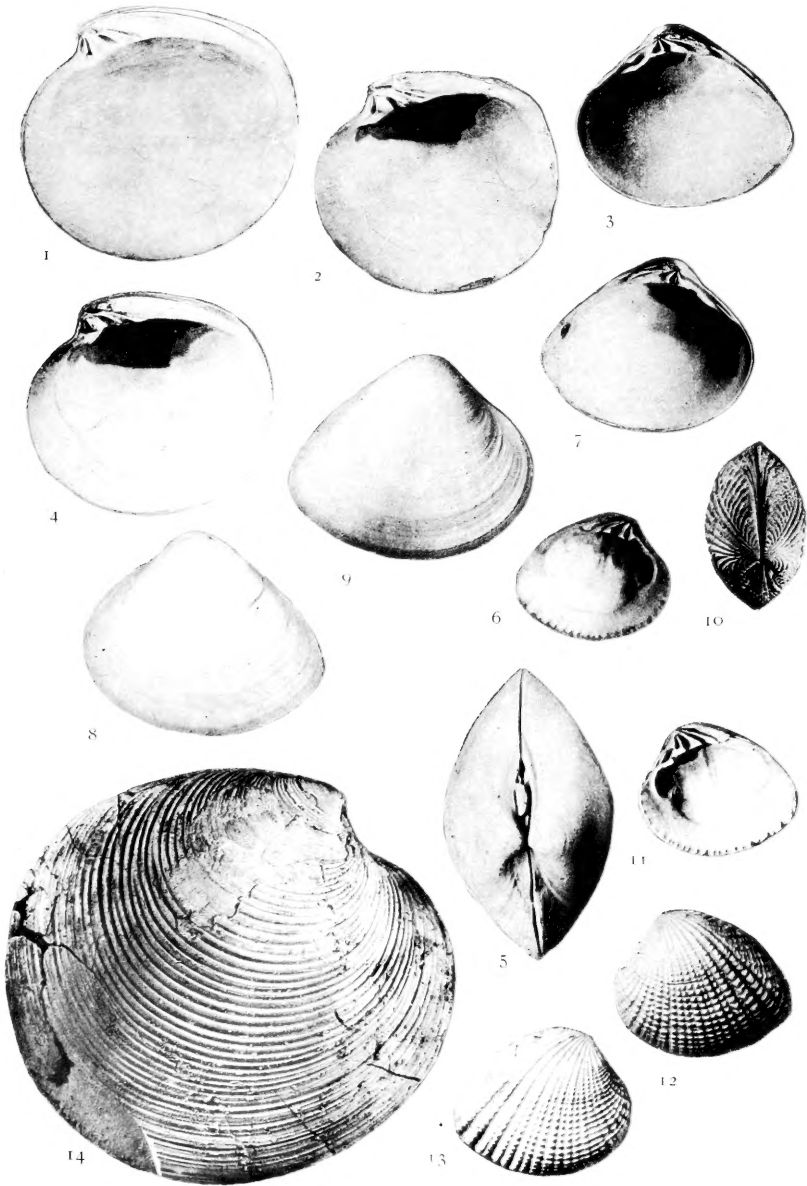


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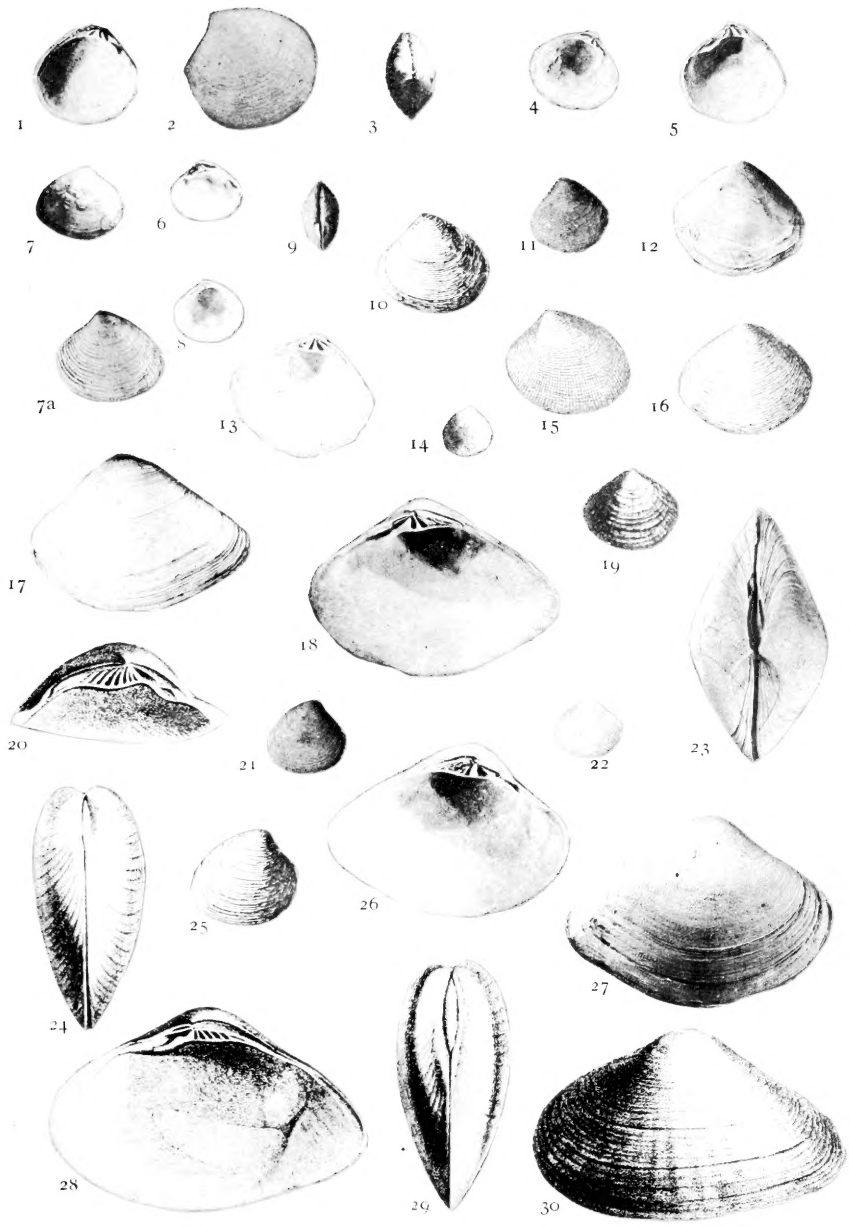


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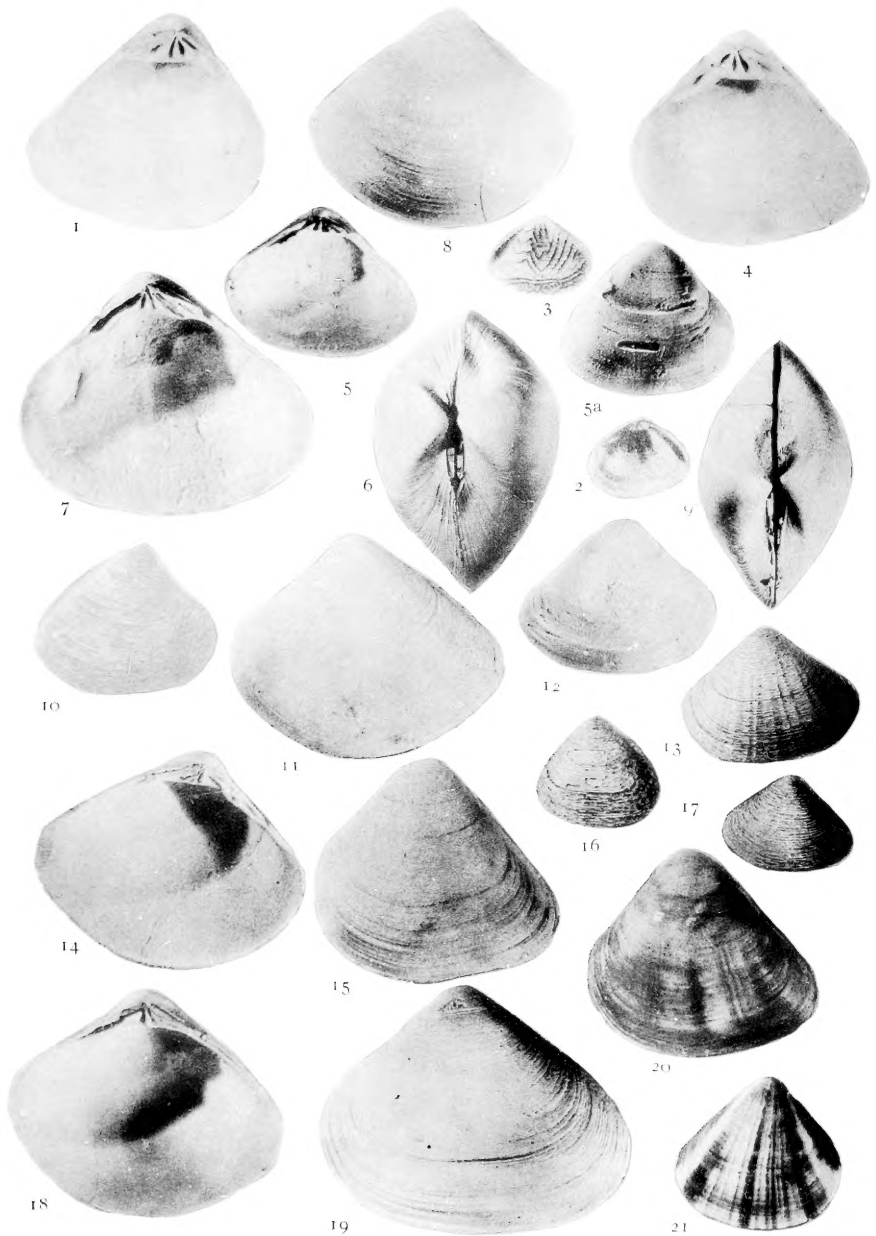


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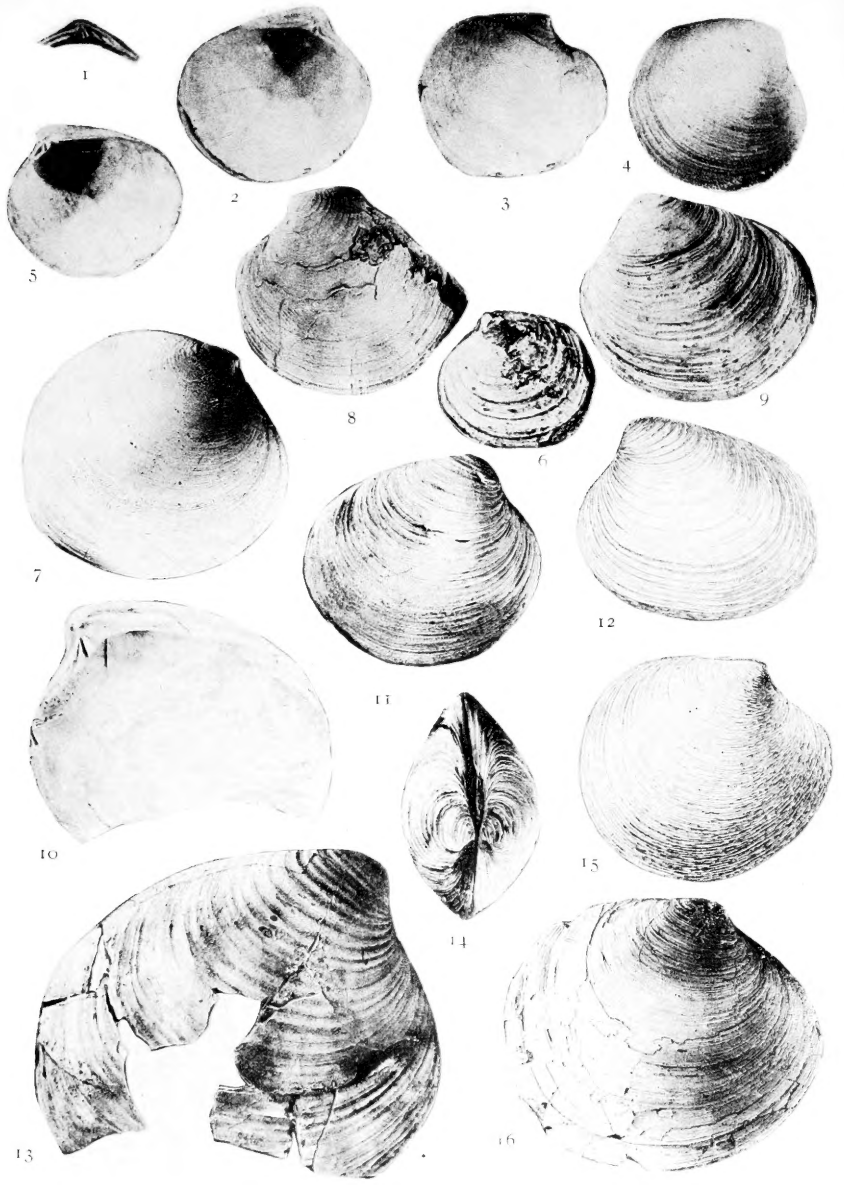


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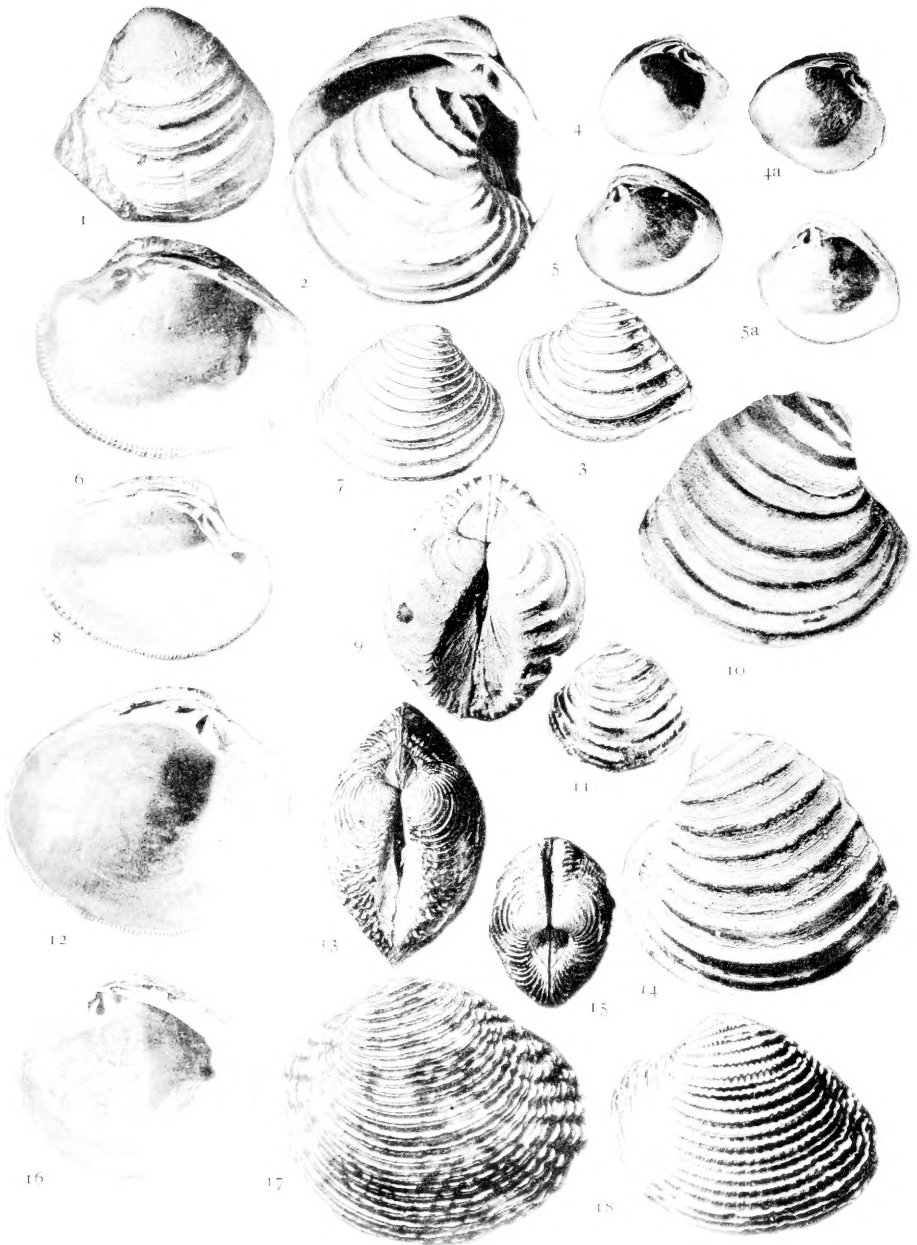




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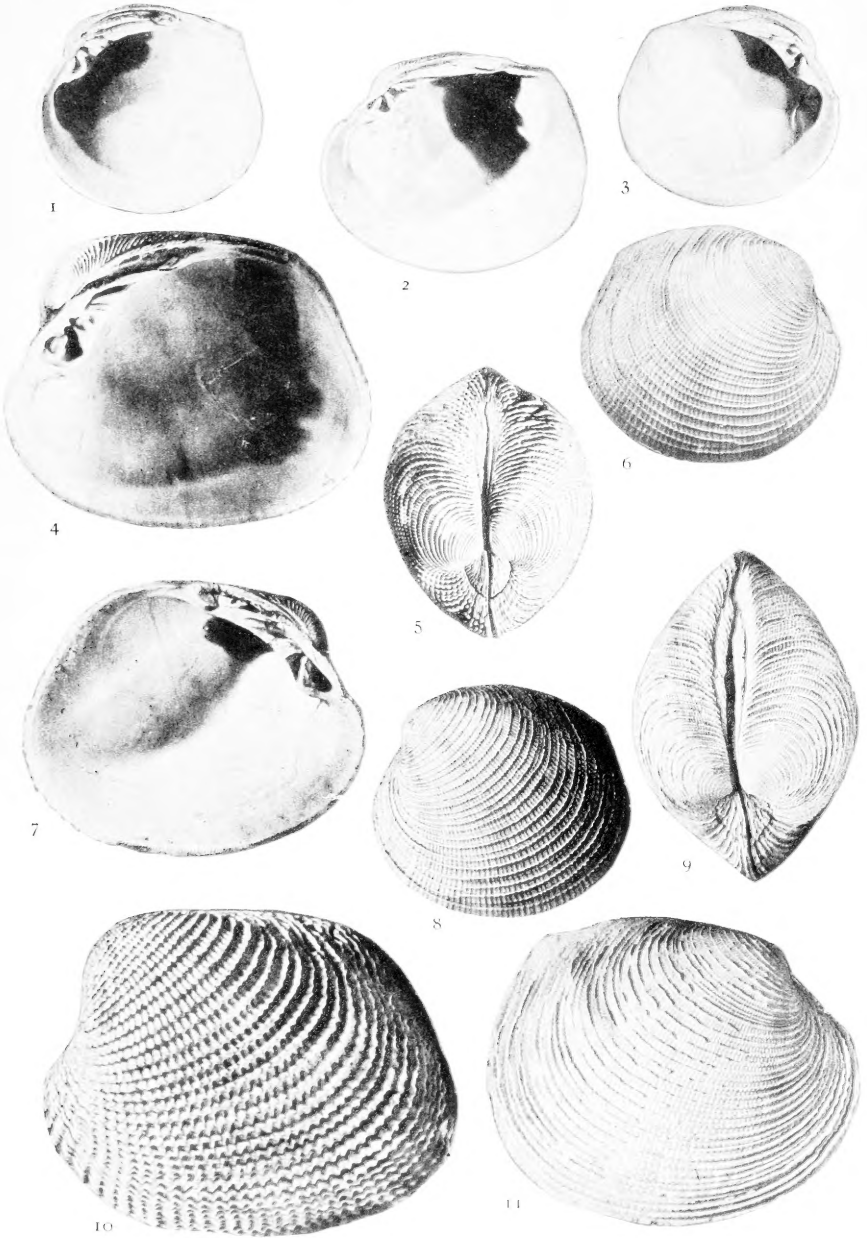


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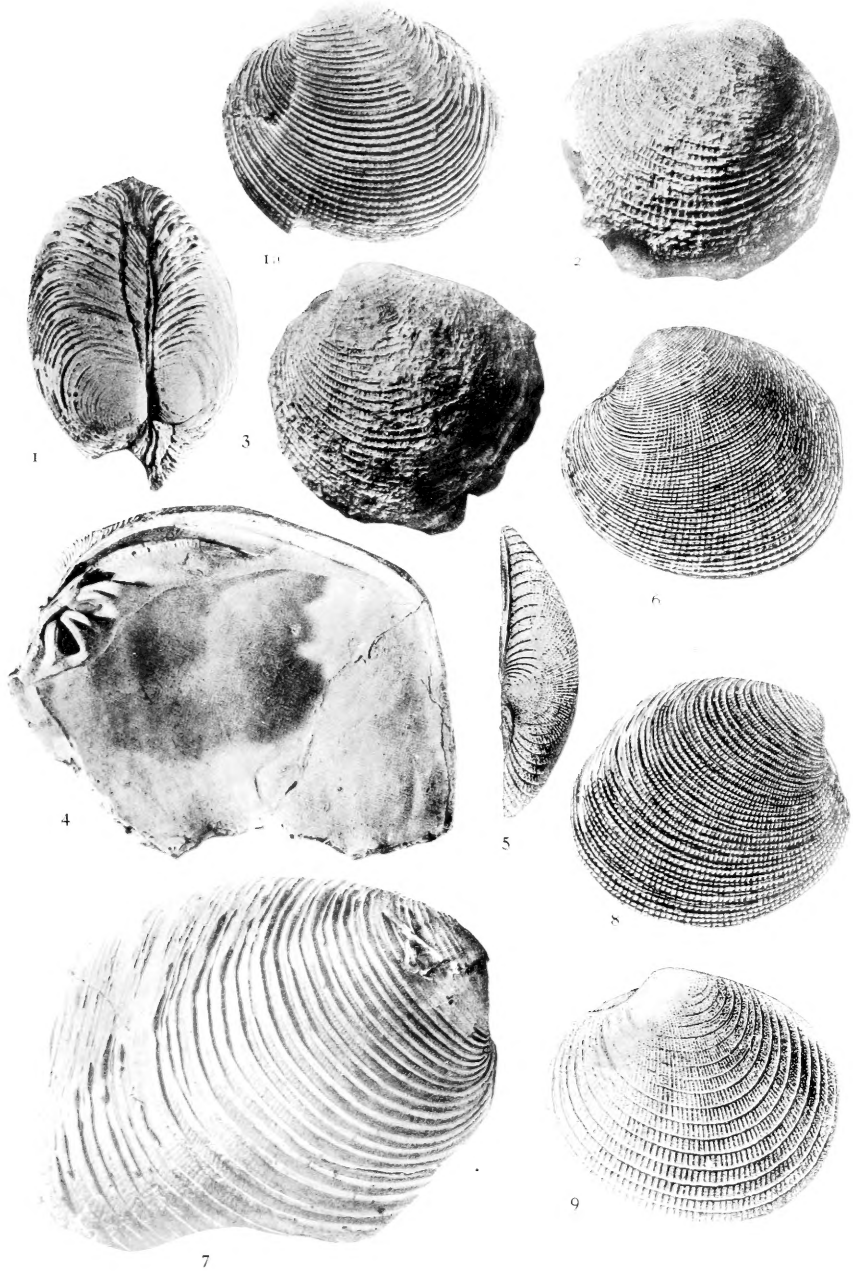


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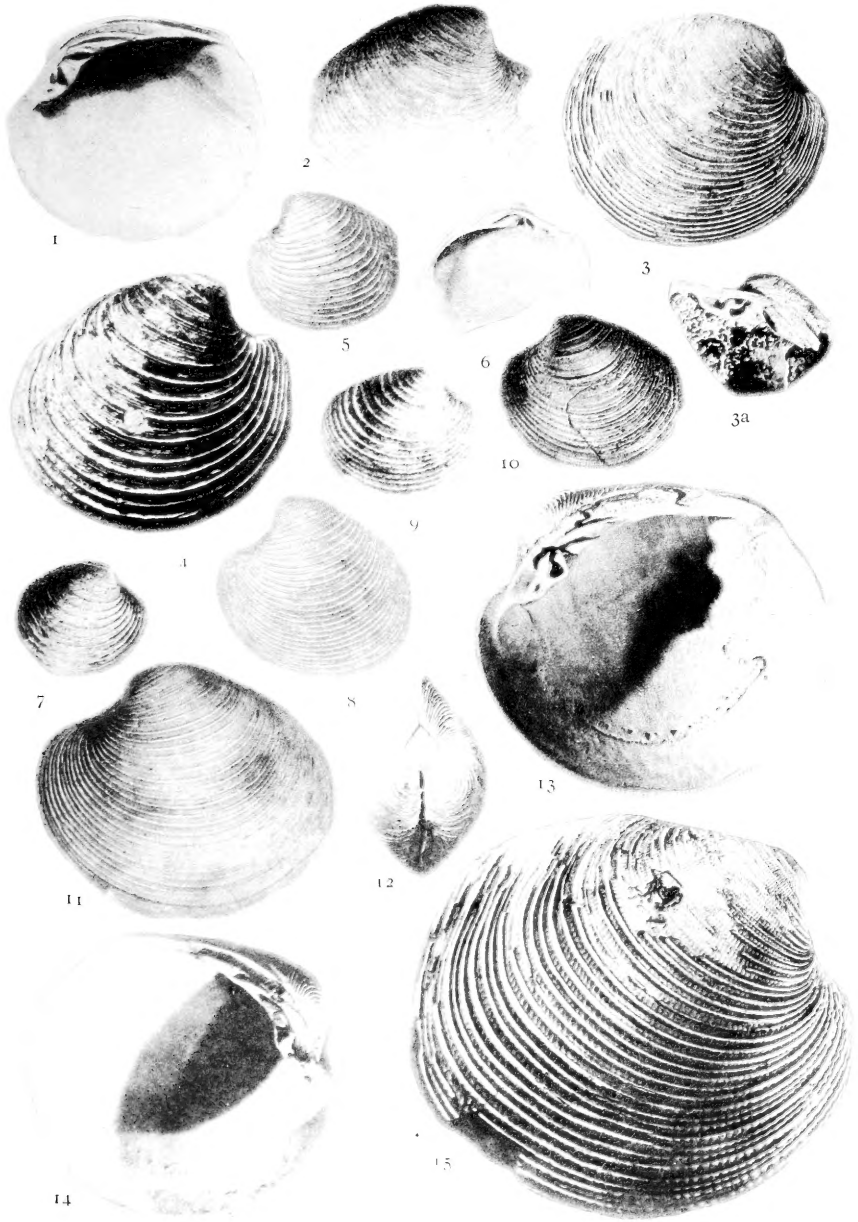


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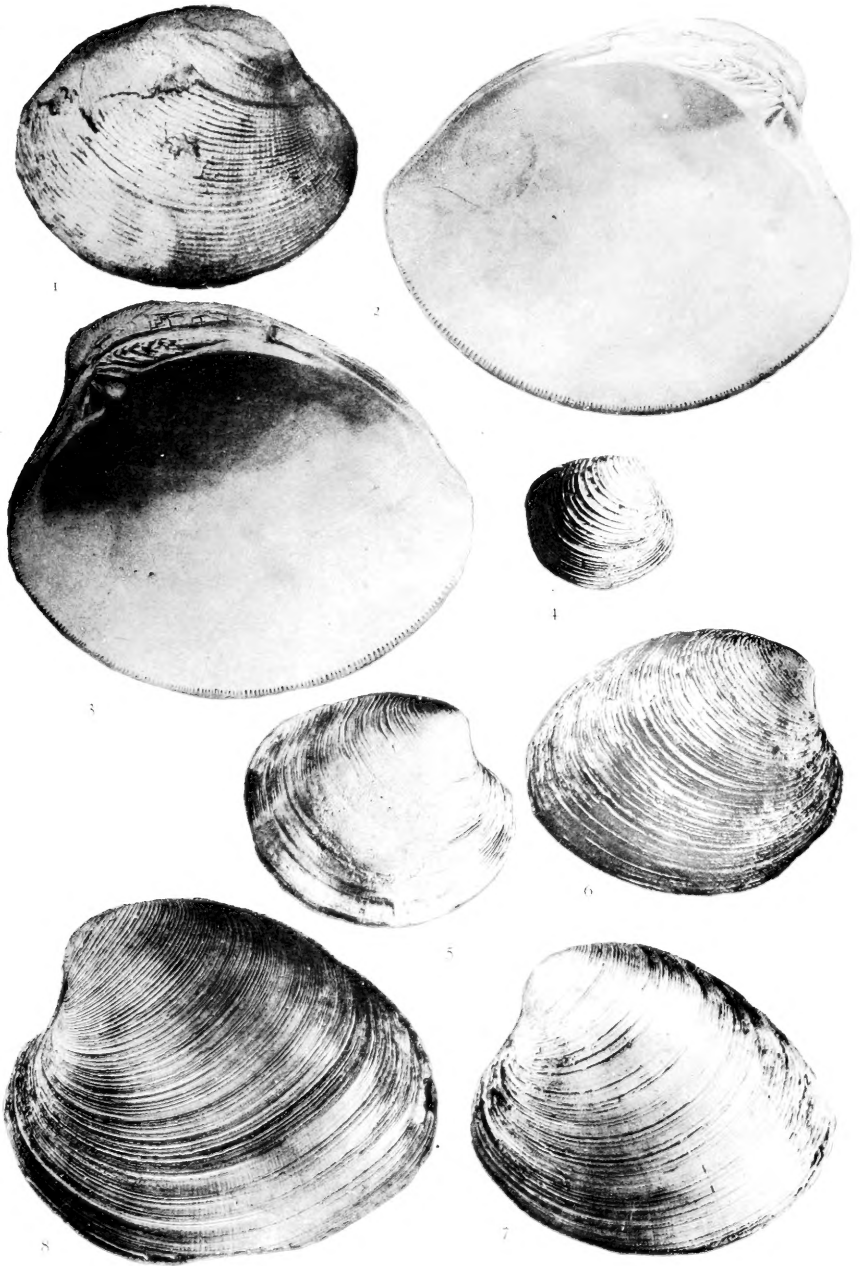




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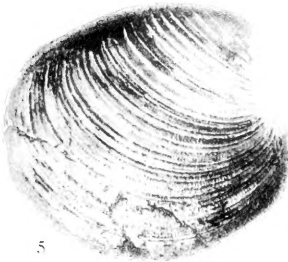
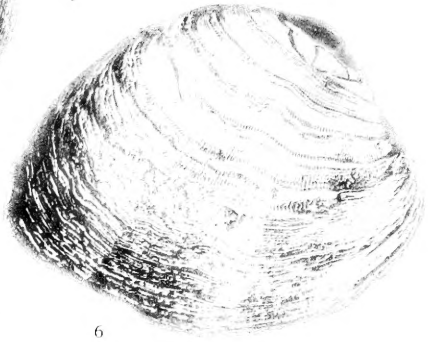
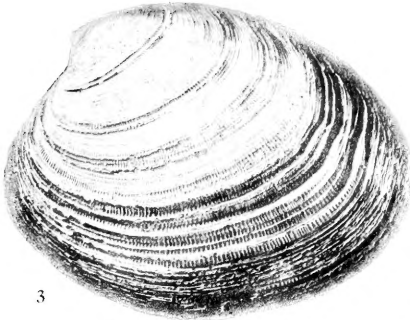
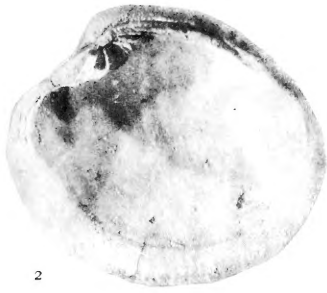




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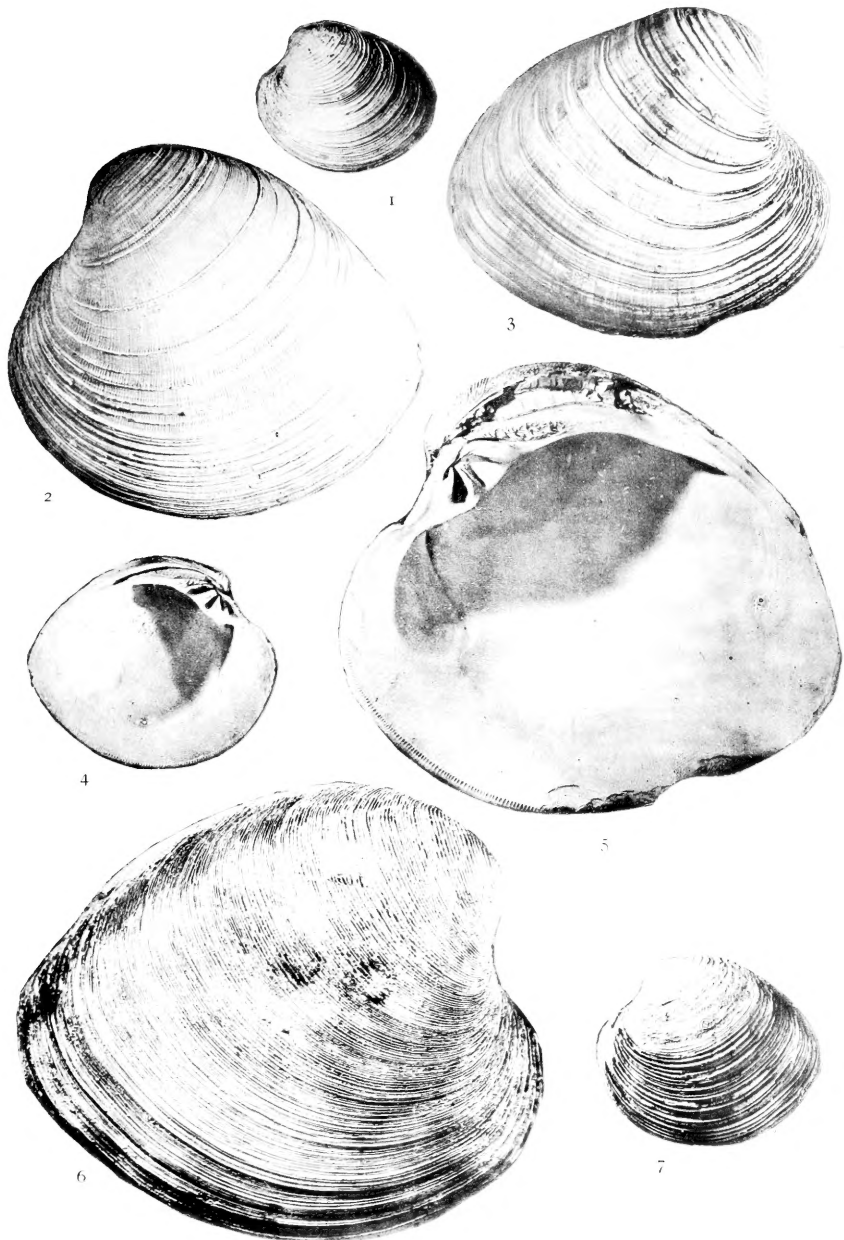




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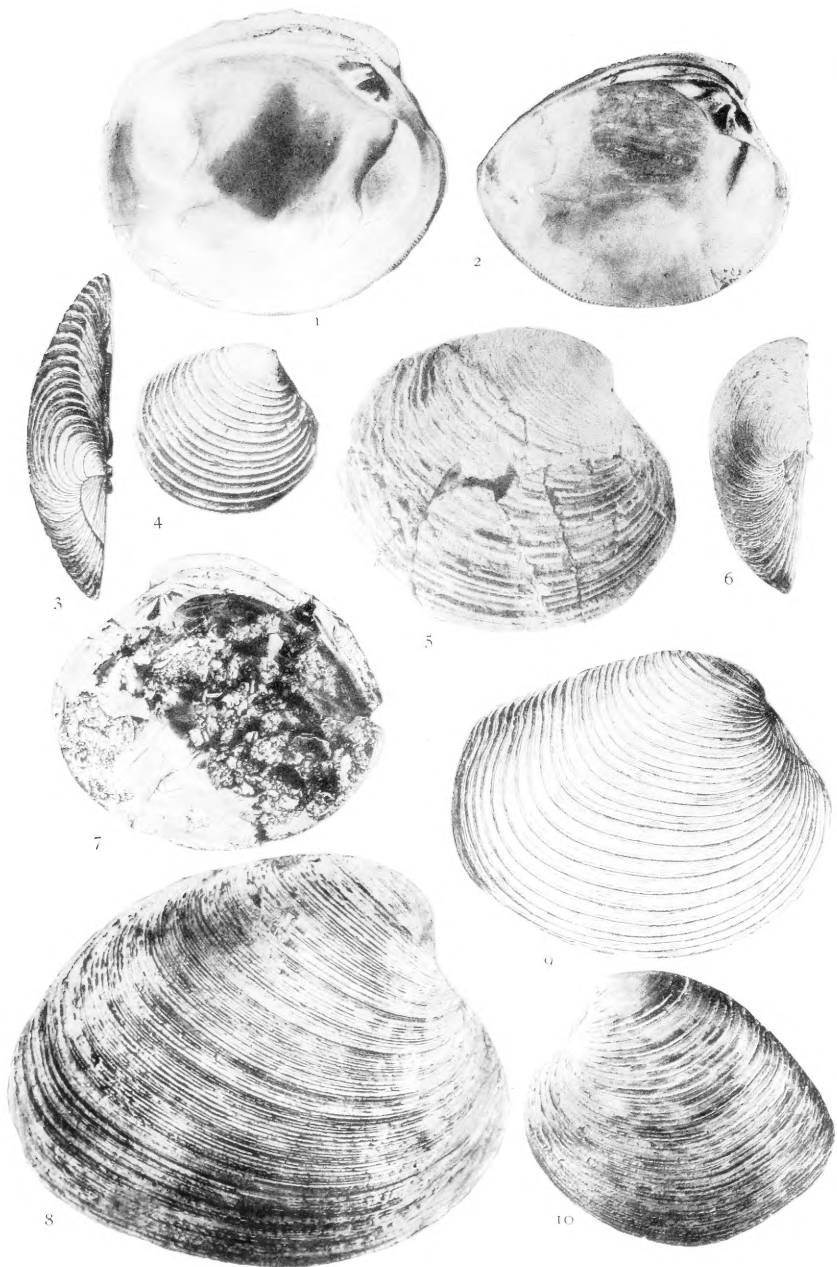




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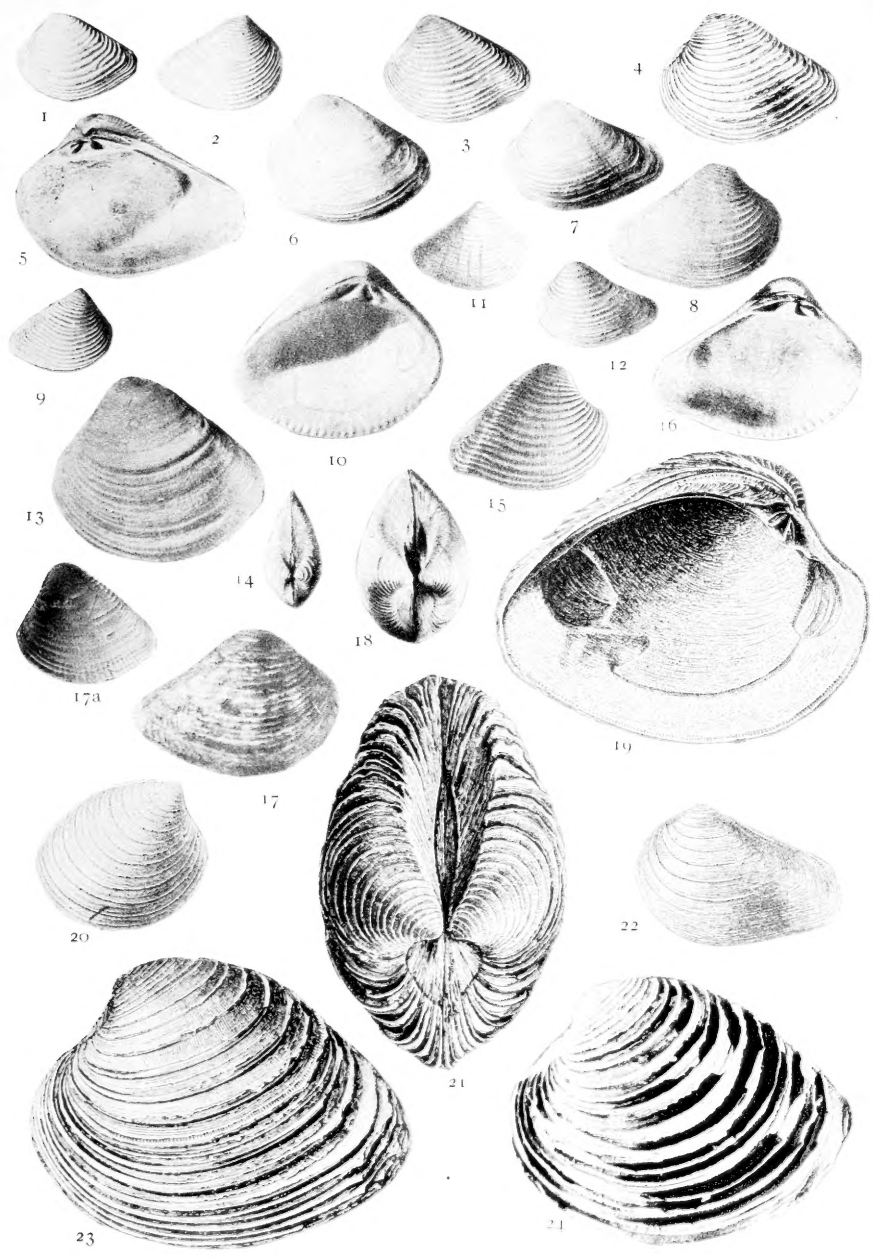




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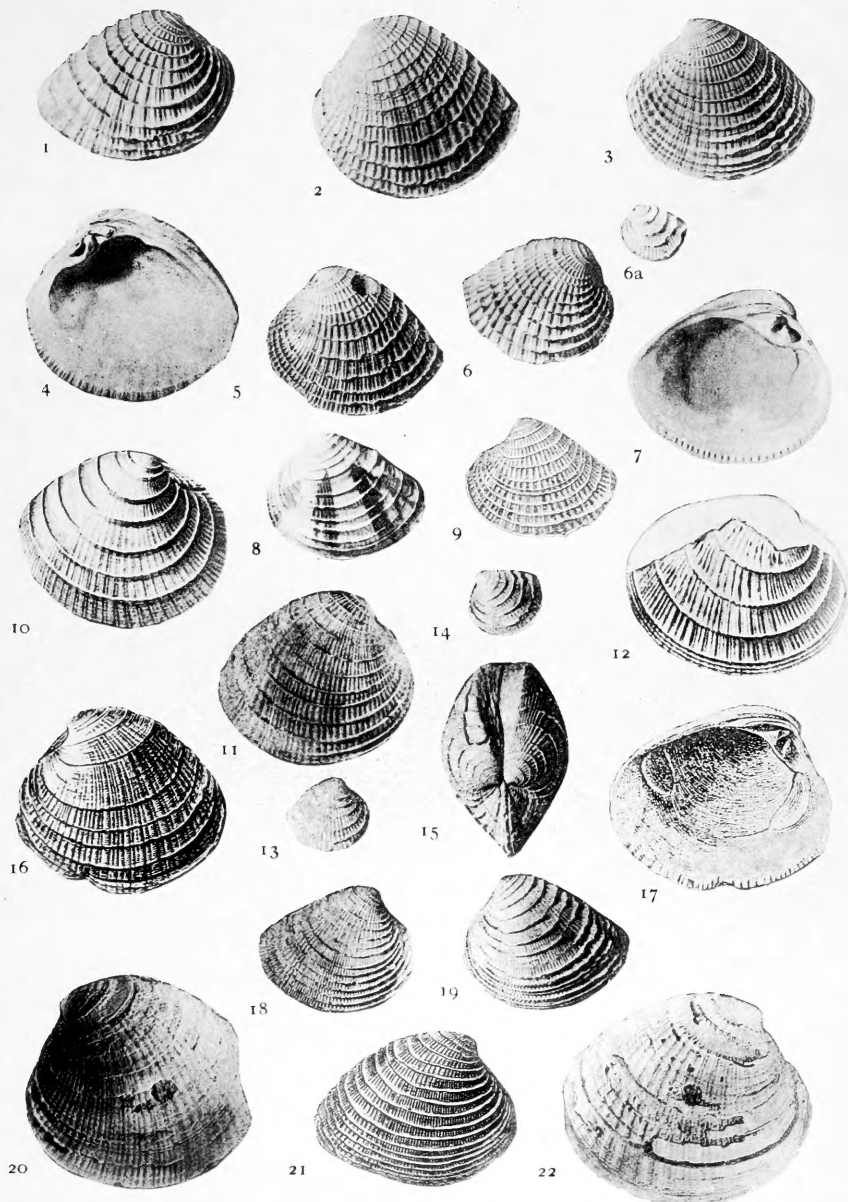




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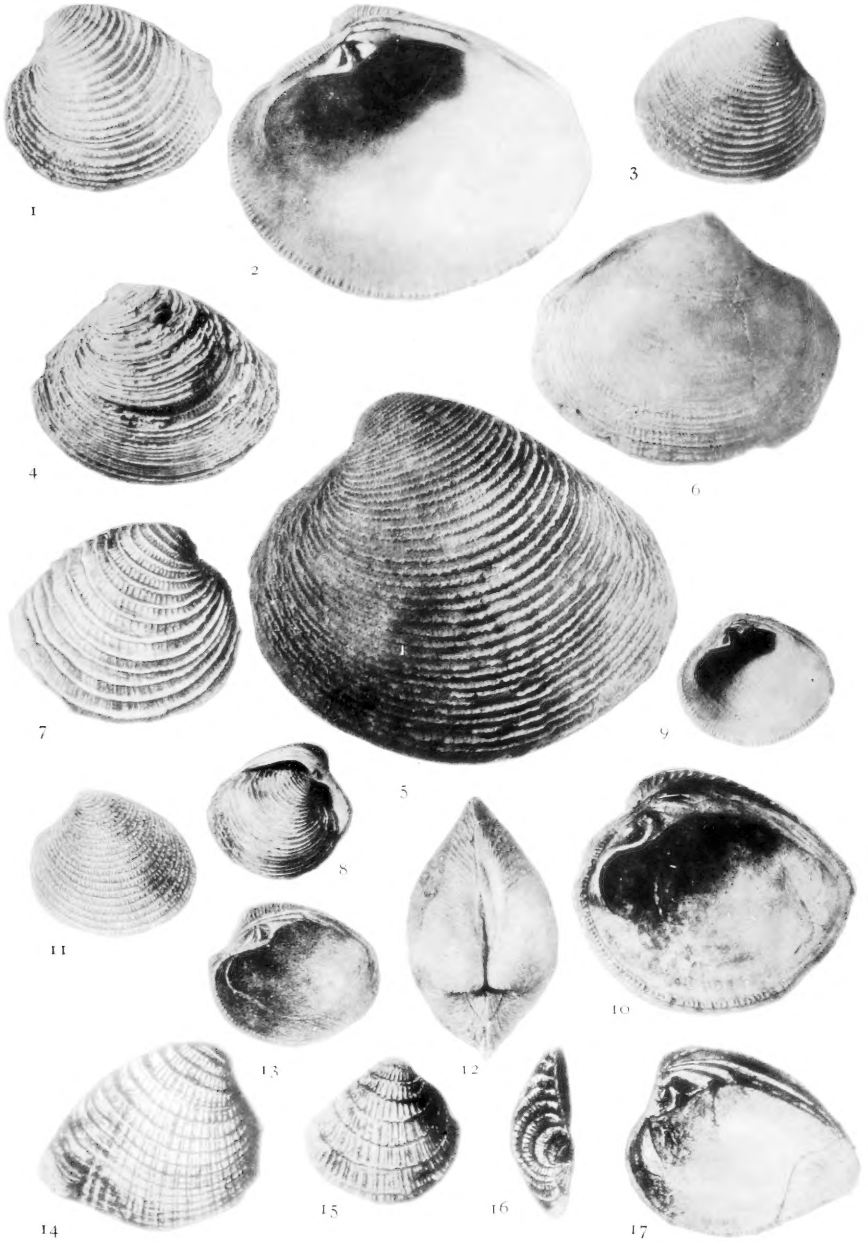


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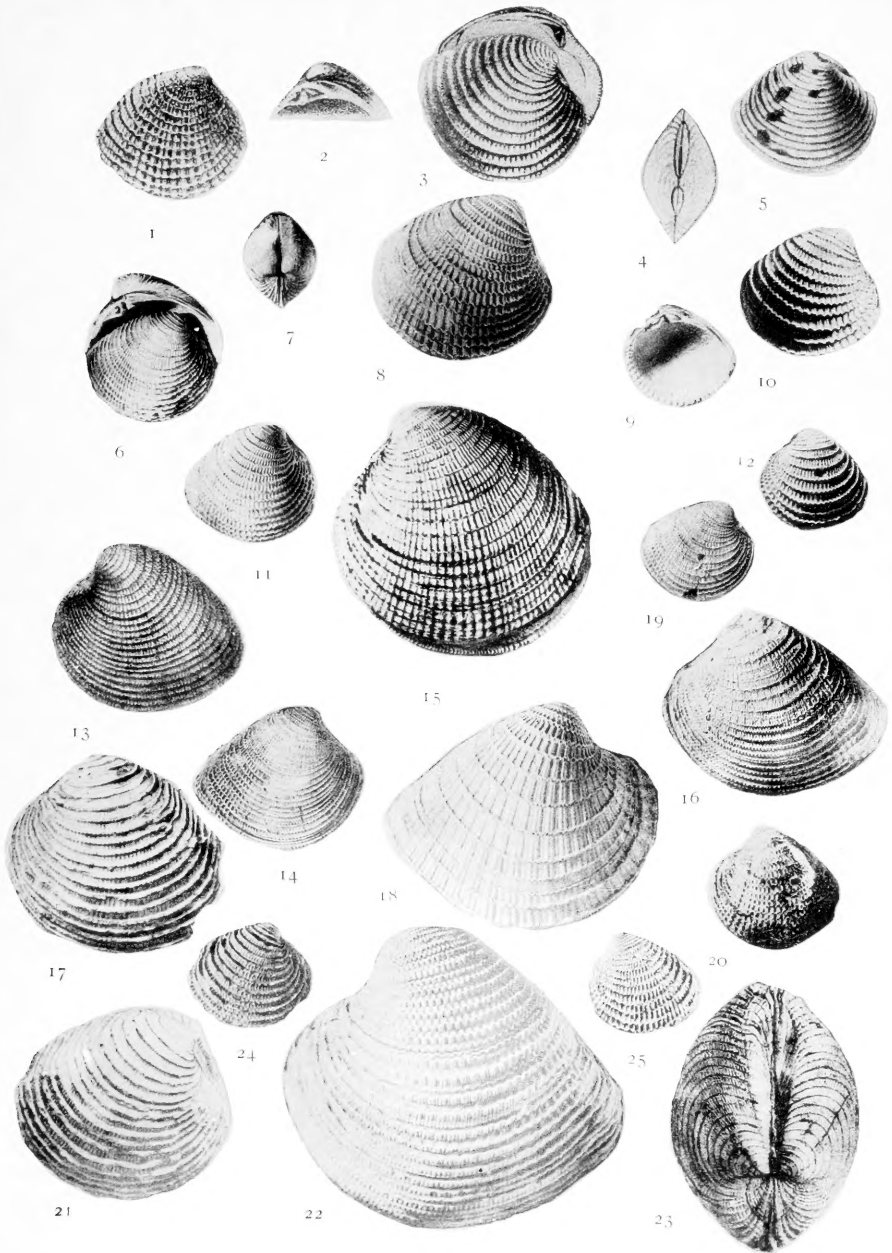


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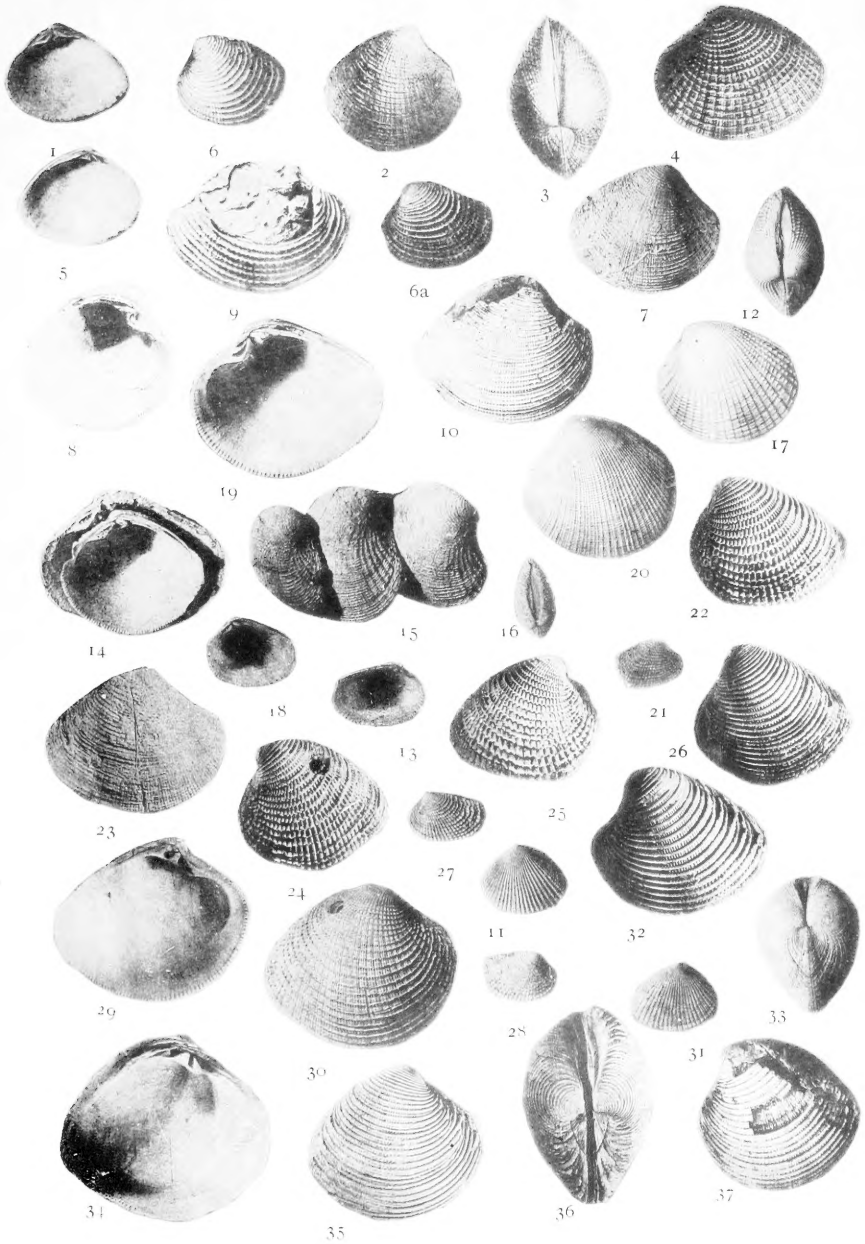


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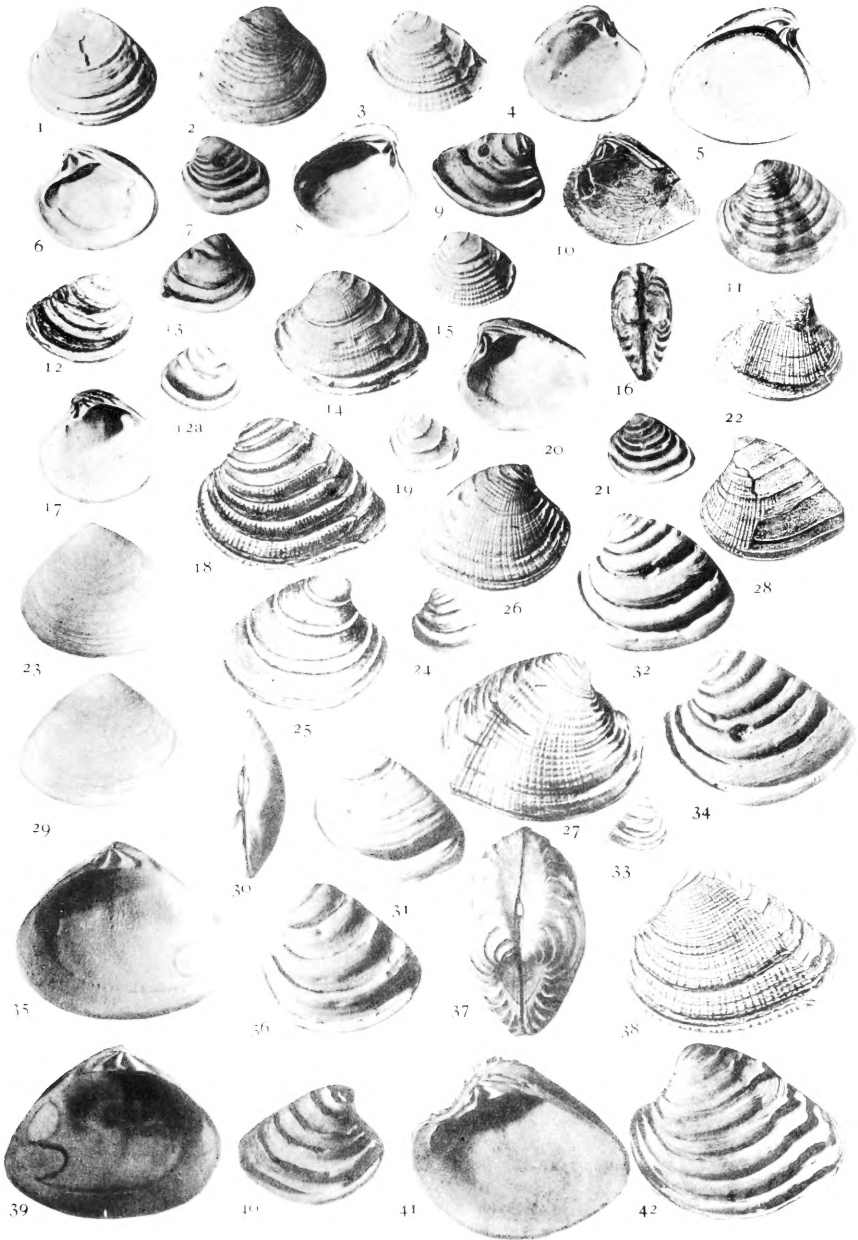




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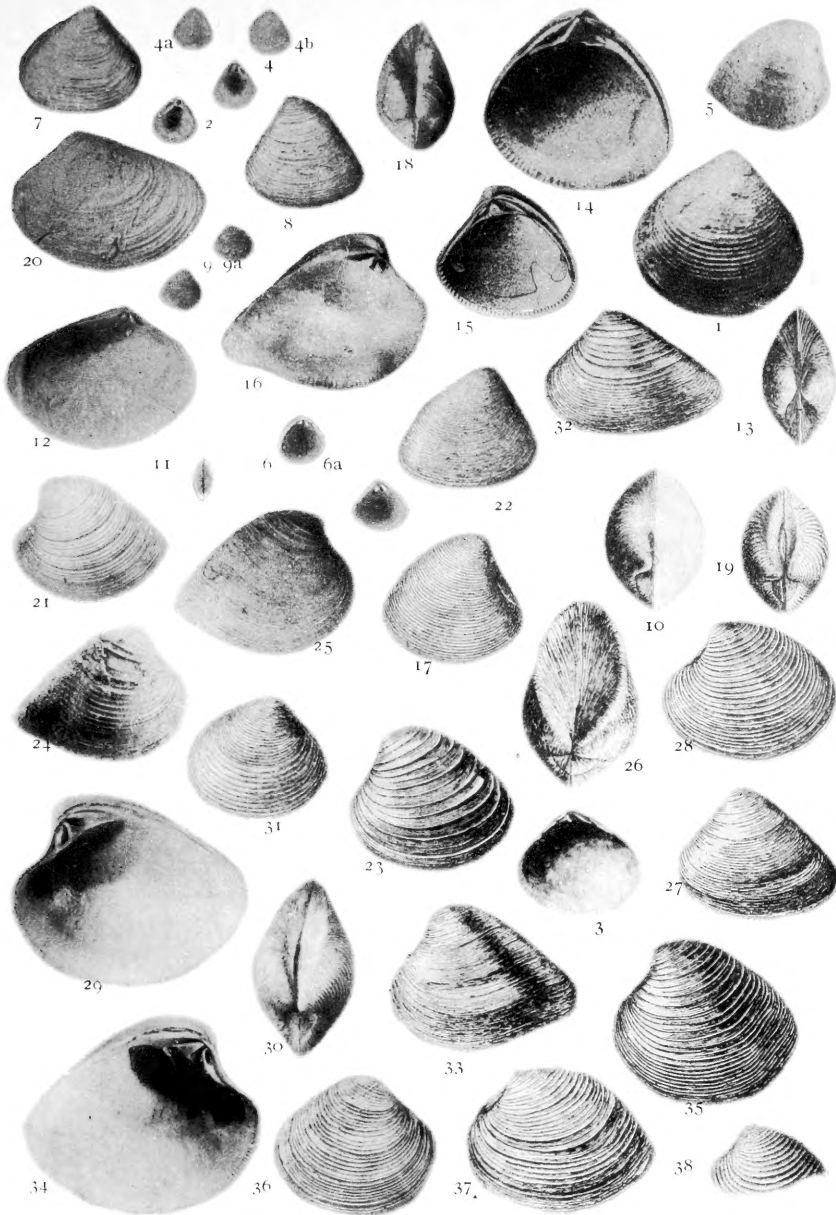


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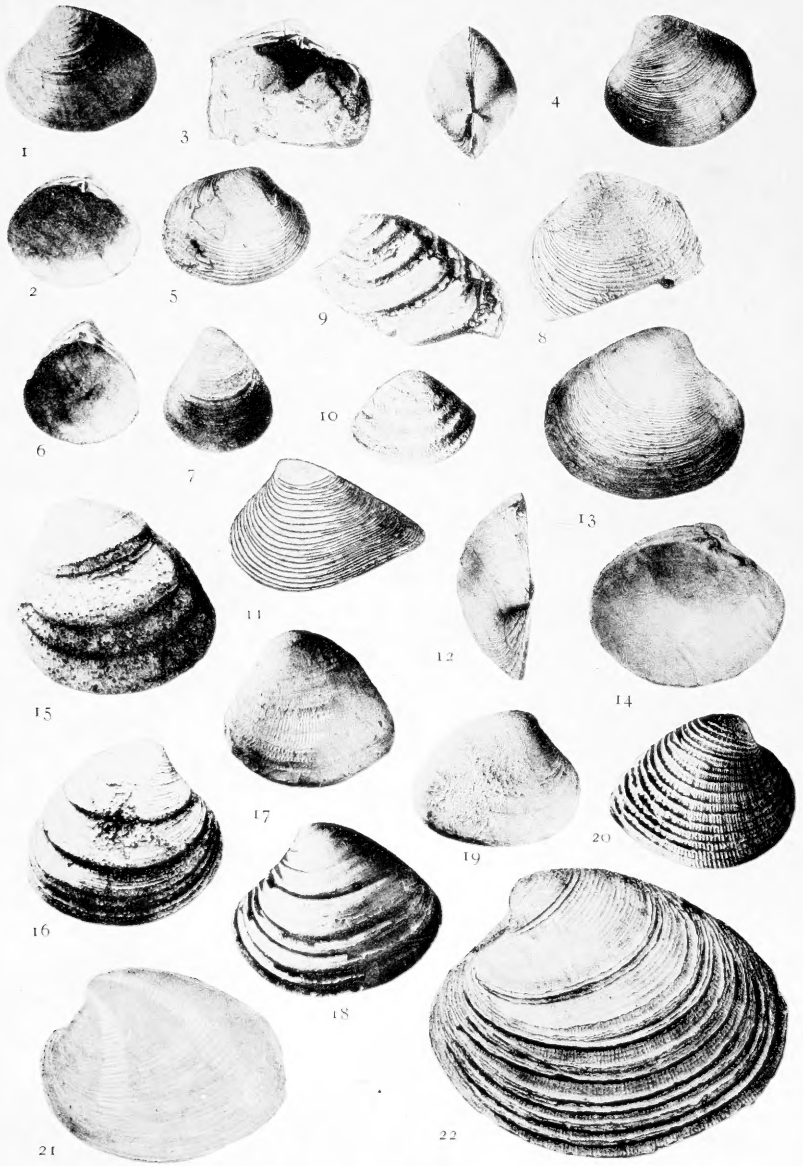
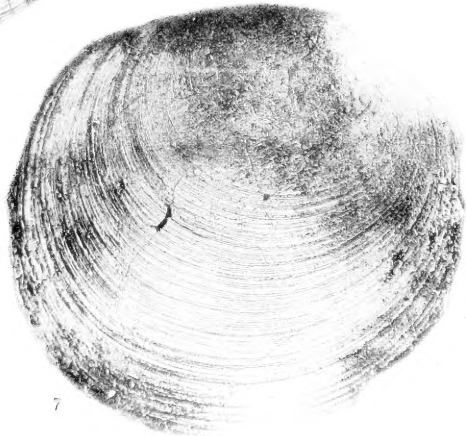
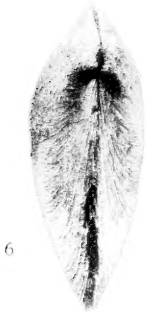
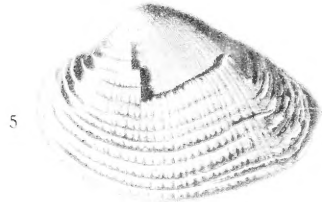


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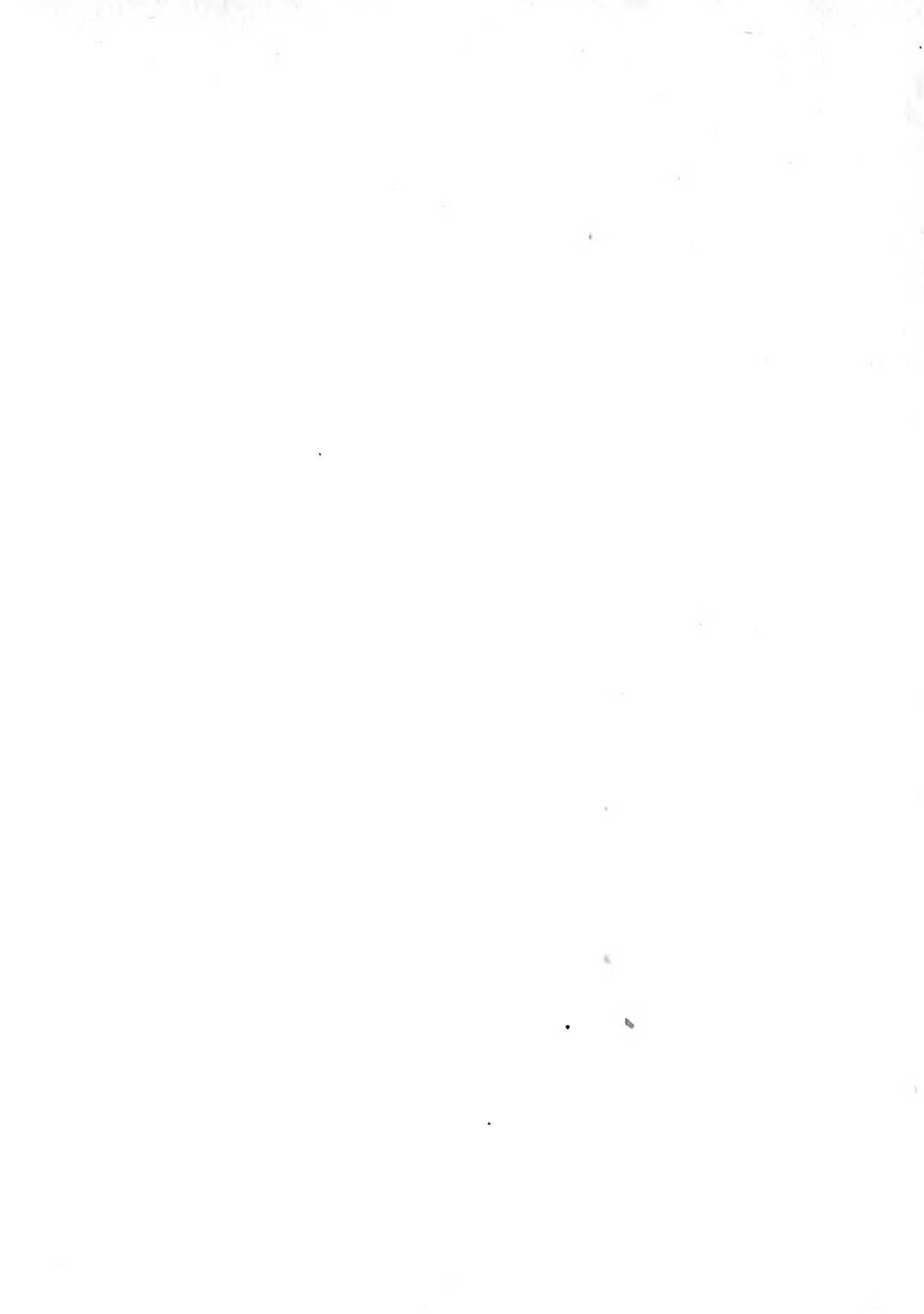
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