

CENOZOIC MURICIDAE OF THE WESTERN ATLANTIC REGION
Part III—*CHICOREUS* (*PHYLLONOTUS*)

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I. ABSTRACT

There are 18 species of the muricine subgenus *Phyllonotus* recognized in the Cenozoic of the western Atlantic region; three of these species are extant. The earliest known species here referred to *Phyllonotus* is from the lower Oligocene Red Bluff Clay of Mississippi. The group is believed to have been derived from a *Hexaplex* ancestor because of similarities of protoconch type in the earlier fossil species and of coloration in the Recent species. *Phyllonotus* is thought to have given rise to the subgenera *Chicoreus* s.s. and *Siratus*.

An endemic western Atlantic form, *Phyllonotus* migrated through the Isthmian passage, probably in late Miocene time, and evolved into the four species presently known from the eastern Pacific. The sub-

genus is and has always been confined to the New World.

All 18 western Atlantic Cenozoic species are treated systematically, including one new species *Chicoreus* (*Phyllonotus*) *leonensis* E. H. Vokes, from the Choctawhatchee Formation of northern Florida.

II. INTRODUCTION

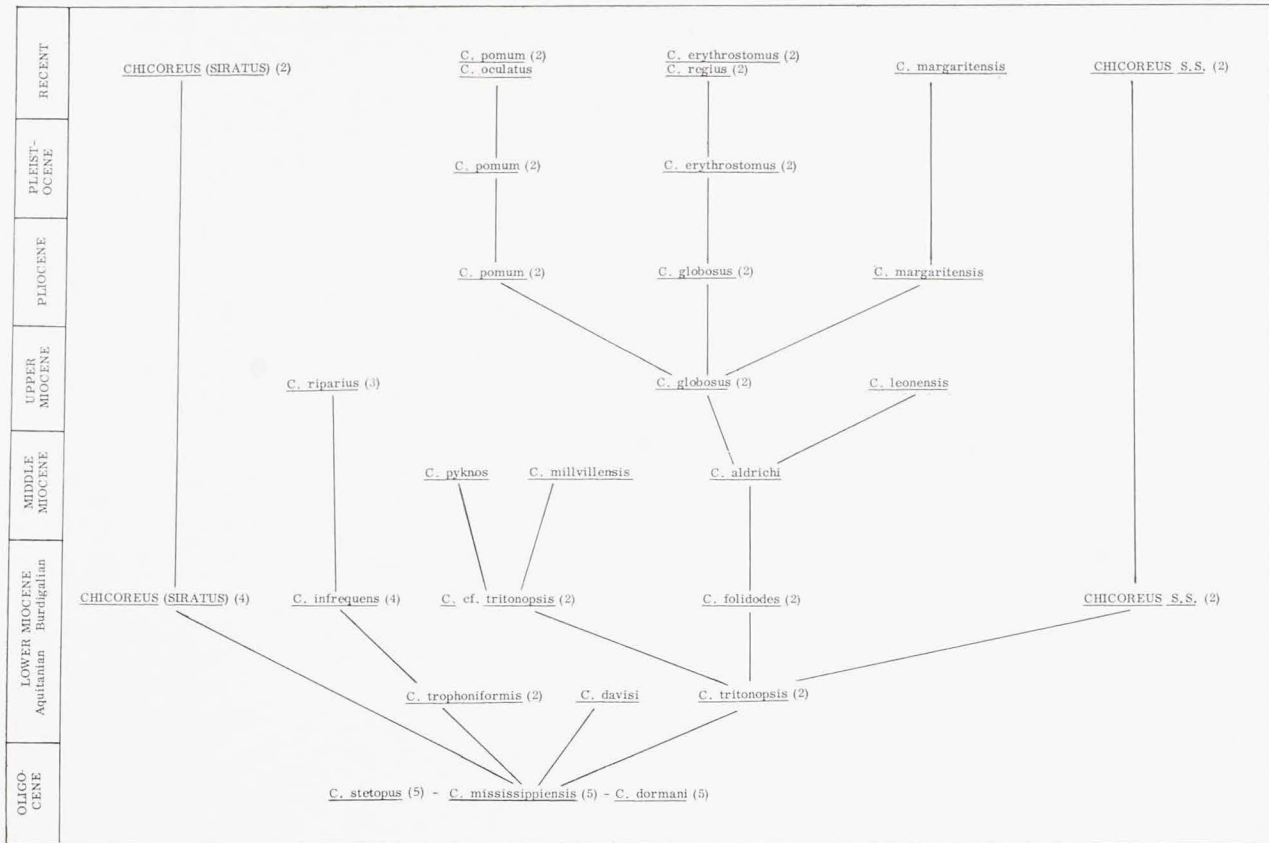
The generic name *Phyllonotus* was proposed in 1833 by Swainson (expl. to plate 100) in a table with no species being named, but was described as "Canal moderate . . . Varices foliated, mostly three." In the same work, on plate 109, he then figured and described the first species to be referred to this new genus: *Murex* (*Phyllonotus*) *imperialis* var. *a*. This variety was stated to differ from the typical *imperialis* in having

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Table I. Phylogeny of CHICOREUS (PHYLLONOTUS) and related forms. (Number of nuclear whorls in parentheses where known.)

a rose colored aperture rather than an orange one. It is not felt today that this difference is worthy of a separate name and the type of *Phyllonotus* is *Murex imperialis* var. *a* Swainson=*M. imperialis* Swainson (= *Murex margaritensis* Abbott, new name for *M. imperialis* Swainson, 1831, non *M. imperialis* Fischer, 1807.)

The characters which serve to unite the species of *Phyllonotus* are the irregular placement of the varices with respect to each other; the appearance of an irregular number of varices per whorl; and the varical ornamentation being limited to no more than short open spines, or often completely lacking. In contrast the members of *Chicoreus* s.s. usually, although not always, have three rather foliaceous, regularly aligned varices and a marked anal notch. The type species of the two groups are quite distinctive but many species are intermediate in character and difficult to assign to one or the other. The early species here referred to *Phyllonotus* are in this ambiguous position as befits an emerging subgeneric differentiation and they are placed here because of the phylogenetic development of the line rather than because of a strong resemblance to the type species of *Phyllonotus*.

The *Phyllonotus* line evidently diverged from a *Hexaplex* ancestor in the late Eocene. These two groups still share certain marked traits such as a tendency to have brown and white spiral color bands and pink apertures. Both also have a peculiar type of protoconch in the early Tertiary species. In the subfamily Muricinae there are two distinct types of nuclear whorls. One of these is found in the *Pterynotus* group and has only two somewhat bulbous whorls. The other type appears in the *Hexaplex* group and in the early *Phyllonotus* and consists of four or five smooth, conical whorls.

These two types of embryonic shells recur throughout the Muricinae. It would appear that the four or five whorl type is more primitive as it is seen primarily in Eocene to Miocene species, but there are Recent species which also show this type of nucleus so that the true significance of the difference in embryonic shell is not clear. The trend toward a decrease in the number of whorls from four to two occurs independently in several lines. It is assumed that the *Chicoreus* (*Siratus*) line diverged in early

Miocene time from the ancestral *Phyllonotus* type for the lower Miocene species of *Siratus* all have the four whorl nucleus but the species living today have the two whorl type. Table I depicts these relationships as envisioned by the writer.

The *Chicoreus* s.s. line probably comes off this same early *Phyllonotus* stock. The first species considered by the writer to be referable to *Chicoreus* s.s. are the late lower Miocene *C. lepidodus* and *C. dajardinoides*. The division at this point is somewhat arbitrary for these early species could easily have remained with the ancestral group, but it is in these two species that the foliaceous varices and the pronounced anal notch first appear. These two characteristics are the distinguishing marks of the *Chicoreus* s.s. group. *C. solidodes* was also originally included in this *Chicoreus* s.s. group in the previous monograph (Vokes, 1965) but later work on the phylogeny has indicated that this species should be placed in *Phyllonotus*. The flaring parietal shield, such an obvious characteristic in the Recent *Phyllonotus*, does not appear until the late Miocene with *C. globosus*. Except for the lack of this parietal lip the early species more nearly resemble the *Phyllonotus* type than they do the *Chicoreus* s.s. type and so the species which are ancestral to both lines are placed with *Phyllonotus* rather than with *Chicoreus* s.s. It is an unfortunate rule of nomenclature that the generic name of a group is determined by priority rather than phylogeny for the more logical sequence would be to have the groups named *Phyllonotus* s.s. and *Phyllonotus* (*Chicoreus*). This would be a better expression of the true affiliation of the lines.

In the previous *Chicoreus* monograph (Vokes, 1965, p. 182) it was suggested that the *Chicoreus* line originated from a *Pterynotus* ancestor. Additional work on *Phyllonotus* indicates that *Phyllonotus* and *Chicoreus* are closely related to each other but more distantly related to *Pterynotus*. The nature of the development of the early whorls is completely different. In the *Pterynotus* group the first post-nuclear whorl has six small distinct varices which, on the second whorl, become three varices and three intervarical nodes. In *Chicoreus* and in *Phyllonotus* the first post-nuclear whorl has about a dozen equal axial nodes. In *Chicoreus* on the second or third whorl certain

of these are strengthened to form three (or four) varices and the remainder become intervarical nodes. In the *Phyllonotus* group the early post-nuclear whorls are identical to those of *Chicoreus* and not until the third or fourth post-nuclear whorl are certain of the nodes strengthened to form varices. But these varices are irregularly placed with reference to the preceding whorl and there is no column formed up the spire by the varices such as that present in *Chicoreus*.

The members of the *Phyllonotus* group are subtropical shallow water dwellers and are active predators or scavengers. The group is confined to the New World where there are seven Recent species, three in the western Atlantic and four in the eastern Pacific. Although the line has never been very great in number of species the number of individuals at a given locality can be impressive, as witness TU 759 where over 1500 specimens of *C. pomum* were collected by the writer and friends.

As in the other portions of this series on the Muricinae the author has endeavored to include all references to fossil representatives but the synonymies do not include all references to Recent citations for to do so would needlessly extend the work.

III. ACKNOWLEDGMENTS

This project has been supported by a grant from the National Science Foundation (G. B. 6048) and the assistance is gratefully acknowledged. The writer also wishes to thank the following persons for their assistance in the preparation of this paper: Katherine V. W. Palmer, Paleontological Research Institution; Horace G. Richards and R. Tucker Abbott, Academy of Natural Sciences of Philadelphia; Leo G. Hertlein, California Academy of Sciences; Joseph Rosewater and G. Arthur Cooper, U. S. National Museum; J. Wyatt Durham and Joseph H. Peck, Jr., Museum of Paleontology, University of California, Berkeley; all of whom loaned material essential to the study. She would like to thank the members of the editorial committee for their many useful suggestions toward the improvement of the manuscript, and also F. Stearns MacNeil, Fort Myers, Florida, and Robert Chambers, Wagner Free Institute of Science, Philadelphia, for valuable information.

IV. SYSTEMATIC DESCRIPTIONS

Phylum MOLLUSCA

Class GASTROPODA

Subclass PROSOBRANCHIA

Order NEOGASTROPODA

Suborder STENOGLOSSA

Family MURICIDAE

Subfamily MURICINAE

Genus CHICOREUS Montfort, 1810

Subgenus PHYLLONOTUS Swainson, 1833

CHICOREUS (PHYLLONOTUS)
MISSISSIPPIENSIS (Conrad)

Plate 1, figs. 6-7

- Murex mississippiensis* CONRAD, 1847 [1848], Acad. Nat. Sci. Phila., Proc., v. 3, p. 286; CONRAD, 1848, Acad. Nat. Sci. Phila., Jour. (Ser. 2) v. 1, pt. 2, p. 116, pl. 11, fig. 30.
- Murex mississippiensis* Conrad. CONRAD, 1865, Amer. Jour. Conch., v. 1, p. 16.
- Murex mississippiensis* Conrad. DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 139 (in part only).
- Not *Murex mississippiensis* Conrad. DALL, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1566 (= *C. tritonopsis*).
- Murex (Chicoreus) mississippiensis* Conrad. COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 23.
- Murex mississippiensis* Conrad. DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 73 (in part only).
- Murex mississippiensis* Conrad. COOKE, 1922, U. S. Geol. Surv. Prof. Paper 129-E, p. 84.
- Not *Murex mississippiensis* Conrad. ANDERSON, 1929, California Acad. Sci., Proc., (Ser. 4) v. 18, no. 4, p. 137 (= *Cantharus scrupeus* Olsson).
- Murex mississippiensis* Conrad. MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 128.
- Murex (Murex) mississippiensis* Conrad. GARDNER, 1945, Geol. Soc. Amer., Mem. 11, p. 38, 187, pl. 19, fig. 6.
- Murex mississippiensis* Conrad. MOORE, 1962, Acad. Nat. Sci. Phila., Proc., v. 114, p. 77.
- [*Chicoreus (Phyllonotus)*] *mississippiensis* Conrad. E. H. VOKES, 1964, Malacologia, v. 2, no. 1, p. 10.

Diagnosis: Subfusiform, with three elevated varices, and an intermediate prominent obtuse longitudinal ridge; between two of the varices on the body whorl is a smaller ridge; revolving lines prominent, alternated in size, profound on the varices; longitudinal wrinkles distinct; labrum with six prominent lines within, the margin regularly foliated; canal long. Length 17-10 [?].

"It belongs to the subgenus PHYLLONOTA [*sic*] of Swainson." (Conrad, 1848).

Dimensions of lectotype: height 33 mm, diameter 21 mm.

Lectotype: ANSP 13482 (MacNeil MS in Moore, 1962, p. 77).

Type locality: Vicksburg, Mississippi.

Occurrence: Red Bluff Clay, Mississippi; lower Oligocene. Byram Marl and Mint Springs Marl, Mississippi; unnamed formation, Nuevo León, Mexico; middle Oligocene.

Figured specimens: Fig. 6, ANSP 13482 (lectotype). Fig. 7, UNSM 645427; height 20 mm, diameter 11 mm, locality TU 76. Other occurrences: TU locality nos. 66, 226, 334, 335, 336.

Discussion: The oldest known *Phyllonotus* occurs in the lower Oligocene Red Bluff Clay of Mississippi. This same species, *C. mississippiensis*, continues through the middle Oligocene Mint Springs and Byram marls. In the Mint Springs there is another form which occurs with the typical *C. mississippiensis* and is here separated under the name of *C. stetopus* (de Gregorio). In the younger Byram Marl there is yet another form which has been named *C. dormani* (Vokes). It is quite possible that all three names refer to the same biologic species; however, for stratigraphic purposes it seems more useful to distinguish them. The typical *C. mississippiensis* is found in all three formations; *C. stetopus* occurs in the Red Bluff and the Mint Springs, and *C. dormani* is confined to the Byram.

The three forms have been "lumped" together by all previous authors, including Conrad himself. One of the specimens in the type lot of *C. mississippiensis* is *C. dormani* and is here figured (pl. 1, fig. 9). Cooke (1922, p. 84) listed "*Murex mississippiensis*" as occurring at eight of his ten localities in the Byram Marl, but many of these specimens are actually *C. dormani*.

Comparison of the specimens here figured of *C. mississippiensis* and *C. dormani* might, at first glance, suggest that the lectotype of *C. mississippiensis* more nearly resembles the specimens called *C. dormani* than *C. mississippiensis*. This is a function of the relative magnification of the specimens. The lectotype is X 1½ and the others are X 2. As a result the ornamentation of the lectotype appears more subdued than is actually the case. *C. dormani* may be distin-

guished from *C. mississippiensis* by the smoother aspect of the ornamentation of *C. dormani* and by the presence of a single strong intervarical node in contrast to the two weaker ones of *C. mississippiensis*.

Conrad cited his type specimen as measuring "1 7-10," a figure presumed to represent inches on the basis of other species described in the same paper. However, none of the five specimens in the type lot is this large. The largest of the specimens measures 33 mm, or 1⅜ inches, and was selected by MacNeil as lectotype because it is the same size as Conrad's figured specimen. The largest specimens of *C. mississippiensis* present in the collections of the U. S. National Museum measure approximately 40 mm or 1½ inches. It is doubtful that the species attains a larger size. Specimens from the Byram Marl in general are larger than those from the older beds, thus the lectotype in all probability came from the Byram.

C. mississippiensis is common at most localities in the Vicksburg Group, including the Red Bluff, Mint Springs and Byram horizons. Gardner (1945, p. 187, pl. 19, fig. 6) figured a good specimen of true *C. mississippiensis* from an unnamed middle Oligocene sandstone bed near the village of China, Nuevo León, in northeastern Mexico, extending the geographic range considerably.

Anderson (1929, p. 137) cited a specimen from the lower Tuberá Group (Burdigalian) of northern Colombia as "*Murex mississippiensis*" with a reference to Dall's figure of "*M. mississippiensis*" (Dall, 1915, pl. 5, fig. 10). Examination of Anderson's shell, in the collection of the California Academy of Sciences, shows that it is to be referred to *Cantharus scrupus* Olsson, described (1964, p. 163, pl. 37, fig. 8) from the Neogene Esmeraldas Formation of Ecuador (either late Miocene or early Pliocene). This species is closely related to *Cantharus multangulus* (Philippi) from the Neogene and Recent fauna of the Florida-Yucatán area and serves to corroborate Olsson's statement (1964, p. 7) that the mollusks of the Esmeraldas Formation "show intimate relationship with Caribbean species, Miocene and Recent, indicating the free communications which then existed between the Pacific and Atlantic oceanic realms."

CHICOREUS (PHYLLONOTUS) STETOPUS
(de Gregorio)

Plate 1, figs. 1-5

Murex migus DE GREGORIO, 1890, Ann. Géol. Paléontologie, livr. 7, p. 95, pl. 7, figs. 30-33. *Non Murex craticulatus* var. *migus* de Gregorio, 1885.

Murex stetopus DE GREGORIO, 1890, Ann. Géol. Paléontologie, livr. 7, p. 96, pl. 7, fig. 34.

Murex tingarus DE GREGORIO, 1890, Ann. Géol. Paléontologie, livr. 7, p. 96, pl. 7, fig. 36.

Murex migus de Gregorio. COSSMANN, 1893, Ann. Géol. Paléontologie, livr. 12, p. 32 (including *M. stetopus* and *M. tingarus* in synonymy).

Murex migus de Gregorio. PALMER, 1937, Bulls. Amer. Paleontology, v. 7, no. 32, p. 268, pl. 35, figs. 3, 7, 8, 11 (after de Gregorio, 1890), (including *M. stetopus* and *M. tingarus* in synonymy).

Not *Murex* cf. *migus* de Gregorio. PALMER, 1937, Bulls. Amer. Paleontology, v. 7, no. 32, pl. 35, fig. 1 (?="Murex" *laevavari-cosus* Whitfield).

Not *Murex* cf. *migus* de Gregorio. BRANN and KENT, 1960, Bulls. Amer. Paleontology, v. 40, no. 184, p. 571 (?="Murex" *laevavari-cosus* Whitfield).

Murex migus de Gregorio. PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 783.

Murex stetopus de Gregorio. PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 783, 784.

Murex tingarus de Gregorio. PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 783, 784.

Diagnosis: "Testa subturbiniformis, elegans, suburgida; tribus varicibus subfoliaceis, in series dispositis, postice vix spinosis; in singulo earum interstitio duabus vel tribus costis etiam in series axiales dispositis; funiculis spiralibus notatis, confertis, alternantibus majore et minore.

"Celle espèce a une très grande analogie avec le *M. missipiënsis* [sic] Conr. (Conrad Vicksburg [sic] p. 116, pl. 11, f. 30) auquel auparavant je l'avais référée. Mais en étudiant mieux la description de Conrad, je l'ai considérée comme une espèce voisine; car il dit qu'en chaque interstice il y a une côte, tandis que dans nos exemplaires il y en a deux ou trois." (*M. stetopus* de Gregorio, 1890).

Dimensions of incomplete holotype: height 14.5 mm, diameter 10 mm.

Holotype: PRI 26431.

Type locality: Unknown, probably Mint Springs Bayou, Vicksburg, Mississippi (= TU 76).

Occurrence: Mint Springs Marl, middle Oligocene.

Figured specimens: Fig. 1, PRI 26431 (holotype). Fig. 2, UNSM 645646; height

17 mm, diameter 10 mm; locality TU 76. Figs. 3-5, after de Gregorio, 1890.

Discussion: In 1890 the Marquis Antoine de Gregorio published an elaborate monograph on the Eocene fossils of Alabama, based on material shipped to him, presumably, from the world famous collecting locality at Claiborne Bluff, on the Alabama River, Monroe County, Alabama. Palmer (1937, p. 5) said of this work: "De Gregorio did a great service by bringing together the literature and illustrations of the Eocene of Alabama. He frequently confused the age of the horizons and in the writer's estimation overnamed species. Many of the specimens represented are merely different stages of growth in the same species." Such seems to be the case with the three species of *Murex* named by de Gregorio in his monograph. These three species, *M. migus*, *M. tingarus*, and *M. stetopus*, were united in synonymy, under the name *M. migus*, by Cossmann (1893, p. 32). On the basis of the original illustrations this seems to be correct; however, the name *Murex migus* had been used previously by de Gregorio himself (1885, p. 244) and thus another name must be employed for the species. The second name proposed by de Gregorio was *M. stetopus* and because, by great perseverance, Dr. Katherine V. W. Palmer was able to locate the type specimen of this species in the de Gregorio Collection at the University of Palermo, Sicily, (Palmer and Brann, 1966, p. 783 and personal communication) it is the logical choice of available names. The types of both *M. migus* and *M. tingarus* are lost.

Palmer (1937, p. 268) agreed with Cossmann's synonymy but added that "specimens of the form have not been found at Claiborne," having previously remarked (1937, p. 5) of de Gregorio: "There is the possibility that his collections may have become mixed and some of the species described from Claiborne may be extraneous." Almost certainly the species under discussion here falls in this category. No specimens like those figured by de Gregorio have been found by the writer at Claiborne Bluff (= TU 78) but several which match the holotype and the figures very well have been collected at Mint Springs Bayou in Vicksburg, Mississippi (TU 76). It is presumed, therefore, that de Gregorio's locality data was in error and *C. stetopus* actually

comes from the middle Oligocene Mint Spring Marl and not from the Eocene formations of Claiborne Bluff.

Because de Gregorio's description is somewhat inconclusive a few additional words of description are in order. On the holotype the early whorls are eroded but other specimens and de Gregorio's illustration of "*Murex migus*" (refigured here pl. 1, fig. 4) show a protoconch consisting of five smooth, conical whorls typical of the early *Phyllonotus* group. The early post-nuclear whorls have three varices with two intervarical nodes between each pair; these two intervarical nodes persist up to the adult stage. The spiral ornamentation is coarse and consists of four strong ribs on the early whorls with smaller secondary riblets intercalated on about the fifth whorl. On the body whorl and pillar there are approximately ten primaries alternating with secondaries. The varices have a slight open flange along the edge and there is a small spine at the shoulder.

C. stetopus occurs with the more common *C. mississippiensis* and is very closely related to it. The two forms differ in *C. stetopus* having coarser ornamentation, a more inflated body whorl, and a small spine at the shoulder. It is possible that *C. stetopus* is only an extreme variant of *C. mississippiensis* but the differences appear to be constant.

In Palmer's work on the Claiborne fauna she figured a specimen from Hickory, Mississippi, (1937, pl. 35, fig. 1) which she compared with *M. migus*. In the Tulane Geological Collections there are several specimens which are the same as Palmer's figured specimen from a locality near Hickory (TU 85, Rose Hill, Miss.) and they are not to be referred to *M. migus*. They seem to be the species named *Murex laevavaricosus* Whitfield from the middle Eocene Shark River Formation of New Jersey. The holotype of Whitfield's species is evidently lost (Palmer and Brann, 1966, p. 782) but his illustration shows a shell which is almost certainly the same as the Tulane specimens. This species is not muricid but is to be referred to that group of Eocene shells which have been called *Siphonalia* by authors.

CHICOREUS (PHYLLONOTUS) DORMANI
(E. H. Vokes)

Plate 1, figs. 8, 9

Murex (Phyllonotus) dormani E. H. VOKES,
1963, Tulane Stud. Geol., v. 1, no. 4, p.
156, pl. 2, figs. 3a, 3b.

Diagnosis: "Shell of moderate size. Nucleus smooth, $3\frac{1}{2}$ [five] whorls ending at a small varix or riblet. Post-nuclear whorls convex, about five in the adult; suture deeply impressed. Axial sculpture consists of three high, rounded varices, which bear a single open spine at the shoulder, commonly lost in the adult. Varices excavated behind, irregularly placed with respect to the corresponding varix on the previous whorl. Between each pair of varices is one strong intervarical node (sometimes two in the younger stages). Spiral ornamentation exceedingly variable, with a tendency toward one primary thread on the shoulder, and three to six secondaries and tertiary threadlets between the suture and this first primary. Usually two or three secondary threadlets between the first and the second primary thread which is at the periphery; few secondaries and no tertiaries on the remainder of the whorl, in general only primaries, about 15 on the body whorl, becoming obscure on the pillar. Aperture oval, labium smooth, distinct, separate from body wall at anterior end. Outer lip with about eight denticles internally. Anterior canal moderately long, recurved; antecedent canals forming an anterior fasciole." (Vokes, 1963).

Dimensions of holotype: height 22 mm, diameter 14.8 mm.

Holotype: USNM 644373.

Type locality: Vicksburg, Mississippi.

Occurrence: Byram Marl, Mississippi; middle Oligocene.

Figured specimen: Fig. 8, USNM 644373 (holotype). Fig. 9, ANSP 13483; height 24.7 mm, diameter 15 mm; locality, Vicksburg, Mississippi.

Other occurrences: TU locality nos. 334, 335.

Discussion: In the original description of this species the type locality was given as Byram, Mississippi. It has since been ascertained that this was in error and the type specimen really came from Vicksburg, Mississippi, in the Byram Marl. There are numerous specimens of *C. dormani* in the collections of the U. S. National Museum from Vicksburg.

Prior to this time *C. dormani* has not been recognized by authors and the specimens are found in collections together with the more common *C. mississippiensis* with which it occurs. In the type lot of *C. mississippiensis* there is a fine specimen of *C.*

dormani (here figured, pl. 1, fig. 9). The two species may be distinguished by the smoother appearance of *C. dormani* and its one strong intervarical node in contrast to the two weaker ones of *C. mississippiensis*.

CHICOREUS (PHYLLONOTUS) DAVISI
(Richards)

Plate 2, figs. 2a, 2b

Murex davisi RICHARDS, 1943, Jour. Paleontology, v. 17, no. 5, p. 524, pl. 85, figs. 1, 2.

Murex davisi Richards. RICHARDS, 1962, Amer. Phil. Soc., Trans., v. 40, pt. 1, p. 21, fig. 67j.

Diagnosis: "Shell subfusiform; six convex whorls; three elevated varices on body whorl with a longitudinal rib between. Between the two varices nearest the aperture there are five indistinct ribs. No spines. Aperture more than half the length of the shell; canal deflected to the left. Surface of the shell covered with alternating thick and thin revolving lines. Seven aperture teeth." (Richards, 1943).

Dimensions of holotype: height 45 mm, diameter 29 mm.

Holotype: ANSP 15836.

Type locality: Gillette marl pits, Silverdale, Onslow County, North Carolina (=TU 704).

Occurrence: "Trent Marl" (Silverdale Beds), North Carolina; lower Miocene.

Figured specimen: USNM 645425; height 46 mm, diameter 27 mm; locality TU 562. Other occurrences: TU locality no. 704.

Discussion: In 1961 the Highway Department of Onslow County, North Carolina, opened a marl pit for the purpose of obtaining road metal for a new road then under construction. This pit (TU 562) is perhaps one-eighth of a mile from the old "Gillette marl pit" (TU 704) at Silverdale, and on the opposite side of the highway. The fauna is the same at the two localities. While the pit was being used by the county it was kept dry by pumping and for a time afforded excellent collecting of the Silverdale fauna. Over 150 specimens of *Murex davisi* were collected at this locality, giving ample opportunity to study variation in this rather variable species. Large specimens of *C. davisi* resemble large specimens of *C. tritonopsis* from the correlative Tampa Limestone of Florida, but the early development is different. In this respect the Silverdale species is more akin to *C. trophoniiformis* in that the formation of varices is irregular and these do not appear until the third or fourth whorl. The spiral ornamentation of *C. davisi* is more subdued and the overall appearance of the shell is smoother. The denticles on the outer lip are more conspicuous in both of the Florida species than in *C. davisi*, in which they are completely lacking or only poorly developed. A few specimens of *C. davisi* show an open flange at the edge of the varices, especially that portion on the siphonal canal. This thin flange is usually worn off, as all specimens in the collection show abrasion due to wave action. In the entire lot there is not one perfect specimen for figuring. It is presumed that *C. davisi* lived in extremely shallow water.

C. davisi was originally assigned to the "Trent Marl" by Richards. But at the time he stated: "The Trent marl of North Carolina was originally regarded as Eocene (Miller 1912); however, a restudy of the formation including an analysis of its invertebrate fauna by Kellum (1926) demonstrated that it was younger, probably of lower Miocene age, although there was a possibility that it might be Oligocene." (1943, p. 518). Additions to the fauna, Richards said, tended to confirm the lower Miocene age. The Trent Formation is, however, an indurated limestone, completely different from the unconsolidated marls at Silverdale. Therefore, some question arises concerning the assignment of the fauna at Silverdale to the Trent. There seems little doubt that the Silverdale beds are of lower Miocene age but the writer would prefer not to use the term "Trent Formation" in conjunction with the Silverdale material until the matter is resolved.

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CHICOREUS (PHYLLONOTUS)
TROPHONIFORMIS (Heilprin)

Plate 2, figs. 7, 8

Murex trophoniiformis HEILPRIN, 1887, Wagner Free Inst. Sci., Trans., v. 1, p. 107, pl. 15, fig. 40.

Murex trophoniiformis Heilprin. DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 140 (in part); DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 74 (in part), not pl. 9, fig. 7 (= *C. tritonopsis*).

Murex mississippiensis Conrad. DALL, 1915, U. S. Natl. Mus., Bull. 90, pl. 5, fig. 10 only (not of Conrad).

Alectrion gardnerae DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 70.

Murex trophoniiformis Heilprin. COOKE and MOSSOM, 1929, Florida Geol. Surv., Ann. Rept. 20, p. 88, 89; not pl. 8, fig. 2

(after Dall, 1915, pl. 9, fig. 7, = *C. tritonopsis*).

Murex trophoniformis Heilprin. MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 129.

Murex trophoniformis Heilprin. COOKE, 1945, Florida Geol. Surv., Bull. 29, p. 117, 130, 131; not fig. 15-2 (after Cooke and Mossom, 1929, pl. 8, fig. 2, = *C. tritonopsis*).

[*Chicoreus (Phyllonotus)*] *trophoniformis* (Heilprin). E. H. VOKES, 1964, Malacologia, v. 2, no. 1, p. 10.

Diagnosis: "Shell having the form of *Trophon*; whorls about six, sub-angulated superiorly, very convex; varices placed at irregular intervals, four on the body-whorl, the intervarical spaces with one, or two, or even three secondary costae; aperture about two-thirds the length of shell, contracted into a short, sharply-deflected, and open canal; surface of shell covered with numerous alternating, elevated lines." (Heilprin 1887)

Dimensions of holotype: height (incomplete) 1.2 inches, diameter .8 inches.

Holotype: Wagner Free Inst. Sci. no. 869.

Type locality: Ballast Point, Tampa Bay, Hillsborough County, Florida.

Occurrence: Tampa Limestone, Florida; lower Miocene.

Figured specimens: Fig. 8, USNM 165085; height 30 mm, diameter 16.5 mm. Fig. 7, USNM 214737 (holotype-*Alectrion gardnerae* Dall); height (incomplete) 16 mm, diameter 12 mm. Locality of both, Ballast Point, Tampa Bay, Florida.

Discussion: In 1915 (pl. 9, fig. 7) Dall figured a specimen which he identified as "*Murex trophoniformis* Heilprin" but it actually is a very large specimen of Heilprin's other Tampa species "*Murex*" *tritonopsis*. At the same time Dall (*ibid.*, pl. 5, fig. 10) figured as "*Murex mississippiensis* Conrad" (under which name he included *M. tritonopsis* Heilprin) a specimen of *C. trophoniformis*. This confusion has led to a misconception of the two species on the part of subsequent authors. To further complicate the matter, in the same volume Dall also described a new species, *Alectrion gardnerae*, which he said was received "too late for figuring." Mansfield (1937, p. 128) placed this species in the synonymy of *Murex tritonopsis* due to the afore-mentioned confusion, but examination of the type specimen (USNM 214737) shows that it is really a synonym of *C. trophoniformis*. As the specimen has never been figured, an illustration is given here.

C. trophoniformis is easily recognized by

its lack of varices on the first three or four whorls. *C. tritonopsis*, with which it occurs, has three varices and two intervarical nodes between each pair beginning about the second post-nuclear whorl. *C. tritonopsis* is a much more common species than *C. trophoniformis*. In the U. S. National Museum collection from the Tampa Limestone there are numerous specimens of *C. tritonopsis* but only four specimens of *C. trophoniformis*.

There is another species which authors have cited as "*Murex trophoniformis* Weinkauff, 1884." If this were a valid taxon it would preoccupy *Murex trophoniformis* Heilprin. Fortunately, when one investigates the history of this name it is clear that no problem is present. The 1884 date refers to a paper by Monterosato wherein that author listed a species "*Muricidea blainvillei* var. *trophoniformis*" crediting the authority as Weinkauff. However, if one looks up Weinkauff's usage he finds only "*Murex cristatus* var." There is no mention of the name *trophoniformis* and it is a nude name (Weinkauff, 1873, p. 5). Monterosato, in 1878, was the first to give the name as "*Murex (Ocinebra) blainvillei* var. *trophoniformis*" but as used here it was also a nude name. Likewise, in 1882, Bucquoy, Dautzenberg, and Dollfus, cited only "*Murex blainvillei* Var. ex forma *trophoniformis* Weink. (*vide* Monterosato)." Their usage is also a nude name and the 1884 Monterosato work is the first to identify this variety as the shell figured by Reeve as *Murex cristatus* (1845, pl. 26, fig. 112). But this time the genus *Muricidea* was the one to which the species was referred (for which we may be grateful) and so the Heilprin name is not preoccupied unless one wishes to place both forms under the broad genus *Murex* s.l. The name "*Muricidea*" is an erroneous synonym of *Muricopsis* Bucquoy, Dautzenberg, and Dollfus (see Vokes, 1964, p. 18, for a discussion of this problem).

CHICOREUS (PHYLLONOTUS)

TRITONOPSIS (Heilprin)

Plate 2, figs. 1, 5

Murex tritonopsis HEILPRIN, 1887, Wagner Free Inst. Sci., Trans., v. 1, p. 107, pl. 15, fig. 39.

Murex mississippiensis Conrad. DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 139 (in part, not of Conrad); DALL, 1915, U. S. Natl. Mus., Bull. 90,

p. 73 (in part, *not* of Conrad), *not* pl. 5, fig. 10 (= *C. trophoniformis*).

Murex trophoniformis Heilprin, DALL, 1915, U. S. Natl. Mus., Bull. 90, pl. 9, fig. 7 only (*not* of Heilprin).

Murex trophoniformis Heilprin, COOKE and MOSSOM, 1929, Florida Geol. Surv., Ann. Rept. 20, pl. 8, fig. 2 only (*not* of Heilprin).

Murex tritonopsis Heilprin, MANSFIELD, Florida Geol. Surv., Bull. 15, p. 128.

Murex trophoniformis Heilprin, COOKE, 1945, Florida Geol. Surv., Bull. 29, fig. 15-2 only (*not* of Heilprin).

Murex tritonopsis Heilprin, COOKE, 1945, Florida Geol. Surv., Bull. 29, p. 133.

Diagnosis: "Shell consisting of about six regularly-convex whorls; varices, three on each whorl, profoundly convex and entirely destitute of spines or lamellar processes; two more or less nodulose costae between each pair of varices; aperture exceeding one-half the length of shell, the canal deflected, very narrow; surface of shell covered with closely placed, elevated revolving lines, which regularly alternate in size." (Heilprin, 1887)

Dimensions of holotype: height 1.2 inches, diameter .7 inches.

Holotype: Wagner Free Inst. Sci. no. 868.

Type locality: Ballast Point, Tampa Bay, Hillsborough County, Florida.

Occurrence: Tampa Limestone, Florida; lower Miocene.

Figured specimens: Fig. 1, USNM 21440; height 45 mm, diameter 26 mm. Fig. 5, USNM 643748; height 23.5 mm, diameter 16 mm. Locality of both, Ballast Point, Tampa Bay, Florida.

Discussion: Dall (1915, pl. 5, fig. 10) figured a specimen as "*Murex mississippiensis*" under which name he included the species *Murex tritonopsis* Heilprin but his shell is not *C. mississippiensis* nor *C. tritonopsis*, it is *C. trophoniformis* (Heilprin). For *C. trophoniformis* he figured a very large specimen of *C. tritonopsis* (*ibid.*, pl. 9, fig. 7). This exchange has resulted in subsequent authors also confusing the two species.

C. tritonopsis is much like the older *C. mississippiensis* but differs in having a protoconch with only two bulbous whorls as opposed to the "primitive" type of protoconch seen in *C. mississippiensis* with five smooth conical whorls. Like the older species *C. tritonopsis* is quite common at the type locality. It may be distinguished from the less abundant *C. trophoniformis* by the regular appearance of the varices and the heavier spiral ornamentation.

CHICOREUS (PHYLLONOTUS)

cf. TRITONOPSIS (Heilprin)

Plate 2, fig. 6

Incertae sedis GARDNER, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 522, pl. 53, fig. 7.

Diagnosis: "Shell small, solid, stout, fusiform, the maximum diameter falling near the median horizontal. Aperture approximately half the length of the entire shell. Whorls 5 in the conch, those of the spire buccinoid, increasing rapidly in diameter, the body inflated medially, abruptly constricted into the short pillar. Sutures inconspicuous, finely crenulated by the axials of the preceding whorl. Protoconch small, smooth, twice-coiled, the initial turn flattened behind, immersed at the tip, the second whorl broadly convex. Opening of conch indicated by the abrupt appearance of the conchal sculpture, both axial and spiral. Axials on the early whorls very narrow, sharply rounded, closely crowded probably as many as 15 on the posterior portion of the conch and 10 on the medial portion, equal and equi-spaced, smoothly rounded, uniform in prominence between the sutures, wider than the intercostals, every fourth rib on the last whorl of the spire and the body strengthening into a simple varix; axials persisting well down on the pillar, the rib directly behind the terminal varix, however, more or less obsolete. Spiral sculpture sharply threading the conch from the nucleus to the anterior fasciole, overriding the axials and equally prominent on the costal and intercostal areas; primaries 4 on the whorls of the spire, increasing slightly in elevation from the posterior to the anterior suture, approximately 12 on the body and pillar, sharply rounded, abruptly elevated, regularly spaced; a filamentary secondary intercalated between each pair of primaries on the later whorls, and a slightly stronger secondary between the posterior primary and the suture line. Anterior threaded with half a dozen closely spaced, linear lirae. Aperture sinuous, minutely gourd-shaped in outline, obtusely angulated at the posterior commissure. Labrum arcuate, varicated a little behind the margin, the varix abutting against the preceding volution and posteriorly produced upon it; labral margin thin, sharp, and finely crenate in harmony with the spirals; inner surface of varix denticulate, the denticles normally 8 and elongated at right angles to the margin, except the denticle at the entrance to the anterior canal, which is rudely parallel to the canal. Labium excavated at the base of the body, heavily glazed from the commissure to the entrance to the canal; a rather obscure parietal tooth developed directly in front of the commissure. Pillar wash rugose. Anterior canal imperfect in the figured specimen, short, flexuous, bent backward slightly and arched to the right;

possibly closed in perfect adults. Anterior fasciole diverging only slightly from the canal, emarginate at its extremity." (Gardner, 1947)

Occurrence: Chipola Formation, Florida; (?) uppermost lower Miocene.

Figured specimen: USNM 371878; height 14.5 mm, diameter 8.3 mm; locality USGS 2211 (=TU 453). Other occurrences: TU locality no. 787.

Discussion: In the U. S. National Museum collection from the lower bed (*i.e.*, Chipola Formation) at Alum Bluff (USGS 2211 = TU 453) there are several immature specimens of *Phyllonotus* which Gardner referred only to "*incertae sedis*." These specimens appear to be more closely related to *C. tritonopsis* than to any known Chipola species. The two-whorled nucleus, the development of the early whorls, the type of denticulation on both the inner and outer lips, all match well with *C. tritonopsis*. The spiral ornamentation is somewhat coarser in the younger shell but this may represent only an ecologic difference.

Another specimen, unfortunately also a juvenile, has been found at TU 787 on Ten Mile Creek. Because these immature specimens are the only known examples of this form it is advisable not to describe a new species until better material is available.

CHICOREUS (PHYLLONOTUS) INFREQUENS (E. H. Vokes)

Plate 1, figs. 10a, 10b

Murex (Phyllonotus) infrequens E. H. Vokes, 1963, *Tulane Stud. Geol.*, v. 1, no. 4, p. 156, pl. 1, figs. 4a, 4b.

Diagnosis: "Shell of moderate size, spire elevated. Nucleus consists of four polished, conical whorls, terminating in a crescentric varix. Seven post-nuclear whorls in the adult, more or less convex. Early post-nuclear whorls ornamented by 14 equal axial nodes, which are crossed by three spiral threads. On the third to fourth whorls three of these axial nodes become stronger, forming varices, with the others remaining as intervarical nodes; two to three between each pair of varices. Spiral sculpture consists of four to five primary threads on the medial portion of the shell with one secondary and two tertiary threadlets between each pair of primary threads; approximately 12 primary threads on the body whorl and pillar. On the anterior portion of the varices and on the extended siphonal canal small open spinelets are produced where the primary threads cross. Aperture oval in shape, labium thin, slightly flaring, marked by numerous rugae which are a reflection of the underlying ornamentation; weak pos-

terior anal notch. Outer lip crenulated by 12 to 14 paired denticles. Siphonal canal short, broad, recurved." (Vokes, 1963)

Dimensions of holotype: height 36 mm, diameter 19 mm.

Holotype: USNM 644374.

Type locality: TU 458, Chipola River above Farley Creek (SW $\frac{1}{4}$ Sec. 20, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida; (?) uppermost lower Miocene.

Figured specimen: USNM 644374 (holotype). Other occurrences: TU locality nos. 70, 196, 457, 546, 547.

Discussion: In the original discussion of this species (Vokes, 1963, p. 156) it was suggested that it might be the same as the form cited by Gardner (1947, p. 522, pl. 53, fig. 7) as "*incertae sedis*" from the Chipola Formation at Alum Bluff. The writer has now examined Gardner's specimen and the two are not the same. The latter species is covered in the present paper under the name *C. (P.) cf. C. tritonopsis*.

C. infrequens would appear on the basis of general shell morphology to be most closely related to *C. trophoniformis* from the Tampa Limestone. However, the younger species has the "primitive" four whorl nucleus and the older form has a bulbous two whorl protoconch. There is at least one other instance in the Muricinae of a reversion to the four whorl type from a two whorl ancestor so it may be possible that this has happened in the case of *C. infrequens*.

CHICOREUS (PHYLLONOTUS) FOLIDODES (Gardner)

Plate 3, figs. 1a, 1b

Murex trophoniformis Heilprin. DALL, 1890, *Wagner Free Inst. Sci. Trans.*, v. 3, pt. 1, p. 140 (in part, *not* of Heilprin); DALL, 1903, *ibid.*, v. 3, pt. 6, p. 1577 (*not* of Heilprin); DALL, 1915, *U. S. Natl. Mus., Bull.* 90, p. 74 (in part, *not* of Heilprin).

Murex (Chicoreus) folidodes GARDNER, 1947, *U. S. Geol. Surv. Prof. Paper* 142-H, p. 520, pl. 53, fig. 5.

Murex (Chicoreus) folidodes Gardner. GARDNER in PARKER, 1948, *Nautilus*, v. 61, p. 93.

Chicoreus (Chicoreus) folidodes (Gardner). E. H. VOKES, 1965, *Tulane Stud. Geol.*, v. 3, no. 4, p. 184, pl. 1, figs. 1a, 1b.

Diagnosis: "Shell of moderate dimensions, rather heavy, stout fusiform, the maximum diameter falling in front of the median horizontal. Aperture little more than half as high as the entire shell. Whorls of conch probably 7, the early volutions broadly convex, the body increasing

less rapidly in diameter than the whorls of the spire; the posterior margin of the closely appressed later volutions creeping up a little on the preceding whorl. Protoconch imperfectly preserved; final whorl small and smooth, somewhat flattened laterally. Axials on the early volutions narrow, well rounded, retractive, arranged in series slightly off set at the suture and performing about half a turn, increasing in prominence toward the anterior suture, equal and separated by concave interspaces of approximately their own width, commonly 9. Varices developed by the strengthening of every third rib, the costal to the right of the varix becoming increasingly feeble and finally obsolete, the costal to the left of the varix, gradually transformed into a rather prominent peripheral node; varices on the later whorls foliaceous, the free edges sharply fluted in a series of short, serrate processes, open toward the aperture; the primary spirals forming the axes of the spines; spines tending to lengthen anteriorly, most produced on the pillar. Entire surface except the apical region macroscopically shagreened by the sharp laminar incrementals, numbering about 4 to the millimeter over the greater part of the adult shell; the free edges worn down in the type but probably in fresh specimens finely fluted by the spirals, even by the secondaries and tertiaries. Spiral sculpture well developed. Primary spirals 5 on the whorls of the spire, 13 or 14 on the body and pillar, rather angular and separated on the posterior portion of the shell by angular interspaces, equally prominent on the costals and intercostals, but more elevated toward the anterior suture; linear secondaries intercalated between each pair of primaries on the third or fourth whorl of the conch, the number of intercalated secondaries increased on the fifth whorl to 2, on the final whorl of the spire to 3 or 4, and on the periphery of the body to 4 or 5, the medial secondary usually stronger than those on either side. Anterior fasciole not well differentiated, threaded with 9 or 10 subequal lirae. Aperture exclusive of the canal obliquely elliptical, emarginate posteriorly. Curvature of outer lip a little broader than that on the inner; margin of outer lip sharply crenate in harmony with the spiral sculpture, the interspiral channels showing up on the inner surface as low ridges and produced for some little distance within the mouth of the aperture. Labium smoothly excavated at the base of the body, heavily glazed. Pillar margin sharply rounded at the entrance to the canal. Anterior canal broad, compressed dorsoventrally, curved backward, obliquely truncate at its extremity, probably closed in the perfect adult; former canals, one to each varix, quite sharply divergent from the final canal." (Gardner, 1947)

Dimensions of holotype: height 43.3 mm, diameter 25 mm.

Holotype: USNM 371852.

Type locality: USGS 3419 (=TU 457), "one mile below Bailey's Ferry," Chipola River, Calhoun County, Florida.

Occurrence: Chipola Formation, Florida; (?) uppermost lower Miocene.

Figured specimen: USNM 644821; height 42 mm, diameter 24.8 mm; locality TU 554. Other occurrences: TU locality nos. 457, 546, 787.

Discussion: This species was originally included in the *Chicoreus* s.s. monograph (Vokes, 1965, p. 184) but subsequent work on the phylogeny of the *Phyllonotus* group as a whole has indicated that placement in the subgenus *Phyllonotus* is more meaningful. *C. foliododes* at present appears to be the best choice for an ancestor to the *C. globosus*-*C. pomum* complex. The juveniles of these latter species especially resemble *C. foliododes* in good Haeckelian fashion.

In the Tulane collections this species has been found only at localities on the Chipola River or at the eastern end of the section exposed along Ten Mile Creek, in beds which are more like those on the river than farther west along the creek. However, Parker (1948, p. 93) reported "*Murex*" *foliododes* as occurring at the bridge on Ten Mile Creek (=TU 70) in association with *Cassis delta*, a species which also is more typical of the Chipola River fauna. Parker noted that at this locality "the richest fauna, including a new *Cassis*, was found along a six inch bank of bluish clay which was of a different color and more arenaceous texture than the 'maple sugar' brown clay above and below it." (*ibid.*, p. 90).

CHICOREUS (PHYLLONOTUS)

ALDRICHI (Gardner)

Plate 3, figs. 2a, 2b

Murex (Chicoreus) aldrichi GARDNER, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 521, pl. 53, fig. 11.

Diagnosis: "Shell large, heavy, not very stout, the aperture more than half as long as the entire shell. Apex broken away so that the exact number of whorls is not determinable but probably about 7; whorls increasing regularly in diameter and with a moderate degree of rapidity, convex, the maximum inflation falling a little in front of the median horizontal. Body whorl rather abruptly constricted into the broad pillar. Volutions closely appressed, the posterior margin in front of the varices creeping up on the preceding whorl; suture lines inconspicuous, irregular; protoconch not pre-

served. Axials on the early whorls narrow, rounded, equispaced and equispaced, uniform in elevation between the sutures, 9 in number. Varices developed by the strengthening of every third rib, the intermediate costals gradually becoming obsolete toward the sutures and appearing on the later whorls as peripheral tubercles, that to the left of the varix usually more elevated than that on the right; varices 3 in number, abruptly elevated, sharply rounded on their summits, finely laminated on the side toward the aperture, quite strongly retractive and continuous, so that each of the three series performs approximately half a revolution around the axis of the shell. Spiral sculpture regular; primaries 5 in number on the whorls of the spire and 13 or 14 on the body; rather narrow, prominently elevated lirations, equally strong on the varical and intervarical areas separated from one another by slightly wider areas, the spacings equal on the spire and medial portion of the body but widening slightly on the base of the body and the pillar; secondaries not intercalated on the early whorls of the spire, a single threadlet introduced along toward the close of the spire, while on the penultima and ultima 2 or even 3 lirations are intercalated between each pair of primaries; secondaries on the pillar similar to those on the medial portion of the body; threading on the anterior fasciole very fine and close. Aperture exclusive of the canal ovate, obscurely sulcate posteriorly. Curvature of outer lip higher than that of the inner; outer lip symmetrically arcuate, varicated behind the margin, thin, sharp, and finely crenate at the margin in harmony with the spiral sculpture; lirate within, the lirae persisting to the outer edge of the labrum and corresponding in position to the interprimary areas. Labium strongly but smoothly excavated at the base of the body, evenly and heavily glazed from the commissure to the entrance to the canal. Inner margin of pillar well-rounded. Anterior canal broad, probably of moderate width and possibly closed in the perfect adult. Anterior fasciole sharply rounded, diverging from the canal at an angle of approximately 45 degrees; space between the fasciole and the linear canal opening occupied by a cuneate, shelly lamina; anterior extremity of canal broken away." (Gardner, 1947)

Dimension of holotype: height 53.5 mm, diameter 31.5 mm.

Holotype: USNM 645424 (formerly Johns Hopkins Collections).

Type locality: Shell Bluff, Shoal River, Walton County, Florida (=TU 69).

Occurrence: Shoal River Formation, Florida; middle Miocene.

Figured specimen: USNM 645424 (holotype).

Discussion: *C. aldrichi* is closely related to *C. foliododes* from the Chipola Formation.

The principal difference is the lack in *C. aldrichi* of the small spines on the varices usually seen in *C. foliododes*. The body whorl of *C. foliododes* is marked by a rather strong, single node between each pair of varices but *C. aldrichi* has in addition a secondary smaller node. Whether these differences are of specific validity or whether they are within the range of variability of a single species cannot be said until more material is available for the Shoal River form. *C. aldrichi* was based on a single specimen collected by T. H. Aldrich. The holotype was originally in the collection of the Paleontological Laboratory at Johns Hopkins University. That collection has been acquired by the U. S. National Museum and the holotype now is located there. In addition there are two more incomplete specimens in the U.S.N.M. collections. In spite of extended collecting by the Tulane Geology Department at the Shell Bluff locality (TU localities 69, 69A, 69B) not even a fragment of the species has been found.

CHICOREUS (PHYLLONOTUS)

PKYNOS (Gardner)

Plate 2, figs. 4a, 4b

Murex trophoniformis Heilprin. DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 74 (in part, *not* of Heilprin).

Murex (*Chicoreus* ?) *pyknos* GARDNER, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 522, pl. 53, fig. 10.

Diagnosis: "Shell rather low but thick and stout. Aperture more than half as long as the entire shell. Whorls closely appressed, broadly convex, increasing somewhat irregularly in diameter, probably about 7 in the conch. Body rather abruptly constricted into the short, broad pillar. Protoconch not preserved. Axials on the early whorls 9, rather low, rounded, separated by equal interspaces. Rather low broad varices developed by the strengthening of every third rib, the terminal varix, however, decidedly more prominent than those behind it; axial to the right of the varix becoming increasingly feeble and finally obsolete, the axial to the left of the varix forming a moderately prominent peripheral node. Spiral sculpture regular; 4 or 5 lirations on the early whorls equal and equispaced and uniformly elevated on the costal and intercostal areas; 5 primaries on the final whorl of the spire, 9 or 10 on the body and 2 on the pillar; secondaries intercalated on the next to the last whorl of the spire, 1 between each pair of primaries; 2 or 3 secondaries usually developed between each pair on the last whorl of the spire and the body and as many as

4 between the primaries on the pillar. Anterior fasciole denticated but probably finely liriate. Aperture wide, obliquely elliptical. Outer lip broadly arcuate, varicose a little behind the margin; the margin crenulated by the spirals; on the inner labral surface, about 8 low, short lirae. Inner wall of aperture strongly concave, heavily glazed; inner margin of pillar sharply rounded. Anterior canal rather short, oblique, sinistrally directed; margins parallel, rather close together. Anterior fasciole well-defined, not parallel to the canal opening but changing its direction with each resting stage; the resultant fasciole, asymmetrically arcuate; space between the fasciole and the canal opening filled by a thin lamina unsculptured except for incrementals." (Gardner, 1947)

Dimensions of holotype: height 32 mm, diameter 20.8 mm.

Holotype: USNM 115771.

Type locality: USGS 2615, Shell Bluff, Shoal River, Walton County, Florida* (=TU 69).

Occurrence: Shoal River Formation, Florida; middle Miocene.

Figured specimen: USNM 115771 (holotype).

Discussion: Dall (1915, p. 74) cited "*Murex trophoniformis* Heilprin" as occurring in the "Chipola Marl, at the county bridge, formerly Bailey's Ferry, Chipola River, Florida," but gave only the specimen numbers 155771 and 214440. The latter number identifies a specimen which is *C. tritonopsis*. The number 115771 was originally labeled "*Murex trophoniformis* Heilpr. var." and the locality on the label is "Lower Bed at Shoal Riv. Watson [*sic*] Co., Florida." Mansfield (1937, p. 129), in his synonymy of *Murex trophoniformis*, cited Dall, 1915, p. 74, but added "part, Shoal River form, U.S.N.M. 115771, excluded." Presumably the reference by Dall to the Chipola was for other specimens. Gardner (1947, p. 520) stated that the *Murex trophoniformis* of Dall, 1890 (p. 140), was, in part, the Chipola species she named *Murex foliodex*. The specimen number 155771 she made the

holotype of another new species, *Murex pyknos*.

C. pyknos is similar to *C. millvillensis* (Richards and Harbison) from beds of equivalent age in New Jersey. The principal difference observable in the two type specimens is the presence in *C. millvillensis* of about 12 teeth on the outer lip whereas in *C. pyknos* there are but eight such teeth. The 12 paired teeth are typical of most of the *Phyllonotus* group such as *C. pomum*, *C. globosus*, *C. infrequens* and *C. trophoniformis*. The lesser number of unpaired denticles are found in others of the group, including *C. mississippiensis*, *C. davisii* and *C. riparius*. The number seems to be more or less constant within a species so it is probable that this difference indicates two valid forms. Other minor differences include a slightly more scabrous surface texture in *C. millvillensis* and two intervarical nodes rather than one as seen in *C. pyknos*.

C. pyknos is a rare species at the type locality but Gardner suggested that other specimens from one-half mile down Shoal River from Shell Bluff might be the same and examination of the U.S.N.M. specimens indicates this is correct. This locality has not been located by the Tulane Geology Department, nor have any specimens of *C. pyknos* been collected at Shell Bluff (TU localities 69, 69A, 69B).

CHICOREUS (PHYLLONOTUS)
MILLVILLENSIS (Richards and
Harbison)

Plate 2, figs. 3a, 3b

Murex millvillensis RICHARDS and HARBISON, 1942, Acad. Nat. Sci. Phila., Proc., v. 94, p. 212, pl. 19, fig. 16.

Diagnosis: "Shell subfusiform with three elevated varices, and an intermediate prominent irregular longitudinal ridge; between two of the varices on the body whorl is a smaller ridge. Revolving lines are prominent, occurring in groups of three separated by slightly thicker spiral ridges; longitudinal wrinkles distinct; canal long. Twelve teeth on the aperture.

"This differs from *Murex mississippiensis* (Conrad) by having three spiral lines instead of one or two. Also *M. mississippiensis* does not have the twelve aperture teeth, but instead has six prominent lines on the labium; also the ridge is straighter along the body whorl and does not curve as in *M. millvillensis*." (Richards and Harbison, 1942)

Dimensions of holotype: height 32.5 mm, diameter 19 mm.

*Gardner gave the type locality for this species as "5 miles west of Mossyhead, Walton County, Fla." In her list of localities (1947, p. 483) she remarks in a footnote for locality no. 3742 that "5 miles west of Mossyhead" is the type locality for the Shoal River Formation at Shell Bluff, actually 3½ miles North 25° West of Mossyhead. Certainly five miles west of Mossyhead would be nowhere near Shoal River.

Holotype: USNM 498975.

Type locality: Millville, Cumberland County, New Jersey.

Occurrence: Kirkwood Formation, New Jersey; lower middle Miocene.

Figured specimen: USNM 498975 (holotype).

Discussion: *Murex millvillensis* was described from a collection of fossils obtained from a well near Millville, New Jersey. The type is from a depth of 505 feet, with additional specimens from 460 feet, in beds the authors ascribed to the Kirkwood Formation, of lower middle Miocene age. The species is relatively common, there being eight paratypes from the same well.

Although Richards and Harbison compared their species with *Murex mississippiensis* from the Oligocene there is really only a subgeneric resemblance between the two, and *C. millvillensis* more nearly resembles *C. pyknos* from correlative beds in northern Florida. These two are compared in the discussion of the latter species. *C. millvillensis* also is much like *C. tritonopsis* from the Tampa Limestone the primary difference being in the greater number of denticles on the outer lip and the lack of denticles on the inner lip of *C. millvillensis*.

There is a group of early and middle Miocene species of *Phyllonotus* including *C. tritonopsis*, *C. trophoniformis*, *C. davisii*, *C. pyknos*, and *C. millvillensis*, that are very much alike; the differences between them are a matter of degree rather than any definite characters.

CHICOREUS (PHYLLONOTUS)

RIPARIUS (E. H. Vokes)

Plate 3, figs. 4a, 4b

Murex (Phyllonotus) riparius E. H. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 4, p. 157, pl. 1, figs. 5a, 5b.

Diagnosis: "Shell moderate in size, spire elevated. Three nuclear whorls, of which the first two are smooth and noticeably flattened, the last faintly ornamented and convexly rounded; nucleus ending at strong rib-like varix. Six post-nuclear whorls in the adult, convex, with impressed suture. Ornamentation of the early whorls consists of 11 equal axial nodes crossed by four to five spiral threads. On the fourth to fifth post-nuclear whorls three of the axial nodes increase gradually in size, becoming varices on the fifth whorl, with the others forming weak intervarical nodes, one or two between each pair of varices. Spiral ornamentation consists of five primary threads with one intercalated secondary on the

medial portion of the shell, and with two additional tertiary threadlets on the adult whorls only; 13 primary threads on the body whorl and pillar. Where the primary spiral threads cross the varices, small open spinelets are produced on the apertural side of the varix; these spinelets are better developed on the anterior portion of the varix, and especially on the extended siphonal canal where two fairly long spines occur. Aperture subcircular, labium smooth, somewhat appressed, with posterior anal notch. Outer lip crenulated with eight to ten denticles. Siphonal canal short, broad, recurved at anterior end." (Vokes, 1963)

Dimensions of holotype: height 22.5 mm, diameter 12 mm.

Holotype: USNM 644375.

Type locality: TU 60, Jackson Bluff, Ochlockonee River, Leon County, Florida.

Occurrence: Choctawhatchee Formation, Florida; upper Miocene.

Figured specimen: USNM 644375 (holotype).

Discussion: This rare species, known only from the type locality, seems to represent an evolutionary "dead-end." It has no known descendants and, although it occurs with a species of the *C. pomum* complex, it is not closely related to that line. The trend to a lesser number of embryonic whorls mentioned in the introduction is also apparent in this line. *C. infrequens*, the presumed ancestor of *C. riparius* retains the ancestral type of nucleus with four, smooth, conical whorls. The nucleus of *C. riparius* is more like that of the *C. pomum* complex in overall shape but is unique in having distinct ornamentation of the last embryonic whorl. The nuclear whorls of the Muricinae in general are all notably smooth until terminated by a small varix marking the initiation of ornamentation, both axial and spiral.

CHICOREUS (PHYLLONOTUS)

LEONENSIS E. H. Vokes, n. sp.

Plate 6, figs. 1, 2

Murex pomum Gmelin. MANSFIELD, 1930, Florida Geol. Surv., Bull. 3, p. 83, pl. 11, fig. 9 (not of Gmelin).

Murex pomum Gmelin. STUBBS, 1940, Jour. Paleontology, v. 14, no. 5, p. 512 (in part, not of Gmelin).

Diagnosis: Nuclear whorls unknown; seven post-nuclear whorls in the adult. Earliest post-nuclear whorls ornamented by about 12 equal axial nodes; on the fourth to fifth whorl every fourth node enlarged to form a small varix, three to a complete turn, gradually increasing in size with each successive varix. Other axial nodes remaining to form three small equal inter-

varical ridges between each pair of varices. Varices relatively smooth on the apertural side and slightly recurved backwards; no spinose processes developed except on the siphonal canal. Varices buttressed on the back side by raised ridges formed by the primary spiral ribs. Spiral ornamentation on earliest whorls consisting of three strong ribs with three secondary threads intercalated on about the fourth whorl; on the fifth whorl tertiary threadlets also appearing. On the body whorl primary and secondary ribs are difficult to distinguish with ten to 12 strong ribs and numerous smaller threadlets between each pair of the stronger ribs. Spiral ornamentation crossed by myriad fine axial growth lines giving a shagreened surface texture.

Siphonal canal broad, recurved, and bearing two rows of small open spines on the anterior prolongation of the varices. Outer lip extended in advance of the varix and marked internally by ten to 12 denticulations corresponding to the strong spiral ribs of the outer surface. Inner lip bearing about five denticulations on the anterior portion, corresponding to the underlying spiral ribs. Parietal lip imperfectly preserved but almost certainly large and flaring in the adult.

Dimensions of holotype: height 79 mm, diameter (incomplete) 40 mm.

Holotype: USNM 370189.

Type locality: Harvey's Creek, one half mile above abandoned mill, Leon County, Florida.

Occurrence: Choctawhatchee Formation, upper Miocene.

Figured specimens: Fig. 1, USNM 370189 (holotype). Fig. 2, USNM 645426 (paratype); height 19.5 mm, diameter 11 mm; locality TU 60.

Discussion: The specimen Mansfield figured as "*Murex pomum*" from the Choctawhatchee Formation of northern Florida is not that species but is a new form. Although closely related to *C. pomum* it may be distinguished by the presence of three small equal intervarical nodes instead of the one or two of *C. pomum* and by the complete absence of any spinose processes on the varices of *C. leonensis* even at an early stage. Small specimens of *C. pomum* usually have open spines on the varices of the juvenile shells although these gradually disappear until the adult shell is virtually spineless except on the siphonal canal. In *C. leonensis* the varices are almost smooth on the apertural face and recurved backward in a manner not seen in *C. pomum*.

C. pomum is not known from the upper Miocene in Florida. It first appears in the

Pliocene Caloosahatchee Formation. *C. pomum* is presumed to be a descendant of the other upper Miocene species, *C. globosus* (Emmons), and *C. leonensis* is probably a distinct evolutionary side line that led nowhere. It is a rare form, the above description being a composite of the three known specimens. One of these is the holotype, which came from a locality no longer accessible on Harvey's Creek, a few miles from the better known locality at Jackson Bluff on the Ochlockonee River, Leon County, Florida (TU 60). The Tulane Geological Collection contains one juvenile specimen (the paratype) and the terminal varix of a third specimen which would have been larger than the holotype.

CHICOREUS (PHYLLONOTUS)

GLOBOSUS (Emmons)

Plate 4, figs 1-3;

Plate 5, figs 1-3

- Murex globosa* EMMONS, 1858, Rept. North Carolina Geol. Surv., p. 247, fig. 105 A.
- Murex globosus* EMMONS, CONRAD, 1863, Acad. Nat. Sci. Phila., Proc. for 1862, [v. 14], p. 560.
- Not *Murex globosus* KOCH and WEICHMANN, 1872, Arch. Ver. Naturgesch. Mecklenburg, p. 12, pl. 1, fig. 3 (= *Murex paucispinatus* Roth v. Telegd, *vide* Tembroek, 1963, p. 309).
- Murex (Phyllonotus) pomum* Gmelin, DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 142 (in part, *not* of Gmelin).
- Murex pomum* Gmelin, DALL, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1600 (not of Gmelin).
- Murex (Phyllonotus) pomum* Gmelin, WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 290 (in part, *not* of Gmelin).
- Murex globosa* EMMONS, MANSFIELD, 1930, Florida Geol. Surv., Bull. 3, p. 83.
- Murex (Phyllonotus) pomum* Gmelin, CLENCH and PÉREZ FARFANTE, 1945, *Johnsonia*, v. 1, no. 17, p. 26 (in part, *not* of Gmelin).
- Murex (Phyllonotus) pomum* Gmelin, GARDNER, 1948, U. S. Geol. Surv. Prof. Paper 199-B, p. 219, pl. 29, fig. 22, 24 (*not* of Gmelin, except for synonymy which is for *M. pomum* in part).
- Murex (Phyllonotus) pomum* Gmelin, OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 234, pl. 34, fig. 1 (*not* of Gmelin, except for synonymy which is for *M. pomum* in part).
- Murex (Phyllonotus) pomum* Gmelin, DUBAR, 1958, Florida Geol. Surv., Bull. 40, p. 197 (in part, *not* of Gmelin).
- [*Chicoreus (Phyllonotus)*] *globosus* (Em-

mons). E. H. VOKES, 1964, *Malacologia*, v. 2, no. 1, p. 10.

Phyllonotus globosus (Emmons). OLSSON and PETIT, 1964, *Bulls. Amer. Paleontology*, v. 47, no. 217, p. 549, pl. 82, fig. 2.

Diagnosis: "Shell rather globose, or obtusely fusiform, and with four principal varices; intermediate ones irregular and spirally, traversed by many angular ridges, body whirl inflated, aperture oval, peristome continuous, and extending posteriorly on the body whirl, forming an angulated canal; outer lip ridged within and crenulated on the margin; columella lip ridged, and one ridge at the posterior angle; beak reflexed. Miocene of the Cape Fear River." (Emmons, 1858)

Dimensions of holotype: Approximately 5 inches (Emmons, 1858, p. 248).

Holotype: Not found.

Type locality: Cape Fear River (probably Neills Eddy Landing), Columbus County, North Carolina.

Occurrence: Pinecrest Beds, Florida; upper Miocene. Waccamaw Formation, North and South Carolina; Caloosahatchee Formation, Florida; Pliocene.

Figured specimens: Fig. 1, USNM 645419; height 77.5 mm, diameter 41 mm; locality TU 726. Fig. 2, USNM 645420; height 21 mm, diameter 12 mm; locality TU 519. Fig. 3, USNM 645421; height 135 mm, diameter (excluding spines) 81 mm; locality TU 523. Other occurrences: TU locality nos. 68, 79, 202, 203, 283, 520, 521, 527, 529b, 531, 532, 535, 536, 539b, 541, 558, 728, 729, 730, 736, 739, 741, 752, 756, 767, 768, 769, 770, 797, 802, 816, 870.

Discussion: In the upper Miocene beds of southern Florida there appears a species of *Phyllonotus* which is unlike anything that preceded it. This species is large, elaborately frondose, and has a strongly flaring parietal lip. Although named over one hundred years ago by Emmons it was not recognized by modern workers until 1964 when Olsson and Petit (1964, p. 549) and the writer (Vokes, 1964, p. 10) pointed out that the form was different from *C. pomum*, with which species it had been consistently confused. *C. globosus* is known only from southern Florida in the upper Miocene but by Pliocene time had spread as far north as North Carolina. During this same period of expansion the species seems also to have moved southward and westward through the Isthmian passage to give rise to the Recent species of *Phyllonotus* found on the West Coast of tropical America. The Recent *C. (Phyllonotus) erythrostomus* (Swainson) is almost identical with Miocene specimens of *C. globosus*, the only discernible difference

being that *C. globosus* has three to four varices and *C. erythrostomus* has four to five varices. *C. regius* goes one step farther and has six to seven varices but otherwise is still very much like the other two species. One small genetic "quirk" which appears in all three species is a twist in the upper spine on the siphonal canal, suggesting that the West Coast species are even more closely related to the ancestral form than are the western Atlantic species such as *C. pomum* and *C. margaritensis*.

C. globosus occurs in the Pliocene Caloosahatchee Formation together with the descendant form, *C. pomum*. These two species have been combined by all workers, but they may be readily distinguished. *C. globosus* is a more elongated, lighter shell. The two specimens here figured (pls. 4 and 5, figs. 1 and 4) are shells of approximately the same dimensions but the specimen of *C. globosus* weighs 18 grams and that of *C. pomum* weighs 44 grams. Both specimens, it should be noted, are from the same locality. In addition the two species may be differentiated by the more inflated whorls and longer spines of *C. globosus*, the larger size attained by that species, and the development of the varices at a later stage in *C. globosus* (fourth post-nuclear whorl) than in *C. pomum* (third post-nuclear whorl).

In the collections of the Museum of Paleontology, University of California, Berkeley, there are several broken specimens from the Imperial Formation of southern California that seem to be referable to *C. globosus*. Unfortunately all are too incomplete for absolute identification. The Caribbean affinities of the Imperial Formation have been noted by several authors. Durham (1950, p. 30-33) summarized previous work on the Imperial Formation and came to the conclusion that the beds are lower Pliocene in age. He added: "The relationship between the Florida Pliocene and the Imperial Formation appears to be one of similar facies and possibly of common ancestry for certain species." (1950, p. 34).

CHICOREUS (PHYLLONOTUS)

POMUM (Gmelin)

Plate 4, figs. 4-5;

Plate 5, figs. 4-5

Murex pomum GMELIN, 1791, *Systema Naturae*, ed. 13, v. 1, pt. 6, p. 3527.

Murex asperimus LAMARCK, 1822, *Anim. s. Vertèbres*, v. 7, p. 164.

- Murex mexicanus* PETIT, 1852, Journ. de Conchyl., v. 3, p. 51, pl. 2, fig. 9.
- Murex pomiformis* "Martini" MÖRCH, 1852, Cat. Conch. Yoldi, p. 96.
- Murex (Phyllonotus) pomum* Gmelin. DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 142 (= *C. globosus* (Emmons) in part).
- Murex pomum* Gmelin. BROWN and PILSBRY, 1913, Acad. Nat. Sci. Phila., Proc., v. 65, p. 495.
- Not *Murex pomum* Gmelin. PILSBRY and BROWN, 1917, Acad. Nat. Sci. Phila., Proc., v. 69, p. 34 (= *C. dujardinioides* Vokes).
- Murex (Phyllonotus) pomum* Gmelin. MAURY, 1922, Bulls. Amer. Paleontology, v. 9, no. 38, p. 96.
- Murex (Phyllonotus) pomum* Gmelin. WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 290, pl. 17, fig. 9.
- Not *Murex pomum* Gmelin. MANSFIELD, 1930, Florida Geol. Surv., Bull. 3, p. 83, pl. 11, fig. 9 (= *C. leonensis* Vokes, n. sp.)
- Murex pomum* Gmelin. RICHARDS, 1935, Jour. Paleontology, v. 9, p. 257; RICHARDS, 1938, Geol. Soc. Amer., Bull., v. 49, p. 1293.
- Murex pomum* Gmelin. STUBBS, 1940, Jour. Paleontology, v. 14, p. 512 (= *C. leonensis* Vokes, n. sp., in part).
- Murex (Phyllonotus) pomum* Gmelin. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 26, pl. 14, figs. 1-4 (not including references to *M. imperialis* Swainson, *M. oculatus* Reeve, nor *M. globosus* Emmons).
- Murex (Phyllonotus) pomum* Gmelin. GARDNER, 1948, U. S. Geol. Surv. Prof. Paper 199-B, p. 219 (in part), not pl. 29, figs. 22, 24 (= *C. globosus*).
- Murex (Phyllonotus) pomum* Gmelin. OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Mon. 8, p. 234 (in part), not pl. 34, fig. 1 (= *C. globosus*).
- Not *Murex pomum* Gmelin. ROWETT, 1957, Gulf Coast Assoc. Geol. Soc., Trans., v. 7, p. 154 (= *Hexaplex fulvescens*).
- Murex (Phyllonotus) pomum* Gmelin. DUBAR, 1958, Florida Geol. Surv., Bull. 40, p. 196 (= *C. globosus* in part).
- Murex (Phyllonotus) pomum* Gmelin. WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 285, pl. 26, figs. 1, 2.
- Murex pomum* Gmelin. RICHARDS, 1962, Amer. Phil. Soc., Trans., v. 52, pt. 3, p. 80.
- [*Chicoreus (Phyllonotus)*] *pomum* (Gmelin). E. H. VOKES, 1964, Malacologia, v. 2, no. 1, p. 10.
- Diagnosis*: "M. testa ovata nodosa; varicibus tribus ad septem, cauda latiore.

PLATE 1

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1. (X 3) PRI 26431 (holotype); height 14.5 mm, diameter 10 mm. Locality: Unknown. (?) Mint Springs Marl, middle Oligocene.	
2. (X 2) USNM 645646; height 17 mm, diameter 10 mm. Locality: TU 76. Mint Springs Marl, middle Oligocene.	
3. (X 2) " <i>Murex migus</i> " de Gregorio. From de Gregorio, 1890, pl. 7, fig. 30a, 30b.	
4. (X 4) " <i>Murex migus</i> " de Gregorio. From de Gregorio, 1890, pl. 7, fig. 33.	
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8-9. <i>Chicoreus (Phyllonotus) dormani</i> (E. H. Vokes) (X 2)	139
8. USNM 644373 (holotype); height 2.2 mm, diameter 14.8 mm. Locality: Vicksburg, Mississippi. Byram Marl, middle Oligocene.	
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10. <i>Chicoreus (Phyllonotus) infrequens</i> (E. H. Vokes) (X 1½)	143
USNM 644374 (holotype); height 36 mm, diameter 19 mm. Locality: TU 458. Chipola Fm., (?) lower Miocene.	

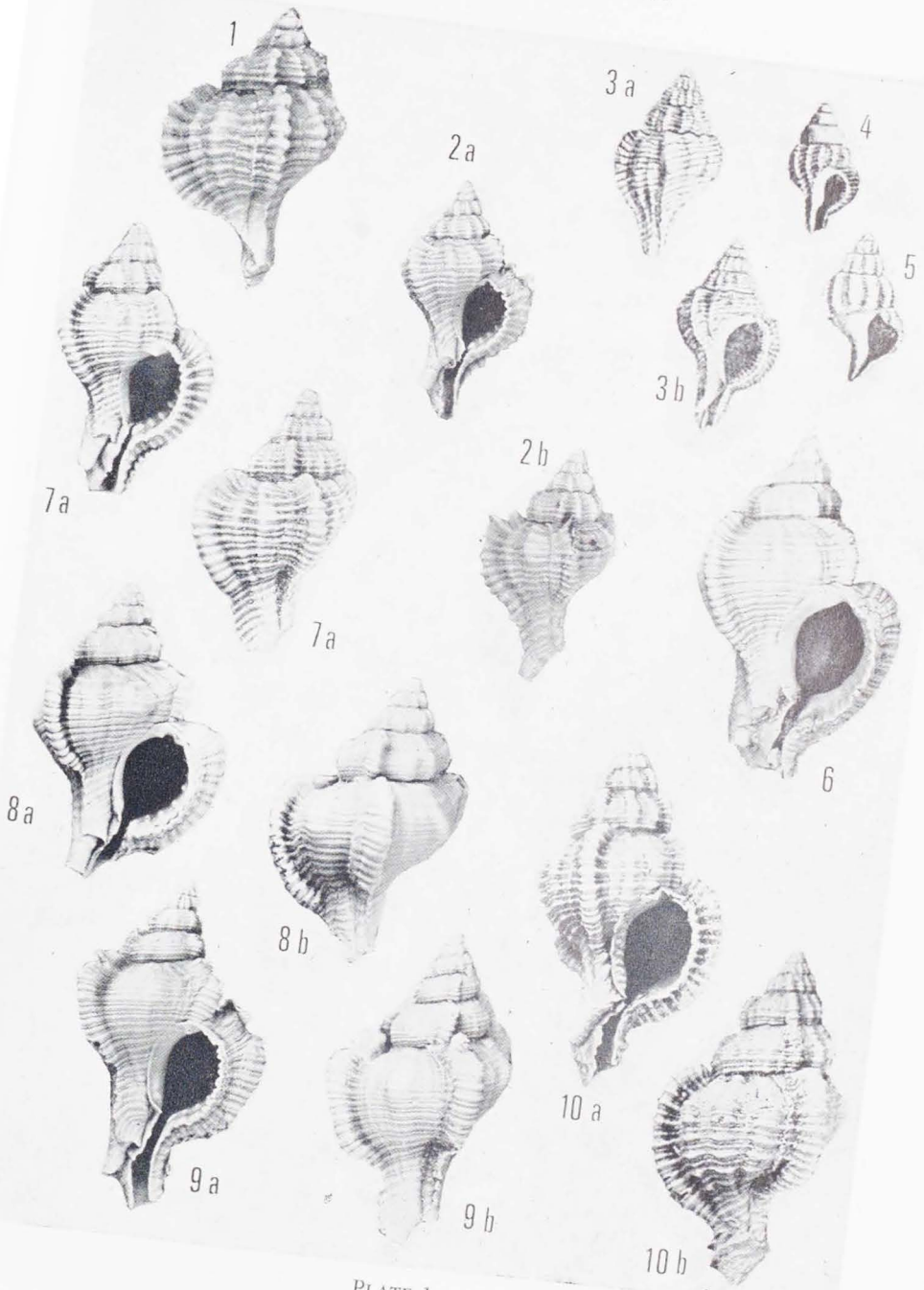


PLATE 1

"Habitat in mari, Africam occidentalem alluente, testa ponderosa, trunculo affinis." (Gmelin, 1791).

"Type figure:" Martini, 1777, *Conchylien-Cabinet*, v. 3, pl. 109, fig. 1023 (here designated).

Type locality: St. Thomas, Virgin Islands (designated by Clench and Pérez Farfante, 1945, p. 27).

Occurrence: Bowden Formation, Jamaica; (?) upper Miocene or Pliocene, Mare Formation, Venezuela; Caloosahatchee Formation, Florida; Pliocene. Unnamed post-Caloosahatchee formation, Florida; Pleistocene. Fort Thompson Formation, Florida; unnamed formations in Panama, Cuba, South Carolina and Louisiana; late Pleistocene. Recent, western Atlantic from Cape Hatteras, North Carolina, to Brazil, including entire Gulf of Mexico and Caribbean Sea.

Figured specimens: Fig. 4, USNM 645422; height 76.5 mm, diameter 48 mm; locality TU 726. Fig. 5, USNM 645423; height 22 mm, diameter 12 mm; locality TU 519. Other occurrences: TU locality nos. 79, 201, 202, 203, 206, 529a, 529b, 539a, 540, 580, 583, 725, 727, 732, 733, 737, 738, 739,

743, 746, 747, 748, 749, 750, 751, 755, 759 (1500 specimens), 767, 768, 788, 793, 803, 816.

Discussion: *C. pomum* is the most abundant and widespread muricine species in the western Atlantic. In the Recent fauna it ranges from as far north as Cape Hatteras, North Carolina, to off the coast of Brazil. The depth range is shallow, usually from 3 to 40 fathoms. Bullis (1964, p. 105) reported specimens from greater depths off the mouth of the Amazon River, noting that the depths, up to 80 fathoms, are "well beyond the bathymetric range formerly considered typical. This probably indicates salinity tolerances since the enormous river drainage along this entire coast must certainly lower salinities appreciably out to the vicinity of the 20 fathom curve."

As with most ubiquitous species *C. pomum* is quite variable and has had a number of other species placed in synonymy with

PLATE 2

Figures	Page
1. <i>Chicoreus (Phyllonotus) tritonopsis</i> (Heilprin) (X 1) USNM 21440 (topotype); height 45 mm, diameter 26 mm. Locality: Ballast Point, Tampa Bay, Florida. Tampa Limestone, lower Miocene.	141
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7-8. <i>Chicoreus (Phyllonotus) trophoniformis</i> (Heilprin) (X 2) 7. USNM 214737 (holotype- <i>Alectrion gardnerae</i> Dall); height (incomplete) 16 mm, diameter 12 mm. Locality: Ballast Point, Tampa Bay, Florida. Tampa Limestone, lower Miocene.	140
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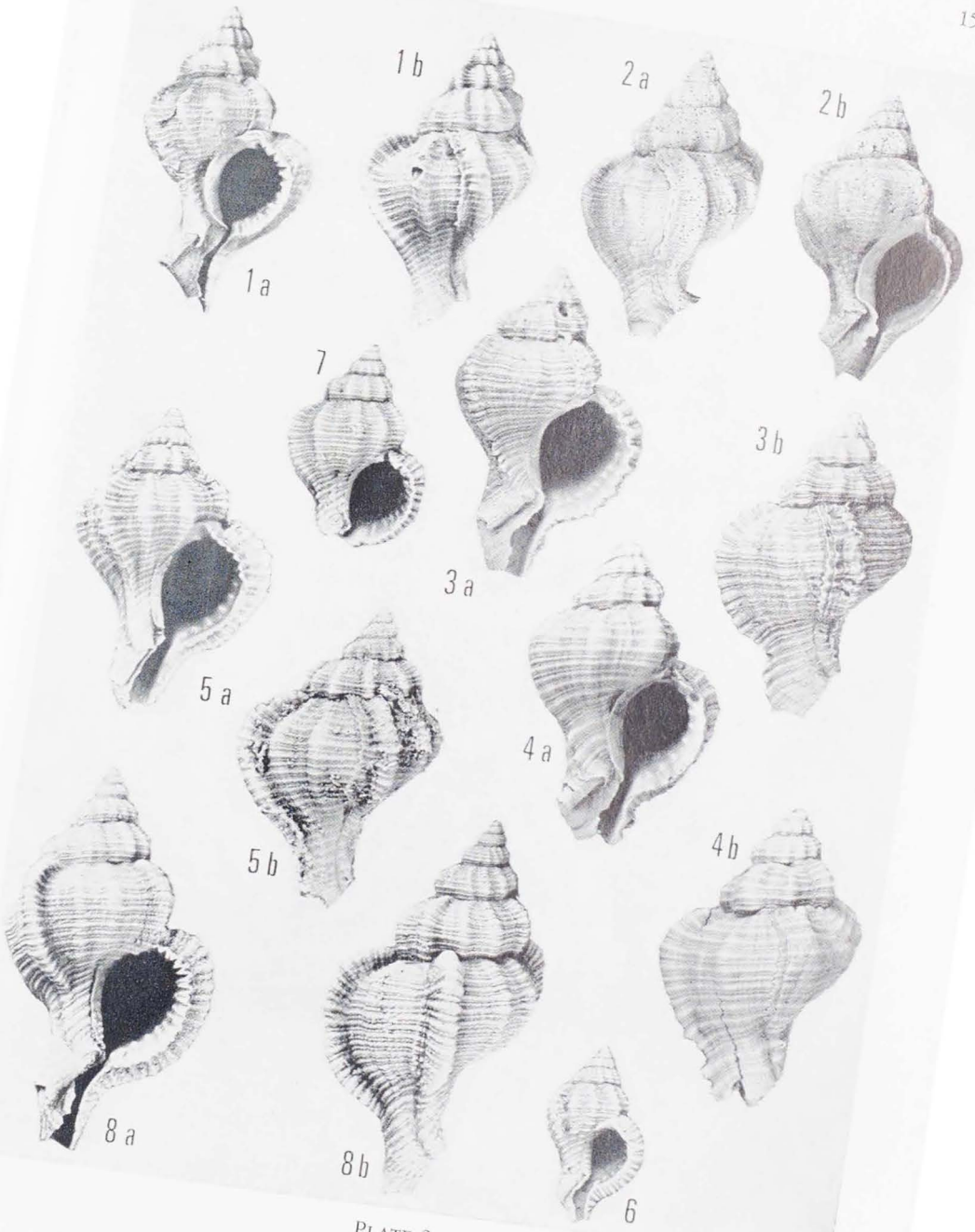


PLATE 2

it. Although some of these references are accepted by the writer some most definitely are not. *Murex asperrimus* Lamarck is based on certain of the same references in Martini (1777) cited by Gmelin and acts to restrict the polyspecific *Murex pomum* of Gmelin to the presently recognized form. *Murex pomiformis*, a name used by Martini in a non-binomial work (1777), was adopted by several later authors for the species. *Murex mexicanus* Petit is based on a variety found along the north Yucatán coast which is noticeably pink in color but otherwise indistinguishable from the typical *C. pomum*.

Of the species invalidly placed in synonymy with *C. pomum*, *C. margaritensis* (Abbott) has been discussed by Abbott (1958, p. 11), Clench (1959, p. 333), and the writer (Vokes, 1964, p. 10). In the present paper it is discussed further and the reasons for accepting it as a valid form are cited. A second species, *C. globosus* (Emmons), has also until recently been synonymized with *C. pomum* but Olsson and Petit (1964, p. 549) and the writer (Vokes, 1964, p. 10) have both indicated its identity as a valid taxon. A third species, *C. oculus* (Reeve) has not been recognized by modern workers. The species was named without locality and although Reeve insisted that it was possible to distinguish the new species "at a glance from any variety of the *Murex pomum*" (1845, pl. 9, expl.) it has been consistently referred to *C. pomum*. But the writer is of the opinion that *C. oculus* is indeed a valid species and the reader is

referred to the discussion of that species for further details.

With one exception *C. pomum* is not known before the Pliocene. That one exception is in the Bowden Formation of Jamaica. These beds were considered by Woodring (1928, p. 108) to be upper middle Miocene (Vindobonian) in age. Earlier (1922, p. 197) Olsson suggested that these beds were upper Miocene in age and later Palmer (1945, p. 8) observed that the Bowden foraminiferal fauna had a very modern aspect and that "the Choctawhatchee Miocene fauna of Florida is very closely related to that of the Bowden." In the Choctawhatchee Formation the species of *Phyllonotus* which is found is not *C. pomum*, but *C. leonensis* Vokes, n. sp., a related form. In southern Florida the upper Miocene species is *C. globosus*, and *C. pomum* does not appear until the Pliocene in the Caloosahatchee Formation. There are no authenticated reports of *C. pomum* from the Miocene, all upon investigation prove to be misidentifications. Therefore, it seems not unreasonable to suggest the Bowden may perhaps be Pliocene rather than upper Miocene in age. Eames (personal correspondence) has reached the same conclusion on the basis of the planktonic foraminifers. It is, of course, possible that *C. pomum* evolved in the warmer southern waters and moved into Florida with the advent of warmer Pliocene seas. But there is no record of this species in the Miocene beds of South or Central America.

PLATE 3

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1. <i>Chicoreus (Phyllonotus) foliododes</i> (Gardner) (X 1)..... USNM 644821; height 42 mm, diameter 24.8 mm. Locality: TU 554. Chipola Fm., (?) lower Miocene.	145
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3. <i>Chicoreus (Phyllonotus) margaritensis</i> (Abbott) (X 1)..... ANSP 35993 (topotype); height 100 mm, diameter 76 mm. Locality: Isla Margarita, Venezuela. Recent.	156
4. <i>Chicoreus (Phyllonotus) riparius</i> (E. H. Vokes) (X 2)..... USNM 644375 (holotype); height 22.5 mm, diameter 12 mm. Locality: TU 60. Choctawhatchee Fm., upper Miocene.	147

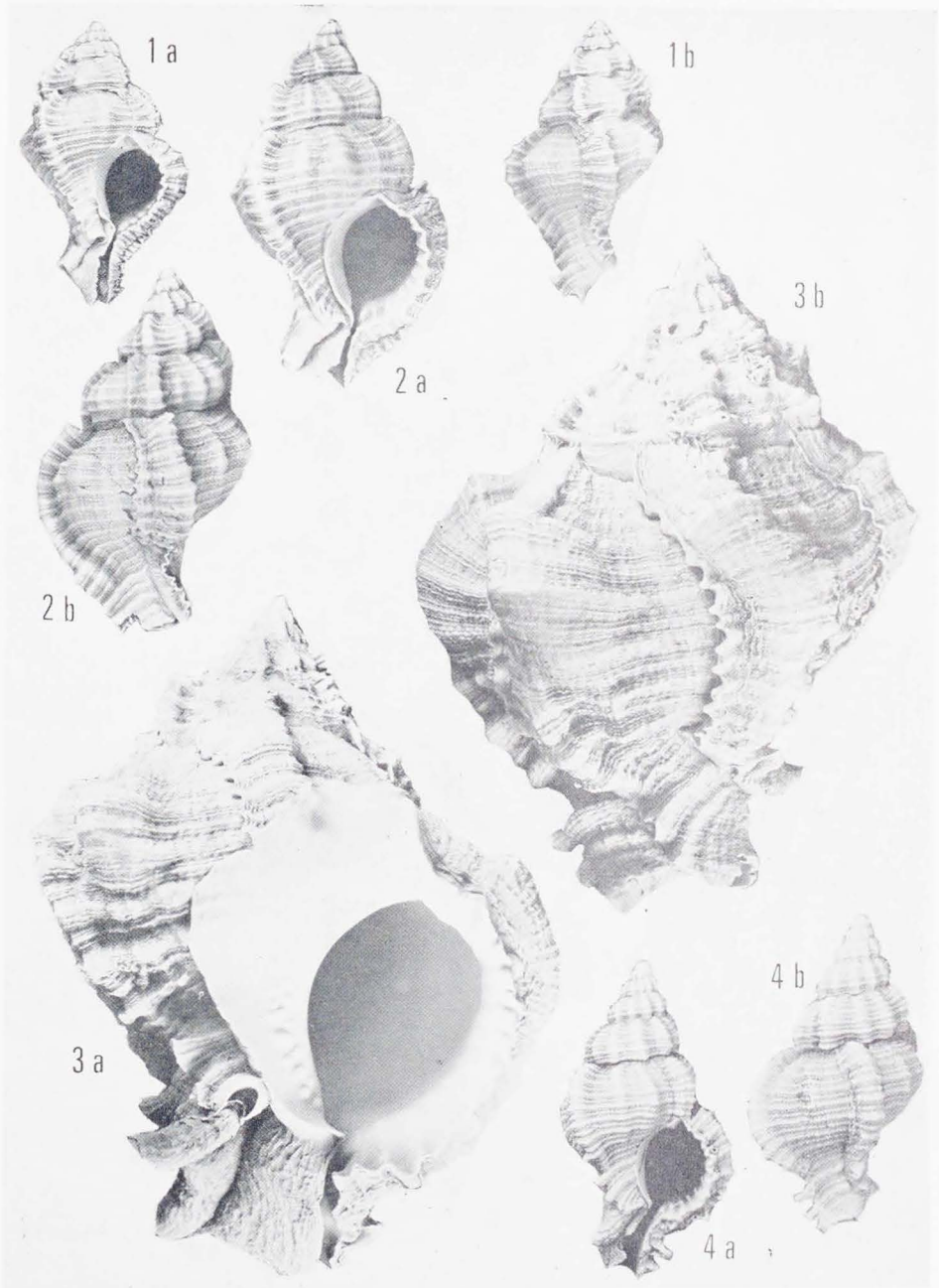


PLATE 3

CHICOREUS (PHYLLONOTUS)
MARGARITENSIS (Abbott)

Plate 3, figs. 3a, 3b

Murex imperialis SWAINSON, 1831, Zool. Illus., (Ser. 2) v. 2, pl. 67. *Non Murex imperialis* Fischer, 1807.

Murex (Phyllonotus) imperialis var. *a* SWAINSON, 1833, Zool. Illus., (Ser. 2) v. 3, pl. 109.

Murex (Phyllonotus) pomum Gmelin. CLENCH and PÉREZ FARFANTE, 1945, *Johnsonia*, v. 1, no. 17, p. 26 (in part, not of Gmelin).

Murex (Phyllonotus) margaritensis ABBOTT, 1958, *Acad. Nat. Sci. Phila.*, Mon. 11, p. 61, pl. 1, figs. n, o. New name for *M. imperialis* Swainson non Fischer.

Murex (Phyllonotus) pomum margaritensis Abbott. CLENCH, 1959, *Johnsonia*, v. 3, no. 39, p. 333, pl. 175, figs. 1, 2.

[*Chicoreus (Phyllonotus)*] *margaritensis* (Abbott). E. H. VOKES, 1964, *Malacologia*, v. 2, no. 1, p. 10.

Diagnosis: "Shell ponderous, with from four to five varices between the two lips; the varices simple, nodulous, and obtuse; intermediate, or false varices, none; aperture yellow, orange, or red; inner lip striated only at the base." (Swainson, 1831).

Holotype: Not found.

Type locality: "Island of Margarita," Venezuela.

Occurrence: Cumaná Formation, Venezuela; Pliocene. Recent, northern South America only.

Figured specimen: ANSP 35993 (topotype); height 100 mm, diameter 76 mm; locality, Isla Margarita, Venezuela.

Discussion: This elegant species has been the subject of much controversy in recent years. It was recognized by all of the early writers as a valid form and was figured as early as 1777 by Martini in the *Conchylien-*

Cabinet, v. 3, pl. 110, figs. 1024, 1025. However, when Gmelin named *Murex pomum* he included these Martini figures as well as those of true *pomum* with his description. Lamarck (1822, p. 164) may be considered the "first reviser" for he included only references to Martini's figures 1021-1023, which are *pomum*, and Gmelin's *Murex pomum* in the synonymy of his *Murex asperinus* (which for reasons unknown to the writer he felt necessary to give another name). He definitely stated that *Murex asperinus* (= *pomum*) had only three varices. Even Tryon (1880, p. 101) the most notorious "lumper" of modern times recognized the species as valid and noted: "This shell is generally attributed to the Pacific coast of North America, which appears to be a mistake. Its different zoological region taken in connection with its great solidity may serve to distinguish it from *M. bicolor* [= *M. erythrostromus* Swainson] and *M. regius*, both of which it mimics so closely in coloration." Both Reeve (1845, pl. 11) and Sowerby (1879, pl. 17) attributed a locality of "California" to this species, no doubt as Tryon correctly diagnosed, due to confusion with the common "pink-mouthed *Murex*," *C. (Phyllonotus) erythrostromus* (Swainson), of the Pacific coast. Reeve's reference to "Isabella Island, California" is probably Isla Isabela, just south of Mazatlán, Mexico. Kiener (1843, p. 70) came somewhat closer stating, "Habitat la mer Pacifique, les cotes de l'île Marguerite."

Clench and Pérez Farfante (1945, p. 26) placed *M. imperialis* Swainson, 1831 (the yellow-apertured form), in synonymy with

PLATE 4

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| 1-3. <i>Chicoreus (Phyllonotus) globosus</i> (Emmons) | 148 |
| 1. (X 1) USNM 645419; height 77.5 mm, diameter 41 mm.
Locality: TU 726. Caloosahatchee Fm., Pliocene. | |
| 2. (X 2) USNM 645420; height 21 mm, diameter 12 mm.
Locality: TU 519. Caloosahatchee Fm., Pliocene. | |
| 3. (X 1) USNM 645421; height 135 mm, diameter 81 mm.
Locality: TU 523. Pinecrest Beds, upper Miocene. | |
| 4-5. <i>Chicoreus (Phyllonotus) pomum</i> (Gmelin) | 149 |
| 4. (X 1) USNM 645422; height 76.5 mm, diameter 48 mm.
Locality: TU 726. Caloosahatchee Fm., Pliocene. | |
| 5. (X 2) USNM 645423; height 22 mm, diameter 12 mm.
Locality: TU 519. Caloosahatchee Fm., Pliocene. | |



PLATE 4

Murex pomum but excluded *M. imperialis* var. *a* Swainson, 1833 (the pink-apertured form) They did not discuss this disposition of the two forms but noted that the specimens of *M. pomum* from Trinidad have "a decidedly pinkish cast in the aperture" (1945, p. 27).

Abbott (1958, p. 61) was the first to point out that the name *Murex imperialis* Swainson was preoccupied by that of Fischer. He renamed the species and gave an excellent discussion of the differences between this form and the more widespread *Murex pomum*. Clench (1959, p. 333) declared that other than the deep pink color of the aperture there was no consistent difference between the two forms and reduced *margaritensis* to a subspecies of *Murex pomum*.

The present writer was undecided (1964, p. 10) about the exact status of the species until she found, in the collections of the Museum of Paleontology, University of California, Berkeley, numerous specimens of undeniable *C. margaritensis* from the Cumaná Formation of northern Venezuela. The age of the Cumaná Formation is now considered to be Pliocene (Bermudez, 1966). Some of the specimens of *C. margaritensis* come from the long known fossil beds near Cumaná, in the state of Sucre, Venezuela, and others come from the Island of Cubagua, a Federal Dependency located between the Island of Margarita and the state of Sucre on the mainland.

The discovery of the fossil specimens of *C. margaritensis* indicates that this species is at least as old as *C. pomum* and has maintained its identity in a local area through

geologic time. In light of this history of separation it does not seem reasonable to place the two species together. Both are probably descended from the common ancestor, *C. globosus*, which also gave rise to the Pacific coast species *C. erythrostomus* and *C. regius*, thus explaining the similarity of all four forms. Olsson and Petit (1964, p. 549) suggested that *C. globosus* was more closely related to *C. margaritensis* than to *C. pomum* and that some of the fossil specimens of *C. globosus* "are so similar to the Recent species [*C. margaritensis*] as to warrant the use of the same name." The writer cannot agree with this latter statement for the specimens of *C. globosus* are higher spired and in general a lighter and more graceful shell. In addition, they usually bear foliaceous open spines on the varices and these are never present in *C. margaritensis*.

CHICOREUS (PHYLLONOTUS)
OCULATUS (Reeve)

Plate 6, figs. 3a, 3b

Murex oculatus REEVE, 1845, Conch. Icon., v. 3, *Murex*, pl. 9, fig. 36; REEVE, 1846, Zool. Soc. London, Proc., pt. 13 (1845), p. 86.

Murex (Phyllonotus) pomum Gmelin. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 26 (in part, not of Gmelin).

Diagnosis: "Shell fusiformly oblong, rather thick, slightly scabrous throughout, transversely ridged and striated, with two tubercles between the varices; three-varicose, varices tuberculated with short rather complicated lamellae; whitish, stained with reddish brown, varices painted alternately with square red spots, columella reddish yellow, interior of the aperture white, lip

PLATE 5

Figures

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| 1-3. <i>Chicoreus (Phyllonotus) globosus</i> (Emmons) | 148 |
| 1. (X 1) USNM 645419; height 77.5 mm, diameter 41 mm.
Locality: TU 726. Caloosahatchee Fm., Pliocene. | |
| 2. (X 2) USNM 645420; height 21 mm, diameter 12 mm.
Locality: TU 519. Caloosahatchee Fm., Pliocene. | |
| 3. (X 1) USNM 645421; height 135 mm, diameter 81 mm.
Locality: TU 523. Pinecrest Beds, upper Miocene. | |
| 4-5. <i>Chicoreus (Phyllonotus) pomum</i> (Gmelin) | 149 |
| 4. (X 1) USNM 645422; height 76.5 mm, diameter 48 mm.
Locality: TU 726. Caloosahatchee Fm., Pliocene. | |
| 5. (X 2) USNM 645423; height 22 mm, diameter 12 mm.
Locality: TU 519. Caloosahatchee Fm., Pliocene. | |



PLATE 5

spotted with black-brown, especially at the upper part, apex red, canal rather short, recurved." (Reeve, 1845).

Dimensions of lectotype: height 80 mm, diameter 47 mm.

Lectotype: BMNH.

Type locality: Dominica, B.W.I. (here designated).

Occurrence: Recent only, Caribbean and Gulf of Mexico.

Figured specimen: USNM 602926; height 97 mm, diameter 58 mm; locality, Dominica, B.W.I., 5 to 10 fathoms.

Discussion: Although this species has been synonymized by some authors with *C. pomum* the two forms are distinct. *C. oculatus* is marked by a peculiar type of spiral ornamentation which consists of about a dozen small spiral cords. Where these cords cross the varices scabrous open spinelets are formed and behind the varices these cords form odd buttress-like structures. Between the varices, where these cords are crossed by the axial growth lines, these lines are "bent" backward to form a series of loops. The intervarical nodes are also buttressed on the back side in the same manner as the varices. The overall color of the shell is lighter than *C. pomum* and the species on the whole seems more closely related to the West Coast *C. peratus* (Keen) than to *C. pomum*.

As Reeve named his species without a locality, Dominica, B.W.I., the locality of the specimen here figured is designated as the type locality. This specimen was selected because it very nearly matches the dimensions of the lectotype, but the species attains a much larger size. One specimen from Key West, Florida, in the collection of the writer measures 130 mm in height.

V. NOTES ON THE WEST COAST SPECIES OF *PHYLLONOTUS*

As has been noted in the previous section of this paper there are two species of *Phyllonotus* from the West Coast of tropical America which are clearly descended from the upper Miocene *C. globosus*. A third species, *C. peratus* (Keen), is more closely related to *C. pomum* and *C. oculatus*. However, a fourth species, "*Murex*" *brassica* Lamarck, bears every evidence of being a hybrid between *Phyllonotus* and *Hexaplex*. In coloration it most closely matches the West Africa species *Hexaplex rosarium* (Röding) and *H. duplex* (Röding) (the "*Murex saxatilis*" of authors, not of Linnaeus) but bears no resemblance to the Recent West American species of *Hexaplex* such as *H. radix* (Gmelin) and *H. nigritus* (Philippi), the species referred to the genus "*Muricanthus*" by Keen and other West Coast workers. In shell form it more nearly matches the species of *Phyllonotus*, having a strong labrum formed in advance of the varix. But, it has closed spines unlike either group. The writer is of the opinion that the West African species of *Hexaplex* gave rise to the West American species of *Hexaplex* via northern South America during the late Miocene. Inasmuch as *Phyllonotus* is thought originally to have been derived from a *Hexaplex* ancestor, perhaps this is a case of phylogenetic history repeating itself. It would appear that "*Murex*" *brassica* is intermediate between *Hexaplex* and *Phyllonotus* representing a more primitive line of development. In view of the stronger morphological resemblance to *Phyllonotus* than to *Hexaplex* it is here somewhat reluctantly placed in the subgenus *Phyllonotus*.

PLATE 6

Figures

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| 1-2. <i>Chicoreus (Phyllonotus) leonensis</i> E. H. Vokes, n. sp. | 147 |
| 1. (X 1) USNM 370189 (holotype); height 79 mm, diameter (incomplete) 40 mm.
Locality: Harvey's Creek, Leon County, Florida. Choctawhatchee Fm., upper Miocene. | |
| 2. (X 2) USNM 645426 (paratype); height 19.5 mm, diameter 11 mm.
Locality: TU 60. Choctawhatchee Fm., upper Miocene. | |
| 3. <i>Chicoreus (Phyllonotus) oculatus</i> (Reeve) (X 1) | 158 |
| USNM 602926; height 97 mm, diameter 58 mm.
Locality: Dominica, B.W.I. Recent. | |

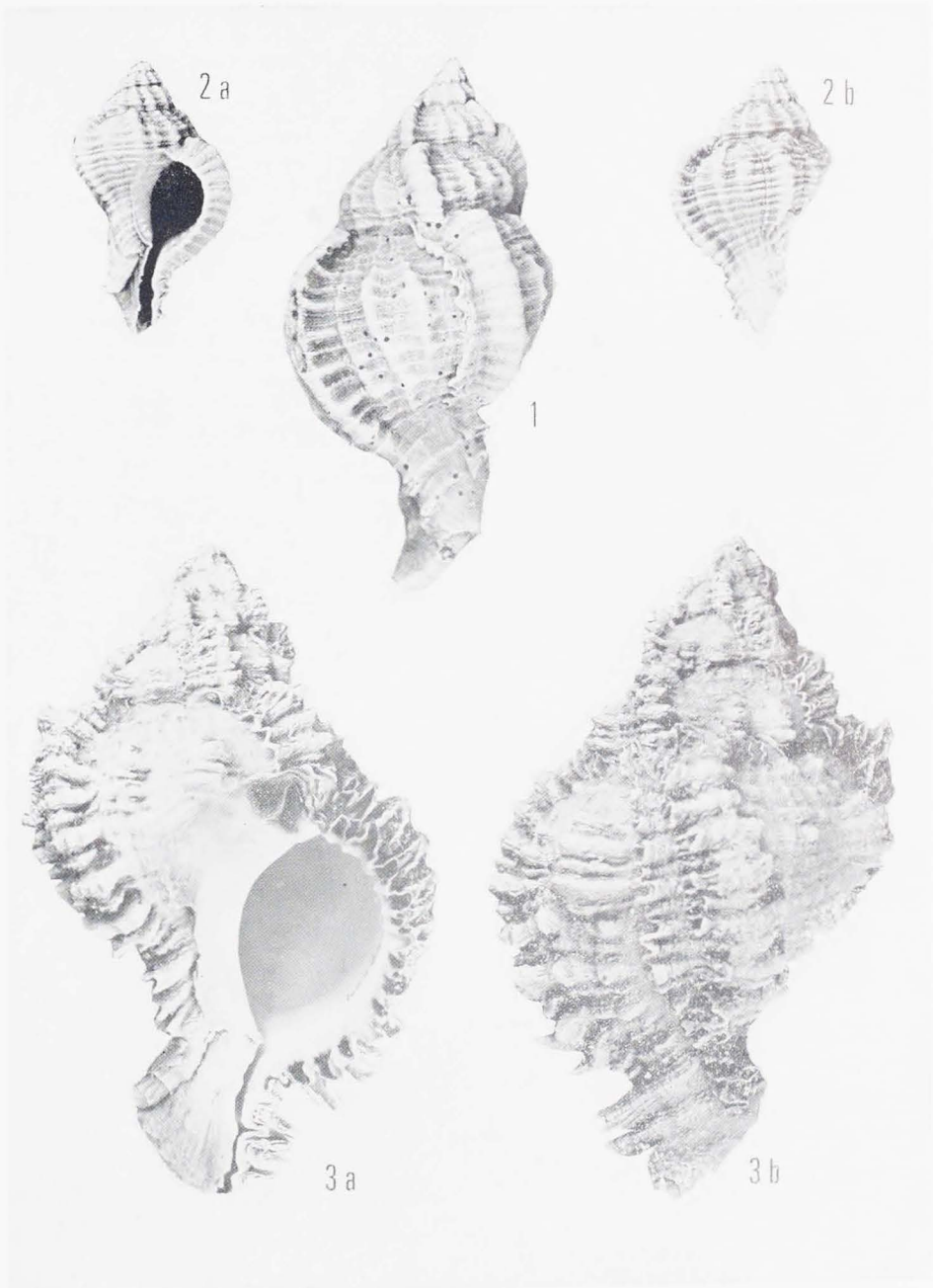


PLATE 6

VI. LOCALITY DATA

The following are Tulane University locality numbers:

60. Choctawhatchee Fm., borrow pits at Jackson Bluff, Ochlockonee River, (NW $\frac{1}{4}$ Sec. 21, T1S, R4W), Leon Co., Florida.
66. Byram Marl, type locality, west bank of Pearl River, at Byram, Hinds Co., Mississippi.
68. Caloosahatchee Fm., North St. Petersburg, 70th Ave. at 9th St. N., Pinellas Co., Florida.
69. Shoal River Fm., type locality, Shell Bluff, Shoal River, (NW $\frac{1}{4}$ Sec. 4, T3N, R21W), about $3\frac{1}{2}$ miles north of Mossyhead, Walton Co., Florida.
- 69A. Shoal River Fm., first ravine upstream from Shell Bluff, Shoal River, (NW $\frac{1}{4}$ Sec. 4, T3N, R 21W), about $3\frac{1}{2}$ miles north of Mossyhead, Walton Co., Florida.
- 69B. Shoal River Fm., ravine just to east of locality 69A, just east of Shell Bluff, Shoal River, (NW $\frac{1}{4}$ Sec. 4, T3N, R21W), about $3\frac{1}{2}$ miles north of Mossyhead, Walton Co., Florida.
70. Chipola Fm., Ten Mile Creek, at bridge of Florida Highway 73, (NW $\frac{1}{4}$ Sec. 12, T1N, R10W), Calhoun Co., Florida.
76. Mint Springs Marl, type locality, Mint Springs Bayou, just off U. S. Highway 61 (Business) at Vicksburg Natl. Military Cemetery, Vicksburg, Warren Co., Mississippi.
78. Gosport Sand, Claiborne Bluff, east bank of Alabama River, south of bridge of U. S. Highway 84, Monroe Co., Alabama.
79. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, spoil banks north and south sides of Caloosahatchee River, at Ortona Lock, (Sec. 27, T42S, R30E), Glades Co., Florida.
85. Wautubbee Fm., roadcut on county road four miles northeast of Rose Hill, Jasper Co., Mississippi.
196. Chipola Fm., Ten Mile Creek, about $\frac{1}{4}$ mile upstream from bridge of Florida Highway 73, (NE $\frac{1}{4}$ Sec. 11, T1N, R10W), Calhoun Co., Florida.
201. Unnamed post-Caloosahatchee formation, pit just south of Belle Glade, Palm Beach Co., Florida.
202. Caloosahatchee Fm., south bank of Caloosahatchee River, about two miles west of LaBelle, (SE $\frac{1}{4}$ Sec. 12, T43S, R28E), Hendry Co., Florida.
203. Caloosahatchee Fm., north bank of Caloosahatchee River, about two miles east of Fort Denaud, (SW $\frac{1}{4}$ Sec. 11, T43S, R28E), Hendry Co., Florida.
206. Pinecrest Beds and unnamed post-Caloosahatchee formation mixed, junction of U. S. Highway 27 and Florida Highway 78, just west of Moore Haven, Glades Co., Florida.
226. Red Bluff Clay, type locality, Red Bluff, Chickasawhay River about four miles south of Shubuta, Wayne Co., Mississippi.
283. Pinecrest Beds and unnamed post-Caloosahatchee formation mixed, spoil banks on cross canal 1.3 miles southwest of Port Charlotte Railroad Station (formerly Murdock), on Florida Highway 771, (Sec. 12, T40S, R21E), Charlotte Co., Florida.
334. Byram Marl, field on east side of U.S. Highway 61 (Business), about $\frac{1}{2}$ mile north of Vicksburg Natl. Military Cemetery, Vicksburg, Warren Co., Mississippi.
335. Byram Marl, roadcut on U. S. Highway 61 (Business), about one mile north of Vicksburg Natl. Military Cemetery, Vicksburg, Warren Co., Mississippi.
336. Byram Marl, above waterfall on small creek crossing U. S. Highway 61 (Business), about $1\frac{1}{2}$ miles north of Vicksburg Natl. Military Cemetery, Vicksburg, Warren Co., Mississippi.
453. Chipola Fm., Alum Bluff (lower beds), Apalachicola River, (NE $\frac{1}{4}$ Sec. 24, T1N, R8W), Liberty Co., Florida.
457. Chipola Fm., west bank of Chipola River, about $\frac{1}{2}$ mile below Ten Mile Creek, (SW $\frac{1}{4}$ Sec. 17, T1N, R9W), Calhoun Co., Florida. (Same as USGS 2213, 2564, and 3419, "One mile below Bailey's ferry.")
458. Chipola Fm., east bank of Chipola river, above Farley Creek, (SW $\frac{1}{4}$ Sec. 20, T1N, R9W), Calhoun Co., Florida.
519. Caloosahatchee Fm., Harney Pond Canal spoil banks, at Florida Highway 78, northwest side of Lake Okeechobee, (NW $\frac{1}{4}$ Sec. 18, T40S, R33E), Glades Co., Florida.
520. Pinecrest Beds, spoil banks, canal 0.9 miles east of Brighton on Florida Highway 70, (Sec. 25, T37S, R32E), Highlands Co., Florida. (Incorrectly given in previous papers as " $\frac{1}{2}$ mile east of Brighton.")
521. Pinecrest Beds, north shore Lake Okeechobee, Pumping Station no. 129, (NW $\frac{1}{4}$ Sec. 2, T40S, R33E), Glades Co., Florida.
523. Pinecrest Beds, Harney Pond Canal spoil banks, six miles northwest of Florida Highway 78, Brighton Indian Reservation, (NW $\frac{1}{4}$ Sec. 22, T39S, R32E), Glades Co., Florida.
527. Caloosahatchee Fm., north shore Lake Okeechobee, Pumping Station no. 127, (NE $\frac{1}{4}$ Sec. 35, T39S, R33E), Glades Co., Florida.
- 529a. Fort Thompson Fm., same as TU 529b, but stratigraphically higher.
- 529b. Caloosahatchee Fm., north bank of Caloosahatchee River, about two miles west of LaBelle, (SE $\frac{1}{4}$ Sec. 12, T43S, R28E), Hendry Co., Florida.
531. Pinecrest Beds, spoil banks, canal crossing Florida Highway 771 about one mile west of Port Charlotte Railroad

- Station (formerly Murdock), (SE $\frac{1}{4}$ Sec. 12, T40S, R21E), Charlotte Co., Florida.
532. Pinecrest Beds, spoil banks on cross canal $1\frac{3}{4}$ miles south of Florida Highway 771, 1.3 miles southwest of Port Charlotte Railroad Station (formerly Murdock), (SE $\frac{1}{4}$ Sec. 24, T40S, R21E), Charlotte Co., Florida.
535. Pinecrest Beds, Indian Prairie Canal spoil banks, at Florida Highway 78, north shore Lake Okeechobee, (Sec. 24, T39S, R33E), Glades Co., Florida.
536. Caloosahatchee Fm., south bank of Caloosahatchee River about one mile east of LaBelle, (Sec. 3 & 4, T43S, R29E), Hendry Co., Florida. (Designated as type locality of the Caloosahatchee Formation by Olsson *in* Olsson and Petit, 1964, p. 519.)
- 539a. Unnamed post-Caloosahatchee formation, Shell Creek (upper beds), about eight miles east of Cleveland, (Sec. 30, T40S, R25E), Charlotte Co., Florida.
- 539b. Caloosahatchee Fm., Shell Creek (lower beds), about eight miles east of Cleveland, (Sec. 30, T40S, R25E), Charlotte Co., Florida.
540. Pinecrest Beds, Miami Canal spoil banks, one to three miles south of pumping station at Palm Beach County line, Broward Co., Florida.
541. Caloosahatchee Fm., Miami Canal spoil banks, two miles north of pumping station at Broward County line, Palm Beach Co., Florida.
546. Chipola Fm., Ten Mile Creek, about $1\frac{1}{2}$ miles west of Chipola River, (NW $\frac{1}{4}$ Sec. 12, T1N, R10W), Calhoun Co., Florida. (?=USGS 2212, "one mile west of Bailey's Ferry.")
547. Chipola Fm., west bank of Chipola River, about $\frac{1}{4}$ mile above Four Mile Creek, (SW $\frac{1}{4}$ Sec. 29, T1N, R9W), Calhoun Co., Florida.
554. Chipola Fm., east bank of Chipola River at power line crossing, (SW $\frac{1}{4}$ Sec. 17, T1N, R9W), Calhoun Co., Florida.
558. Waccamaw Fm., borrow pits at north end of Crescent Beach Airport, Crescent Beach, Horry Co., South Carolina.
562. "Silverdale Beds," Onslow County marl pit, on south side of Webb Creek, near Silverdale, Onslow Co., North Carolina.
580. Unnamed post-Caloosahatchee formation, North New River Canal spoil banks, one mile south of South Bay, Palm Beach Co., Florida.
583. Caloosahatchee Fm., Miami Canal spoil banks, seven miles north of pumping station at Broward County line, Palm Beach Co., Florida.
704. "Silverdale Beds," Gillette's marl pit, at Silverdale, Onslow Co., North Carolina.
725. Unnamed post-Caloosahatchee formation, North New River Canal spoil banks, three miles south of South Bay, at Okeelanta, Palm Beach Co., Florida.
726. Caloosahatchee Fm., Hendry County rockpit, $\frac{1}{2}$ mile north of Florida Highway 80, three miles west of LaBelle, (SE $\frac{1}{4}$ Sec. 14, T43S, R28E), Hendry Co., Florida.
727. Unnamed post-Caloosahatchee formation, borrow pits 2.2 miles east of U. S. Highway 27, 15 miles south of South Bay, Palm Beach Co., Florida.
728. Pinecrest Beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, just across from U. S. Corps of Engineers Structure 65-D, (Sec. 33, T36S, R33E), Okeechobee Co., Florida.
729. Pinecrest Beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, approximately $\frac{1}{2}$ mile south of U. S. Corps of Engineers Structure 65-D, (S $\frac{1}{2}$ Sec. 33, T36S, R33E), Okeechobee Co., Florida.
730. Pinecrest Beds, embankment of Seaboard Airline Railroad, just west of Kissimmee River, (NW $\frac{1}{4}$ Sec. 20, T36S, R33E), Highlands Co., Florida.
732. Unnamed post-Caloosahatchee formation, borrow pits on Florida Highway 715, four miles north of Hillsborough Canal, at Belle Glade, Palm Beach Co., Florida.
733. Unnamed post-Caloosahatchee formation, North New River Canal spoil banks, one mile north of Florida Highway 80, at South Bay, Palm Beach Co., Florida.
736. Pinecrest Beds, spoil banks on south side of Florida Highway 70 and east side of Kissimmee River, Okeechobee Co., Florida.
737. Pinecrest Beds, levee fill, L-28, 2.8 miles west of gate at U. S. Corps of Engineers Structure S-12-A, at "Forty-Mile Bend," U. S. Highway 41, Dade Co., Florida.
738. Pinecrest Beds, levee fill, L-28, 12 miles northwest of gate at Structure S-12-A, on U. S. Highway 41, Dade Co., Florida.
739. Pinecrest Beds, levee fill, L-28, 17 miles northwest of gate at Structure S-12-A, on U. S. Highway 41, Dade Co., Florida.
741. Pinecrest Beds, levee fill, L-28, 3.6 miles west and 3.6 miles south of pumping station on Miami Canal at Palm Beach County line, Broward Co., Florida.
743. Unnamed post-Caloosahatchee formation, spoil banks on drainage canal seven miles east of U. S. Highway 27, 15 miles south of South Bay, Palm Beach Co., Florida.
746. Unnamed post-Caloosahatchee formation, North New River Canal spoil banks, 5.3 miles north of pumping station at Broward County line on U. S. Highway 27, Palm Beach Co., Florida.
747. Unnamed post-Caloosahatchee formation, North New River Canal spoil banks,

- two miles south of South Bay, Palm Beach Co., Florida.
748. Unnamed post-Caloosahatchee formation, Lake Okeechobee levee, two miles north of South Bay, Palm Beach Co., Florida.
749. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, borrow pits on south side of "Glades Airport," 1.3 miles south of Pahokee south city limits on Florida Highway 715, Palm Beach Co., Florida.
750. Unnamed post-Caloosahatchee formation, spoil banks cross canal 3.1 miles south of Lake Harbor on Miami Canal, Palm Beach Co., Florida.
751. Unnamed post-Caloosahatchee formation, North New River Canal spoil banks, 1½ miles south of South Bay, Palm Beach Co., Florida.
752. Pinecrest Beds, spoil banks on south side of Canal 41-C ("Slough Ditch") at crossing of country road, 4.3 miles east of Brighton and 1.4 miles south of Florida Highway 70, (SE ¼ Sec. 33, T37S, R33E), Highlands Co., Florida.
755. Caloosahatchee Fm., Miami Canal spoil banks, 17.4 miles north of pumping station at Broward County line, Palm Beach Co., Florida.
756. Pinecrest Beds, spoil banks west side of Elkcan Waterway, Port Charlotte Development, 2.3 miles southeast of Port Charlotte Railroad Station (formerly Murdock) and 1.7 miles east of U. S. Highway 41 (Sec. 10, T40S, R22E), Charlotte Co., Florida.
759. Unnamed post-Caloosahatchee formation, spoil banks north side of Caloosahatchee River, two miles west of Ortona Lock, (NE ¼ Sec. 29, T42S, R30E), Glades Co., Florida.
767. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, spoil banks north side of Caloosahatchee River, five miles west of Ortona Lock, (NW ¼ Sec. 36, T42S, R29E), Glades Co., Florida.
768. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, spoil banks north side of Caloosahatchee River, 5½ miles west of Ortona Lock, (NW ¼ Sec. 35, T42S, R29E), Glades Co., Florida.
769. Pinecrest Beds, spoil banks east side of Kissimmee River, 1½ to two miles south of U. S. Corps of Engineers Structure 65-D (NE ¼ Sec. 35, T36S, R33E), Okeechobee Co., Florida.
770. Pinecrest Beds and Caloosahatchee Fm. mixed, spoil banks west side of Kissimmee River, 1½ to 3½ miles north of Florida Highway 70, (Sec. 10, 14, 15, and 28, T37S, R33E), Highlands Co., Florida.
788. Pinecrest Beds and unnamed post-Caloosahatchee formation mixed, spoil banks at U-shaped canal on north side of Florida Highway 771, 3.4 miles southwest of U. S. Highway 41 at Port Charlotte Railroad Station (formerly Murdock), (Sec. 15, T40S, R21E), Charlotte Co., Florida.
793. Unnamed post-Caloosahatchee formation, borrow pits just east of Florida Highway 80, 2½ miles southwest of LaBelle, (NW ¼ Sec. 18, T43S, R29E), Hendry Co., Florida.
797. Pinecrest Beds, material exposed during construction of "Alligator Alley," 13.3 miles east of Florida Highway 29, (T49S, R32E), Collier Co., Florida.
802. Pinecrest Beds, spoil banks south side of Caloosahatchee River, 4¼ miles west of Ortona Lock, (SE ¼ Sec. 25, T42S, R29E), Glades Co., Florida.
803. Unnamed post-Caloosahatchee formation, spoil banks south side of Caloosahatchee River, two miles west of Ortona Lock, (NE ¼ Sec. 29, T42S, R30E), Glades Co., Florida.
816. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, borrow pits, Cecil M. Webb Wildlife Management Area, 1.8 miles east of U. S. Highway 41 and 7.2 miles north of the Lee County line, Charlotte Co., Florida.
870. Waccamaw Fm., pits on east side of North Carolina Highway 130, 2.8 miles north of Old Dock School, Old Dock, Columbus Co., North Carolina.

The following are U. S. Geological Survey locality numbers:

- USGS 2211. Chipola Fm., Alum Bluff (lower beds), Apalachicola River, (NE ¼ Sec. 24, T1N, R8W), Liberty Co., Florida. (=TU 453)
- USGS 2615. Shoal River Fm., log landing, farm of Dr. K. T. McClellan (1895), five miles west of Mossyhead, Walton Co., Florida.

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November 20, 1967

REVIEW

THE GEOLOGY OF SCOTLAND

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THE GEOLOGY OF SCOTLAND, edited by Gordon Y. Craig. Published in the United States by Archon Books, Hamden, Connecticut; and, in Great Britain, by Oliver & Boyd Ltd, Edinburgh and London, 1965, xv + 556 pp., illus., folding geologic map in color, \$20.00

This is the first general book on the geology of Scotland since 1844 when the present publishers (Oliver & Boyd) issued the *Guide to the Geology of Scotland* which was written by James Nicol, a student of Robert Jameson. This long interval is quite surprising when one considers the key roles that James Hutton and the remainder of the Edinburgh Circle played in the birth and development of geology as a science. Indeed, Scotland became the principal battleground in the intellectual struggle between the Neptunist (Werner, Jameson, etc.) and the Plutonist (Hutton, Playfair and Sir James Hall). It was in Edinburgh that Sir James demonstrated the molten origin of granite and basalt, and at Siccar Point, near Edinburgh, that James Hutton conceived of the unconformity, the interruption that punctuated his earlier concept of the vast temporal continuum, with "no vestige of a beginning, no prospect of an end." Clearly, a new and modern treatment of this classic area of British geology was desirable and much needed.

In the one hundred and twenty years which have elapsed since Nicol's book appeared, the body of geological knowledge has become so great that it is virtually impossible for one person to write a com-

prehensive book on Scottish geology. Thus, twelve specialists in various aspects of the geology of Scotland have collaborated under the editorial leadership of Gordon Y. Craig to produce the present synthesis.

The first chapter, the *Geological Growth of Scotland*, is a general account of geological evolution by T. Neville George. This is followed by sections on the Lewisian, the Torridonian and Moian, and the Dalradian complexes. The next several parts deal with the stratigraphy, paleogeography and structure of the Lower Paleozoic rocks, the Old Red Sandstone, and the Carboniferous, Permian and Triassic, Jurassic, Cretaceous, and Tertiary sediments followed by a section on the marine erosion, deposition, glaciation and fossiliferous "Interglacial" deposits of the Quaternary. The fifteenth and concluding chapter is devoted to the economic resources of Scotland, both metallic and non-metallic. There is a terminal index.

The book is large, handsome and extremely well-done. There are numerous figures and photographic plates, all of high quality. Fold-in maps and sections are used throughout the volume. The finest of these is a large fold-out geologic map in full color at the scale of 25 miles to the inch. This map is bound with a full stub permitting it to be unfolded and used alongside the text, an invaluable aid to comprehension of this well planned and extremely valuable work. It was printed in Glasgow; this likely accounts for the modest price. If printed in the United States, it would be expensive.