

**UNITED STATES DEPARTMENT OF THE INTERIOR**

**THE MOLLUSCAN FAUNA OF THE  
ALUM BLUFF GROUP OF FLORIDA**

**PART IV. VENERACEA**

**GEOLOGICAL SURVEY PROFESSIONAL PAPER 142-D**



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# THE MOLLUSCAN FAUNA OF THE ALUM BLUFF GROUP OF FLORIDA

BY  
JULIA GARDNER

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## PART IV. VENERACEA

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## DISTRIBUTION OF THE FAUNA

The following list shows the localities cited by number in the text and tables:

75. 6 miles west of Gainesville, Alachua County, Fla.
- 322b. Nigger Sink, 8 miles north of Newmansville, Alachua County, Fla.
323. Near Hawthorn, Alachua County, Fla.
356. Sullivan's field, Levy County, Fla.
359. Chimney Rock Quarry, half a mile north of Gainesville, Alachua County Fla.
360. Preston's marl bed,  $3\frac{1}{2}$  miles north of Waldo, Alachua County, Fla.
361. Hogtown Creek, at old mill 2 miles northwest of Gainesville, Alachua County, Fla.
365. Johnsons Sink, 4 miles northwest of Hawthorn, Levy County, Fla.
369. Hammock west of Magnesia Springs, near Hawthorn, Alachua County, Fla.
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395. 50-foot well in Tallahassee, Leon County, Fla.
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2211. Lower bed, Alum Bluff, Liberty County, Fla.
2212. Tenmile Creek, 1 mile west of Baileys Ferry, Calhoun County, Fla.
2213. 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla.
2214. Tenmile Creek, 1 mile west of Baileys Ferry, Calhoun County, Fla.
2238. Fournoy's mill race, 2 miles east of Argyle, Walton County, Fla.
2302. 2 miles west of Tallahassee, Leon County, Fla.
2322. Sopchoppy Creek, Wakulla County, Fla.
2324. White Sulphur Springs (White Springs), Suwannee River, Hamilton County, Fla.
2380. Clay Springs, Orange County, Fla.
2564. McClelland farm, 1 mile below Baileys Ferry, Calhoun County, Fla.
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2568. Lower or "Chipola" bed at Alum Bluff, Apalachicola River, Liberty County, Fla.
2611. West bank of Suwannee River, SW.  $\frac{1}{4}$  NW.  $\frac{1}{4}$  SE.  $\frac{1}{4}$  sec. 8, T. 4 S., R. 11 E., near Dell, Lafayette County, and 15 miles south of Ellaville, Madison County, Fla.
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2646. Oak Grove, Yellow River, Okaloosa County, Fla.
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2653. "Otaheite beds," on east Blackwater Creek, 15 miles west of Oak Grove, Okaloosa County, Fla.
2675. 1 mile south of railroad bridge at Milligan, Okaloosa County, Fla.
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2868. Fuller's earth bed, Quincy, Gadsden County, Fla.
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3385. Gastropod Gulch, 4 miles southeast of Bainbridge, Decatur County, Ga.
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3396. Sam Dickens's field, 7 miles southeast of Bainbridge, Decatur County, Ga.
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3742. Shell Bluff, Shoal River, Walton County, Fla.
3747. 8 miles south of Lake De Funiak, Walton County, Fla.
3748. Summerville mill race, 1 mile east of Argyle, Walton County, Fla.
3749. Allen Senterfeit's mill, 3 or 4 miles north of Campton, Walton County, Fla.
3856. 6 miles west-northwest of Mossyhead, Walton County, Fla.
4966. 1,000 feet above Georgia, Florida & Alabama Railroad bridge over Ochlockonee River, Wakulla County, Fla.
4976. White Springs, Hamilton County, Fla.
4977. W. C. Rose's farm, West Sopchoppy, Wakulla County, Fla.
4978. Rose's Mill Creek, 3 miles west of Sopchoppy, Wakulla County, Fla.
4986. Miller's quarry, 1 mile from Ellenton, Manatee County, Fla.
4991. Ochlockonee River, 1 mile north of Holland, Leon County, Fla.
5079. One-half mile below Shell Bluff, Shoal River, Walton County, Fla.
5080. First ravine below Shell Bluff, Shoal River, Walton County, Fla.
5184. First ravine below Shell Bluff, Shoal River, Walton County, Fla.
5192. Folk's Creek, 4 miles south of Argyle, Walton County, Fla.
5193. Crowder's Crossing,  $1\frac{1}{2}$  miles below Shell Bluff, Shoal River, Walton County, Fla.
5194.  $1\frac{1}{2}$  miles below Shell Bluff, Shoal River, Walton County, Fla.
5195. First ravine below Shell Bluff, Shoal River, Walton County, Fla.
5613. Coronet phosphate mine, 5 miles southeast of Plant City, Hillsborough County, Fla.
5618.  $3\frac{1}{2}$  miles southwest of De Funiak Springs, Walton County, Fla.
5629. Coronet phosphate mine, 5 miles southwest of Plant City, Hillsborough County, Fla.
5630. 100 yards below Oak Grove Bridge, Yellow River, Okaloosa County, Fla.
5631. Oak Grove Bridge, Yellow River, Okaloosa County, Fla.
5632. Oak Grove, Yellow River, Okaloosa County, Fla.
5633. Oak Grove, Yellow River, Okaloosa County, Fla.
6175. Left bank of Suwannee River three-fourths mile above White Springs, Columbia County, Fla.
6196. Rock stratum lying immediately above fuller's earth at Ellenton, Manatee County, Fla.

6197. Limestone underlying fuller's earth at Ellenton, Manatee County, Fla.
6208. Marl underlying phosphate of Pierce Phosphate Co., Pierce, Polk County, Fla.
6209. 2½ miles southwest of Phosphate Mining Co.'s pit No. 4, Mulberry, Polk County, Fla.
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6775. Spring on left bank of Suwannee River about 100 yards above Rock Island and about half a mile above White Springs, Columbia County, Fla.
6776. Spring on left bank of Suwannee River about 100 yards above Rock Island and about half a mile above White Springs, Columbia County, Fla.
6778. Spring on left bank of Suwannee River about 100 yards above Rock Island and about half a mile above White Springs, Columbia County, Fla.
6783. Langston's Sink, about 4 miles northwest of Lake City, on road to White Springs, Columbia County, Fla.
6800. Preston Sink, 3 miles north of Waldo, Alachua County, Fla.
6801. Lochloosa Creek, near Magnesia Spring, about 3 miles west of Hawthorn, Alachua County, Fla.
7054. 400 feet below bridge, Oak Grove, Okaloosa County, Fla.
7055. Old Senterfeit mill, 4½ miles southwest of Laurel Hill, Walton County, Fla.
7148. Gastropod Gulch, 5½ miles southeast of Bainbridge, Decatur County, Ga.
7151. Tenmile Creek, Calhoun County, Fla.
7183. Alum Bluff (lower bed), Liberty County, Fla.
7256. Look and Tremble Shoals, Chipola River, Calhoun County, Fla.
7257. Sexton's marl bed, sec. 11, T. 1 N., R. 10 W., Tenmile Creek, Calhoun County, Fla.
7261. Upper Alaquia Lethu (?) Bluff, near De Funiak Springs, Walton County, Fla.
7264. De Funiak *Cardium* beds, Alaquia Creek, Walton County, Fla.
7468. Sopchoppy, Wakulla County, Fla.
7847. Lake Butler, Bradford County, Fla.
7893. Boynton Landing, Choctawhatchee River, Washington County, Fla.
9957. Gully south of the road and east of the bridge over White's Creek, on road from Eucheeanna to Knox Hill, 6.7 miles south of Argyle, 1.7 miles southeast of Eucheeanna, Walton County, Fla.
9958. Site of Flournoy's old mill, about 1¼ miles northeast of Argyle, Walton County, Fla.
9959. One-fourth mile west by north of Pleasant Ridge Church, 5.2 miles southwest of De Funiak Springs, Walton County, Fla.
9960. Folk's Creek, sec. 21 or 22, T. 3 N., R. 18 W., 6 miles south of Argyle and 1.7 miles from Eucheeanna, Walton County, Fla.
9961. Horse Creek, 1½ miles south of Oak Grove, Okaloosa County, Fla.
9994. John M. P. McClelland's farm, Chipola River, Calhoun County, Fla.
10596. Waldo Bridge over Bruce Creek, 5 miles west of Red Bay, Walton County, Fla.
10603. Gully south of the road and east of the bridge over White's Creek, on road from Eucheeanna to Knox Hill, 6.7 miles south of Argyle, 1.7 miles southeast of Eucheeanna, Walton County, Fla.
10608. White's Creek, half a mile below bridge on Eucheeanna-Knox Hill road, Walton County, Fla.
10609. The Woodyard, three-fourths mile above Shell Landing, Holmes Creek, Washington County, Fla. (lower bed).
10610. The Woodyard, three-fourths mile above Shell Landing, Holmes Creek, Washington County, Fla. (upper limestone.)
10611. White's Creek near water's edge, half a mile below bridge over creek on road from Eucheeanna to Knox Hill, 6.7 miles south of Argyle, 1.7 miles southeast of Eucheeanna, Walton County, Fla.
10612. Chester Spence's farm, 5 miles southwest of De Funiak Springs, at head of Sconter's Mill Creek, Walton County, Fla.
10658. Shell Bluff, Shoal River, 6 miles west-northwest of Mossyhead, Walton County, Fla.
10659. Tanner's mill (Old Senterfeit mill), 4 miles southwest of Laurel Hill, Okaloosa County, Fla.
10660. Lower bed, Alum Bluff, Liberty County, Fla.
10661. Godwin Bridge over Shoal River, 5 to 6 miles north-west of Mossyhead, Walton County, Fla.
10662. Lower bed, Shoal River, between Godwin Bridge and Shell Bluff, 5 to 6 miles west-northwest of Mossyhead, Walton County, Fla.
10663. Crowder's Crossing, 1½ miles below Shell Bluff, Shoal River, Walton County, Fla.
10860. Boynton Landing, 4 miles east of Miller's Ferry, Washington County, Fla.
10869. Folk's Creek, 6 miles south of Argyle, Walton County, Fla.

# THE MOLLUSCAN FAUNA OF THE ALUM BLUFF GROUP OF FLORIDA

By JULIA GARDNER

## PART IV. VENERACEA

### INTRODUCTION

This paper, the fourth of the series upon the Mollusca of the Alum Bluff group, covers the Veneracea—one of the most highly organized superfamilies of the Pelecypoda and one of the most prolific in the tropical seas. The recognized Alum Bluff species number 44. The general character of the faunas of the three formations is well exemplified in the venerids. The Chipola venerid fauna is subtropical and remarkably diversified. Over 60 per cent of the total number of species occur in this one formation. The succeeding Oak Grove carries only 10 species—less than 25 per

cent—but the individuals in the Oak Grove probably outnumber those in the Chipola. The Shoal River shows a decided increase in the number of species peculiar to the formation though the total number does not greatly exceed that of the Oak Grove. Of the 15 species represented (a little less than one-third the total number) 11 are restricted to the Shoal River.

The modernity of the Alum Bluff Veneracea is striking, with the exception of a few of the less conspicuous genera. The dominant features of the Alum Bluff venerids are those which still persist in the Floridian faunas to-day.

### Distribution of species of Veneracea in the Alum Bluff group of Florida

[r, rare; p, present; c, common; a, abundant; pr, prolific. The localities within each formation are listed in geographic order from north to south and from west to east]

	Georgia— Oak Grove sand			Florida—Chipola formation																Florida— Oak Grove sand				
	Near Bainbridge, Ga.			Boynton Landing	1 mile west of Baileys Ferry		Sexton's marl bed Tenmile Creek	1 mile below Bai- leys Ferry		Tenmile Creek	Lower bed, Alum Bluff		Quincy	2 miles west of Tallahassee		Sopchoppy Creek	Near White Springs				Oak Grove, Yel- low River			
	3386	3385	7148		2212	2214		7257.	2213		2564	3419		7151.	2211		7183	3704.	2302	395	7468.	6175	6769	4976
Dosinia (Dosinidia) chipolana Dall.....				r	p		r	p		r	?p	c	c				?c					c	p	
(Dosinidia) liogona Dall.....																								
(Dosinidia) dalli Gardner, n. sp.....																								
Clementia grayi Dall.....																	c					r		
Grateloupia (Cytheriopsis) aluminensis Dall.....												p												
Transenella utica Dall.....							r	r		r		a	p											
chipolana Dall.....																								
dasa Gardner, n. sp.....				p																				
dasa makra Gardner, n. subsp.....				p																				
santarosana Dall.....				?r																		p	r	
Gafrarium (Gouldia) erosum Dall.....																								
(Gouldia) erosum bolteni Gardner, n. subsp.....							?p	p	p			c	c									p	r	
(Gouldia) altum Dall.....				?r																		p	r	
(Gouldia) phacotum Gardner, n. sp.....																								
Macrocallista acuminata Dall.....																	?c					a	p	
(Paradione) maculata Linnaeus.....				p	c		p	c	c	c	p													
(Paradione) waltonensis Gardner, n. sp.....																								
Callocardia (Agriopoma) sincera Dall.....					c			c			p													
(Agriopoma) prosayana Gardner, n. sp.....																								
(Agriopoma) prosayana dodona Gardner, n. subsp.....																						p		
(Agriopoma) albofons Gardner, n. sp.....																								
Pitaria floridana Dall.....					p		?p	c	a	a	?p	c	?p				r	p	c	a	a			
waltonensis Gardner, n. sp.....																								
(Hysteroconcha) harrisi Maury.....								r				r												
Antigona caesarina (Dall).....					p	r																		
(Ventricola) n. sp. (?) cf. A. blandiana (Guppy).....					p	r		r	c	c		c	p	?r			p							
Chione chipolana Dall.....					p			c	c	c		p					p				c			
sp. undetermined.....																								
(Lirophora) burnsi Dall.....				r	c	c	p	c	c	c	p	c					r							
(Lirophora) burnsi discreta Gardner, n. subsp.....																								
(Lirophora) sellardsi Gardner, n. sp.....				c		p		r														r	pr	a
(Lirophora) glyptocyma Dall.....																								
(Lirophora) glyptocyma daphne Gardner, n. subsp.....																								
(Lirophora) funiakensis Gardner, n. sp.....																								
(Lirophora) trimeris Gardner, n. sp.....																								
(Lirophora) ceramota Gardner, n. sp.....																								
(Timoclea) sp. undetermined.....										r														
(Timoclea) sp. undetermined.....																								
Anomolocardia chipolana Dall.....										?r		r										r	pr	a
Venus langdoni Dall.....	?c	p	?c									a	c		c		r							
prodroma Gardner, n. sp.....			?p																					
nannodes Gardner, n. sp.....																								
Parastarte chipolana Gardner, n. sp.....										p														
Petricola (Rupellaria) sp. undetermined.....																								

## Distribution of species of Veneracea in the Alum Bluff group of Florida—Continued

	Florida—Oak Grove sand					Florida—Shoal River formation														
	Oak Grove, Yellow River	Oak Grove, Yellow River	Oak Grove, Yellow River	Oak Grove, Yellow River	Oak Grove, Yellow River	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead	6 miles west northwest of Mossyhead
	5680	5683	7054	2632	7055	3749	3856	2645	3732	3742	3731	5080	5184	5195	5079	5193	5194	3733	3748	3747
Dosinia (Dosinidia) chipolana Dall.																				
(Dosinidia) liogona Dall.		p	p	p			r			r					c	c	p	p	?p	
(Dosinidia) dalli Gardner, n. sp.							?c												r	r
Clementia grayi Dall.																				
Grateloupia (Cytheriopsis) aluminosa Dall.																				
Transenella utica Dall.																				
chipolana Dall.																				
dasa Gardner, n. sp.																				
dasa makra Gardner, n. subsp.																				
santarosana Dall.																				
Gafrarium (Gouldia) erosum Dall.																				
(Gouldia) erosum bolteni Gardner, n. subsp.																				
(Gouldia) altum Dall.																				
(Gouldia) phacotum Gardner, n. sp.																				
Macrocallista acuminata Dall.																				
(Paradione) maculata (Linnaeus).	r	r	c	r	p															
(Paradione) waltonensis Gardner, n. sp.							r			p										
Callocardia (Agriopoma) sincera Dall.																				
(Agriopoma) prosayana Gardner, n. sp.							c													
(Agriopoma) prosayana dodona Gardner, n. subsp.	r									c									?p	p
(Agriopoma) albofonsi Gardner, n. sp.																				
Pitaria floridana Dall.																				
waltonensis Gardner, n. sp.																				
(Hysteroconcha) harrisi Maury										p										
Antigona caesarina (Dall.)																				
(Ventricola) n. sp. (?) cf. A. blandiana (Guppy)																				
Chione chipolana Dall.																				
sp. undetermined																				
(Lirophora) burnsi Dall.																				
(Lirophora) burnsi discreta Gardner, n. subsp.																				
(Lirophora) sellardsi Gardner, n. sp.																				
(Lirophora) glyptocyma Dall.	c	a	a	r	p															
(Lirophora) glyptocyma daphne Gardner, n. subsp.																				
(Lirophora) funiakensis Gardner, n. sp.																				
(Lirophora) trimeris Gardner, n. sp.																				
(Lirophora) ceramota Gardner, n. sp.																				
(Timoclea) sp. undetermined																				
(Timoclea) sp. undetermined																				
Anomolocardia chipolana Dall.																				
Venus langdoni Dall.																				
prodroma Gardner, n. sp.																				
nannodes Gardner, n. sp.																				
Parastarte chipolana Gardner, n. sp.																				
Petricola (Rupellaria) sp. undetermined																				

## SYSTEMATIC DESCRIPTIONS

## Superfamily VENERACEA

## Family VENERIDAE Leach

Dall<sup>1</sup> describes this family as follows:

Valves equal, free, closed, with prosogyrous beaks, variably sculptured, with the margins more or less dentate, except in the smooth species; adductor scars peripheral, pedal distant; pallial sinus more or less sinuated; area very distinct; resilium usually external, embraced by the ligament; hinge plate developed; formula of the cardinals usually  $\frac{L\ 101010}{R\ 010101}$  with a single obsolete lateral in one valve, the cardinals frequently bifid, usually radially disposed and subequal in size, except the posterior left one, which is often obsolete or obscure; supplementary cardinals or rugosities are present in specialized forms.

Jurassic to recent fauna.

<sup>1</sup> Dall, W. H., Contributions to the Tertiary fauna of Florida, Wagner Free Inst. Sci. Trans., vol. 3, pt. 3, p. 552, 1895.

## Subfamily DOSINIINAE Dall

Dall<sup>2</sup> describes this group as follows:

This group is composed chiefly of orbicular shells with concentric sculpture, which have a large arcuate foot and long, closely united siphons. The hinge, except in *Clementia*, which is somewhat degenerate and has the hinge much reduced in relative size, has three left and four right cardinals. There are usually no posterior laterals, and the anterior laterals, when present, are usually practically obsolete.

The group recedes in time to the Eocene and has never been very abundant in species. \* \* \*

The earlier representatives of the subfamily have a corrugated area on the adjacent surfaces of the nymphs and posterior lateral teeth, and it is interesting to note that in the nepionic young of *Dosinidia*, sometimes even up to a size of 10 millimeters, this corrugation is retained, though, as the shell grows, it becomes obscure and finally disappears.

<sup>2</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1224, 1903.



Genus *DOSINIA* Scopoli

1777. *Dosinia* Scopoli, Introductio ad historiam naturalem sistens genera lapidum, plantarum et animalium, p. 398.

Type: *Chama dosin* Adanson = *Dosinia africana* Gray. (Recent, off the coast of Senegal.)

Dall<sup>3</sup> describes this genus as follows:

Animal with a large arcuate foot and closely united siphons. Complete dental formula (the posterior right cardinal, being extremely thin, is often broken off, eroded, or obsolete) L. oioioio.oio R. ioioioi.ioi. The thick middle cardinals are often bifid or excavated. Valves suborbicular, generally compressed, with a long and strong ligament seated in a groove and enfolding a heavy resilium; lunule small, impressed; escutcheon narrow, nearly linear or absent; hinge plate broad and thick; valve margins smooth; pallial sinus rather long and usually acute, anterior lateral teeth nearly obsolete and usually simple; sculpture usually of elegantly concentric grooves and interspaces, sometimes raised into lamellae at the borders of the lunule and escutcheon, crossed rarely with weak radial threads; coloration of the recent species rarely disposed in patterns and usually pale, many species being white. The periostracum is usually thin and polished.

These rather large and rotund shells are very much in evidence in the Tertiary and Recent faunas. The Recent species number about 100 and have an almost universal distribution in the temperate and warmer inshore waters.

The genus is relatively scarce in the faunas of the Alum Bluff group, a single species only having been recognized at each horizon. The three species are closely related and all referable to the section *Dosinidia*, but the differences which separate them, though slight, are constant.

Concentric lamellae sharply elevated toward the posterior margin:

Basal margin obscurely truncate.

*Dosinia (Dosinidia) chipolana* Dall.

Basal margin evenly rounded.

*Dosinia (Dosinidia) liogona* Dall.

Concentric lamellae closely appressed toward the posterior margin-----*Dosinia (Dosinidia) dalli* Gardner, n. sp.

Section *DOSINIDIA* Dall

1902. *Dosinidia* Dall, U. S. Nat. Mus. Proc., vol. 26, p. 347.

Type: *Venus concentrica* Born. Recent off the east coast from Hatteras to Aspinwall.

Dall<sup>4</sup> describes this group as follows:

Valves suborbicular, more or less compressed, white, with a sculpture of concentric grooving, the interspaces never lamellose; furnished with an obvious periostracum; lunule small, impressed; escutcheon absent; pallial sinus ample, ascending, angular in front; middle cardinals broad, sulcate or bifid, anterior lateral small, feeble, smooth.

This group is confined to the tropical and warmer temperate waters of America, where it replaces all the other sections of the genus. The nepionic young have the posterior cardinals corrugated and there are obscure traces of a posterior lateral, but these characteristics are soon lost and leave no traces in the adult.

*Dosinia (Dosinidia) chipolana* Dall

Plate XXIV, Figure 1

1903. *Dosinia (Dosinidia) chipolana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1229, pl. 54, fig. 4.

Dall describes this species as follows:

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 toward 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 36.5, length 39.0, diameter 17.0 millimeters.

The nepionic young of this species have very much the form of the adult and are usually sculptured in much the same way.

Type: U. S. Nat. Mus. No. 114576.

Type locality: No. 2211, Alum Bluff (lower bed), Liberty County, Fla.

A few juveniles with the concentric sculpture uniformly developed over the entire valve occur in the marl at Tenmile Creek. They probably represent a distinct and undescribed species. The Chipola species is relatively broader than *D. liogona* from the Oak Grove or *D. dalli* from the Shoal River. The character of the sculpture and dentition is similar to that of the former. *Dosinia chipolana* Dall is common at Alum Bluff and fairly well represented at other localities in the marl. The individuals from Sopchoppy are casts but apparently identical with those from Chipola River.

Occurrence: Chipola formation, localities 7893<sup>r</sup>, 2212<sup>p</sup>, ?7257<sup>r</sup>, 2213<sup>p</sup>, 3419<sup>r</sup>, ?7151<sup>p</sup>, 2211<sup>c</sup>, 7183<sup>c</sup>, ?7468<sup>c</sup>.

*Dosinia (Dosinidia) liogona* Dall

Plate XXIV, Figure 2

1903. *Dosinia (Dosinidia) liogona* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1230, pl. 54, fig. 11 (in part).

Dall describes this species as follows:

Shell much resembling the last, from which it differs by the less convex posterior dorsal margin; smooth or feebly sculptured beaks, sculpture rising into sharp, fine lamellae toward the ends of the shell, smaller adductor scars, narrower hinge plate, and different form of the nepionic young. Height 45, length 48, diameter 18 millimeters.

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.

Type: U. S. Nat. Mus. No. 135891.

Type locality: No. 2646, Oak Grove, Yellow River, Okaloosa County, Fla.

The sharp elevation of the concentric lamellae as well as the less evenly rounded umbonal area serve

<sup>3</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1227, 1903.

<sup>4</sup> Idem, p. 1229.

to separate the Oak Grove species from *D. dalli* Gardner, n. sp. of the Shoal River.

A new species closely allied to *D. liogona* but too imperfect to describe occurs at Folks Creek, 4 miles south of Argyle. It differs from the Oak Grove species in the larger, relatively higher, and more inflated valves.

- Occurrence: Oak Grove sand, localities 2646°, 5632°, 5633°, 7054°, 2652°.

***Dosinia* (*Dosinidia*) *dalli* Gardner, n. sp.**

Plate XXIV, Figures 3-5

Shell of moderate dimensions, suborbicular, compressed. Posterior and basal margins evenly rounded. Anterior extremity slightly produced. Umbones rather full, acutely pointed at the tips, incurved and prosogyrate; lunule narrow, cordate, delimited by an impressed line, smooth excepting for incrementals. Escutcheon not defined. Outer surface sculptured with clean-cut, closely appressed lamellae, regularly spaced over the medial portion of the valve, irregular at the umbones and toward the basal margin of the adults. Hinge plate moderately broad and heavy. Ligament groove deep. First anterior cardinal laminar, separated from the one behind it by a deep and narrow groove; second anterior cardinal flattened upon its anterior surface; only one posterior cardinal developed and that rather slender and sulcate; the other posterior cardinal indicated by the slight elevation of the hinge plate behind the posterior groove. Muscle scars large. Pallial sinus broad, angular, ascending, the apex of the angle in a line with the tips of the umbones and about halfway from the umbones to the basal margin.

Dimensions: Altitude, 31.5 millimeters; latitude, 33.0 millimeters; diameter, 12.5 millimeters.

Type and paratype: U. S. Nat. Mus. No. 352540,

Type locality: No. 5193, Crowders Crossing, half a mile below Shell Bluff, Shoal River, Walton County, Fla.

*Dosinia dalli* Gardner, n. sp., is very closely related to *D. liogona* Dall, and the young of the two species are practically inseparable; both of them are higher relatively and have more prominent umbones than the young of *D. chipolana* Dall. The adult *D. dalli* are more evenly rounded at the posterior margin than the adult *D. liogona*, the sculpture is appressed rather than elevated, particularly toward the posterior margin, and the pallial sinus is, as a rule, more steeply ascending.

Occurrence: Shoal River formation, localities 3856°, 3742°, 5079° (young abundant), 5193°, 5194°, 3733°, 3748°, 7264°, 5192°, 5618°, 9959°; Aldrich collection.

**Genus *CLEMENTIA* Gray, 1847**

1840. *Clementia* Gray, Synopses of the contents of the British Museum, 42d ed., p. 149 (nomina nuda).

1842. *Clementia* Gray, idem, 44th ed., p. 75. "The *Tapes* and *Venerupes* have oblong shells with very compressed teeth, and the *Clementia* are like the latter but are very thin and have a cavity in the margin before and behind the teeth." (No type selected.)

1847. *Clementia* Gray, Zool. Soc. London Proc., 1847, p. 184.

Type: *Venus papyracea* Gray in Wood's Supplement, Index testaceologicus, 1828. (Recent in the South Pacific.)

Only two copies of Gray's Synopses are known—one of them in the possession of the British Museum, the other in the South Kensington Museum. The Synopsis of 1840 is merely a check list of the contents of the cases in the British Museum and certainly gives no standing to the names first used in it. In the Synopsis of 1842 no types or examples are given, and the short comparative discussion does not seem to be a sufficient foundation for the erection of a genus. If the second Synopsis is thrown out *Clementia* dates from 1847.

Dall<sup>5</sup> describes this genus as follows:

Shell thin, inflated, with prominent beaks, a ligament external and enfolding the resilum and extending slightly in front of the beaks; the anterior left and two posterior right hinge teeth more or less bifid; there are no lateral teeth; the pallial sinus is long, angular, narrow, ascending; valve margins entire, and the valves delicately sculptured, concentrically striate or undulate, sometimes with oblique decussating striae.

The Recent species are restricted to the Indo-Pacific and west American waters.

There is a single well-established species in the Alum Bluff, with possibly a closely allied form represented by very imperfect material.

***Clementia grayi* Dall**

Plate XXIV, Figure 6

1900. *Clementia grayi* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1193, pl. 37, fig. 12.

1903. *Clementia grayi* Dall, idem, pt. 6, p. 1236.

Dall described this species in 1903 as follows:

Shell thin, convex, rude, concentrically coarsely and irregularly striated, near the beaks concentrically undulated, without lunule or escutcheon; 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 millimeters.

This fine species is not unlike the *C. vatheletii* Mabilie, living in Korea. The only recent species now known to inhabit American waters is *C. solida* Dall, from the west coast of Mexico; the *C. subdiaphana* Carpenter, recent and fossil in California, is not a member of this genus, and the *C. gracillima* Carpenter is unidentifiable and founded on a nepionic shell which has not assumed adult characters.

Type: U. S. Nat. Mus. No. 107381.

Type locality: No. 2646, Oak Grove, Yellow River, Okaloosa County, Fla.

<sup>5</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1235, 1903.

The type, which, except for a couple of fragments, is unique in the Oak Grove sand, is much larger than any of the individuals from Sopchoppy (Chipola formation) or from the Shoal River formation, but there are no other characters by which they may be separated. Apparently, too, the young shells are much thinner, for although the interior of the type is smooth the fragment of an immature shell from Oak Grove and the other forms mentioned are all concentrically undulated in harmony with the external sculpture. The casts from Sopchoppy and some of the specimens from the Shoal River beds have the typical transversely ovate, posteriorly truncate outline, but there are others from the environs of Mossyhead which, from the imperfect specimens at hand, appear to be relatively higher and less elongated transversely. The specimens are, however, too poorly preserved to warrant description.

Occurrence: Chipola formation, locality 7468°. Oak Grove sand, locality 2646°. Shoal River formation, localities ?3856°, ?5079°, 5194°, ?5192°.

#### Subfamily MERETRICINAE Dall

Dall<sup>6</sup> describes this group as follows:

This great group contains a large proportion of the Veneridae and many of the more elegant and beautiful forms. They are characterized in general by a smooth or concentrically sculptured surface, often with a vernicose periostracum; smooth inner margins to the valves; a single anterior lateral lamella in the left valve, received in a pit or between two less conspicuous lamellae in the opposite valve; three cardinal teeth in each valve, of which some may be grooved or bifid; the lunule circumscribed and defined by an incised line, the escutcheon not defined or circumscribed except sometimes by color markings or the absence of surface sculpture; the ligament is external though sometimes depressed, the pallial sinus varying from almost obsolete to deep and angular; siphons of moderate length with papillose orifices, the tubes united for a great part of their length; the margin of the mantle largely free, more or less papillose; the foot large, hatchet-shaped, not byssiferous. The nymphs and adjacent teeth are sometimes corrugated, and the posterior right and anterior left dorsal margins of the valves beyond the hinge plate are often grooved to receive the beveled edge of the valve opposite. The shells are always porcellaneous. Many names have been given to the different mutations of the type, of which some among the most familiar, as *Dione*, *Callista*, *Caryatis*, and *Cytherea*, are preoccupied in other cases.

The forms which are precursors occur as early as the Cretaceous, and even possibly in the Jura, but most of these early forms are not typical, and the genera really begin to assume typical form only in the Eocene.

It is known from the researches of Bernard that the anterior and posterior teeth of the same valve are originally continuous laminae; thus the superior lamina of the left valve breaks up into the posterior cardinal and the anterior lateral, while the inferior lamina divides to form the two other cardinals of that valve. Ordinarily, the primary connections are lost sight of in the adult, and the cardinal teeth appear to spring from an imaginary center under the hinge margin above them. In certain groups, such as *Callocardia*, *Atopodonta*, or *Veneriglossa*, however, the anterior and posterior right cardinals remain connected as well as the anterior and middle left cardinals, and

when the valves are closed the former are inserted above the latter and between them and the hinge margin, while the middle right cardinal fits in below the united pair of the left valve, thus giving an odd look to the hinge, the reason for which requires some study to recognize. As a whole the *Meretrix* group represents an earlier type than typical *Venus* and one with somewhat more archaic hinge characters. Of these *Callocardia* is unquestionably the least developed.

Owing to the weight of other characters and the fact that no linear arrangement can adequately represent the intricate relationship of such a group as the Veneridae, I have not placed *Callocardia* at the head of the subfamily, but rather at the head of the portion of the series following *Meretrix*, to which it seems, by other characters, to be allied. It may be well, however, to contrast the hinge characters that their features may be clearly understood.

The subfamily as a whole is distinguished from the Veneridae by the invariable presence of one or more anterior lateral teeth. This tooth, when there is but one, is on the hinge plate of the left valve and is received into a pit, or between two much more feeble anterior laterals in the right valve. In such groups as *Cytherea* Boltzen the anterior lateral is degenerate, and in senile specimens nearly obsolete, but traces of it may always be detected in youthful or normal adult specimens.

#### Genus GRATELOUPIA Desmoulins

1828. *Grateloupia* Desmoulins, Soc. linnéenne de Bordeaux Bull., vol. 2, p. 243.

Type: *Donax irregularis* Basterot. (Miocene of Bordeaux.)

Dall<sup>7</sup> defines this genus as follows:

Valves elongate oval, concentrically striate; three cardinals in each valve, the posterior right cardinal fused with the nymphal rugosities; the pallial sinus long and acute, reaching to the vertical of the anterior lateral lamina.

The Tertiary *Grateloupia* is apparently the precursor of *Tivela*, a not inconspicuous group in the Recent tropical and subtropical seas.

The genus has only a single representative in the Alum Bluff and that restricted to the type locality at Alum Bluff.

#### Subgenus CYTHERIOPSIS Conrad

1865. *Cytheriopsis* Conrad, Am. Jour. Conchology, vol. 1, p. 146.

Type: *Cytherea hydana* Conrad = *Grateloupia moulinsi* Lea. (Eocene (Claiborne group) of Alabama.)

The subgenus is characterized by the trigonal outline, the fusing of the left posterior cardinal with the nymphal rugosities, and the short, rounded pallial sinus.

#### *Grateloupia* (*Cytheriopsis*) *alumensis* Dall

Plate XXV, Figure 1

1903. *Grateloupia* (*Cytheriopsis*) *alumensis* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1239, pl. 52, fig. 14.

Dall describes this species as follows:

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

<sup>6</sup> Dall, W. H., Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, pp. 1236-1238, 1903.

867196 (1)-50--2 (142-1)

<sup>7</sup> Dall, W. H., Synopsis of the family Veneridae and of the North American Recent species: U. S. Nat. Mus. Proc., vol. 26, p. 348, 1902.

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 millimeters, of the younger but better preserved valve figured 15, height 12.5, diameter 8.0 millimeters; diameter of adult 20.0, height 32.0 millimeters.

This species is easily distinguished from *G. hydana* by its more equilateral, trigonal form, smoother surface, and more ample sinus.

Type: U. S. Nat. Mus. No. 114609.

Type locality: No. 2211, lower bed at Alum Bluff, Liberty County, Fla.

The species is restricted in its known distribution to the type locality.

Occurrence: Chipola formation, locality 2211P.

#### Genus TRANSENNELLA Dall

1883. *Transennella* Dall, U. S. Nat. Mus. Proc., vol. 6, p. 340.

1903. *Transennella* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1240.

Type: *Transennella conradina* Dall. (Recent from Hatteras to Key West.)

Dall describes this genus in 1883 as follows:

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 shell, the grooves turning upward at the ends, while on each side 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 analog to such sculpture known to me occurs on the outside of such Lucinidae as the Lamarckian *L. divaricata*, *Woodia*, and some Nuculidae 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 as 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*.

In 1903 Dall adds:

Shell small, trigonal, with lively coloration; smooth and polished or concentrically striate; hinge with three cardinals in each valve, the middle left cardinal bifid; an elongated anterior lateral in the left valve, received in a sulcus in the right valve; lunule defined by an incised line, escutcheon not defined; nymphs without rugosities; pallial sinus angular, free below, obliquely ascending; internal margins of the valves sharply tangentially grooved with numerous sulci. \* \* \*

This group makes its first appearance in the Oligocene, since which it has been a characteristic American type. The well-developed typical species, so far as yet known, are all members of the Atlantic fauna.

*Transennella* is rather an inconspicuous genus in the faunas of the Alum Bluff group. It has not been observed in any of the collections from the Shoal River formation, and in the Oak Grove sand it is known by only a single and not at all common species. Of the four Chipola species and subspecies only one is

common—*Transennella utica* Dall—and this is restricted in its known distribution to the environs of the type locality at Alum Bluff.

Shell transversely ovate in outline, produced and sharply nasute posteriorly; sculpture obsolete on the medial portion of the disk-----*Transennella utica* Dall.

Shell ovate-trigonal or trigonal in outline, little or not at all produced posteriorly; sculpture not obsolete on the medial portion of the disk:

Outline ovate-trigonal; concentric sulci fine and sharp over the entire disk-----*Transennella chipolana* Dall.

Concentric sulci relatively coarse:

Altitude closely approximating the latitude.

*Transennella dasa* Gardner, n. sp., s. l.

Outline conspicuously *Chione*-form.

*Transennella dasa* Gardner, n. sp., s. s.

Outline rounded, trigonal.

*Transennella dasa makra* Gardner, n. subsp.

Altitude perceptibly lower than the latitude; outline rounded trigonal----*Transennella santarosana* Dall.

#### *Transennella utica* Dall

Plate XXV, Figure 2

1903. *Transennella utica* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1240, pl. 57, fig. 12.

Dall describes this species as follows:

Shell small, only moderately convex, subtrigonal, inequilateral, polished, with shallow, concentric sulci, less marked in the center of the disk, diminishing in number and increasing in strength toward 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 defined; 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 6.0, height 4.5, diameter 2.5 millimeters, 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.

Type: U. S. Nat. Mus. No. 114590.

Type locality: No. 2211, lower bed (Chipola formation) at Alum Bluff, Liberty County, Fla.

Environmental conditions at Alum Bluff seem to have been peculiarly favorable to this small bivalve. At the single locality it is quite abundant and exhibits a wide degree of variation. Elsewhere in the Chipola formation it is extremely rare.

Occurrence: Chipola formation, localities 2213<sup>r</sup>, 3419<sup>r</sup>, 2211<sup>a</sup>, 7183<sup>p</sup>.

#### *Transennella chipolana* Dall

Plate XXV, Figure 3

1903. *Transennella chipolana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1241, pl. 57, fig. 6.

Dall describes this species as follows:

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 4.8, height 4.0, diameter 2.0 millimeters.

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.

Type: U. S. Nat. Mus. No. 109230.

Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla.

This small form is best characterized by the fineness and regularity of the concentric sculpture.

Occurrence: Chipola formation, localities 7257<sup>r</sup>, 2213<sup>r</sup>, 3419<sup>p</sup>.

***Transennella dasa* Gardner, n. sp.**

Plate XXV, Figures 4-5

Shell small, thick, solid, moderately inflated, trigonal in outline, conspicuously *Chione*-form. Umbones well rounded, prominent, subcentral in position, the acute tips incurved and prosogyrate. Lunule large, elongate cordate, outlined by a shallow sulcus. Escutcheon not defined. Anterior margin little or not at all bowed in front of the lunule. Posterior margin steeply declining, produced and nasute ventrally. Base line straight or feebly arcuate. External surface sulcate from the umbones to the base, the sulci finer and closer on the posterior area, more distant anteriorly than medially. Hinge heavy, normal; anterior and medial right cardinals laminar; posterior cardinal feebly sulcate; socket for the reception of the left anterior lateral very deep; anterior and posterior left cardinals simple and laminar, the middle cardinal feebly bifid; anterior left lateral short but very prominent. Adductor scars relatively large, subovate, the anterior set higher than the posterior. Pallial line distinct, remote from the margin; pallial sinus rather short, broad, quite steeply ascending. Marginal grooves few in number, running at an angle to the posterior lateral margins, subparallel to the basal and anterior margins.

Dimensions: Right valve: Altitude, 4.3 millimeters; latitude, 4.8 millimeters; semidiameter, 2.0 millimeters. Left valve: Altitude, 4.8 millimeters; latitude, 5.2 millimeters; semidiameter, 1.75 millimeters.

Cotypes: U. S. Nat. Mus. No. 352551.

Type locality: No. 7893, Boynton Landing, Choctawhatchee River, Washington County, Fla.

*Transennella dasa* is remarkable for its small, heavy shell and trigonal outline. The subspecies *T. dasa makra* is larger and less angular, and individuals of the same size as *T. dasa* do not bear the same evidences of maturity in the impressed muscle scars and the tendency toward a thickening of the shell along the area of the attached mantle.

Occurrence: Chipola formation, locality 7893<sup>p</sup>.

***Transennella dasa makra* Gardner, n. subsp.**

Plate XXV, Figure 6

Shell small, moderately inflated, rounded trigonal in outline, the altitude closely approximating the latitude. Umbones full and smoothly rounded, subcentral, the tips acute and prosogyrate. Lunule rather large, elongate, cordate, defined by a shallow sulcus and the obsolescence of the concentric sculpture. Escutcheon not defined. Anterior extremity bowed in front of the lunule. Posterior margin feebly arcuate, rounding rather sharply into the base. Ventral margin approximately horizontal posteriorly and medially, strongly upcurved anteriorly. External surface concentrically sulcated, the sulci finer and closer posteriorly. Hinge normal; the anterior and medial right cardinals laminar; the posterior right cardinal feebly sulcate; the anterior and posterior left cardinals laminar; the medial left cardinal feebly sulcate. Adductor scars relatively large, distinct. Pallial line remote from the margin; pallial sinus broad, rather steeply ascending, very obtuse at the extremity. Marginal sulci very few in number, subparallel to the margin posteriorly and ventrally, oblique to the margin anteriorly.

Dimensions: Altitude, 5.3 millimeters; latitude, 6.0 millimeters; semidiameter, 1.5 millimeters.

Type: U. S. Nat. Mus. No. 352552.

Type locality: No. 7893, Boynton Landing, Choctawhatchee River, Washington County, Fla.

*Transennella dasa makra* Gardner, n. subsp., may quite possibly prove to be specifically distinct. In spite of its larger size it is not so heavy as *dasa* and much less angular. Some of the individuals very closely approach *T. santarosana* Dall, but they are higher relatively and the umbones are more strongly and smoothly rounded.

Occurrence: Chipola formation, locality 7893<sup>p</sup>.

***Transennella santarosana* Dall**

Plate XXV, Figure 7

1903. *Transennella santarosana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1241, pl. 57, fig. 13.

Dall describes this species as follows:

Shell small, plump, subtrigonal, polished, and sculptured with numerous slightly irregular concentric sulci; beak 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 millimeters.

This is easily distinguished from *T. chipolana* by its less sharp and crowded sculpture and its more convex valves.

Type: U. S. Nat. Mus., No. 135890.

Type locality: No. 2646, Oak Grove, Yellow River, Okaloosa County, Fla.

*Transennella santarosana* approaches *T. dasa makra* Gardner, n. subsp., but it is not so high relatively,

and the umbones are not so full. A single valve from Boynton Landing is doubtfully referred to this species. The sculpture is much more feeble posteriorly than is normal for the group, and there is a fine secondary striation discernible which may or may not be fortuitous.

Occurrence: Chipola formation, locality ?7893<sup>r</sup>. Oak Grove sand, localities 2646<sup>p</sup>, 5632<sup>r</sup>.

#### Genus GAFRARIUM Bolten

1798. *Gafrarium* Bolten, Museum Boltenianum, part 2, p. 176.

Type: *Venus pectinata* Linnaeus. (Recent in the Indo-Pacific.)

Shell rather small but heavy, transversely oval or subtrigonal, equivalve, subequilateral. Umbones low, not conspicuous. External sculpture concentric, radial, or reticulate. Lunule and escutcheon fairly well differentiated. Ligament external, seated on a nymph. Hinge of each valve furnished with three simple or feebly sulcated cardinals; anterior lateral of left valve received between lamellae of right. Adductor impressions rounded or somewhat elongate. Pallial line simple or sinuated; inner margins smooth or denticulate.

The genus has been reported from the Mesozoic, but the determinations are dubious. It undoubtedly occurs, however, in both the American and European Tertiary. The living species are, in the main, oriental.

The distribution of the genus in the Alum Bluff group is unequal. In the Chipola formation there is only a single species and subspecies, but they are common. In the Oak Grove sand there is a closely allied less common form and another species too imperfect to describe but allied to the rare *G. phacotum* of the Shoal River formation, the single representative of *Gafrarium* at the horizon. The Chipola species, *G. erosum* Dall, is doubtless the forerunner of *G. metastriatum* Conrad, which is so common in the later Tertiary of the Carolinas and Florida.

Radial sculpture very fine, commonly obsolete:

Latitude of shell perceptibly greater than the altitude.

*Gafrarium (Gouldia) erosum* Dall, s. l.

Concentric sculpture persistent on the umbonal area and the medial portion of the disk.

*Gafrarium (Gouldia) erosum* Dall, s. s.

Concentric sculpture obsolete on the umbonal area and the medial portion of the disk.

*Gafrarium (Gouldia) erosum bolteni* Gardner, n. subsp.

Latitude of shell approximately equal to the altitude.

*Gafrarium (Gouldia) altum* Dall.

Radial sculpture fine but distinct on the lateral areas; concentric sculpture reduced to incrementals.

*Gafrarium (Gouldia) phacotum* Gardner, n. sp.

#### Subgenus GOULDIA C. B. Adams

1847. *Gouldia* C. B. Adams, Catalogue of genera and species of Recent shells in collection of C. B. Adams, p. 29.

Type: *Gouldia cerina* C. B. Adams. (Recent from Hatteras to the Barbados.)

*Gouldia* is characterized by the reticulate sculpture, the greater prominence of the radial striations toward the anterior and posterior margins of the valves, the simple cardinals, the slightly sinuous pallial line, and the nondenticulate inner margins.

All the recognized Alum Bluff species of *Gafrarium* are referable to the subgenus *Gouldia*.

#### *Gafrarium (Gouldia) erosum* Dall

Plate XXV, Figure 8

1903. *Gafrarium (Gouldia) erosum* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1248, pl. 57, fig. 10.

Dall describes this species as follows:

Shell rounded trigonal, rather thin, subcompressed, the surface finely, evenly, closely, concentrically sulcate, with a few almost microscopically minute radial striulae 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 7.3, height 6.2, diameter 4.0 millimeters.

This species is especially characterized by its fine, even, concentric sculpture and nearly total absence of radial striae.

Type: U. S. Nat. Mus. No. 114721.

Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla.

The larger, less compressed forms, in which the concentric sculpture does not persist across the disk until the adult stages, have been segregated under the subspecies *bolteni*.

Occurrence: Chipola formation, localities 2213<sup>p</sup>, 2564<sup>p</sup>, 2211<sup>c</sup>, 7183<sup>c</sup>.

#### *Gafrarium (Gouldia) erosum bolteni* Gardner, n. subsp.

Plate XXV, Figure 9

Shell rather small, moderately compressed, rudely trigonal in outline. Posterior dorsal margin more produced and more steeply declining than the anterior; anterior lateral margin broadly rounding into the upcurved base; posterior lateral margin obtusely truncate. Umbones small, sharply rounded, and feebly prosogyrate at their tips, slightly anterior in position. Lunule elongate, lanceolate, delimited by an incised line and the abrupt disappearance of the discal sculpture. Escutcheon obscurely defined by an obtuse ridge and by the partial disappearance of the sculpture. External surface finely grooved concentrically toward the lateral and ventral margins, smooth in the umbonal region and on the medial portion of the disk; microscopically fine radial striae usually developed upon the lateral areas. Dentition normal for the group. Laminar anterior and posterior cardinals and a cuneate medial cardinal in each valve, a well-developed anterior lateral in the left and a double socket to receive it in the right; posterior



dorsal margins grooved and ridged to function as laterals. Anterior muscle scar rather small, subcircular; posterior muscle scar larger, somewhat oblong. Pallial line distinct. Sinus very shallow. Inner margins smooth.

Dimensions: Right valve: Altitude, 4.5 millimeters; latitude, 4.8 millimeters; semidiameter, 0.9 millimeter. Left valve: Altitude, 5.0 millimeters; latitude, 5.3 millimeters; semidiameter, 1.0 millimeter.

Cotypes: U. S. Nat. Mus. No. 352554.

Type locality: No. 3419, McClelland farm, 1 mile below Baileys Ferry, Calhoun County, Fla.

The subspecies runs smaller and is less compressed than *G. erosum* s. s. The concentric sculpture is not developed until the adolescent stages and persists across the disk only in the adult. Consequently the umbonal region is smooth and there is a bare patch upon the medial portion of the shell.

Occurrence: Chipola formation, localities 7257<sup>p</sup>, 2213<sup>p</sup>, 3419<sup>c</sup>, 7151<sup>p</sup>.

***Gafrarium (Gouldia) altum* Dall**

Plate XXV, Figure 10

1903. *Gafrarium (Gouldia) altum* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1249, pl. 57, fig. 5.

Dall describes this species as follows:

Shell small, high, rounded trigonal, the beaks small but prominent and rather pustular than pointed; surface with faint, irregular, concentric striae and wrinkles; toward 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 millimeters.

This species is characterized chiefly by its small size, irregular and feeble sculpture, and wide sinuation of the pallial line.

Type: U. S. Nat. Mus. No. 135892

Type locality: No. 2646, Oak Grove, Yellow River, Okaloosa County, Fla.

The individuals from Boynton Landing are all immature, but in relative dimensions they approach much more closely to *G. altum* than to the common Chipola species *G. erosum* Dall.

Occurrence: Chipola formation, locality 7893<sup>r</sup>. Oak Grove sand, localities 2646<sup>p</sup>, 5632<sup>r</sup>.

***Gafrarium (Gouldia) phacotum* Gardner, n. sp.**

Plate XXV, Figure 11

Shell small, subequilateral, lentiform, quite highly polished within. Umbones well rounded, not very prominent, their tips acute and prosogyrate. Lunule narrow, elongate-cordate, defined by an incised line. Escutcheon not differentiated. Anterior dorsal margin declining a little more steeply than the posterior; lateral margins arcuate, rounding smoothly into the arcuate base. External surface sculptured anteriorly with feeble radials, nine in the type, least feeble toward the margin and altogether obsolete toward

the umbones; concentric sculpture developed only in the form of incrementals; a well-defined concentric color banding also preserved. Cardinals three in each valve, radiating fanlike from beneath the umbones; the anterior and posterior cardinals laminar, the medial cuneiform; anterior lateral of left valve small, received between the clasping laminae of the right. Adductor scars relatively large, the anterior more elongated and set a little higher than the posterior. Pallial line remote from the base; pallial sinus indicated merely by a dent in the pallial scar. Inner margins with a couple of *Transennella*-like grooves, which are, however, parallel to the margin throughout their extent.

Dimensions: Altitude, 3.2 millimeters; latitude, 3.0 millimeters; diameter, 1.2 millimeters.

Type: U. S. Nat. Mus. No. 352553.

Type locality: No. 7264, De Funiak "*Cardium* beds," Alaquá, Walton County, Fla.

These small shells are apparently not fully mature, but they are the only representatives of the species in rather extensive collections. They are furthermore so strongly and uniquely characterized by the subcircular compressed valves and the radial wrinkling toward the anterior margin that they can scarcely be disregarded in a monographic study. A single valve of a new but closely allied species was collected in the Chipola formation. It differs from *G. phacotum* in the strong concentric sculpture on the ventral portion of the shell.

Occurrence: Shoal River formation, localities 7261<sup>r</sup>, 7264<sup>r</sup>, 5618<sup>r</sup>.

**Genus *MACROCALLISTA* Meek**

1876. *Macrocallista* Meek, U. S. Geol. and Geog. Survey Terr. Rept., vol. 9, p. 179.

Type: *Venus gigantea* Gmelin = *Venus nimbosa* So-lander. (Pliocene and Pleistocene of the Carolinas and Florida; Recent on the east coast from Hatteras to the Florida Keys and west to Texas.)

Dall<sup>\*</sup> describes this genus as follows:

Shell ovate, solid, porcellaneous, microscopically radially lined, polished, smooth or concentrically waved, usually with a vivid coloration and vernicose periostracum; lunule definitely limited, unequally divided, the right portion slightly larger, internal margins smooth; pallial sinus ample, pointed in front; left anterior and right posterior dorsal margins grooved to receive the edge of the other valve; the anterior laterals and three cardinal teeth present in each valve, the right posterior cardinal more or less distinctly grooved or bifid.

The genus includes a considerable number of large and very attractive Tertiary and Quaternary species, inhabitants chiefly of the warmer seas.

*Macrocallista* has three representatives in the Alum Bluff group, and one of them, *M. maculata* (Linnaeus), is present apparently at all three horizons and still persists along the east coast from Hatteras to the West

<sup>\*</sup> Dall, W. H., Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1252, 1903.

Indies. *M. maculata* has not been recognized, however, in the typical Shoal River but only in the collection from De Funiak Springs, an assemblage remarkable for its many peculiar features. The characteristic Shoal River species, *M. waltonensis*, is allied to *M. maculata* and is probably an offshoot from it. The remaining species, *M. acuminata* Dall, is more closely allied to a Ballast Point species and is its possible descendant.

Altitude approximately two-thirds the latitude; dorsal areas outlined by a well-defined keel. *Macrocallista acuminata* Dall. Altitude more than two-thirds the latitude; dorsal areas not sharply defined:

Posterior dorsal margin feebly arcuate; pallial sinus angulated at its extremity.

*Macrocallista (Paradione) maculata* Linnaeus.

Posterior dorsal margin oblique; pallial sinus broadly rounded at its extremity.

*Macrocallista (Paradione) waltonensis* Gardner, n. sp.

#### **Macrocallista acuminata Dall**

Plate XXIV, Figure 7

1903. *Macrocallista acuminata* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1255, pl. 57, fig. 3.

1915. *Macrocallista (Paradione) acuminata* Dall, U. S. Nat. Mus. Bull. 90, pl. 24, fig. 2 (other figures excluded).

In 1903 Dall described this species as follows:

Shell smooth, polished, with faint indications of incremental lines, very inequilateral; the beaks at the anterior fourth or nearly so; the lunule narrowly cordate, impressed, not sharply circumscribed; anterior end rounded, base evenly arcuate; shell sometimes a little rostrate near the posterior end; posterior dorsal slope slightly arcuate; posterior end elongated, rather sharp; hinge normal; pallial sinus nearly horizontal, pointed behind, in the young reaching forward more than half the length of the shell. Length 27.5, height 16.5, diameter 9 millimeters. Fully adult specimens, according to fragments obtained, reach a length of 80 millimeters.

This species is not unlike *M. reposta* Conrad of the Miocene but is more inequilateral and more acute behind. It probably does not attain the size of the Miocene form, which is often 120 millimeters in length and appears to have a shorter pallial sinus and a more elongate and distant anterior lateral tooth.

Type: U. S. Nat. Mus. No. 114631.

Type locality: No. 2211, lower bed (Chipola formation) at Alum Bluff, Liberty County, Fla.

*Macrocallista acuminata* is much compressed, as compared with other species of the genus and is strongly produced posteriorly. The individuals from the "silex beds" of Ballast Point which have been listed under this species are smaller, more inflated, and not so sharply rostrate behind. The species is restricted in its known distribution to the beds at Alum Bluff.

Occurrence: Chipola formation, localities 2211°, 7183°, 7468°.

#### **Section PARADIONE Dall**

1909. *Paradione* Dall, Malacological Soc. London Proc., vol. 8, p. 197.

1886. *Chionella* Cossmann, Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris, vol. 1, p. 105.

Not *Chionella* Swainson, Treatise on malacology, p. 335 (footnote), 1840.

Type: *Cytherea ovalina* Lamarck. (Calcaire grossier of the Paris Basin.)

Dall<sup>9</sup> describes this section as follows:

Shell ovate-trigonal, the posterior cardinals short, the pallial sinus reaching to the middle of the shell, or nearly. \* \* \*

In the recent species, like *Venus chione*, the sinus is nearly horizontal, its apex pointing below the anterior adductor scar; in the Eocene species it is more elevated, and in *C. ovalina*, which Fischer selected as type (Cossmann having mentioned no type), it points to the upper margin of the anterior scar. But this distinction seems insufficient to base any further subdivision upon. In a general way this section differs from *Macrocallista* proper in being shorter and more trigonal, the other characters mentioned being functions of the difference in form.

#### **Macrocallista (Paradione) maculata (Linnaeus)**

1758. *Venus maculata* Linnaeus, Systema naturae, 10th ed., p. 686.

1767. *Venus maculata* Linnaeus, idem, 12th ed., vol. 1, p. 1132.

1818. *Cytherea maculata* Lamarck, Histoire naturelle des animaux sans vertèbres, vol. 5, p. 566.

1838. *Chione maculata* Gray, Analyst, vol. 8, p. 306.

1857. *Cytherea? (Meretrix) dariena?* Conrad, U. S. Pacific R. R. Expl., vol. 6, pt. 2, p. 72, pl. 5, fig. 21.

Not *Meretrix dariena* Conrad, Appendix to the preliminary geological report of W. P. Blake, 33d Cong., 1st sess., Ex. Doc. 129, p. 18, 1855.

Not *Meretrix dariena* Conrad, U. S. Pacific R. R. Expl., vol. 5, appendix, p. 328, pl. 6, fig. 55, 1855.

1881. *Callista maculata* Gabb, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 8, p. 344.

1903. *Macrocallista (Chionella) maculata* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1256.

Linnaeus described this species in 1758 as follows:

V. testa cordata laevi; maculis exoletis sparsis. \* \* \*

Habitat in O. Americano.

Dall in 1903 says:

This is one of the most elegant species of the group, and after careful study I have been unable to find any constant characters which would serve to separate the Oligocene [Miocene] from the recent shell. The Chipola specimens average smaller than the recent ones, and the Costa Rica fossils are shorter in proportion than the average of those now living, but both features may be accidental and are paralleled by recent individuals examined. During the cold Miocene epoch this species migrated to more congenial seas but returned with the milder Pliocene and has since remained on our coasts. Conrad named two species *Meretrix dariena*, one of which is identified with this by Gabb, and I think correctly, the other being a *Clementia* already discussed in this memoir. (See p. 1235.)

In *M. maculata* the pallial sinus is ample and rises more from the horizontal than in the species previously mentioned, but not as high as in the Parisian forms. It is variable in acuteness, some specimens having the anterior part pointed, others linguiform, and still others rather blunt, as if obliquely truncated.

Shell rather large, transversely ovate-trigonal in outline, moderately compressed. Umbones broadly rounded, not very conspicuous, the tips acute and prosogyrate, falling within the anterior third. Lunule elongate-cordate, wider in the right valve than in the left, defined by an impressed line which commonly

<sup>9</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1252.



becomes indistinct away from the umbones. Escutcheon not defined. Shell flattened posteriorly but without sharply delimited dorsal areas. Anterior lateral margin bowed in front of the lunule, rounding smoothly into the strongly upcurved base; posterior margin arching broadly from the umbones to the posterior basal angle; base line straight behind, feebly arcuate medially. Ligament and dentition normal for the group. Interior of shell in many specimens slightly thickened over the area of the attached mantle. Adductor and pallial scars distinct. Pallial sinus broad, angular, the dorsal and ventral margins rudely parallel, the extremity obliquely truncate or joining the ventral margin at an acute angle.

Most of the Shoal River forms are immature or imperfect, but they are apparently identical with the Chipola forms, though a little higher relatively. Certainly the outlines of the posterior dorsal margins and of the pallial sinus are similar.

The Recent species is a larger and heavier race than the Chipola, whereas the Oak Grove specimens are intermediate, though running closer to the Chipola. All the peculiar features, however—the hunched posterior outline and the broad and angular sinus—persist from the Chipola on to the Recent, and if a separation be made on the size and weight of the shell the Pliocene and Recent forms are involved, and it is doubtful if after the erection of a considerable number of new species the relationships of this compact group would be better expressed.

Occurrence: Chipola formation, localities 7893<sup>p</sup>, 2212<sup>c</sup>, 7257<sup>p</sup>, 2213<sup>c</sup>, 2564<sup>c</sup>, 3419<sup>c</sup>, 7151<sup>p</sup>. Oak Grove sand, localities 2646<sup>a</sup>, 5632<sup>p</sup>, 5630<sup>r</sup>, 5633<sup>r</sup>, 7054<sup>c</sup>, 2652<sup>r</sup>, 7055<sup>p</sup>. Shoal River formation, localities 7264<sup>r</sup>, ?5618<sup>p</sup>.

***Macrocallista (Paradione) waltonensis* Gardner, n. sp.**

Plate XXIV, Figures 8–9

Shell rather large, heavy, moderately compressed. Umbones flattened, the tips acute and prosogyrate, placed within the anterior third. Lunule well differentiated, elongate cordate in outline, defined by a shallow impressed line and the abrupt disappearance of any incremental sculpture which may be developed on the disk. Escutcheon not delimited. Dorsal areas smooth, flattened, defined by an obtuse ridge. Anterior dorsal margin oblique along the lunular area, bowing out in front of it; posterior dorsal margin feebly arcuate, quite evenly declining, rounding smoothly into the base, which is strongly upcurved anteriorly. External surface smooth except for an obscure growth sculpture. Ligament external, lodged in a deep groove which extends almost half the length of the dorsal margin. Medial cardinals of right valve flattened and proximate for the reception of the laminar anterior tooth of the left valve; posterior cardinal of right valve thin but quite deeply striate; medial cardinal of left valve

rather heavy, cuneate; posterior left cardinal laminar, produced a little less than half the length of the ligament; anterior lateral of left valve short but prominent, clasped between the laminae of the right. Anterior portion of shell thickened along a line dropped from the umbones, the thickness evanescent toward the pallial line. Anterior muscle impression prominent, semielliptical in outline; posterior muscle scar less conspicuous because of the thinner posterior portion of the shell, slightly larger than the anterior. Pallial line distant from the margin; pallial sinus moderately deep, linguiform, the dorsal line of the sinus approximately horizontal. Basal margin smooth within.

Dimensions: Altitude, 51.0 millimeters; latitude, 71.0 millimeters; semidiameter, 17.8 millimeters.

Type: U. S. Nat. Mus. No. 352541.

Type locality: No. 5080, first ravine below Shell Bluff, Shoal River, Walton County, Fla.

*Macrocallista waltonensis* runs larger than the Chipola and Oak Grove analogs. The posterior dorsal margin declines more smoothly and more rapidly, and the extremity of the sinus is evenly rounded instead of angulated, as in *M. maculata* Linnaeus.

Occurrence: Shoal River formation, localities 3856<sup>r</sup>, 3742<sup>p</sup>, 5184<sup>p</sup>, 5079<sup>c</sup>, 3733<sup>r</sup>, ?5618<sup>r</sup>.

**Genus CALLOCARDIA A. Adams**

1864. *Callocardia* A. Adams, *Annals and Mag. Nat. Hist.*, 3d ser., vol. 13, p. 307.

Type: *Callocardia guttata* A. Adams. (Recent in the China Sea.)

Shell ovate to subtriangular; umbones anterior, involute; lunule circumscribed by a faintly incised line; escutcheon not delimited; ligament external, lodged in a deep groove; nymphs prominent; exterior sculpture concentric; three more or less discrepant cardinals in each valve, commonly bifid or cuspid; two lateral lamellae in right valve which receive between them the anterior lateral tooth of the left valve; pallial sinus varying widely within the limits of the genus, angular and sharply defined to almost obsolete; inner margins of valves entire.

The group is first recognized in the Eocene; since that time, it has formed a fairly conspicuous and widely distributed factor in the molluscan faunas of the warmer seas.

Three out of the four *Callocardias* represented in the Alum Bluff group are members of one of the most noteworthy groups of the later Tertiary and Recent—that of *Callocardia sayana* Conrad and *Callocardia morrhuana* Linsley. It is interesting that so prominent a group should have been so early established and already diversified. The Chipola species, *C. sincera* Dall, is well characterized, but the later analogs—*C. prosayana dodona* Gardner, n. subsp., from the Oak Grove, and *C. prosayana* Gardner, n. sp., from the

Shoal River—run very close to certain end members of *C. sayana* Conrad, though in the totality of their characters they seem quite distinct. The fourth species, *C. albofonte* Gardner, n. sp., is apparently restricted to the environs of White Springs and is remarkable for its mactroid outline.

Shell moderately or rather strongly inflated, not *Mulinia*-form in outline:

Shell relatively short; posterior extremity truncated almost at right angles to the base line.

*Callocardia (Agriopoma) sincera* Dall.

Shell relatively broad:

Pitting of the external surface little or not at all marked in the adult forms.

*Callocardia (Agriopoma) prosayana* Gardner, n. sp.

Pitting of the external surface very marked in the adult forms.

*Callocardia (Agriopoma) prosayana dodona* Gardner, n. subsp.

Shell compressed, *Mulinia*-form in outline.

*Callocardia (Agriopoma) albofonte* Gardner, n. sp.

#### Subgenus AGRIOPOMA Dall

1902. *Agriopoma* Dall, U. S. Nat. Mus. Proc., vol. 24, p. 509.

Type: *Cytherea texasiana* Dall. (Recent in the Gulf of Mexico.)

This subgenus as separated by Dall is characterized by the heavy chalky shell, the less involute umbones, and especially by the deep and angular pallial sinus.

#### *Callocardia (Agriopoma) sincera* Dall

Plate XXV, Figure 12

1903. *Callocardia (Agriopoma) sincera* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1260, pl. 55, fig. 12.

1915. *Callocardia (Agriopoma) sincera* Dall, U. S. Nat. Mus. Bull. 90, p. 146, pl. 25, fig. 7 (in part).

Dall described this species in 1903 as follows:

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 beak 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 beveled edge of the opposite valve; pallial sinus short, angular, ascending. Length 20.75, height 17.5, diameter 10.0 millimeters.

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.

Type: U. S. Nat. Mus. No. 114747.

Type locality: No. 2212, Tenmile Creek, 1 mile west of Baileys Ferry, Calhoun County, Fla.

The form that occurs at Ballast Point is smaller and shorter than that of Chipola River, the altitude and latitude being approximately equal. The dimensions, together with the vertical truncation of the posterior portion of the shell of the Ballast Point form, give to it a squarish aspect which is quite distinct from the cordate outline of the Chipola River form.

*C. sincera* is shorter, however, and more nearly quadrate in outline than either *C. prosayana* Gardner, n. sp., or the subspecies *C. prosayana dodona*, the analogs at the later horizons.

Occurrence: Chipola formation, localities 2212°, 2213°, 7151°.

#### *Callocardia (Agriopoma) prosayana* Gardner, n. sp.

Plate XXV, Figures 13-14

Shell rather large and thick but very fragile, transversely ovate-trigonal in outline, strongly inflated. Umbones very full, involute, the tips acute and prosogyrate. Lunule large, cordate, circumscribed by a shallow impressed line. Escutcheon not defined. Anterior extremity of shell rostrate; posterior dorsal margin gently declining, feebly arcuate; posterior lateral margin obtusely truncate; base line quite strongly arcuate. Earlier stages of shell smooth or faintly striated concentrically; adult finely and closely wrinkled concentrically away from the umbones, the sculpture carried across the lunule, though with diminished prominence. Ligament lodged in a deep and angular groove; hinge normal but very delicate, the teeth exceedingly thin and fragile; right anterior and medial cardinals laminar, the inner surfaces flattened and opposing; posterior cardinal mesially sulcate; anterior and medial cardinals of left valve uniting to form an acute V, anteriorly inclined; posterior cardinal laminar, very delicate; anterior lateral short, comparatively slender, dentiform. Adductor scars distinct; anterior adductor small, crescentic, set rather close to the outer margin; posterior adductor scar larger but not so distinct. Pallial line distant from the base; pallial sinus rather short but very broad, steeply ascending, the apical angle not far from 60°. Inner margins smooth.

Dimensions: Right valve: Altitude, 29.0 millimeters; latitude, 35.5 millimeters; semidiameter, 12.0 millimeters. Left valve: Altitude, 30.0 millimeters; latitude, 38.5 millimeters; diameter of double valves, 23.1 millimeters.

Cotypes: U. S. Nat. Mus. No. 352547.

Type locality: No. 3856, 6 miles west-northwest of Mossyhead, Walton County, Fla.

*Callocardia prosayana* Gardner, n. sp., follows much the same range of variation in size and relative dimensions as the later Miocene species, but the shell is more inflated, the umbones more strongly involute, the anterior extremity more produced, and the hinge more delicate. *Callocardia prosayana* s. s. runs larger and heavier than the subspecies *C. prosayana dodona*, and the pitting of the external surface which characterizes the Oak Grove form is less strongly and less uniformly developed. Apparently this peculiarity of sculpture begins earlier in the Shoal River race but does not persist through the adult stages.

Occurrence: Shoal River formation, localities 3856°, 3742°, 5184°, 3733°, ? 3748°, ? 5192°, 5618°.

***Callocardia (Agriopoma) prosayana dodona* Gardner, n. subsp.**

Plate XXV, Figures 15-16

1903. *Callocardia (Agriopoma) sayana* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1261. (Synonymy, figure, and description excluded.)

Shell of moderate dimensions, rather thin, transversely ovate-trigonal in outline, strongly inflated in the umbonal region. Umbones full, the tips acute and somewhat involute, placed a little in front of the median line. Lunule rather large, cordate, defined by the abrupt cessation of the concentric lamellae which ornament the disk. Escutcheon suggested by the flattening of the shell and the disappearance of the sculpture. Anterior portion of shell quite strongly bowed in front of the lunule, rounding smoothly into the almost horizontal base; posterior dorsal margin feebly arcuate; lateral margin obtusely truncate. External surface sculptured with very fine concentric lamellae which are often minutely crinkled or pitted. Ligament deeply inset, extending about half the length of the posterior dorsal margin. Right anterior and medial cardinals laminar, their inner surfaces flattened and opposed; posterior cardinal produced, longitudinally sulcate; left anterior and medial cardinals uniting in an acute V, the arm formed by the medial cardinal the heavier; posterior cardinal laminar, produced; anterior lateral short, compressed, subacute; adductor scars rather small, the anterior the smaller of the two, placed at the extremity of the anterior lateral, its outer margin slightly elevated; posterior adductor placed lower down and very close to the outer margin. Pallial line distinct; pallial sinus steeply ascending, produced almost but not quite to the median vertical, bluntly rounded at its extremity. Inner margins simple.

Dimensions: Altitude, 18.0 millimeters; latitude, 21.0 millimeters; semidiameter, 6.5 millimeters.

Type: U. S. Nat. Mus. No. 349444.

Type locality: No. 5630, 100 yards below Oak Grove, Yellow River, Okaloosa County, Fla.

*Callocardia prosayana dodona* Gardner, n. subsp., is the Oak Grove analog of *C. sincera* Dall of the Chipola and *C. prosayana* Gardner, n. sp., of the Shoal River. It is relatively broader and more inflated than *C. sincera* and differs from *C. prosayana* s. s. in the surface ornamentation. It is smaller and less trigonal in outline than *C. sayana*, less acutely rostrate both anteriorly and posteriorly, and usually has a more produced pallial sinus. The pitting upon the external surface of the adult is very marked, much more so than in any of the other adult Alum Bluff species.

Occurrence: Oak Grove sand, localities 2646<sup>p</sup>, 5630<sup>r</sup>.

***Callocardia (Agriopoma) albofonte* Gardner, n. sp.**

Plate XXV, Figures 17-18

Shell rather small, heavy, ovate-trigonal in outline, moderately compressed. Umbones obtuse, flattened,

moderately conspicuous by reason of their position at the apex of an angle of a little more than 90°. Lunule rather wide, elongate cordate, defined by an incised line. Escutcheon not delimited. Anterior extremity of shell broadly rounded in front of the lunule. Posterior dorsal margin declining rather steeply, rounding quite sharply into the feebly arcuate base. Dorsal areas indicated by an obscure flattening of the shell posteriorly. External sculpture restricted to concentric lamellae, incremental in character. Ligament deeply inset. Hinge normal; in the right valve, laminar anterior and medial cardinals, a rather slender, cuneate, posterior cardinal and a deep socket for the reception of the left anterior lateral; in the left valve, the anterior and medial cardinals forming an acute V, a laminar posterior cardinal and a subacute, short, compressed anterior lateral. Muscle scars small but prominent, particularly the anterior. Pallial line distinct; pallial sinus broad, steeply ascending, produced almost or quite to the median vertical, broadly rounded at its extremity. Inner margins smooth.

Dimensions: Altitude, 13.5 millimeters; latitude, 17.0 millimeters; diameter, 3.5 millimeters.

Type: U. S. Nat. Mus. No. 352555.

Type locality: No. 6776, half a mile above White Springs, Suwannee River, Columbia County, Fla.

The species is preserved chiefly in the form of casts that are compressed, and transversely elongated, with obtuse, slightly anterior umbones. There is usually a shallow medial depression which extends from the umbones nearly to the base, and the anterior muscle scar is prominently elevated.

*Callocardia albofonte* is abundant in the environs of White Springs on Suwannee River, but it has not been recognized elsewhere. It is decidedly the smallest and most compressed of the Alum Bluff *Callocardias* and is remarkable for its similarity in external appearance to a small *Mulinia congesta*.

Occurrence: Chipola formation, localities 7468<sup>r</sup>, 6175<sup>p</sup>, 6769<sup>c</sup>, 4976<sup>a</sup>, 6776<sup>a</sup>.

**Genus PITARIA Römer**

1857. *Pitaria* Römer, Kritische Untersuchung der Arten des Molluskengeschlechts *Venus* bei Linné und Gmelin, Inaug.-Diss., Marburg, p. 15.

Type: *Venus tumens* Gmelin. (Recent off the west coast of tropical Africa.)

Römer describes this genus as follows:

T. trigono-cordata, transversim striata; sinu palliari profundo, obtuso-triangulari; dente laterali papilliformi; margine interno laevi. *C* [allista] *tumens* Gmel. (le *Pitar* Adans.).

Dall<sup>10</sup> says:

Shell trigonal, plump, concentrically striate or rippled, with an inconspicuous periostracum and delicate coloration; lunule circumscribed, but the escutcheon not defined; inner margins

<sup>10</sup> Dall, W. H., Synopsis of the family Veneridae and of the North American Recent species: U. S. Nat. Mus. Proc., vol. 26, p. 353, 1902.

smooth, pallial sinus ample, elongate, somewhat ascending, pointed in front; middle cardinal stout, the others slender; the posterior cardinals feebly grooved, the others entire; the cardinals of the right valve discontinuous where they touch the dorsal margin and not separated from the latter by a groove; anterior lateral adjacent, distinct; nymphs and teeth smooth; dorsal margins grooved as in *Meretrix*. Widely distributed in the Tropics.

Römer's original name, *Pitar*, is a vernacular African word, not really entitled to be used without Latinization, for which in 1862, he substituted *Caryatis*, which is preoccupied in Lepidoptera since 1816. It is probable that a Latinized form as above should be adopted for the group.

*Pitaria* is represented in the Chipola formation by two species belonging to very distinct subgenera—one species the prolific *Pitaria floridana* Dall and the other the very rare *Pitaria harrisi* Maury, both of them restricted in their known distribution to the Chipola. The genus has not been recognized in the Oak Grove sand, but in the Shoal River formation *Pitaria floridana* is closely paralleled by *Pitaria waltonensis* Gardner, n. sp.

Shell ovate-trigonal in outline; a fine zigzag sculpture developed in the adults.....*Pitaria (Hyphantosoma) floridana* Dall.

Zigzag sculpture introduced in the early stages of development, inclined to become obsolete on the summits of the concentric ridges.

*Pitaria (Hyphantosoma) floridana* Dall.

Zigzag sculpture generally confined to the ventral two-thirds of the adult, equally prominent upon the concentric ridges and the interspaces.

*Pitaria (Hyphantosoma) waltonensis* Gardner, n. sp.

Shell *Astarte*-form in outline and sculpture.

*Pitaria (Hysteroconcha [Lamelliconcha]) harrisi* Maury.

#### Subgenus PITARIA s. s.

Type: *Venus tumens* Gmelin. (Recent off the west coast of tropical Africa.)

Dall<sup>11</sup> describes this group as follows:

Shell subtrigonal or ovate, convex, solid, smooth or concentrically sulcate or waved; pallial sinus ample, deep, reaching the middle of the shell, moderately ascending; hinge with a well-developed anterior lateral, the posterior cardinals often grooved; lunule not deeply impressed, bounded by an incised line, escutcheon not limited or well defined; internal margins entire, smooth.

This group includes the majority of the so-called Cythereas, which have a subtrigonal solid shell, unpolished, with an inconspicuous periostracum and concentric sculpture of lines, wrinkles, small waves or sulci, not raised into lamellae or distally elevated. They are nearly all tropical and largely Oriental shells.

#### Section HYPHANTOSOMA Dall

1902. *Hyphantosoma* Dall, U. S. Nat. Mus. Proc., vol. 26, p. 354.

Type: *Cytherea carbacea* Guppy. (Miocene of the Bowden beds, Jamaica.)

The members of this group are characterized by the zigzag surface sculpture.

#### *Pitaria (Hyphantosoma) floridana* Dall

Plate XXV, Figure 19

1903. *Pitaria (Hyphantosoma) floridana* Dall. Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1267, pl. 54, fig. 10.

<sup>11</sup> Dall, W. H., Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1265, 1903.

Dall describes this species as follows:

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 25.0, diameter 17.0 millimeters.

Young shells were abundant in the marl, full-grown ones comparatively scarce.

Type: U. S. Nat. Mus. No. 114753.

Type locality: No. 2212, Tenmile Creek, 1 mile west of Baileys Ferry, Calhoun County, Fla.

The extraordinarily high rate of infant mortality in this species is a source of much difficulty to the paleontologist, for the characteristic zigzag rippling is not acquired until the earliest stages are past. The juveniles are higher relatively than the adults and, when very young, are *Dosinia*-like in outline. By reason of the variations in relative dimensions, the smooth or concentrically striated surface, and the similar hinge characters the young of *Pitaria floridana* Dall are commonly separable with difficulty from the young of *Callocardia*. The characteristic sculpture is begun even later in *P. waltonensis*, and the impressed zigzag lines unlike those of *P. floridana*, which commonly become obsolete in crossing the concentric ridges, are equally impressed upon the ridges and the interspaces. There is, however, no other described species with which the adults may be confused. *Pitaria carbacea* Guppy is a larger, more inflated shell, with a more distinctly defined and uniformly developed radial sculpture. In the Pliocene species, the characteristic *Hyphantosoma* sculpture becomes almost or entirely obsolete, and in the Recent forms it persists in the fresh shells only in the color pattern, though the subcutaneous divaricate sculpture is revealed on erosion.

Occurrence: Chipola formation, localities 2212<sup>p</sup>, ?7257<sup>p</sup>, 2213<sup>c</sup>, 2564<sup>a</sup>, 3419<sup>a</sup>, ?7151<sup>p</sup>, 2211<sup>c</sup>, ?7183<sup>p</sup>.

#### *Pitaria (Hyphantosoma) waltonensis* Gardner, n. sp.

Plate XXV, Figures 20-21

Shell of moderate dimensions for the genus and moderately heavy, transversely ovate-trigonal in outline, strongly inflated. Umbones prominent, subcentral or slightly anterior, the tips acute and prosogyrate; umbonal angle not far from 135°. Anterior dorsal slope less gentle than the posterior; anterior extremity rounding broadly into the upcurved base; posterior extremity broad, obtusely truncate; base line broadly arcuate. Lunule cordate, rather wide, circumscribed by an incised line. Escutcheon not differentiated. Umbonal region smooth excepting for a fine incremental striation; ventral two-thirds of the adult sculptured with fine, close-set, concentric ridges,

which are most prominent toward the basal and lateral margins and are continued, though with slightly diminished prominence, across the lunule; the characteristic zigzag sculpture developed along with the concentric but most prominent upon the medial and ventral portions of the disk, becoming obsolete laterally. Ligament sunken in a deep V-shaped groove produced about half the length of the posterior dorsal margin. Dentition normal, moderately heavy; anterior and medial laterals of right valve laminar, their inner faces flattened and proximate; posterior right cardinal bifid; anterior and medial cardinals of left valve united to form an acute  $\Lambda$ , the anterior arm of the  $\Lambda$  the thinner and the more laminar; posterior left cardinal produced and very delicate; left anterior lateral prominent, dentiform, received in the double socket of the right valve. Adductor and pallial scars distinct; anterior adductor scar smaller than the posterior, rudely semielliptical in outline, the inner margin straight and accentuated by the slight thickening of the shell behind it; posterior adductor also semielliptical, set a little lower than the anterior. Pallial line distant from the margin; pallial sinus short, broad, gently ascending, obtusely angulated at its extremity. Inner margins smooth.

Dimensions: Altitude, 21.5 millimeters; latitude, 25.5 millimeters; semidiameter, 9.0 millimeters.

Type: U. S. Nat. Mus. No. 352549.

Type locality: No. 3742, Shell Bluff, Shoal River, Walton County, Fla.

*Pitaria waltonensis* Gardner, n. sp., is the close analog of *P. floridana* Dall of the Chipola formation. The Shoal River species is more inflated, broader and less produced posteriorly, with a relatively broader lunule. The sculpture of *P. floridana* Dall is begun at an earlier stage in the development of the shell and is commonly discontinuous upon the concentric ridges, appearing rather as a zigzag series of pits between the concentric lamellae. In *P. waltonensis*, on the other hand, the zigzag lines are equally impressed upon the concentric ridges and the interspaces. Unlike *P. floridana*, the Shoal River species is represented almost entirely by adult shells.

Occurrence: Shoal River formation, localities 3742<sup>p</sup>, 5080<sup>r</sup>, 5079<sup>r</sup>.

#### Subgenus HYSTEROCONCHA Fischer

1887. *Hysteroconcha* Fischer, Manuel de conchyliologie, p. 1079.

Type: *Venus dione* Linnaeus. (Recent in the West Indies.)

Shell subtrigonal, plump, concentrically laminate; lunule and escutcheon situated in an impressed area and defined by a deeply incised line; laminae spinose near the boundary of the posterior area; coloration tinted, not in patterns; inner margins smooth; pallial sinus linguiform, ample, free, slightly ascending; hinge as in *Pitaria*, the edges of the nymphs finely granular, and the stout middle cardinal sometimes obscurely channeled. Habitat tropical American seas.<sup>12</sup>

#### Section LAMELLICONCHA Dall

1902. *Lamelliconcha* Dall, U. S. Nat. Mus. Proc., vol. 26, p. 354.

Type: *Cytherea concinna* Sowerby. (Recent on the west coast from Magdalena Bay to Ecuador and Peru.)

Dall characterized this section as follows:

Shell trigonal, subcompressed, concentrically ribbed or laminate, without spines; the edges of the nymphs smooth; otherwise like *Hysteroconcha*. Tropical seas, especially in America.

#### *Pitaria* (*Hysteroconcha* [*Lamelliconcha*]) *harrisi* Maury

1903. *Pitaria* (*Lamelliconcha*) *astartiformis* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1269 (in part).

Not *Pitaria* (*Lamelliconcha*) *astartiformis* Conrad, 1848.

1910. *Pitaria* (*Lamelliconcha*) *harrisi* Maury, Bull. Am. Paleontology, vol. 4, No. 21, p. 37, pl. 9, fig. 7.

Miss Maury described this species as follows:

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 millimeters. 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, Fla. Cornell University collection.

The species has not been recognized in the later collections.

*Pitaria astartiformis* Conrad from the Vicksburg group is relatively higher and more trigonal in outline than the Chipola species.

Occurrence: Chipola formation, localities 2213<sup>r</sup>, 2211<sup>r</sup>; Cornell University collection.

#### Genus ANTIGONA Schumacher

1817. *Antigona* Schumacher, Essai d'un nouveau système des habitations des vers testacés, p. 154, = *Cytherea* Bolten, Museum Boltenianum, p. 177, 1798. Not *Cytherea* Fabricius (Diptera), 1795.

Type: *Antigona lamellaris* Schumacher. (Recent in the Indo-Pacific.)

Dall<sup>13</sup> characterizes this genus as follows:

Shell large and rotund, valves convex, with strong sculpture in which the concentric element predominates, with well-marked lunule and escutcheon, the latter unequally divided between the valves, larger in the left valve; umbones plump; ligament set in a groove; cardinals large, the middle left and the posterior two right cardinals bifid, the left anterior lateral papilliform, obscure, sometimes obsolete; pallial line with a small, short, rounded sinus; inner margins of the valves crenulate.

This group of large and striking shells has a meager representation in the Alum Bluff and has been recognized only in the Chipola formation. *Antigona caesarina* (Dall) is restricted to the type locality, but

<sup>12</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1265, 1903.

<sup>13</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1272, 1903.

the second species is closely allied to *Antigona blandiana* (Guppy), of the Bowden beds of Jamaica.

Concentric lamellae crenulated, recurved toward the umbones----- *Antigona caesarina* (Dall).  
Concentric lamellae simple, not recurved toward the umbones----- *Antigona* sp. cf. *A. blandiana* (Guppy).

#### Subgenus ANTIGONA s. s.

Type: *Antigona lamellaris* Schumacher. (Recent in the Indo-Pacific.)

Dall<sup>14</sup> describes this subgenus as follows:

Shell large, reticulately sculptured; the portion of the escutcheon in the right valve (when not defective) forming a thin lamina which projects over the sunken ligament and almost completely hides it; pallial sinus wide, short, and rather rounded in front; lateral tooth minute or obsolete.

#### *Antigona caesarina* (Dall)

Plate XXV, Figure 22

1903. *Cytherea caesarina* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1275, pl. 53, fig. 5.

Dall describes this species as follows:

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 lamellae, 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 millimeters; length of an internal cast from White Beach 75, height 60, diameter 46 millimeters.

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. multicosata* 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 [Miocene] times.

Type: U. S. Nat. Mus. No. 114754.

Type locality: No. 2212, Tenmile Creek, 1 mile west of Baileys Ferry, Calhoun County, Fla.

The casts from White Beach are probably distinct, and the race is larger than that of the Chipola, the umbones more inflated, and the outline rudely quadrangular rather than ovate. The posterior dorsal margin is not far from horizontal and approximately two-thirds the width of the shell. The umbones are nearer to the anterior extremity than in *A. caesarina*, and the base is much less obliquely rounded.

*A. caesarina* (Dall) is characterized not only by the large size and obliquely ovate outline, but also by the

numerous concentric lamellae, with their margins expanded and recurved toward the umbones and crinkled like a pie crust.

Occurrence: Chipola formation, locality 2212<sup>p</sup>.

#### Section VENTRICOLA Römer

1867. *Ventricola* Römer, Malakozoologische Blätter, vol. 14, p. 115.

Type: *Chione rugosa* (Chemnitz). (Recent in the tropical waters of the east coast.)

Dall<sup>15</sup> characterizes this group as follows:

Shell large with strong, recurved, concentric lamellae regularly spaced, between which are smaller concentric threads; pallial sinus small, angular; lunule deeply impressed.

#### *Antigona (Ventricola) n. sp.?*

1903. *Cytherea (Ventricola) blandiana* Guppy. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1272 (in part). Not *Venus blandiana*, Guppy, 1874.

The *Antigona (Ventricola)* from the Chipola, which has been referred to *blandiana*, is known from only a few fragmentary individuals, but these certainly indicate a species decidedly less inflated and more nearly orbicular in outline than the Bowden form. The White Beach specimens are more closely allied to the Chipola than to the Bowden species, but the material is too imperfect to permit definite determination.

Occurrence: Chipola formation, localities 2212<sup>r</sup>, 2213<sup>r</sup>.

#### Subfamily VENERINAE Dall

Dall<sup>16</sup> characterizes the subfamily as follows:

The present subfamily is characterized by the total absence of lateral teeth. The siphons are usually comparatively short and more or less separate from each other. The foot is hatchet shaped and, in the adult, not byssiferous except among the nestlers. The young undergo their development outside of the parent shell.

#### Genus CHIONE Megerle von Mühlfeld

1811. *Chione* Megerle von Mühlfeld, Magazin Gesell. naturf. Freunde Berlin, vol. 5, p. 51.

Not *Chione* Desvoidy, 1830 (Diptera).

Not *Chione* Gray, 1838 = *Macrocallista*.

Type: *Venus dysera* Chemnitz = *Chione cancellata* (Linnaeus). (Recent off the east coast from Hatteras to Trinidad.)

Dall<sup>17</sup> describes this genus as follows:

This group contains solid trigonal shells which have three cardinals in each valve and (excepting a few aberrant species) have the valve margins entirely crenulate; all have a small triangular sinus, a lunule circumscribed by an incised line, an escutcheon not limited by any line and defined chiefly by a deficiency of coarse sculpture and a more or less pronounced ridge radiating from the beak toward the posterior margin. The ligament, though inset, is usually visible externally; some of the central cardinals may be grooved or bifid; rugosities appear on the hinge in a few instances. The sculpture is variable, chiefly comprising concentric ribs or lamellae and less prominent radials.

<sup>14</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1272, 1903.

<sup>15</sup> Idem, p. 1281.

<sup>17</sup> Idem, p. 1287.

<sup>14</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1272, 1903.



A few, mostly small forms, have the concentric sculpture less prominent than the radial. The lamellae are often expanded into elegant leaf-like processes distally. In a number of cases the right posterior dorsal margin is grooved to receive the beveled edge of the opposite valve behind the hinge plate.

The genus is a prominent and very widely distributed group in both the Tertiary and Quaternary seas.

Though not conspicuously numerous in species, *Chione* probably includes as many individuals as any genus of the Alum Bluff bivalves, with the possible exception of *Phacoides*. *Chione* s. s. is well represented in the Chipola, but it has not been recognized in the Oak Grove and is known in the Shoal River from only a single juvenile. The group *Lirophora*, on the other hand, is common in the Chipola, abundant in the Shoal River, and exceedingly prolific in the Oak Grove. At all three horizons there are closely related forms specifically or subspecifically distinct, one of them characterized by the coalescence of the concentric ribs to a greater or less degree, the other by a discrete concentric ribbing. *Chione burnsii* and its subspecies *discreta* are the Chipola forms that bear this relation, *Chione glyptocyma* and its subspecies *daphne*, those of the Oak Grove, and *Chione trimeris* and *Chione ceramota*, those of the Shoal River. Only at Oak Grove is the discretely ribbed form the more abundant. All three pairs are restricted to a single horizon, though the closely related *C. sellardsi* occurs in both the Chipola and the Oak Grove. *Chione* (*Timoclea*) sp. is present in the Chipola and the Shoal River, though it is not represented by determinable individuals.

Concentric laminae thin, sharp, regular in size and spacing:

Radial sculpture not uniform over the entire shell.

*Chione chipolana* Dall.

Radial sculpture uniform over the entire shell.

*Chione* sp. indet.

Concentric laminae thickened, commonly confluent, more or less irregular in size and spacing:

Latitude of adult shell not exceeding 35.0 millimeters:

Concentric laminae on the umbonal area sharp and distant; radial sculpture strongly incised in species characterized by the confluence of the concentric ribs:

Concentric ribs confluent.

*Chione (Lirophora) burnsii* Dall.

Concentric ribs not confluent:

Concentric ribs continued across the dorsal area in the form of sharply elevated laminae.

*Chione (Lirophora) burnsii discreta*  
Gardner, n. subsp.

Concentric ribs breaking down near margin of the dorsal area into fine component laminae----- *Chione (Lirophora) sellardsi*

Gardner, n. sp.

Concentric laminae on the umbonal area obtuse and in many specimens closely spaced.

Shell rarely exceeding 25.0 millimeters in latitude; concentric ribs, few and much thickened, breaking down near margin of the dorsal area into fine component laminae.

*Chione (Lirophora) sellardsi* Gardner, n. sp.

Shell normally exceeding 25.0 millimeters in latitude; concentric ribs generally numerous, in some specimens confluent, not greatly thickened, generally continued across the dorsal area in the form of sharply elevated laminae:

Concentric ribs not confluent.

*Chione (Lirophora) glyptocyma* Dall.

Concentric ribs in whole or in part confluent:

Concentric laminae little or not at all elevated laterally.

*Chione (Lirophora) glyptocyma daphne*  
Gardner, n. subsp.

Concentric laminae elevated laterally.

*Chione (Lirophora) funiakensis*  
Gardner, n. sp.

Latitude of adult shell exceeding 35.0 millimeters:

Concentric ribs in whole or in part confluent:

Shell not conspicuously large and heavy; radial lineation generally developed.

*Chione (Lirophora) funiakensis* Gardner, n. sp.

Shell conspicuously large and heavy; radial lineation little or not at all developed.

*Chione (Lirophora) trimeris* Gardner, n. sp.

Concentric ribs not confluent.

*Chione (Lirophora) ceramota* Gardner, n. sp.

Subgenus **CHIONE** s. s.

Type: *Venus dysera* Chemnitz = *Chione cancellata* (Linnaeus). (Recent off the east coast from Hatteras to Trinidad.)

Dall<sup>18</sup> describes this subgenus as follows:

Sculpture of radial ribs decussated by concentric, sharp, elevated lamellae; the dental formula is  $\frac{L. \text{ioioio}}{R. \text{ioioi}}$ ; the teeth are generally entire and smooth or feebly channeled. The siphons are short and partly separated.

**Chione chipolana** Dall

Plate XXVI, Figure 1

1903. *Chione chipolana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1290, pl. 55, fig. 20.

Dall describes this species as follows:

Shell moderately convex, in general much resembling *C. cancellata*, but smaller, with the radial sculpture finer, the radii more numerous, the concentric lamellae 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 25.6, diameter 18.0 millimeters.

Type: U. S. Nat. Mus. No. 114739.

Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla.

The adult shell is somewhat flexuous, owing to the slight constriction behind the dorsal area; the anterior extremity is bowed slightly in front of the lunule and rounds smoothly into the upcurved base, but the posterior extremity of the shell is obliquely truncate from the umbones almost to the base; the postero-ventral extremity is sharply rounded and the base flexuous in the adult. On the young shells the radials are uniform over the entire disk, but in the adults they are very fine over the anterior medial portion

<sup>18</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1287, 1903.

of the disk, slightly coarser toward the anterior extremity, decidedly coarser on the slightly depressed posterior medial portion of the disk, and abruptly finer toward the escutcheon. The interior of the shell is commonly somewhat thickened, so that the muscle and pallial scars are very distinct. The pallial line is distant from the base and the pallial sinus very short. The crenation upon the inner margins is very fine. As might be expected, *Chione chipolana* Dall resembles more closely that type of *C. cancellata* which is represented upon the Florida coast than it does the races to the south.

A single worn valve from a place near Alaquá, Walton County, is more closely sculptured concentrically than most of the Chipola shells but presents no other characters by which it may be separated.

Occurrence: Chipola formation, localities 2212<sup>p</sup>, 2213<sup>c</sup>, 2564<sup>c</sup>, 3419<sup>c</sup>, 2211<sup>c</sup>, 7183<sup>p</sup>, ?3704<sup>r</sup>, 7468<sup>p</sup>. Shoal River formation, locality ?7264<sup>r</sup>.

#### *Chione* sp. indet.

1903. *Chione* sp. indet. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1292.

This shell is moderately large, moderately compressed, and trigonal in outline, with a strongly rounded base. The umbones are not prominent and slightly anterior, with acute and prosogyrate tips. The lunule is short but wide and on the fresh surfaces is concentrically sculptured. Erosion, however, reveals a very fine subcutaneous radial lineation. The escutcheon also is wide and produced the entire length of the posterior dorsal margin. Directly in front of the escutcheon the shell is planed off over an area of approximately the same width as the escutcheon, but unlike the escutcheon the planed area widens toward the ventral margin. The concentric sculpture is continued across this area, but disappears abruptly at the inner margin of the escutcheon. The concentric sculpture is remarkably uniform over the entire external surface from the lunule to the escutcheon. It is badly worn down in all the available specimens but apparently takes the form of rather coarse concentric lamellae fluted on their ventral surfaces and numbering 10 to 12 to the centimeter. On further weathering the concentric sculpture disappears entirely, leaving only the fine and regular subsurficial radials, which unlike the radials of *C. chipolana* are uniform in width and arrangement over the entire disk. The characters of the interior are not well preserved. The dentition seems to be normal, and the pallial sinus is very short and angular. The species recognized by Dall in 1913 is apparently represented in considerable abundance in the environs of White Springs on Suwannee River. The material is all in bad shape, however, and there is no individual worthy of being selected as the type. There is still another nameless form near Sopchoppy characterized by a very

fine and even radial sculpture similar to that of the Alum Bluff species but with a distant though uniform concentric sculpture.

Occurrence: Chipola formation, localities 2211<sup>p</sup>, 7468<sup>r</sup>, 6769<sup>p</sup>, 6776<sup>c</sup>.

#### Section LIROPHORA Conrad

1863. *Lirophora* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, pp. 575, 586.

Type: *Circumphalus athleta* Conrad = *Chione latirata* (Conrad) (Miocene and Pliocene of the Middle and south Atlantic coasts; Recent from Hatteras to Brazil.)

Dall<sup>19</sup> describes this section as follows:

Sculpture of broad concentric waves, attenuated and often conspicuously lamellose distally; radially striate; ligament not covered by the valve margins; the edges of the right nymph and of the left posterior cardinal with interlocking rugosities. \* \* \*

In this section we have an interesting exhibit of development from forms like those just described [*Chione* s. s.] to those in which the middle concentric ribbing becomes dense and heavy, then irregular, more or less coalescent and finally entirely so, and of reversion to the earlier type under circumstances, we may assume, which make it better suited to the environment than that which had been laboriously evolved. In the existing faunas we have *C. kelletii* of the Pacific coast, in which the coalescent ribs form a smooth, even surface on the middle of the disk, with high, leaf-like expansions distally; forms like *C. paphia*, in which the ribs have become even and regular; and still others, wanting the distal expansions, in which the size and sequence of the thick ribs seems to depend on mere luck or accident. So that we may have an evolution from a clear-cut, elegant, attractive type of sculpture to a dull, unformed, irregular type, which in its turn may meet the difficulties of the situation better than the former.

#### *Chione* (*Lirophora*) *burnsii* Dall

Plate XXVI, Figures 2-3

1900. *Venus* (*Anaitis*) *burnsii* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, pl. 42, fig. 4. (Fig. 11 excluded.)

1900. *Venus* (*Anaitis*) *ulocyma* Dall, idem, pt. 5, pl. 42, fig. 5a. (Fig. 5 excluded.)

Not *Chione* (*Lirophora*) *ulocyma* Dall, idem, pt. 6, p. 1296.

1903. *Chione* (*Lirophora*) *burnsii* Dall, idem, pt. 6, p. 1294. (Fig. 11 excluded.)

Dall describes this species as follows:

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 lamellae; 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 toward 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 millimeters.

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.

<sup>19</sup> Dall, W. H., op. cit., vol. 3, pt. 6, pp. 1288, 1293, 1903.



Type: U. S. Nat. Mus. No. 114755.

Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla.

*Chione trimeris* from the Shoal River fauna is a larger and heavier shell with the elevated foliations on the anterior portion of the shell much more prominent and a much more obscure radial sculpture. *Chione funiakensis* Gardner, n. sp., is intermediate between *C. trimeris* and *C. burnsii* in dimensions and in the prominence of the radial sculpture, but the concentric laminae are elevated laterally as in *C. trimeris*. Those individuals in which the ribs do not coalesce have been segregated under the subspecies *C. burnsii discreta*.

Occurrence: Chipola formation, localities 7893<sup>r</sup>, 2212<sup>c</sup>, 2214<sup>c</sup>, 7257<sup>p</sup>, 2213<sup>c</sup>, 2564<sup>c</sup>, 3419<sup>c</sup>, 7151<sup>p</sup>, 2211<sup>c</sup>.

*Chione (Liophora) burnsii discreta* Gardner, n. subsp.

Plate XXVI, Figure 4

1900. *Chione (Liophora) burnsii* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, pl. 42, fig. 11.

1903. *Chione (Liophora) burnsii* Dall, idem, pt. 6, p. 1294 (part).

Shell of moderate dimensions and thickness, transversely ovate-trigonal in outline, apparently less compressed than *C. burnsii* s. s. because of the character of the sculpture. External surface ornamented with 9 to 15 heavy, concentric, recurved ribs, pinched out abruptly upon the dorsal area into narrow flanges which disappear with equal abruptness at the margin of the escutcheon; later ribs of adult somewhat pinched and flaring anteriorly as well; a very fine secondary concentric striation also developed; radial sculpture restricted to the ventral surfaces of the ribs. Ligament, dentition, and adductor and pallial scars normal for the species.

Dimensions: Altitude, 24.0 millimeters; latitude, 30.2 millimeters; semidiameter, 9.8 millimeters.

Type: U. S. Nat. Mus. No. 353834.

Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla.

The forms intermediate between the typical *C. burnsii* and the type of the subspecies *C. burnsii discreta* are relatively few in number. The subspecies, though present in the lower beds of the Chipola formation, is more characteristic of the upper beds and is apparently the race from which descended the exceedingly prolific *Chione glyptocyma* Dall of the Oak Grove sand. The Oak Grove species is a more delicate shell than the ancestral form and is sculptured with more numerous and consequently less heavy concentric ribs. The radial lineation instead of being restricted to the ventral surface of the ribs as in the Chipola form is continuous in the Oak Grove species across the interspaces between the ribs.

Occurrence: Chipola formation, localities 2214<sup>p</sup>, 2213<sup>r</sup>.

*Chione (Liophora) sellardsi* Gardner, n. sp.

Plate XXVI, Figures 5-6

Shell of moderate dimensions for the group and average convexity, heavy, trigonal, commonly somewhat flexuous posteriorly. Umbones slightly anterior, flattened upon their summits, the tips acute and prosogyrate; umbonal angle a little more than 90°. Lunule rather small, conspicuously cordate, slightly wider in the right valve than in the left, circumscribed by a deeply incised line, closely striated in harmony with the concentric sculpture. Escutcheon wide, produced almost to the ventral margin, closely and finely laminated. Anterior extremity bowed in front of the lunule, rounding broadly into the upcurved base; posterior extremity obliquely truncate, rounding sharply into the base; base line somewhat flexuous posteriorly and medially, upcurved anteriorly. External surface sculptured with 10 to 12 heavy concentric ribs, thickened and recurved on the medial and ventral portions of the shell, more or less unequal in size and spacing, though preserving a certain uniformity in general aspect; ribs becoming abruptly obsolete directly behind the lunule and breaking up directly in front of the escutcheon into closely packed lamellae, which at the margin of the escutcheon are turned at an acute angle and directed obliquely across it; a fine secondary concentric striation developed over the entire disk, generally coarser on the outer surface of the heavy ribs; traces of a feeble but uniform radial sculpture persisting on the outer surfaces of the ribs and forming with the secondary concentric sculpture an irregular checkering; radials generally obsolete altogether on the concave surfaces between the ribs. Ligament short but rather deeply inset, the groove only a little longer than the posterior cardinal. Dentition normal; three cardinals radiating fanlike in either valve; the anterior right cardinal very thin and laminar; the medial cardinal rather heavy, deltoid; the posterior cardinal produced and moderately robust; the left anterior cardinal also laminar but heavier than that of the right valve; the medial cardinal deltoid; the posterior thin and laminar; inner surface of lunule flexuous and finely crenate. Adductor and pallial scars distinct; anterior adductor somewhat pyriform in outline, the posterior semielliptical. Pallial line distant from the margin; pallial sinus a mere nick. Inner margins very finely crenate ventrally and anteriorly.

Dimensions: Right valve: Altitude, 20.3 millimeters; latitude, 25.0 millimeters; semidiameter, 9.2 millimeters.

Type: U. S. Nat. Mus. No. 349444.

Type locality: No. 7893, Boynton Landing, Choctawhatchee River, Washington County, Fla.

*Chione sellardsi* Gardner, n. sp., is allied to *Chione burnsii discreta* Gardner, n. subsp., of the Chipola formation and to *Chione glyptocyma* Dall of the Oak Grove fauna. The concentric ribs are fewer in number, however, and decidedly heavier than in *glyptocyma*. Instead of pinching out into a narrow flange on the dorsal area, as in both *C. burnsii discreta* and *C. glyptocyma*, the ribs of *C. sellardsi* break down into the laminae which by their confluence make up the fold.

*Chione sellardsi*, though common only in the environs of the type locality, has a meager representation in the Oak Grove as well.

Occurrence: Chipola formation, locality 7893°. Oak Grove sand, localities 2646<sup>r</sup>, 2652<sup>r</sup>.

***Chione (Lirophora) glyptocyma* Dall**

Plate XXVI, Figure 7

1903. *Chione (Lirophora) glyptocyma* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1296, pl. 55, fig. 21

Dall describes this species as follows:

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 5 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 16 to 23 ribs, in *C. burnsii* when the ribs are not confluent there are 9 to 11. 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 millimeters, but the form may be longer or more trigonal, as in all these species. I have figured a youngish valve 26.5 millimeters 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.

Type: U. S. Nat. Mus. No. 135887.

Type locality: No. 2646, Oak Grove, Yellow River, Okaloosa County, Fla.

The flanges on the dorsal area serve to separate the species from *Chione sellardsi* of the Chipola fauna. The features by which it may be isolated from *Chione burnsii discreta* Gardner, n. subsp., the Chipola analog and probable ancestor, have already been related. The Shoal River analog *Chione ceramota* is a larger and heavier shell with broader and rather more numerous ribs, which instead of disappearing abruptly directly behind the lunule, as is common in *C. glyptocyma*, become attenuated and widely flaring. The end members, which are characterized by the confluence of some or all of the ribs, have been segregated under the subspecies *C. glyptocyma daphne*.

*Chione glyptocyma* is by reason of its abundance one of the most conspicuous elements in the entire Oak Grove fauna. Though surprisingly constant in view of the mass of material by which the species is represented, a series can be established ranging from individuals sculptured with numerous equal and equally spaced concentric ribs, standing erect, to end members of the subspecies *daphne*, which are devoid of sculpture except a few concentric riblets in the umbonal region and a faint radial lineation.

Occurrence: Oak Grove sand, localities 2646<sup>r</sup>, 5632<sup>r</sup>, 5631<sup>a</sup>, 5630<sup>c</sup>, 5633<sup>a</sup>, 7054<sup>a</sup>, 2652<sup>p</sup>.

***Chione (Lirophora) glyptocyma daphne* Gardner, n. subsp.**

Plate XXVI, Figure 8

Shell of moderate dimensions, rather heavy, moderately compressed, transversely ovate-trigonal in outline. Umbones smoothly rounded, tapering evenly to the small, acute, and prosogyrate tips. Lunule cordate, circumscribed by a deeply incised line, finely striated concentrically. Escutcheon rather wide, lanceolate, produced the length of the dorsal margin. Anterior extremity bowed in front of the lunule, rounding smoothly into the upcurved base; posterior dorsal margin steeply descending, the lateral margin obtusely truncate, rounding sharply into the somewhat flexuous base. Surface sculpture variable; concentric ribbing rather fine at the tips of the umbones, the ribs of the medial and ventral portion of the disk, however, much thickened and more or less completely coalescent; radial lineation continuous from the umbones to the basal margin; dorsal areas well differentiated, sculptured with the pinched and laminar extremities of the component concentric ribs of the disk; a very fine secondary striation also developed and unlike the primary laminae continued obliquely across the escutcheon. Ligament groove deep, produced a little beyond the posterior cardinal. Dentition normal; three cardinals radiating fanlike in each valve; anterior right cardinal short thin, laminar; the medial cardinal moderately elevated, deltoid; the posterior cardinal produced; anterior left cardinal heavier than the right; medial cardinal cuneate; posterior cardinal laminar, produced; posterior dorsal margins beveled and grooved to function as laterals. Adductor and pallial scars distinct, the area of the attached mantle surface usually a little thickened. Pallial line rather far removed from the base; pallial sinus very short, narrow, angulated at its extremity. Inner anterior and ventral margins finely crenate.

Dimensions: Altitude, 22.0 millimeters; latitude, 26.3 millimeters; diameter, 14.6 millimeters.

Type: U. S. Nat. Mus. No. 352548.

Type locality: No. 7055, old Senterfeit mill, 4½ miles southwest of Laurel Hill, Walton County, Fla.

These end members of the *glyptocyma* group are characterized by the relatively heavy shell and the more or less coalescent concentric ribs. The general aspect of the shell is very similar to that of some of the larger forms of *Astarte*, which develop pronounced resting stages. In some of the specimens the laminae on the dorsal areas show a tendency to break down much as in *C. sellardsi*, but the shell is larger and not so heavy relatively and the concentric ribbing is less pronounced and more irregular. *Chione funiakensis*, on the other hand the nearest of kin in the Shoal River fauna, is a thinner shell than the subspecies *daphne*, not so high relatively, with the concentric laminae more elevated laterally and the radial lineation more uniformly developed. Apparently the subspecies is an offshoot from the exceedingly prolific Oak Grove *glyptocyma*. Though unable to compete with the normal form in the environs of Oak Grove, it seems to have found conditions peculiarly favorable a little to the west.

Occurrence: Oak Grove sand, localities 2646<sup>r</sup>, 5632<sup>r</sup>, 2652<sup>r</sup>, 7055<sup>a</sup>.

***Chione (Liophora) funiakensis* Gardner, n. sp.**

Plate XXVI, figures 9-11

Shell of moderate thickness and dimensions for the genus and moderately compressed, transversely ovate-trigonal in outline. Umbones decidedly anterior, well rounded, tapering evenly to the acute, prosogyrate, proximate tips. Lunule cordate, moderately wide, the right lunular area slightly wider than the left, finely laminated in harmony with the concentric sculpture, outlined by a deeply incised groove; Escutcheon lanceolate, extending the length of the posterior dorsal margin, even more finely laminated than the lunule. Anterior extremity strongly bowed in front of the lunule, rounding smoothly into the upcurved base; posterior dorsal margin steeply declining, the extremity obtusely truncate; base line arcuate, somewhat flexuous. External surface sculptured with about 15 to 20 concentric ribs, which become increasingly broader toward the ventral margin and tend to coalesce on the disk; posterior areas defined by an abrupt change in the character of the sculpture, the ribs giving place to elevated shelly plates, which become obsolete just in front of the margin of the escutcheon; dorsal surface, both on the plates and the area between them, very finely striated concentrically; analogous plate also developed on the anterior portion of the shell, though at a later stage; anterior plates recurved; radial sculpture manifested in the form of a radial lineation, in some individuals persistent on the disk from the umbones to the basal margin, in other individuals restricted to the ventral surface of the ribs, absent on the dorsal areas, except on the under surface of the plates. Ligament and dentition normal;

three cardinals radiating fanlike in each valve; anterior right cardinal short and laminar; middle cardinal heavier, cuneate; posterior cardinal also rather heavy and produced; anterior and middle left cardinals rather short, not very heavy; the posterior cardinal laminar and produced; posterior dorsal margin of left valve beveled to fit in corresponding groove of right valve. Adductor muscle scars distinct, the posterior the larger. Pallial line far distant from the base, the sinus very short, narrow, and angulated at its extremity. Inner ventral and anterior margins finely crenate.

Dimensions: Right valve: Altitude, 28.3 millimeters; latitude, 37.5 millimeters; semidiameter, 8.9 millimeters. Left valve (immature shell): Altitude, 22.7 millimeters; latitude, 27.8 millimeters; semidiameter, 7.3 millimeters.

Cotypes: U. S. Nat. Mus. No. 352545.

Type locality: No. 5618, 3½ miles southwest of De Funiak Springs, Walton County, Fla.

*Chione funiakensis* is not so large nor so wide as *C. trimeris*, the most abundant member of the group in the environs of Shell Bluff. Both the concentric and the radial sculpture are more uniform in character than they are in *C. trimeris*, and the radial sculpture in particular is more persistent over the disk. In this feature *C. funiakensis* approaches *C. burnsi* Dall, a Chipola species of similar dimensions but with the anterior laminae less prominently developed and at a later stage in the growth of the shell. The Oak Grove analog *Chione glyptocyma daphne* Gardner, n. subsp., is not so large; the ribs when not coalescent are more undulatory, and the radial sculpture is less uniformly developed. The numerous individuals tentatively referred to this species from half a mile below Shell Bluff are all immature, but they exhibit the relatively strong and even sculpture, both radial and concentric, which characterizes *C. funiakensis*.

Occurrence: Shoal River formation, localities ?5079°, 5193°, ?3733°, ?7261<sup>r</sup>, 7264<sup>p</sup>, 5618°.

***Chione (Liophora) trimeris* Gardner, n. sp.**

Plate XXVII, Figures 1-3

Shell large and heavy for the genus, rude and inelegant in aspect, transversely ovate-trigonal in outline, moderately compressed. Umbones anterior, well rounded, twisted forward, the tips acute and proximate. Lunule large, sunken, conspicuously cordate, the right lunular area slightly wider than the left, outlined by an impressed line and very finely laminated in harmony with the secondary concentric sculpture. Escutcheon wide, lanceolate, produced almost to the basal margin, sculptured with laminae similar to those of the lunule but even finer. Anterior extremity strongly bowed in front of the lunule, rounding smoothly into the upcurved base;

posterior extremity obliquely truncate, rounding sharply into the base. External surface sculptured with heavy concentric ribs, more or less completely coalescent over the medial portion of the disk but abruptly elevated laterally into thin, shelly plates, recurved anteriorly but not posteriorly, continuing only to the margins of the lunule and escutcheon; a very fine secondary concentric imbrication developed, persistent across the lunule and escutcheon; a rather fine incised radial sculpture also developed in many specimens entirely obsolete except on the ventral surface of the ribs, stronger toward the umbones and the ventral margin than on the medial portion of the disk. Ligament external, lodged in a linear groove extending less than half the length of the escutcheon. Hinge normal but rather heavy; the anterior cardinal in the right valve and the posterior cardinal in the left very thin and delicate; the medial cardinals cuneate; the posterior cardinal of the right valve also somewhat cuneate but much more produced; the anterior cardinal of the left valve short and rather slender. Muscle and pallial scars distinct; the posterior adductor scar larger than the anterior and more nearly semielliptical. Pallial line rather far removed from the margin; pallial sinus very short and narrow, slightly ascending, angulated at the extremity. Inner margins, except the posterior dorsal margin, finely crenate.

Dimensions: Right valve: Altitude, 34.0 millimeters; latitude, 41.3 millimeters; semidiameter, 12.4 millimeters. Left valve: Altitude, 36.5 millimeters; latitude, 48.5 millimeters; semidiameter, 12.5 millimeters.

Cotypes: U. S. Nat. Mus. No. 352543.

Type locality: No. 3742, Shell Bluff, Shoal River, Walton County, Fla.

*Chione trimeris* Gardner, n. sp., is the largest and rudest member of the genus in the Alum Bluff fauna. It is abundant in the environs of the type locality and fairly constant in its characters. Away from the type locality, however, it is less common and more variable. Near Mossyhead, for example, the specimens are higher on the average than the typical race, and bear a few heavy ribs, which do not show so strong a tendency to coalesce. Peripheral members, however, are not separable. At De Funiak Springs the representatives of this group are so distinct that they have been segregated under another name, *Chione funiakensis*. This species has a smaller and more delicate shell than *C. trimeris* and a stronger and more persistent radial sculpture. *Chione burnsi* Dall is also smaller and more strongly sculptured radially and differs further in the much less marked elevation of the lamellae on the anterior portion of the shell.

Occurrence: Shoal River formation, localities 3856<sup>c</sup>, 2645<sup>r</sup>, 3732<sup>p</sup>, 3742<sup>p</sup>, 3731<sup>r</sup>, 5080<sup>p</sup>, 5184<sup>p</sup>, ?3748<sup>p</sup>, ?3747<sup>r</sup>, ?5192<sup>r</sup>, 5195<sup>p</sup>.

# *Chione (Lirophora) ceramota* Gardner, n. sp.

Plate XXVII Figure 4

Shell large and moderately heavy for the genus, transversely ovate-trigonal in outline. Umbonal region broadly and smoothly rounded, the umbones tapering gradually to the acute and prosogyrate tips; umbonal angle a little more than 90°. Lunular margin flexuous. Anterior extremity strongly bowed in front of the lunule, rounding evenly into the up-curved base; posterior dorsal margin steeply declining; posterior extremity obtusely truncate, rounding sharply into the base; base line somewhat flexuous. Lunule cordate, slightly wider in the right valve than in the left, finely laminated concentrically. Escutcheon rather wide, produced the length of the dorsal margin, finely and evenly striated. External surface sculptured with about 20 heavy laminar ribs, which are strongly recurved over the disk and show here and there a tendency to coalesce; dorsal area marked by an abrupt transition of the recurved ribs to an outstanding flange; anterior extremities of ribs also free but less sharply differentiated, attenuated and widely flaring; a fine secondary concentric striation also developed in the interspaces, which are as a rule entirely concealed by the dorsal curvature of the ribs; a rather obscure radial lineation developed on the ventral surface of the ribs but entirely absent on the inner surface and on the lateral areas. Ligament deeply inset in an angular groove, which is produced only a little beyond the extremity of the posterior cardinals. Dentition normal for the species, rather heavy; anterior cardinal of right valve very short, thin, and laminar; medial right cardinal strong, elevated, deltoid; the posterior cardinal moderately heavy and produced; anterior left cardinal rather slender, laminar; the middle cardinal less prominent than that of the right valve; the posterior cardinal laminar, produced almost to the extremity of the ligament groove; dorsal margin of left valve beveled to fit into the groove along the inner dorsal margin of the right. Adductor scars distinct, the posterior larger and more semielliptical in outline than the anterior. Pallial line well marked, far removed from the base; pallial sinus very short, narrow, ascending, angulated at its extremity. Inner basal and anterior margins finely crenate.

Dimensions: Right valve: Altitude, 31.7 millimeters; latitude, 39.3 millimeters; semidiameter, 11.8 millimeters.

Type: U. S. Nat. Mus. No. 351924.

Type locality: No. 3732, Dave Adams Mill Creek, sec. 2, T. 3 N., R. 21 W., Walton County, Fla.

*Chione ceramota* is the analog in the Shoal River fauna of *C. glyptocyma* in the Oak Grove. The shell is larger, however, and the ribs more numerous and widely flaring behind the lunule instead of evanescent, as in *C. glyptocyma*.

Occurrence: Oak Grove sand, locality ?3749<sup>p</sup>. Shoal River formation, localities 3856<sup>a</sup>, 3732<sup>r</sup>, 3742<sup>p</sup>, 3731<sup>p</sup>, ?3748<sup>p</sup>.

Section **TIMOCLEA** Thomas Brown

1827. *Timoclea* Thomas Brown, Illustrations of the conchology of Great Britain and Ireland, pl. 19, fig. 11.

Type: *Venus ovata* Pennant. (Recent off the shores of western Europe and in the Mediterranean.)

Dall<sup>20</sup> described this section as follows:

Sculpture predominantly radial, the concentric element feeble; the middle left and two posterior right cardinals grooved; the escutcheon smooth. The siphons are united to their orifices in this group.

The presence of the group in the Alum Bluff is witnessed by juveniles probably referable to two species—one from the Chipola formation (3419), the other from the Shoal River (7264), both of them distinct from any described species, though similar in general character to *Chione grus* (Holmes).

Section **CHAMELEA** Mörch

1853. *Chamelea* Mörch, Catalogus conchyliorum, Comes de Yoldi, fasc. II, p. 23.

Type: *Venus gallina* Linnaeus. (Recent in the Mediterranean.)

Dall<sup>21</sup> characterizes this group as follows:

Sculpture of narrow, close concentric waves or low lamellae without radials or distal lamellation; teeth entire; escutcheon and lunule smooth; the ligament exposed. The siphons are partly united.

*Chione* (*Chamelea*) *rhodia* Dall

1903. *Chione* (*Chamelea*) *rhodia* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1301, pl. 55, fig. 10.

The specimens so identified from Oak Grove are the young of *Venus*.

Genus **ANOMALOCARDIA** Schumacher

1817 *Anomalocardia* Schumacher, Essai d'un nouveau système des habitations des vers testacés, pp. 44, 134.

Type: *Venus flexuosa* Linnaeus. (Recent in the West Indies and southward to Brazil.)

Dall<sup>22</sup> describes this genus as follows:

This group is distinguished by its general aspect and similarity of the species rather than by strongly marked characters, and if it had not been generally accepted I should have been tempted to regard it as merely a subgenus of *Chione*.

The dental formula is  $\frac{L. \text{ioioio}}{R. \text{oioioi}}$ . The teeth are entire and rather slender and diverge widely from their common center. The upper side of the posterior left cardinal and the lower edge of the right nymph are usually minutely rugose. The external sculpture usually is of coarse, more or less confluent, concentric ribs, with obsolete radial striae, though when the shell disintegrates under the influence of decay it is seen to have internally a strong radial element in its structure. \* \* \* The sculpture of the shell is often obsolete at the middle of the valves, which in the typical group are covered by a vernicose olivaceous periostracum. The inner margins are crenulate and the valves attenuated and more or less nasute behind. The

ligament is exposed and rather short; the lunule and escutcheon impressed, the posterior right dorsal margin grooved to receive the edge of the opposite valve. The beaks are rather pointed in most of the species and the pallial sinus is very small, angular, and sometimes almost obsolete. Most of the species are very solid and heavy.

The meager representation of the genus in the Alum Bluff, is augmented by a single juvenile. *Anomalocardia floridana* Conrad has been reported from the "Sopchoppy limestone" (a shallow-water facies of the Chipola formation), but the presence of this Tampa Bay species is not confirmed by any of the available material.

*Anomalocardia penita* Conrad

1846. *Venus penita* Conrad, Am. Jour. Sci., 2d ser., vol. 2, p. 399.

1887. *Venus penita* Conrad. Heilprin, Wagner Free Inst. Sci. Trans., vol. 1, p. 116.

1903. *Anomalocardia floridana* Conrad. Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1303 (in part: figures excluded).

1915. *Anomalocardia floridana* Conrad. Dall, U. S. Nat. Mus. Bull. 90, p. 150, pl. 23, figs. 4, 5 (in part: figures excluded).

Conrad described this species in 1846 as follows:

Cuneiform, concentrically striated, the lines strong anteriorly, posteriorly less distinct, 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 shows the form of the teeth, and an impression in the rock copies the exterior characters of the shell.

Dall gives the following notes in 1903:

Conrad figures two species, the first and largest under the name of *Venus penita* (p. 399) and the second *V. floridana*. I am somewhat inclined to think Heilprin was right in uniting them, but in a very large number of specimens I have found none which agrees precisely with Conrad's figure of *V. penita*. The identity of the common species of the silex beds with *V. floridana* is, however, undoubted, and therefore I have preferred to use that name, as Conrad's type of *V. penita* did not come from the silex beds but was a cast in limestone, evidently the Tampa limestone, the next succeeding horizon. There is a chance that *V. penita* may turn up again and prove distinct from *V. floridana*, and it seems more prudent for the present to treat them separately. \* \* \*

*Anomalocardia penita* Conrad appears to differ by a more slender and elongated shell, the posterior end of which shows hardly any flexuosity but is extended like that of *A. caloosana*, while the lunular region is much less impressed than in *A. floridana*.

This form is not typical but might be regarded as a precursor, in which *Anomalocardia* is developing from *Chione*.

The species has not been recognized in any of the later collections.

Occurrence: Chipola formation. ("Sopchoppy limestone, and Baileys Mill Creek sink, and of the Tampa limestone overlying the silex beds at Ballast Point, Fla.")—Dall.)

<sup>20</sup> Dall, W. H., Contributions to the Tertiary fauna of Florida: Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1288, 1903.

<sup>21</sup> Idem, p. 1289.

<sup>22</sup> Idem, p. 1302.

**Anomalocardia chipolana Dall**

Plate XXVIII, Figure 1

1903. *Anomalocardia chipolana* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 6, p. 1304, pl. 55, fig. 1.

Dall describes this species as follows:

Shell small, trigonal, produced behind, sculptured with elevated concentric lines, more crowded toward the base; both lunule and escutcheon feebly defined, beaks low and pointed; hinge very delicate, normal, the internal margins faintly crenulate; both ends of the shell rounded, the base with hardly any flexuosity. Length 7.0, height 5.0, diameter 3.0 millimeters.

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.

Type: U. S. Nat. Mus. No. 114592.

Type locality: No. 2211, Alum Bluff (lower bed of Chipola formation), Liberty County, Fla.

The juvenile from Chipola River is probably referable to a closely related but distinct species, differing in the more acutely rounded and closely sculptured umbones.

Occurrence: Chipola formation, localities 3419<sup>r</sup>, 2211<sup>r</sup>.

**Genus VENUS (Linnaeus) Lamarck**

1758. *Venus* Linnaeus, Systema naturae, 10th ed., p. 68.

1799. *Venus* Lamarck, Soc. nat. hist. Paris Mém., Prodrome d'une nouvelle classification des coquilles, p. 84.

Type: *Venus mercenaria* Linnaeus. (Recent off the east coast of North America from Prince Edward Island to Yucatan.)

Dall<sup>23</sup> describes this genus as follows:

The genus *Venus*, as restricted, is a very compact and homogeneous group, illustrating the highest development of the hinge structure and the most extreme limit of size afforded by the genus in its widest sense. While not affording such exemplars of beauty in color and sculpture as the tropical groups contain, nevertheless the reputation of the species as a basis for Indian trade and a very important food supply is worthy of its distinction as type of the most characteristic product of evolution in the Pelecypoda.

The shell of *Venus* is solid and heavy, porcellaneous, and somewhat earthy; the periostracum extremely thin and hardly visible; the form is rounded or trigonal with faint radial striation and stronger concentric lamellosity; the inner margins are crenulate; the pallial sinus is small and triangular; the beaks are prominent; the lunule and escutcheon well defined; there are two bifid cardinal teeth in the left valve; one posterior bifid and two anterior simple cardinals in the right valve; a supplementary posterior cardinal in each valve below the ligamentary nymph is modified to form a rugose area of which the asperities interlock with those of the opposite valve. The genus is represented on muddy or sandy bottom in shallow water from the north shore of the Gulf of Mexico to Cape Cod, with some still more northern colonies reaching the Gulf of St. Lawrence; a single species is found in the Oregonian region. The group appears first in the Oligocene and seems to have had its maximum development in the Miocene. As far as yet known it is confined to North America and Japan.

Three species of *Venus* have been recognized in the Alum Bluff—the earliest, *Venus langdoni* Dall, obvi-

ously of the group of *Venus ducatei* Conrad from the Calvert formation (lower Chesapeake) of the middle Atlantic coast, the other two intermediate in their characters between *Venus ducatei* and *Venus mercenaria* Linnaeus. Each species is chiefly known from a single formation, though there is a certain amount of overlapping. *Venus langdoni* Dall, which is restricted in Florida to the Chipola formation, persists into the Oak Grove sand in the environs of Bainbridge, Decatur County, Ga. *Venus prodroma* occurs near De Funiak Springs, though elsewhere it is restricted to the Oak Grove. *Venus nannodes* has not been recognized except in deposits of Shoal River age. At no locality is the genus very abundantly represented, and nowhere, except possibly near Laurel Hill in Walton County, does it assume the relative importance in the molluscan faunas which it holds in the faunas of the later Miocene.

Concentric laminae conspicuously elevated, relatively distant upon the medial portion of the shell, not fused.

*Venus langdoni* Dall.

Concentric laminae not conspicuously elevated, crowded upon the medial portion of the shell, recurved, and commonly fused:

Latitude of adult shell generally exceeding 6.5 millimeters.....*Venus prodroma* Gardner, n. sp.

Latitude of adult shell rarely exceeding 6.5 millimeters.  
*Venus nannodes* Gardner, n. sp.

**Venus langdoni Dall**

Plate XXVII, Figure 7; Plate XXVIII, Figures 2-3

1900. *Venus langdoni* Dall, Wagner Free Inst. Sci. Trans., vol. 3, pt. 5, p. 1198, pl. 42, figs. 2, 7, 12 (no description).

1903. *Venus langdoni* Dall, idem, pt. 6, p. 1308.

Dall described this species in 1903 as follows:

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 striae 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 millimeters.

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.

Type: U. S. Nat. Mus. No. 114569.

Type locality: No. 2211, lower bed at Alum Bluff, Liberty County, Fla.

<sup>23</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1306, 1903.



*Venus langdoni* suggests *Venus ducatei* of the later Miocene of the middle Atlantic coast, though the northern species is rather higher and less produced anteriorly and is sculptured with closer and less elevated concentric laminae. The conspicuously elevated lamellae and their relatively distant spacing upon the medial portion of the shell serve to separate *Venus langdoni* from *Venus prodroma* and *Venus nannodes* of the later Alum Bluff.

Occurrence: Chipola formation, localities 2211<sup>a</sup>, 7183<sup>c</sup>, 395<sup>c</sup>, 7468<sup>r</sup>. Oak Grove sand, localities ?3386<sup>c</sup>, 3385<sup>p</sup>, ?7148<sup>c</sup>.

***Venus prodroma* Gardner, n. sp.**

Plate XXVIII, Figures 4-5

Shell rather small for the genus, not very heavy, full, ovate-trigonal in outline. Umbonal area smoothly inflated, the umbones acute, incurved, and prosogyrate at their tips, which fall near the margin of the anterior third. Lunule wider in the right valve than in the left, the cordate outline defined by a deeply incised linear groove. Escutcheon defined by the abrupt suppression of the concentric lamellae, arcuate-cuneate in outline, wider and more sharply defined in the left valve than in the right; an obscure ridge developed a little behind the escutcheon. Anterior extremity of shell bowed out in front of the lunule; posterior extremity broadly rounded or slightly produced; basal margins smoothly arcuate, more strongly upcurved in front than behind. External surface covered with crowded lamellae, bent forward, flattened, and commonly more or less fused on the medial portion of the shell, persisting across the lunule though much less coarse on it, reduced on the left valve of the escutcheon to fine striations, much less reduced on the right valve. Ligament external, the area wide, wedging out at the extremities; the groove behind deeply undercutting the dorsal margin. Roughened area rather small. Dentition normal for the genus; three cardinals radiating fanlike in each valve; the anterior cardinals short, simple; the medial cardinals heavier, feebly bifid; the right posterior cardinal deeply sulcate; the left posterior cardinal laminar and produced. Interior of shell generally thickened, especially anteriorly, within the area of the attached mantle. Adductor muscle scars large, the anterior semicylindrical, buttressed along its inner surface in the adult shell; posterior muscle scar larger than the anterior and more irregular in outline; pedal scar small but deep, set under the anterior extremity of the hinge plate. Pallial line distant from the margin, especially toward the front, distinct; pallial sinus rather short, trigonal, terminating in an acute angle of approximately 60°, dorsal margin approximately horizontal. Inner margins very finely crenate.

Dimensions: Right valve: Altitude, 62.0 millimeters; latitude, 73.5 millimeters; semidiameter,

24.0 millimeters. Left valve: Altitude, 68.0 millimeters; latitude, 78.7 millimeters; semidiameter, 25.0 millimeters.

Cotypes: U. S. Nat. Mus. No. 352544.

Type locality: No. 7055, old Senterfeit mill, 4½ miles southwest of Laurel Hill, Walton County, Fla.

*Venus prodroma* is the probable forerunner of the later Miocene and Recent *Venus mercenaria* Say. The older shell is heavier and more inflated, particularly in the medial and anterior portions. The average *Venus prodroma* is less produced and pointed behind than the average *Venus mercenaria*, though they both offer a rather wide series of variations. The fusing of the concentric lamellae is generally more marked in the later form, and the thickening upon the inner surface is less marked and less uniformly developed.

*Venus ducatei* Conrad, one of the characteristic fossils of the Calvert formation of Maryland, is a shell of similar dimensions and outline. It differs, however, in the concentric sculpture. The laminae of the Maryland shell are more elevated and less closely spaced than in *Venus prodroma*, and there is no fusing upon the medial portion of the shell. Indeed, in the character of the concentric sculpture, *Venus ducatei* is intermediate between *Venus langdoni* Dall and *Venus prodroma*.

*Venus nannodes* from Shell Bluff suggests a dwarf *Venus prodroma*. The shell is about three-fifths the size of the Laurel Hill species, though it is more inflated and generally heavier. The lunule is shorter and wider as a rule and the concentric sculpture more dense.

The young suggest *V. rileyi* Conrad in conformation, though the concentric lamination is much heavier and the recurving and fusing of the laminae much more pronounced.

Except for its occurrence near De Funiak Springs, a locality which has yielded a fauna with more Oak Grove affinities than any other in the Shoal River formation, *Venus prodroma* is restricted in its known distribution to the Oak Grove sand.

Occurrence: Oak Grove sand, localities ?7148<sup>p</sup>, ?7054<sup>r</sup>, 2652<sup>c</sup>, 7055<sup>a</sup>, 3749<sup>c</sup>. Shoal River formation, locality 5618<sup>c</sup>.

***Venus nannodes* Gardner, n. sp.**

Plate XXVIII, Figures 6-7

Shell rather heavy but small and dwarfish, ovate-trigonal to rudely quadrate in outline, moderately convex, the maximum inflation near the medial portion of the shell. Umbones smoothly rounded, the tips small, incurved, prosogyrate, falling near the margin of the anterior third. Lunule short but wide, finely laminated, outlined by a deeply incised linear groove. Escutcheon very wide, wedging out toward the umbones, the outer margin arcuate, the portion in the right valve much more strongly sculptured than

that in the left; an obscure ridge developed a little behind the escutcheon. Anterior extremity bowed out in front of the lunule, the posterior broadly rounded or produced to an obtusely pointed extremity; basal margins arcuate, upcurved anteriorly. External surface covered with closely crowded lamellae bent toward the umbones, flattened and commonly fused over the medial portion, discrete but densely packed laterally. Ligament external, the area relatively large, with a deeply undercutting groove behind it. Roughened area rather small in most individuals. Hinge plate heavy. Dentition normal for the species; three cardinals radiating fan-like in each valve; the medial and posterior cardinals in the right valve and the anterior and medial cardinals in the left inclined to be bifid; anterior right cardinal and posterior left very thin and laminar. Inner surface of adult thickened anteriorly within the area of the attached mantle. Adductor scars distinct, rudely semicylindrical, the anterior more prominent by reason of the thickening along its inner margin; pedal scar small but deeply inset under the anterior extremity of the hinge plate. Pallial line distinct, more remote from the ventral margin anteriorly than posteriorly; pallial sinus rather short, terminating in an acute angle of approximately 60°, the dorsal line of the sinus nearly horizontal; inner margins sharply crenate.

Dimensions: Right valve: Altitude, 51.5 millimeters; latitude, 57.0 millimeters; semidiameter, 22.3 millimeters. Left valve: Altitude, 45.0 millimeters; latitude, 53.5 millimeters; semidiameter, 19.5 millimeters.

Cotypes: U. S. Nat. Mus. No. 351878 (right valve); No. 352542 (left valve).

Type locality: Right valve: No. 3742, Shell Bluff, Shoal River, Walton County, Fla. Left valve: No. 3856, 6 miles west-northwest of Mossyhead, Walton County, Fla.

*Venus nannodes* is typically a small, heavy, strongly inflated shell, closely allied to *V. prodroma* Gardner, n. sp. It differs from the Oak Grove species in the smaller size and generally higher and heavier shell. At certain localities, however, the shells are rather thin, a character emphasized by the decortication of the outer surface, and the forms approach the relatively small *Venus prodroma*, which is developed in the environs of De Funiak Springs.

In superficial characters *Venus plena inflata* Dall from Yorktown is rather close, though it is a thinner, less inflated shell, is more trigonal in outline, and has more strongly anterior umbones.

Occurrence: Shoal River formation, localities 3856<sup>c</sup>, 3742<sup>p</sup>, 3731<sup>p</sup>, ? 5080<sup>p</sup>, 5184<sup>p</sup>, 5195<sup>r</sup>, ? 3748<sup>c</sup>; Aldrich collection.

#### Subfamily GEMMINAE Dall

Dall<sup>24</sup> defines this group as follows:

This group includes small species of Veneridae which are characterized by viviparity and carry the young for a considerable period, like *Sphaerium*, within the perivisceral chamber. They have, as a rule, purple and white coloration, if any, and a smooth or concentrically striated surface. They live in sand or mud in moderate depths of water on both coasts of North America, and have not been identified from any other region.

#### Genus PARASTARTE Conrad

1863. *Parastarte* Conrad, Acad. Nat. Sci. Philadelphia Proc. for 1862, p. 288.

Type: *Parastarte triquetra* Conrad. (Recent off the Florida Peninsula and occurs also in the Miocene, Pliocene, and Pleistocene deposits of Florida.)

Conrad described this species as follows:

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 channeled above.

The genus includes a number of small but heavy shells, smooth or feebly sculptured concentrically. The lunule is very large, but there is no defined escutcheon. The ligament is short and external. The venerid hinge of three radiating cardinals in each valve is so modified by the relative prominence of the medial cardinal of the right valve and the anterior and medial cardinals of the left that it superficially resembles that of *Astarte*. The pallial sinus is very shallow and the inner margins crenate. *Parastarte* is restricted in its known distribution, both recent and fossil, to the Florida peninsula. Hitherto the earliest deposits at which the group had been recognized were those at Jackson Bluff on Ochlockonee River. By the discovery of a new species in the Chipola formation the origin of the genus is pushed back to the beginning of the Miocene.

#### *Parastarte chipolana* Gardner, n. sp.

Plate XXVII, Figures 5-6; Plate XXVIII, Figure 8

Shell roughly a minute isosceles triangle with an apical angle of approximately 60°; valves highly inflated medially, flattened laterally. Umbones full, prominent by reason of their position at the apex of the angle, the tips minute and feebly prosogyrate. Posterior slope a little steeper than the anterior and the posterior basal angle less gently rounded; basal margin approximately horizontal medially, upcurved laterally. Lunule extending to the basal angle, depressed but not delimited by an incised groove. Posterior area flattened and cut off from the medial portion by an obtuse ridge. External sculpture reduced to incrementals with a few exaggerated growth stages toward the base. Ligament very short, ex-

<sup>24</sup> Dall, W. H., op. cit., vol. 3, pt. 6, p. 1329, 1903.



ternal, opisthodontic. Hinge with three radiating cardinals in each valve but so modified that they superficially resemble the dentition of *Astarte*; anterior cardinal of right valve reduced to a very thin, low, rather short lamina; the posterior cardinal also thin and short but more elevated; medial cardinal very heavy, deltoid; anterior and medial cardinals of left valve rather heavy, laminar, diverging on either side of the deep socket that receives the large cardinal of the right valve; posterior left cardinal reduced to a short, thin lamina similar to the right anterior cardinal; posterior lateral margin of right valve and anterior lateral margin of left feebly sulcated to receive the beveled edges of the opposite valve. Characters of interior distinct. Adductor scars rather large for so small a shell, irregular in outline. Pallial line distant from the base, the pallial sinus little more than a deep dent. Interior in many specimens obscurely striate radially in harmony with the finely crenate inner margins.

Dimensions: Right valve (paratype): Altitude, 2.8 millimeters; latitude, 2.7 millimeters; semidiameter, 0.9 millimeter. Left valve (type): Altitude, 2.65 millimeters; latitude, 2.5 millimeters; semidiameter, 0.9 millimeter.

Type and paratype: U. S. Nat. Mus. No. 352546.

Type locality: No. 3419, McClelland farm, 1 mile below Bailey's Ferry, Calhoun County, Fla.

*Parastarte chipolana* Gardner, n. sp., is obviously the progenitor of the later Tertiary and Recent *Parastarte triquetra* Conrad. Conrad's species runs larger and, as a rule, the umbones are narrower and more sharply rounded. The Chipola species is, however, more uniform in outline than the later form.

This is the first reported occurrence of the genus in strata older than the Chesapeake group.

Occurrence: Chipola formation, locality 3419<sup>2</sup>.

#### Family PETRICOLIDAE D'Orbigny

##### Genus PETRICOLA Lamarck

1801. *Petricola* Lamarck, *Système des animaux sans vertèbres*, p. 121.

Type: *Venus lapicida* Gmelin. (Recent on the South Atlantic Coast and in the West Indies.)

Shell thin, oval or elongate, commonly irregular, gaping. Umbones anterior but not terminal. External sculpture predominantly radial; inner margins smooth. Lunule ill-defined. Ligament external, attached to nymphs. Armature of right valve generally consisting of two cardinals, the posterior of which is grooved or bifid; third rudimentary cardinal rarely present; left valve furnished either with three divergent

cardinals, the middle one bifid, the remaining two simple, or with two divergent cardinals—a simple posterior and a bifid anterior; laterals absent in the normal adult. Pallial sinus narrow, as a rule, and ascending, varying considerably in depth.

A nestling or burrowing genus, which exhibits the variability characteristic of dwellers in such a habitat.

The group has been recognized from strata as early as the Cretaceous; the Recent species, which number only about 25, are widely distributed in the temperate and warmer waters.

The evidence of the presence of *Petricola* in the Alum Bluff rests upon a single fragment. It is sufficient, however, to prove the existence, in the latest of the Alum Bluff horizons, of a group hitherto not recognized in strata older than the Yorktown formation.

##### Subgenus RUPELLARIA Fleuriau-Bellevue

1802. *Rupellaria* Fleuriau-Bellevue, *Mémoire sur quelques nouveaux genres de mollusques et de vers lithophages*, p. 3.

Type: *Venus lithophaga* Retzius. (Recent in the Mediterranean.)

Dall<sup>25</sup> characterized this subgenus as follows:

Shell inflated and rounded in front, attenuated and more compressed behind; sculpture chiefly radial, stronger anteriorly.

##### *Petricola* (*Rupellaria*) sp. indet.

A single fragment of a left valve referable to this group was collected in the Shoal River formation of Walton County. The shell is very thin and probably immature. The valves are compressed for the group and the beaks low and decidedly anterior. The posterior dorsal margin is apparently nearly horizontal. The entire external surface is sculptured with crowded, somewhat crinkled radials, more sharply elevated laterally than upon the medial portion of the shell and interrupted by the rather prominent resting stages. The ligament area indicates a strong and deeply sunken ligament. The cardinals are thin but sharply elevated, the anterior lower than the other two and partly fused with the dorsal margin, the medial cut so deep that it is almost A-shaped, the posterior thin and laminar and removed from the dorsal margin. The pallial sinus is deep and rudely rectangular in outline.

This species, too poorly preserved to name, is the possible progenitor of *Petricola harrisii* Dall of the Yorktown Miocene. It is apparently a relatively lower and less inflated shell and certainly a shell with a much finer radial sculpture than that of *P. harrisii*.

Occurrence: Shoal River formation, locality 3 856<sup>2</sup>.

<sup>25</sup> Dall, W. H., op. cit., vol. 3, pt. 5, p. 1058, 1903.



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**PLATES XXIV-XXVIII**

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## PLATE XXIV

[The specimen figured is the type unless otherwise stated]

FIGURE 1. *Dosinia (Dosinidia) cnipolana* Dall (p. 153). Exterior of left valve; altitude 36.5 millimeters; latitude 39.0 millimeters. (After Dall.)

FIGURE 2. *Dosinia (Dosinidia) liogona* Dall (pp. 153-154). Exterior of right valve; altitude 45.0 millimeters; latitude 48.0 millimeters. (After Dall.)

FIGURES 3-5. *Dosinia (Dosinidia) dalli* Gardner, n. sp. (p. 154).

3. Exterior of right valve (paratype); altitude 37.5 millimeters; latitude 40.0 millimeters (not the type).

4. Umbonal view of double valves (type); diameter 12.5 millimeters.

5. Interior of right valve (type); altitude 31.5 millimeters; latitude 33.0 millimeters.

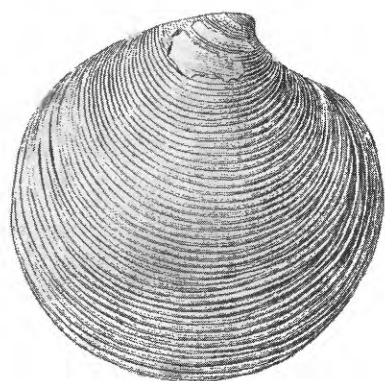
FIGURE 6. *Clementia grayi* Dall (pp. 154-155). Exterior of left valve; altitude 55.0 millimeters; latitude 63.0 millimeters. (After Dall.)

FIGURE 7. *Macrocallista acuminata* Dall (p. 160). Exterior of left valve; altitude 16.5 millimeters; latitude 27.5 millimeters. (After Dall.)

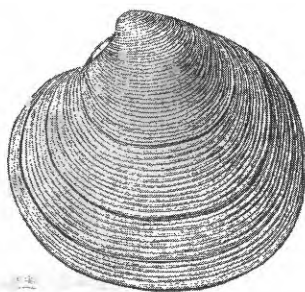
FIGURES 8-9. *Macrocallista (Paradione) waltonensis* Gardner, n. sp. (p. 161).

8. Interior of right valve; altitude 51.0 millimeters; latitude 71.0 millimeters.

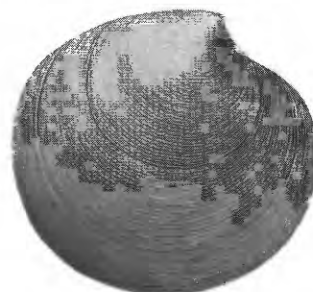
9. Exterior of right valve; altitude 51.0 millimeters; latitude 71.0 millimeters.



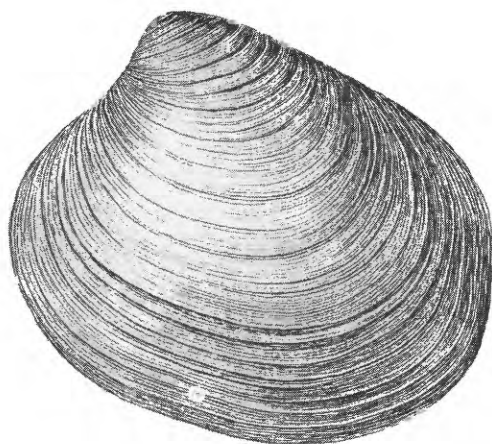
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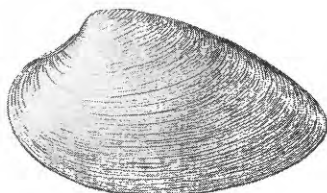
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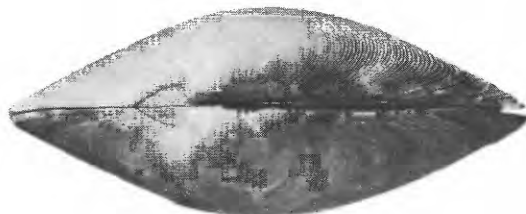
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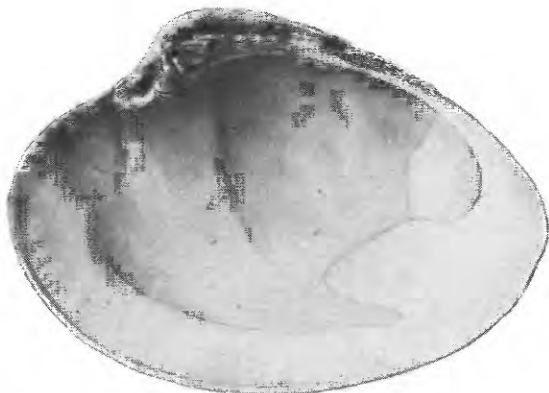
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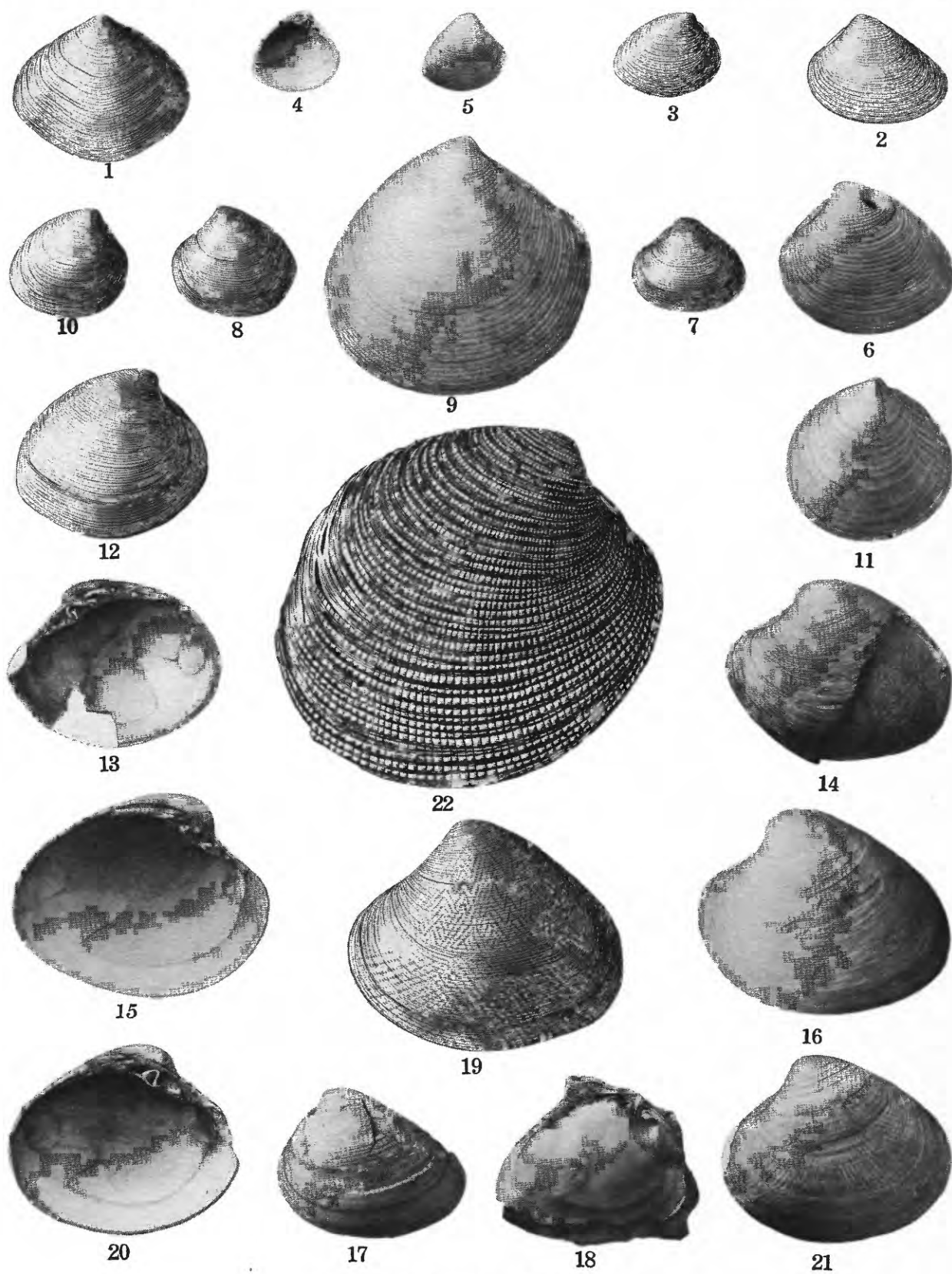


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VENERACEA OF THE ALUM BLUFF GROUP



VENERACEA OF THE ALUM BLUFF GROUP

## PLATE XXV

- FIGURE 1. *Grateloupia* (*Cytheriopsis*) *alumensis* Dall (pp. 155–156). Exterior of right valve; altitude 12.5 millimeters; latitude 15.0 millimeters. (After Dall.)
- FIGURE 2. *Transennella utica* Dall (p. 156). Exterior of left valve; altitude 4.5 millimeters; latitude 6.0 millimeters. (After Dall.)
- FIGURE 3. *Transennella chipolana* Dall (pp. 156–157). Exterior of right valve; altitude 4.0 millimeters; latitude 4.8 millimeters. (After Dall.)
- FIGURES 4–5. *Transennella dasa* Gardner n. sp. (p. 157).
4. Interior of left valve (cotype); altitude 4.8 millimeters; latitude 5.2 millimeters.
5. Exterior of right valve (cotype); altitude 4.3 millimeters; latitude 4.8 millimeters.
- FIGURE 6. *Transennella dasa makra* Gardner, n. subsp. (p. 157). Exterior of left valve; altitude 5.3 millimeters; latitude 6.0 millimeters. (After Dall.)
- FIGURE 7. *Transennella santarosana* Dall (pp. 157–158). Exterior of left valve; altitude 5.5 millimeters; latitude 6.5 millimeters. (After Dall.)
- FIGURE 8. *Gafrarium* (*Gouldia*) *erosum* Dall (p. 158). Exterior of left valve; altitude 6.2 millimeters; latitude 7.3 millimeters. (After Dall.)
- FIGURE 9. *Gafrarium* (*Gouldia*) *erosum bolteni* Gardner, n. subsp. (pp. 158–159). Exterior of right valve (cotype); altitude 4.5 millimeters; latitude 4.8 millimeters.
- FIGURE 10. *Gafrarium* (*Gouldia*) *altum* Dall (p. 159). Exterior of right valve; altitude 4.5 millimeters; latitude 4.5 millimeters. (After Dall.)
- FIGURE 11. *Gafrarium* (*Gouldia*) *phacotum* Gardner, n. sp. (p. 159). Exterior of right valve; altitude 3.2 millimeters; latitude 3.0 millimeters.
- FIGURE 12. *Callocardia* (*Agriopoma*) *sincera* Dall (p. 162). Exterior of right valve; altitude 17.5 millimeters; latitude 20.75 millimeters. (After Dall.)
- FIGURES 13–14. *Callocardia* (*Agriopoma*) *prosayana* Gardner, n. sp. (p. 162).
13. Interior of right valve (cotype); altitude 29.0 millimeters; latitude 35.5 millimeters.
14. Exterior of left valve (cotype); altitude 30.0 millimeters; latitude 38.5 millimeters.
- FIGURES 15–16. *Callocardia* (*Agriopoma*) *prosayana dodona* Gardner, n. subsp. (p. 163).
15. Interior of left valve; altitude 18.0 millimeters; latitude 21.0 millimeters.
16. Exterior of left valve; altitude 18.0 millimeters; latitude 21.0 millimeters.
- FIGURES 17–18. *Callocardia* (*Agriopoma*) *albofonte* Gardner, n. sp. (p. 163).
17. Exterior of left valve; altitude 13.5 millimeters; latitude 17.0 millimeters.
18. Cast of interior of right valve (not the type) .
- FIGURE 19. *Pitaria* (*Hyphantosoma*) *floridana* Dall (p. 164). Exterior of left valve; altitude 25.0 millimeters; latitude 29.2 millimeters. (After Dall.)
- FIGURES 20–21. *Pitaria* (*Hyphantosoma*) *waltonensis* Gardner, n. sp. (pp. 164–165).
20. Interior of left valve; altitude 21.5 millimeters; latitude 25.5 millimeters.
21. Exterior of left valve; altitude 21.5 millimeters; latitude 25.5 millimeters.
- FIGURE 22. *Antigona caesarina* (Dall) (p. 166). Exterior of right valve; altitude 58.0 millimeters; latitude 66.0 millimeters. (After Dall.)

## PLATE XXVI

FIGURE 1. *Chione chipolana* Dall (pp. 167-168). Exterior of right valve; altitude 25.6 millimeters; latitude 32.0 millimeters. (After Dall.)

FIGURES 2-3. *Chione (Liophora) burnsii* Dall (pp. 168-169).

2. Exterior of left valve; altitude 26.0 millimeters; latitude 34.0 millimeters. (After Dall.)

3. Exterior of left valve (not the type); altitude 13.5 millimeters; latitude 17.0 millimeters. (After Dall.)

FIGURE 4. *Chione (Liophora) burnsii discreta* Gardner, n. subsp. (p. 169). Exterior of left valve; altitude 24.0 millimeters; latitude 30.2 millimeters. (After Dall.)

FIGURES 5-6. *Chione (Liophora) sellardsi*, n. sp. (pp. 169-170).

5. Interior of right valve; altitude 20.3 millimeters; latitude 25.0 millimeters.

6. Exterior of left valve; altitude 20.3 millimeters; latitude 25.0 millimeters.

FIGURE 7. *Chione (Liophora) glyptocyma* Dall (p. 170). Exterior of left valve; altitude 21.5 millimeters; latitude 26.5 millimeters (After Dall.)

FIGURE 8. *Chione (Liophora) glyptocyma daphne* Gardner, n. subsp. (pp. 170-171). Exterior of right valve; altitude 22.0 millimeters; latitude 26.3 millimeters.

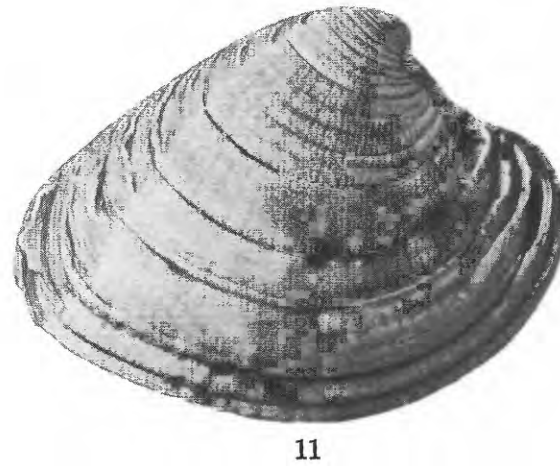
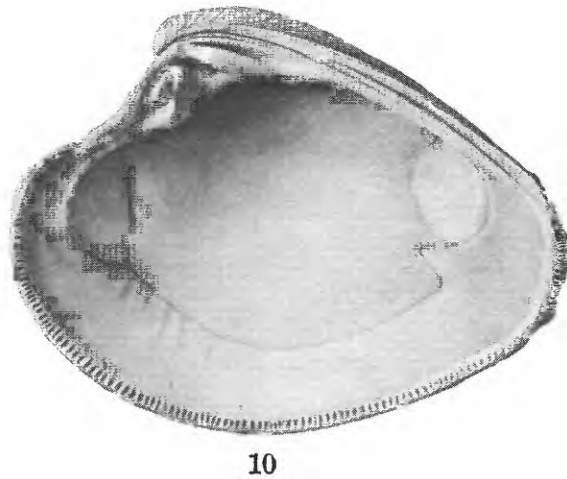
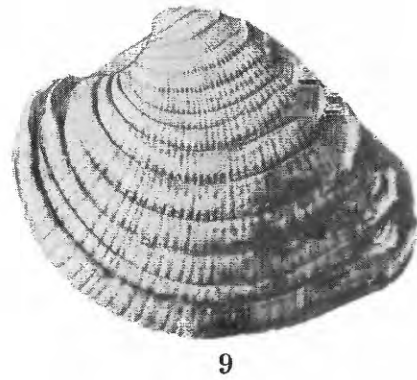
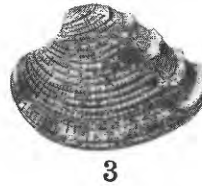
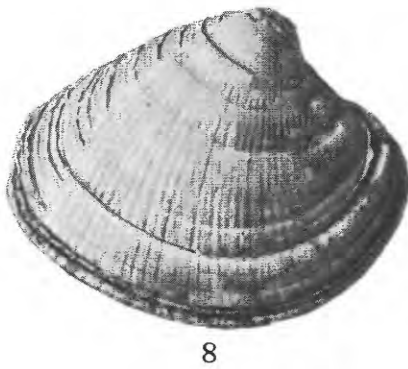
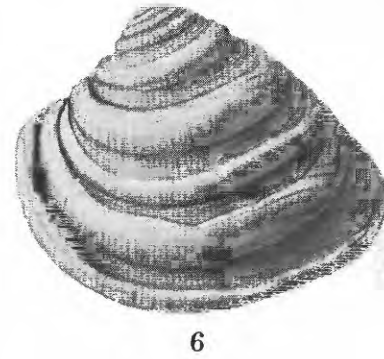
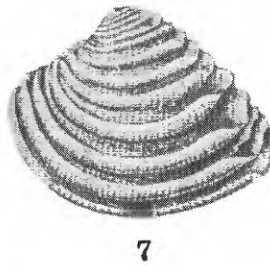
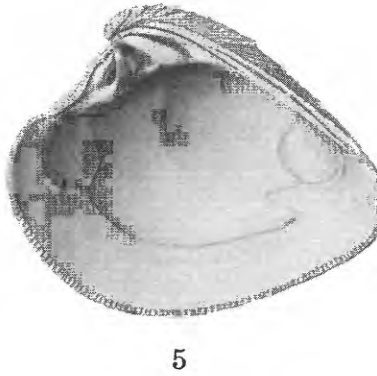
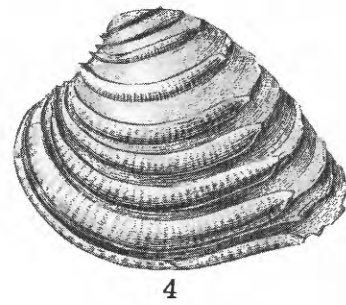
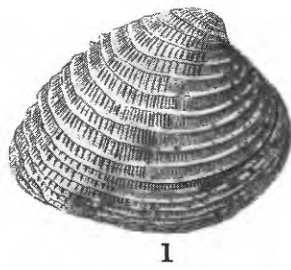
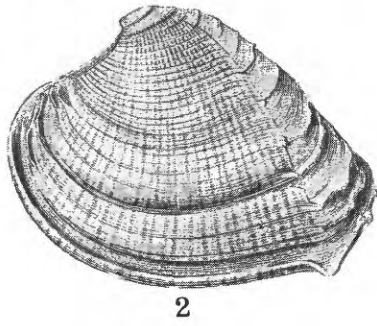
FIGURES 9-11. *Chione (Liophora) funiakensis* Gardner, n. sp. (p. 171).

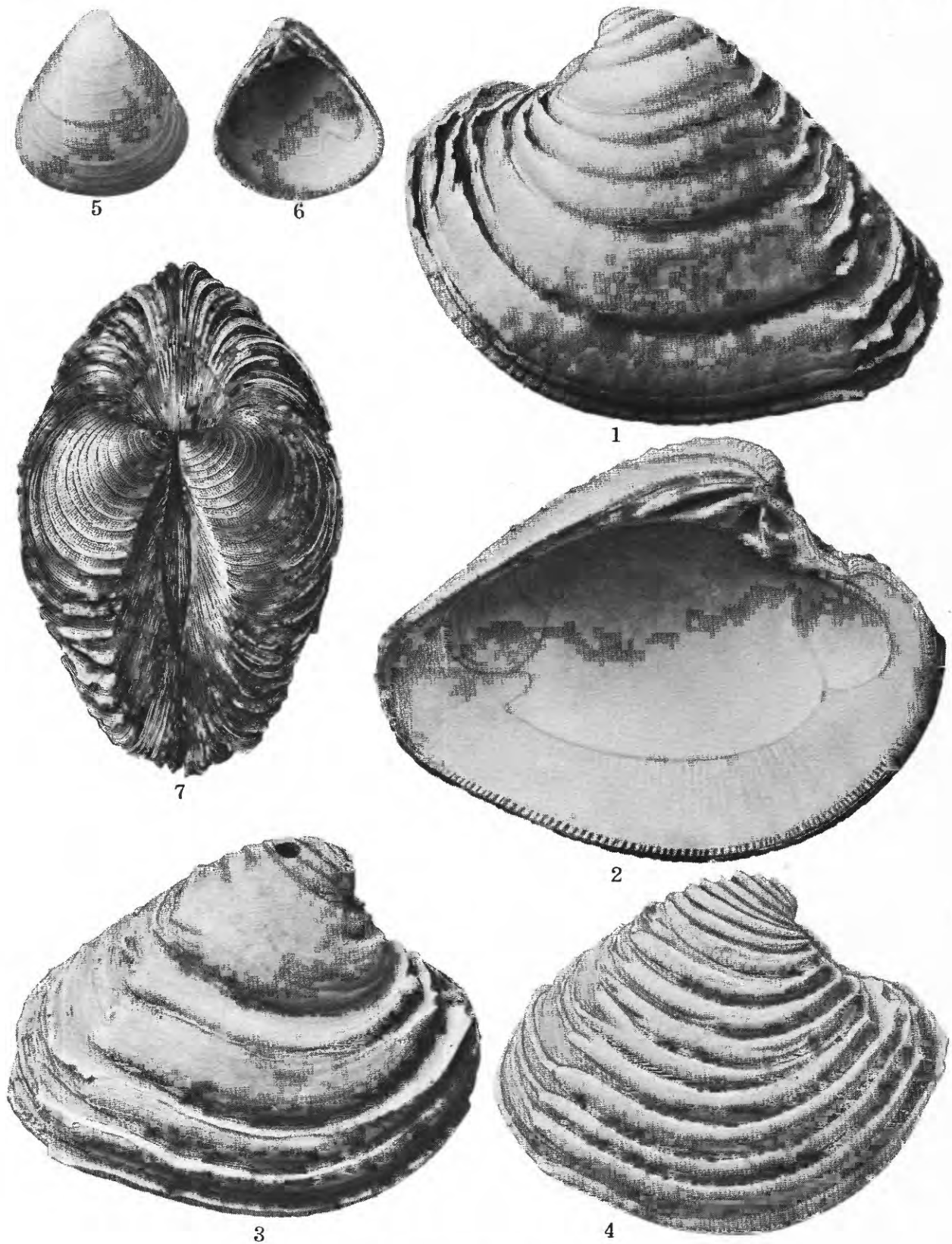
9. Exterior of left valve (cotype); altitude 22.7 millimeters; latitude 27.8 millimeters.

10. Interior of right valve (cotype); altitude 28.3 millimeters; latitude 37.5 millimeters.

11. Exterior of right valve (cotype); altitude 28.3 millimeters; latitude 37.5 millimeters.







VENERACEA OF THE ALUM BLUFF GROUP

## PLATE XXVII

FIGURES 1-3. *Chione (Lirophora) trimeris* Gardner, n. sp. (pp. 171-172).

1. Exterior of left valve (cotype); altitude 36.5 millimeters; latitude 48.5 millimeters.
2. Interior of left valve (cotype); altitude 36.5 millimeters; latitude 48.5 millimeters.
3. Exterior of right valve (cotype); altitude 34.0 millimeters; latitude 41.3 millimeters.

FIGURE 4. *Chione (Lirophora) ceramola* Gardner, n. sp. (p. 172). Exterior of right valve; altitude 31.7 millimeters; latitude 39.3 millimeters.

FIGURES 5-6. *Parastarte chipolana* Gardner, n. sp. (pp. 176-177).

5. Exterior of right valve; altitude 2.65 millimeters; latitude 2.5 millimeters.
6. Interior of right valve (paratype); altitude 2.8 millimeters; latitude 2.7 millimeters.

FIGURE 7. *Venus langdoni* Dall (pp. 174-175). Umbonal view of double valves; diameter 50.0 millimeters. (After Dall.)

## PLATE XXVIII

FIGURE 1. *Anomalocardia chipolana* Dall (p. 174). Exterior of left valve; altitude 5.0 millimeters; latitude 7.0 millimeters. (After Dall.)

FIGURES 2-3. *Venus langdoni* Dall (pp. 174-175).

2. Exterior of left valve; altitude 65.0 millimeters; latitude 82.0 millimeters. (After Dall.)

3. Interior of left valve; altitude 65.0 millimeters; latitude 82.0 millimeters. (After Dall.)

FIGURES 4-5. *Venus prodroma* Gardner, n. sp. (p. 175).

4. Interior of right valve (cotype); altitude 62.0 millimeters; latitude, 73.5 millimeters.

5. Exterior of left valve (cotype); altitude 68.0 millimeters; latitude 78.7 millimeters.

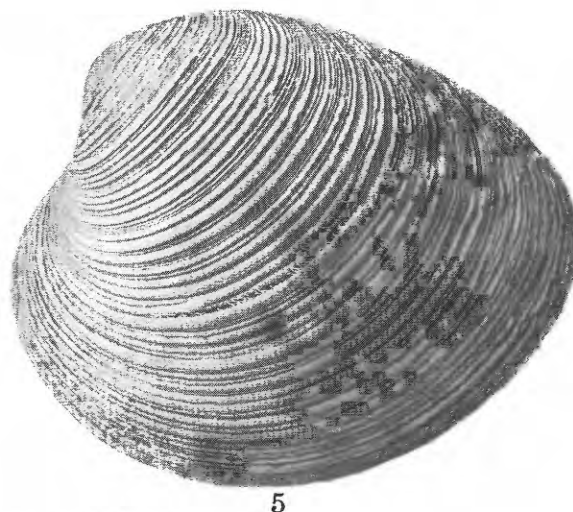
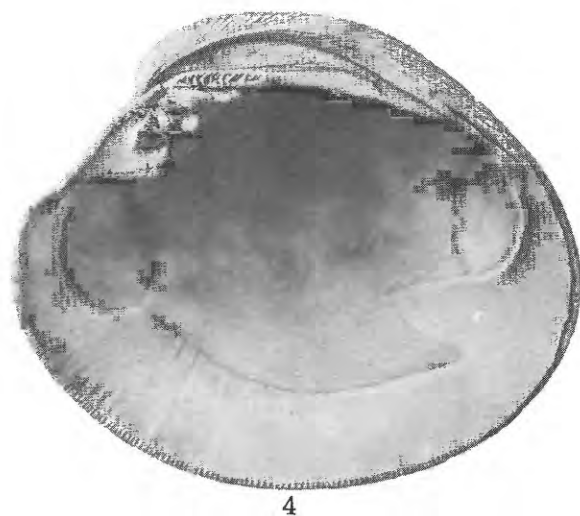
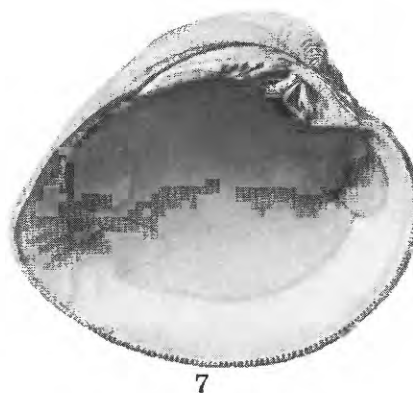
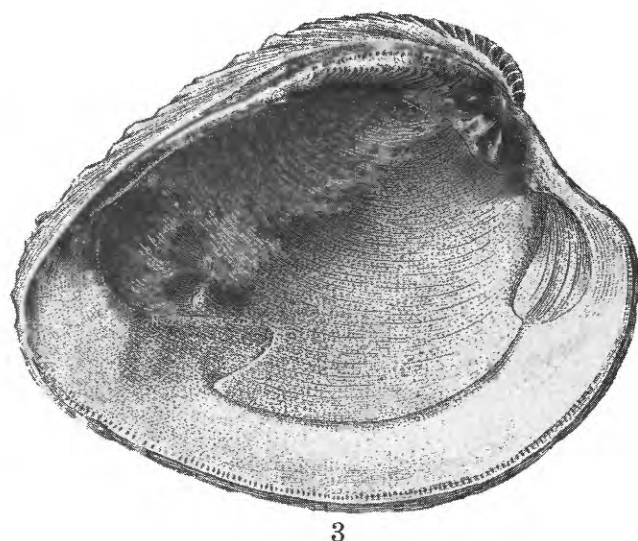
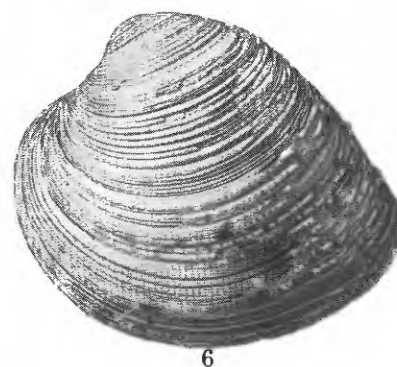
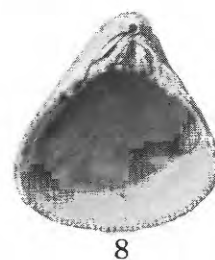
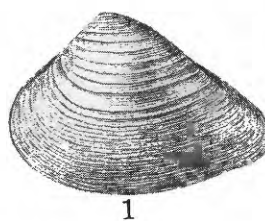
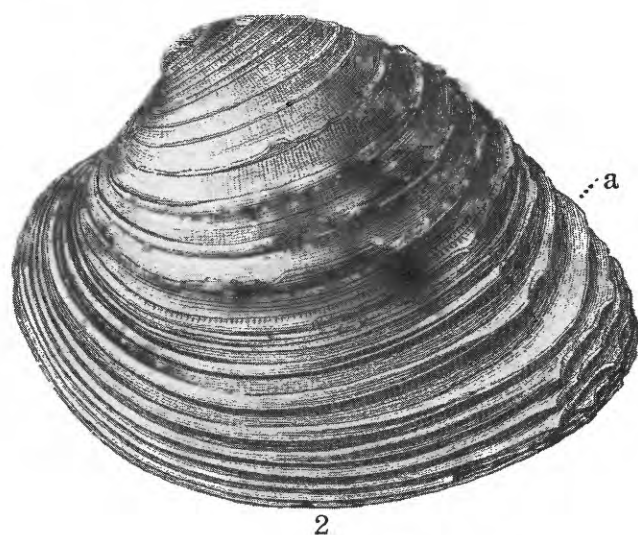
FIGURES 6-7. *Venus nannodes* Gardner, n. sp. (pp. 175-176).

6. Exterior of left valve (cotype); altitude 45.0 millimeters; latitude 53.5 millimeters.

7. Interior of left valve (cotype); altitude 45.0 millimeters; latitude 53.5 millimeters.

FIGURE 8. *Parastarte chipolana* Gardner, n. sp. (pp. 176-177). Interior of left valve; altitude 2.65 millimeters; latitude 2.5 millimeters.

NOTE.—The types of formerly described species have been remeasured, and some of the dimensions here given differ from those in the original descriptions.



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