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CARDIIDAE (MOLLUSCA: BIVALVIA) FROM THE CHIPOLA FORMATION, CALHOUN COUNTY, FLORIDA

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CONTENTS

ILLUSTRATIONS

I. ABSTRACT

Fifteen species of cardiid bivalves are reported from the type area of the Chipola Formation in Calhoun County, Florida. These 15 species are assigned to nine genera and four subfamilies; one new subgenus, *Trachycardium (Conilocardium)* - type species *"Cardium (Trachycardium)" cestum* Dall - and five new species: *Acrosterigma (Vasticardium) hoerleorum, Papyridea miocica, Papyridea multicostula, Fragum tunicula,* and *Trigoniocardia (Americardia) decidua* are described.

More than 40,000 valves were examined during the study, with slightly more than one-third of these proving to be referrable to *Trigoniocardia (Trigoniocardia) simrothi* (Dall). This species together with *Dinocardi-*

um chipolanum (Dall) and *Trigoniocardia (Trigoniocardia?) burnsii* (Dall) constitute almost three-fourths of the cardiid fauna.

Variation in the distribution of some of the species poses problems, probably of ecologic nature, that at present cannot satisfactorily be resolved; others appear to be of possible time/stratigraphic significance.

Use of long-wave ultraviolet light has permitted the study of latent color patterns on a number of the species; these have been of much use in confirming their generic identification.

II. INTRODUCTION

Species referrable to genera of the family Cardiidae constitute a significant element in the bivalve fauna of the type area of the Chipola Formation in Calhoun County, Florida. More than 40,000 valves representing 15 species assigned to 12 genus-groups are present in the Tulane University collections. These have been secured from 58 localities including outcrops along the Chipola River downstream from the site of the old, abandoned, Bailey's Ferry of Dall (1890-1903) and subsequent authors, as well as along the courses of Tenmile Creek, which enters the Chipola River from the west at Bailey's Ferry, and of Farley Creek which enters from the east about one and three-quarter miles downstream (up-dip) from the ferry site. A map showing the trends of these streams and the relative positions of the collecting localities has been published in *Tulane Studies in Geology and Paleontology* (1972, v. 10, p. 28).

Dall (1898, pp. 1080-1109) described ten new Chipola species that were referred to the genus *Cardium* with various subgeneric assignments. For the most part these were located as being from the "Oligocene marl of the Chipola River, Calhoun County, Florida" or from the "Oligocene of the Chipola marl, Calhoun County, Florida." Most of the species with the former localization prove to have been collected from exposures on the Chipola River in the basal part of the formation as exposed below the Bailey's Ferry site (Gardner's 1926, "one mile below Bailey's Ferry"); those with the latter localization were primarily from the lower beds of the formation as exposed along Tenmile Creek (Gardner's 1926, "one mile west of Bailey's Ferry").

In addition to the ten new species, Dall also identified as Chipola species two others that had originally been described from other non-Chipola localities. Gardner (1926, pp. 130-142) recorded the same twelve forms, although with some changes in subgeneric assignment; in addition, she described as members of the Chipola fauna two others known from other localities. She did not recognize either of these latter in the collections available to her from the Calhoun County outcrops. The first of these two, *"Cardium (Cerastoderma) chipolanum* subsp. *alumen"* (Gardner, 1926, p. 138, pl. 23, fig. 6) is present, though rare, in the Tulane University collections from the upper part of the formation along Farley Creek where it is always associated with the typical form of the species; it is here interpreted as being only a minor, apparently ecologic, variant whose greater abundance at Alum Bluff and other localities cited by Gardner may be an expression of the influences of a shallower water environment in which a more coarsely grained quartzose sandstone matrix predominates, as compared with the finer grained lime-sand matrix of the typical Chipola facies. Gardner's second Chipola species *"Cardium [Fragum (Trigoniocardia)]" sellardsi* (1926, p. 140, pl. 23, figs. 11-12) was described from Boynton Landing on the Choctawhatchee River in Washington County, Florida (=TU 1145). It is not represented in the Tulane University collections from the type Chipola region.

The two Chipola forms referred by Dall and by Gardner to species originally described from non-Chipola horizons and localities prove, on the basis of the much more comprehensive collections now available, to be new species and are here described, together with three previously unrecognized ones. One of the latter, here denominated *Trigoniocardia (Americardia) decidua*, n. sp., was represented in the material that Dall assigned to his *"Cardium (Fragum) Burnsii"* although most specimens are somewhat larger than the typical form of that species.

The nomenclatorial history of the species considered in the present report is given in Table 1.

III. DISTRIBUTION OF THE CARDIID SPECIES

Cardiid species occur at every locality represented in the Tulane University collections from the type area of the Chipola Formation. However, some localities are more rewarding in terms of faunal diversity than are others. Furthermore, the smaller side tributaries, Tenmile Creek and Farley Creek, are always accessible for collecting while those localities along the Chipola River banks may be submerged during intervals of high water. Therefore, the total bulk of material secured from the different localities varies to the point that a simple listing of the number of valves of a species at each separate station would yield no significant information. There are, nevertheless, differences in the distribution of the various species that appear to be of stratigraphic and/or ecologic significance. For Table 2 the outcrops on the Chipola River, which trend essentially across the strike of the strata, have been divided rather arbitrarily into an upper and a lower sequence with the division occurring a short distance upstream from the mouth of Farley Creek. The latter, which enters the Chipola from the east, meanders through a sequence that is equivalent to at least the lower half of the upper sequence; Tenmile Creek, which enters the river from the west at Bailey's Ferry a short distance upstream from the Chipola/Chattahootchee contact, traverses strata of the lower sequence.

The most ubiquitous species are *Dinocardium chipolanum* (Dall), *Trigoniocardia (Trigoniocardia?) burnsii* (Dall), *Laevicardium compressum* (Dall); almost equally as widespread although slightly less abundant are *Trachycardium (Conilocardium) cestum* (Dall), *"Trachycardium" virile* (Dall) and *Trigoniocardia (Americardia) decidua,* n. sp.

Species with distribution having a possible stratigraphic significance are: *Acrosterigma (Vasticardium) hoerleorum,* n. sp., and *Papyridea bulbosa* (Dall), both known only from the lower sequence along the Chipola

TABLE 1

Dall, 1898	Gardner, 1926	This Paper
Cardium propeciliare n. sp.	*Cardium (Acanthocardia) propeciliare*	*Acanthocardia propeciliare*
Cardium acrocome n. sp.	*Cardium (Acanthocardia) acrocome*	*Agnocardia acrocome*
Cardium (Trachycardium) inconspicuum Guppy	*Cardium (Trachycardium) inconspicuum*	*Acrosterigma (Vasticardium) hoerleorum* n. sp.
Cardium (Trachycardium) cestum n. sp.	*Cardium (Trachycardium) cestum*	*Trachycardium (Conilocardium) cestum*
Cardium (Trachycardium) virile n. sp.	*Cardium (Trachycardium) virile*	*"Trachycardium" virile*
Cardium (Trachycardium) parile n. sp.	*Cardium (Trachycardium) parile*	*"Trachycardium" parile*
Cardium (Cerastoderma) chipolanum n. sp.	*Cardium (Cerastoderma) chipolanum*	*Dinocardium chipolanum*
	Cardium (Cerastoderma) chipolanum alumen n. subsp.	*Dinocardium chipolanum* (variant)
Cardium (Fragum) Burnsii n. sp.	*Cardium (Fragum) burnsii*	*T. (Trigoniocardia?) burnsii*
Cardium (Trigoniocardia) alicula n. sp.	*Cardium [Fragum (Trigoniocardia)] alicula*	*Fragum tunicula* n. sp.
Cardium (Trigoniocardia) Simrothi n. sp.	*Cardium [Fragum (Trigoniocardia)] simrothi*	*T. (Trigoniocardia) simrothi*
		T. (Americardia) decidua n. sp.
Cardium (Papyridea) bulbosum n. sp.	*Cardium (Papyridea) bulbosum*	*Papyridea bulbosa*
		Papyridea miocica n. sp.
		Papyridea multicostula n. sp.
Cardium (Laevicardium) compressum n. sp.	*Cardium (Laevicardium) compressum*	*Laevicardium compressum*

River and Tenmile Creek, and *"Trachycardium" parile* (Dall), *Papyridea miocica,* n. sp., and *P. multicostula,* n. sp., found only in collections from the upper sequence along the river and Farley Creek. *Fragum tunicula,* n. sp., is known solely from the stratigraphically higher beds but since it is represented only by two valves in the Chipola River area this restriction may not be significant.

Acanthocardia propeciliare (Dall) also is primarily a species of the fauna of the stratigraphically higher beds of the formation with 1226 of the 1251 valves counted coming from that part of the section; however, the remaining 25 valves are from the lower strata exposed along the Chipola River, three of them having been collected from the lowest exposures immediately adjacent to the contact with the underlying Chattahootchee Formation. Hence the distribution of this species appears to be more a factor of ecologic than of purely stratigraphic control.

The most obvious example of the action of some type of ecologic control is afforded by the distribution of *Trigoniocardia (Trigoniocardia) simrothi* (Dall). This is the most abundant cardiid species in the collections, being represented by 13,702 valves, of which 10,506 come from the exposures of the lower sequence along the Chipola River. In contrast, there are but two valves in the Tenmile Creek collections, one from the immediate basal contact at TU 830, the other a little higher in the section at TU 196. The comparative list (Table 3) of the number of valves of the species known from the basal contact on the Chipola River (TU 547 + 810) and from approximately five feet stratigraphically higher (TU 554) as contrasted with the basal bed on Tenmile Creek (TU 830) and approximately five feet higher (TU 546) clearly indicates that there is some significant environmental factor involved, especially since the two areas are less than 1.5 miles distant one from the other.

Examination of Tables 2 and 3 clearly reveals that *T. simrothi* is but the extreme example of a pronounced faunal difference between the two areas. *Agnocardia acrocome, Papyridea bulbosa* and *Acrosterigma (Vasticardium) hoerleorum* reveal the reverse situation in that they are not rare in the Tenmile Creek collections but are represented from the localities along the Chipola River by two *(A. acrocome)* or three *(P. bulbosa, A. hoerleorum)* valves. Indeed, every species on the lists, other than *Trachy-*

PLATE 1

Figures Page

1, 2. *Acanthocardia propeciliare* (Dall) 152
1. Figured specimen, USNM 243507 (X 2); height 17.8 mm, length 17.3 mm. Locality: TU 821, Farley Creek.
2. Figured specimen, USNM 243508 (X 2); height 21.3 mm, length 20.8 mm. Locality: TU 821, Farley Creek.

3-5. *"Trachycardium" virile* (Dall) 154
3. Figured specimen, USNM 243509 (X 1.5); height 30.7 mm, length 28.7 mm. Locality: TU 951, Tenmile Creek.
4. Figured specimen, USNM 243510 (X 1.5); height 26.4 mm, length 23.3 mm. Locality: TU 554, Chipola River. Note that the three most anterior costae of the posterior series bear oblique scalelike serrations on both anterior and posterior sides.
5. Figured specimen, USNM 243511; height 19.1 mm, length 18.1 mm. Locality: TU 817, Tenmile Creek. 5a. Exterior of valve (X 2). 5b. Detail of surface ornamentation (X 4).

6. *Agnocardia acrocome* (Dall) 153
Figured specimen, USNM 243512; height 37.5 mm, length 35.5 mm. Locality: TU 830, Tenmile Creek. 6a. Detail of surface ornamentation (X 4). 6b. Exterior of valve (X 1.5).

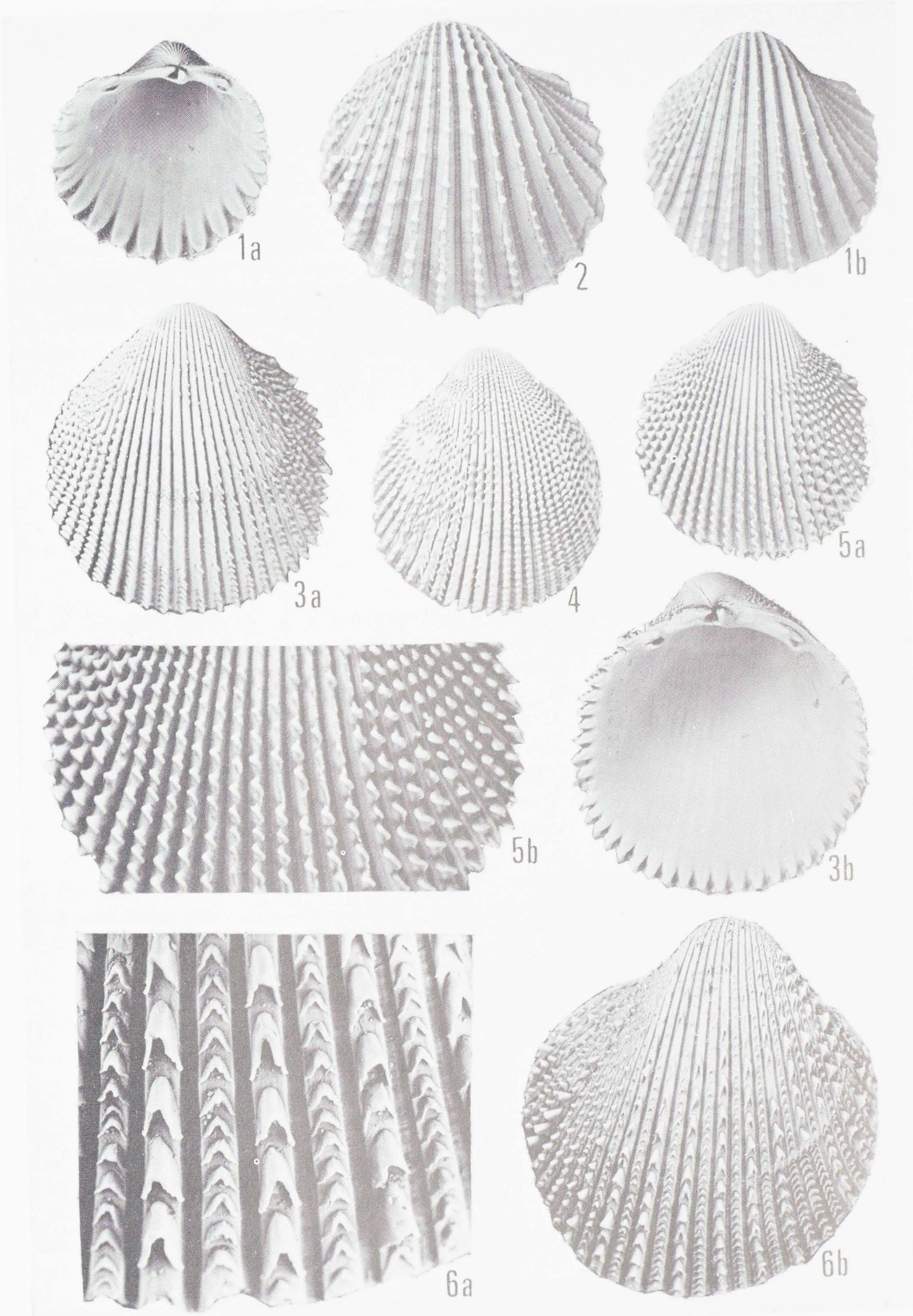

PLATE 1

TABLE 2

	LOWER SEQUENCE				UPPER SEQUENCE				TOTAL TYPE AREA CHIPOLA FM.	
	Tenmile Creek				Chipola River		Farley Creek			
	#	%	#	%	#	%	#	%	#	%
Acanthocardia propeciliare (Dall)	1	+	24	.21	679	6.11	547	9.64	1251	3.10
Agnocardia acrocome (Dall)	46	.37	0	—	2	.02	0	—	48	.12
"Trachycardium" virile (Dall)	1051	8.48	109	.98	67	.60	18	.32	1245	3.09
"Trachycardium" parile (Dall)	0	—	0	—	364	3.27	13	.23	377	.93
Trachycardium (Conilocardium) cestum (Dall)	202	1.63	197	1.77	1464	13.16	556	9.80	2419	6.00
Acrosterigma (Vasticardium) hoerleorum n. sp.	46	.37	3	.03	0	—	0	—	49	.12
Papyridea bulbosa (Dall)	28	.23	3	.03	0	—	0	—	31	.08
Papyridea miocica n. sp.	0	—	0	—	198	1.78	89	1.57	287	.71
Papyridea multicostula n. sp.	0	—	0	—	81	.72	125	2.20	206	.51
Fragum tunicula n. sp.	0	—	0	—	2	.02	0	—	2	+
Trigoniocardia (Trigoniocardia) simrothi (Dall)	2	.02	10506	94.20	2887	25.96	307	5.41	13702	33.96
Trigoniocardia (Trigoniocardia?) burnsii (Dall)	3711	29.92	200	1.79	1268	11.40	1979	34.87	71.58	17.74
Trigoniocardia (Americardia) decidua n. sp.	222	1.79	14	.12	86	.77	813	14.36	1135	2.81
Laevicardium compressum (Dall)	2617	21.55	34	.30	1169	10.51	182	3.21	4056	10.05
Dinocardium chipolanum (Dall)	4413	35.60	63	.56	2854	25.66	1046	18.43	8376	20.76
	12393	99.99	11153	99.99	11121	99.98	5675	100.04	40342	99.98

In each of the sequences above the column headed "#" represents the number of valves of each species present in the collections from the area concerned. The column headed "%" represents the percentage representation of that species relative to the total number of valves.

cardium (Conilocardium) cestum, reveals a preference for one area or the other and even *T. cestum* is more abundant in the basal Chipola River collections listed in Table 3 than it is in the comparable Tenmile Creek ones.

This situation is not unique to the cardiid species. The muricid gastropod *Chicoreus lepidotus* E. H. Vokes is, she informs me, represented by 111 specimens from the lower sequence along the Chipola River (including 32 and 68 from TU 457 and 554, respectively), but that only a single specimen has been found along Tenmile Creek (from TU 830), and Hoerle (1976, p. 17) stated that of 250 specimens of *Conus aquoreus* S.E. Hoerle, only two were from TU 830, with all of the rest from the Chipola River localities, it being "a common species at both the type locality, TU 554, and TU 457 ('one mile below Bailey's Ferry')." The reverse situation is noted for *Conus ambonos* S. E. Hoerle (1976, p. 13), *C. vergrandis* S. E. Hoerle (p. 18), *C. tricoratus* S. E. Hoerle (p. 20), and *C. rapunculus* S. E. Hoerle (p. 21), all being much more abundantly represented in the Tenmile Creek collections than in those from the Chipola River. The same situation holds true for several species of *Chicoreus (Siratus)* (E. H. Vokes, 1970, p. 51, and personal communication).

No explanation for the differences in the faunas of these two relatively approximate and stratigraphically equivalent areas is immediately apparent. Undoubtedly it is due to some ecologic factors, but their nature is as yet unknown. The sediment from the lower strata in the two areas appears to be identical in nature, being a medium to fine-grained lime-sand that, when dissolved, proves to have a small clay fraction; the amount being essentially the same in each area. Higher beds along the Tenmile Creek section reveal a change of facies, becoming a blue-gray, fine-grained sandy to silty, micaceous mudstone with appreciably lower calcium carbonate content than that of the basal marls. The fauna also changes, containing many thin-shelled tellinid species plus other forms of softer-bottom habit. Some Bryozoa from this part of the section show evidences suggestive of slightly reduced salinities (Scolaro, 1968, unpubl. diss.). This part of the section we interpret as representing a shallow-water lagoonal facies, perhaps a back-reef area. There is, however, no evidence that would indicate that such a condition was present during the time of the deposition of the basal beds here concerned, although it may be possible that a near-by reef was affecting water circulation to some extent. Solitary corals and small heads of colonial types occur frequently at all of the localities cited in Table 3 and there is no noticeable difference in the abundance or specific composition of these forms between the Tenmile Creek and the Chipola River stations.

IV. COLOR PATTERNS

Through the utilization of a commercial laundry bleach (sodium hypochlorite) and a long-wave ultraviolet light, it has been possible to reveal the color patterns characteristic of certain of the species here treated (see Vokes and Vokes, 1968, p. 76). These are illustrated on plates 9 and 10. In the majority of cases the patterns are not strikingly different from those to be observed on Recent species of the same genus. Thus the pattern exhibited by *Trachycardium (Conilocardium) cestum* (Dall) (Pl. 9, figs. 1, 2) is wholly comparable to that present on *T. isocardia* (Linnaeus), type of the genus *Trachycardium;* that of *Dinocardium chipolanum* (Dall) (Pl. 9, fig. 8) is not to be differentiated from that of *D. robustum* (Solander), type of *Dinocardium* Dall; while the patterns revealed on the three species of *Papyridea* (Pl. 9, figs. 3-5) may each be matched by one of the many rose-tinted color variants of *P. soleniformis* (Bruguière), type of that genus. Specimens of *Laevicardium compressum* (Dall) show a variable pattern of zig-zag markings that may be apparently confined to certain growth stages (Pl. 9, fig. 2b) or may intersect across the entire surface (Pl. 9, fig. 2a); similar variations may be observed on *L. laevigatum* (Linnaeus), on *L. mortoni* (Conrad), and on *L. pictum* (Ravenel) of the Recent western Atlantic faunas. And it may be noted that the pattern of more or less isolated and discrete dark spots or blotches seen on *"Trachycardium" parile* (Dall) (Pl. 9, fig. 7) is not too different from that to be observed on specimens of *T. muricatum*

TABLE 3

	Chipola River		Tenmile Creek	
	(547+810)	(554)	(830)	(546)
Acanthocardia propeciliare (Dall)	3	17	1	0
Agnocardia acrocome (Dall)	0	0	20	11
"Trachycardium" virile (Dall)	17	68	260	360
Trachycardium (Conilocardium) cestum (Dall)	48	117	34	59
Acrosterigma (Vasticardium) hoerleorum, n. sp.	1	1	23	13
Papyridea bulbosa (Dall)	0	0	10	12
Trigoniocardia (Trigoniocardia) simrothi (Dall)	1202	6667	1	0
Trigoniocardia (Trigoniocardia?) burnsii (Dall)	85	62	1043	1352
Trigoniocardia (Americardia) decidua, n. sp.	4	8	57	67
Laevicardium compressum (Dall)	6	10	79	489
Dinocardium chipolanum (Dall)	15	24	353	804
Total number of valves present	1381	6974	1881	3167

(Linnaeus), while that seen on specimens of *"T." virile* (Pl. 10, figs. 4,5) is more like that to be seen on younger, more immature specimens of the type species, *T. isocardia* (Linnaeus).

Acrosterigma (Vasticardium) hoerleorum, n. sp., has a pattern that is very like that of *A. (V.) elongatum* (Bruguière), type species of the subgenus (compare Pl. 10, figs. 1 & 2) and is wholly unlike that of *Acrosterigma dalli* (Heilprin), type of the genus, which is here illustrated for the first time (see Pl. 10, fig. 3). It is also worthy of note that the interior of *A. (V.) hoerleorum* has the same deeply colored posterior margin as is present in *A. (V.) elongatum* (compare Pl. 10, figs. 1b & 2b).

No modern species with a design similar to that of *Acanthocardia propeciliare* (Dall) is known to the writer. In general, it is only the beaded nodes that show a dark coloration with, however, the tint occasionally being extended down on to the top of the ribs immediately adjacent to the bead to

PLATE 2

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1, 3. *"Trachycardium" parile* (Dall) 156

1. Figured specimen, USNM 243513 (X 1.5); height 24.8 mm, length 23.0 mm. Locality: TU 547, Chipola River.
2. Figured specimen, USNM 243514; height 22.1 mm, length 22.0 mm. Locality: TU 547, Chipola River.

2a, b. Exterior and interior of valve (X 1.5). 2 c, d. Details of valve ornamentation (X 4).

3-7. *Trachycardium (Conilocardium) cestum* (Dall) 158

3. Figured specimen, USNM 243515 (X 1); height 42.0 mm, length 36.2 mm. Locality: TU 458, Chipola River.
4. Figured specimen, USNM 243516 (X 1); height 47.5 mm, length 36.8 mm. A proportionately higher specimen than usual. Locality: TU 555, Chipola River.
5. Figured specimen, USNM 243517 (X 1); height 35.0 mm, length 29.9 mm. Locality: TU 458, Chipola River.
6. Figured specimen, USNM 243518 (X 1); height 27.1 mm, length 24.6 mm, diameter (paired valves) 21.0 mm. Locality: TU 458, Chipola River.
7. Figured specimen, USNM 243519 (X 4); height 42.5 mm, length 34.0 mm. Locality: TU 458, Chipola River. Detail of surface ornamentation; note the fine pustules on the sides of the costae and in the interspaces.

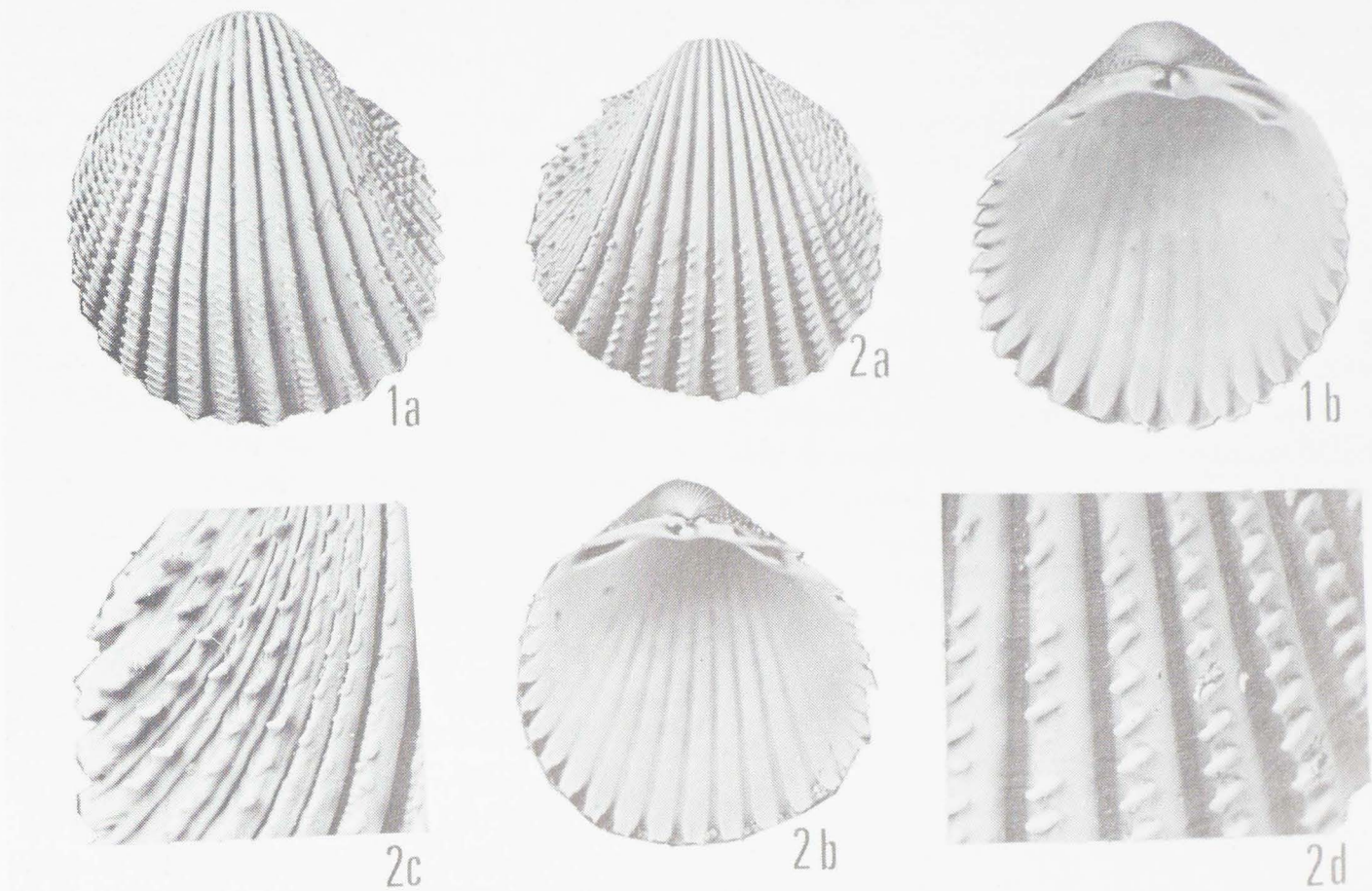

PLATE 2

give a definitely rounded spot; it is almost as if the coloring material had flowed down from the top of the bead.

No recognizable distinctive coloration could be developed on *Acrocardium acrocome* (Dall) nor on any of the species here referred to the subfamily Fraginae, including *Fragum tunicula,* n. sp., *Trigoniocardia simrothi* (Dall), *T. burnsii* (Dall) or *T. (Americardia) decidua,* n. sp. Many of the Recent species referred to the Fraginae are white in color and it may well be that this condition also was characteristic of the species here concerned.

V. ACKNOWLEDGMENTS

The writer is greatly indebted to Thomas R. Waller of the United States National Museum for the loan of type and referred specimens and to Druid Wilson of the U.S. Geological Survey for additional information on specimens studied by Dall and Gardner. Mrs. R. C. Hoerle of West Palm Beach, Florida, was most generous in the use of the species in the Hoerle collections, and the writer's wife and scientific colleague aided greatly in all stages of the preparation of the manuscript; her suggestions were most helpful.

The careful reading and thoughtful comments offered by the members of the Editorial Committee are much appreciated.

VI. SYSTEMATIC DESCRIPTIONS

Family CARDIIDAE Lamarck, 1809
Subfamily CARDIINAE Lamarck, 1809
Genus ACANTHOCARDIA Gray, 1851

Acanthocardia GRAY, 1851, List of British Animals in the Collections of the British Museum, pt. 7, p. 23.

Type species, by subsequent designation, Stoliczka, 1870, *Cardium aculeatum* Linnaeus, 1758. Recent; Atlantic Coast of Europe from southern England to Iberian Peninsula, the Mediterranean and Adriatic Seas and southward to Morocco.

ACANTHOCARDIA PROPECILIARE (Dall)
Plate l, figures 1, 2; Plate 9, figure 6

Cardium propeciliare DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1080; *ibid.,* 1903, v. 3, pt. 6, pl. 48, fig. 12; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 131 [Holotype, USNM 114768; "Oligocene. Chipola River, Calhoun County, Florida"].

NOT *Cardium (Trachycardium) propeciliare* Dall. DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 142, pl. 18, fig. 7 [=*Cardium (Cerastoderma) phlyctaena* Dall, 1900].

Cardium (Acanthocardia) propeciliare Dall. GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 132, pl. 22, fig. 5 ["Type locality : No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla."].

This attractive species is one of the most distinctive and easily recognized cardiids in the Chipola fauna. The number of ribs varies between 18 and 21, usually 19 or 20; they are characteristically trigonal with smooth sides and with their crests raised above the slopes to form a distinct keel that is surmounted by round topped or knobbed spines. The inter-rib areas are flat bottomed, separated from the sloping costal sides by a narrow vertical rise that gives the areas an almost gutter-like appearance. The "cross-striated" ornamentation mentioned by Dall in his description tends to vary over the valve areas. In the better preserved specimens of the present collections the transverse ornament of the intercostals on the median and postero-median surfaces has the appearance more of a ladder-like arrangement of raised growth lamellae, and only toward the anterior and posterior ends does it suggest striations.

Dall described this species only as from the "Oligocene marl of the Chipola River, Calhoun County, Florida," and, in 1905 he essentially repeated this locality when he designated USNM specimen 114768 as the holotype (*in* Schuchert *et al.,* p. 131). Gardner (1926, p. 132) cited the type locality as USGS 2213, "1 mile below Baileys Ferry . . . ", indicating that it was rare in the collections. In the much more extensive Tulane University collections this species proves to be most abundant in the upper portion of the formation as exposed on the Chipola River and along Farley Creek (see Table 2). It is relatively rare in the collections from the lower beds that appear to be the equivalents of those from which the collections were made that were studied by Dall and Gardner. Only a single, immature valve has been obtained from Tenmile Creek,

suggesting some aspect of ecologic control of the distribution of the species, which is not readily apparent at this time. The single valve is from the basal portion of the formation where the lithology seems more similar to that of the stratigraphically equivalent deposits exposed in the banks of the Chipola River than are the upper strata of the Tenmile Creek section. These latter are notably more silty and with a decidedly smaller lime content than is found in the deposits along the river.

Figured specimen, USNM 243507; height 17.8 mm, length 17.3 mm, diameter (left valve) 7.7 mm; locality TU 821 (Pl. 1, fig. 1).

Figured specimen, USNM 243508; height 21.3 mm, length 20.8 mm, diameter (left valve) 9.4 mm; locality TU 821 (Pl. 1, fig. 2).

Figured specimen, USNM 243558; height 25.1 mm, length 22.6 mm, diameter (left valve) 10.7 mm; locality TU 555 (Pl. 9, fig. 6).

Genus AGNOCARDIA Stewart, 1930

Agnocardia STEWART, 1930, Acad. Nat. Sci. Phila., Spec. Publ. 3, pp. 37, 264.

Type species, by original designation, *Cardium (Trachycardium) claibornense* Aldrich. Middle Eocene (Claibornian); Gulf Coastal states.

AGNOCARDIA ACROCOME (Dall)
Plate 1, figure 6

Cardium acrocome DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1081; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 2; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 128 [Holotype, USNM 114759; "Oligocene, Chipola River, Calhoun County, Florida"].

Cardium (Acanthocardia?) acrocome (Dall). WOODRING, 1925, Carnegie Inst. Wash., Publ. 366, p. 135 [compared to *C. (A?) dissidepictum* Woodring].

Cardium (Acanthocardia) acrocome Dall. GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 133, pl. 22, fig. 7.

Trachycardium (Agnocardia) acrocome (Dall). STEWART, 1930, Acad. Nat. Sci. Phila., Spec. Publ. 3, p. 265.

Dall's type and only specimen was a worn and immature individual: "Alt. 7.5, lon. 7.5, diam. 6 mm."* The largest specimen in the Tulane collection, a right valve from TU 830, has dimensions as follows: height 49.1 mm, length 46.5 mm, diameter 20.5 mm. The Hoerle Collection contains an even larger left valve from TU 951 with a height of 55.5 mm and a length of 46.7 mm.

The number of costae varies from 45 to 47, the majority of the specimens showing 46. On the median and anterior costae there is a regular alternation of those bearing large triangular hollow spines with those having much smaller such spines (Pl. 1, fig. 6a). The large spines clearly suffer from breakage during fossilization and collection; one fragmentary specimen from TU 951, which when complete was probably about 38 mm high, has one spine preserved that is 5.2 mm high with the tip showing slight breakage suggesting a length of as much as 6 mm. Dall stated that "on the posterior area nearly all of the ribs have low spines." This may reflect the worn condition of the valve as shown in the original illustration. The present specimens reveal an interestingly varied pattern. The postero-ventral angulation is marked by a strong-spined rib, this is followed posteriorly by a low-spined one, then another strong-spined, with four low-spined intervening before the next strong-spined one. Posterior to this there are three or four low-spined ones followed by two or three strong-spined ribs near the postero-dorsal corner.

This species is almost wholly confined to the lower strata of the Chipola Formation on Tenmile Creek and is rare at all localities where found. There are no specimens in either the Tulane nor the Hoerle collections from the area of "one mile below Bailey's Ferry," said by Gardner to be the type locality. Oddly enough, the only two specimens in the collections from the Chipola

*It is to be noted that all of Dall's dimensions of Chipola cardiid species clearly cite the diameter as though it was that of paired valves. This form of citation holds even for species where only a single valve was known; *e.g. "Cardium (Acanthocardia)" acrocome* and *"Cardium (Papyridea)" bulbosum,* of which Gardner (1926, p. 142) said "The type is unique . . . ", for which the cited dimensions are "Long. 27, alt. 23.5, diam. 10 mm."

River banks, a large left valve from TU 547 and a small individual from TU 549, are both from strata relatively high in the geologic section.

Figured specimen, USNM 243512; height 37.5 mm, length 35.5 mm, diameter (right valve) 10.7 mm; locality TU 830 (Pl. 1, fig. 6).

Subfamily TRACHYCARDIINAE Stewart, 1930
Genus TRACHYCARDIUM Mörch, 1853

Trachycardium MÖRCH, 1853, Catalogus Conchyliorum . . . Comes de Yoldi, fasc. 2, p. 34.

Type species, by subsequent designation, von Martens, 1870, *Cardium isocardia* Linnaeus, 1758. Recent; West Indies from Hispaniola to Trinidad, the Caribbean coast of northern South and Central America and the southern Gulf of Mexico around the Yucatán Peninsula and westward at least as far as Isla Carmen, Mexico.

Four species in the Chipola fauna have in the past (Dall, 1900; Gardner, 1926) been referred to the genus *Trachycardium.* None show the characteristic ornament of round-topped imbricating scales that are strongly developed over all, or almost all of the surfaces of the costae on the median part of the valves; hence none appear referrable to that genus *sensu stricto.* Two of the four, *"Cardium (Trachycardium)" virile* Dall and *"C. (T.)" parile* Dall, have an ornamentation that, especially posteriorly, is comprised of obliquely sloping scales along the posterior sides of the costae. This is most similar to that present on *Trachycardium belcheri* (Broderip and Sowerby), the type species of *Phlogocardia* Stewart, 1930, but the anterior ornament on the latter species is different from that found on the Chipola forms, in which it is somewhat more like that of *Trachycardium* s.s. Accordingly no subgeneric assignment of these two species is made at the present time. *"Cardium (Trachycardium)" cestum* Dall, a third Chipola species so assigned by Dall, has the general form and hinge of typical *Trachycardium* but differs in the nature of the external ornamentation and is here referred to the new subgenus *Conilocardium.* The fourth species, identified by Dall as *"Cardium" inconspicuum* Guppy, described from the Bowden beds of Jamaica, is here described as a new species, referred to *Acrosterigma* subgenus *Vasticardium* Iredale, 1927.

"TRACHYCARDIUM" VIRILE (Dall)
Plate 1, figures 3-5; Plate 10, figures 4, 5

Cardium (Trachycardium) virile DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1086; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 1; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 133 [Holotype, USNM 114764; "Oligocene. Near Bailey Ferry, Calhoun County, Florida"]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 136, pl. 23, fig. 1 ["Type locality: No. 2212, Tenmile Creek, 1 mile west of Baileys Ferry, Calhoun County, Fla."].

Dall's detailed description of the ornamentation on this species is accurate for

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PLATE 3

Figures — Page

1-5. *Acrosterigma (Vasticardium) hoerleorum* H. E. Vokes, n. sp. 162

1. Holotype, USNM 243520 (X 1); height 52.3 mm, length 44.0 mm. Locality: TU 546, Tenmile Creek.
2. Paratype A, USNM 243521 (X 1); height 51.3 mm, length 43.6 mm. Locality: TU 830, Tenmile Creek.
3. Paratype B, USNM 243522 (X 1.5); height 31.2 mm, length 25.2 mm, diameter (paired valves) 18.2 mm. Locality: TU 951, Tenmile Creek.
4. Paratype C, USNM 243523 (X 1.5); height 32.7 mm, length 27.8 mm. Locality: TU 830, Tenmile Creek.
5. Paratype D, USNM 243524 (X 1.5); height 40.5 mm, length 34.8 mm. Locality: TU 830, Tenmile Creek.

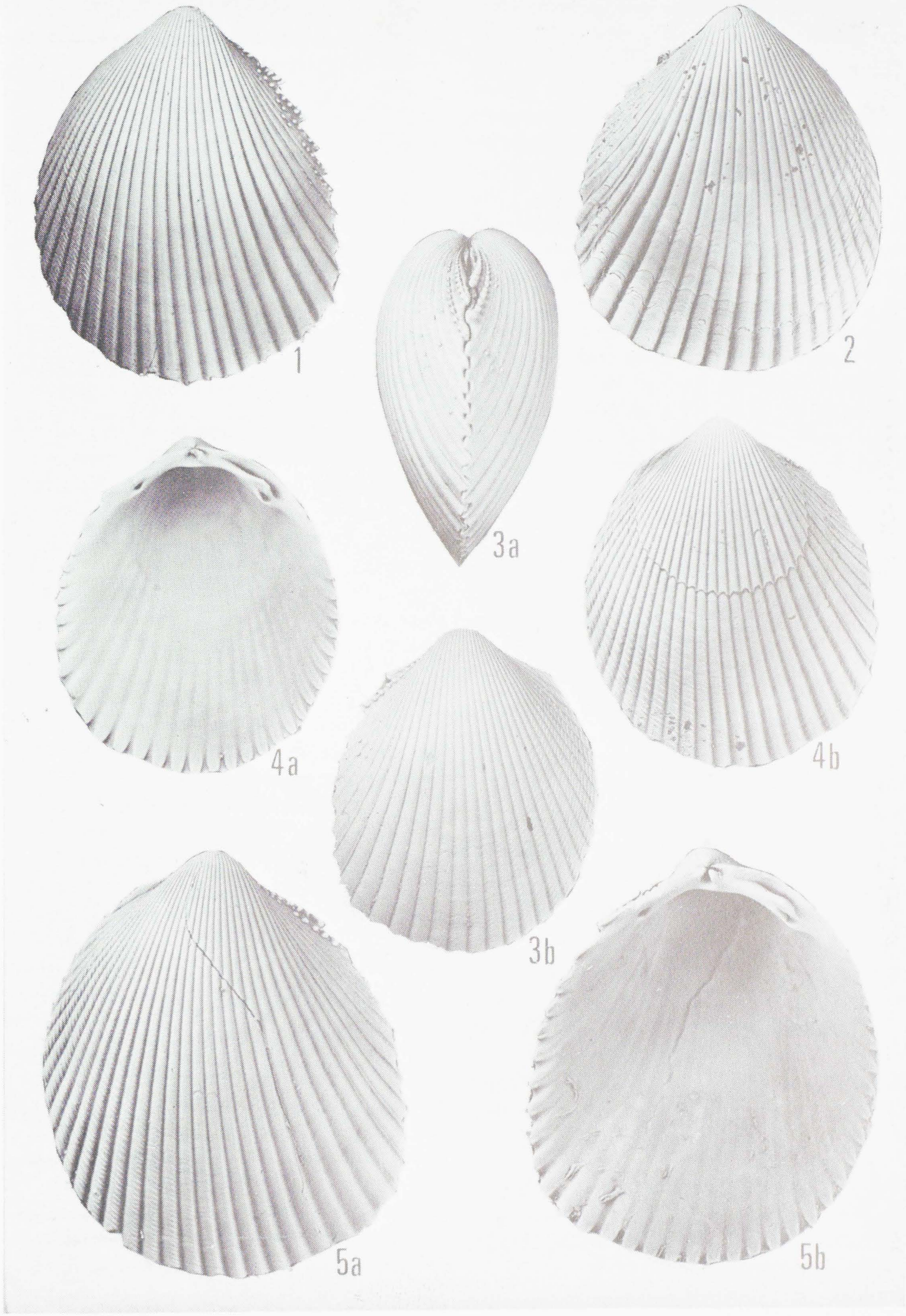


PLATE 3

specimens the size of his type, but this feature proves to change with growth. Thus the number of anterior costae with "the strung and flattened cup-imbrication like *Cardium consors* in miniature" increases during the development, with smaller specimens such as that figured from TU 817A having but 11 ribs so ornamented, whereas the larger one from TU 961 has 16 near the margins, but with the more posterior of these showing on their upper portions the twisted oblique scales serrating the keel on the posterior side of the rib, characteristic of the costation on the main body of the valve.

The number of ribs varies from 38 to 42 with the majority having 39 or 40. One specimen (Pl. 1, fig. 4) is unique in that the three most anterior ribs of the posterior series develop oblique scalelike serrations on both anterior and posterior sides as they approach the postero-ventral margin.

"Trachycardium" virile occurs throughout the Chipola Formation but is abundant only in the lower part of the section on Tenmile Creek where there are more valves in the collection from TU 830 (260) or from TU 546 (360) than are known from all of the localities along the Chipola River and Farley Creek sections (194). The largest specimen noted in the Tulane University collections has a height of 33.0 mm, and a length of 29.1 mm. It is from locality TU 820 on Farley Creek.

Figured specimen, USNM 243509; height 30.7 mm, length 28.7 mm, diameter (left valve) 11.9 mm; locality TU 951 (Pl. 1, fig. 3).

Figured specimen, USNM 243510; height 26.4 mm, length 23.3 mm, diameter (right valve) 10.2 mm; locality TU 554 (Pl. 1, fig. 4).

Figured specimen, USNM 243511; height 19.1 mm, length 18.1 mm, diameter (left valve) 6.7 mm; locality TU 817 (Pl. 1, fig. 5).

Figured specimen, USNM 243561; height 17.8 mm, length 17.3 mm, diameter (left valve) 6.8 mm; locality TU 830 (Pl. 10, fig. 4).

Figured specimen, USNM 243562; height 22.2 mm, length 20.1 mm, diameter (left valve) 7.3 mm; locality TU 546 (Pl. 10, fig. 5).

"TRACHYCARDIUM" PARILE (Dall)

Plate 2, figures 1, 2; Plate 9, figure 7

Cardium (Trachycardium) parile DALL, 1900, Wagner Free Inst. Sci., Trans. v. 3, pt. 5, p. 1086; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 17; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 131 [Holotype, USNM 114647; "Oligocene. USNM 114647; "Oligocene. Alum Bluff, Chipola River, Calhoun County, Florida"*]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 136, pl. 23, fig. 2 ["Type locality: No. 2211, lower bed, Alum Bluff, Liberty County, Fla."].

NOT *Cardium (Trachycardium) parile* Dall. DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 143, pl. 4, fig. 6 [". . . Tampa silex beds at Ballast Point, Tampa Bay; . . ."]; MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 252 [Tampa reference only].

"Trachycardium" parile is one of the more easily identifiable cardiid species in the Chipola fauna being marked by the relatively low number of ribs (22 to 27, with the majority having 24 or 25) and their unusual ornament in which the surficial "projections" or "imbrications" gradually change from completely crossing the more anterior ribs to a position as "spinules" on their posterior side toward the rear of the valve. Dall's original description, however, appears to have been based upon a single specimen and the number of ribs marked by each type of ornament is subject to variation; thus the number of anterior ribs that are completely crossed by the "imbrications" varies from seven to twelve in the material here studied. Furthermore, the "four ribs next posterior [that] have on their tops slender arcuate rather sparse imbrications" have not been observed; the spacing of the imbrications being relatively constant and consistent with that of those on the more anterior ribs. Dall's statement may, in fact, reflect the fragility of this ornament, the projections being easily broken away with little evidence left of their previous occurrence.

This species was described from the lower bed at Alum Bluff where it is common to abundant. In the Tulane University collec-

*Alum Bluff is on the east bank of the Apalachicola River in Liberty County, Fla. Dall's original description located the species as ". . . the lower bed at Alum Bluff and on the Chipola River, Calhoun County, Florida." The citation above is clearly a *lapsus.*

tions from the Chipola Formation of Calhoun County it is present only in the upper half of the section and actually is most abundant in the uppermost fossiliferous strata exposed on the Chipola River. Although Gardner listed it as "present" at her locality "2213, one mile below Baileys Ferry," and as "rare" at locality "3419, McClelland farm 1 mile below Baileys Ferry," it is wholly absent in all Tulane collections from the twelve localities situated in the lower half of the section exposed along the Chipola River. In view of the fact that there seems little doubt but that some mixing of the early collections did occur (see discussion of occurrence of *Fragum tunicula,* n. sp.), it may well be that such was the basis for the record of the present species in the Bailey's Ferry area.

The Tampa Limestone specimen figured by Dall (1915, pl. 4, fig. 6) as this species seems clearly to represent some other form and is, on the whole, more reminiscent of *Acanthocardia propeciliare* than of any other Chipola species, having essentially triangular ribs with nodes on their crests and so far as can be observed, no trace of the "spinule"-like development on the posterior side of the more posterior ribs.

Figured specimen, USNM 243513; height 24.8 mm, length 23.0 mm, diameter (left valve) 10.1 mm; locality TU 547 (Pl. 2, fig. 1).

Figured specimen, USNM 243514; height 22.1 mm, length 22.0 mm, diameter (right valve) 8.8 mm; locality TU 547 (Pl. 2, fig. 2).

Figured specimen, USNM 243559; height 25.7 mm, length 23.4 mm, diameter (left valve) 9.7 mm; locality TU 555 (Pl. 9, fig. 7).

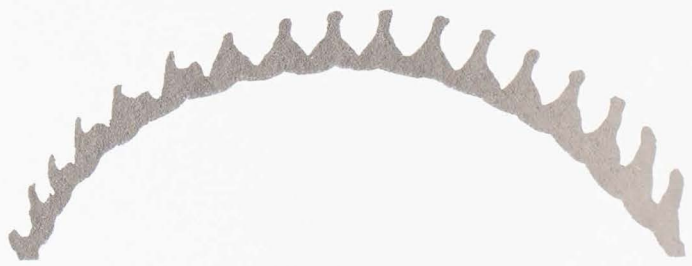
Subgenus CONILOCARDIUM, new subgenus

Type species, *Cardium (Trachycardium) cestum* Dall. Chipola Formation lower Miocene, Florida.

Diagnosis: Trachycardiids with outline and hinge that is typical of the genus, but differing strikingly in the nature of the external ornamentation. In typical *Trachycardium* the surface is marked by radial ribs that are round-topped, moderately wide and separated by interspaces of approximately equal width, with the tops of each rib being well-covered by heavy, more or less imbricating, arched scales that, on the median and posterior areas of the valve, are prolonged down along the posterior side of the rib until they tend to abut against the next succeeding one. The anterior limb of each scale is shorter than the posterior, resulting in a rather decided posterior "slant" to the top of the individual scale. The anterior costae are marked by essentially symmetrical, thickened and almost bead-like scales that on the anteriormost eight or nine ribs show no tendency toward a posterior prolongation.

In contrast, the ribbing on Dall's *"Cardium (Trachycardium)" cestum* is, on the anterior and median parts of the valve surface, essentially triangular in section (text fig. 1) with the triangles capped by an elevated keel, which in turn is surmounted by relatively distant transverse bead-like imbrications. On the main body of the valve these "beads" cross the crest of the keel and tend to extend down almost equally on the upper part of its anterior and posterior sides resulting in the "T-rail" shape described by Dall. Those on the more anterior ribs tend to extend down along the anterior side of the keel, but not on its posterior side, although they are higher posteriorly than anteriorly and, as expressed by Dall in his original description, appear as if "pressed over backward" to overhang the interspaces. The sides of these anterior and median costae are pustulose, with relatively numerous small, dust-like pustules that are arranged in more or less curved rows trending from the bottom of the interspace up the sides of the costae, the arch of the trend being toward the umbo.

The posterior portion of the valve surface has a markedly different ornament. The margin of the valve in this region is deeply serrate with the crests of the serrations marking the centers of the costae and with the raised edges forming a sort of double keel, one side of which marks the anterior edge of the rib-crest, the other the posterior edge and with a distinctly depressed area between them. This condition is most strongly developed on the more anteriorly located costae of the posterior series, but the anterior segment soon weakens and



Text figure 1. Diagrammatic section showing profile of the radial ribbing of *Trachycardium (Conilocardium) cestum* (Dall).

becomes little more than a slightly raised ridge bordering the linear interspace area, while the posterior segment becomes strengthened and tends to project somewhat anteriorly to overhang the median rib crest. The ornamentation on the posterior element of the rib keels consists of diagonally trending, raised beads with an anterior side that is distinctly above the summit; these "beads" do not extend down the sides of the keel. The anterior keel segment is usually smooth and non-ornamented; one specimen has been noted, however, in which the anteriormost costa had beading similar to that of the posterior segment. Interspaces and sides of the costae in this area lack the pustulose ornamentation that is so characteristic of the more anterior areas and tend to show only somewhat irregularly-developed growth lamellae.

TRACHYCARDIUM (CONILOCARDIUM) CESTUM (Dall)

Plate 2, figures 3-7; Plate 9, figure 1; Text figure 1

Cardium (Trachycardium) cestum DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1083; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 14; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 128 [Holotype, USNM 114757; "Oligocene. Chipola River, Calhoun County, Florida"]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 133, pl. 22, fig. 8 ["Cotypes: U. S. Nat. Mus. No. 114757. Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla."].

NOT *Cardium (Trachycardium) cestum* Dall. DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 142, pl. 4, fig. 13 ["Tampa silex beds, at Ballast Point, Tampa Bay . . ."] = *(Cardium (Trachycardium) delphicum ballastum* Mansfield, 1937.

Trachycardium (Conilocardium) cestum is widely disseminated in the Chipola fauna, occurring at 48 of the 58 localities from which collections have been made and present in all recognizable facies in the typical area, although apparently absent from the lower bed at Alum Bluff. Some variation of possible ecologic significance may be observed in the counts of the number of costae present on specimens from different horizons or areas of Chipola exposure. Dall, in his original description, cited the number as 34; however, a count of 200 specimens shows a variation between 28 and 35, with 154 of the total falling within the 31 to 33 range, (56 specimens with 31, 57 with 32 and 41 with 33 costae). When we compare the number of ribs on 40 specimens from the lower beds on the Chipola River with those of a similar number from the lower strata exposed on Tenmile Creek, we find that 17 of the 40 from the Chipola River show 33 costae while only three from the Tenmile Creek area have this number. Sixteen of those from the latter area have 31 ribs. As is noted elsewhere in the present paper, this is but one aspect of the faunal

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PLATE 4

Figures — Page

1-3. *Papyridea multicostula* H. E. Vokes, n. sp. 169

1. Holotype, USNM 243525 (X 1.5); height 25.4 mm, length 31.8 mm. Locality: TU 548, Chipola River.
2. Paratype A, USNM 243526 (X 1.5); height 25.4 mm, length 31.6 mm. Locality: TU 458, Chipola River.
3. Paratype B, USNM 243527 (X 4); height 17.5 mm, length 23.7 mm. Locality: TU 458, Chipola River.

3a. Oblique view of anterior end; note abundant papillose granulations posteriorly that give way to beads on the most anterior ribs. 3b. Oblique view of posterior end of valve; note the development of median groove on ribs of posterior series.

4. *Papyridea bulbosa* (Dall) 165

Figured specimen, USNM 243528; height 23.5 mm, length 27.6 mm. Locality: TU 458, Chipola River.

4a. Lateral view of valve (X 1.5). 4b. Oblique view (X 4) of ornamentation on median surface of more posterior ribs that appear to gradually strengthen to the transverse beads of the anterior-most ribs. 4c. Oblique view (X 4) of posterior end of valve showing progressive change in rib shape and ornamentation.

PLATE 4

differences that mark the basal beds at these two, relatively close, exposed sections.

This is the largest form of *Trachycardium* in the Chipola fauna. One right valve in the collections from locality TU 950 has a height of 54.8 mm, a length of 42.8 mm with a diameter of 20.6 mm. This individual valve is the largest Chipola cardiid in the Tulane University collections, but is exceeded in size by the specimen of *Agnocardia acrocome* in the Hoerle Collection cited in the discussion of that species.

Figured specimen, USNM 243515; height 42.0 mm, length 36.2 mm, diameter (right valve) 15.7 mm; locality TU 458 (Pl. 2, fig. 3).

Figured specimen, USNM 243516; height 47.5 mm, length 36.8 mm, diameter (right valve) 17.8 mm; locality TU 555 (Pl. 2, fig. 4).

Figured specimen, USNM 243517; height 35.0 mm, length 29.9 mm, diameter (left valve) 13.2 mm; locality TU 458 (Pl. 2, fig. 5).

Figured specimen, USNM 243518; height 27.1 mm, length 24.6 mm, diameter (paired valves) 21.0 mm; locality TU 458. (Pl. 2, fig. 6).

Figured specimen, USNM 243519; height 42.5 mm, length 34.0 mm, diameter (right valve) 15.6 mm; locality TU 458 (Pl. 2, fig. 7).

Figured specimen, USNM 243550; height 38.7 mm, length 33.2 mm, diameter (right valve) 13.3 mm; locality TU 458 (Pl. 9, fig. 1a).

Figured specimen, USNM 243551; height 48.5 mm, length 38.2 mm, diameter (right valve) 17.9 mm; locality TU 555 (Pl. 9, fig. 1b).

Genus ACROSTERIGMA Dall, 1900

Acrosterigma DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, pp. 1073, 1090.

Type species, by original designation, *Cardium dalli* Heilprin. Pliocene; Florida.

Dall distinguished *Acrosterigma* as a "Section" of the genus *Trachycardium* on the basis of the "elevated mesial rib internally, radiating from the umbonal cavity" that is usually present in *Cardium dalli* Heilprin (1887, p. 131, pl. 16a, fig. 70). As observed by Stewart (1930, p. 265), however, the ridge is variable in development and "the Academy has one large specimen (length *ca.* 13 cm) on which it is absent from the left valve and very small in the right valve." It is also absent on one relatively immature (height 48 mm) specimen of the almost 100 in the Tulane collections. Stewart concluded (p. 266); "This ridge therefore is considered of no systematic value."

The nature of the hinge and ornamentation, nevertheless, does appear to be distinctive and diagnostic. In the type species the hinge-line is strongly bent in the area of the cardinal teeth so that a line connecting these with the anterior and posterior laterals forms an angle of 115 to 120 degrees with, as noted by Stewart, the large anterior lateral a little more distant from the cardinals than is the the posterior one. The manner in which the low, broadly rounded, almost flat median radial ribs overhang the deeply channelled interspaces to the extent that, in immature specimens they almost completely roof over them to form narrow inter-costal tunnels is a distinctive feature. Further, these median costae are finely beaded on both lateral margins, but not on their tops, even on the anterior ribs. The more posterior costae are beaded on their posterior side only with the beads being somewhat stronger and more erect than are those on the median and anterior costae.

Subgenus VASTICARDIUM Iredale, 1927

Vasticardium IREDALE, 1927, Rec. Australian Mus., v. 16, no. 1, pp. 75-6.

Type species, by original designation, *Cochlea nebulosa* Martyn, 1786 [non-binomial, I.C.Z.N. Opinion 456] + *Cardium elongatum* "Bruguière" Reeve, [= *Cardium elongatum* Bruguière, 1789]. Recent, Indo-Pacific seas.

There is considerable uncertainty as to the correct name to be applied to the type species of *Vasticardium*. Iredale identified "A magnificent cockle measuring 137.5 mm in length" from Vanikoro as *V. nebulosum* (Martyn) with reference to the *Universal Conchologist* v. 2, 1786, pl. 140, adding that "the figure given by Reeve [1844, pl. 9, fig. 46] of *Cardium elongatum* Bruguière refers to this species." The International Commission on Zoological Nomenclature in Opinion

456, published March, 1957, rejected the names proposed by Martyn in *The Universal Conchologist* because that author failed to apply consistently the principles of binomial nomenclature.

The problem as to the correct substitute name to be used stems from the fact that Bruguière added to his very detailed original description of *Cardium elongatum* (1789, p. 228) references to six illustrations including three from Lister, Born, and Martini and Chemnitz that were based upon specimens said to have come from Jamaica. The Lister and Born figures had been cited previously by Gmelin (1791, p. 3250) in reference to *Cardium magnum* Linnaeus. Keen (1937, p. 22) and subsequent authors have tended to stress this feature, Keen stating that "*Cardium elongatum* Bruguière, 1792, is based upon the same figures as *C. leucostomum* Born, 1778; its type locality is Jamaica, so that Reeve's use of the name for an Indo-Pacific species is obviously untenable." Not only did this overlook the fact that among the other figures cited were some from non-Jamaican localities, but more importantly, the fact that Bruguière based his description upon actual specimens at hand rather than upon any published illustration. Bruguière clearly stated (freely translated):

> This species is remarkable for its large size, for its elongate form and for the number of ribs with which it is ornamented; *the shell of which I give the description* [italics mine] is not the largest; there are in the collections those which surpass it by almost twice the length and with the other dimensions in proportion; it is "trois pouces sept lignes" [about 80 mm] in length, "deux pouces sept lignes" [about 62 mm] wide and "deux pouces quatres lignes" [58 mm] in depth. The shape is an elongate oval with the sides almost equal; each valve is ornamented exteriorly by 39 or 40 longitudinal ribs separated by narrower squared interspaces. The first dozen ribs are ornamented on their convexity by very small, granular tubercles, especially those close to the ligament [Bruguière clearly used an orientation of the valves that is the reverse of that presently accepted]. The median ribs are square and marked on each side by projecting striae that crenulate them; the fifteen most posterior ribs are a little more rounded, closer together than the previous ones and marked along their length by elevated striations that are lying one above the other from top to bottom, that is to say, with the edges towards the top.
>
> The region of the lunule is lanceolate, flat, lamellar, six lines long, three and a half wide, reddish. I have counted 37 deep crenulations of conical shape on the interior of the margins of each valve; those in front are more separated, more oblique than the others and of a flesh-colored tint; those which come after are equal, except above in the region of the lunule, where they have a little more depth than the others; these are fitted exactly the one into the other and leave only a small gap between on the anterior face. The interior of the valves is white . . .
>
> *Du cabinet de M. le chevalier de la Marck.* [italics of Bruguière]

The writer's personal collections made in the Philippine Islands in 1952-53 contain three complete specimens plus two isolated valves that agree well with the above description. All have 39 or 40 ribs with 37 or 38 internal marginal crenulations differing primarily in the fact that the more fresh specimens show a distinctly pinkish-brown tint along the crenulated posterior margin, the "flesh-color" noted by Bruguière. Also, the number of tuberculated posterior costae tends to vary between 7 and 9 rather than 12. The writer agrees with Clench and Smith when they state (1944, p. 7) that "Bruguière's *T. [Trachycardium] elongatum* was probably based upon an East Indian specimen. *T. magnum* and *T. elongatum* are exceedingly close, the differences being very slight indeed. . . . Bruguière pointed out that *T. elongatum* possesses 39 to 40 ribs, while *T. magnum* generally has 32 to 35. However, we possess specimens of *T. magnum* showing a variation in the number of ribs, one specimen having 40 ribs, two specimens with 38 while all others have less than 36 ribs. We believe that this variation in the number of ribs has been responsible for most of the confusion which has existed."

The Chipola species mis-identified by Dall (1900, p. 1082) as "*Cardium*" *inconspicuum* Guppy, a Bowden form from Jamaica, has the anterior costae marked by transversely "shingled" cross-ridges similar to the "elevated striations . . . lying one above the other from top to bottom" of the species of Bruguière; the posterior costae are marked by granular tubercles that are most numerous and strongly developed adjacent to the ligament, and the posterior margin is notch-

ed by the projecting ends of the costae. Under ultra-violet light this crenulated margin reveals a pattern indicative of its having been strongly colored during life, as in the modern *Vasticardium elongatum.*

ACROSTERIGMA (VASTICARDIUM) HOERLEORUM H. E. Vokes, n. sp.
Plate 3, figures 1-5; Plate 10, figure 2

Cardium (Trachycardium) inconspicuum Guppy. DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1082 [in part, Chipola reference only; not *Cardium inconspicuum* Guppy, 1886, "Miocene of Jamaica"]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 137.

Acrosterigma inconspicuum Guppy. STEWART, 1930, Acad. Nat. Sci. Phila., Spec. Publ. 3, p. 137 [reference to Gardner, 1926].

Diagnosis: Shell of medium size, subequilateral, broadly subovate, with the anterior and antero-ventral margins broadly and almost equally rounded, straightening out somewhat along the median and postero-ventral region to the rather sharply arched postero-ventral "corner," above which the posterior margin is curved to a degree almost equal to that of the anterior end; umbones narrow, moderately high, not strongly inflated. Ornamentation consisting of rather low radial ribs, 32 to 37 in number, separated by narrower interspaces; ribs on the anterior and median areas of the valve broad, slightly rounded above, with shallow, round-bottomed interspaces the bottoms of which are a little less than one-half as wide as the more flattened upper surface of the intervening costae; on well-preserved specimens the first three ribs smooth and the next anterior 11 to 13 marked by raised, scalelike growth lamellae that reflect the slight denticulation of the anterior margin and thus are slightly arcuate dorsally on the crest of the ribs; the number of ribs so ornamented increasing from but three or four in the earliest stages observed with the remaining costae on the anterior and median surface having smooth tops but the lateral slopes and interspaces crenulated by raised growth lamellae. Interspaces between the first three ribs immediately behind the postero-ventral "corner" distinguished by the development of a low, rounded inter-rib, which is absent elsewhere on the valve. The posterior slope marked by seven or eight flattened costae, the two most dorsal being rather narrow and raised, with relatively strong elongately curved beads on their crests; the next succeeding ribs low, flattened and wide, with narrow, almost linear interspaces; these ribs tending to have slender scalelike beads on their antero-posterior sides that extend into the interspace area. (These beads apparently are easily broken or eroded off, often being preserved only on one or two of the five or six ribs on which they may be observed in unusually well-preserved specimens.)

Holotype, USNM 243520; height 52.3 mm, length 44.0 mm, diameter (left valve) 13.2 mm; locality TU 546 (Pl. 3, fig. 1).

Paratype A, USNM 243521; height 51.3 mm, length 43.6 mm, diameter (right valve) 13.3 mm; locality TU 830 (Pl. 3, fig. 2).

Paratype B, USNM 243522; height 31.2 mm, length 25.2 mm, diameter (paired valves) 18.2 mm; locality TU 951 (Pl. 3, fig. 3).

Paratype C, USNM 243523; height 32.7 mm, length 27.8 mm, diameter (left valve) 9.0 mm; locality TU 830 (Pl. 3, fig. 4).

PLATE 5

Figures Page

1-4. *Papyridea miocica* H. E. Vokes, n. sp. 168

1. Paratype A, USNM 243529 (X 1.5); height 27.6 mm, length 35.1 mm. Lateral view of specimen from coral facies.
Locality: TU 547, Chipola River.

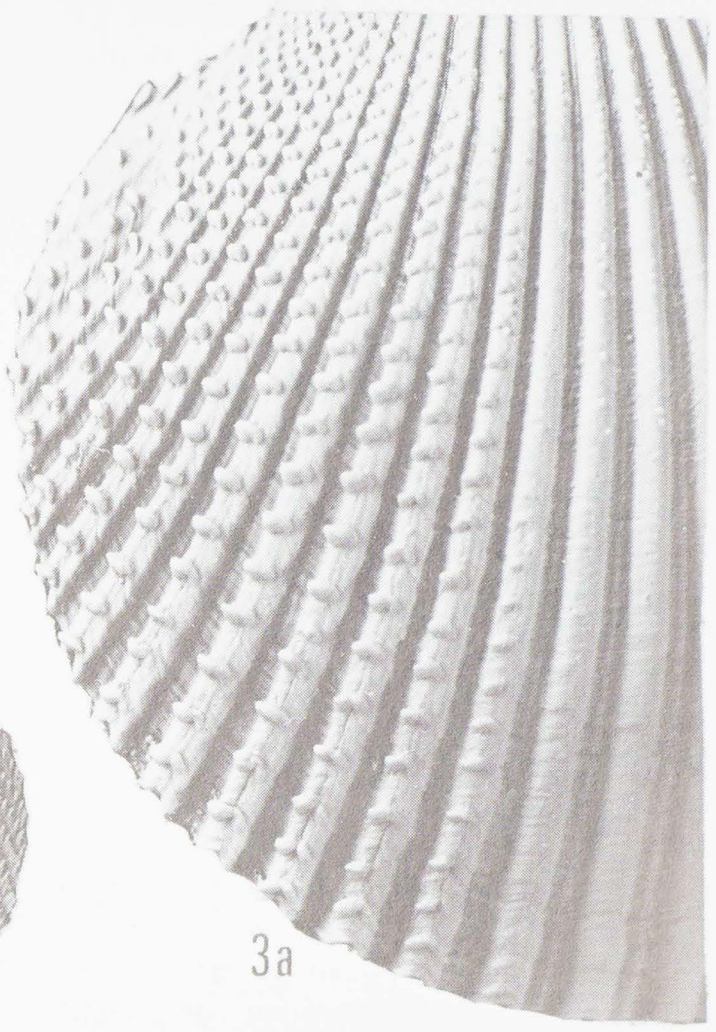
2. Holotype, USNM 243530 (X 1.5); height 28.3 mm, length 39.2 mm.
Locality: TU 825, Farley Creek.

3. Paratype B, USNM 243531; height 26.5 mm, length 33.3 mm. Specimen from coral facies.
Locality: TU 547, Chipola River.
3a. Oblique view (X 4) of anterior end of valve showing strong transverse beading of ribs. 3b. Oblique view (X 4) of posterior end of valve showing development of curved, scalelike spines on posterior side of costae only, and the deep median groove on most posterior ribs. 3c. Lateral view (X 1.5).

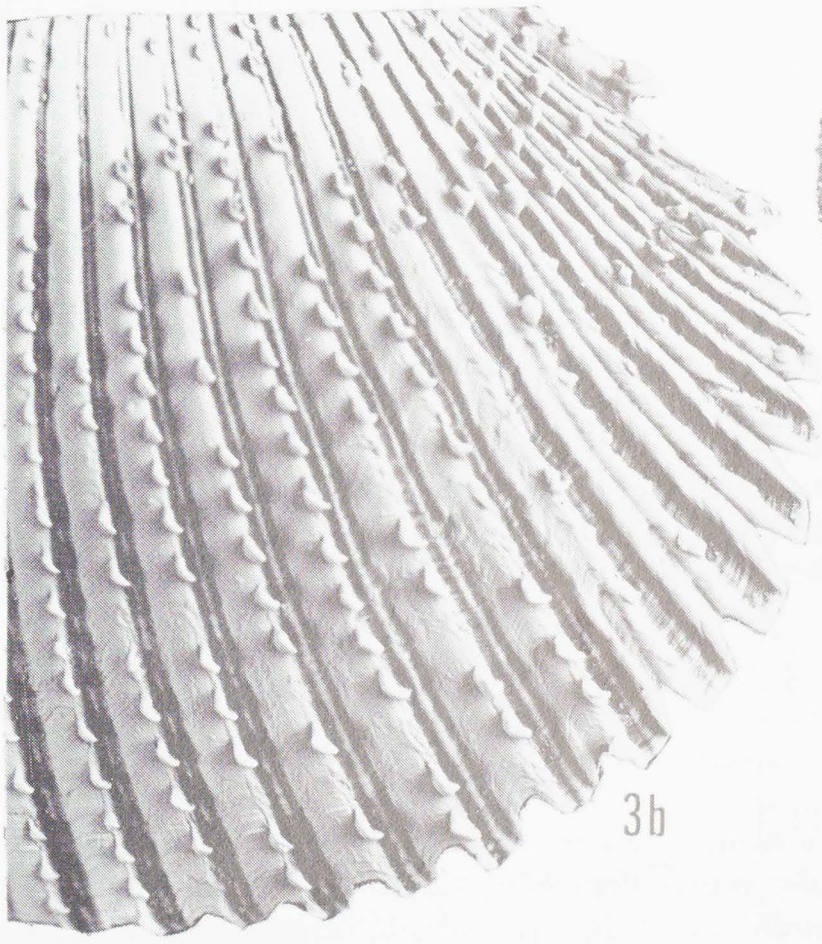
4. Paratype C, USNM 243532 (X 1.5); height 19.9 mm, length 27.4 mm.
Locality: TU 825, Farley Creek.

1

2



3a



3b

3c

4

PLATE 5

Paratype D, USNM 243524; height 40.5 mm, length 34.8 mm, diameter (left valve) 11.0 mm; locality TU 830 (Pl. 3, fig. 5).

Paratype E, USNM 243560; height 45.9 mm, length 38.4 mm, diameter (right valve) 12.5 mm; locality TU 830 (Pl. 10, fig. 2).

The largest specimen in the collections, an incomplete right valve from TU 830, has a height of 60.5 mm, and a diameter of about 14 mm.

Discussion: Neither Dall nor Gardner figured the Chipola form that they identified as *Cardium inconspicuum* Guppy, a species described from the "Miocene" of Jamaica and reported from the fauna of the Bowden Formation by Woodring (1925, p. 138, pl. 19, figs. 1, 2), who added (p. 139): "A worn broken valve from the Chipola formation called *C. inconspicuum* has narrower ribs and wider interspaces." According to Woodring, the typical Bowden form has 40 to 41 ribs with only the 10 to 13 anterior ribs "ornamented by transverse or slightly oblique" beads. The Chipola specimens have 32 to 37 ribs, the majority having 34 or 35 (based upon a count of 25 specimens); of these the anterior 15 or 16 show transverse, bead-like ornamentation. *"Cardium (Trachycardium)" waylandi* Woodring (1925, p. 139, pl. 19, figs. 3, 4), also from the Bowden fauna, is similar in shape and number of costae, but it differs in details of ornamentation, primarily in that the ribs tend to be flat-topped and to overhang the narrow, deeply channeled interspaces. *"Cardium (Trachycardium)" linguatigris* Maury (1917, p. 373 [209], pl. 62 [136], fig. 2) appears to be the Dominican Miocene analogue of *A. hoerleorum,* but it differs in having 42 costae.

The recent Panamic-Pacific species *"Cardium (Trachycardium)" pristipleura* Dall, 1901 (p. 389) [= *Cardium maculosum* Sowerby. 1833 (non Wood, 1815) + *C. maculatum* Sowerby, 1840 (non Gmelin, 1791), + *C. hornelli* Tomlin, 1928] also is to be referred to *Acrosterigma (Vasticardium).* According to Keen (1971, p. 153) it has 34 to 39 ribs; hence it appears possible that it is a paciphile descendant of *A. (V.) hoerleorum,* n. sp., which has 32 to 37 ribs.

It gives much pleasure to dedicate this species to Mr. and Mrs. R. C. Hoerle (Bob and Shirley) of West Palm Beach, Florida, with whom we have spent many pleasant and productive days collecting and discussing the Chipola fauna.

Genus PAPYRIDEA Swainson, 1840

Papyridea SWAINSON, 1840, Treatise on Malacology, p. 374.

Type species, by subsequent designation, Gray, 1847 [November], *Cardium soleniforme* Bruguière, 1789. Recent; Cape Hatteras to southern Brazil.

Swainson included four species in his cardiid "subgenus" *Papyridea* but did not cite their authors:

"P. Soleniforme. Wood, Conch., pl. 56, f. 3.
apertum. Ib. 56, f. 2.
transversum. Sow. Conch. f. 4
ringens. Wood, pl. 53, f. 1, 2."

Wood's *Index Testaceologicus* (1828, p. 27) (I do not have present access to his *General Conchology)* also cites no author for the species *soleniforme,* but lists among others the references to Lister, Gualtieri, and Martini and Chemnitz that are also cited by Bruguiere (1789, p. 235) in describing his *soleniforme,* plus the illustrations given in the *Tableau Encyclopédique et Méthodique* (1798, pl. 296, figs. 6a, b). He also added "Gm. 3226 [*S. bullatus*]" wherein Gmelin gives the same Lister, Gualtieri, and Martini and Chemnitz references, plus two that are cited with question; these are to Knorr and to Rumphius "mus. t. 44, f. N ?". This latter was the sole reference cited by Linnaeus in 1758 (sp. 31, p. 673) for the original description of his *"Solen bullatus."* This is a very poor figure and cannot certainly be identified, Dall's (1900, p. 1106) suggestion that it represents an arcid species being as good a guess an any. Herrmannsen (1847 [Sept. 8], p. 200) cited, as the type of *Papyridea, "Card. bullatum L."* an obvious reference to the *"Solen" bullatum,* presumably of the Gmelin edition of the *Systema Naturae,* but this cannot be accepted since

Linnaeus never described a *"Cardium bullatum."* Gray's designation two months later, of *soleniforme* is the oldest valid one with which I am acquainted.

This species was identified for many years as *spinosum* Meuschen, 1787, following Dall (1900, p. 1106), but that name had been used the year before by Lightfoot in the *Portland Catalogue;* accordingly Clench and Smith (1944, pp. 16, 17) applied the name *hiatus* Meuschen, overlooking the fact that the Meuschen names in the *Museum Geversianum* were not consistently binomial and hence not nomenclatorially available.

PAPYRIDEA BULBOSA (Dall)
Plate 4, figure 4; Plate 9, figure 4

Cardium (Papyridea) bulbosum DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1109; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 20; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 128 [Holotype, 114762; "Oligocene, Chipola River, Florida"]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 142, pl. 23, fig. 17 ["Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla."].

As noted by Gardner, the original description was based upon a single individual; examination of a larger number of specimens indicates that there is a considerable degree of variation in the number of radials (see Table 4) and that Dall's counts of 9 anterior, 16 medial and 13 posterior = 38 ribs, are too precise to define the species. Counts of the ribbing on 23 specimens in the Tulane University collections show a variation between 37 and 44 in total number of ribs and between 12 and 14 in the number on the posterior area. The distribution of the counts as to total number of radial ribs seems to suggest variability without any tendency to a precise maxima; the number of radials on the posterior area, however, clearly indicates that 13 is the normal complement.

There is much variation in the nature of the ribs, also. Dall described those on the posterior end as being obliquely flattened, with their highest part on the posterior side and the last three or four bearing minute spiny pustules. Well-preserved specimens show that the most anterior one or two of

TABLE 4

Number of radial ribs on Chipola species of *Papyridea:*

A. Total number of ribs.

B. Number on posterior area only.

Species:	A. Number of radial ribs:															Number of specimens counted:
	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
P. miocica	4	7	14	15	21	14	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80
P. bulbosa	—	—	—	—	—	3	4	4	3	4	2	2	1	—	—	—	—	—	—	—	—	—	—	23
P. multicostula	—	—	—	—	—	—	—	—	—	—	—	1	5	11	11	6	9	9	9	9	5	4	1	80

Species:	B. Number of posterior radials:									Number of specimens counted:
	9	10	11	12	13	14	15	16	17	18	
P. miocica	—	—	—	—	1	1	5	31	11	1	50
P. bulbosa	—	—	—	5	16	2	—	—	—	—	23
P. multicostula	1	3	20	23	3	—	—	—	—	—	50

the ribs is obliquely flattened; the immediately succeeding rib tends to have a shallow, rather indistinct groove that progressively becomes more strongly developed on the more posterior ribs until in some forms it has completely divided them (Pl. 4, fig. 4c). The anterior portion of each rib is "pushed" laterally until it is so adjacent to the posterior segment of the preceding radial as to limit the intervening interspace to a narrow grooved line. The "spiny pustules," which are better described as small, curved, platy spines, may be present to greater or less degree on all of the posterior ribs. In general they are more numerous and strongly developed on the more posterior ribs where they are always present only on the segment posterior to the median "groove." They tend to be weak and present only on the extreme posterior apex of the obliquely flattened, anteriorly located ribs of this series, and seem to have thus been particularly exposed to wear and breakage, being almost always absent on specimens from localities of more coarse-grained matrix, and but sparsely preserved on those from the finer-grained sites.

Ribbing on the median portion of the valve immediately in front of the posterior series is marked by being rather lower and rounded with interspaces that are approximately two-thirds as wide. The demarcation between the ribs and the interspaces is sharp, almost grooved. This results in the interspaces appearing as if marked by a low, broad interrib. Anteriorly the median costae become progressively more triangular in profile; then near the anterior end there develops a series of ribs that are more-or-less the image of the posterior set in that they become obliquely flattened with the highest part on the anterior side and bear curved, platy spines on the crest and anterior slope (Pl. 4, fig. 4b). Well-preserved specimens show that the entire surface of the valve between third or fourth most anterior and posterior radials is covered with minute granular pustules that usually are more numerous in the interspace areas but which tend to be somewhat stronger, more prominent, and often aligned along the crests of the more anterior of the costae on the median area of the valve. This feature emphasizes the rather gradual transition from the median to the anterior ribbing, and being often eroded away in specimens from more coarse matrix localities, makes impossible any statement as to the range of variation in the numbers of

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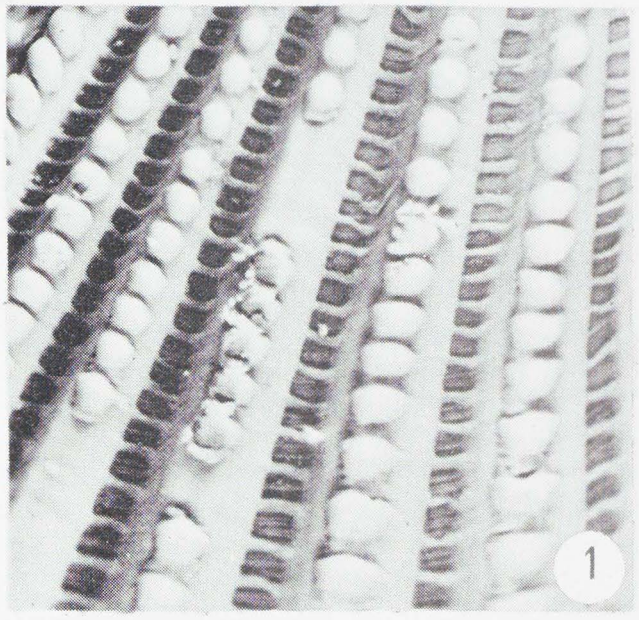
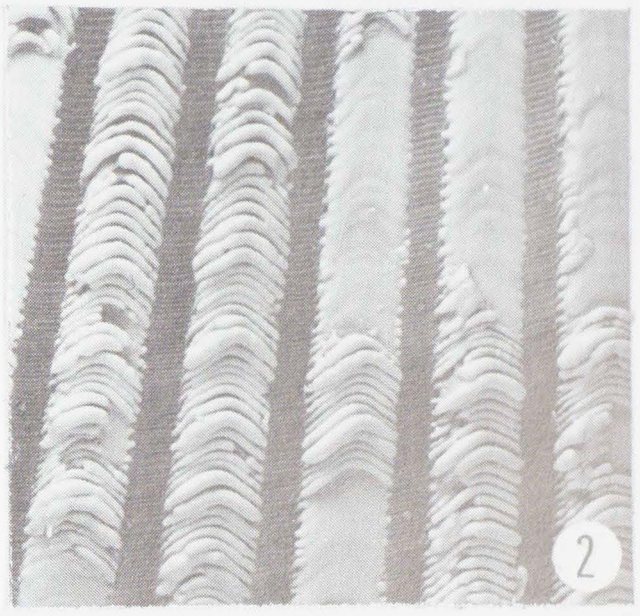
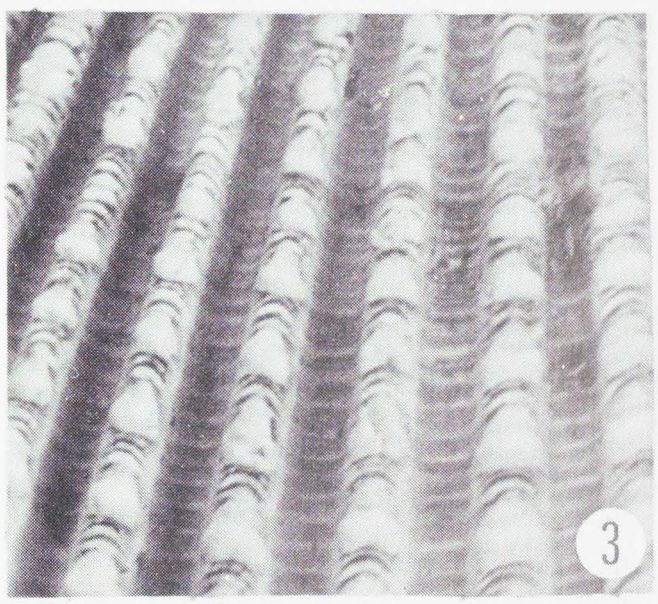
PLATE 6

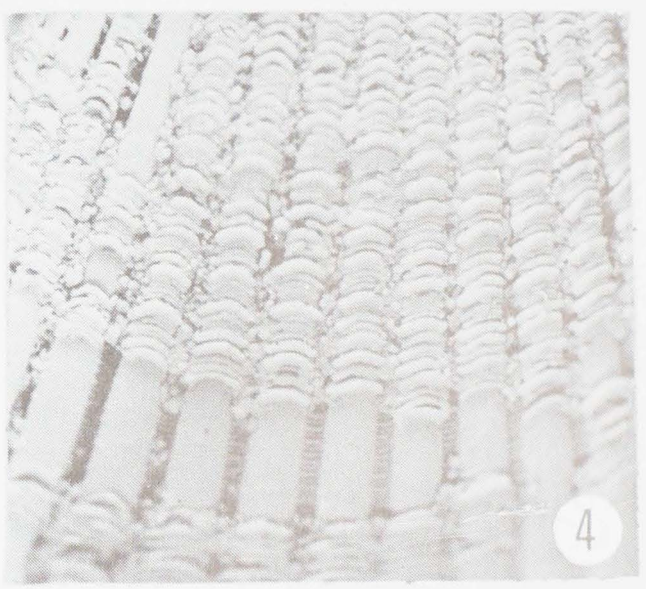
Figures Page

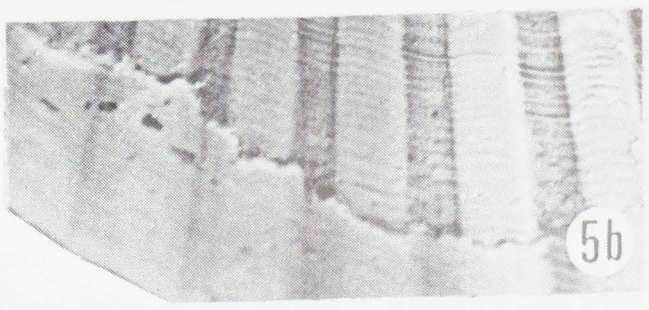
1. *Trigoniocardia (Trigoniocardia) simrothi* (Dall) 180
   Figured specimen, USNM 243536 (X 15).
   Locality: TU 554, Chipola River.
2. *Trigoniocardia (Americardia) media* (Linnaeus) 178
   Figured specimen, USNM 711237 (X 6).
   Locality: TU R-109, north coast of Panamá; Recent.
3. *Trigoniocardia (Trigoniocardia) burnsii* (Dall) 181
   Figured specimen, USNM 243541 (X 22).
   Locality: TU 830, Tenmile Creek.
4. *Trigoniocardia (Americardia) decidua* H. E. Vokes, n. sp. 184
   Holotype, USNM 243543 (X 8).
   Locality: TU 546, Tenmile Creek.
5. *Fragum tunicula* H. E. Vokes, n. sp. 172
   a. Paratype A, USNM 243534 (X 12); showing scattered nodes.
   b. Paratype B, USNM 243535 (X 12); showing non-nodose intritacalx area and surface of shell when intritacalx is removed by erosion.
   Locality of both: TU 453, Alum Bluff, Apalachicola River.
6. *Trigoniocardia (Americardia) columba* (Heilprin) 178
   Figured specimen, USNM 243563 (X 8).
   Locality: TU 201, Bermont Formation, Belle Glade, Florida.











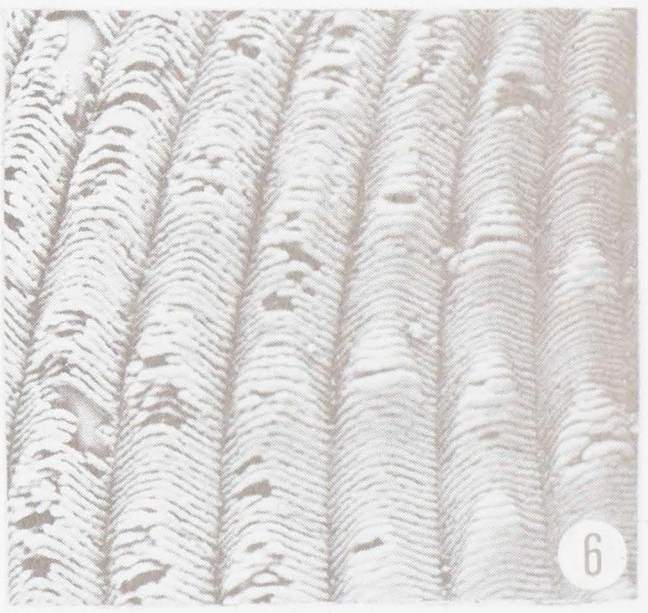


PLATE 6

the median and anterior ribs. In general the number of anterior costae appears to vary between six and ten, but these figures are based upon too few specimens to be significant.

Papyridea bulbosa may be separated most easily from the other Chipola species of the genus by its shape, being proportionately shorter and higher than either of the other two forms and having the greatest valve height posterior to the umbones, almost at the postero-ventral segment. The umbones are located slightly behind the anterior third of the total length. The antero-dorsal margin is rounded, passing into the very regularly and evenly rounded anterior and antero-ventral margin, the arc of the curve gradually flattening off from a position directly below the umbones to the postero-ventral corner which, in turn, is broadly and regularly arched around the posterior end to the relatively straight posterior dorsal edge. The arc of the posterior margin tends to be strongly serrated, with the indentations developed at the site of the median groove of the posterior ribs rather than at the interspaces.

Although no paired valves are available for study, the shape of the valve margin indicates that the anterior ventral gape was moderately strong, and that the posterior one was even greater, proportionately, than it is in the Recent *P. soleniforme.*

P. bulbosa appears to be confined to approximately the lower one-quarter to one-third of the Chipola Formation. At locality TU 458, the stratigraphically highest occurrence of the species, it is associated with *P. multicostula,* n. sp., in the lowest known occurrence of that form.

Figured specimen, USNM 243528; height 23.5 mm, length 27.6 mm, diameter (left valve) 7.5 mm; locality TU 458 (Pl. 4, fig. 4).

Figured specimen, USNM 243556; height 19.1 mm, length 22.0 mm, diameter (right valve) 5.4 mm; locality TU 830 (Pl. 9, fig. 4).

PAPYRIDEA MIOCICA H. E. Vokes, n. sp.
Plate 5, figures 1-4; Plate 9, figure 3

Diagnosis: Shell of moderate size for the genus, elongate-ovate in outline, and of average inflation; umbones situated anterior to the midlength of the valve at approximately two-fifths of the total length; anterior, ventral and posterior margins all arcuate, the ventral more broadly so than the others; posterior dorsal slope almost straight, anterior dorsal margin straight but the shell profile somewhat concave due to the projection of the moderately inflated umbones; anterior gape apparently not developed, posterior one linear, very narrow.

Ornamentation consisting of numerous (32 to 39, see Table 4) radial ribs separated by interspaces that vary in width over different areas of the valve but are always narrower than the primary radials; each interspace, except the most anterior and most posterior ones, bearing a narrow, rounded interriblet that is defined by a distinct, round-bottomed groove. Shape of the primary radials varying on different areas of the valve. A posterior sequence (Pl. 5, fig. 3b), usually of 16 ribs (Table 4), having obliquely flattened costae that have an angulate crest near the posterior side, with numerous narrow, curved, scalelike spinules on the crest and the posterior slope. This sequence covering almost the entire posterior half of the total length of the valve; with the four or five most anterior of the ribs having a flat-topped anterior slope, the immediately posterior costae tending to develop a broad, shallow concavity on this slope, which progressively becomes deep and stronger posteriorly until, on the ribs intersecting the posterior end of the valve, it has developed into a narrow, deep and angulate groove that divides the ribs into two segments with the serrations of the posterior margin marking the site of the grooves and being margined by the two segments of the rib. Costae on the anterior slope usually relatively high and round-topped, marked by curved, scalelike imbrications along their crests (Pl. 5, fig. 3a). The number of these ribs seemingly increases with increasing growth; in the early stages only the anteriormost eight or ten ribs marked by the imbrications, with the ribs of the median portion being round-topped and covered with small granular pustules, those on the crests tending to be somewhat more strongly developed than the ones on the sides and interspace areas. These stronger pustules increasing in size as growth continues and eventually opening ventrally to form erect scalelike imbrications identical with those of the more anterior ribs; in some specimens as many as 16 ribs eventually imbricated in this manner. An elongate, non-ribbed, lunule-like antero-dorsal area present on both valves, but always wider and better developed on the right valve than on the left.

The inner margin crenulate anteriorly and medially, strongly serrated posteriorly; hinge typical of the genus.

Holotype, USNM 243530; height 28.3 mm, length 39.2 mm, diameter (right valve) 9.7 mm; locality TU 825 (Pl. 5, fig. 2).

Paratype A, USNM 243529; height 27.6 mm, length 35.1 mm, diameter (right valve) 9.1 mm (a coral facies variant); locality TU 547 (Pl. 5, fig. 1).

Paratype B, USNM 243531; height 26.5 mm, length 33.3 mm, diameter (left valve) 9.5 mm (a coral facies variant); locality TU 547 (Pl. 5, fig. 3).

Paratype C, USNM 243532; height 19.9 mm, length 27.4 mm, diameter (left valve) 6.8 mm; locality TU 825 (Pl. 5, fig. 4).

Paratype D, USNM 243555; height 30.2 mm, length 37.2 mm, diameter (right valve) 11.0 mm; locality TU 555 (Pl. 9, fig. 3).

Discussion: Two variant forms of a relatively strongly ribbed species of *Papyridea* occur in the middle and upper beds of the Chipola Formation. They agree in details of ornamentation as well as in the degree of variability observable in the number of radials, but are to be distinguished on the basis of differences in outline and overall proportions. The most widely distributed, though less abundant form, is more narrowed posteriorly and has, as a result, the appearance of being considerably more elongate than the other, although comparative measurements indicate that the difference in elongation is not as great as it appears to be; specimens of essentially equal height showing a height to length ratio average of .730:1 in the elongate forms and .791:1 in the others. This latter type is, however, the most abundantly represented form in the collections, with no less than 145 specimens from two localities, TU 547 and TU 555, both of which are in coral-reef facies. While occasional coral specimens have been found at the localities from which the more normal type has been collected, it is here believed that the difference between the two variants is to be interpreted as an ecologic response to differing environmental facies. The more widely distributed, more elongate variant is here described as representing the typical form of the new species.

Papyridea miocica may readily be distinguished from *P. bulbosa* by its different shape, being more elongate with narrower posterior end and with the greatest valve height sub-umbonal, rather than posterior in position. The lack of an anterior gape, and the much reduced posterior one are also distinctive as are all details of the ornamentation. *P. multicostula,* n. sp., differs in having many more radial ribs, with those on the median part of the valve low and weakly developed, giving that portion of the valve an appearance of being almost smooth.

PAPYRIDEA MULTICOSTULA
H. E. Vokes, n. sp.
Plate 4, figures 1-3; Plate 9, figure 5

Diagnosis: Shell of moderate size for the genus, ovate, almost semicircular in outline; umbones relatively low, situated approximately at the anterior two-fifths of the total length; anterior and posterior margins each almost straight with a slight ventral trend, other margins broadly and regularly rounded, the extreme posterior end markedly serrate. Posterior gape relatively strong, the anterior weak, possibly not developed.

Ornamentation of rather strong radial ribs on the anterior and posterior ends with those on the median portion of the valve low, rounded and inconspicuous; all ribs and interspaces except those most anterior and posterior in position granulously pustulate. The anterior ribs (Pl. 4, fig. 3a) flat-topped, obliquely sloping, the apex, toward the anterior side, marked by scalelike imbrications; the imbrications becoming broader and crossing the whole upper surface of the rib during the later stages of growth and also tending to develop on the ventral ends of some of the more anterior ribs of the median segment, with the result that, while there are usually only six to eight imbricated anterior ribs on the younger shells, the number of ribs so ornamented is ten to twelve on adult specimens. The ribs on the median surface broad, very low and round-topped, the intervening interspaces usually about one-half the width of the rib and containing a narrow round-topped inter-rib that is separated from the adjacent primary solely by a linear groove; the combination of ribs and inter-ribs all of approximately the same height such as to give the median area a superficially smooth and unornamented aspect. The posterior ribs (Pl. 4, fig. 3b) tending to be broad and flattened, somewhat sloping antero-ventrally, with small scalelike spines present only on the posterior slope and across the narrow, rugose interspaces. The surfaces of the ribs tri-partite, having relatively narrow raised marginal areas that are strikingly smooth and devoid even of growth lamellae, with the intervening median area rather strongly ornamented by arcuate lamellae representing the former positions of the apex of the deep serrations that mark the posterior end.

The inner margin of the valves are but weakly crenulate medially in keeping with the low surficial ribbing, the crenulations being somewhat stronger anteriorly; hinge typical of the genus.

Holotype, USNM 243525; height 25.4 mm, length 31.8 mm, diameter (left valve) 7.8 mm; locality TU 548 (Pl. 4, fig. 1).

Paratype A, USNM 243526; height 25.4 mm, length 31.6 mm, diameter (right valve) 7.6 mm; locality TU 458 (Pl. 4, fig. 2).

Paratype B, USNM 243527; height 17.5 mm, length 23.7 mm, diameter (left valve) 5.4 mm; locality TU 458 (Pl. 4, fig. 3).

Paratype C, USNM 243557; height 20.8 mm, length 26.2 mm, diameter (right valve) 5.8 mm; locality TU 1048 (Pl. 9, fig. 5).

Discussion: Papyridea multicostula may be distinguished at once by the nature of the ribbing on the median surface of the valve. The total number of ribs is highly variable (Table 4) but in general they are more numerous than in the other Chipola species. In contrast, the number of posterior radials is less. Together with *P. bulbosa* it may be distinguished from *P. miocica* in lacking the lunular-like unornamented area on the antero-dorsal margin.

This new species first occurs in the Chipola Formation in association with *P. bulbosa* at TU locality 548, the stratigraphically highest occurrence of the latter form. It is widely present, usually in association with *P. miocica,* n. sp., in the stratigraphically higher collections from localities along the Chipola River and Farley Creek, but it is not represented in those made along Tenmile Creek. The deposits in the two former areas are somewhat sandy and calcareous, often with corals present, both solitary (mainly *Antillophyllia chipolana* Weisbord) and colonial forms representing several different genera; the associated faunas seem to suggest the deposition in open marine waters at depths of about 20 to 40 fathoms. The strata in the upper portion of the section along Tenmile Creek, on the other hand, are generally finer grained, silty with associated clays, and tend to have a fauna of back reef or lagoonal facies, certain of the Bryozoa present even being suggestive of somewhat reduced salinity (Scolaro, 1968, unpubl. diss.).

PLATE 7

Figures Page

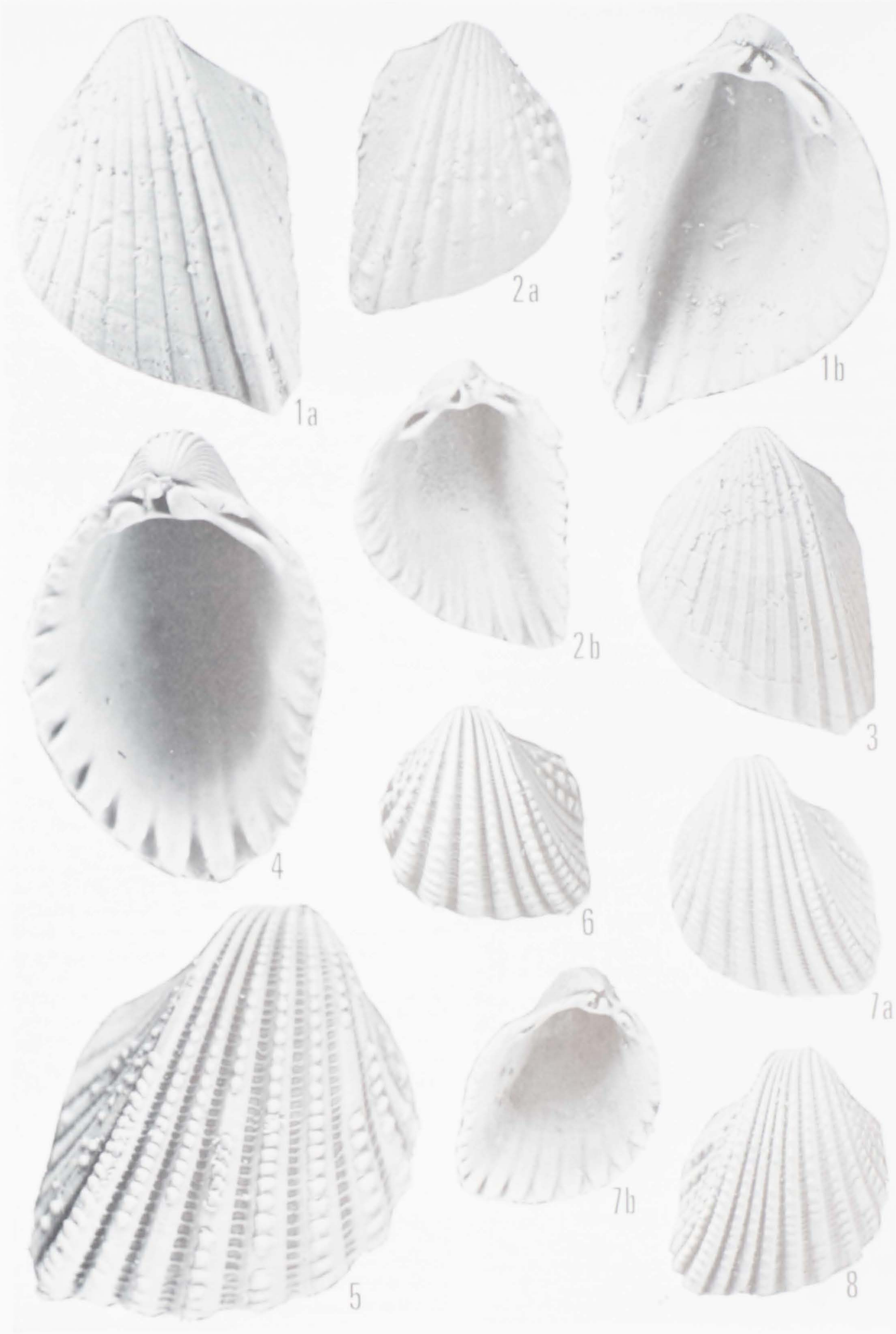


PLATE 7

Subfamily FRAGINAE Stewart, 1930
Genus FRAGUM Röding, 1798

Fragum RÖDING, 1798, Museum Boltenianum, p. 189.

Type species, by tautonomy, *Cardium fragum* "Gmel." [Linnaeus, 1758]. Recent; tropical Pacific from Amami Islands southward to, and including the East Indies.

The following species seems more closely related to species of the Indo-Pacific genus *Fragum* than to any other group. The exceedingly sharp postero-ventral umbonal ridge, straight and strongly denticulate posterior margin, and especially the details of the hinge structure with well-developed, peg-shaped, subequal cardinals and strong, peg-shaped lateral teeth, the anterior lateral somewhat more distant from the cardinals than is the posterior one, all seem close to the characters exhibited by *Fragum.* In overall shape it probably most closely resembles *Fragum mundum* (Reeve) (1845, pl. 22, sp. 125) originally described from "Lord Hood's Island, Pacific Ocean (found among coral and sand)."

The most similar generic type presently reported from the Western Hemisphere is *Apiocardia* Olsson (1961, p. 252), described as a subgenus of *Trigoniocardia,* with *Cardium obovale* Sowerby as type species by original designation. The hinge of this form (see Pl. 7, fig. 4) differs from that of the present species in having the anterior lateral very closely approximate to the cardinals, with the posterior more distant and peculiarly modified, in that what usually is the raised ventral side of the lateral socket in the right valve has migrated posteriorly and developed into a full-fledged lateral tooth whose anterior end is almost directly behind the socket for the left posterior lateral. This is, in actuality, only an end-product of a tendency also to be observed in the lateral teeth of *Cardium graniferum* Broderip and Sowerby, the type species of *Trigoniocardia* Dall, 1900.

FRAGUM TUNICULA H. E. Vokes, n. sp.
Plate 6, figure 5; Plate 7, figures 1-3

Cardium (Trigoniocardia) alicula DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1103 [in part, *not* pl. 40, fig. 12]; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 5.

NOT *Cardium (Trigoniocardia) alicula* Dall. SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 128 [Holotype, USNM 157549; "Oligocene. Ballast Point, Tampa Bay, Florida"]; DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 144, pl. 25, fig. 8 [same figure as Dall, 1900, pl. 40, fig. 12].

Cardium (Trigoniocardia) berberum DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 145 [in part, references to Dall, 1903, pl. 48, fig. 5, and to occurrences at Alum Bluff and Chipola River only].

NOT *Cardium (Trigoniocardia) berberum* Dall. MANSFIELD, 1937, Florida, Geol. Surv., Bull. 15, p. 249, pl. 18, figs. 2, 3 [Holotype, USNM 166113 from Tampa Limestone, distinguished from "*C. aliculum* Dall from the Chipola formation . . ."].

Cardium [Fragum (Trigoniocardia)] aliculum Dall. GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 140, pl. 23, fig. 15 [same figure as Dall, 1903, pl. 48, fig. 5].

Diagnosis: Shell moderately small, obliquely subtriangular, elevated, with a pronounced keel extending from the posterior side of the umbones to the postero-ventral margin, which is sharply angulated at this point; anterior margin relatively short, broadly rounded into the ventral margin, which is almost straight, but with a tendency to be slightly concave immediately in front of the keel. Ornament of radial ribs with seven to nine ribs, usually eight, on the posterior slope and 11 to 13, usually 12 or 12 on the keel and anterior slope; ribs on posterior slope relatively flat-topped but with rounded sides sloping into narrow, almost linear interspaces; the most dorsal of these ribs tending to be distinctly broader than those ventral to it and the interspace between it and the remaining ribs is approximately twice as wide as those below. Keel usually marked by a strong rib that is noticeably higher and narrower than those anterior to it, although the two immediately anterior are proportionately narrower, higher, and with relatively broader interspaces than the other costae on the anterior surface, these latter tending to be broad and low, with linear interspaces; all anterior interspaces marked by a ladder-like ornamentation of low, transverse growth lamellae that are most visible in the three or four broader interspaces immediately in advance of the keel. Surfaces of all ribs with transversely elongated and rounded pustules; these, however, being part of the intritacalx are easily eroded away, together with the thin, smooth and shiny outer shell layer. When this is lost, the ornamentation has a wholly different appearance, with a chalklike shell marked by flat-topped costae that are straight sided and separated by flat-bottomed interspaces, both costae and interspaces being crossed by the low, transverse growth lamellae; inner margins of anterior and ventral areas fluted internally, posterior margin rather strongly denticulate.

Holotype, USNM 243533; height 14.7 mm, length 10.5 mm, diameter (left valve) 5.8 mm; locality TU 453, lower bed, Alum Bluff (Pl. 7, fig. 1).

Paratype A, USNM 243534; height 10.5 mm, length 8.0 mm, diameter (right valve) 3.9 mm; locality TU 453 (Pl. 6, fig. 5a; Pl. 7, fig. 2).

Paratype B, USNM 243535; height 11.1 mm, length 8.5 mm, diameter (left valve) 3.6 mm (a decorticated specimen); locality TU 453 (Pl. 6, fig. 5b; Pl. 7, fig. 3).

(Note: These measurements made with the straight posterior margin in a vertical position.)

Discussion: Fragum tunicula differs at sight from other Chipola cardiid species in its much more strongly keeled shell with shorter posterior end, narrower interspaces between the ribbing when the intritacalx is present, and more sharply rounded posterior end. It appears to differ from the true Tampa Limestone *C. alicula* of Dall in its somewhat more flaring posterior margin, especially toward the dorsal end; conversely, the anterior side of the Tampa species is proportionately broader and more flaring so that the overall height: length relationship appears to be essentially the same.

Few specific names of Florida Miocene species have as complex a history as the *"Cardium alicula"* of Dall and the present species. Although not explicitly so stated by Dall, it appears that the name *C. alicula* was applied initially to a specimen from the Tampa Limestone at Ballast Point in Tampa Bay – the original of Dall's 1900, plate 40, figure 12 – with the subsequent acquisition of specimens from Alum Bluff leading to a revision of the original description and the preparation of the illustration that was printed in 1903 on plate 48, figure 5 of the "Contributions to the Tertiary Fauna of Florida," Part 6. In 1905, in Schuchert, *et al.,* Dall designated the originally illustrated Ballast Point specimen as the holotype of the species with USNM number 157549. Later, in 1915 (p. 144), he again cited *C. alicula* from the Tampa Limestone with synonymic reference to the original 1900 illustration "pl. 40, fig. 12 (only)," but with the distribution said to be "Oligocene of the Tampa silex beds, Ballast Point, Tampa Bay, and of the lower bed at Alum Bluff, Chattahoochee River [now the Apalachicola River], Florida. Dall and Burns. U. S. Natl. Mus. No. 165209." At the same time, on the next page (p. 145), he proposed the name *"Cardium (Trigoniocardia) berberum,* new species," without illustration, but with synonymic reference to *"Cardium (Trigoniocardia) alicula* (part), . . . pl. 48, fig. 5, . . . (not pl. 40, fig. 12)". The original statement concerning *berberum* was:

> "Oligocene of Tampa silex beds and of the lower bed at Alum Bluff, Florida, and of the Chipola River marl, Calhoun County, Florida. U. S. Nat. Mus. No. 166113.
>
> "When first described it was thought that the Ballast Point specimen of *C. alicula* was worn and that its differences from the Chipola form were due to erosion. The recovery of a well-preserved valve from the silex beds, together with specimens of the Chipola form, has enabled a more exact comparison to be made, which shows that the form from the Chipola marl beds is distinct. It may be recognized by its more narrow form and by the very conspicuous denticulation of the margin of the truncated end of the valves. *C. alicula,* so far as known, is confined to the Ballast Point horizon, but the present species is present also at Chipola. The Ballast Point specimens are U. S. Nat. Mus. No. 166113."

It seems clear that Dall was proposing the name *C. berberum* as a substitute name for the *"alicula"* of his earlier plate 48, figure 5, but he used the designation of "new species" rather than "new name." In 1937, Mansfield (p. 249, pl. 18, figs. 2, 3) restricted the name *C. berberum* to the valve from the Tampa silex beds, giving a formal description and stating that the "Holotype, left valve (U. S. Nat. Mus. No. 166113) measures: Length, 8.7 mm; height, 13.3 mm; semidiameter, 4.5 mm." [This specimen is better termed the "lectotype," since it was not formally designated as holotype by Dall whose hypodigm also included the "specimens of the Chipola form."] Mansfield then added the statement that *"Cardium berberum* is closely related to *C. aliculum* Dall from the Chipola formation of Florida but differs from it in having a narrower and more sloping area at and behind the umbo and 3 to 4 more ribs in

front of the posterior ridge. The outlines of the two species are similar."

In the meantime, Gardner, in 1926, overlooking or ignoring both Dall's citation of the type of *C. alicula* as being the Tampa form and his 1915 statement that the species "so far as known is confined to the Ballast Point horizon," reported *"aliculum"* as from the Chipola fauna, adding: "Cotypes: U. S. Nat. Mus. No. 157550" [Dall had said in 1905 that the holotype bore the number 157549] and "Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Florida." This action was clearly invalid, but seems to have been accepted by Mansfield in 1937 (p. 249) in comparing *C. berberum* with *"C. aliculum* Dall from the Chipola formation" and, on the following page (1937, p. 250), listing *"Cardium (Trigoniocardia)* cf. *C. aliculum* Dall" with synonymic citations to Dall, 1900, "p. 1103 (part), pl. 40, fig. 12" and 1915, "p. 144, pl. 25, fig. 8." Mansfield then observes that: "Two valves from the 'silex beds' of the Tampa limestone, Ballast Point, Tampa Bay, Fla., were identified as *Cardium aliculum* Dall, one a right valve (U. S. Nat. Mus. No. 157549) figured by Dall in 1900, and the other a left valve (U. S. Nat. Mus. No. 165209) . . . The 'silex beds' specimens when compared with specimens of *C. aliculum* Dall, *a species described from the Chipola formation* [italics mine], reveal, so far as can be discerned, similar external sculpture but appear to differ from the Chipola species in having a narrower shell with less produced posterior-ventral area." Thus Mansfield followed Gardner's lead and

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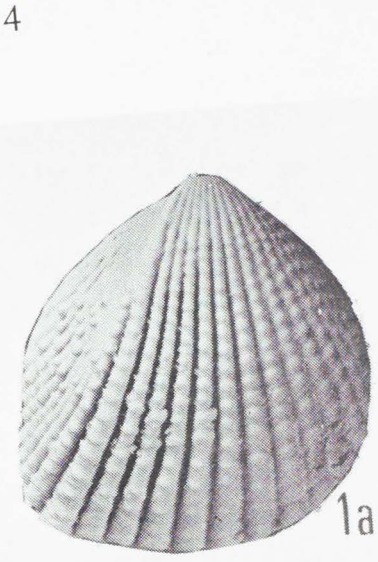
PLATE 8

Figures Page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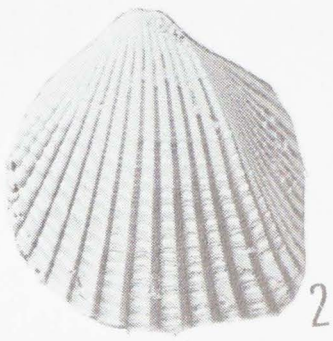
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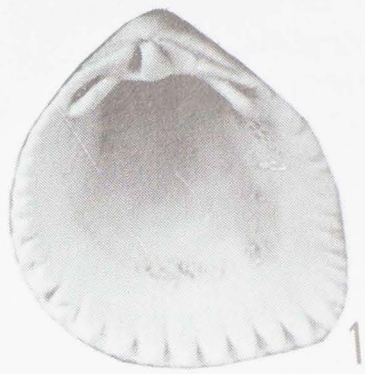
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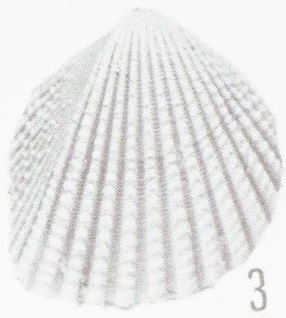
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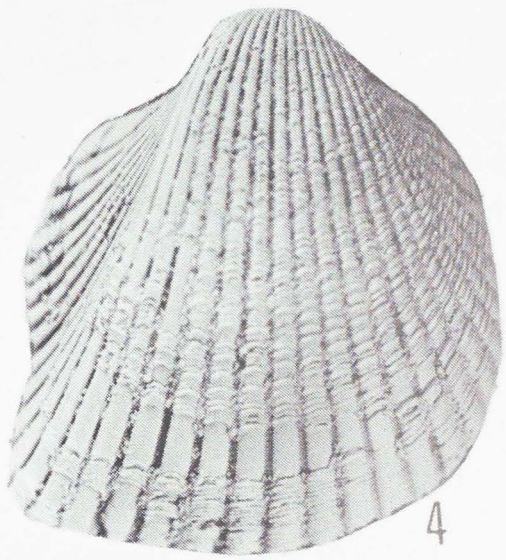
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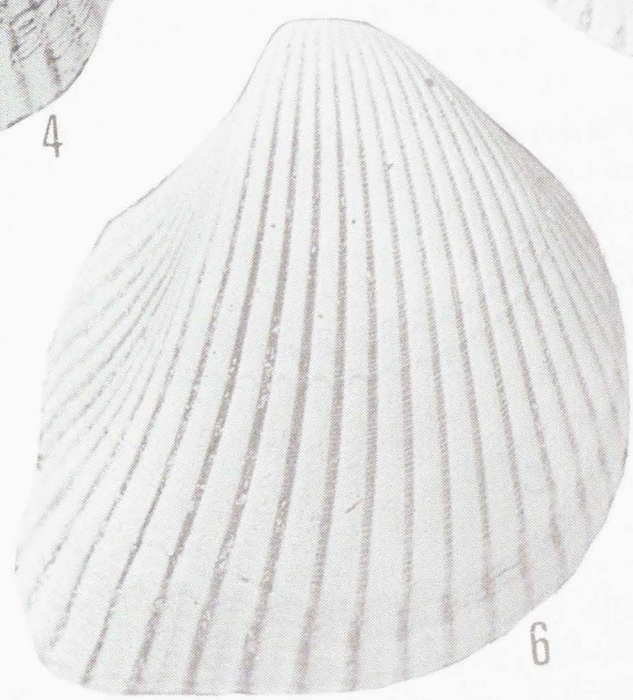
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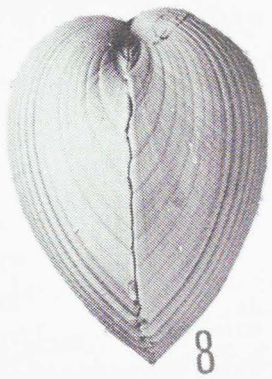
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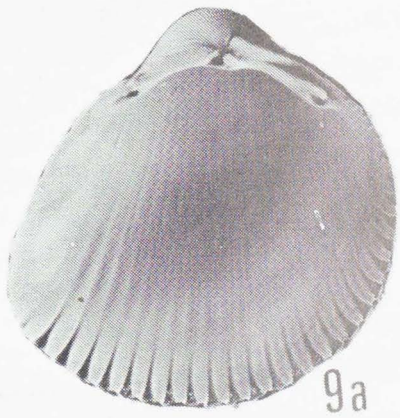
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9b


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PLATE 8

completely ignored the conclusions of Dall, which had priority and were binding, even though he, like Dall, was discussing the fauna of the Tampa Limestone.

Finally, it is to be noted that Gardner (1926, p. 140) also distinguished the Chipola species from the Tampa form, stating that "the Ballast Point specimens are relatively higher and much narrower dorsally, with no trace of a constriction either behind or in front of the posterior keel and with fewer and even lower costals."

To summarize the above history, it appears that three species, two from the Tampa Limestone of Ballast Point, Tampa Bay, Florida, and the third from the Chipola fauna of northern Florida, have been confused under the names *alicula,* or *aliculum,* and *berberum* by Dall (1900, 1905, 1915), Gardner (1926), and Mansfield (1937), with both of the latter authors agreeing that the two Tampa species differed from that found in the Chipola fauna, both in shape and in number of costals. A count of the ribbing on 25 valves from the Chipola as exposed in the lower beds at Alum Bluff as compared with the two specimens of *alicula* from Tampa, mentioned by Dall, plus those of the "holotype" of *berberum* gives the comparison shown in Table 5.

The numbers indicated do not agree with Gardner's statement that the Tampa specimens had "fewer . . . costals"; however, it must be added that they are notably lower and less distinct than are those of the Chipola form and, indeed are so much so as to make it most difficult to be certain as to the actual number present, especially on the more anterior dorsal areas of the two valves. These counts serve to document the fact that the Chipola form does differ from the Tampa ones, especially when the differences in shape noted by Mansfield and Gardner are also taken into account.

As a result, there is no escaping the conclusion that the Chipola species that was referred to by Gardner as *"Cardium [Fragum (Trigoniocardia)] aliculum* Dall" remains without a valid scientific name. It is here denominated as *Fragum tunicula,* new species. Dall's specific name *alicula* was derived from a Latin noun of feminine gender that was the name for a light upper garment, and was probably applied in allusion to the thin, deciduous, pustule-bearing outer shell layer or intritacalx that is easily worn off to leave smooth-topped radial ribs. (Being used as a noun in apposition, see Code of International Nomenclature, Article 11 (g) (2), the specific name should not be changed to agree in gender with the generic epithet as it would be if adjectival in origin, and hence should continue to be cited as *alicula,* rather than *aliculum.*) The suggested substitute name *berberum* was apparently derived from the Greek "berberion," the name applied to a shabby outer garment. The name *tunicula* here proposed for the species from the Chipola Formation is selected in agreement with the implication of these previous terms, being the diminutive form of the Latin feminine noun *"tunica"* – a garment or skin.

Finally, it is to be noted that while Dall, in the original description of *C. alicula* cited it as from the Ballast Point silex beds, the lower bed at Alum Bluff, and "the marls of the Chipola River, Calhoun County, Florida," and Gardner listed it as common at "locality No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla." and abundant in three collections from the lower bed at Alum Bluff, the Tulane University collections contain only two speci-

TABLE 5

	anterior area						posterior area		
Number of ribs	11	12	13	14	15	16	7	8	9
Chipola species	12	10	3	–	–	–	4	16	5
C. alicula	–	–	1	1	–	–	2	–	–
C. berberum (type)	–	–	–	–	–	1	–	–	1

mens from the Chipola River area that represent the species figured by Dall in his 1903, plate 48, figure 5 illustration. There are, however, 153 valves in the material from the lower bed at Alum Bluff.

Collections from within the area of one mile below the site of the former Bailey's Ferry contain more than 11,000 valves of cardiid species (see Table 2), but not one is representative of the present form. Both Chipola River specimens present in our collections come from strata higher in the section (localities TU 458 and TU 459), which contain other species suggesting their correlation with the Alum Bluff strata. It seems quite clear that the collections examined by Dall and Gardner were inadvertently mixed, either by Burns the collector, or by Museum technicians at the time when the material was being unpacked and processed for study. This is further confirmed by the fact that the specimens bearing the U. S. Nat. Mus. no. 157550 which were referred to by Miss Gardner as the "Cotypes" and were said to have come from "locality: No. 2213, 1 mile below Baileys Ferry . . ." contain matrix remnants that are composed of a poorly sorted mixture of angular quartz sand in a yellow clay, whereas the strata of the area one mile below Bailey's Ferry is mainly a lime and clay mixture that is almost wholly lacking in quartz. The quartz sand/clay matrix is that which is characteristically present at Alum Bluff, and there can be no doubt whatsoever, but that these specimens at least, are from that locality and horizon.

Genus TRIGONIOCARDIA Dall, 1900

Trigoniocardia DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1075.

Type species, by original designation, *Cardium graniferum* Broderip and Sowerby, 1829. Recent; Gulf of California to northern Peru.

As noted by Stewart (1930, p. 267) the species of the typical subgenus of *Trigoniocardia* have the anterior lateral teeth "crowded against" the cardinals, while in the subgenus *Americardia* they "are not so close to the cardinals and may be almost as far removed as the posterior laterals" resulting in "a more symmetrical hinge" (p. 268). Despite the statement to the contrary by Olsson (1961, p. 251) *Trigoniocardia* s.s. as well as *Americardia* is marked by the presence of a thin, ornamented, deciduous, outer layer, or intriticalx (see D'Attilio and Radwin, 1971). That of *Trigoniocardia* is distinguished by the presence of discrete nodes, usually more or less transverse in position, that mark the central parts of the ribs. The spaces between the nodes appear to be completely smooth on unworn specimens but may show weak lineations of growth increments with wear. The interspace areas have a distinctly ladder-like ornament of raised transverse ridges that may be seen, on slightly worn specimens, to be superimposed upon and somewhat angularly discordant from the growth lamellae, especially toward the anterior ventral margin (see Pl. 6, fig. 1).

This has been observed on specimens of the type species from Tulane University locality R-176, off Jesusita Island, Gulf of Nicoya, Costa Rica; on *T. simrothi* Dall, from the Chipola Formation; on specimens of the Bowden form identified by Woodring (1926, p. 142, pl. 19, figs. 8, 9) as the Santo Domingo Miocene species *"Cardium" haitense* Sowerby, (1850, p. 52, pl. 10, fig. 11); on the Costa Rican "Pliocene" [= early Pleistocene] *"Cardium (Fragum)" callopleurum* Gabb (1881, p. 375, pl. 47, fig. 77), from the Moín Formation, and its apparent ancestor *"Cardium" heredium* Olsson (1922, p. 227, pl. 27, fig. 10), from the lower Pliocene Rio Banano Formation (= "Gatun" of Olsson); on the Caloosahatchee species *T. wilcoxi* Dall (1900, p. 1106; 1903, pl. 48, fig. 9); and on the Recent *T. antillarum* (d'Orbigny) (1845, p. 338, pl. 27, figs. 53-55). One or two exceptionally well-preserved specimens of *T. simrothi* Dall permit the suggestion that both the transverse ridges and the inter-ridge areas were overlain by an exceedingly thin and tenuous glaze, apparently easily worn away and wholly absent from most specimens examined.

The intritacalx of *Americardia* has a very different expression, but also seems to show more variation between different species than does that of *Trigoniocardia.* The basic form consists of close concentric threads

that are arched on the tops of the radial ribs, where, on *T. (A). media* (Linnaeus), – the type species (see Pl. 6, fig. 2), – approximately every sixth and seventh or seventh and eighth threads are somewhat broader and higher than the five or six intervening ones and simulate transverse nodes. The interspaces are much more finely cross-striated, with usually three elevated threads for each of those on the rib tops; these tend to unite on the sides of the ribs to form the coarser ones on the upper surface. The new Chipola species described below has a similar intritacalx (Pl. 6, fig. 4) except that there is more variation in the detail of the rib-top ornament. In this form the occurrence of the more coarse and elevated threads is irregular, with, at times, as many as five fine threads intervening between adjacent coarser ones, but more often there are only one or two, and occasionally none. Furthermore, rather than appearing as paired units as in *T. media,* the coarser threads tend to be single, being paired only in those more rare cases in which no intervening fine ones are present. The intriticalx of the Caloosahatchee and Bermont species *T. (A.) columba* (Heilprin) (1887, p. 93, pl. 9, fig. 26, 26a; + *C. arestum* Dall, 1900, p. 1102, pl. 40, fig. 10) shows yet another variation in that the threads on the rib tops tend, periodically, to become differentially elevated, superficially simulating nodes (see Pl. 6, fig. 6). Typically there are about ten to twelve fine threads between each two nodelike structures, which, in turn, are composed of from four to six threads. Careful "dissection" reveals no true nodose swelling underlying the

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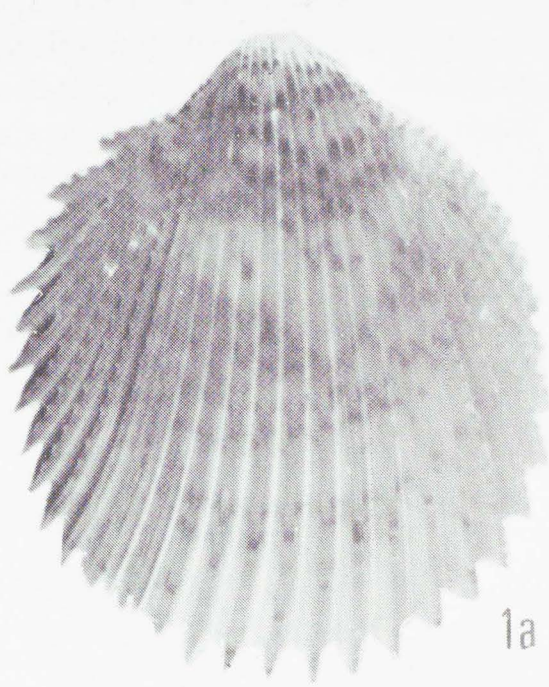
PLATE 9

Color patterns under ultraviolet light (X 1.5)

Figures Page

1. *Trachycardium (Conilocardium) cestum* (Dall) 158
   a. Figured specimen, USNM 243550; height 38.7 mm, length 33.2 mm. Locality: TU 458, Chipola River.
   b. Figured specimen, USNM 243551; height 48.5 mm, length 38.2 mm. Locality: TU 555, Chipola River.
2. *Laevicardium compressum* (Dall) 185
   a. Figured specimen, USNM 243552; height 20.4 mm, length 19.7 mm. Locality: TU 950, Chipola River.
   b. Figured specimen, USNM 243553; height 22.0 mm, length 20.7 mm. Locality: TU 950, Chipola River.
3. *Papyridea miocica* H. E. Vokes, n. sp. 168
   Paratype D, USNM 243555; height 30.2 mm, length 37.2 mm. Locality: TU 555, Chipola River.
4. *Papyridea bulbosa* (Dall) 165
   Figured specimen, USNM 243556; height 19.1 mm, length 22.0 mm. Locality: TU 830, Tenmile Creek.
5. *Papyridea multicostula* H. E. Vokes, n. sp. 169
   Paratype C, USNM 243557; height 20.8 mm, length 26.2 mm. Locality: TU 1048, Farley Creek.
6. *Acanthocardia propeciliare* (Dall) 152
   Figured specimen, USNM 243558; height 25.1 mm, length 22.6 mm. Locality: TU 555, Chipola River.
7. *"Trachycardium" parile* (Dall) 156
   Figured specimen, USNM 253559; height 25.7 mm, length 23.4 mm. Locality: TU 555, Chipola River.
8. *Dinocardium chipolanum* (Dall) 185
   Figured specimen, USNM 243554; height 39.8 mm, length 38.3 mm. Locality: TU 825, Farley Creek.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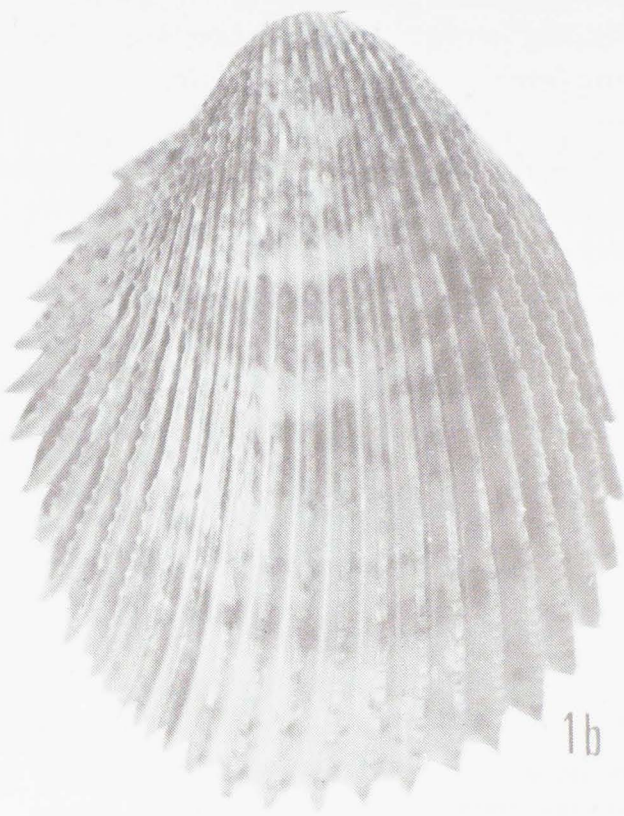
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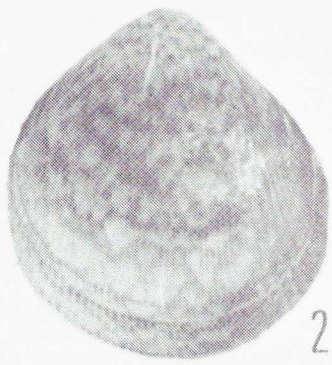
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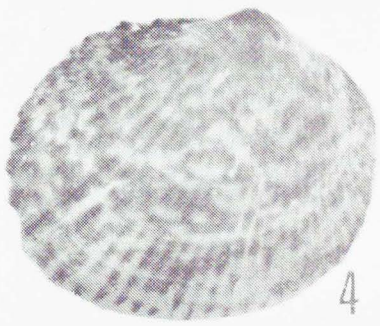
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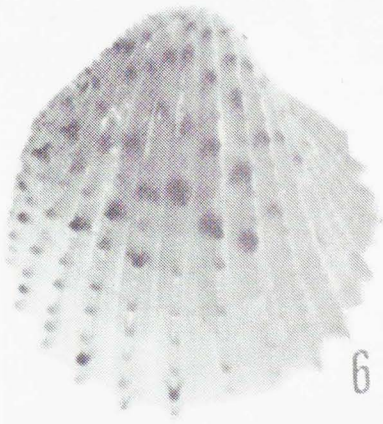
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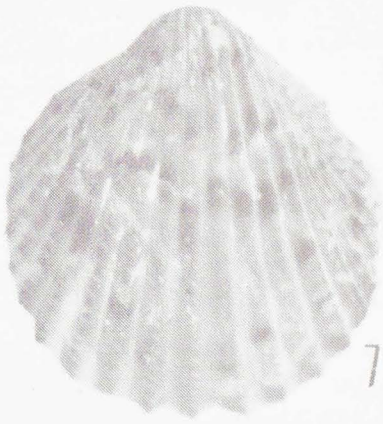
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PLATE 9

threads either in the lower levels of the intritacalx or on the ribs themselves, which are completely smooth when the layer is removed.

The intritacalx of *"Cardium (Fragum)" burnsii* Dall is, in some respects, more or less intermediate in character between that present on typical *Trigoniocardia* and that of the subgenus *Americardia.* It has the discrete nodes of *Trigoniocardia,* but the inter-nodal area has transverse threading similar to that in the intervals between the coarse elevated threads of *Americardia.* Similarly, the hinge shows much variation with respect to the position of the anterior lateral teeth. In the majority of the specimens examined they tend to be closely approximate to the cardinals in typical *Trigoniocardia* position, but in some, usually smaller and more immature individuals, they are almost as distant as in typical forms of *Americardia.* Accordingly, this species is here only questionably referred to the typical subgenus.

TRIGONIOCARDIA (TRIGONIOCARDIA) SIMROTHI (Dall)
Plate 6, figure 1; Plate 7, figures 5-8

Cardium (Trigoniocardia) Simrothi DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1104; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 8; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 132 [Holotype, USNM 114767; "Oligocene, Chipola River, Calhoun County, Florida"].

Cardium [Fragum (Trigoniocardia)] simrothi Dall. GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 141, pl. 23, fig. 10 ["Cotypes: U. S. Nat. Mus. No. 114767. Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla."].

Trigoniocardia simrothi (Dall). WEISBORD, 1964, Bulls. Amer. Paleontology, v. 45, no. 204, p. 261 [compared with *T. caboblanquensis* Weisbord].

Trigoniocardia (s.s.) *simrothi* (Dall). GLIBERT and VAN DE POEL, 1970, Inst. Roy. Sci. Nat. Belg., Mém., ser. 2, fasc. 84, p. 59 ["Miocene (Chipola). Oak Grove (Floride, U.S.A.)"].

As may be noted in Table 2, this species is the dominant cardiid form in terms of numbers of valves present in our Chipola collections, a position that it achieves because of its abundance in the faunas from the deposits exposed in the banks of the Chipola River, where Gardner (1926, p. 102) noted it as being prolific – the only cardiid species so designated in her study. Here it occurs in greatest profusion in approximately the lower third to lower half of the geologic section, and is definitely less common in the upper part of the section exposed along the river and on Farley Creek. For some reason not presently clear, it is exceedingly rare (only two specimens present) in the collections from Tenmile Creek, where the lower strata are well-exposed.

While only slightly suggested by Dall's original figure, the most distinctive feature of this species is the tendency, mentioned by Gardner (1926, p. 141), for "the two ribs directly in front of the posterior keel [to be] commonly a little narrower than those anterior to them and [to] seem to lose their ornamentation more readily, thus lending to the costal [rib] which defines the posterior keel a prominence which it would not otherwise possess." While two is the usual number of such smaller ribs, some specimens show only one and others have as many as three. These ribs are not only smaller in width, but also in elevation and thus tend to give the ventral margin a distinct but shallow insinuation directly anterior to the sharply projecting keel-rib.

The number of ribs varies to only a minor extent, with eight or nine on the posterior slope and 11 to 14, including the keel-rib, on the anterior segment. The number in the latter area is more commonly 13 than the 11 noted by Dall; the variation appears, however, to be mainly a function of the width of the most dorsal rib in the series. In some specimens it is wide, low and smooth; these tend to have 11 or 12 ribs. In others, it is narrow, often nodose; these tend to have 13 or 14 ribs. The two types occur together and apparently represent only normal variation, although there does seem to be proportionately more of the first type in the basal strata than in those higher in the section.

The citation of this species from Oak Grove by Glibert and Van de Poel (1970, p. 59) is almost certainly an error. Neither Dall nor Gardner mention its occurrence in that fauna and it is not represented in the Tulane collections, where the dominant cardiid is *Trigoniocardia apateticum* (Dall) (1900, p.

1105; 1903, pl. 48, fig. 6), which is superficially similar to *T. simrothi* but lacks the smaller ribs in front of the keel.

Figured specimen, USNM 243536; height 7.6 mm, length 6.8 mm, diameter (right valve) 3.0 mm; locality TU 554 (Pl. 6, fig. 1; Pl. 7, fig. 5).

Figured specimen, USNM 243537; height 7.8 mm, length 7.6 mm, diameter (left valve) 3.3 mm; locality TU 554 (Pl. 7, fig. 6).

Figured specimen, USNM 243538; height 8.2 mm, length 7.4 mm, diameter (left valve) 3.4 mm; locality TU 554. A specimen with the ribs in front of the keel-rib not markedly narrower than the rest (Pl. 7, fig. 7).

*Figured specimen,*USNM 243539; height 9.0 mm, length 8.3 mm, diameter (right valve) 3.8 mm; locality TU 554 (Pl. 7, fig. 8).

TRIGONIOCARDIA (TRIGONIOCARDIA?) BURNSII (Dall)

Plate 6, figure 3; Plate 8, figures 1-3

Cardium (Fragum) Burnsii DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1101 [in part]; 1903, *ibid.,* v. 3, pt. 6, pl. 48, fig. 15; SCHUCHERT *et al.,* 1905, U. S. Natl. Mus., Bull. 53, p. 128 [Holotype, USNM 114770; "Oligocene, Chipola River, Calhoun County, Florida"]; WOODRING, 1925, Carnegie Inst. Wash., Publ. 366, p. 141 [compared with *C. (F.) elattocostatum* Woodring]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 140 [in part], pl. 23, fig. 13 [referred to "Section" *Fragum* s.s.; "Type locality: No. 2213, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla."].

Trigoniocardia (Americardia) burnsii (Dall). STEWART, 1930, Acad. Nat. Sci. Phila., Spec. Publ. 3, p. 268.

Trigoniocardia (Americardia?) burnsi (Dall). GLIBERT and VAN DE POEL, 1970, Inst. Roy. Sci. Nat. Belg., Mém., ser. 2, fasc. 84, p. 60 ["Miocene (Chipola). Oak Grove (Floride, U.S.A.)"].

It seems quite certain that Dall included two forms in his original description of this species; that represented by the holotype is here discussed, the other is formally described as *T. (Americardia) decidua,* n. sp. As may be noted in Table 6, the number of ribs on the valve as given in the Dall description — 22 to 24 on the area anterior to the postero-ventral angulation and 12 to 14 posterior to it — agrees more closely with the number present in typical examples of *T. (A.) decidua,* but the nodose condition of intritacalx ornamentation on the holotype fixes the name on the form that also proves to be the more widespread and abundantly represented of the two species concerned.

As also noted above, the characters of the hinge of *T. burnsii* tend to vary between those considered distinctive of the modern species of *Trigoniocardia* and those of *Americardia,* especially as concerns the relative position of the anterior lateral teeth with respect to the cardinals. This combination of features characteristic of the two subgenera has made it difficult to distinguish between specimens of *T. burnsii* and *T. decidua* when the intritacalx has been eroded away. The rib counts, as shown in Table 6, overlap to some degree; accordingly, no firm reliance can be placed upon this feature. As

TABLE 6

Number of radial ribs:

Localities of specimens of *T. (T.) burnsii*	Anterior surface								Posterior surface						Valves counted:
	17	18	19	20	21	22	23	24	9	10	11	12	13	14	
TU 458, Chipola River	—	2	6	9	4	4	—	—	1	7	10	7	—	—	25
TU 830, Tenmile Creek	2	4	8	9	1	1	—	—	—	5	17	3	—	—	25
TU 825, Farley Creek	1	5	7	10	2	—	—	—	—	8	13	3	1	—	25
Total - *burnsii* —	3	11	21	28	7	5	0	0	1	20	40	13	1	0	75
T. (A.) decidua —	0	0	0	1	6	15	22	6	0	0	6	26	15	3	50

a result, the statistics as to the number and percentages of these species present in the collections from the various Chipola localities (see Table 2), cannot be considered as wholly definitive. This is particularly true for the collections from Farley Creek localities where the average sediment size is somewhat more coarse-grained than is typical of that from the Chipola River and Tenmile Creek areas. Presumably this coarser sediment size reflects a somewhat higher-energy type of environment and hence probably greater bottom sediment movement. This combination seems have been the cause of the observable fact that there is a considerably larger percentage of surficially worn and abraded specimens in these collections than are to be found in those from the other areas. These have been assigned in the table on the basis of rib counts and hinge characteristics, even though as noted above, these are known to be variable and hence unreliable, for they are the only available characters preserved. Accordingly, it is possible that the actual number of specimens of *T. burnsii* in the Farley Creek collections is higher, and the number of *T. decidua* lower, than is given in the table.

As was also true of *T. simrothi,* the citation by Glibert and Van de Poel (1970, p. 60) of *T. burnsii* as an Oak Grove species is almost certainly erroneous. It is not listed as from that locality by either Dall or Gardner and no remotely similar species is seen in the Tulane University Oak Grove collections.

Figured specimen, USNM 243540; height 8.2 mm, length 7.5 mm, diameter (right valve) 3.1 mm; locality TU 546 (Pl. 8, fig. 1).

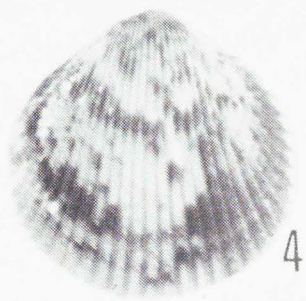
Figured specimen, USNM 243541; height 7.4 mm, length 7.0 mm, diameter (left valve) 2.8 mm; locality TU 830 (Pl. 6, fig. 3; Pl. 8, fig. 2).

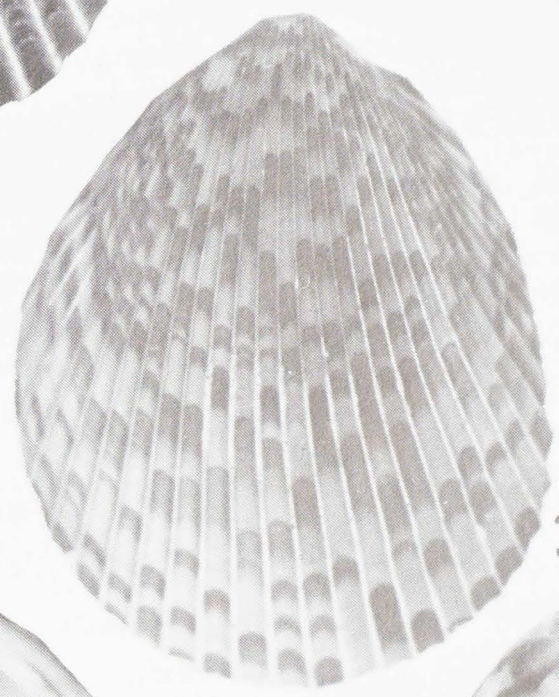
Figured specimen, USNM 243542; height 6.8 mm, length 6.5 mm, diameter (right valve) 2.7 mm; locality TU 830 (Pl. 8, fig. 3).

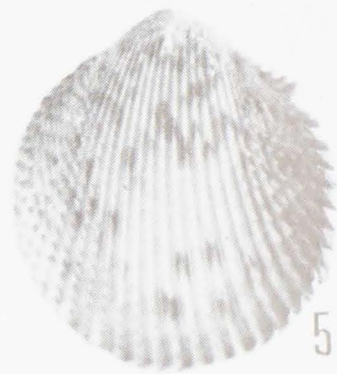
PLATE 10

Figures Page

1. *Acrosterigma (Vasticardium) elongatum* (Bruguière) 161
   Figured specimen, USNM 711239 (X .75); height 91.0 mm, length 68.4 mm, diameter (paired valves) 52.5 mm. Exterior and interior of left valve.
   Locality: Calitupan Island, Bohol, Philippines; Recent.
2. *Acrosterigma (Vasticardium) hoerleorum* H. E. Vokes, n. sp. 162
   Paratype E, USNM 243560 (X 1.5); height 45.9 mm, length 38.4 mm. Exterior and interior of right valve.
   Locality: TU 830, Tenmile Creek.
   Note: Compare the ultraviolet light color pattern of *A. (V.) hoerleorum* with that of the Recent *A. (V.) elongatum,* type of the subgenus. The broad external color bands of the Recent species are of a reddish tint as are the darkly colored denticulate internal margins. Note the difference between these patterns and that of the Pliocene *Acrosterigma dalli,* type of the genus.
3. *Acrosterigma (Acrosterigma) dalli* (Heilprin) 160
   Figured specimen, USNM 243564 (X .9); height 64.2 mm, length 51.3 mm, diameter (left valve) 17.8 mm. Color pattern as revealed by ultraviolet light.
   Locality: TU 529, Caloosahatchee Formation, Caloosahatchee River, Florida.
4, 5. *"Trachycardium" virile* (Dall) 154
   4. Figured specimen, USNM 243561 (X 1.5); height 17.8 mm, length 17.3 mm.
      Locality: TU 830, Tenmile Creek.
   5. Figured specimen, USNM 243562 (X 1.5); height 22.2 mm, length 20.1 mm.
      Locality: TU 546, Tenmile Creek.
      Color patterns as revealed by ultraviolet light.







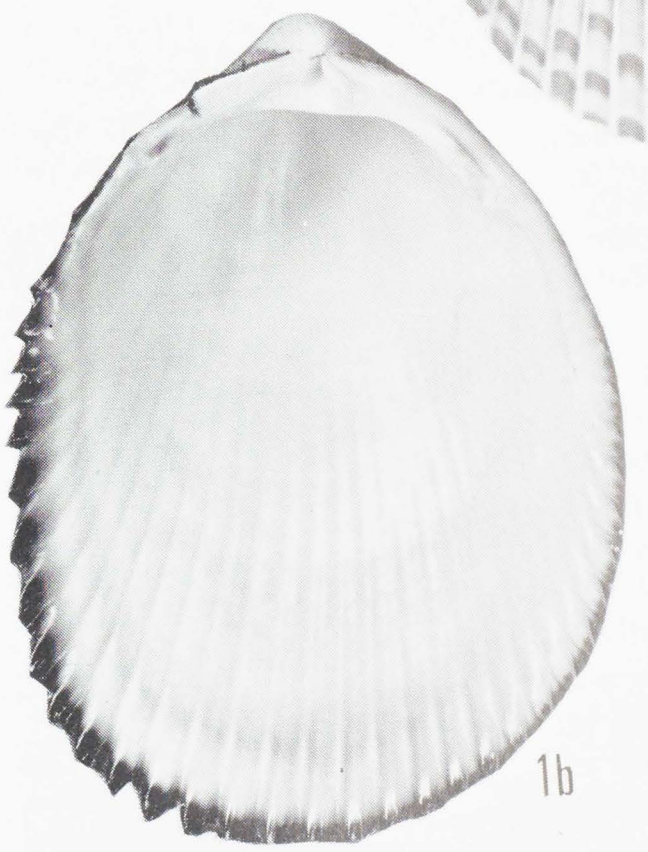


PLATE 10

Subgenus AMERICARDIA Stewart, 1930

Americardia STEWART, 1930, Acad. Nat. Sci., Phila., Spec. Publ. 3, pp. 37, 267.

Type species, by original designation, *Cardium medium* Linnaeus, 1758. Recent; North Carolina, the West Indies and Caribbean Sea southward to Bahia and Trindade Isl., Brazil.

The characters that serve to distinguish *Americardia* from the typical forms of *Trigoniocardia* have been noted in the discussion of the latter group.

TRIGONIOCARDIA (AMERICARDIA) DECIDUA H. E. Vokes, n. sp.

Plate 6, figure 4; Plate 8, figures 4-6

Cardium (Fragum) Burnsii DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1101 [in part].

Diagnosis: Shell relatively small, subquadrate, moderately inflated, on the average slightly more inflated than typical specimens of *T. burnsii* and noticeably less so than those of *T. simrothi.* Anterior margin broadly convex, almost straight, broadly rounding antero-ventrally into the slightly arched ventral margin, which, in turn, is strongly angulate into the concave posterior end; the angulate postero-ventral margin being the result of a well-developed obtuse angulation of the valve surface, and the posterior concavity marking the end of a median depression that traverses the median portion of the posterior end. Surface of valve ornamented by strong radial ribs with 20 to 24 ribs (usually 22 or 23) on and anterior to, the postero-ventral angulation and with 11 to 14 (usually 12 or 13) on the posterior slope; ribs separated by much narrower interspaces. Intritacalx on unworn specimens (see Pl. 6, fig. 4) consisting of arched concentric threads certain of which are more strongly developed, simulating nodes. Much variation in the details of the intritacalx in this species (see discussion of the genus *Trigoniocardia* above). The arcuate concentric threads tend to extend laterally beyond the crests of the ribs, giving the inter-rib areas an almost linear appearance. With the intritacalx eroded away, the interspaces prove to be approximately one-fourth the width of the adjacent ribs, showing a well-developed ladder-like pattern of low transverse lamellae that appear to be the remnant bases of the transverse intritacalx structures; the rib tops, however, then appearing wholly smooth. Internal margins fluted, with raised denticulations marking the inter-rib areas. Hinge normal for the subgenus *Americardia,* with the anterior lateral teeth moderately distant from the cardinals, although not as distant as are the posterior laterals.

Holotype, USNM 243543; height 12.3 mm, length 11.6 mm, diameter (right valve) 5.1 mm; locality TU 546 (Pl. 6, fig. 4; Pl. 8, fig. 4).

Paratype A, USNM 243544; height 11.6 mm, length 11.8 mm, diameter (right valve) 4.7 mm; locality TU 830 (Pl. 8, fig. 5).

Paratype B, USNM 243545; height 15.6 mm, length 15.0 mm, diameter (right valve) 6.3 mm; locality TU 830 (Pl. 8, fig. 6).

Discussion: Trigoniocardia (Americardia) decidua suggests a small version of *T. (A.) media* (Linnaeus), differing primarily in the details of its intritacalx ornament and the lesser number of radial ribs on the surface anterior to the postero-ventral angulation. As noted above in the discussion of *T. burnsii* (Dall), specimens of *T. burnsii* and *T. decidua* lacking the intritacalx are difficult to separate, although fully adult specimens of *T. decidua* tend to attain dimensions almost twice those of *burnsii*, and in these large forms the median groove and the consequent marginal insinuation of the posterior end are notably stronger than is ever attained on specimens of *T. burnsii.* Paratype B, USNM 243545, is the largest of the 1135 specimens present in the Tulane collections.

Subfamily LAEVICARDIINAE Keen, 1936
Genus LAEVICARDIUM Swainson, 1840

Laevicardium SWAINSON, 1840, Treatise on Malacology, p. 373.

Type species, by subsequent designation, Stoliczka, 1871, *Cardium oblongum* Gmelin. Recent; Mediterranean and Adriatic Seas.

The ribbing on the median and anterior portion of the valves of *L. oblongum* is more strongly developed than it is on the majority of the species usually referred to this genus. *Laevicardium laevigatum* (Linnaeus), selected as type by Herrmannsen (1847, p. 571) and by Gray (1847, p. 185), is more representative of the usual form, but unfortunately was not originally included by Swainson in his description of the genus. The absence of *C. laevigatum* and the inclusion of *C. oblongum* seems inexplicable in the light of Swainson's statement that the surface of the shell of *Laevicardium* is "neither ribbed nor spired [sic]."

LAEVICARDIUM COMPRESSUM (Dall)
Plate 8, figure 7; Plate 9, figure 2

Cardium (Laevicardium) compressum DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1109;1903, *ibid.*, v. 3, pt. 6, pl. 48, fig. 21; SCHUCHERT *et al.*, 1905, U.S. Nat. Mus., Bull. 53, p. 129 [Holotype, USNM 114769; "Oligocene, Calhoun County, Florida"]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 142, pl. 23, fig. 16 ["Type locality: No. 2213; 1 mile below Baileys Ferry, Chipola River, Calhoun County, Fla."].

Dall's specific name for this form is in allusion to the posterior area being "compressed so that the pinch gives to the posterior margin a distinct insinuation." Examination of a large number of specimens (364 from TU 458) reveals that this is a highly variable character with the form illustrated by Dall as an extreme. Approximately fifty per cent of the specimens show no marginal reflection of any compression, and in the vast majority of the forms in which it is to be noted it is marked solely by a slight straightening of the generally broad margin curvature; a typical example of this expression is shown on pl. 8, fig. 7.

This species, like *Dinocardium chipolanum,* is widely distributed in all facies of the Chipola Formation and generally is present in considerable numbers, although there are only about one-half as many valves of *L. compressum* as there are of *D. chipolanum* in the Tulane collections.

Figured specimen, USNM 243546; height 21.8 mm, length 20.8 mm, diameter (right valve) 7.5 mm; locality TU 458 (Pl. 8, fig. 7).

Figured specimen, USNM 243552; height 20.4 mm, length 19.7 mm, diameter (left valve) 6.8 mm; locality TU 950 (Pl. 9, fig. 2a).

Figured specimen, USNM 243553; height 22.0 mm, length 20.7 mm, diameter (left valve) 6.5 mm; locality TU 950 (Pl. 9, fig. 2b).

Genus DINOCARDIUM Dall, 1900

Dinocardium DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1074 [as "section" of "subgenus" *Cerastoderma* Mörch].

Exocardium OLSSON, 1964, Neogene Mollusks from Northwestern Ecuador, p. 55 [type species by original designation, *Cardium (Dinocardium) ecuadorialis* Olsson, 1932].

Type species, by original designation, "*Cardium magnum* Born = *C. ventricosum* Brug." [= *C. robustum* Lightfoot *in* Solander, 1786]. Recent; Cape May, New Jersey, to west and north coasts of the Yucatán Peninsula to Isla Contoy, but apparently not present on the eastern Caribbean coast.

Dall's citation of *Cardium magnum* Born as type of his new "section" of *Cerastoderma* was apparently a *lapsus* inasmuch as he included both the Born and Bruguière species in the synonymy of his "*Cardium" (Cerastoderma) robustum* Solander" on p. 1099 of the same work.

Olsson (1964, p. 55) referred *D. chipolanum* to his subgenus *Exocardium* which he defined, in part, as having the posterior area "generally smooth and polished, without ribbing." Although the ribbing on the Chipola species is somewhat subdued it is nevertheless definitely present and on immature forms is almost as strongly developed as it is on the more anterior areas of the valve. The writer believes that the Ecuadorian species is at best an end-variant of the *Dinocardium* tendency toward reduction of the posterior ribbing, a feature well shown in the type species of that genus.

DINOCARDIUM CHIPOLANUM (Dall)
Plate 8, figures 8-10; Plate 9, figure 8

Cardium (Cerastoderma) chipolanum DALL, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, p. 1098, pl. 40, fig. 8; SCHUCHERT *et al.*, 1905, U. S. Natl. Mus., Bull. 53, p. 129 [Holotype, USNM 114765; "Oligocene. Chipola River, Florida"]; GARDNER, 1926, U. S. Geol. Surv. Prof. Paper 142-C, p. 138, pl. 23, fig. 9 ["Type locality: No. 2212, Tenmile Creek, 1 mile west of Baileys Ferry, Chipola River, Calhoun County, Fla."].

Dinocardium (Exocardium) chipolanum Dall. OLSSON, 1964, Neogene Mollusks from Northwestern Ecuador, p. 55.

Cerastoderma (s.s.) *chipolanum* (Dall). GLIBERT and VAN DE POEL, 1970, Inst. Roy. Sci. Nat. Belg., Mém., ser. 2, fasc. 84, p. 40.

Although Dall *in* Schuchert *et al.* (1905, p. 129) cites the type locality for this species as "Chipola River, Florida," Gardner (1926, p. 138) states that the type was from locality "No. 2212, Tenmile Creek, 1 mile west of Baileys Ferry, Chipola River, Calhoun County, Fla."

As aptly noted by Dall, this species "is a miniature *Cardium robustum,* and is especially characteristic of the Chipola horizon." It occurs at all Tulane University localities from which more than a very few specimens were collected, the sole exceptions being TU 550, and TU 807, an *Ostrea/Spondylus* reef facies on the Chipola River. This is the only suggestion of facies control in its distribution for it otherwise is present in the open-water, coral reef and back-reef or lagoonal (?) facies. It is almost always one of the more abundantly represented species at any locality. For example, there are more than 800 valves in the collections from TU 546, which so far as we can determine, is the same as USGS locality 2212, cited by Gardner as type locality.

The "subspecies" *alumen* described by Gardner (1926, p. 138, pl. 32, fig. 6) from the Alum Bluff Chipola strata occurs with the more typical form at almost all Chipola localities. At best, it is no more than a variety; its dominance at Alum Bluff may suggest some ecologic control factor. The sediment at that locality seems to be more coarse-grained and to have a higher quartzose sand and lower lime content than that of the Chipola River exposures; it may represent more shallow-water deposition.

The largest specimen noted in the collections, a left valve from locality TU 458, has a height of 50.3 mm, a length of 49.1 mm, and a diameter of 17.8 mm.

Figured specimen, USNM 243547; height 30.5 mm, length 30.3 mm, diameter (paired valves) 23.2 mm; locality TU 458 (Pl. 8, fig. 8).

Figured specimen, USNM 243548; height 33.6 mm, length 33.5 mm, diameter (left valve) 13.1 mm; locality TU 458 (Pl. 8, fig. 9).

Figured specimen, USNM 243549; height 45.7 mm, length 44.3 mm, diameter (left valve) 16.0 mm; locality TU 827 (Pl. 8, fig. 10).

Figured specimen, USNM 243554; height 39.8 mm, length 38.3 mm, diameter (right valve) 14.6 mm; locality TU 825 (Pl. 9, fig. 8).

VII. LOCALITY DATA

The following Tulane University fossil localities in the Chipola Formation, Calhoun County, Florida, have yielded specimens referrable to the family Cardiidae:

70. Tenmile Creek, north bank at bridge of Florida Highway 73 (NW ¼ Sec. 12, T1N, R10W).
196. Tenmile Creek, north bank ca. 0.25 mile upstream from TU 70 (NE ¼ Sec. 12, T1N, R10W).
456. Tenmile Creek, north bank ca. 0.25 mile downstream from TU 70 (NW ¼ Sec. 12, T1N, R10W).
457. Chipola River, west bank ca. 0.5 mile downstream from mouth of Tenmile Creek (SW ¼ Sec. 17, T1N, R10W).
458. Chipola River, east bank ca. 0.3 mile upstream from mouth of Farley Creek (SW ¼ Sec. 20, T1N, R9W).
459. Chipola River, east bank about 1500 feet upstream from mouth of Taylor Lake Branch (NW ¼ Sec. 29, T1N, R9W).
546. Tenmile Creek, north bank 1.75 miles west northwest of mouth of creek at Bailey's Ferry (SW ¼ NE ¼ Sec. 12, T1N, R10W).
547. Chipola River, west bank about 2000 feet upstream from mouth of Fourmile Creek (SW ¼ Sec. 29, T1N, R9W).
548. Chipola River, west bank at bend about 1800 feet downstream from mouth of Farley Creek (NW ¼ Sec. 29, T1N, R9W).
549. Chipola River, east bank ca. 0.25 mile below mouth of Fourmile Creek (NE ¼ Sec. 20, T1N, R9W).
550. Chipola River, east bank 1.25 miles below mouth of Tenmile Creek (NE ¼ Sec. 20, T1N, R9W).
551. Chipola River, east bank ca. 0.5 mile below mouth of Fourmile Creek (NE ¼ Sec. 32, T1N, R9W).
552. Chipola River, east bank ca. 1.5 miles downstream from mouth of Tenmile Creek (NE ¼ Sec. 20, T1N, R9W).
553. Chipola River, east bank at mouth of Farley Creek (SW ¼ Sec. 20, T1N, R9W).
554. Chipola River, east bank immediately downstream from power line crossing (SW ¼ Sec. 17, T1N, R9W).
555. Chipola River, east bank about 1000 feet above mouth of Fourmile Creek (SW ¼ Sec. 29, T1N, R9W).
655. Tenmile Creek, north bank ca. 0.1 mile downstream from TU 70 (NW ¼ Sec. 12, T1N, R10W).
708. Small waterfall on tributary entering Tenmile Creek from south ca. 0.25 mile downstream from TU 70 (NW ¼ Sec. 12, T1N, R10W).
709. Tenmile Creek, south bank ca. 0.25 mile downstream from TU 70 (NW ¼ Sec. 12, T1N, R10W).

710. Tenmile Creek, south bank between mouth of Mayo's Mill Branch and unnamed stream 1000 feet upstream (NW ¼ Sec. 11, T1N, R10W).
711. Chipola River, west bank ca. 0.25 mile upstream from mouth of Farley Creek (SW ¼ Sec. 20, T1N, R9W).
786. Tenmile Creek, north bank about 50 yards upstream from TU 196 (NE ¼ Sec. 11, T1N, R10W).
787. Tenmile Creek, south bank ca. 1.5 miles west northwest of mouth of creek at Bailey's Ferry (SW ¼ Sec. 12, T1N, R10W).
806. Chipola River, west bank ca. 0.5 mile below powerline crossing at TU 554 (NW ¼ Sec. 20, T1N, R9W).
807. Chipola River, west bank 0.25 mile downstream from powerline crossing at TU 554 (NE ¼ NW ¼ Sec. 20, T1N, R9W).
810. Chipola River, east bank ca. 0.25 mile below Bailey's Ferry (NW ¼ SW ¼ Sec. 17, T1N, R9W).
817. Mouth of large gully entering Tenmile Creek from south side (Center SE ¼ Sec. 12, T1N, R10W).
818. Farley Creek, south bank 0.1 mile west of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W).
819. Farley Creek, south bank 0.2 mile west of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W).
820. Farley Creek, north bank immediately upstream from bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W).
821. Farley Creek, north bank 0.1 mile east of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W).
822. Farley Creek, south bank 0.25 miles east of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W).
823. Farley Creek, south bank ca. 2000 feet east of bridge of Florida Highway 275 (SE ¼ Sec. 21, T1N, R9W).
824. Farley Creek, north bank ca. 0.5 mile east of bridge of Florida Highway 275 (SE ¼ Sec. 21, T1N, R9W).
825. Farley Creek, north bank at abandoned mill ca. 0.25 mile west of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W).
826. Farley Creek, north bank ca. 0.1 mile west of TU 825 (on line between Sec. 20 & 21, T1N, R9W).
827. Farley Creek, south bank ca. 0.5 mile west of bridge of Florida Highway 275 (SE ¼ Sec. 20, T1N, R9W).
828. Farley Creek, south bank immediately upstream from unnamed tributary entering from north ca. 0.75 mile west of bridge on Florida Highway 275 (SE ¼ Sec. 20, T1N, R9W).
829. Unnamed tributary entering Farley Creek from north near TU 828, west bank about 200' above confluence (SE ¼ Sec. 20, T1N, R9W).
830. Tenmile Creek, north bank at power line crossing, ca. 1.3 miles west northwest of mouth of creek at Bailey's Ferry (SE ¼ SE ¼ Sec. 12, T1N, R10W).
831. Tenmile Creek, north bank 1.1 miles west northwest of mouth of creek at Bailey's Ferry (SW ¼ SW ¼ Sec. 7, T1N, R9W).
949. Chipola River, west bank ca. 0.1 mile downstream from power line crossing (SW ¼ Sec. 17, T1N, R9W).
950. Chipola River, west bank ca. 200 feet above mouth of Farley Creek (NE ¼ SW ¼ Sec. 20, T1N, R9W).
951. Tenmile Creek, south bank ca. 1.5 miles west northwest of mouth of creek at Bailey's Ferry (SE ¼ Sec. 12, T1N, R10W).
998. Tenmile Creek, north bank ca. 1.6 miles west northwest of mouth of creek at Bailey's Ferry (NW ¼ SE ¼ Sec. 12, T1N, R10W).
999. Farley Creek, south bank ca. 900 feet west of bridge on Florida Highway 275 (SW ¼ SW ¼ Sec. 21, T1N, R9W).
1019. Chipola River, east bank 0.3 miles downstream from power line crossing (NE ¼ NW ¼ Sec. 20, T1N, R9W).
1020. Chipola River, east side at mouth of small tributary (not shown on USGS topographic map) ca. 0.5 mile downstream from power line crossing (near W side NE ¼ Sec. 20, T1N, R9W).
1021. Tenmile Creek, north bank at north end of first meander upstream from TU 546, ca. 0.45 mile east of bridge on Florida Highway 73 (SE ¼ NW ¼ Sec. 12, T1N, R9W).
1047. Chipola River, west bank 0.1 mile downstream from mouth of Farley Creek (SE ¼ SW ¼ Sec. 20, T1N, R9W).
1048. Farley Creek, south bank ca. 0.6 mile east of bridge on Florida Highway 275 (SW ¼ NE ¼ Sec. 21, T1N, R9W).
1049. Farley Creek, south bank ca. 1.0 mile east of bridge on Florida Highway 275 (NE ¼ NE ¼ Sec. 21, T1N, R9W).
1050. Chipola River, west bank at powerline crossing (SW ¼ Sec. 17, T1N, R9W).
1051. Tenmile Creek, south bank just downstream from TU 817 (SE ¼ Sec. 12, T1N, R10W).
1052. Tenmile Creek, north bank, immediately upstream from large, dry meander cut-off (SE ¼ Sec. 12, T1N, R10W).
1097. Tenmile Creek, south bank of cut-off meander, ca. 500 yards east of Florida Highway 73 (SW ¼ NW ¼ Sec.12, T1N, R10W).
1098. Tenmile Creek, south bank just east of power line crossing (SE ¼ SE ¼ Sec. 12, T1N, R10W).
1196. Farley Creek, north bank ca. 0.65 mile east of bridge on Florida Highway 275 (SW ¼ NE ¼ Sec. 29, T1N, R9W).

Localities mentioned in this report that are not from the type area of the Chipola Formation in Calhoun County:

201. Spoil banks at pit (now abandoned) just south of Belle Glade, at Belle Glade Camp, Palm Beach County, Florida. Bermont Formation.
453. Alum Bluff, Apalachicola River, Liberty County, Florida (NE ¼ Sec. 24, T1N, R8W). Locality is in "lower beds." Chipola Formation.
529. Caloosahatchee River, north bank about 3 miles downstream from La Belle, Hendry County, Florida. Caloosahatchee Formation.
953. Moín Hill, Costa Rica; railroad cut and ditches adjacent to road to Sandoval. Locality is 4.5 kilometers west of Puerto Limon. Moín Formation.
954. Hill cut immediately behind Standard Fruit Co. box factory and just west of cemetery at Pueblo Nuevo and ca. 2 kms west of Puerto Limon, Costa Rica. Moin Formation.
1145. Boynton Landing, east bank of Choctawatchee River, just above Boynton Cut-Off (which connects Choctawhatchee River and Holmes Creek), (SE ¼ Sec. 31, T2N, R16W), Washington Co., Florida. Chipola Formation.
R-109. Material dredged from Bahia de las Minas at Isla Payardi, Dist. de Colon, Atlantic Coast of Panamá. Recent.
R-186. Beach and immediately offshore at leper colony, Palo Seco, Canal Zone, Panamá. Recent.

VIII. LITERATURE CITED

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REVIEWS

THE CORAL REEF PROBLEM, by William Morris Davis, a reprint of the 1928 edition, with an introduction by Albert V. Carozzi. Published by Robert E. Krieger Publishing Company, Huntington, New York, 1976, xvi + 596 pp., illus.

William Morris Davis became interested in coral reefs in 1868 while a student in N. S. Shaler's geology class at Harvard. Much later, after Davis became renowned as a geomorphologist, he retired early from Harvard University (1912) and devoted fully fifteen years to a complete geomorphological analysis of coral reefs. His classic study was published in 1928, reaffirming the Darwinian concepts of intermittently subsiding islands with fringing reefs developing ultimately into complex atolls. He produced his own all-encompassing theory of coral reef development, relating many apparently unrelated and contradictory facts about coral reefs into his refinement of the subsidence theory, tempered with limited acceptance of glacial-control of certain features in marginal reef belts. This work is of fundamental importance to geological theory.

FOSSILS AND PROGRESS: Paleontology and the Idea of Progressive Evolution in the Nineteenth Century, by Peter J. Bowler. Published by Science History Publications, New York, 1976, viii + 191 pp., $9.95

This volume is concerned with the apparent progressive development of life, through earth history, from the simplest to the most complex forms, and the role of this crucial observation, the concept of "progression", in the mid-nineteenth century debates over evolutionary theory. Among those whose ideas are treated in some depth are Georges Cuvier, Adolphe Brongniart, Geoffroy Saint Hilaire, Louis Agassiz, Robert Chambers, Charles Darwin, and Charles Lyell. The text treats the origin and development of "progressionism" as a concept, its opponents and their arguments, the complications introduced by recognition of divergence and the weakening of the concept of linear evolution, and concludes with an analysis titled "Darwinism and Progression". It provides intriguing additional insight into the history of evolutionism. —H.C.S.