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CENOZOIC MURICIDAE OF THE WESTERN ATLANTIC REGION PART VIII – *MUREX* S.S., *HAUSTELLUM*, *CHICOREUS*, AND *HEXAPLEX*; ADDITIONS AND CORRECTIONS

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CONTENTS

I. ABSTRACT

A total of 165 names have been applied to western Atlantic species referred herein to the muricid genera *Murex* s.s., *Haustellum*, *Hexaplex*, and *Chicoreus*, including its four subgenera: *Chicoreus* s.s., *Siratus*, *Phyllonotus*, and *Naquetia*. Of these, 101 are valid and are treated systematically; however, the two species of *Murex* s.s. present are only questionably referred to the western Atlantic fauna. Of the remaining 99 valid species there are 16 of *Haustellum*, 22 of *Chicoreus* s.s., 28 of *Siratus*, 19 of *Phyllonotus*, one of *Naquetia*, and 13 of *Hexaplex*. Of these 99 species, eight occur in Eocene beds, with the oldest known from the Middle Eocene Weches Formation of Texas; seven occur in Oligocene beds; 31 in Miocene formations; and 46 in Plio-Pleistocene strata. There are 42 species in the Recent fauna, but only 18 are confined to the Recent, the remainder are both living and fossil. Of this number 9 are new species and are named herein. They are: *Haustellum mimiwilsoni*, from the Cumaná Formation of Venezuela and the Río Banano Formation of Costa Rica; *Chicoreus (Chicoreus) jungi*, from the Grand Bay Formation, Carriacou, West Indies; *Chicoreus (Chicoreus) veronica* and *Chicoreus (Siratus) habros*, from the Agueguexquite Formation, Mexico; *Chicoreus (Siratus) miltos*, from the Concepcion Inferior Formation, Mexico; *Chicoreus (Siratus) sextoni* and *Chicoreus (Phyllonotus) louisae*, from the Chipola Formation, Florida; *Chicoreus (Phyllonotus) initialis*, from the Weches Formation, Texas; and *Hexaplex isthmicus*, from the Gatun Formation, Panama.

II. INTRODUCTION

The first part of this study appeared in 1963 as a monograph on the genus *Murex sensu stricto*. In the succeeding years six additional parts appeared; the last, that on the genera *Calotrophon* and *Attiliosa*, was published in 1976. It was my plan at the conclusion of the study of the subfamily Muricinae, which was completed with this latter part, to present a part VIII – Summary and Corrections for the entire subfamily, before embarking upon the subfamilies Muricopsinae and Ocenebrinae.

However, in 1976, my husband Harold and I made the first of many collecting trips to the Dominican Republic. This first visit resulted in so many new taxa that a decision was made to do a separate paper on the Dominican muricids, in which these taxa would be described before being incorporated into the proposed Summary. Little did I suspect that this project would require 13 years and culminate finally in a different Part 8 – the *Neogene Paleontology of the northern Dominican Republic* (Vokes, 1989b), which forms only a portion of a major study on the fauna of the Mio-

Pliocene of that country. It is fortunate that I waited, for in the Dominican report 32 species of Muricinae are treated, of which 13 are described therein. Nineteen of the 32 are species of the genera covered in the present work; the remainder will be treated in subsequent parts.

When Part I of *Cenozoic Muricidae* was published in 1963, the Tulane Geological Collections consisted of material from only 555 localities; today the localities number over 1500. The Cenozoic localities have increased from 160 to more than 1000. Recent collecting localities represented have grown from 42 to nearly 600. Thus, a great deal of new information has been accumulated.

Much of this has been published already, as in the case of the Dominican Republic material. I have described new species of *Murex* (1967a), and new species of *Chicoreus* (1974a). Petuch (1987, and elsewhere) has named several new forms. But the time has come to assimilate this scattered information into one (currently) complete summary of all species of Muricinae, fossil and Recent, presently known from the western Atlantic region.

In addition to new material, several taxonomic changes shifting species into different genera, and genera into different subfamilies have been made. These changes will be discussed with the relevant taxonomic groups. A general reference chart appears below as Table 1, to indicate where supraspecific taxa are currently placed.

III. STRATIGRAPHIC CORRELATION

In the interval since this series began great strides have been made in long-range geologic correlation by means of planktic foraminifera and calcareous nannofossils. Rather than repeat the discussion for every species that occurs in these formations it seems more useful to list all of them together with the most recent information on correlations. It should be noted that the formations discussed here are only those in which species of Muricinae occur. This is *not* intended to be a definitive analysis of all Neogene formations in the western Atlantic. For the best synthesis of the stratigraphy (Upper Cretaceous to Holocene) of the Atlantic and Gulf Coastal Plain the reader is referred to Carter (1984).

Unfortunately, there is a recurring problem in that the formations in which mollusks are most abundant are those nearshore facies where the planktic foraminifera and calcareous nannofossils are least likely to be encountered. In the deep-water facies where the latter are most abundant, mollusks are almost nonexis-

TABLE 1

Genera of the subfamily Muricinae that occur in the western Atlantic.

Covered in this paper

Murex s.s. [?none in the Western Atlantic]

Haustellum

Chicoreus
Chicoreus s.s., *Siratus*, *Phyllonotus*, *Naquetia*

Hexaplex

To be covered in next paper

Pterynotus
Pterynotus s.s., *Pterochelus*, *Purpurellus*

Poirieria
Poirieria s.s., *Paziella*, *Pazinotus*, *Flexopteron*

Aspella

Dermomurex
Dermomurex s.s., *Takia*, *Gracilimurex*, *Trialatella*

Calotrophon

Attiliosa

tent. Thus, there are many formations for which we have no better correlation data than we did 30 years ago.

In general, there has been little change in the stratigraphic assignments of the Paleogene formations. An excellent correlation chart for the Paleogene of the Gulf Coastal Plain has been given by Dockery (1980, pp. 22-23). The Paleocene, Eocene, and Oligocene units are essentially unchanged. However, the Silverdale beds of North Carolina, originally placed in the Early Miocene are now placed in the latest Oligocene (Chickasawhayan Stage), as is the Tampa Limestone of peninsular Florida.

The Chipola Formation of northwestern Florida was the subject of a detailed study by Akers (1972), who determined that the formation is Burdigalian (planktic zones N.4-8) rather than Helvetian as I once suggested (Vokes, 1965b, p. 205). The resemblances to the Helvetian beds in southern France are evidently due more to ecology than time. The Cantaure Formation of Venezuela monographed by Jung (1965) also has been dated as Burdigalian (Hunter and Bartok, 1974, p. 147) and is correlated with the Quiroz fauna of the La Rosa Formation (= Agua Clara Formation; see Bolli, 1972).

The Pirabas Limestone of Brazil has been referred to ages ranging from Cretaceous (resulting in citations of the genus *Murex* as dating back to the Cretaceous) to Middle Miocene. In a recent discussion of the problem (Vokes, 1989b, p. 28), I concluded that these beds probably correlated with the Tampa Limestone and thus were Early Miocene, possibly correlating with the Baitoa Formation of the Dominican Republic. However, if the Tampa should prove to be older, then it is possible that the Pirabas also is Late Oligocene.

Once considered the most widespread of all Neogene horizons, most of the "Middle Miocene" formations throughout the area are now dated as Pliocene. In large measure the reason for older dates for many of the younger Neogene formations is their supposed correlation with the "Middle Miocene" Bowden fauna of Jamaica. Because this was the first "modern" faunal study and because Woodring (1928) did such a thorough job, it became the standard by which all others were measured. Unfortunately, due to lack of knowledge of the living Caribbean fauna, in particular deeper water forms, the Lyellian technique of percent of living species gave an age that was older. More recent planktic evidence places the Bowden shell bed in the basal Pleistocene (N.22) rather than Middle Miocene, as it was originally considered by Woodring (see Lamb and Beard, 1972, p. 32).

The Shoal River Formation of northwestern Florida is still placed in the Middle Miocene (Carter, 1984, zones N.8-13). The Yellow River Formation (formerly the "*Yoldia* Faunizone" of the Choctawhatchee Formation, now Group) has been demonstrated to be Middle Miocene (N.14) on the basis of the rich planktic fauna (Akers, 1972, p. 12). In the Atlantic Coastal Plain section the Calvert, Choptank, and St. Marys formations of Maryland and northeastern Virginia, and the Kirkwood Formation of New Jersey, are still considered to be Middle Miocene (Blackwelder and Ward, 1976; Gibson, 1983). In the Caribbean, the Grand Bay Formation of the island of Carriacou has been shown by Robinson and Jung (1972, p. 124) also to be of Middle Miocene age.

Most formations formerly placed in the Late Miocene are now Pliocene and in the U.S. only the Red Bay Formation of the Choctawhatchee Group (Akers, 1972, p. 13), the St. Marys Formation of southeastern Virginia (= Eastover Formation: Ward and Blackwelder, 1980) and North Carolina (Gibson, 1983) remain in the Late Miocene.

The Tubará Group of Colombia is no longer considered to be Early to Late Miocene but is probably Late Miocene to Early Pleistocene in age. There is no positive information but the "*Murex mississippiensis*" of Anderson (1929, p. 139) from the lower Tubará is *Cantharus scrupeus* Olsson, 1964, described from the Early Pliocene Esmeraldas Formation of Ecuador (N.19), and various species from the "upper Tubará" correlate with species from the Pinecrest (mid-Pliocene) and Moín (Early Pleistocene) beds of other areas. Incidentally, although the original spelling for the group was as "Tuberá" (Anderson, 1929, p. 92), the correct spel-

ling for the name of this village in Colombia on the road between Barranquilla and Cartegena is Tubará.

The most definitive work to date on correlations in the western Atlantic has been that done in the Dominican Republic (Saunders, Jung, and Biju-Duval, 1986). Their paper demonstrates that the Baitoa Formation is Late Early Miocene (= Chipola Formation), the Cercado is Late Miocene, and the Gurabo is latest Miocene and Early Pliocene.

The Mao Formation in the Dominican Republic is a deep-water unit that marks the last major transgression over the entire area. There are numerous formations throughout the western Atlantic that correlate with this mid-Pliocene aged (N.20) unit. In southern Florida the Pinecrest Beds* have become much better known as the result of major new excavations in the vicinity of Sarasota. These beds, dated as N.20 (Akers, 1974) are essentially the same age as the more northerly Jackson Bluff Formation of the Choctawhatchee Group, which in turn is the southern equivalent of the Atlantic Coastal Plain Yorktown and Duplin formations (for all of these see Akers, 1972, 1974, and Akers and Koeppel, 1973). A great deal of "fine-tuning" has been done on the exact correlation of the units in the Atlantic Coastal Plain by various authors; for a summary the reader is referred to Blackwelder (1981), Carter (1983, 1984), Gibson (1983), and Hazel (1983).

In the Isthmus of Tehuantepec of southern Mexico there are several "formations," which represent the shoaling of the Salina Basin. Originally described as being of ages ranging from Early Oligocene to Late Miocene, they are now considered to be Middle Miocene (La Laja, Deposito, and Encanto formations), Late Miocene (Medias Aguas Beds of Akers, 1980), and Early to Middle Pliocene (Concepcion, Filisolo, and Agueguexquite beds), ranging from N.19 at the bottom to N.20 at the top (Kohl, 1985). There is a slight difference in the dating of the units near the coast studied by Kohl (1985) and the more inland outcrops studied by Akers (1979, 1980), but as our fossils come from the inland areas, Akers' intrepretation is followed.

In Panama there is still no positive dating of the Gatun Formation but in Costa Rica the "upper Gatun" of Olsson (1922, p. 182) is now called the Río Banano Formation and has a good N.20 fauna (Akers, personal communication). The Gatun has been correlated with the Urumaco Formation of Venezuela, considered by Bolli (1972, fig. 3) as Late Miocene. It was also correlated with the Angostura Formation of Ecuador by Olsson (1964, p. 8), which is dated by Whittaker (1988, p. 10) as probably Late Miocene. However, it is my opinion that the resemblance between the Angostura and the Gatun is due more to facies than age (see Vokes, 1989c, p. 108), and the Gatun is probably Early Pliocene in age.

In Venezuela Bolli (1972, fig. 3) has also dated the Punta Gavilan Formation as mid-Pliocene. The Cabo Blanco Group, considered by Weisbord (1962) as Late Miocene to Pliocene in age is now dated as basal Pleistocene, on the basis of the appearance of the foraminifer *Globorotalia truncatulinoides*, and correlated with the Cumaná Formation. The Cumaná has been considered by most workers to be Late Pliocene; however, in the *Lexico Estratigrafico de Venezuela* (1970, p. 187) the age was moved up to Early Pleistocene on the grounds that the zone of *Globorotalia truncatulinoides* (N.21-23) has been reassigned to the Pleistocene. There is some question as to the validity of this placement and these units will be classified as "Plio-Pleistocene" herein.

The Caloosahatchee Formation continues to be a problem, largely because it spans the line arbitrarily taken to be the boundary between the Pliocene and the Pleistocene. Authors have been arguing over the exact placement of this boundary for years. The general consensus today is that the boundary should be placed between planktic zones N.21 and 22, or between the Piacenzian and the Calabrian. The age of the Caloosahatchee is from 1.5 to 2.5 m.y.; thus, if the boundary is placed at 1.8 m.y. (after Blackwelder, 1981, p. 9),

*Petuch (1986) considers that the name "Pinecrest" is preoccupied by an earlier use of the name for a Triassic formation in Utah. As pointed out in Vokes (1988, p. 2, footnote), this is irrelevant and the name "Pinecrest Beds" will continue to be used herein.

the older portions are Late Pliocene (N.21) but the upper parts are Early Pleistocene (N.22), and the exact age of this unit varies from locality to locality (see Hazel, 1983, figure 4). What has been called the Waccamaw Formation in North and South Carolina has the same problem with age. The lower beds, now termed the Bear Bluff Formation (DuBar, 1974), are Late Pliocene and the upper beds are Early Pleistocene (see Akers, 1972, p. 40), correlating with the Caloosahatchee Formation at its type locality on the Caloosahatchee River (= locality TU 536). The type locality of Blackwelder's (1981) Windyan Substage (Early Pleistocene) is essentially the same as our locality TU 558 and the muricid fauna is identical to that of the typical Caloosahatchee Formation.

If the upper portions of the Caloosahatchee and Waccamaw formations are N.22, then they correlate with the Moín Formation in Costa Rica, which Akers (1972) dated as N. 22. However, his samples were taken at approximately 40 meters above sea-level (TU locality 954). Later, we collected at about 60 meters above sea-level (TU 1240) and Dr. Akers dated this material (personal communication) as N.23 or mid-Pleistocene. Therefore, the lower portions of the Moín are believed to correlate with the Caloosahatchee and the upper portions would correlate with the Bermont Formation (= unnamed post-Caloosahatchee formation of Vokes, 1963a, 1965a, 1967b, etc.) in southern Florida.

IV. ACKNOWLEDGMENTS

To thank all of the people who have assisted in this study, which is the distillation if not the culmination of a 30 year career, I would have to thank everyone I know. Therefore, I would like to begin by expressing my gratitude to all of my colleagues, professional and amateur, who, through the years, have provided information, specimens, and hospitality in their homes and museums. But for the preparation of this paper, I do want to add a special note of thanks to certain individuals. First among these would be the late Joseph H. Peck and his successors, Liz Nesbitt and David R. Lindberg, who lent to me (back in 1966!) all of the Caribbean fossil muricid material in the collections of the Museum of Paleontology, University of California, Berkeley, and have never once suggested that I return it. I hope this paper justifies their trust in me. Thanks also go to Peter Jung, Naturhistorisches Museum, Basel, Switzerland, for his kindness in allowing me to examine the collections under his care as well as for the loan of the type specimen of *Chicoreus (Chicoreus) jungi*, and to Louise Compton, of Marietta, Georgia, who graciously gave me two specimens of *Chicoreus (Phyllonotus) louisae*, when I asked to borrow them. Susan Stephens, Sanibel, Florida, has been extremely helpful, providing specimens from and information concerning the Pliocene outcrops near Sarasota, Florida. Kevan and Linda Sunderland, Sunrise, Florida, provided much data on the habitats of living western Atlantic species. Several persons have donated or loaned specimens, either as types or figured specimens: Thomas G. Andrews, Jr., Nacogdoches, Texas; Jack Gibson-Smith, formerly of Caracas, Venezuela, now Surry, England; Jose and Marcus Coltro, of Sao Paulo, Brazil; James Allen, Alexandria, Louisiana, and Paul Drez, Albuquerque, New Mexico. As always, the members of the staff of the U. S. National Museum (Thomas R. Waller and Warren Blow, Paleobiology; M. G. Harasewych, Recent Mollusca) and the Academy of Natural Sciences of Philadelphia (George M. Davis and David S. Wiedner) have been very generous in lending specimens. Hubert C. Skinner took on the formidable task of editing the manuscript (however, I hold him blameless for any errors that have crept through). Finally, my deepest thanks go to my husband Harold E. Vokes, field assistant, photographer, curatorial aid, and listener.

V. SYSTEMATIC DESCRIPTIONS

In general, information on synonymies and localities given in earlier parts of this series will not be repeated. Only references that have appeared since the original treatment, or citations that have changed in some way will be included. Most references to Recent occurrences will not be included, except for the ones in two important books on the Muricidae

(Radwin and D'Attilio, and Fair), which both appeared in 1976. This will not be absolute but in the interest of brevity it seems of little value to repeat material that is unchanged.

Superfamily MURICACEA Rafinesque, 1815
Family MURICIDAE Rafinesque, 1815
Subfamily MURICINAE Rafinesque, 1815
Genus MUREX Linné, 1758

Murex LINNÉ, 1758, Systema Naturae, ed. 10, p. 746.

Type species: *Murex tribulus* Linné, 1758, by subsequent designation, Montfort, 1810.

Discussion: For a discussion of this genus, its synonyms, biology, anatomy, and taxonomy, the reader is referred to Ponder and Vokes (1988).

In my original treatment of what was then called the genus *Murex* s.s. (Vokes, 1963a) there were 19 species in the fossil record of the western Atlantic. Of that number, one (*Murex vaughani* Maury, 1910) is now placed in *Dermomurex (Takia)*, one (*Murex williamsi* Maury, 1925) is a *Cymatium* (Schmelz, 1989, p. 137; see pl. 12, figs. 5, 6 herein), two are synonyms of other species, and the remaining fifteen taxa are almost equally divided between the genus *Haustellum* and the subgenus *Chicoreus (Siratus)*. In the 1963 work I considered all species with three spinose varices and a long siphonal canal as "*Murex* s.s." Within this group I separated two subgroups (without taxonomic rank): the "Indo-Pacific" form, with a straight siphonal canal; and the "Western Atlantic" form, in which the canal is deflected dorsally.

Very soon, as my continuing study of the Muricidae progressed, I realized that the "Western Atlantic" forms were better placed in *Chicoreus (Siratus)* and in Part II of the series this shift was made (Vokes, 1965a, pp. 183, 195). However, not until after extensive work on the Recent Indo-Pacific members of the genus *Murex* (Ponder and Vokes, 1988) did it become obvious to me that the "Indo-Pacific" forms with straight siphonal canals were better placed in *Haustellum*. Thus, with the two possible exceptions discussed below, there are *no* members of *Murex* s.s. in the western Atlantic fauna, fossil or Recent.

Subgenus MUREX sensu stricto

MUREX (MUREX) SURINAMENSIS Okutani

Murex (Murex) surinamensis OKUTANI, 1982, Venus, Jap. Jour. Malac., v. 41, no. 2, p. 109, pl. 1, figs. 1-3, text-figs. 1 (protoconch), 2 (operculum); OKUTANI, 1983, Crust. Moll. Suriname and French Guiana, p. 273 (figured).

Murex surinamensis Okutani. PONDER and VOKES, 1988, Rec. Australian Mus., Suppl. 8, p. 12, text-fig. 12 (holotype).

Holotype: Natl. Sci. Mus. Tokyo, NSMT-Mo 60021; height 98.5 mm, diameter 29.3 mm.

Type locality: Lat. 10°46'N, Long. 61°32'W, 94 meters. (This point is approximately Port of Spain, Trinidad.)

Occurrence: Recent only.

Discussion: Although described from material said to be collected by the Japan Marine Fishery Resources Research Center (JAMARC) along the coast of Surinam (Suriname), the coordinates cited in the original description (Okutani, 1982) pinpoint a location that is not the coast of Suriname (near Lat. 6°N, Long. 55°W). Furthermore, the fact that this is one of only two possible species of *Murex* s.s. (and the second is extremely dubious) presently recognized in the western Atlantic, adds to the doubt that these coordinates are correct. Unfortunately, the obvious possibility that the coordinates should read 61° *East* is no solution, as that places the locality in the middle of the Arabian Basin, with water depths of almost 5000 meters. Therefore, I can only say that these coordinates are unlikely, and the true locality is unknown.

Murex surinamensis is undoubtedly a true member of *Murex* sensu stricto, having small, adaperturally directed, spines between the major spines on the siphonal canal. This feature is unique to *Murex* s.s. In addition, the operculum is identical to that found in the group of *Murex pecten* Lightfoot, 1786, with a nucleus that is subcentral rather than terminal, as in most species of *Murex* (see Ponder and Vokes, 1988, text-fig. 1-A). The species most nearly resembles the Australian *Murex queenslandicus* Ponder and Vokes, 1988; however, that species has more numerous spines on the siphonal canal (six in *M. queenslandicus* in contrast to four in *M. surinamensis*).

If it should be proved that *M. surinamensis* is from the western Atlantic, the biogeographical implications are most exciting. There is no known ancestor in this part of the world, but it is obvious that members of many different muricine genera have made their way from one side of the world to the other. We still do not understand much about the mechanisms of these long distance movements. Considering that there are numerous members of *Haustellum,* which I consider to be a western Atlantic group, throughout the Indo-Pacific, there is no compelling reason we should not have species of *Murex* s.s. in the western Atlantic.

MUREX (MUREX) MACULATUS Verrill
Text-figure 1

Murex maculatus VERRILL, 1950, Nautilus, v. 63, no. 4, p. 126, pl. 9, fig. 3 (*non Murex maculatus* Reeve, 1845).

Holotype: Not found; height 47 mm, diameter 19 mm (*fide* Verrill, 1950b, p. 126).

Type locality: Dominica, Lesser Antilles.

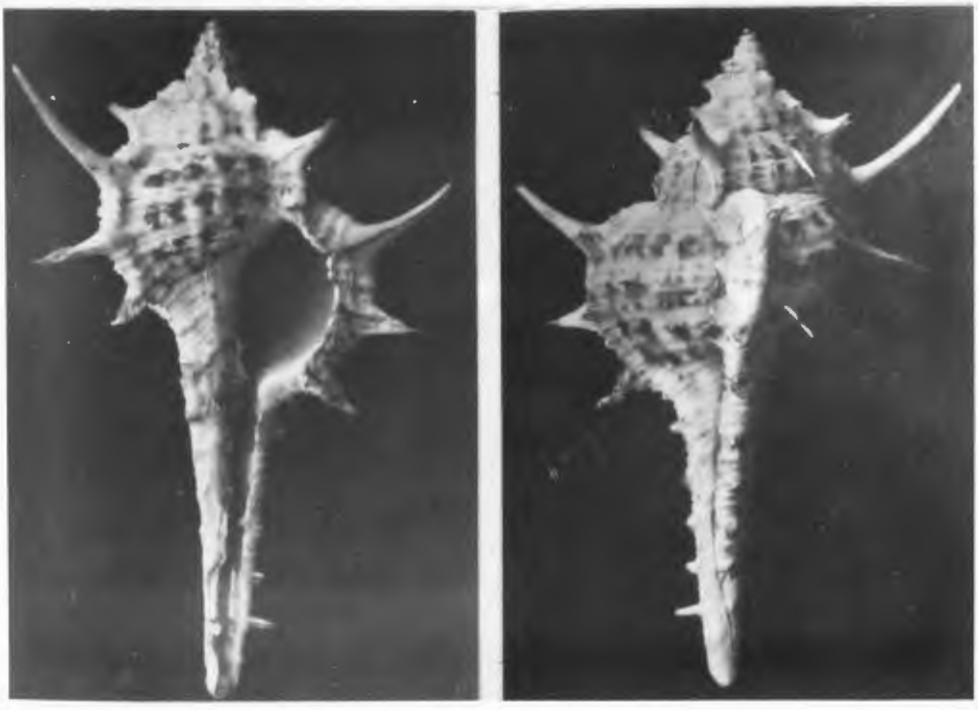
Occurrence: Recent only.

Figured specimen: Holotype (from Verrill's original photographs).

Discussion: Verrill (1950b, p. 126, pl. 9, fig. 3) described *Murex maculatus* from 40-50 fms (73-91 m), off Dominica, Lesser Antilles. His illustration (refigured here as text-fig. 1, from Verrill's original photographs, now in my possession*) shows a shell with just three long straight spines on the varices of the body whorl and five spines on the long straight siphonal canal.

There is a slight similarity to *M. surinamensis,* which may be from the same general area. But the specimens illustrated by Okutani (1982, pl. 1, figs. 1-3) have numerous secondary spines on both

*According to Johnson (1989, p. 12), A. H. Verrill invented the autochrome photographic process in 1902. These prints, which are a strange reddish brown color, are presumed to be made by his process. They have an amazing degree of fine-grained detail, as can be seen from this copy of the originals.



Text-figure 1. *Murex (Murex) maculatus* Verrill (holotype); height 47 mm, diameter 19 mm; Dominica, Lesser Antilles (X 2, approximately).

the body whorl and the canal. The only species that nearly matches the illustration of *M. maculatus* is *M. carbonnieri* (Jousseaume, 1881) (see Ponder and Vokes, 1988, text-fig. 7, holotype) from the Indian Ocean and Red Sea. That species differs in having small secondary spines between the three major spines on the body whorl portion of the varices. Verrill's specimen does not show any trace of these spines. However, the color patterns are suspiciously similar. If one examines the picture of *M. maculatus* closely it is obvious that the color spots have been *painted* on! One assumes that the color of the holotype was faded and Verrill touched up the spots so that they would show better in the photograph. None of Verrill's type material has been found (*fide* Johnson, 1989, p. 16, and personal search). Unless the type ("two living specimens; the type in my collection": Verrill, 1950b, p. 126) or additional material can be located this species will remain an enigma. Should it prove to be valid, then a new name will be necessary, as *M. maculatus* Verrill, 1950, is preoccupied by *M. maculatus* Reeve, 1845.

Genus HAUSTELLUM Schumacher, 1817

Haustellum SCHUMACHER, 1817, Essai Vers Test., p. 213.

Type species: *Murex haustellum* Linné, 1758, by tautonomy.

Discussion: As before, the reader is referred to Ponder and Vokes (1988) for a detailed study of this genus, including the reasons why many of the species customarily placed in *Murex* s.s. have been transferred to *Haustellum*. That study revealed certain morphologic differences, including the presence of a labral tooth in species of *Murex* s.s. but not in *Haustellum*, the presence of rugae* on the parietal lip of species of *Haustellum* but not in *Murex*, early teleoconch ornamentation, color pattern, and other features that convinced me the resemblances between *Murex* s.s. and *Haustellum* are due more to convergence than to close relationship. This was discussed in several later papers (Vokes, 1989b, p.24; 1990a, p. 3; 1990b, p. 124) and need not be repeated here. The ultimate conclusion is that there are no species of *Murex* s.s. (with the possible exception of the two discussed above) in the western Atlantic and those species that formerly were termed "Indo-Pacific" forms of *Murex* s.s. (Vokes, 1963a) should be placed in *Haustellum*.

A brief geologic history of the Muricinae, leading to the development of the genus *Haustellum*, has been given in Ponder and Vokes (1988, p. 13). This was further elaborated in the Dominican Republic study (Vokes, 1989b, p. 25), where I described the evolution of the New World forms of the genus. The group of species that comprise *Haustellum* and *Chicoreus* today began with an Middle Eocene representative of the subgenus *Phyllonotus* [see *C.(P.) initialis*, n. sp., below], which presumably gave rise to the subgenus *Siratus* before the Oligocene. The Early Oligocene *Chicoreus (Siratus) stetopus* (de Gregorio, 1890), which I originally placed in *Phyllonotus*, is the first recognizable species of *Siratus* (see pl. 6, fig. 1; also MacNeil and Dockery, 1984, pl. 4, fig. 16, for a very good example). *Siratus* gave rise to *Chicoreus* s.s. and *Haustellum* sometime before the beginning of the Miocene. If the Pirabas Limestone is in fact correlative with the Tampa Limestone, then *Haustellum messorius* (as *Murex sutilis* White) first appears in the Late Oligocene. It is certainly present by the Late Early Miocene (Baitoa Formation, Dominican Republic). Species of *Chicoreus* s.s. also are present in both the Baitoa and the Chipola formations.

The two lines, *Siratus* and *Haustellum*, continued to develop in parallel fashion throughout the remainder of the geologic record. This fact was demonstrated clearly in the study of the Dominican muricids where there are two distinct species present – *Haustellum messorius* and *Chicoreus (Siratus) domingensis* (Sowerby, 1850) – that are so nearly alike in ornamentation it often is difficult to distinguish them. This problem is discussed in detail in the Dominican work (Vokes, 1989b, p. 25).

*The function of these rugae is unknown; but they appear on almost all species of *Haustellum*, *Siratus*, and *Phyllonotus* (a few species have lost them secondarily). However, they do not appear on any species of *Chicoreus* s.s., indicating to me that this group is less closely related to the others than they are to each other. It is an unfortunate fluke of nomenclatural priority that *Chicoreus* is the oldest taxon.

Inasmuch as *all* of the species considered in Part I are now placed elsewhere, it is useful to list the fossil species with their correct taxonomic placement (see Table 2). In the case of the Recent species originally listed (Vokes, 1963a, Table I) for "Indo-Pacific" form read *Haustellum;* for "Western Atlantic" form read *Chicoreus (Siratus).* Species no longer in *Haustellum* will be treated systematically with the appropriate genus later in this series.

HAUSTELLUM MESSORIUS (Sowerby)
Plate 1, figures 1-5

Murex messorius Sowerby. BARRIOS M., 1960, Rep. Colombia, Serv. Geol. Nacl., Bol. Geol., v. 6, p. 279, pl. 9, fig. 8.

Murex (Murex) messorius Sowerby. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 103 [not all references], pl. 3, figs. 6, 7 [not fig. 8 = *H. polynematicus* (Brown and Pilsbry)]; VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 197; VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 81, pl. 1, figs. 1 (lectotype)-3, pl. 2, figs. 1-8.

Murex (Murex) domingensis Sowerby. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, pl. 2, fig. 6 only (not of Sowerby).

[?] *Murex* cf. *messorius* Sowerby. GONZALEZ and FLORES, 1972, Bol. Inst. Oceanogr. Univ. Oriente, v. 11, no. 2, p. 76, text-figs. 2a (radula, as *Thais deltoidea*, not fig. 9a, as stated), 8.

Murex messorius Sowerby. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 68, pl. 11, fig. 7; FAIR, 1976, The Murex Book, p. 58, pl. 3, fig. 33 only [not figs. 34, 35 = *H. chrysostoma bellus* (Reeve)].

Murex (Haustellum) messorius Sowerby. VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 25, pl. 1, figs. 1-5.

Synonyms:

Murex nigrescens SOWERBY, 1841, Conch. Illus., pl. 198, fig. 113; SOWERBY, 1841, Zool. Soc. London, Proc., pt. 8 (1840), p. 138; VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 81.

Murex funiculatus REEVE, 1845, Conch. Icon., v. 3, *Murex*, pl. 19, fig. 74; REEVE, 1846, Zool. Soc. London, Proc., pt. 13 (1845), p. 88 (*non M. funiculatus* Schlotheim, 1820, *nec* Defrance, 1827); VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 81.

Murex recurvirostris Broderip. GABB, 1873, Amer. Phil. Soc., Trans., (N.S.) v. 15, pt. 1, p. 201; PILBBRY, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 353; WOODRING *in* DURHAM, ARGELLANO, and PECK, 1955, Geol. Soc. Amer., Bull., v. 66, p. 984; WOODRING, 1959, U.S. Geol. Surv., Prof. Paper 306-B, p. 214, pl. 35, figs. 5, 8, pl. 36, figs. 11, 12 (not of Broderip).

Murex sutilis WHITE, 1887, Mus. Nacl. Rio de Janiero, Arch., v. 7, p. 137, pl. 11, fig. 11; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 103, pl. 4, fig. 8.

Murex (Murex) woodringi CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 9, pl. 4, figs. 1-3; VOKES, 1965,

TABLE 2. Fossil species originally covered in Part I.

SPECIES NAME	CURRENT PLACEMENT
M. quirosensis F. Hodson	*Siratus*
M. chipolanus Dall	*Siratus*
M. gardnerae Vokes = *juliagardnerae* Vokes	*Siratus*
M. gilli (Maury)	*Haustellum*
M. polynematicus Brown and Pilsbry	*Haustellum*
M. vaughani Maury	*Dermomurex (Takia)*
M. pennai Maury = *pennae* Maury	*Haustellum*
M. toria Maury = *yaquensis* Maury	*Siratus*
M. williamsi Maury	*Cymatium (Gutturnium)*
M. sutilis White = *messorius* Sowerby	*Haustellum*
M. messorius Sowerby	*Haustellum*
M. nicholsi Gardner	*Siratus*
M. domingensis Sowerby	*Siratus*
M. yaquensis Maury	*Siratus*
M. antillarum Hinds = *formosus* Sowerby	*Siratus*
M. rubidus Baker	*Haustellum*
M. chrysostoma Sowerby	*Haustellum*
M. anniae Smith	*Haustellum*
M. anniae bellegladeensis Vokes	*Haustellum*

Tulane Stud. Geol., v. 3, no. 4, p. 197; VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 81.

Murex messorius var. *gustaviensis* NOWELL-USTICKE, 1969, Suppl. List. New Shells, p. 15, pl. 3, fig. 649.

Murex garciai PETUCH, 1987, New Caribbean Moll. Faunas, p. 66, pl. 11, figs. 9, 10.

Murex samui PETUCH, 1987, New Caribbean Moll. Faunas, p. 67, pl. 11, figs. 7, 8.

The following references, included under *M. messorius* in 1963, p. 103, *do not* apply to this species:

Murex recurvirostris Broderip. RUTSCH, 1934, Schweizer. Palaeont. Gesell., Abh., v. 54, no. 3, p. 64, pl. 4, fig. 1; v. 55, no. 1, p. 136 [= *H. donmoorei* (Bullis)].

Murex (Murex) recurvirostris Broderip. PERRILLIAT MONTOYA, 1960, Paleontología Mexicana, no. 8, p. 21, pl. 3, figs. 9, 10 [= *H. bellegladeensis* (Vokes)].

Murex (Murex) recurvirostris recurvirostris Broderip. WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 278, pl. 26, figs. 3, 4 [= *H. donmoorei* (Bullis)].

Lectotype: Brit. Mus. (Nat. Hist.), BMNH 1964-349 (designated by Vokes, 1967a, p. 82); height 64 mm, diameter 29 mm.

Type locality: St. Lucia, Windward Islands, Lesser Antilles (designated by Vokes, 1967a, p. 82).

Occurrence: Pirabas Limestone, Brazil; Thomonde Formation, Haiti; Encanto Formation, Veracruz, Mexico; Quebradillas Limestone, Puerto Rico; Upper Tubará Group, Colombia; Gatun Formation, Panama; Río Banano Formation, Costa Rica; Baitoa, Las Cahobas, Cercado, Gurabo, and Mao formations, Dominican Republic; Cumaná Formation, Venezuela; Bowden Formation, Jamaica; unnamed Pleistocene formation, Barbados. Recent, western Atlantic from Greater Antilles to Venezuela.

Figured specimens: Fig. 1, USNM 878001; height 41.3 mm, diameter 20.9 mm; Guadeloupe, F. W. I. Fig. 2, Mus. Nacl. Rio de Janiero 2953-1 (holotype – *Murex sutilis* White); height 38 mm, diameter 17 mm (*fide* White, 1887, p. 138; *ex*

PLATE 1

Figures Page

1-5. *Haustellum messorius* (Sowerby) 9

1. (X 1 1/2) USNM 878001; height 41.3 mm, diameter 20.9 mm.
Locality: Guadeloupe, F. W. I; Recent.
2. (X 1 1/2) Mus. Nacl. Rio de Janiero 2953-1 (holotype – *Murex sutilis* White); height 38 mm, diameter 17 mm (*fide* White, 1887, p. 138; *ex* White, 1887, pl. 11, fig. 11).
3. (X 1) USNM 878002; height 46.7 mm, diameter 32 mm.
Locality: TU R-109, Panama; sub-Recent.
4. (X 1 1/2) USNM 323852; height 36.6 mm, diameter 21.6 mm.
Locality: TU 1215, Dominican Republic; Gurabo Formation.
5. (X 1 1/2) UCMP 38644; height 26.5 mm, diameter 15 mm.
Locality: UCMP S-64, Bolívar, Colombia; Tubará Group.

7-8. *Haustellum gilli* (Maury) 12

7. (X 1 1/2) USNM 450345; height 34.6 mm, diameter 21.4 mm.
Locality: TU 951, Florida; Chipola Formation.
8. (X 1 1/4) UCMP 38645; height 39.8 mm, diameter (including spines) 28.4 mm.
Locality: UCMP S-8360, Paraguaná Peninsula, Venezuela; Cantaure Formation.

6, 9, 10. *Haustellum chrysostoma* (Sowerby) (X 1) 13

6. BMNH 1974-90 (syntype – *M. bellus* Reeve); height 53.4 mm, diameter 27 mm.
Locality: Unknown; Recent.
9. USNM 643760, height 47 mm, diameter 29 mm.
Locality: USGS 18253, Cabo Blanco, Venezuela; Mare Formation.
10. UCMP 38646; height 50.9 mm, diameter 36 mm.
Locality: UCMP S-110, Cumaná, Venezuela; Cumaná Formation.

11. *Haustellum polynematicus* (Brown and Pilsbry) (X 1 1/2) 13
USNM 450346; height 36.8 mm, diameter 23.4 mm.
Locality: TU 958, Panama; Gatun Formation.
(Color pattern under ultraviolet light)

12. *Haustellum rubidus* (Baker) (X 1 1/2) 17
USNM 878003; height 30.5 mm, diameter 16.4 mm.
Locality: TU R-42, off Florida; Recent.

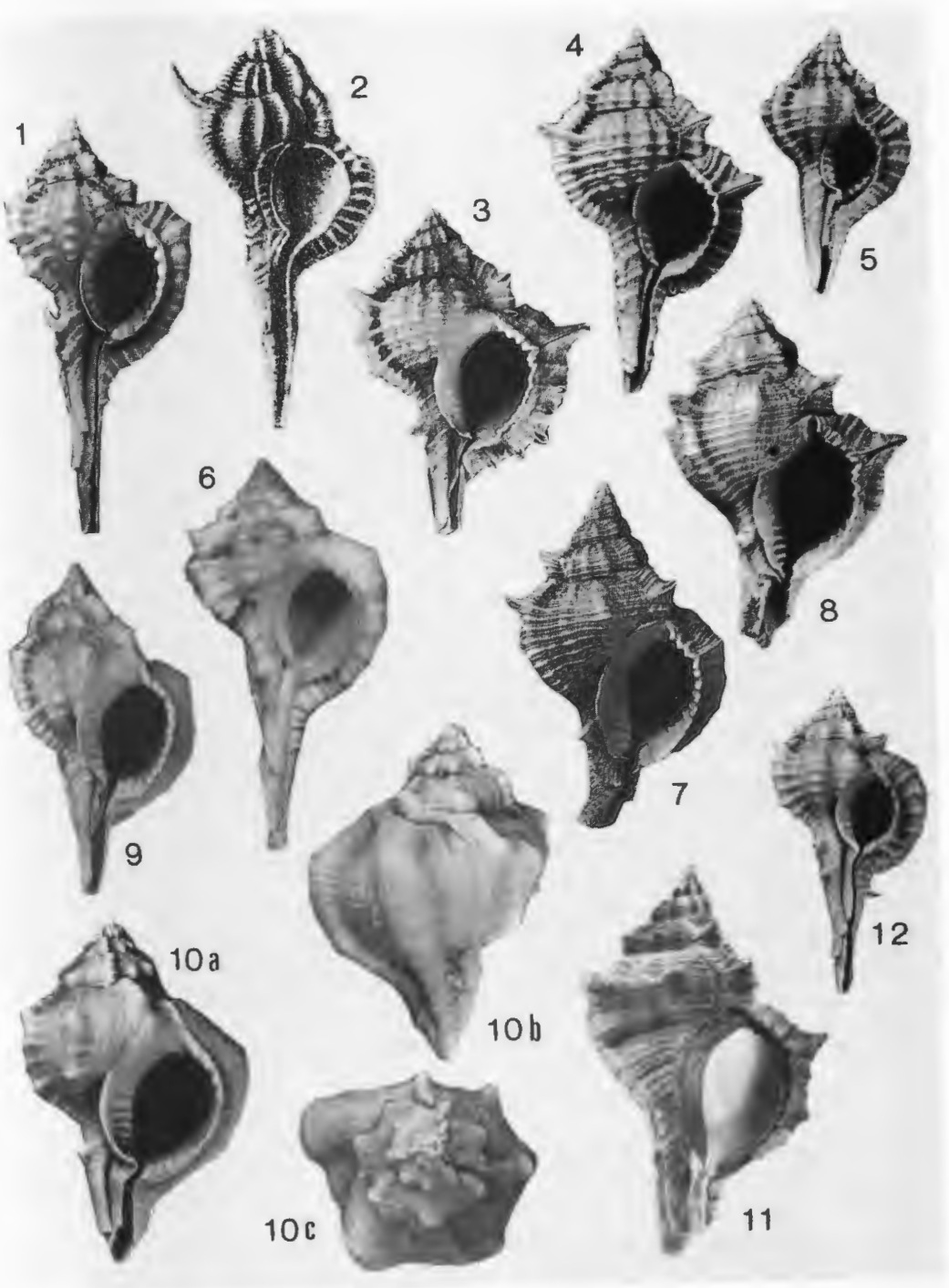


PLATE 1

White, 1887, pl. 11, fig. 11). Fig. 3, USNM 878002; height 46.7 mm, diameter 32 mm; locality TU R-109. Fig. 4, USNM 323852; height 36.6 mm, diameter 21.6 mm; locality TU 1215. Fig. 5, UCMP 38644; height 26.5 mm, diameter 15 mm; locality UCMP S-64, Depto. de Bolívar, Colombia. Additional localities: TU 589, 635, 705, 757, 958, 967, 1241. For localities in the Dominican Republic, see Vokes, 1989b, p. 27.

Discussion: The species *H. messorius* is among the most widespread and abundant in the western Atlantic. It is the oldest known species of *Haustellum,* first occurring in the Pirabas Limestone, and continuing throughout the geologic record up to the present. It is especially common in all of the more shallow-water Neogene formations of the Dominican Republic and has been discussed extensively in the report on that country (Vokes, 1989b, p. 25). In addition to the citations given in the synonymy above, there are a number of other references to occurrences in the Dominican Republic given in that publication. These are all unillustrated lists of fossil occurrences and are not repeated here.

In the Recent fauna the species is widespread throughout the region south of Florida and north of Brazil. There have been a number of names proposed for what I consider infraspecific variations, all of which have been figured, some in color, in a popular work (Vokes, 1990a) on the subject.

Gonzalez and Flores (1972, p. 76, text-fig. 8) have illustrated six specimens of what they call "*Murex* cf. *messorius,*" from the coast of Venezuela. Their uncertainty is understandable, as the specimens are certainly atypical with low spires and almost square whorls, as a result of a strong spiral cord at the base of the body whorl. Given the species variability of *H. messorius,* they are probably just that – atypical specimens – but they may prove to be a new species.

HAUSTELLUM PENNAE (Maury)
Plate 2, figure 4

Murex domingensis Sowerby. MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 102(266) [in part, "the mutation with four or five intervarical ribs" only], pl. 16(42), fig. 5.

Murex pennae MAURY, 1925, Ser. Geol. Min. Brazil, Mon. 4, p. 141, pl. 6, fig. 4.

Murex (Murex) pennai Maury [emend.]. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 102, pl. 4, fig. 5 (*ex* Maury, 1925, pl. 6, fig. 4).

Murex (Murex) domingensis Sowerby. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, pl. 2, fig. 7 only (not of Sowerby).

Murex (Haustellum) pennae Maury. VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 27, pl. 1, figs. 9-13.

Holotype: Not found; height 50 mm, diameter 20 mm (*fide* Maury, 1925).

Type locality: Pirabas Limestone; mouth of Rio Pirabas, State of Pará, Brazil.

Occurrence: Pirabas Limestone, Brazil; Cercado and Gurabo formations, Dominican Republic.

Figured specimen: USNM 323854; height 48 mm, diameter 23.1 mm; locality TU 1219. For additional localities in the Dominican Republic, see Vokes, 1989b, p. 30.

Discussion: This is one of the more common species in the Cercado Formation and shallow-water portions of the Gurabo Formation in the Dominican Republic. It has been discussed extensively in the Dominican Republic report (Vokes, 1989b, p. 27) and little needs to be added here. As noted in that discussion, *H. pennae* is much more similar to the Recent Indo-Pacific species *H. mindanaoensis* (Sowerby, 1841) than it is to any western Atlantic form, fossil or Recent. The relationships certainly are not understood.

HAUSTELLUM GILLI (Maury)
Plate 1, figures 7, 8

Murex (Murex) gilli Maury. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 100, pl. 2, figs. 1-4.

Chicoreus (Siratus) gilli (Maury). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 183; VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 5.

Murex (Murex) polynematicus Brown and Pilsbry. JUNG, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 520, pl. 69, fig. 6 (not of Brown and Pilsbry).

Murex (Haustellum) gilli (Maury). VOKES, 1988, Tulane Stud. Geol. Paleont., v. 21, no. 1, p. 17.

Holotype: USNM 639075; height 9 mm, diameter 4 mm.

Type locality: Oak Grove Sand; Oak Grove, Florida (= TU 91).

Occurrence: Oak Grove Sand and Chipola Formation, Florida; Cantaure Formation, Venezuela.

Figured specimens: Fig. 7, USNM 450345; height 34.6 mm, diameter 21.4 mm; locality TU 951. Fig. 8, UCMP 38645; height 39.8 mm, diameter (including spines) 28.4 mm; locality UCMP

S-8360, Paraguaná Peninsula, Venezuela. Additional localities: TU 457, 554, 555, 655, 709, 711, 787, 818, 820, 823, 825, 827, 830, 831, 998, 999, 1051, 1269.

Discussion: As noted in a previous paper (Vokes, 1988, p. 17), specimens from the Early Miocene Cantaure Formation of Venezuela, cited as *M. polynematicus* by Jung (1965, p. 520, pl. 69, fig. 6) are better referred to the correlative *H. gilli,* although there is a certain resemblance to the younger Panamanian *H. polynematicus.* We have several specimens from the Cantaure Formation (TU 1269) and they lack the lower spire, smaller aperture and, especially, the second varical spine, characters that distinguish *H. polynematicus* from *H. gilli* (compare pl. 1, figs. 7, 8, and 11).

HAUSTELLUM POLYNEMATICUS
(Brown and Pilsbry)
Plate 1, figure 11

Murex (Murex) gilli polynematicus Brown and Pilsbry. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 101, pl. 2, fig. 5.

Murex messorius Sowerby. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, pl. 3, fig. 8 only (not of Sowerby).

Murex (Murex) polynematicus Brown and Pilsbry. OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 137, pl. 29, figs. 2, 2a.

Chicoreus (Siratus) gilli polynematicus (Brown and Pilsbry). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 183.

Not *Murex (Murex) polynematicus* Brown and Pilsbry. JUNG, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 520, pl. 69, fig. 6 [= *H. gilli* (Maury)].

Murex (Haustellum) polynematicus Brown and Pilsbry. VOKES, 1988, Tulane Stud. Geol. Paleont., v. 21, no. 1, p. 17, pl. 1, fig. 6.

Haustellum polynematicus (Brown and Pilsbry). VOKES, 1989, Tulane Stud. Geol. Paleont., v. 22, no. 4, p. 112, pl. 1, fig. 2.

Holotype: Acad. Nat. Sci. Philadelphia, ANSP 1719; height 54.5 mm, diameter 33.7 mm.

Type locality: Gatun Formation; Gatun Locks, Panama.

Occurrence: Angostura Formation and Esmeraldas Beds, Ecuador; Gatun Formation, Panama; (?)Angostura Formation, Nariño, Colombia.

Figured specimen: USNM 450346; height 36.8 mm, diameter 23.4 mm; locality TU 958. Additional localities: TU 757, 959, 961, 1398, 1431, 1432, 1433, 1507.

Discussion: Haustellum gilli and *H. polynematicus* have been a problem with regard to their proper generic placement. With a better understanding of the relationship between *Murex* s.s. and *Haustellum* this problem is finally resolved (to my satisfaction, at least), for among the muricids of the region, these two, plus their close relative *H. chrysostoma* (Sowerby) [see below], are the most similar to typical Indo-Pacific species of *Haustellum.*

This species has been discussed in two other papers (Vokes, 1988, p. 18; 1989c, p. 112) dealing with the Mio-Pliocene of the Pacific coast of Ecuador where the species occurs, as well as in southern Colombia. But the form is most common in the Gatun Formation, from whence it was originally described. In the Tulane Collections there are over 300 specimens from seven Gatun localities.

As noted elsewhere (Vokes, 1989b, p. 24, etc.), the presence of wide brown spiral bands is characteristic of most species of *Haustellum.* Although the line of *H. gilli-H. polynematicus* is now extinct and there are no living descendants, examination of *H. polynematicus* under ultraviolet light reveals that it (and presumably *H. gilli* also) had the typical color pattern (see pl. 1, fig. 11).

HAUSTELLUM CHRYSOSTOMA (Sowerby)
Plate 1, figures 6, 9, 10

Murex (Murex) chrysostomus [*sic*] Sowerby. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 109, pl. 4, fig. 9.

Murex (Murex) chrysostoma Sowerby. JUNG, 1969, Bulls. Amer. Paleontology, v. 55, no. 247, p. 489, pl. 49, figs. 8-10.

Not *Murex chrysostoma* Sowerby var.? RIOS, 1970, Coastal Brazilian Seashells, p. 77, pl. 21; RIOS, 1975, Brazilian Marine Moll. Icon., p. 84, pl. 24, fig. 339 [= *Chicoreus (Siratus) carolynae* Vokes].

Murex chrysostomus [*sic*] Sowerby. GONZALEZ and FLORES, 1972, Bol. Inst. Oceanogr. Univ. Oriente, v. 11, no. 2, p. 79, text-figs. 2c (radula, as *Thais haemastoma floridana,* not fig. 9c, as stated), 11.

Not *Murex chrysostoma* Sowerby. RIOS, 1985, Seashells of Brazil, p. 81, pl. 29, fig. 354 [= *Chicoreus (Siratus) carolynae* Vokes].

Murex chrysostoma Sowerby. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 64, pl. 10, figs. 10, 11; FAIR, 1976, The Murex Book, p. 30, pl. 3, fig. 18 (?syntype).

Murex messorius Sowerby. PETUCH, 1988, Neogene History Trop. Amer. Moll., p. 157,

pl. 37, fig. 13 (not of Sowerby).
Haustellum chrysostoma (Sowerby). VOKES, 1989, Tulane Stud. Geol. Paleont., v. 22, no. 4, p. 123, pl. 1, figs. 1-3.

? Synonym:

Murex bellus REEVE, 1845, Conch. Icon., v. 3, *Murex*, pl. 21, fig. 84; REEVE, 1846, Zool. Soc. London, Proc., pt. 13 (1846), p. 88.
Murex bellus Reeve (= *Murex chrysostoma*). CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1,no. 17, p. 10; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 64, pl. 10, fig. 11.
Murex messorius Sowerby. FAIR, 1976, The Murex Book, pl. 3, figs. 34, 35 only.

Holotype: Not found; height 71 mm, diameter 38.2 mm (measurements of specimen figured by Sowerby, 1834, pl. 58, fig. 1).

Type locality: Tobago Island, Trinidad and Tobago (designated by Clench and Pérez Farfante, 1945, p. 12).

Occurrence: Bahía Formation, Ecuador; Melajo Clay, Trinidad; Mare and Cumaná formations, Venezuela. Recent, northern South America, from Goajira Peninsula, Colombia, to Trinidad and Tobago (Vokes, 1989d, p. 126).

Figured specimens: Fig. 6, BMNH 1974-90 (syntype – *M. bellus* Reeve); height 53.4 mm, diameter 27 mm; locality unknown. Fig. 9, USNM 643760, height 47 mm, diameter 29 mm; locality USGS 18253, Cabo Blanco area, Venezuela. Fig. 10, UCMP 38646; height 50.9 mm, diameter 36.0 mm; locality UCMP S-110, Cumaná, Edo. de Sucre, Venezuela.

Discussion: In a recent paper (Vokes, 1989d), this species was reported from the Early Pliocene Bahia Formation of the Pacific coast of Ecuador. In view of the fact that today *H. chrysostoma* is limited to northern South America, this is a considerable range extension. It is not, however, an extension of age, as Jung (1969, p. 489, pl. 49, figs. 8-10) has reported the species from the Late Miocene Melajo Clay of Trinidad.

In the same paper its resemblance to the Miocene to Recent species *H. messorius* (Sowerby) was examined in detail and it was concluded that *H. chrysostoma* is generally larger, smoother, has a more appressed suture, a more inflated body whorl and a larger aperture, with a more expanded parietal shield that is at least partially yellow in color.

PLATE 2

Figures Page

1, 2. *Haustellum mimiwilsoni* Vokes, n. sp. 16
1. (X 1) UCMP 14142 (holotype); height 60 mm, diameter 39.7mm.
Locality: UCMP S-122, Isla Cubagua, Venezuela; Cumaná Formation.
2. USNM 323864 (paratype); height (incomplete) 13.4 mm, diameter 13.5 mm (fig. 2a, X 3; fig. 2b, X 10).
Locality: TU 589, Costa Rica; Río Banano Formation.
3. ?*Haustellum adelosus* (Vokes) (X 1 1/2) 17
NMB H 17000 (holotype); height 42.7 mm, diameter 24.4 mm.
Locality: NMB 16818, Cañada de Zamba, Dominican Republic (= TU 1354); Gurabo Formation.
4. *Haustellum pennae* (Maury) (X 1 1/2) 12
USNM 323854; height 48 mm, diameter 23.1 mm.
Locality: TU 1219, Dominican Republic; Gurabo Formation.
5, 6. *Haustellum olssoni* (Vokes) 20
5. (X 1 1/2) USNM 450347; height 38.5 mm, diameter (including spines) 23.8 mm.
Locality: TU 954, Costa Rica; Moín Formation.
6. (X 10) USNM 878004; height 17.6 mm, diameter (excluding spines) 7.6 mm.
Locality: TU R-101, off Panama; Recent.
7-9. *Haustellum donmoorei* (Bullis) 18
7. (X 1 1/4) USNM 878005; height 50.8 mm, diameter 26 mm.
Locality: off Guyana; Recent.
8. (X 10) Vokes Coll. (paratype); height 34.2 mm, diameter (including spines) 16.3 mm.
Locality: *Oregon* Sta. 2275, off Suriname; Recent.
9. (X 1) PRI 26200 (paratype – *M. olssoni* Vokes); height (incomplete) 50 mm, diameter 33 mm.
Locality: Cabo Blanco, Venezuela; Mare Formation.

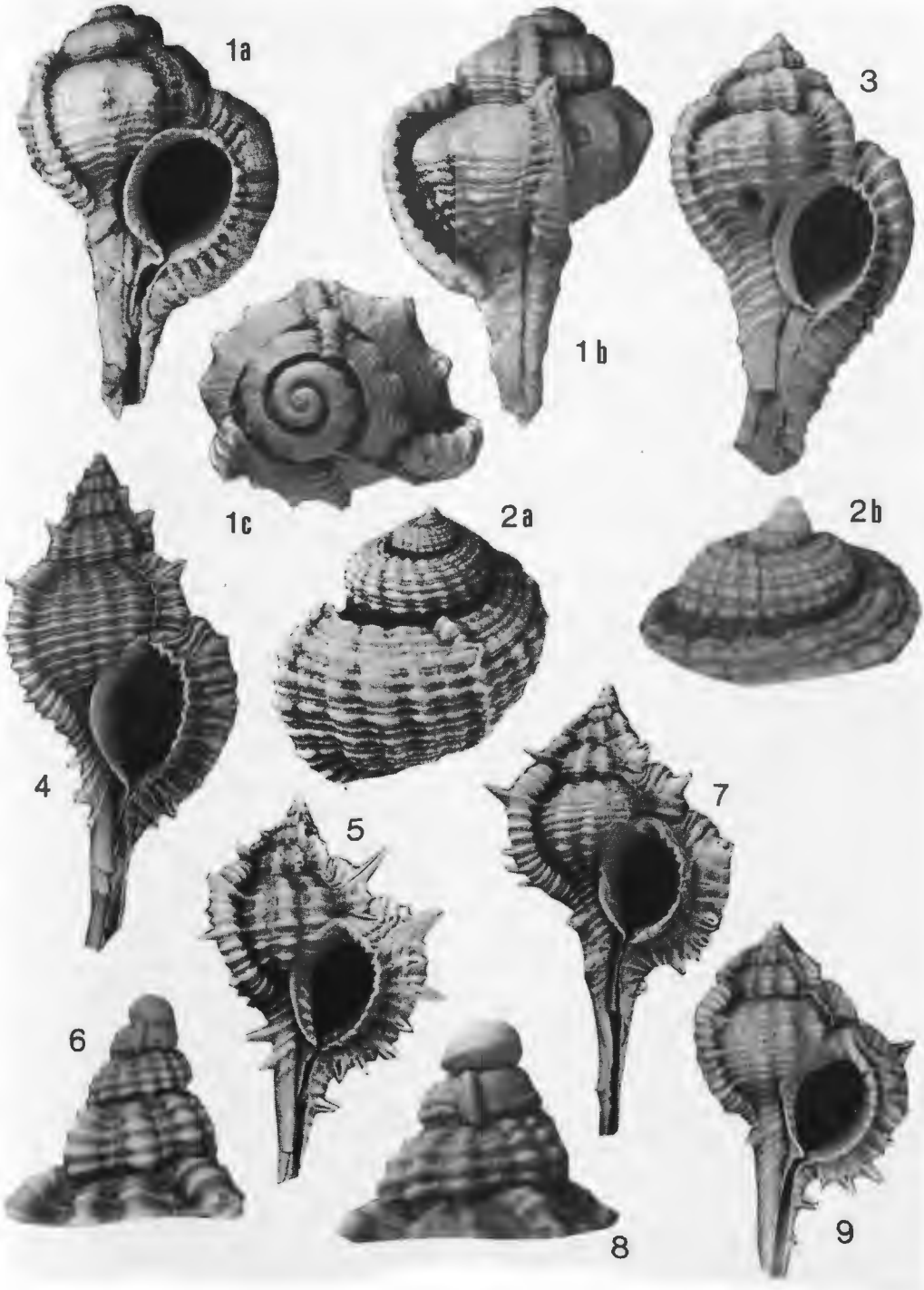


PLATE 2

The species *Murex bellus* Reeve has been considered by most writers to be a synonym of *H. chrysostoma*. Examination of the type lot in the British Museum (Natural History) shows that there are certain differences. The shell is generally smaller, with a less inflated body whorl. Examples that match the lectotype (BMNH 1974-90; see pl. 1, fig. 6 herein) best (*e.g.*, Radwin and D'Attilio, 1976, pl. 10, fig. 11; de Jong and Coomans, 1988, pl. 36, fig. 389B) come from Aruba or Curaçao. According to de Jong and Coomans (1988, p. 71), both forms live within 12 km of each other, but the specimens that match *H. bellus* live under sand, and those that match *H. chrysostoma* (de Jong and Coomans, 1988, pl. 36, fig. 389A) live on a muddy substrate. Therefore, the *H. bellus* type is probably just an ecophenotypic variation.

Petuch (1976) has described the ecology of a community that includes *H. chrysostoma*, along the coast of Venezuela. He notes that the species feeds on *Chione*, *Tellina*, and *Macoma*.

In the collections of the Museum of Paleontology, University of California, Berkeley, there are several specimens of *H. chrysostoma* from the type locality of the Cumaná Formation at Cumaná, Edo. de Sucre, Venezuela. At one of the localities (S-110, 2.5 km northeast of the "Castillo") there are several examples that are either gerontic or some sort of ecologic variants. They begin as normal shells with three varices but on the last whorl develop an extra varix (see pl. 1, fig. 10).

HAUSTELLUM MIMIWILSONI Vokes, n. sp.
Plate 2, figures 1, 2

Murex (Haustellum) sp. VOKES, 1974, Malac. Soc. Australia, Jour., v. 3, no. 1, p. 13, pl. 3, fig. 2.

Murex (?Haustellum) species aff. *M. wilsoni* (D'Attilio and Old). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 30, pl. 1, fig. 8.

Description: Shell consisting of probably four teleoconch whorls and a protoconch of three and one-half smooth, slightly bulbous whorls, ending at a small varix. Spiral ornamentation on earliest teleoconch whorls of several alternating wide and narrow flattened cords, gradually increasing in number to approximately 10 major cords on the body whorl, plus an additional two major cords on siphonal canal. Axial ornamentation on earliest teleoconch whorls of faint ridges, giving an undulatory appearance to the spiral cords; about 24 ridges per whorl until on fourth post-nuclear whorl three of these ridges strengthen into varices, with others remaining as three elongate swellings between each pair of varices. On body whorl the portion of these ridges at the shoulder more produced, forming pointed nodes. Varices rounded, ornamented only by the spiral cords passing over, greatly excavated abaperturally. Whorls inflated, suture with a deep channel, sharply edged by the posteriormost spiral cord, crossed only by adapical portion of varices. Aperture circular, almost entire; inner lip appressed at posterior end, free standing and expanded at anterior end, marked by numerous elongate rugae over entire length. Inside of outer lip with faint elongate lirations, approximately corresponding to spaces between major cords. Siphonal canal long, straight, almost closed over but open by a narrow slit.

Holotype: Museum of Paleontology, University of California, Berkeley, UCMP 14142; height 60 mm, diameter 39.7 mm. Collected by P. Andrews, C. T. Newcomb, and L. W. Henry, March 9, 1930.

Type locality: UCMP S-122, Cumaná Formation; about 400 m south of house at Las Calderas, Isla Cubagua, Edo. de Nueva Esparta, Venezuela.

Etymology of name: *mimus* (L.) = mimic + *wilsoni*, an Australian species.

Occurrence: Cumaná Formation, Venezuela; Río Banano Formation, Costa Rica.

Figured specimens: Fig. 1, UCMP 14142 (holotype). Fig. 2, USNM 323864 (paratype); height (incomplete) 13.4 mm, diameter 13.5 mm; locality TU 589.

Discussion: In the collections of the Museum of Paleontology, University of California, Berkeley, there is a single specimen of a most unusual species of *Haustellum*. I originally considered this species an American "ancestor" of the Recent Australian *H. wilsoni* D'Attilio and Old, 1971 (Vokes, 1974b, p. 13). At that time there was just this unique example, but subsequent collecting has provided a second incomplete specimen, which is placed in the same species. Unfortunately the early whorls of the Venezuelan shell are completely eroded, and the later whorls of the Costa Rican shell are lacking, so this is not absolutely certain. The two are so totally different from all other American species that the two specimens are believed to be the same species.

The similarity to *H. wilsoni* is striking. One difference is the nature of the protoconch, which in *H. wilsoni* is extremely large (2.5 mm in diameter in contrast to 1.0 mm in the new species), and another is the lack of rugae on the inner lip of the Australian species. The two shells are figured for comparison in the aforementioned paper (Vokes, 1974b, pl. 3, figs. 1 and 2).

The only American species that has even a slight resemblance is the Dominican *?H. adelosus* (Vokes, 1989), discussed below. This species has a similar-sized protoconch but with only two whorls in contrast to the three and one-half whorls in *H. mimiwilsoni;* the siphonal canal is wider, with a small varical flange along its length; and the suture is not channeled. However, this species is the only apparently related form outside of Australia.

?HAUSTELLUM ADELOSUS (Vokes)
Plate 2, figure 3

Murex (?Haustellum) adelosus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 30, pl. 1, figs. 6, 7.

Holotype: Naturhistorisches Museum Basel, NMB H 17000; height 42.7 mm, diameter 24.4 mm.

Type locality: Gurabo Formation; Cañada de Zamba, west side of Río Cana, approximately 4.5 km (airline) below the ford at Caimito, Dominican Republic (= TU 1354).

Occurrence: Cercado and Gurabo formations, Dominican Republic.

Figured specimen: NMB H 17000 (holotype). For additional localities in the Dominican Republic, see Vokes, 1989b, p. 31.

Discussion: This unusual species, known only from the Dominican Republic, does not resemble any other species of muricid, except *H. mimiwilsoni,* as noted above. Furthermore, *H. adelosus* is unique in possessing an expanded varical flange along the siphonal canal, which makes its assignment to the genus *Haustellum* questionable. But, as there is no other genus to which it bears a closer relationship, and given the apparent close relationship with *H. mimiwilsoni,* it will be placed here provisionally.

All of the localities at which this species is found are coral reefs, and it is presumed that this species was a reef-dweller. It is regretable that there is no living descendant to which we may compare *?H. adelosus* for verification of this ecological information.

HAUSTELLUM RUBIDUS (F. C. Baker)
Plate 1, figure 12

Murex (Murex) rubidus Baker. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 108, pl. 4, figs. 3, 4.

Murex rubidus Baker. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 71, pl. 11, fig. 15; FAIR, 1976, The Murex Book, p. 73, pl. 3, fig. 40.

Synonyns:

Murex cracherodi SOWERBY, 1879, Thes. Conch., v. 4, *Murex,* p. 5 [nude name; label in BMNH on specimen of *H. rubidus*].

Murex marcoensis SOWERBY, 1900, Jour. of Malacology, v. 7, p. 162 (figured, with name spelled *narcoensis* in error).

Murex recurvirostris delicatus M. SMITH, 1940, Nautilus, v. 54, p. 45.

Murex citrinus M. SMITH, 1940, Nautilus, v. 54, p. 45; CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 8, pl. 3, fig. 6 (holotype).

Lectotype (designated by Clench and Pérez Farfante, 1945, p. 8): Harvard Mus. Comp. Zool., MCZ 147272; height 37.4 mm, diameter 21.5 mm (as figured by Clench and Pérez Farfante, 1945, pl. 3, fig. 2)

Type locality: Cedar Keys, Florida.

Occurrence: Pinecrest, Caloosahatchee, and Bermont formations, Florida; Moín Formation, Costa Rica. Recent, North Carolina to northern South America.

Figured specimen: USNM 878003; height 30.5 mm, diameter 16.4 mm; locality TU R-42. Additional localities: TU 536, 579, 580, 583, 725–27, 729, 733, 743, 747, 755, 759, 767–70, 788, 792, 802, 803, 939, 954, 973, 975, 978, 991, 1000, 1023, 1174, 1175, 1177, 1240, 1491, 1512, 1524.

Discussion: Haustellum rubidus is common in the Plio-Pleistocene beds of southern Florida. However, there are also rare specimens from the Moín Formation, Costa Rica (TU 954, 1240). The more southern specimens differ slightly from the typical form in that they have a more appressed suture but otherwise the shells are indistinguishable. In the Recent fauna the species occurs, for the most part, from North Carolina to the east and west coasts of Florida and the Bahama Islands. But it also occurs off northern Honduras (Bay Islands, Kevan Sunderland Collection), northern South America (to Ceará, Brazil: Rios, 1985, p. 82) and very fine specimens are being dredged off the Atlantic coast of Panama in about 36 meters.

The species is extremely close to *H. messorius* and may be distinguished princi-

pally by its smaller size. This causes difficulty with young examples of *H. messorius*, but at equal height, *H. messorius* has one less whorl than *H. rubidus*. The protoconchs are also slightly different; that of *H. messorius* has one and one-half whorls but *H. rubidus* has about one and three-quarters whorls (*not* two and one-half, as stated in Radwin and D'Attilio, 1976, p. 71). The intervarical nodes are larger in *H. rubidus* and the spiral ornamentation less pronounced, giving the shell a "smoother" aspect than the more nodulose *H. messorius*.

HAUSTELLUM DONMOOREI (Bullis)
Plate 2, figures 7-9

Murex recurvirostris Broderip. RUTSCH, 1934, Schweizer. Palaeont. Gesell., Abh., v. 54, no. 3, p. 64, pl. 4, fig. 1; v. 55, no. 1, p. 136 (not of Broderip).

Murex (Murex) recurvirostris recurvirostris Broderip. WEISBORD, 1962, Bulls. Amer. Paleontology, v. 42, no. 193, p. 278, pl. 26, figs. 3, 4 (not of Broderip).

Murex (Murex) donmoorei BULLIS, 1964, Tulane Stud. Zoology, v. 11, no. 4, p. 101, figs. 1, 2; BAYER, 1971, Bull. Mar. Sci., v. 21, no. 1, p. 152, fig. 25 (two specimens).

Murex (Murex) olssoni VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 84 [in part, Cabo Blanco paratype only], pl. 3, fig. 3 only.

Murex donmoorei Bullis. GONZALEZ and FLORES, 1972, Bol. Inst. Oceanogr. Univ. Oriente, v. 11, no. 2, p. 78, text-figs. 2b (radula, as *Thais rustica*, not fig. 9b, as stated), 10; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 65, pl. 10, fig. 3, text-fig. 36 (protoconch); FAIR, 1976, The Murex Book, p. 38, pl. 3, fig. 38 (holotype); PETUCH, 1987, p. 88, pl. 18, fig. 5 (same specimen as Bayer's upper figure).

Holotype: USNM 635146; height 50 mm, diameter (excluding spines) 22.5 mm.

PLATE 3

Figures — Page

1-3. *Haustellum anniae* (Smith) (X 1 1/2) 21
1. USNM 608528; height 36 mm, diameter (excluding spines) 16 mm.
Locality: off Yucatán Peninsula; Recent.
2. USNM 878006; height 32.3 mm, diameter (excluding spines) 13 mm (fig. 2b, X 10).
Locality: TU R-42, off Florida; Recent.
3. USNM 450348; height 37.5 mm, diameter (excluding spines) 16.3 mm (fig. 3b, X 10).
Locality: TU 759, Florida; Bermont Formation.

4-8. *Haustellum bellegladeensis* (Vokes) (X 1 1/2) 21
4. USNM 450349; height 38.3 mm, diameter 19.3 mm.
Locality: TU 539B, Florida; Caloosahatchee Formation.
5. USNM 450350; height 41.5 mm, diameter 22.5 mm.
Locality: TU 727, Florida; Bermont Formation.
6. (X 10) USNM 450351; height 27.9 mm, diameter (excluding spines) 16 mm.
Locality: TU 201, Florida; Bermont Formation.
7. USNM 878007; height 37.4 mm, diameter 20.5 mm.
Locality: TU R-42, off Florida; Recent.
8. USNM 450352; height 31.4 mm, diameter 21 mm.
Locality: TU 1046, Mexico; Agueguexquite Formation.

9. *Haustellum sallasi* (Rehder and Abbott) (X 1 1/2) 22
USNM 878008; height 36.4 mm, diameter 21 mm.
Locality: off Cabo Catoche, Quintana Roo, Mexico; Recent.

10-12. *Haustellum cabritii* (Bernardi) 23
10. (X 1 1/2) USNM 450353; height (as is) 30.5 mm.
Locality: TU 953, Costa Rica; Moín Formation.
11. (fig. 11a, X 2; fig. 11b, X 10) USNM 450354; height (incomplete) 18.5 mm, diameter (excluding spines) 11 mm.
Locality: TU 954, Costa Rica; Moín Formation.
12. (X 2) USNM 450355; height (as is) 36.4 mm.
Locality: TU 954, Costa Rica; Moín Formation.

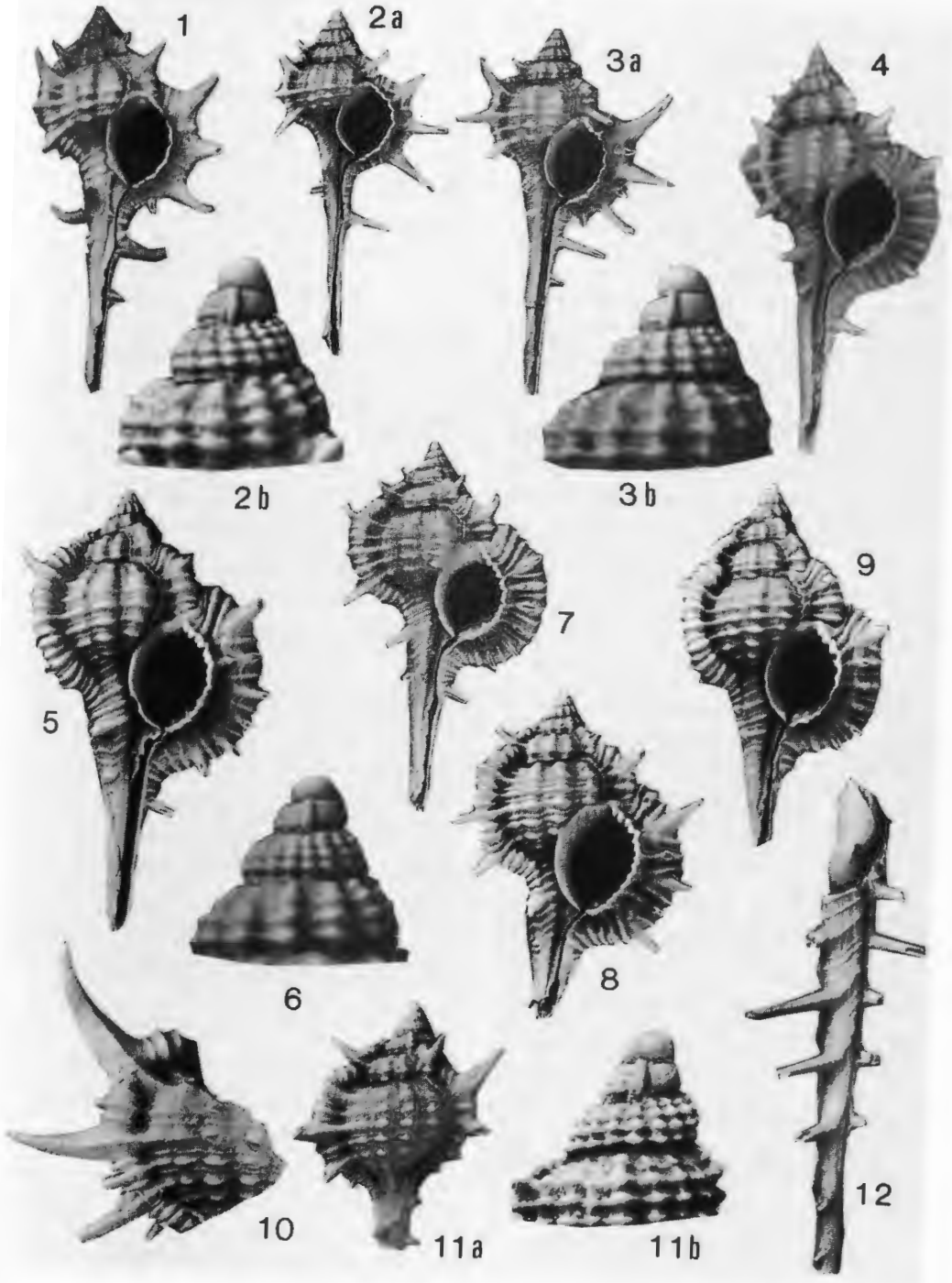


PLATE 3

Type locality: *Oregon* Station 2254, 45 mi north of St. Andrews Point, British Guiana (Guyana), 20-22 fms (37-40 m).

Occurrence: Punta Gavilan and Mare formations, Venezuela. Recent, northern South America, from French Guiana to Venezuela.

Figured specimens: Fig. 7, USNM 878005; height 50.8 mm, diameter 26 mm; off Guyana, 45-54 m. Fig. 8, Vokes Coll. (paratype); height 34.2 mm, diameter (including spines) 16.3 mm; locality *Oregon* Sta. 2275, off Suriname. Fig. 9, PRI 26200 (paratype – *M. olssoni* Vokes); height (incomplete) 50 mm, diameter 33 mm; locality, Cabo Blanco, Venezuela.

Discussion: In the original description of *H. olssoni* (Vokes, 1967a, p. 84), specimens from the Plio-Pleistocene of Venezuela at Punta Gavilan and Cabo Blanco were included in that species. However, examination of material from these formations in the collections of the Naturhistorisches Museum Basel shows the shells to have a keeled protoconch, which is characteristic of *H. donmoorei* (compare pl. 2, figs. 6 and 8), as well as the wider body whorl with four or five axial ridges in contrast to the three generally present in *H. olssoni*. A few specimens also show several spines on the siphonal canal.

HAUSTELLUM OLSSONI (Vokes)
Plate 2, figures 5, 6

Murex recurvirostris Broderip. GABB, 1881, Acad. Nat. Sci. Phila., Jour., (Ser. 2) v. 8, pt. 4, p. 349 (not of Broderip).

Murex (Murex) olssoni VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 84 [in part, not all localities], pl. 3, figs. 1, 2 only [fig. 3 = *H. donmoorei* (Bullis)]; BAYER, 1971, Bull. Mar. Sci., v. 21, no. 1, p. 151, text-fig. 24.

Murex olssoni Vokes. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 69, pl. 7, fig. 6, pl. 14, fig. 8; FAIR, 1976, The Murex Book, p. 64, pl. 2, fig. 14 (holotype).

Holotype: USNM 677704; height 52 mm, diameter (excluding spines) 23 mm.

Type locality: *Oregon* Station 4896, Gulf of Morrosquillo, Colombia, 23-27 fms (42-49 m).

Occurrence: Tubará Group, Colombia; Moín Formation, Costa Rica. Recent, off Panama and Colombia.

Figured specimens: Fig. 5, USNM 450347; height 38.5 mm, diameter (including spines) 23.8 mm; locality TU 954. Fig. 6, USNM 878004; height 17.6 mm, diameter (excluding spines) 7.6 mm; locality TU R-101. Additional localities: TU 953, 956, 1239, 1240, 1307, 1495, 1496.

Discussion: When this species was originally described, we had only a small amount of fossil material collected by Axel Oisson in what he termed the "upper Gatun formation" at Puerto Limón. Since that time we have collected extensively in the Limón area and we now recognize two units: the "upper Gatun," which is the mid-Pliocene Río Banano Formation; and the Moín Formation, which is the "coralline limestone" of Olsson (1922) and is younger – Early to mid-Pleistocene in age. The species of *Haustellum* in the Río Banano is *H. messorius* and that in the Moín is *H. olssoni*. This is a result of environment rather than age, as both species are still present in the southern Caribbean; however, *H. olssoni* lives in water averaging about 60 meters in depth (see Bayer, 1971, p. 151, for an extensive list of stations) in contrast to the much shallower habitat of *H. messorius*.

At the time of the original description, specimens from the Punta Gavilan and Mare formations of Venezuela were included. As discussed above, these are now referred to *H. donmoorei*. Specimens from the Agueguexquite Formation, Mexico, are better placed in *H. bellegladensis* (see below).

Although this species is most abundant in the Pleistocene Moín Formation (we have hundreds of specimens from numerous localities), in the collections of the Museum of Paleontology, University of California, Berkeley, there are two specimens from the Tubará Group at Punta Pua (about 25 km northeast of Cartegena, Depto. de Bolívar), Colombia. The presence of this species, known elsewhere only from the Pleistocene and Recent Fauna, is one of the reasons for dating the upper Tubará Group as also Pleistocene in age.

It would appear that *H. olssoni* and *H. donmoorei* occupy approximately the same ecologic niche, with no known overlap in distribution. According to Bayer (1971, pp. 151-152) *H. olssoni* is found off Panama and Colombia, and *H. donmoorei* is taken from off Venezuela east to the Guianas. However, *H. olssoni* lives in somewhat deeper water (about 60 meters, average, in contrast to about 40 meters, average, for *H. donmoorei*, according to Bayer).

HAUSTELLUM ANNIAE (M. Smith)
Plate 3, figures 1-3

Murex (Murex) anniae Smith. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 110, pl. 4, fig. 2.

Murex anniae Smith. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 61 [in part], pl. 11, fig. 6 only [pl. 7, fig. 15 = *H. bellegladeensis* (Vokes)]; FAIR, 1976, The Murex Book, p. 21, pl. 3, fig. 42 [same specimen figured herein, pl. 3, fig. 1]; PETUCH, 1988, Neogene History Trop. Amer. Moll., p. 154, pl. 32, fig. 6 [also specimen figured herein, pl. 3, fig. 1].

Synonym:

Murex lindajoyceae PETUCH, 1987, New Caribbean Moll. Faunas, p. A1, pl. 29, figs. 1-3.

Holotype: Florida State Museum, US 1350; height 33 mm, diameter 20 mm (*fide* Smith, 1940, p. 44).

Type locality: Bermont Formation; Ortona Lock, Caloosahatchee River, Florida (= TU 79) (*fide* Clench and Pérez Farfante, 1945, p. 6).

Occurrence: Bermont Formation, Florida. Recent, Florida and Yucatán Peninsula.

Figured specimens: Fig. 1, USNM 608528; height 36 mm, diameter (excluding spines) 16 mm; locality, off Yucatán Peninsula. Fig. 2, USNM 878006; height 32.3 mm, diameter (excluding spines) 13 mm; locality TU R-42. Fig. 3, USNM 450348; height 37.5 mm, diameter (excluding spines) 16.3 mm; locality TU 759. Other occurrences: TU localities 79, 539A, 768, 802, 803, 816, 939, 1512.

Discussion: The name *Murex anniae* is the oldest taxon in a group of four closely related species (*anniae, lindajoyceae, bellegladeensis,* and *sallasi*), and for this reason is often used as the name for other members of the group. It is entirely possible that these four represent variations of the same biologic species, but they do have certain geologic and geographic distinctions and I prefer to keep them separate, while bearing in mind the fact that they may be synonyms.

Originally *H. anniae* was described without locality or stratigraphic information. When I originally treated the species (Vokes, 1963a, p. 110) there were only about five specimens known. Three of these are from locality TU 531, at which the other material seems to be from the Caloosahatchee beds, and for this reason I assigned the species to the Caloosahatchee Formation. However, at all Florida spoilbank localities there is always the possibility of more than one formation being present, as it is at the nearby locality TU 283 (just across the road and railroad from TU 531). This seems to be the case, for in all of our subsequent collecting *H. anniae* has been found exclusively in the Bermont Formation, all in western Florida, and almost all along the Caloosahatchee River.

This group of four "species" is marked by having lost the "typical" *Haustellum* rugae on the inner lip, evidently a fairly recent (geologically speaking) development. As noted below, in *H. bellegladeensis* the stratigraphically older specimens commonly have these rugae and in one intermediate specimen, taken to be the "ancestral" *H. anniae,* these rugae are also present.

Although it is difficult to separate the two forms, *H. anniae* is generally recognizable by the greatly reduced strength of the varices. The spines seem to arise from the body itself, rather than being set upon the raised varical ridges (compare pl. 3, figs. 1 and 7, for example) but the individual spines themselves are longer. The intervarical nodes also are less swollen, giving the shell an "emaciated" appearance.

In the fossil record, *H. anniae* and *H. bellegladeensis* do not occur together. There must be some ecologic difference that separates the two, for *H. anniae* is found only in western Florida and *H. bellegladeensis* in eastern Florida. Thus, they might be considered valid geographic subspecies. But, in the Recent fauna this is not the case. Today *H. anniae* occurs on both sides of the Florida peninsula and off Yucatán (pl. 3, fig. 1). This form is especially common in the material dredged off the western coast of Florida (TU R-42) in depths of about 45 meters. These specimens have been named *Murex lindajoyceae* by Petuch (1987, p. A1, pl. 29, figs. 1-3), who considers that *H. anniae* is "a much larger and more robust shell with only two intervarical ribs" (compare pl. 3, figs. 2 and 3). The number of intervarical ribs is not a constant feature. Many specimens of *H. anniae* have three intervarical ridges; generally two are stronger, with the most adapertural one reduced.

HAUSTELLUM BELLEGLADEENSIS (Vokes)
Plate 3, figures 4-8

Murex (Murex) recurvirostris Broderip. PER-

RILLIAT MONTOYA, 1960, Paleontología Mexicana, no. 8, p. 21, pl. 3, figs. 10, 11 (not of Broderip).

Murex (Murex) anniae bellegladeensis VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 111, pl. 4, fig. 1.

Murex bellegladeensis Vokes. FAIR, 1976, The Murex Book, p. 25, pl. 3, fig. 32 (same specimen figured herein, pl. 3, fig. 6); PETUCH, 1988, Neogene History Trop. Amer. Moll., pl. 23, fig. 16 (not in text).

Murex anniae Smith. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 61 [in part], pl. 7, fig. 15 only.

Holotype: USNM 643758; height 40 mm, diameter (excluding spines) 20.5 mm.

Type locality: TU 201, Bermont Formation; two mi south of Belle Glade, Palm Beach County, Florida.

Occurrence: Agueguexquite Formation, Mexico; Caloosahatchee and Bermont formations, Florida; post-Pleistocene, Louisiana. Recent, from Savannah, Georgia, to Galveston, Texas.

Figured specimens: Fig. 4, USNM 450349; height 38.3 mm, diameter 19.3 mm; locality TU 539B. Fig. 5, USNM 450350; height 41.5 mm, diameter 22.5 mm; locality TU 727. Fig. 6, USNM 450351; height 27.9 mm, diameter (excluding spines) 16 mm; locality TU 201. Fig. 7, USNM 878007; height 37.4 mm, diameter 20.5 mm; locality TU R-42. Fig. 8, USNM 450352; height 31.4 mm, diameter 21 mm; locality TU 1046. Additional localities; TU 580, 638, 725, 733, 747, 751, 977, 978, 1023.

Discussion: As noted in the original description, *H. bellegladeensis* is closely related to the Recent *H. sallasi* (Rehder and Abbott). The latter, confined to the area off the east coast of the Yucatán Peninsula, is a narrower shell with almost no varical spines. It is possible that these two forms are synonyms but geologically the more inflated, spinose *H. bellegladeensis* first occurs in the mid-Pliocene Agueguexquite Formation of Mexico. It is common here, originally reported as *Murex recurvirostris* Broderip by Perrilliat Montoya (1960, p. 21, pl. 3, figs. 10, 11); we have many specimens from her locality (= TU 1046) and our locality TU 638. In some Mexican specimens there are still faint rugae on the inner lip, indicating that this is the ancestral form from which all of the varieties being discussed here are derived originally. For this reason, I prefer to maintain the name *H. bellegladeensis*, even though it may actually be a synonym of the older taxon.

In the Tulane Collections from locality TU 539B (Shell Creek, Florida), we have one specimen (pl. 3, fig. 4) that has fairly strong rugae (for the species). Shell Creek is one of the few places in southern Florida where it is (?was) possible to collect in-place material and this shell was found in the Caloosahatchee portion of the section. It is intermediate between typical *H. bellegladeensis*, with heavy varices and intervarical nodes, and *H. anniae* with weak nodes and diminished varices. From the stratigraphical placement of the specimen, it may reveal the beginning of the separation of the *H. anniae* form. Whether it should be referred to *H. bellegladeensis* or to *H. anniae* is a matter of choice, but I consider it closer to *H. bellegladeensis* than to *H. anniae* and, therefore, it is included with this species.

Most specimens of *H. bellegladeensis* and *H. anniae* are easy to separate, but there are occasional long-spined examples of *H. bellegladeensis* that are very like *H. anniae*. Once again, because the *H. bellegladeensis* morph is clearly the ancestral form, I prefer to maintain the species distinction.

As mentioned above, the two forms do not occur together in the Bermont Formation with *H. bellegladeensis* being confined to eastern Florida. In the Recent fauna, however, typical inflated *H. bellegladeensis* occurs off Savannah, Georgia, to off Galveston, Texas. Numerous bright orange specimens have been collected from the "scallop-dumps" in material originally dredged off the east coast of Florida in depths of about 30 meters. It is also common in the material from "Mud-lump 90" (TU 977), which was deposited in water depths of about 60 meters (Morgan, *et al.*, 1963, p. 41) on the basis of the depth ranges of the microfauna.

HAUSTELLUM SALLASI (Rehder and Abbott)
Plate 3, figure 9

Murex recurvirostris sallasi REHDER and ABBOTT, 1951, Soc. Malac. "Carlos de la Torre" (Habana), Rev., v. 8, no. 2, p. 58, pl. 9, figs. 7, 8; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96.

Murex sallasi Rehder and Abbott. FAIR, 1976, The Murex Book, p. 74, pl. 3, fig. 37 (holotype).

Holotype: USNM 597515; height 50 mm, diameter 23 mm.

Type locality: Approximately 60 mi northwest of Cabo Catoche, Quintana Roo, Mexico, 18-20 fms (33-37 m).

Occurrence: Recent only, off northeastern Yucatán Peninsula.

Figured specimen: USNM 878008; height 36.4 mm, diameter 21 mm; locality, off Cabo Catoche, Quintana Roo, Mexico.

Discussion: This species, which may be a senior synonym of *H. bellegladeensis*, is confined to the type area. All specimens seen come from this small area; most have been taken by shrimpers. *Haustellum sallasi* is the least spinose of the group of four species under consideration, and also has a narrower body and higher spire than any of the other forms.

HAUSTELLUM CABRITII (Bernardi)
Plate 3, figures 10-12

Murex cabritii BERNARDI, 1859, Jour. de Conchyl., v. 7, p. 30l, pl. 10, fig. 3; RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 63, pl. 10, fig. 12; FAIR, 1976, The Murex Book, p. 28, pl. 3, fig. 39.

Murex (Murex) cabritii Bernardi. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 3, pl. 1, figs. 1-3; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96; BAYER, 1971, Bull. Mar. Sci., v. 21, no. 1, p. 154, text-fig. 26.

Holotype: Not found; height 65 mm, diameter 25 mm (*fide* Bernardi, 1859, p. 301).

Type locality: Barbados (designated by Clench and Pérez Farfante, 1945, p. 4).

Occurrence: Moín Formation, Costa Rica. Recent, east and west coasts of Florida, Honduras, to Barbados.

Figured specimens: Fig. 10, USNM 450353; height (as is) 30.5 mm; locality TU 953. Fig. 11, USNM 450354; height (incomplete) 18.5 mm, diameter (excluding spines) 11 mm; locality TU 954. Fig. 12, USNM 450355; height (as is) 36.4 mm; locality TU 954. Additional localities: TU 1240, 1307.

Discussion: This well known species has been reported from the fossil record only in passing (Vokes, 1988, p. 20) but there are numerous fragments in the Moín Formation of Puerto Limón, Costa Rica. Today the species lives in water depths of 29-139 meters (16-76 fms) in the Gulf of Mexico (Vokes, 1963a, p. 96) and 18-35 meters off Honduras (David Robinson, personal communication). This latter depth is shallower than the average of 60 meters for living examples of *H. olssoni*, which occurs in great numbers in the same beds. Perhaps the fragmentary condition of fossil specimens of *H. cabritii* is due to post-mortum transportation down-slope.

The generic placement of *H. cabritii* has been discussed in another work (Vokes, 1990a, p. 6) wherein it was noted that the spines on the siphonal canal, the monochromatic color, and the smooth inner lip all point to placement in the genus *Murex* s.s.; however, there is no trace of a labral tooth, and the ornamentation on the early whorls is identical to the other *Haustellum* species (see pl. 3, fig. 11b). It was concluded there that the species is simply the ultimate result of the weakening of the rugae demonstrated in the *H. anniae* group, the increase in spinosity observed in *H. donmoorei*, and the trend toward monochromatic color developed in *H. tryoni* and *H. blakeanus*.

HAUSTELLUM BLAKEANUS (Vokes)

Murex (Murex) blakeanus VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 88, pl. 4, fig. 1.

Murex blakeanus Vokes. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 62, text-fig. 34; FAIR, 1976, The Murex Book, p. 26, pl. 1, fig. 8 (paratype).

Holotype: Harvard Mus. Comp. Zool., MCZ 7287; height 43 mm, diameter (excluding spines) 17 mm.

Type locality: *Blake* Station 254, off Grenada, Lesser Antilles, 164 fms (300 m).

Occurrence: Recent only, (?)southern Caribbean.

Discussion: This species was based upon the material that Clench and Pérez Farfante (1945, p. 5, pl. 2) misidentified as "*Murex tryoni.*" They recorded the species from several localities off the coast of Florida. Specimens of true *H. tryoni* are common in deep-water off the coast of Florida, but I have not seen any examples of *H. blakeanus* from there. In fact, I have seen no examples of *H. blakeanus* taken since the original description. It may well be that the records for *H. tryoni* in Clench and Pérez Farfante (1945, p. 6) include specimens of both species and true *H. blakeanus* is confined to the southern Caribbean, as indicated by Radwin and D'Attilio (1976, p. 62).

HAUSTELLUM TRYONI
(Hidalgo *in* Tryon)

Murex (Tribulus) tryoni HIDALGO *in* TRYON, 1880, Manual of Conchology, v. 2, Muricinae, Purpurinae, p. 134, pl. 70, fig. 427.

Murex (Murex) tryoni Hidalgo. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 5 [in part], not pl. 2 [= *H. blakeanus* (Vokes)].

Murex (Murex) tryoni Hidalgo. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96; BULLIS, 1964, Tulane Stud. Zoology, v. 11, no. 4, p. 101; VOKES, 1967, Tulane Stud. Geol., v. 5, no. 2, p. 86, pl. 4, figs. 2 (holotype), 3.

Murex tryoni Hidalgo. RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 74, pl. 7, fig. 19; FAIR, 1976, The Murex Book, p. 84, pl. 2, fig. 24 (specimen figured by Vokes, 1967, pl. 4, fig. 3).

? Synonym:

Murex sunderlandi PETUCH, 1987, New Caribbean Moll. Faunas, p. 98, pl. 21, figs. 5, 6.

Holotype: Acad. Nat. Sci. Philadelphia, ANSP 35355; height 28 mm, diameter (excluding spines) 14 mm.

Type locality: Lesser Antilles.

Occurrence: Recent only, from Florida to Central America and northern South America.

Discussion: A relatively common species in deeper water, *H. tryoni* ranges throughout the Caribbean. Bullis (1964, p. 101) erroneously reported it from *Oregon* Stations 2230 and 2236 (which he incorrectly placed off French rather than British Guiana); however, the correct stations are 2289 and 2291, both off Suriname. Material collected later by the *Oregon* at Station 3636, off British Honduras (Belize) was figured subsequently (Vokes, 1967a, pl. 4, fig. 3).

Petuch (1987, p. 98, pl. 21, figs. 5, 6) has described as *Murex sunderlandi*, specimens that differ from *H. tryoni* in having the intervarical ridges somewhat reduced and with more numerous brown spiral lines. The species is said to be confined to the Goajira Peninsula area of northern Colombia. This material differs little from that which I reported from *Oregon* Station 4398, off the Goajira Peninsula, Colombia, in the aforementioned work (Vokes, 1967a, p. 86). The differences do not seem to be worthy of specific distinction.

Genus CHICOREUS Montfort, 1810

Chicoreus MONTFORT, 1810, Conchyl. Syst., v. 2, p. 611.

Type species: *Murex ramosus* Linné, 1758, by original designation.

Discussion: Houart (written communication, July 1, 1989) has subdivided the Indo-Pacific species of *Chicoreus* into those members with a labral tooth, which he would place in *Chicoreus* s.s., and those without a labral tooth, which he would place in the subgenus *Triplex* Perry, 1810 (type by monotypy: *T. foliatus* Perry, 1810 = *Murex palmarosae* Lamarck, 1822). This distinction works well in the Indo-Pacific but breaks down when one tries to apply it to the Atlantic Ocean. There would be no members of *Chicoreus* s.s. in the western Atlantic; but the other species do not readily fall into *Triplex*. For example, a large group akin to the Recent *C. florifer* (Reeve, 1846) would have to be placed into a new subgenus. The early members of this group resemble the Australian *C. denudatus* (Perry, 1811), which is the type of *Torvamurex* Iredale, 1936, but the Pliocene to Recent members do not fit well into this taxon, as they are characterized by a small rounded aperture with a tightly closed anal notch.

A further problem would be that these subgenera would be equal in rank to *Siratus* and *Phyllonotus*, or the latter taxa would have to become separate genera. Thus, the sense of relationship indicated by treating them as subgenera of *Chicoreus* would be lost. Therefore, a compromise is to consider these sub-groups as "Species Groups," as was done in Ponder and Vokes (1988), to underscore the fact that the members within each group are more closely related to each other than to the members of the other groups.

Species Group 1: *Chicoreus dujardinoides*

CHICOREUS (CHICOREUS) LEPIDOTUS (Vokes)
Plate 4, figure 1

Chicoreus (Chicoreus) lepidotus (Vokes). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 185, pl. 1, fig. 4; VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 8.

Holotype: USNM 644371; height 34 mm, diameter 20 mm.

Type locality: TU 554, Chipola Formation; Chipola River at power-line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation (lower beds only), Florida.

Figured specimen: USNM 644371 (holotype). Additional localities: TU 810, 830, 1020, 1050.

Discussion: As noted originally, this species is confined to the basal beds of the Chipola Formation, and its "daughter" species, *C. dujardinoides* is normally confined to the upper beds. However, we now have one example of *C. dujardinoides* from locality TU 457 occuring together with about two dozen examples of *C. lepidotus*. The latter species still remains most abundant at the type locality (TU 554; and TU 1050, which is immediately across the river) where we have over 75 specimens. With the facies similarity between localities TU 554 and TU 830, it is surprising that we have but a single specimen from the latter locality.

CHICOREUS (CHICOREUS) DUJARDINOIDES (Vokes)
Plate 4, figure 2

undescribed *Murex*. RICHARDS, 1943, Jour. Paleontology, v. 17, p. 524.

Chicoreus (Chicoreus) dujardinoides (Vokes). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 185, pl. 1, fig. 6; VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 9; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 33, pl. 2, figs. 10, 11.

Chicoreus dujardinoides (Vokes). VOKES, 1979, Tulane Stud. Geol. Paleont., v. 15, p. 112, pl. 1, figs. 7, 8.

Holotype: USNM 644372; height 32.5 mm, diameter 18.5 mm.

Type locality: TU 547, Chipola Formation; Chipola River (SW 1/4 Sec. 29, T1N, R9W), Calhoun County, Florida.

Occurrence: (?)Baitoa Formation, Dominican Republic; Chipola Formation (*usually* upper beds only), Florida.

Figured specimen: USNM 263955; height 34.5 mm, diameter 19 mm; locality TU 820. Additional localities: TU 457 (one specimen), 459, 553, 555, 818--828, 950, 999, 1048, 1196.

Discussion: In an earlier paper (Vokes, 1979, p. 112) I pointed out that the specimen mentioned by Richards (1943, p. 524) as an undescribed *Murex* from the Gabb Collection was the same as the Chipola *C. dujardinoides* and I suggested that it probably came from the correlative Baitoa Formation in the Dominican Republic. In spite of all the collecting that we have done since that time in the Dominican Republic, we have never collected an example of *C. dujardinoides*. However, we did find a Baitoa locality where another Chipola species also occurs and I believe there is no question that the Gabb specimen came from the Baitoa Formation.

This species is almost totally confined to the upper beds of the Chipola Formation, with the exception of the Dominican specimen and, as noted above, the single example from the basal beds at locality TU 457 (= "one mile below Bailey's Ferry" of Dall, Gardner, etc; see Vokes, 1989a). The species is never common, but it is much more widespread than *C. lepidotus*. Along Farley Creek, to the east of the Chipola River, it occurs at almost every locality, but usually in fragmentary condition.

CHICOREUS (CHICOREUS) CORRIGENDUM Vokes
Plate 4, figure 3

Murex (Phyllonotus) compactus Gabb. VAUGHAN and WOODRING *in* VAUGHAN *et al.*, 1921, Geol. Surv. Dominican Republic, Mon. 1, p. 149 (not of Gabb).

Chicoreus (Chicoreus) compactus (Gabb). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 187 [in part, not of Gabb], pl. 2, fig. 3.

Chicoreus (Chicoreus) corrigendum VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 34, pl. 3, figs. 3-5.

Holotype: Naturhistorisches Museum Basel, NMB H 17003; height 41 mm, diameter 23.4 mm.

Type locality: NMB 17284, Baitoa Formation; east side of Río Yaque del Norte, at Boca de los Ríos, just below the confluence of the Río Bao and the Río Yaque, Dominican Republic.

Occurrence: Baitoa Formation, Dominican Republic; Cantaure Formation, Venezuela.

Figured specimen: USNM 113775 (paratype); height 36.5 mm, diameter 20 mm; locality unknown. Additional localities: TU 1269, 1364.

Discussion: The name "corrigendum" was selected for this species because the specimen here figured has had a very confused history. It was originally identified in the collections of the U. S. National Museum as *Murex (Phyllonotus) compactus* Gabb, and was said to be from Potrero, on the Río Amina, Dominican Republic. I figured it as such in the *Chicoreus* part of *Cenozoic Muricidae* (Vokes, 1965a). As was shown in the Dominican Republic report (Vokes, 1989b, p. 34) it is neither *C. compactus*, nor is it from Potrero. In that paper it was described as a new species from the Baitoa Formation.

Other than the seven examples in the type lot, all from the Baitoa Formation, we have one specimen from the Early Miocene Cantaure Formation of Ven-

ezuela (TU 1269) originally collected by Mr. Jack Gibson-Smith.

CHICOREUS (CHICOREUS) ENIGMATICUS Vokes
Plate 4, figure 4

Chicoreus (Chicoreus) enigmaticus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 37, pl. 6, fig. 4.

Holotype: USNM 323897; height 34.3 mm, diameter 24.6 mm.

Type locality: TU 1422, Cercado Formation; Arroyo Bellaco, which is a tributary of Río Cana from the east, at coral reef that is exposed approximately 1 km below the ford at Las Caobas Adentro, 3 km southwest of Las Caobas, Dominican Republic.

Occurrence: Cercado Formation, Dominican Republic.

Figured specimen: USNM 323897 (holotype).

Discussion: This "enigmatic" species bears only a generic resemblance to the other members of the genus *Chicoreus* and yet there is no question that this is the genus into which it should be placed. Based upon a unique specimen from the reefal facies of the Late Miocene Cercado Formation in the Dominican Republic, we can simply note its existence and little more.

PLATE 4

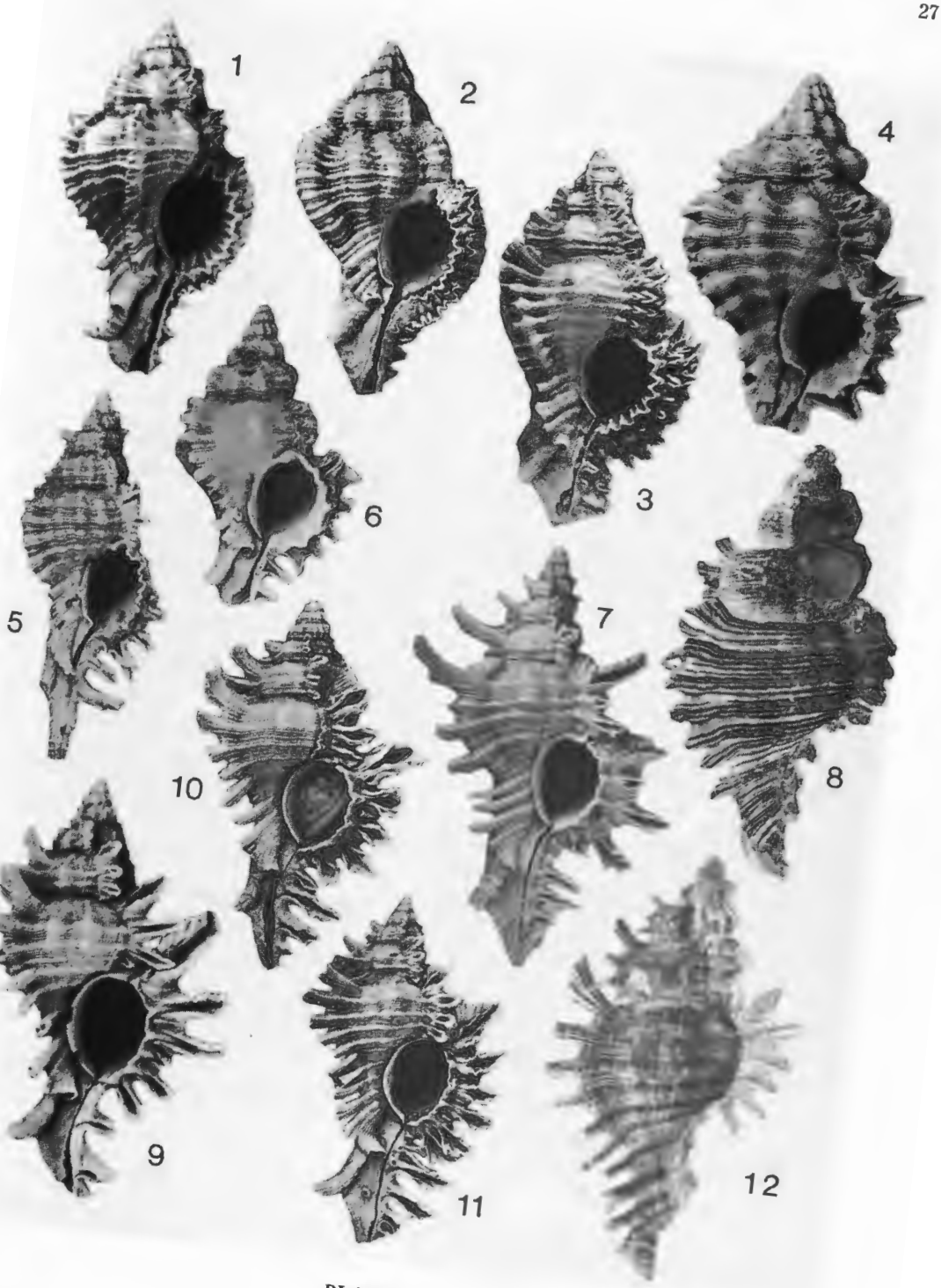


PLATE 4

CHICOREUS (CHICOREUS) COSMANI
Abbott and Finlay
Plate 4, figure 5

Murex spectrum Reeve. HUMFREY, 1975, Sea Shells West Indies, p. 131, pl. 15, figs. 10, 10a (not of Reeve).
Chicoreus cosmani ABBOTT and FINLAY, 1979, Nautilus, v. 93, p. 159, text-figs. 1-9.
Chicoreus (Chicoreus) cosmani Abbott and Finlay. VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 35, pl. 2, fig. 4.

?Synonym:

Murex pudoricolor REEVE, 1845, Conch. Icon., v. 3, *Murex*, pl. 33, fig. 171; REEVE, 1846, Zool. Soc. London, Proc., pt. 13 (1845), p. 108.
Chicoreus pudoricolor (Reeve). FAIR, 1976, The Murex Book, p. 69, pl. 6, figs. 73, 73a.
Chicoreus species. ABBOTT and FINLAY, 1979, Nautilus, v. 93, p. 161, text-figs. 10, 11.

Holotype: USNM 783323; height 79 mm, diameter 40 mm.

Type locality: Ocho Rios, Jamaica, 10-15 ft (3-4.5 m).

Occurrence: Gurabo Formation, Dominican Republic. Recent, Jamaica to Virgin Islands, (?)Netherland Antilles.

Figured specimen: USNM 323863; height 28.5 mm, diameter 11.7 mm; locality TU 1215.

Discussion: A single specimen from a coral-reef locality in the Gurabo Formation, Dominican Republic, is the entire fossil record of this species, which has only recently been recognized in the fauna of the Caribbean.

A specimen collected from Curaçao, Netherland Antilles, was identified by Fair (1976, p. 69) as *C. pudoricolor* (Reeve). The original illustration of Reeve's species is poor, and the type specimen cannot be located. Abbott and Finlay (1979, p. 162) suggest that this specimen may be "a darkly striped, less beaded form of *C. cosmani*" rather than *C. pudoricolor*, which they believe is closer to a young *C. spectrum*. The Curaçao specimen has more resemblance to the Reeve illustration than to specimens of *C. cosmani*, which have a longer siphonal canal and generally four intervarical ridges. Just what the relationship of the Curaçao specimen is to either *C. pudoricolor* or *C. cosmani* is not known. De Jong and Coomans (1988, p. 72) had no specimens of this form from Curaçao; they simply repeat the information given above.

Although Abbott and Finlay relate *C. cosmani* to the Australian species *C. akritos* Radwin and D'Attilio, 1976, there is not much more than a generic relationship. But they are correct in the fact that *C. cosmani* is closer to the Indo-Pacific species of *Chicoreus* than to the western Atlantic ones.

CHICOREUS (CHICOREUS) XESTOS Vokes
Plate 4, figure 6

Chicoreus (Chicoreus) xestos VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 86, pl. 2, figs. 1, 2.

Holotype: USNM 647114; height 42.3 mm, diameter (excluding spines) 21.7 mm.

Type locality: TU 1000, Pinecrest Beds; road-metal pits (now APAC), at end of 17th St., about 8 mi east of U.S. Highway 301 (T36S, R19E), at Sarasota, Sarasota County, Florida [now just north of Fruitville Road exit, on west side of highway I-75].

Occurrence: Pinecrest Beds, Florida.

Figured specimen: USNM 647115 (paratype); height 30.5 mm, diameter 16.5 mm; locality TU 1000.

Discussion: The extensive pits at Sarasota have yielded a few more examples of *C. xestos*, but this remains the only locality for the species. As the name implies, *C. xestos* (L., smooth) may be distinguished from *C. floridanus* Vokes, with which it occurs, by the smoother surface. But more importantly it is characterized by having a denticulate aperture with a broadly open anal notch, in contrast to the rounded, non-denticulate aperture with a very constricted anal notch, typical of *Chicoreus floridanus*.

Species Group 2: *Chicoreus florifer*

CHICOREUS (CHICOREUS) SHIRLEYAE Vokes
Plate 4, figure 8

Chicoreus (Chicoreus) shirleyae VOKES, 1966, Tulane Stud. Geol., v. 5, no. 1, p. 36, text-fig. 1.
Chicoreus shirleyae Vokes. PETUCH, 1988, Neogene History Trop. Amer. Moll., pl. 14, fig. 10 (not in text).

Holotype: USNM 645147; height 88 mm, diameter 39 mm.

Type locality: TU 729, Pinecrest Beds; west side of Kissimmee Canal, east side of Kissimmee River, approximately 1/2 mi south of U. S. Corps of Engineers Structure 65-D (S 1/2 Sec. 33, T36S, R33E), Okeechobee County, Florida.

Occurrence: Pinecrest Beds (lower portion only), Florida.

Figured specimen: USNM 450356; height 65.4 mm, diameter 36.3 mm; locality TU 729.

Discussion: The material discussed in the original description remains the only record of this unusual species. Petuch (1988b, pl. 14, fig. 10) has figured a specimen said to be from the "Buckingham Formation, Sarasota, Florida" (= Pinecrest Beds, TU 1000), but in all of the material I have seen from that locality there are no specimens of *C. shirleyae*. This species occurs with *Vasum olssoni* Vokes, 1966, which also has not been found at Sarasota. I think the reason for the restriction to the Kissimmee area is time and not facies, since many other species are found in both places.

The color pattern of *C. shirleyae* (as revealed by ultra-violet light – pl. 4, fig. 8) is similar to that of *C. floridanus*, with numerous fine dark spiral threads topping each of the spiral cords.

CHICOREUS (CHICOREUS) FLORIDANUS Vokes
Plate 4, figures 9, 12

Chicoreus (Chicoreus) floridanus VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 189, pl. 3, figs. 1-3.

Chicoreus floridensis [*sic*] Vokes. PETUCH, 1988, Neogene History Trop. Amer. Moll., pl. 13, fig. 4 (not in text).

Holotype: USNM 644823; height 73 mm, diameter 38 mm

Type locality: TU 520, Pinecrest Beds; canal 0.9 mi [not 1/3 mi as stated in original description] east of Brighton, Highlands County, Florida.

Occurrence: Jackson Bluff, Pinecrest, and Caloosahatchee formations, Florida; Waccamaw Formation, North and South Carolina.

Figured specimens: Fig. 9, USNM 450357; height 49.2 mm, diameter 28.3 mm; locality TU 1000. Fig. 12, USNM 450358; height 42 mm, diameter 23.7 mm; locality TU 729. Additional localities: TU 726, 728-30, 736, 737, 740, 742, 752, 755, 767-70, 796, 797, 801, 802, 870, 932, 933, 939, 974, 975, 980, 991, 1023, 1044, 1174, 1175, 1177, 1349, 1491-93, 1512, 1524.

Discussion: In the original description of *C. floridanus* the observation was made that the species was ubiquitous in the "upper Miocene and Pliocene" of the southeastern United States (Vokes, 1965a, p. 190). With the ages of the formations shifted upward (see above), the statement now should read "ubiquitous in the Middle Pliocene to Early Pleistocene;" other than that nothing has changed.

This species has been presumed to be ancestral to the Gulf of Mexico *C. dilectus* (Adams) and the Caribbean *C. florifer*. But, a question is raised by the presence in the Middle Pliocene (N.20) Agueguexquite Formation, Veracruz, Mexico, of specimens that are the same as those recently named *C. rachelcarsoni* by Petuch (1987). These specimens have only one intervaricel node, as in the Recent *C. dilectus*, and only five varical fronds. The number of fronds is probably not significant, many examples of *C. floridanus* have only five fronds (see pl. 4, fig. 9) but the presence of a single intervaricel node is. It is my belief that *C. rachelcarsoni* is a synonym of *C. dilectus*, and, thus, this species first appears in the mid-Pliocene Agueguexquite Formation, a more southerly sibling species of *C. floridanus* rather than a linear descendant.

This would mean that the southern form moved into Florida after glacial cooling had wiped out the older *C. floridanus*, explaining why the two species are never found together. The Recent *C. florifer*, with one very large intervaricel node, may be an offshoot of the *C. dilectus* lineage rather than the *C. floridanus* lineage. As many people believe that the two Recent forms are synonymous, this is a reasonable assumption.

The color pattern of *C. floridanus* (as revealed by ultra-violet light – pl. 4, fig. 12) is unlike any living Caribbean species, having what seems to have been a light-colored shell, with numerous dark spiral threads topping each of the spiral cords. This type of pattern is found in a number of Indo-Pacific species, such as *C. palmaerosae* (Lamarck, 1822), but this is almost certainly only parallelism, for the aperture indicates that *C. floridanus* is closely related to *C. dilectus* and *C. florifer*.

CHICOREUS (CHICOREUS) DILECTUS (Adams)
Plate 4, figures 10, 11

Chicoreus (Chicoreus) dilectus (A. Adams). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 191, pl. 3, fig. 4; text-fig. 2 (lectotype).

Chicoreus florifer (Reeve). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 37 [in part, not of Reeve], pl. 6, fig. 7 only.

Chicoreus dilectus (A. Adams). FAIR, 1976, The Murex Book, p. 37, pl. 7, fig. 84.

Synonym:

Chicoreus (Chicoreus) dilectus (A. Adams) variety. VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 87, pl. 2, figs. 3, 4.

Chicoreus dilectus (A. Adams) variety. FAIR, 1976, The Murex Book, p. 37, pl. 7, fig. 85.

Chicoreus rachelcarsonae PETUCH, 1987, New Caribbean Moll. Faunas, p. 13, pl. 1, figs. 9, 10; PETUCH, 1988, Neogene History Trop. Amer. Moll., pl. 31, fig. 11 (not in text).

Lectotype: Brit. Mus. (Nat. Hist.), BMNH 1965-9 (designated by Vokes, 1965a, p. 191); height 55 mm, diameter (excluding spines) 27 mm [not 37 mm, as stated in Vokes, 1965a, p. 191].

Type locality: Sanibel Island, Florida (designated by Clench and Pérez Farfante, 1945, p. 35, for *Murex florifer arenarius*, a synonym).

Occurrence: Agueguexquite Formation, Veracruz, Mexico; Bermont and Anastasia formations, Florida. Recent, Gulf of Mexico.

Figured specimens: Fig. 10, USNM 450359; height 27.4 mm, diameter 15.2 mm; locality TU 1046. Fig. 11, USNM 654369; height 54 mm, diameter (excluding spines) 26.5 mm; locality, off Long Boat Key, Florida. Additional localities: TU 79, 638, 725, 727, 731, 733, 743, 746-48, 750, 759, 767, 768, 788, 791, 802, 803, 939,973, 978, 990.

Discussion: The question of whether the Gulf of Mexico *C. dilectus* and the Caribbean *C. florifer* are the same biologic species has troubled writers for years. As there is a valid geographic separation, perhaps subspecific rank would be more appropriate. But this is complicated by the fact that the junior name (*C. dilectus*) is the older species (geologically speaking), first occurring in the Middle Pliocene (zone N.20) Agueguexquite Formation of Veracruz, Mexico.

The specimens that are found in the Agueguexquite are somewhat atypical, in that they have only five fronds on the varices of the body whorl, in contrast to six normally present in most specimens of *C. dilectus*. But I do not believe this is a significant difference. There are populations living today off the coast of western Florida

PLATE 5

Figures Page

1. *Chicoreus (Chicoreus) elusivus* Vokes (X 1 1/4) 33
   USNM 647110 (holotype); height 44.6 mm, diameter (excluding spines) 21 mm.
   Locality: TU 547, Florida; Chipola Formation.
2. *Chicoreus (Chicoreus)* sp. cf. *clausi* (Dunker) (X 1 1/2) 37
   USNM 365143; height 33.2 mm, diameter 23.9 mm.
   Locality: TU 1352, Dominican Republic; Mao Formation.

3-5, 10. *Chicoreus (Chicoreus) venezuelanus* (Hodson) 35

3. (X 1 1/4) PRI 24101 (paratype); height 48.5 mm, diameter 30 mm.
   Locality: Urumaco, Venezuela; Urumaco Formation.
4. (X 10) USNM 450360; height 20.3 mm, diameter 12 mm.
   Locality: TU 589, Costa Rica; Río Banano Formation.
5. (X 3/4) USNM 450361; height 71.6 mm, diameter (including spines) 49.3 mm.
   Locality: TU 589, Costa Rica; Río Banano Formation.
10. (X 1 1/4) USNM 450362; height (as is) 24.8 mm, diameter (as is) 23.5 mm.
    Locality: TU 959, Panama; Gatun Formation.

6. *Chicoreus (Chicoreus) brevifrons* (Lamarck) (X 1 1/2) 34
   USNM 450363; height 41.7 mm, diameter 22.1 mm.
   Locality: TU 69A, Florida; Shoal River Formation.
7. *Chicoreus (Chicoreus) cornurectus* (Guppy) (X 1 1/2) 33
   USNM 323862; height 45 mm, diameter 26.5 mm.
   Locality: TU 1211, Dominican Republic; Gurabo Formation.
8. *Chicoreus (Chicoreus) jungi* Vokes, n. sp. (X 1) 34
   NMB H 15453 (holotype); height 57.2 mm, diameter 39.5 mm.
   Locality: NMB 10703, Carriacou Island, West Indies; Grand Bay Formation.
9. *Chicoreus (Chicoreus) veronica* Vokes, n. sp. (X 1) 36
   UCMP 38647 (holotype); height 66.6 mm, diameter 40.8 mm.
   Locality: UCMP S-4153, Veronica, Veracruz, Mexico; Agueguexquite Formation.

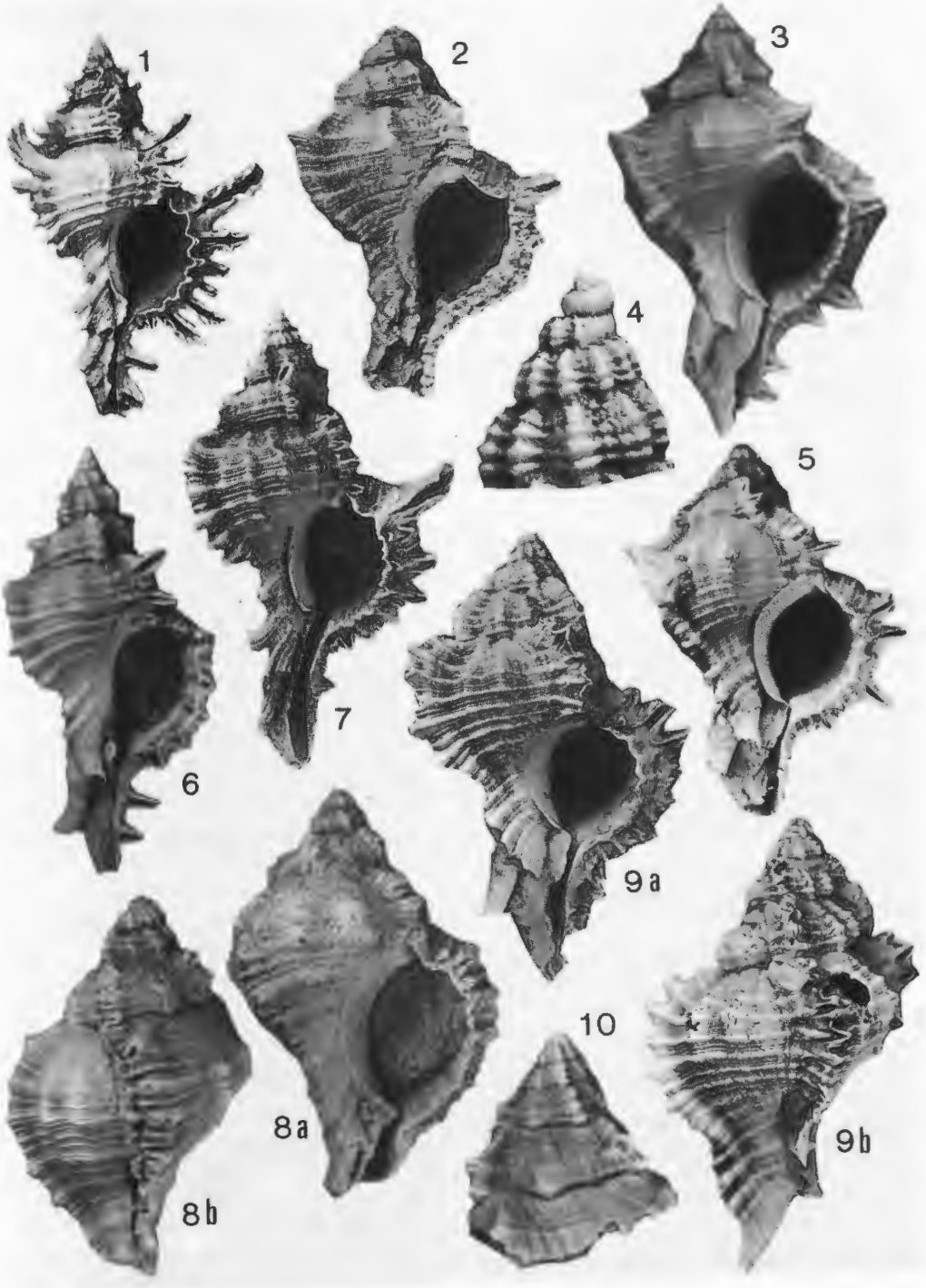


PLATE 5

(see Vokes, 1974a, p. 87, pl. 2, fig. 3) with this same number, which Petuch (1987, p. 13, pl. 1, figs. 9, 10) has named *C. rachelcarsonae*. There are also specimens of *C. florifer* from Roatan, Bay Islands (TU R-503) that have just five fronds and, as noted above, many specimens of *C. floridanus* have only five fronds.

Perhaps the five-frond form is the ancestral type and those modern specimens with only five are atavists. In any case, this is the form found in the Pliocene specimens of the species (pl. 4, fig. 10), which otherwise are identical to the more modern examples. As in the sibling species, *C. floridanus* (above), there is a great deal of variation in the length and width of these fronds. Some specimens have long, thin fronds, others have short, stubby fronds. Again, this is not a significant difference, and at any given locality examples showing every variation occur together.

CHICOREUS (CHICOREUS) FLORIFER (Reeve)

Chicoreus (Chicoreus) florifer (Reeve). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 194, pl. 3, fig. 6.

Chicoreus florifer (Reeve). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 37 [in part], not pl. 6, fig. 6 [= *C. brunneus* (Link)] or 7 [= *C. dilectus* (Adams)], (?)text-figs. 18 (protoconch), 19 (radula); FAIR, 1976, The Murex Book, p. 43, pl. 9, fig. 119.

Synonym:

Chicoreus emilyae PETUCH, 1987, New Caribbean Moll. Faunas, p. 65, pl. 13, figs. 1, 2.

Lectotype: Brit. Mus. (Nat. Hist.), BMNH 1965-11 (designated by Vokes, 1965a, p. 194); height 75 mm, diameter (excluding spines) 40 mm.

Type locality: Honduras.

Occurrence: Recent only, Bahama Islands to Panama.

Discussion: This Caribbean species differs from the Gulf of Mexico *C. dilectus* in having stronger intervarical nodes and longer shoulder spines, which gives the shell a more triangular aspect. The color is variable, with beautiful bright pink specimens being taken off the Bay Islands, Honduras, and from white with brown fronds, to totally dark brown from most localities.

Specimens with extremely long spines have been named *C. emilyae* by Petuch (1987, p. 65, pl. 13, figs. 1, 2). He compares his species to *C. florifer*, which he considers to be confined to Florida, the Bahamas, and Cuba (although the type locality is Honduras), stating that *C. emilyae*, which "ranges from Roatan Is. south to Panama" is "the southern representative of the *C. florifer-dilectus-rachelcarsonae* species complex." We have many specimens of typical *C. florifer* from Honduras, Costa Rica, and Panama (especially TU R-109, where we have hundreds of specimens), and this does not appear to be a valid distinction.

CHICOREUS (CHICOREUS) DUNNI Petuch

Chicoreus dunni PETUCH, 1987, New Caribbean Moll. Faunas, p. 53, pl. 10, fig. 5 (front view; back view without number on back cover).

Holotype: USNM 859835; height 36 mm, diameter (including spines) 20 mm.

Type locality: Eleuthra Island, Bahama Islands.

Occurrence: Recent only, Bahama Islands.

Discussion: Chicoreus dunni is known only from the type area. It is a small, thin-shelled species, almost black, that is obviously closely related to the *C. florifer* complex, but it does seem to be consistently different. Typical *C. florifer* occurs in the same general area and at the same shallow (1 m) depth, but *C. dunni* occurs only in enclosed shallow ponds that may be hypersaline (Kevan Sunderland, personal communication). All of the shells in these ponds are very thin shelled, and *C. dunni* may be no more than an ecologic variation.

CHICOREUS (CHICOREUS) PROLIXUS Vokes
Plate 4, figure 7

Chicoreus (Chicoreus) prolixus VOKES, 1974. Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 88, pl. 2, fig. 5.

Holotype: USNM 647117; height 49 mm, diameter (excluding spines) 23.5 mm.

Type locality: TU 954, Moín Formation; hill cut immediately behind Standard Fruit Co. box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.

Occurrence: Moín Formation, Costa Rica.

Figured specimen: USNM 647117 (holotype). Additional localities: TU 956, 1239, 1240, 1307.

Discussion: Although we have collected many more examples of this species from four additional localities, there is nothing

to be added to the original discussion. Among these are several juveniles that show a very large two whorl protoconch, as anticipated in the original description.

CHICOREUS (CHICOREUS) MERGUS Vokes

Chicoreus (Chicoreus) mergus VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 91, pl. 3, fig. 2.

Chicoreus mergus Vokes. FAIR, 1976, The Murex Book, p. 58, pl. 9, fig. 114 (holotype).

Holotype: USNM 734375; height 48.8 mm, diameter (excluding spines) 25 mm.

Type locality: Bridgetown, Barbados, 40 fms (73 m).

Occurrence: Post-Pleistocene, Louisiana. Recent, Florida Keys to Costa Rica and northern South America.

Discussion: When described, this species was known only from the Recent fauna. Since then we have collected one example from "Mud-lump 90," at the mouth of the Mississippi River (TU 977), in beds which are dated at about 15,000 YBP, and were deposited in about 60 meters depth (Morgan *et al.*, 1963, p. 41).

In the original description a paragraph was inadvertently omitted in which it was noted that this new species was named "mergus," meaning a diver, in honor of John Phillips, of Goleta, California (at that time), who provided the type specimen.

CHICOREUS (CHICOREUS) BULLISI Vokes

Chicoreus (Chicoreus) bullisi VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 91, pl. 3, fig. 3.

Chicoreus bullisi Vokes. FAIR, 1976, The Murex Book, p. 28, pl. 9, fig. 117 (holotype).

Holotype: USNM 734215; height 65 mm, diameter (excluding spines) 31.5 mm.

Type locality: *Oregon* Station 6456, about 90 mi east of the coast of Nicaragua, 75 fms (137 m).

Occurrence: Recent only, off Nicaragua, so far as known.

Discussion: We have no additional information on this species, which may be only a deep-water variant of *C. mergus*. However, as noted in the original description, the general outline of the shell is more akin to the Pleistocene *C. prolixus*, which as the name implies is extremely high-spired.

Species Group 3: *Chicoreus brevifrons*

CHICOREUS (CHICOREUS) ELUSIVUS Vokes
Plate 5, figure 1

Chicoreus (Chicoreus) elusivus VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 82, pl. 1, figs. 1-4.

Holotype: USNM 647110; height 44.6 mm, diameter (excluding spines) 21 mm.

Type locality: TU 547, Chipola Formation; west bank of Chipola River, about 2000 ft above mouth of Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 647110 (holotype). Additional localities: TU 999, 1048.

Discussion: Other than a few additional fragments and a few additional localities, this species remains as elusive as when described.

CHICOREUS (CHICOREUS) CORNURECTUS (Guppy)
Plate 5, figure 7

Not *Murex (Phyllonotus) cornurectus* Guppy. OLSSON, 1922, Bulls. Amer. Paleontology, v. 9, no. 39, p. 131(303) [= *C. venezuelanus* (Hodson)].

Chicoreus (Chicoreus) cornurectus (Guppy). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 186 [in part, not including Chipola specimens = *C. elusivus* Vokes], pl. 2, fig. 2, text-fig. 1 (lectotype); VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 84; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 31, pl. 2, figs. 6-9.

Murex (Chicoreus) cf. *brevifrons* Lamarck. JUNG, 1969, Bulls. Amer. Paleontology, v. 55, no. 247, p. 491, pl. 49, fig. 7.

Not *Chicoreus (Chicoreus) cornurectus* (Guppy). JUNG, 1971, Bulls. Amer. Paleontology, v. 61, no. 269, p. 192, pl. 10, figs. 8, 9 [= *C. jungi* Vokes, n. sp.]

Lectotype: Brit.Mus. (Nat. Hist.), BMNH GG. 20254 (designated by Vokes, 1965a, p. 186); height 89.2 mm, diameter 45 mm.

Type locality: NMB 17287, Baitoa Formation; east side of Río Yaque del Norte, at Boca de los Ríos, just below the confluence of the Río Bao and the Río Yaque, Dominican Republic (restricted by Vokes, 1989b, p. 32).

Occurrence: Baitoa, Cercado, Gurabo and Mao formations, Dominican Republic; Cantaure Formation, Venezuela; Pirabas Limestone, Brazil; (?)Quebradillas Limestone, Puerto Rico; Gatun Formation, Panama; Melajo Clay and Courbaril Beds, Trinidad.

Figured specimen: USNM 323862; height 45 mm, diameter 26.5 mm; locality TU 1211. Addi-

tional localities: TU 757, 960; for localities in the Dominican Republic, see Vokes, 1989b, p. 33.

Discussion: Chicoreus cornurectus is widespread in the Dominican Republic, occurring at almost every locality in the more shallow-water beds. It has also been reported [under the name *Chicoreus brevifrons* (Lamarck, 1822)] from the Cantaure Formation of Venezuela (Jung, 1965, p. 521), from the Pirabas Limestone of Brazil (Maury, 1925, p. 139, pl. 6, fig. 7), from the Gatun Formation of Panama (Woodring, 1959, p. 216, pl. 35, fig. 12) and the Melajo Clay and Courbaril Beds of Trinidad (Jung, 1969, p. 491, pl. 49, fig. 7).

In the Dominican Republic report (Vokes, 1989b, p. 33), I listed the species as occurring at Naturhistorisches Museum Basel localities NMB 15824 and 15832; however, I placed them in the Cercado/Gurabo formation. Both localities are in the Mao Formation along the lower reaches of the Río Gurabo and these two specimens (one adult and one juvenile) document the only occurrence of this species in the Mao Formation. We did not collect *C. cornurectus* at any Mao localities.

CHICOREUS (CHICOREUS) JUNGI Vokes, n. sp.
Plate 5, figure 8

Chicoreus (Chicoreus) cornurectus (Guppy). JUNG, 1971, Bulls. Amer. Paleontology, v. 61, no. 269, p. 192, pl. 10, figs. 8, 9 (not of Guppy).

unnamed species. VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 32.

Description: Nature of protoconch and early teleoconch whorls not known; seven whorls of teleoconch preserved in holotype. Spiral ornamentation on body whorl and siphonal canal of six broad raised welts, with between and covering these an array of primary, secondary, and tertiary spiral cords; entire surface of shell covered with minute shagreened threads. Initial number of axial ridges unknown, by third teleoconch whorl the number reduced (from probably 12) to nine, every other one enlarged into a small varix, with the alternating ridges remaining as strong intervarical nodes; five varices per whorl until sixth teleoconch whorl where the number changes to three per whorl, with two strong intervarical nodes between each pair. Varices low, rounded, ornamented by short open spines where crossed by spiral cords, proportional in strength to that of the cord, the six major ones all of equal size. Suture appressed, undulated by axial ornamentation. Aperture elongate-oval; inner lip narrow, smooth, appressed along entire length, but possibly free-standing at anterior end; inner side of outer lip with several elongate lirae. A strong denticle at posterior end on inner lip, forming a broad anal notch. Siphonal canal moderatly long, presumably recurved at distal end; almost closed but open by a narrow slit.

Holotype: Naturhistorisches Museum Basel, H 15453; height 57.2 mm, diameter 39.5 mm.

Type locality: NMB 10703, Grand Bay Formation; Point Saint Hilaire, Carriacou Island, The Grenadines, West Indies.

Etymology of name: In honor of Peter Jung, of the Naturhistorisches Museum, Basel, Switzerland, who collected the type specimen, and for all his work on the Cenozoic faunas of the western Atlantic.

Occurrence: Grand Bay Formation, Carriacou Island.

Figured specimen: NMBH 15453 (holotype).

Discussion: The specimen figured by Jung (1971, pl. 10, figs. 8, 9) as *C. cornurectus* is not that species and is here described. It differs from *C. cornurectus* in having only very short varical spines, all about equal in length. The outline of the body whorl is gently tapering in contrast to the sharp constriction that demarcates the body whorl from the siphonal canal in *C. cornurectus* (compare pl. 5, figs. 7 and 8).

The holotype is poorly preserved so that details of the early development are uncertain. However, it can be seen that the nature of the early varical formation is unusual, with first five alternating varices and intervarical nodes per whorl being developed and only on the penultimate whorl this number being reduced to three varices with two intervarical nodes between each pair.

The Grand Bay Formation represents a mixed fauna, similar to the famous locality at Bowden, Jamaica, with shallow-water mollusks transported down-slope into depths of as much as 200 meters (Jung, 1971, p. 157). There they were deposited along with specimens of planktic foraminifera, which have yielded a good age dating (Robinson and Jung, 1972, p. 124) of Early Middle Miocene (zone N.11), making it correlative with the Shoal River Formation in northwestern Florida.

CHICOREUS (CHICOREUS) BREVIFRONS (Lamarck)
Plate 5, figure 6

Chicoreus (Chicoreus) brevifrons (Lamarck). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4.

p. 192, pl. 3, fig. 5; VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 84, pl. 1, figs. 5, 6.

Murex (Chicoreus) brevifrons Lamarck. BAYER, 1971, Bull. Mar. Sci., v. 21, no. 1, p. 157, text-figs. 28, 29.

Chicoreus brevifrons (Lamarck). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 34, pl. 4, fig. 10, text-fig. 15 (protoconch); FAIR, 1976, The Murex Book, p. 27, pl. 9, fig. 115.

Synonym:

Murex spectrum variety *incertum* NOWELL-USTICKE, 1969, Suppl. List New Shells St. Croix, p. 15, pl. 3, fig. 665.

Murex incertum Nowell-Usticke. NOWELL-USTICKE, 1971, Suppl. List New Shells St. Croix, Revised Ed., p. 11, pl. 2, fig. 665.

Chicoreus incertum (Nowell-Usticke). FAIR, 1976, The Murex Book, p. 49.

"Type figure": Martini, 1777, Conchylien-Cab., v. 3, pl. 103, fig. 983 (designated by Clench and Pérez Farfante, 1945, p. 30).

Type locality: St. Thomas, Virgin Islands (designated by Clench and Pérez Farfante, 1945, p. 31).

Occurrence: Shoal River Formation, Florida; Encanto Formation (of Akers, 1972), Oaxaca, Mexico; (?)Tubará Group, Colombia; Punta Gavilan and Mare formations, Venezuela; Pleistocene, Barbados and Curaçao. Recent, Caribbean, exclusive of Florida and the Gulf of Mexico.

Figured specimen: USNM 450363; height 41.7 mm, diameter 22.1 mm; locality TU 69A.

Discussion: This species, which often has been confused with *C. cornurectus*, has not been recognized in most fossil units below the Pleistocene. However, I have figured (Vokes, 1974a, p. 84, pl. 1, fig. 5) a single specimen from beds referred to the Encanto Formation (= locality TU 635; Akers, 1972, p. 11) in Oaxaca, Mexico (from the Gulf of Mexico side of the Continental Divide) and more recently another specimen was collected from the Shoal River Formation, northwestern Florida (locality TU 69A), by Paul Drez (pl. 5, fig. 6). Both of these localities are rather unexpected, inasmuch as today the species does not occur in the Gulf of Mexico but is confined to the Caribbean, where it lives among mangrove roots.

Although not cited by Rutsch (1934), in the collections of the Naturhistorisches Museum, Basel, Switzerland, in material from Punta Gavilan, Venezuela, there is a specimen of *C. brevifrons* and in the collections of the Museum of Paleontology, University of California, Berkeley, there are two specimens from unnamed beds near Usiacuri, Atlantico, Colombia (about halfway between Cartegena and Barranquilla). These beds probably are in the Tubará Group, but it is not certain.

Woodring reported *C. brevifrons* from the Gatun Formation of Panama (1959, p. 216). He figured two different species: one (his pl. 35, fig. 12) is *C. cornurectus;* the other (his pl. 35, figs. 11, 13) is neither *C. brevifrons* nor *C. cornurectus*. Unfortunately the specimen is too poorly preserved to be described.

CHICOREUS (CHICOREUS) VENEZUELANUS (F. Hodson)

Plate 5, figures 3-5, 10

Murex (Phyllonotus) cornurectus Guppy. OLSSON, 1922, Bulls. Amer. Paleontology, v. 9, no. 39, p. 131(303) (not of Guppy).

Chicoreus (Chicoreus) venezuelanus (F. Hodson). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 188, pl. 2, fig. 1.

Holotype: Paleont. Resh. Inst., PRI 24097; height 78.5 mm, diameter 54 mm.

Type locality: Urumaco Formation; Río Codore, 4.65 km north and 500 m west of Urumaco, Edo. de Falcón, Venezuela.

Occurrence: Urumaco Formation, Venezuela; Gatun Formation, Panama; Río Banano Formation, Costa Rica.

Figured specimens: Fig. 3, PRI 24101 (paratype); height 48.5 mm, diameter 30 mm; locality same as holotype. Fig. 4, USNM 450360; height 20.3 mm, diameter 12.0 mm; locality TU 589. Fig. 5, USNM 450361; height 71.6 mm, diameter (including spines) 49.3 mm; locality TU 589. Fig. 10, USNM 450362; height (as is) 24.8 mm, diameter (as is) 23.5 mm; locality TU 959.

Discussion: The Urumaco Formation is now known to be Early Pliocene in age rather than Middle Miocene, as it was considered previously (Vokes, 1965a, p. 189). This correlates with the Gatun Formation of Panama, where we have collected two incomplete specimens (pl. 5, fig. 10) that are also referable to *C. venezuelanus*.

In 1922 Olsson monographed the mollusks of the "Miocene" of Costa Rica. We now know that most of the species he illustrated come from the Middle Pliocene (zone N.20) Río Banano Formation (= "Gatun" of Olsson), but some are from the Pleistocene Moín Formation. One of the "Gatun" species he unfortunately did not

illustrate is the one he cited as "*Murex cornurectus* Guppy." We have not collected any specimens of *Chicoreus cornurectus*, nor of *C. brevifrons*, which Olsson thought was probably identical with *C. cornurectus*, in Costa Rica. However, in the Río Banano Formation we have several specimens of the species that is probably what Olsson had, for it fits his description: "The varices are large and cross the spire whorls in a spiral direction. Between the varices there is generally a single rib-like elevation in the middle of the whorl" (1922, p. 304). These specimens seem to be referable to *C. venezuelanus*, although they differ slightly in being more strongly ornamented. But with no more than the very poor type material of *C. venezuelanus* for comparison, this difference does not seem to be critical.

Chicoreus venezuelanus is closely related to *C. brevifrons* and has a protoconch identical to that species (compare pl. 5, fig. 4, with Radwin and D'Attilio, 1976, text-fig. 15, protoconch of *C. brevifrons)* with two and one-half bulbous whorls. However, it may be readily distinguished by the appressed suture, the smoother surface, and the pattern of the varical spines. As was noted in the original discussion of this species (Vokes, 1965a, p. 189), there is a superficial resemblance to the Red Sea species, *C. virgineus* (Röding, 1798), which is derived from, and grades into, the widespread Indo-Pacific *C. ramosus* (Linné, 1758), type of the genus. The relationship between *C. virgineus* and *C. ramosus* is identical to the relationship between *C. venezuelanus* and *C. brevifrons*.

Chicoreus (Chicoreus) veronica Vokes, n. sp.
Plate 5, figure 9

Description: Shell with probably seven teleoconch whorls; protoconch unknown. Spiral ornamentation on earliest preserved whorls of five equal cords; gradually smaller cords intercalated; on body whorl and siphonal canal 15 heavy, raised cords; between these, and often on top of them, numerous fine spiral threads, as many as five between some pairs of cords. Axial ornamentation on earliest preserved whorls of nine equal nodes; on approximately fourth teleoconch whorl every third one enlarged, forming a small varix; others remaining as intervarical nodes, generally two between each pair of varices. In addition, numerous axial growth lines crossing spiral threads giving a shagreened texture to entire shell surface. Varices strong raised ridges, aligned from whorl to whorl up the spire; at crossing of spiral cords short open spines produced, corresponding in size to strength of the cord and connected one to the next by a multi-layered flange. Aperture almost circular, no anal notch; inner lip narrow, smooth, appressed along entire length; inner side of outer lip with several small lirae, best developed on anterior half. Siphonal canal short, broad, almost closed but open by a narrow slit; strongly recurved, previous canals diverging as spurs.

Holotype: Museum of Paleontology, University of California, Berkeley, UCMP 38647; height 66.6 mm, diameter 40.8 mm.

Type locality: UCMP S-4153, Agueguexquite Formation; Veronica, Veracruz, Mexico.

Etymology of name: For the type locality, Veronica, Veracruz.

Occurrence: Agueguexquite Formation, Mexico.

Figured specimen: UCMP 38647 (holotype). Additional localities: TU 638, 1046.

Discussion: In the collections of the Museum of Paleontology, University of California, Berkeley, there is a beautiful specimen of a new species that is said to be from "Veronica, Veracruz." We have not succeeded in locating Veronica, but the associated fauna includes specimens of *Haustellum bellegladeensis* (Vokes), identical to those common in the Agueguexquite Formation. I am sure the locality is somewhere in the vicinity of the type locality of the Agueguexquite, about 15 km east of the old bridge at Coatzacoalcos, for all of the other material with numbers similar to this comes from this area. Therefore, even though the exact locality is uncertain, I do not hesitate to make this specimen the holotype of a new species. We also have broken examples of this species from our localities in the Agueguexquite Formation (TU 638, 1046).

This is a puzzling species, which appears to be intermediate between *Chicoreus* s.s. and *Chicoreus (Siratus)*. The fronds are very short and tend to coalesce into a narrow flange. The inner lip, however, is completely smooth, with no trace of rugae such as most species of *Siratus* have and, for this reason, it seems probable that the resemblance to *Siratus* is a result of convergence. This new species most nearly resembles *C.(C.) venezuelanus* and may

prove to be only a northern variant of that form. But, on the basis of the material at hand, *C. veronica* differs in being more strongly ornamented, with a less appressed suture, a less obvious anal notch, and a small flange along the length of the varices rather than any spines.

CHICOREUS (CHICOREUS) sp. cf. C. CLAUSII (Dunker)
Plate 5, figure 2

[?] *Murex clausii* DUNKER, 1879, Jour. de Conchyl., v. 27, p. 215, pl. 8, fig. 6.

Chicoreus (Chicoreus) species cf. *C. (C.) clausii* (Dunker). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 36, pl. 6, figs. 2, 3.

Holotype: Berlin Museum; height 64 mm, diameter 36 mm.

Type locality: Tema, Ghana, West Africa (restricted by Vokes, 1989b, p. 37).

Occurrence: Mao Formation, Dominican Republic. Recent, West Africa.

Figured specimen: USNM 365143; height 33.2 mm, diameter 23.9 mm; locality TU 1352.

Discussion: In the Middle Pliocene (zone N.20) Mao Formation of the Dominican Republic we collected three battered examples of a species that as best can be determined is the same as the living West African species *C. clausii* (Dunker). There are several other species related to the West African fauna also present in the fossil record of the Dominican Republic; thus, the find is not totally inexplicable.

CHICOREUS (CHICOREUS) SPECTRUM (Reeve)

Chicoreus (Chicoreus) argo (Clench and Pérez Farfante). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 194.

Chicoreus (Chicoreus) spectrum (Reeve). VOKES, 1974, Tulane Stud. Geol. Paleont., v. 11, no. 2, p. 90, pl. 3, fig. 1 (holotype).

Chicoreus spectrum (Reeve). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 43, pl. 5, fig. 1; FAIR, 1976, The Murex Book, p. 77, pl. 8, fig. 112 (holotype).

Holotype: Brit. Mus. (Nat. Hist.), BMNH 1950-23-1; height (incomplete) 113 mm, diameter (excluding spines) 49 mm.

Type locality: Grenada, Lesser Antilles (type locality of *Murex imbricatus* Higgins and Marrat, 1877, = *M. argo* Clench and Pérez Farfante, 1945).

Occurrence: Recent only, Lesser Antilles to northern Brazil.

Discussion: Although *C. cornurectus* has been considered to be ancestral to (or even synonymous with) *C. brevifrons*, we now know the two species are essentially coeval and it is *C. spectrum* that is the living representative of the *C. cornurectus* line. The Recent species has a more elongated shell, both in the spire and, especially, in the siphonal canal. Although large specimens of *C. spectrum* are more common than of *C. cornurectus*, one example of the latter from the Dominican Republic, if complete, would measure 150 mm in height (Vokes, 1989b, p. 33) and would exceed the largest specimens of *C. spectrum*, which reach about 120 mm.

Subgenus SIRATUS Jousseaume 1880

Siratus JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: *Purpura sirat* Adanson, 1757 [= *Murex senegalensis* Gmelin, 1791], by original designation.

Discussion: The origins of the subgenus *Siratus* are uncertain. The Early Oligocene species *C.(S.) stetopus* (de Gregorio) treated below is a likely ancestor for those species similar to the type of the group: *C.(S.) senegalensis*. But, by the Early Miocene the more spinose form also developed, as shown by the several species from Florida and Venezuela. Whether both of these lines were originally derived from the same ancestral type is uncertain and there may be some parallelism involved. Because there is so much intergrading between the two morphotypes – those with spinose varices and those with flanged varices – any attempt to separate the two groups is impossible.

In the original coverage of the species now included in *Siratus*, which as noted above, were considered to be members of *Murex (Murex)*, those Recent species with no fossil representation were not treated systematically and the reader was referred to "The genus *Murex* in the western Atlantic" (Clench and Pérez Farfante, 1945). In the interest of a complete study, they will be included herein; however, the "starting point" will be Clench and Pérez Farfante rather than *Cenozoic Muricidae*, Part I.

CHICOREUS (SIRATUS) STETOPUS (de Gręgorio)
Plate 6, figure 1

Chicoreus (Phyllonotus) stetopus (de Gregorio). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 138, pl. 1, figs. 1-5; MACNEIL and DOCKERY, 1984, Mississippi Bur. Geol., Bull. 124, p. 123, pl. 4, fig. 16 only [fig. 17 = *C.(P.) mississippiensis* (Conrad)].

Holotype: Paleont. Resh. Inst., PRI 26431; height (incomplete) 14.5 mm, diameter 10 mm.

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

Occurrence: Red Bluff and Mint Springs formations, Mississippi.

Figured specimen: USNM 450364; height 26.8 mm, diameter 13.3 mm; locality TU 1289. Additional localities: TU 226, 642, 1288, 1290.

Discussion: When this species was originally treated (Vokes, 1967b, p. 138) we had no material from the Red Bluff Formation (Early Oligocene). In that formation there are many specimens of a small muricid that appears to be the same as the one I referred to *C. stetopus* from the somewhat younger Mint Springs Formation. The Red Bluff specimens are marked by having a varical flange that is extremely expanded in some specimens (pl. 6, fig. 1). Although this species closely resembles members of the subgenus *Phyllonotus (C. mississippiensis* and *C. dormani,* see below) the varical flange is more characteristic of the subgenus *Siratus*. For this reason, it is appropriate to place the species here, although it may be transitional between the

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PLATE 6

Figures

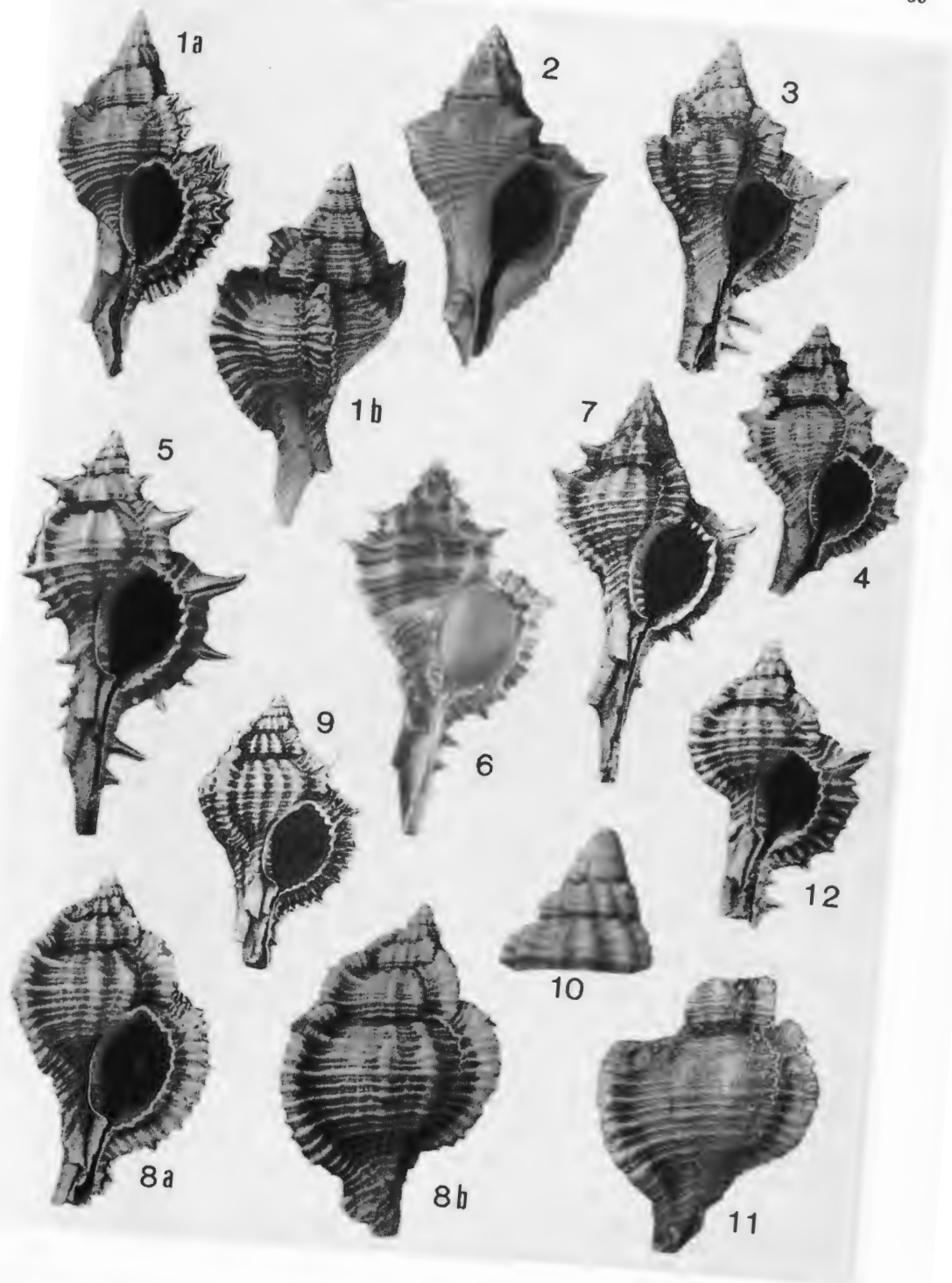

PLATE 6

older *Phyllonotus* group and the younger *Siratus* group.

Chicoreus (Siratus) denegatus (Jung)
Plate 6, figure 2

Murex (Siratus?) triangularis JUNG, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 522, pl. 69, fig. 9, pl. 70, figs. 1, 2.

Murex (Siratus) denegatus JUNG, 1966, Tulane Stud. Geol., v. 4, no. 2, p. 77 (*n.n. pro Murex triangularus* Jung, *non M. triangulus* Brown, 1818, *nec* Risso, 1826, *nec* von Koenen, 1889).

Holotype: Naturhistorisches Museum Basel, NMB H 13711; height 40.1 mm, diameter 24.2 mm.

Type locality: Cantaure Formation; south of Casa Cantaure, Paraguaná Peninsula, Edo. de Falcón, Venezuela (= TU 1269).

Occurrence: Cantaure Formation, Venezuela.

Figured specimen: UCMP 38648; height 34.7 mm, diameter 21 mm; locality UCMP S-8360, same as holotype. Additional localities: TU 1269.

Discussion: When describing this unusual species, Jung (1965, p. 523) stated that "it is doubtful whether this species belongs to the subgenus *Siratus*." His concern is well-founded, for *C. denegatus* is unlike any other species of *Siratus*, with an elongate open aperture and no varical formation until the last two whorls. This latter feature may indicate a closer relationship to the genus *Eupleura* Adams and Adams, 1853. The shell looks not unlike a three-varixed *Eupleura*, but this may only be convergence. In truth, as Jung noted (1965, p. 523), "I have not found any form comparable to this species."

Although common in the Early Miocene beds of the Cantaure Formation, *C. denegatus* has not been found elsewhere.

Chicoreus (Siratus) quirosensis
(F. Hodson)
Plate 6, figures 3, 4

Murex (Murex) quirosensis F. Hodson. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 98, pl. 1, fig. 4.

Chicoreus (Siratus) quirosensis (F. Hodson). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 183.

Murex (Murex) recurvirostris quirosensis F. Hodson. JUNG, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 518, pl. 69, fig. 7.

Holotype: Paleont. Resh. Inst., PRI 24104; height 32 mm, diameter 16 mm.

Type locality: La Rosa Formation; Quiros [Quiroz], Disto. de Miranda, Edo. de Zulia, Venezuela.

Occurrence: La Rosa and Cantaure formations, Venezuela.

Figured specimens: Fig. 3, PRI 24104 (holotype). Fig. 4, USNM 450365; height 28 mm, diameter 16.5 mm; locality TU 1269.

Discussion: This species is now known to have come from the La Rosa Formation, which is correlated with the Agua Clara Formation (see *Lexico Estratigrafico de Venezuela*, 1970, p. 345), dated as Early Miocene (Bolli, 1972) rather than Oligocene as originally considered by Hodson. The Quiroz fauna is correlated with the Cantaure fauna of the Paraguaná Peninsula, from whence Jung (1965, pl. 69, fig. 7) has figured an example similar to that figured herein (pl. 6, fig. 4). These specimens differ from the type (pl. 6, fig. 3) in having a second varical spine at the base of the body whorl; however, other specimens from the Cantaure Formation have only a single spine at the shoulder. This variable character is probably what Hodson was referring to when he stated: "Intergrading forms are found in the States of Zulia and Falcon" (*in* Hodson and Hodson, 1931, p. 37).

Chicoreus (Siratus) chipolanus (Dall)
Plate 6, figures 5, 6

Murex (Murex) chipolanus Dall. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 98, pl. 1, fig. 3.

Chicoreus (Siratus) chipolanus (Dall). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 183; VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 4.

Lectotype: USNM 112156 (designated by Vokes, 1963a, p. 99); height 38 mm, diameter (excluding spines) 20 mm.

Type locality: USGS 2212, Chipola Formation: Tenmile Creek, "one mile west of Chipola River," Calhoun County, Florida (= TU 546).

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 5, USNM 450366; height 29.5 mm, diameter 17 mm; locality TU 456. Fig. 6, USNM 450367; height 37.9 mm, diameter 22.8 mm; locality TU 546. Additional localities: TU 549, 655, 708, 709, 786, 787, 817, 830, 831, 951, 998, 1021, 1051, 1097, 1098.

Discussion: One of the most common muricid species in the Chipola Formation, *C.(S.) chipolanus* is almost totally confined to outcrops along Tenmile Creek. A single

fragment from the Chipola River (TU 549) is the only trace of the species anywhere else.

The color pattern of *C. chipolanus* (as revealed by ultra-violet light, see pl. 6, fig. 6) is similar to many living species of the *Siratus* group, especially *C.(S.) articulatus* (Reeve, 1845), with broad dark bands at the shoulder and base of the body whorl, and dark lines on the raised spiral cords. It appears that this Chipola species with its spinose varices is ancestral to the younger *C.(S.) articulatus*.

CHICOREUS (SIRATUS) JULIAGARDNERAE
Vokes
Plate 6, figure 7

Murex (Murex) gardnerae VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 99, pl. 1, fig. 1.
Chicoreus (Siratus) gardnerae (Vokes). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 183.
Chicoreus (Siratus) juliagardnerae VOKES, 1970, Tulane Stud. Geol. Paleont., v. 8, no. 1, p. 51 (*n.n. pro Murex gardnerae* Vokes, *non Alectrion gardnerae* Dall, 1915 = *Murex trophoniformis* Heilprin, 1887); VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 2.

Holotype: USNM 643750; height 37.5 mm, diameter (excluding spines) 16.6 mm.

Type locality: TU 456, Chipola Formation; Tenmile Creek, about 1/2 mi downstream from bridge of Florida Highway 73 (NE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 643750 (holotype). Additional localities: TU 457, 552, 554, 555, 655, 708, 709, 786, 787, 810, 817, 825, 830, 831, 951, 998, 1021, 1097, 1098.

Discussion: As noted when renaming this secondary homonym (Vokes, 1970c, p. 51), *C.(S.) juliagardnerae* is most common in the outcrops along Tenmile Creek, where it occurs with the similar *C.(S.) chipolanus*. However, *C. juliagardnerae* is more widespread than *C. chipolanus*, as we have several examples from localities along the Chipola River, and one juvenile from Farley Creek (TU 825).

Considering the later species of *Siratus* in the western Atlantic area, it appears that *C.(S.) juliagardnerae*, with its long siphonal canal, is ancestral to the modern species *C.(S.) formosus* (Sowerby).

CHICOREUS (SIRATUS) SEXTONI Vokes, n. sp.
Plate 6, figures 8-11

[?] *Murex* sp. indet. MAURY, 1925, Serv. Geol. Min. Brasil, Mon. 4, pl. 6, fig. 15.
Murex (Murex) nicholsi Gardner. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 105 [in part, not of Gardner], pl. 3, figs. 4, 5 only.
Chicoreus (Siratus) nicholsi (Gardner). VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 3 (not of Gardner).

Description: Shell with seven teleoconch whorls and a protoconch of three and one-half, polished conical whorls, ending at a small recurved varix. Spiral ornamentation on earliest teleoconch whorls of four small cords, increasing in strength and adding intermediary secondary cords up to adult size; body whorl and siphonal canal with about 18 to 20 primary cords and a variable number of secondary cords. Axial ornamentation on earliest teleoconch whorls of about 12 small equal ridges; on fourth teleoconch whorl every fourth ridge strengthened into a small varix, with three intermediate ridges remaining as intervarical nodes; with increasing size adapertural node diminishing or disappearing entirely. Varices, three per whorl, narrow; initially with a small recurved spine at the shoulder but larger specimens with only a series of short open spinelets at crossing of spiral cords; each connected to the next by a thin flange of shell material, somewhat better developed anteriorly. Suture impressed, undulated by axial ornamentation. Aperture oval, inner lip heavy, appressed at posterior end, free-standing at anterior end; with numerous rugae over entire length but stronger on anterior half. Inner side of outer lip with about 10 lirae well within the aperture; one strong nodule at posteriormost part, combining with corresponding strong nodule on inner lip forming anal notch. Margin of outer lip crenulated by small adaperturally directed projections formed by notches corresponding to spiral cords. Siphonal canal relatively short, recurved distally; almost sealed but open by a narrow slit.

Holotype: USNM 450368; height 32 mm, diameter 20.4 mm.

Type locality: TU 951, Chipola Formation; Tenmile Creek, about 1 1/4 mi west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun County, Florida.

Etymology of name: In honor of Cecil Sexton, owner of much of the land along the south bank of Tenmile Creek (including locality TU 951, the type locality), who possibly loves Tenmile Creek even more than I do.

Occurrence: Chipola Formation and Oak Grove Sand, Florida; (?)Pirabas Limestone, Pará, Brazil.

Figured specimens: Fig. 8, USNM 450368 (holotype). Fig. 9, USNM 643751; height 28 mm, diameter 11.5 mm; locality TU 70. Fig. 10, USNM 643767; height 20 mm, diameter 9 mm;

locality TU 70. Fig. 11, Mus. Nacl. Rio de Janeiro DNPM 553; height (as is) 20.5 mm, diameter (as is) 16.8 mm; locality, mouth of Rio Pirabas, Pará, Brazil. Additional localities: TU 91, 196, 546, 547, 548, 655, 787, 817, 820, 830, 831, 950, 998, 1050, 1098.

Discussion: When I originally treated the Chipola species of *Siratus* (Vokes, 1963a) we had a few specimens of a species that appeared to be the same as *C.(S.) nicholsi* (Gardner). Since that time, we have collected hundreds of specimens, almost all from the lowest beds of the Chipola Formation on Tenmile Creek (localities TU 566, 830, and 951), which show that the two are different.

This new species occurs together with *C.(S.) chipolanus* and *C.(S.) juliagardnerae* at outcrops along Tenmile Creek, but it is never as common as the other two; at most localities we have but one or two specimens. Exceptions are TU localities 546 and 830, where a tremendous volume of material has been collected. There is one incomplete shell from the Oak Grove Sand (TU 91), which may be referable to this species and Maury figured an external mold from the Pirabas Limestone of Brazil that appears to be the same (compare pl. 6, figs. 8b, and 11).

Although it occurs with two other members of the same subgenus, *C.(S.) sextoni* may be distinguished by the broader shell shape, by having a shorter siphonal canal and only very short varical spines, which normally merge into a flange. It is closely related to the Shoal River *C.(S) nicholsi*, with which I confused it, but the latter has coarser spiral ornamentation and the tendency to three stronger spiral cords that give rise to short spines where they cross the varices. It is probable that *C.(S.) sextoni* is ancestral to the *C.(S.) domingensis* (Sowerby) – *C.(S.) springeri* (Bullis) line.

CHICOREUS (SIRATUS) NICHOLSI (Gardner)
Plate 6, figure 12

Murex (Murex) nicholsi Gardner. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 105 [in part, not Chipola specimens], pl. 3, fig. 3 only.
Chicoreus (Siratus) nicholsi (Gardner). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 183.
Not *Chicoreus (Siratus) nicholsi* (Gardner). VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 3 [= *C.(S.) sextoni* Vokes, n. sp.].

PLATE 7

Figures — Page

1. *Chicoreus (Siratus) amplius* Vokes (X 1) 44
   USNM 323868 (holotype); height 71 mm, diameter 50 mm.
   Locality: TU 1293, Dominican Republic; Gurabo Formation.
2, 3. *Chicoreus (Siratus) miltos* Vokes, n. sp. (X 1 1/2) 44
   2. UCMP 38649 (holotype); height 42 mm, diameter 23.2 mm.
   Locality: UCMP S-4257, Almagres, Veracruz, Mexico; Concepcion Inferior Formation.
   3. UCMP 38650 (paratype); height 35.5 mm, diameter 18.7 mm.
   Locality: UCMP S-207, Almagres, Veracruz, Mexico; Concepcion Inferior Formation.
4. *Chicoreus (Siratus) eumekes* Vokes (X 1 1/2) 45
   USNM 323869 (holotype); height 44.9 mm, diameter 19.8 mm
   Locality: TU 1215, Dominican Republic; Gurabo Formation.
5-7. *Chicoreus (Siratus) habros* Vokes, n. sp. 45
   5. (X 2) USNM 450370 (holotype); height 28.8 mm, diameter 14.4 mm.
   Locality: TU 1046, Mexico; Agueguexquite Formation.
   6. (X 2) USNM 450371 (paratype A); height 28.7 mm, diameter 13.9 mm.
   Locality: TU 1046, Mexico; Agueguexquite Formation.
   7. (X 1 1/2) UCMP 38651 (paratype B); height (as is) 27.5 mm, diameter (as is) 19.6 mm.
   Locality: UCMP S-4153, Veronica, Veracruz, Mexico; Agueguexquite Formation.
8. *Chicoreus (Siratus) consuela* (Verrill) (X 1 1/4) 46
   USNM 450372; height 55.2 mm, diameter 27.9 mm
   Locality: TU 1240, Costa Rica; Moín Formation.

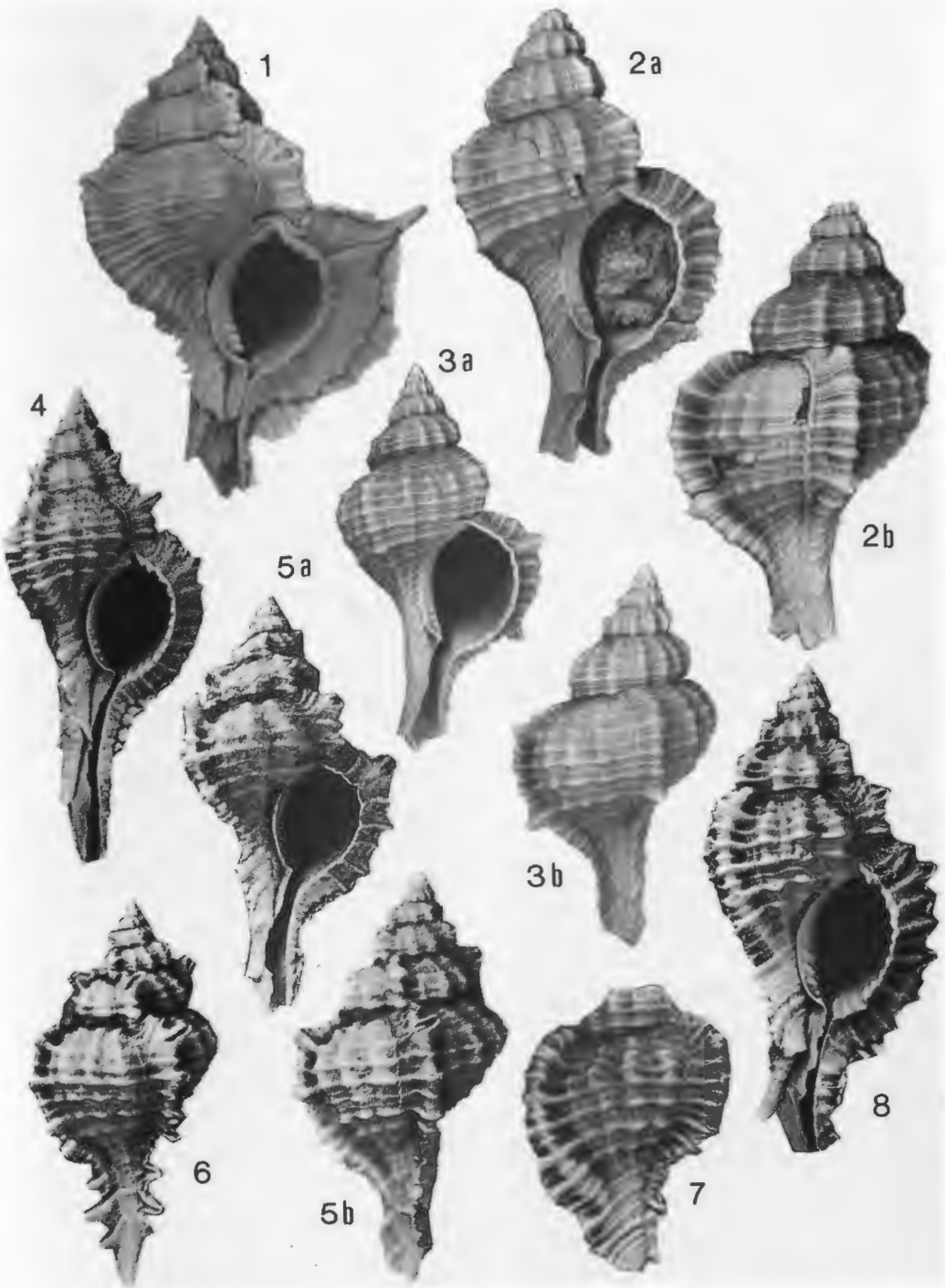

PLATE 7

Holotype: USNM 371851; height 25 mm, diameter 14.5 mm.

Type locality: USGS 3856, Shoal River Formation; 5 to 6 mi west-northwest of Mossyhead, Walton County, Florida.

Occurrence: Shoal River Formation, Florida.

Figured specimen: USNM 450369; height 29.4 mm, diameter 18.8 mm; locality TU 69A.

Discussion: There is not much material available for this species, and that available is poorly preserved. One moderately good juvenile specimen from Shoal River (TU 69A), has a protoconch identical to *C.(S.) sextoni* (three and one-half conical whorls) but is slightly larger in overall size (ca. 0.8 mm *vs.* 0.5 mm in diameter). As shown in the figured specimen (pl. 6, fig. 12), there is a small varical flange, indicating that, as noted previously (Gardner, 1947, p. 519; Vokes, 1963a, p. 106), *C.(S.) nicholsi* is closely related to *C.(S.) domingensis*, but differs from that species in the nature of the protoconch, which in *C.(S.) domingensis* is only one and one-half bulbous whorls.

Chicoreus (Siratus) amplius (Vokes)
Plate 7, figure 1

Murex domingensis Sowerby. MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 102(266) [in part, not of Sowerby], pl. 16(42), fig. 6 only.

Chicoreus (Siratus) amplius VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 49, pl. 3, fig. 6.

Holotype: USNM 323868; height 71 mm, diameter 50 mm.

Type locality: TU 1293, Gurabo Formation; Río Mao, west bank, bluff just below Paso Chorrero, or about 12 km (by road) south of Mao, Dominican Republic (= Bluff 1 of Maury, 1917).

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 323868 (holotype). For additional localities in the Dominican Republic, see Vokes, 1989b, p. 50.

Discussion: In the more shallow-water portions of the Gurabo Formation there are rare specimens (five in all) of a large species, most similar to the Recent *C.(S.) tenuivaricosus* (Dautzenberg, 1927), which lives in depths of 15 to 30 meters off the coast of Brazil. This species, *C.(S.) amplius*, unlike any earlier species, is doubtless ancestral to *C.(S.) senegalensis* (Gmelin), type of the subgenus, and *C.(S.) tenuivaricosus*.

Chicoreus (Siratus) miltos Vokes, n. sp.
Plate 7, figures 2, 3

Description: Shell with seven, possibly eight, teleoconch whorls, protoconch of three polished conical whorls, ending at a small varix. Spiral ornamentation on earliest teleoconch whorls of three equal cords, plus one weaker cord on subsutural slope; three major cords continuing and strengthening, weaker cords intercalated; body whorl with five major cords between shoulder and base of body whorl, another one or two weaker major cords on subsutural slope and three or four on siphonal canal; between major cords are weaker secondary cords, each of these flanked by even weaker tertiary threads, until entire surface of shell repeats a pattern of primary, tertiary, secondary, tertiary, primary spiral cords. Axial ornamentation on earliest teleoconch whorls of 10 or 11 equal ridges; on fifth or sixth whorl every fourth ridge strengthened into a small varix with the others remaining as elongate intervarical nodes, usually three between each pair but rarely with a fourth added. Varices rounded, ornamented by raised welts where the spiral cords cross, that at the shoulder and the base of the body whorl somewhat larger and occasionally producing a short spine. Suture incised, undulated by axial ornamentation. Aperture elongate-oval, inner lip narrow, appressed at posterior end, free-standing at anterior end, with numerous rugae over entire length. Inner side of outer lip with about 16 paired lirae. Siphonal canal moderately long, wide, almost closed but open by a narrow slit; recurved at distal end.

Holotype: Museum of Paleontology, University of California, Berkeley, UCMP 38649; height 42 mm, diameter 23.2 mm.

Type locality: UCMP S-4257, Concepcion Inferior Formation; Almagres, Veracruz, Mexico.

Etymology of name: *miltos* (G.) = red earth, a translation of the Spanish *almagres*, which means the same, referring to the type locality.

Occurrence: Concepcion Inferior Formation, Mexico.

Figured specimens: Fig. 2, UCMP 38649 (holotype). Fig. 3, UCMP 38650 (paratype); height 35.5 mm, diameter 18.7 mm; locality UCMP S-207, Almagres, Veracruz, Mexico. Additional localities: UCMP S-4480, S-4483 (both Nueva Teapa, Veracruz), TU 1028, 1514, 1515.

Discussion: In the collections of the Museum of Paleontology, University of California, Berkeley, there are several specimens of an unusual new species here named *C.(S.) miltos*. Almagres, Veracruz, the type locality, is a station on the Trans-Isthmian Railroad, about 25 km southwest of Jaltipan, and is the nearest village to the locality called "Kilometer-70" by Toula

(1911). Although mollusks are no longer preserved at this locality (= TU 1321) Akers (1981, p. 146) found a good Middle Pliocene microfauna. There are three additional specimens from Nueva Teapa, on Mexico Highway 180, about 12 km east of the old bridge at Coatzacoalcos. In the Tulane collections we also have several incomplete specimens from the Nueva Teapa area, all from the Concepcion Inferior Formation. One of these, if complete, would be about 90 mm in height and larger than any specimens in the present collection, the largest of which is 50 mm.

This new species is not like any other I know. It is unique among the species of *Siratus* (or *Chicoreus*) in that the varices do not form until about the sixth post-nuclear whorl, and there are only two varical spines, one at the shoulder and one at the base of the body whorl. Nevertheless, in all other aspects it is a typical *Siratus*.

Chicoreus (Siratus) eumekes Vokes
Plate 7, figure 4

Chicoreus (Siratus) eumekes VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 51, pl. 3, figs. 11, 12.

Holotype: USNM 323869; height 44.9 mm, diameter 19.8 mm.

Type locality: TU 1215, Gurabo Formation; Río Gurabo, bluffs on both sides, from the ford on the Los Quemados-Sabaneta road upstream to approximately 1 km above the ford, Dominican Republic (= Zone D of Maury, 1917).

Occurrence: Gurabo Formation, Dominican Republic.

Figured specimen: USNM 323869 (holotype). For additional localities in the Dominican Republic, see Vokes, 1989b, p. 52.

Discussion: This species occurs in the coralline facies of the Gurabo Formation, indicating that its nearest relative is the living reef-dweller *C.(S.) consuela* (Verrill).

Chicoreus (Siratus) habros Vokes, n. sp.
Plate 7, figures 5-7

Description: Shell with probably seven teleoconch whorls in the adult, and a protoconch of two and one-half smooth conical whorls, exact termination uncertain. Spiral ornamentation on earliest teleoconch whorls of four equal cords, gradually changing to alternating major and minor cords; body whorl with approximately six major and six minor cords, a few tertiary threadlets intercalated between some pairs; an additional six weaker major and six minor cords on siphonal canal. Axial ornamentation on initial teleoconch whorl of 12 rounded ridges; by third teleoconch whorl every third ridge enlarged to form a varix, with the other two remaining as intervarical ridges; on fourth teleoconch whorl a third intervarical node added between each pair of varices, persisting up to body whorl. Where spiral cords cross varices small open spines produced, that at shoulder slightly larger, all connected by a small flange, best developed on the anterior portion of the whorl and on the siphonal canal. Suture deeply incised, giving a rounded appearance to each whorl. Aperture oval, inner lip narrow, appressed at posterior end, free-standing at anterior end, elongate rugae along entire length. Inner side of outer lip with about nine lirae, anal notch broad and shallow. Siphonal canal long, wide, almost closed but open by a narrow slit; recurved at distal end.

Holotype: USNM 450370; height 28.8 mm, diameter 14.4 mm.

Type locality: TU 1046, Agueguexquite Formation; roadcuts on both sides of Mexico Highway 180, 12 km east of junction with side road into Coatzacoalcos, Veracruz, Mexico. (This is the locality described in Perrilliat Montoya, 1960, p. 5).

Etymology of name: *habros* (G.) = pretty, dainty, graceful.

Occurrence: Agueguexquite Formation, Mexico.

Figured specimens: Fig. 5, USNM 450370 (holotype). Fig. 6, USNM 450371 (paratype A); height 28.7 mm, diameter 13.9 mm; locality TU 1046. Fig. 7, UCMP 38651 (paratype B); height (as is) 27.5 mm, diameter (as is) 19.6 mm; locality UCMP S-4153, Veronica, Veracruz. Additional localities: TU 638, 1347.

Discussion: In the Agueguexquite Formation, to the east of Coatzacoalcos, Veracruz, we have a large number of specimens, almost all of which are fragmentary, of a species most similar to the Dominican *C.(S.) eumekes* Vokes. From the latter it differs in the protoconch with fewer whorls (two and one-half *vs.* three and one-half in *eumekes*), its smaller aperture, more elaborate varical flange, and a surface ornament that appears more "beaded," resulting from the intersection of the stronger spiral cords and smaller intervarical ridges of *C.(S.) habros*. This new species also resembles the later *C.(S.) consuela* but may be distinguished from the latter by its much stronger spiral cords, which result in more produced varical spines, and the more incised suture, which gives the whorls of *C. (S.) habros* a more rounded appearance.

In the collections of the Museum of Paleontology, University of California, Berkeley, from a locality that we have not been able to find (Veronica, Veracruz) there is an incomplete specimen, here figured as paratype B (pl. 7, fig. 7). The fauna at this locality includes *Haustellum bellegladeensis* (Vokes), which as noted above is common in the Agueguexquite Formation, and it is assumed that the beds at Veronica are to be referred to that formation also.

CHICOREUS (SIRATUS) CONSUELA (Verrill)
Plate 7, figure 8

Murex (Murex) pulcher A. Adams. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96.

Not *Murex (Murex) pulcher* A. Adams. CLENCH, 1959, Johnsonia, v. 3, no. 39, p. 333; RIOS, 1970, Coastal Brazilian Seashells, p. 77, pl. 20 [= *C. (S.) coltrorum* Vokes].

Murex (Murex) consuelae [emend.] Verrill. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 111.

Chicoreus (Siratus) consuelae (Verrill). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 195.

Not *Siratus consuela* (Verrill). RIOS, 1975, Brazilian Marine Moll. Icon., p. 84, pl. 24, fig. 342 [= *C.(S.) coltrorum* Vokes].

Siratus consuela (Verrill). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 106, pl. 17, fig. 13; FAIR, 1976, The Murex

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PLATE 8

Figures — Page

1. *Chicoreus (Siratus) yaquensis* (Maury) (X 1 1/4) 48
   ANSP 3255A (paralectotype); height 42 mm, diameter 23 mm.
   Locality: (?)TU 1227, Dominican Republic; Gurabo Formation.
2. *Chicoreus (Siratus) ciboney* (Clench and Pérez Farfante) (X 1 1/4) 49
   USNM 450373; height 41.5 mm, diameter 25 mm.
   Locality: USGS 18398, Jacmel, Haiti; unnamed formation.

3-5. *Chicoreus (Siratus) domingensis* (Sowerby) 50

3. (X 1) USNM 323871; height 55.1 mm, diameter 27.4 mm.
   Locality: TU 1250, Dominican Republic; Gurabo Formation.
4. (X 1) UCMP 38652; height 53.7 mm, diameter 32.8 mm.
   Locality: UCMP S-4004, Jesus Carranza, Veracruz, Mexico; (?)Medias Aguas Beds.
5. (X 1 1/4) UCMP 38653; height 42.5 mm, diameter 24.8 mm.
   Locality: UCMP S-2, Bowden, Jamaica; Bowden Formation.

6-8. *Chicoreus (Siratus) formosus* (Sowerby) 50

6. (X 1) NMB H 16990; height 54.6 mm, diameter 33.7 mm.
   Locality: NMB 15833, Dominican Republic (= TU 1352); Mao Formation.
7. (X 1 1/2) USNM 369459; height 38.4 mm, diameter 19.8 mm.
   Locality: Bowden, Jamaica; Bowden Formation.
8. (X 1) USNM 450374; height (as is) 47 mm, diameter (as is) 32 mm.
   Locality: Telfers Island, Panama; Gatun Formation.

9, 10. *Chicoreus (Siratus) articulatus* (Reeve) 51

9. (X 1 1/2) NMB H 16993; height 35 mm, diameter (excluding spines) 21.6 mm.
   Locality: NMB 15833, Dominican Republic (= TU 1352); Mao Formation.
10. (X 1 1/4) UCMP 38654; height 40.4 mm, diameter 23.3 mm.
    Locality: UCMP S-2, Bowden, Jamaica; Bowden Formation.

11. *Chicoreus (Siratus) springeri* (Bullis) (X 1 1/4) 52
    USNM 450375; height 46 mm, diameter (excluding spines) 25.7 mm.
    Locality: TU 1240, Costa Rica; Moín Formation.
12. *Chicoreus (Siratus) senegalensis* (Gmelin) (X 1 1/4) 53
    USNM 878009; height 44.4 mm, diameter 27.7 mm.
    Locality: Cabo Frio, Brazil; Recent.
13. *Chicoreus (Siratus) thompsoni* (Bullis) (X 1 1/2) 52
    USNM 878010 (paratype); height 33.7 mm, diameter 16.6 mm.
    Locality: *Oregon* Sta. 2061, off Amazon River, Brazil; Recent.

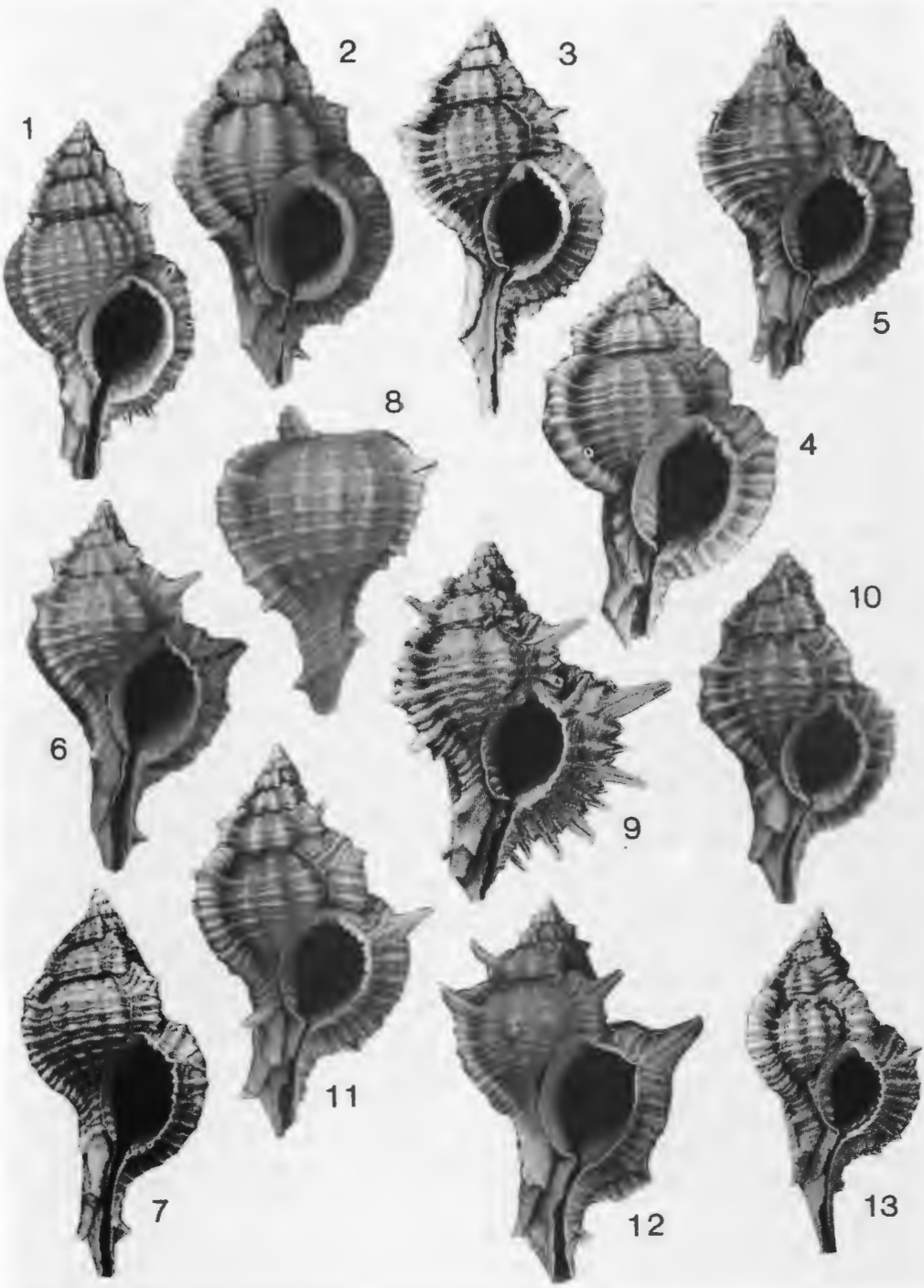

PLATE 8

Book, p. 33, pl. 5, fig. 69.

Not *Murex (Murex) consuelae* (Vokes) [*sic*]. RIOS 1985, Seashells of Brazil, p. 82, pl. 29, fig. 357 [= *C.(S.) coltrorum* Vokes].

Holotype: Not found; height 57-65 mm, diameter 29-34 mm (*fide* Verrill, 1950a, p. 7); Acad. Nat. Sci. Philadelphia, ANSP 209548 (? paratype); height 49.3 mm, diameter 20.4 mm.

Type locality: Off Soufriere, Dominica, Lesser Antilles, 40-50 fms (73-91 m).

Occurrence: Moín Formation, Costa Rica. Recent, Gulf of Mexico and Caribbean Sea.

Figured specimen: USNM 450372; height 55.2 mm, diameter 27.9 mm; locality TU 1240. Additional localities: TU 954, 1239, 1307.

Discussion: The species name *Murex pulcher* A. Adams, 1853, is preoccupied by *M. pulcher* J. Sowerby, 1813, and Defrance, 1827, and has been replaced by the junior synonym originally named as *Murex pulcher* subsp. *consuela* Verrill, 1950. When I first discussed this replacement name (Vokes, 1963a, p. 111), the *Code of Zoological Nomenclature* (ICZN, 1961) mandated an emendation [Art. 31(a)]. However, the Second Edition of the *Code* (ICZN, 1964) reduced this to a recommendation and added [Art. 32(b)] that the original spelling is to be preserved unaltered; therefore, the original orthography must be restored.

This species has been considered to range from the Gulf of Mexico, throughout the Caribbean and beyond, as far south as Espirito Santo, Brazil. However, the specimens south of the Amazon River are a different species, recently named *C.(S.) coltrorum* (Vokes, 1990b, p. 127). Nevertheless, *C.(S.) consuela* is widely distributed in reefal environments, from off the coast of Texas (Flower Garden Banks) to Curaçao (de Jong and Coomans, 1988, p. 71), as well as in the Pleistocene Moín Formation of Costa Rica, where we have numerous specimens from several localities, associated with reefal coral material.

Chicoreus (Siratus) coltrorum Vokes

Murex (Murex) pulcher Adams. CLENCH, 1959, Johnsonia, v. 3, no. 39, p. 333; RIOS, 1970, Coastal Brazilian Seashells, p. 77, pl. 20 (not of Adams).

Siratus consuela (Verrill). RIOS, 1975, Brazilian Marine Moll. Icon., p. 84, pl. 24, fig. 342 (not of Verrill).

Murex (Murex) consuelae (Vokes) [*sic*]. RIOS, 1985, Seashells of Brazil, p. 82, pl. 29, fig. 357 (not of Vokes or Verrill).

Chicoreus (Siratus) coltrorum VOKES, 1990, Nautilus, v. 103, no. 4, p. 127, text-figs. 7-13.

Holotype: Mus. Oceanográfico Rio Grande, MORG 20.749; height 54 mm, diameter 22.4 mm.

Type locality: Ilha de Itaparica, Bahia, Brazil, at low tide.

Occurrence: Recent only, northern Brazil.

Discussion: This species previously has been identified as the Gulf/Caribbean *C.(S.) consuela*. It occurs off the coast of northern Brazil, from Rio Grande do Norte to Espirito Santo, and differs from *C.(S.) consuela* in having a protoconch of only one and one-half whorls; *C.(S.) consuela* has two and one-quarter whorls. In addition, the suture of *C.(S.) coltrorum* is more appressed, causing the individual whorls to appear more rounded and distinct than in *C.(S.) consuela*.

Chicoreus (Siratus) yaquensis (Maury)
Plate 8, figure 1

Murex (Murex) yaquensis Maury. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 107.

Chicoreus (Siratus) yaquensis (Maury). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 50, pl. 3, figs. 7-10.

?Synonym:

Murex toreia MAURY, 1925, Serv. Geol. Min. Brasil, Mon. 4, p. 144-145, pl. 6, fig. 11.

Murex cf. *yaquensis* Maury. MAURY, 1925, Serv. Geol. Min. Brasil, Mon. 4, p. 142-143, pl. 6, fig. 12.

Murex (Murex) toreia Maury. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 102, pl. 4, fig. 6 (*ex* Maury, 1925, pl. 6, fig. 11).

Lectotype: Acad. Nat. Sci. Philadelphia, ANSP 3255; height 34.3 mm, diameter 18.4 mm.

Type locality: TU 1227, Gurabo Formation; Arroyo Zalaya, which crosses the road to Jánico from Santiago de los Caballeros, 11 km south of the bridge over the Río Yaque del Norte at Santiago, Dominican Republic (restricted by Vokes, 1989b, p. 50).

Occurrence: Gurabo Formation, Dominican Republic; (?)Pirabas Limestone, Brazil.

Figured specimen: ANSP 3255A (paralectotype); height 42 mm, diameter 23 mm; locality (?) same as holotype. For additional localities in the Dominican Republic, see Vokes, 1989b, p. 51.

Discussion: When I first treated this species we had no material except for the type lot. Later we collected numerous specimens, all from the deepest water

facies of the Gurabo Formation. Maury (1917, p. 266) thought that *C. yaquensis* might be just a form of *C.(S.) domingensis* (Sowerby), which does occur with *C. yaquensis*, but the two are readily distinguished by the more inflated shell, with distinct beading, present in *C. yaquensis*, and particularly by the totally different protoconch and early whorl development (see Vokes, 1989b, pl. 3, fig. 8).

The unusual nature of the early whorls and the short, stubby siphonal canal demonstrate clearly that *C.(S.) yaquensis* is ancestral to *C.(S.) ciboney* (Clench and Pérez Farfante), which lives today in depths of 350-450 meters – one of the deepest habitats for this deep-water subgenus.

The Brazilian species *Murex toreia* (Maury) is conspecific, based on the material figured by Maury.

CHICOREUS (SIRATUS) CIBONEY
(Clench and Pérez Farfante)
Plate 8, figure 2

Murex (Murex) ciboney CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 20, pl. 10, figs. 1-3; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96.

Chicoreus (Siratus) ciboney (Clench and Pérez Farfante). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 195.

Siratus ciboney (Clench and Pérez Farfante). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 105, pl. 17, fig. 12; FAIR, 1976, The Murex Book, p. 30, pl. 5, figs. 61 (holotype), 64 (type of *Murex trilineatus* Reeve).

Synonyms:

Murex trilineatus REEVE, 1845, Conch. Icon., v. 3, *Murex*, pl. 25, fig. 103 (*non Murex trilineatus* J. Sowerby, 1813).

Chicoreus (Siratus) reevei VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 196 (*n.n. pro Murex trilineatus* Reeve *non* Sowerby).

Murex (Murex) yumurinus SARASÚA and ESPINOSA, 1978, Poeyana, no. 179, p. 2, text-figs. 1a-d; SARASÚA and ESPINOSA, 1984, Poeyana, no. 273, p. 2, not text-figs. 1b, 1c [= *C.(S.) cailleti* var. *kugleri* (Clench and Pérez Farfante, 1945)].

Holotype: Harvard Mus. Comp. Zool., MCZ 147315; height 55 mm, diameter 24.6 mm.

Type locality: *Atlantis* Station 3482, off Matanzas, Cuba, 104 meters.

Occurrence: Unnamed formation, Haiti. Recent, Caribbean Sea.

Figured specimen: USNM 450373; height 41.5 mm, diameter 25 mm; locality USGS 18398, north of Jacmel, Arrondissement of Jacmel, Haiti.

Discussion: This deep-water form, which lives in depths from 350 to 450 meters, has not been reported as fossil but in the U.S. National Museum collections there is one specimen collected in southern Haiti by the late W. P. Woodring, at USGS locality 18398 (on the road from Port au Prince to Jacmel, 9 km northwest of the town of Jacmel; the locality actually is "4 miles S.E. of Trouin"). Almost certainly, this is the same as the locality given in Woodring, *et al.* (1924, p. 242) as USGS 9530, where specimens of *C.(S.) articulatus* were collected. In the Dominican Republic report (Vokes, 1989b, p. 47) I discussed this area, which appears identical in depositional history and age to exposures of the Mao Formation along the Río Gurabo (locality TU 1352) where gravel and shells have been washed down-slope into the extremely deep-water beds of the Mao Formation bringing shallow-water species, such as *C.(P.) pomum* (Gmelin), to rest among specimens of deep-water species such as *C. (S.) articulatus* and *C.(S.) formosus*.

Woodring's Haitian specimen (pl. 8, fig. 2) is identical to those taken in fish-traps off Matanzas, Cuba. These rather massive individuals were named *Murex yumurinus* by Sarasúa and Espinosa (1978), due to confusion over the identity of *C.(S.) ciboney*. I can readily sympathize with their problem, also having been misled by the original illustrations into creating an unnecessary synonym for *C.(S.) ciboney*. The shell illustrated by Sarasúa and Espinosa (1984, text-figs. 1B, 1C) as *C.(S.) ciboney* is not that species, but an example of *C.(S.) cailleti* var. *kugleri* (Clench and Pérez Farfante, 1945), misleading Sarasúa and Espinosa into thinking their specimens were a new species.

The original illustrations of *C.(S.) ciboney* are poor; the shells are tilted at a strange angle. No illustration of the apertural side of the holotype was included, but this subsequently was figured by Fair (1976, pl. 5, fig. 61). It should be noted, in passing, that figures 1 and 2 of the original illustrations are a paratype and figure 3 is the holotype, for which the locality is Matanzas as stated in the text, not Punta Alegre as stated in the plate explanation.

Presumably the two localities are switched and the Punta Alegre locality refers to the smaller specimen.

CHICOREUS (SIRATUS) DOMINGENSIS (Sowerby)
Plate 8, figures 3-5

Murex domingensis Sowerby. MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 101(265) [in part], pl. 16(42), figs. 3, 4 only [fig. 5 = *Haustellum pennae* (Maury), fig. 6 = *Chicoreus (Siratus) amplius* Vokes].

Not *Murex domingensis* Sowerby. ANDERSON, 1929, California Acad. Sci., Proc., (Ser. 4) v. 18, no. 4, p. 137 [= unnamed species of *Chicoreus*].

Murex (Murex) domingensis Sowerby. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 106, pl. 2, figs. 8, 9 only [fig. 6 = *Haustellum messorius* (Sowerby), fig. 7 = *Haustellum pennae* (Maury)].

Chicoreus (Siratus) domingensis (Sowerby). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 43, pl. 4, figs. 1-10, text-fig. 19 (lectotype).

Lectotype: Brit. Mus. (Nat. Hist.), BMNH G. 83 948 (designated by Pflug, 1961, p. 45); height 44.6 mm, diameter 27 mm.

Type locality: TU 1293, Gurabo Formation; Río Mao, west bank, bluff just below Paso Chorrero, or about 12 km (by road) south of Mao, Dominican Republic (= Bluff 1 of Maury, 1917) (restricted by Vokes, 1989b, p. 44).

Occurrence: Gurabo Formation, Dominican Republic; (?)Medias Aguas Beds, Veracruz, Mexico; Punta Gavilan Formation, Venezuela; Bowden Formation, Jamaica.

Figured specimens: Fig. 3, USNM 323871; height 55.1 mm, diameter 27.4 mm; locality TU 1250. Fig. 4, UCMP 38652; height 53.7 mm, diameter 32.8 mm; locality UCMP S-4004, Río Coatzacoalcos, near Jesus Carranza, Veracruz, Mexico. Fig. 5, UCMP 38653; height 42.5 mm, diameter 24.8 mm; locality UCMP S-2, Bowden, Jamaica. For additional localities in the Dominican Republic, see Vokes, 1989b, p. 46.

Discussion: Chicoreus (Siratus) domingensis was covered extensively in the Dominican Republic report and it was noted therein (Vokes, 1989b, p. 45) that the type lot of this species in the British Museum (Natural History) collections includes 22 specimens. Of these, in addition to the lectotype, only three are referable to *C. domingensis*. Nine are *Haustellum messorius* (Sowerby), eight are *Haustellum pennae* (Maury), and one is *C. (S.) amplius* Vokes. That subsequent workers have had problems with the identification of the species is understandable.

In the Dominican Republic *C. domingensis* is confined to the relatively deep-water deposits of the Gurabo Formation. Rare specimens occur in other localities outside the Dominican Republic, however. Rutsch (1934, pl. 4, fig. 2) illustrated a beautiful example from the Punta Gavilan Formation of Venezuela and another specimen from an unknown formation (probably the Late Miocene Medias Aguas Beds) of Veracruz, Mexico is figured here (pl. 8, fig. 4). The species also occurs in the Bowden Formation, Jamaica, together with *C.(S.) articulatus* (Reeve) and specimens that are very similar to *C.(S.) formosus* (Sowerby) (compare pl. 8, figs. 5, 7, and 10). In the Dominican Republic report I considered that *C.(S.) domingensis* was probably ancestral to *C.(S.) formosus* and suggested that the most accurate citation for the Bowden specimens would be as "*C.(S.) domingensis/formosus.*" However, work on this paper has convinced me that the real descendant of *C.(S.) domingensis* is *C.(S.) springeri* (Bullis) and that *C.(S.) formosus* represents a parallel line descended from the Chipola species, *C.(S.) juliagardnerae*. Thus, it is entirely possible to have the lineal descendants of the three Chipola species (*C. chipolanus, C. juliagardnerae, C. sextoni*) all occurring together in the Bowden beds (*C. articulatus, C. formosus, C. domingensis*), as they do in the Chipola Formation.

CHICOREUS (SIRATUS) FORMOSUS (Sowerby)
Plate 8, figures 6-8

Murex formosus SOWERBY, 1841, Conch. Illus., pl. 197, fig. 112; SOWERBY, 1841, Zool. Soc. London, Proc., pt. 8 (1840), p. 139.

Murex (Murex) antillarum Hinds. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 12 [in part, not of Hinds], pl. 6; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 107 [in part, not of Hinds], pl. 3, figs. 2, 3.

Chicoreus (Siratus) antillarum (Hinds). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 196.

Siratus formosus (Sowerby). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 106, pl. 17, fig. 9; FAIR, 1976, The Murex Book, p. 43, pl. 5, fig. 56.

Chicoreus (Siratus) formosus (Sowerby). VOKES, 1980, Of Sea and Shore, v. 11, p. 91, text-figs. 1, 2; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 47, pl. 4, figs. 14-16.

"Type figure": Sowerby, 1841a, pl. 197, fig. 112 (designated by Vokes, 1989b, p. 48); height 79.8 mm, diameter 26.6 mm (*fide* Sowerby, 1841b, p. 139, as "Long. 3.15; lat. ex. var. 1.05 poll.").

Type locality: Puerto Plata, Dominican Republic (restricted by Vokes, 1989b, p. 48).

Occurrence: Mao Formation, Dominican Republic; Gatun Formation, Panama; Bowden Formation, Jamaica. Recent, Caribbean Sea.

Figured specimens: Fig. 6, NMB H 16990; height 54.6 mm, diameter 33.7 mm; locality NMB 15833 (= TU 1352). Fig. 7, USNM 369459; height 38.4 mm, diameter 19.8 mm; locality, Bowden, Jamaica. Fig. 8, USNM 450374; height (as is) 47 mm, diameter (as is) 32 mm; locality, Telfers Island, Panama.

Discussion: There is a strong similarity between *C. domingensis* and *C. formosus* but in the latter species the shell is larger, more coarsely ornamented, and the siphonal canal is considerably longer. Originally, I thought that there was a direct connection between the two species but, now I believe that three parallel lines of evolution led to three similar appearing species. As noted above, in the basal Pleistocene Bowden Formation of Jamaica, specimens that can be referred to *C. domingensis* (pl. 8, fig. 5) occur with those more like *C. formosus* (pl. 8, fig. 7; this specimen is one of two figured by Woodring, 1928, pl. 17, fig. 7, as *Murex recurvirostris* Broderip). Occurring with these is a representative of the third line, *C.(S.) articulatus* (Reeve) (pl. 8, fig. 10).

Although *C.(S.) formosus* and *C.(S) articulatus* live today in the same general area, they do not occur together; *C.(S.) formosus* lives in slightly shallower water, from 20 to 100 meters and *C. (S.) articulatus* lives from about 100 to 200 meters (Kevan Sunderland, personal communication). In the Dominican Republic the two species are found together at one unusual locality (TU 1352), where extremely shallow water species have been washed downslope into very deep water. Here we have 15 specimens of *C.(S.) formosus* together with more than 100 examples of *C.(S.) articulatus,* indicating that the more shallow living specimens of *C.(S.) formosus* were among the material transported into the deep water habitat of *C.(S.) articulatus.* This is the same type of mixed environment that is found at Bowden, explaining the presence of the three different species together.

Chicoreus (Siratus) articulatus (Reeve)
Plate 8, figures 9, 10

Murex articulatus REEVE, 1845, Conch. Icon., v. 3, *Murex,* expl. to pl. 22 (for *Murex motacilla* var., Sowerby, 1841a, pl. 189, fig. 69).

Murex (Murex) recurvirostris recurvirostris Broderip. PERRILLIAT, 1972, Paleontología Mexicana, no. 32, p. 79, pl. 39, figs. 5-8 (not of Broderip).

Siratus articulatus (Reeve). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 104, pl. 17, figs. 2, 3; FAIR, 1976, The Murex Book, p. 22, pl. 5, fig. 58.

Chicoreus (Siratus) articulatus (Reeve). VOKES, 1980, Of Sea and Shore, v. 11, p. 91, text-figs. 3-5; VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 46, pl. 4, figs. 11-13.

Synonyms:

[?] *Murex antillarum* HINDS, 1844, Zool. Soc. London, Proc., pt. 11 (1843), p. 126 [a *nomen dubium;* probably not *M. antillarum* of authors, which = *C.(S.) formosus* Sowerby].

Murex nodatus REEVE, 1845, Conch. Icon., v. 3, *Murex,* pl. 25, fig. 107 (*non M. nodatus* Gmelin, 1791).

Murex gundlachi DUNKER, 1883, Malak. Blatter, (N.S.) v. 6, p. 35, pl. 1, figs. 1, 2.

Murex finlayi CLENCH, 1955, Harvard Mus. Comp. Zool., Brevoria, no. 44, p. 1, text-figs. 1-3; CLENCH, 1959, Johnsonia, v. 3, no. 39, p. 31, pl. 174, figs. 1-3.

Murex woodringi Clench and Pérez Farfante. MORRIS, 1973, Field Guide to Shells, Atlantic and Gulf Coasts and West Indies, Third Ed., p. 193, pl. 52, fig. 6 (not of Clench and Pérez Farfante).

"Type figure": Sowerby, 1841a, pl. 189, fig. 69 (designated by Vokes, 1989b, p. 46); height 50 mm, diameter 25 mm (*fide* Sowerby, 1841a).

Type locality: Off Ocho Rios, Jamaica (restricted by Vokes, 1989b, p. 46).

Occurrence: Mao Formation, Dominican Republic; (?)Medias Aguas Beds, Veracruz, Mexico; unnamed formation, Haiti; Bowden Formation, Jamaica. Recent, Caribbean Sea.

Figured specimens: Fig. 9, NMB H 16993; height 35 mm, diameter (excluding spines) 21.6 mm; locality NMB 15833 (= TU 1352). Fig. 10, UCMP 38654; height 40.4 mm, diameter 23.3 mm; locality UCMP S-2, Bowden, Jamaica. For additional localities in the Dominican Republic, see Vokes, 1989b, p. 47.

Discussion: The problems of identification of *C.(S.) articulatus* and the similar

C.(S.) formosus were discussed at length in an earlier paper (Vokes, 1980) and it was concluded that the best way to distinguish *C. articulatus* from *C. formosus* is by the greater angle of deflection of the siphonal canal in *C. articulatus*. In addition, the color pattern is different; *C. formosus* is monochromatic tan or brown and *C. articulatus* is striped with brown and white bands and also has reddish-brown spiral threads. Both species were figured in Vokes (1980) demonstrating the differences.

More than 100 specimens of this species were collected from one unusual locality (TU 1352) in the Mao Formation in the Dominican Republic. Here, the water depth was probably similar to the habitat of living *C.(S.) articulatus*, as noted above, 100 to 200 meters. The species also occurs at a locality in southern Haiti, near the town of Jacmel, similar in facies to the Mao occurrences (see Vokes, 1989b, p. 47). In addition, we have one specimen from the Bowden Formation, Jamaica (pl. 8, fig. 10), in another deep-water deposit.

Perrilliat (1972, pl. 39, figs. 5-8) figured two specimens from beds at Santa Rosa, Veracruz, Mexico that may be referable to this species. The smaller of the two (USNM 287313 – her pl. 39, figs. 5, 6) is almost certainly the same; the larger (USNM 350018 – her pl. 39, figs. 7, 8) is a battered shell, lacking the diagnostic siphonal canal, but appears to be the same as the smaller one. The aperture is relatively small, with only a shallow anal notch and reduced rugae. This type of aperture is matched by many Recent specimens of this variable species but it does not closely resemble the examples figured here from the Mao and Bowden formations. The age of the beds at Santa Rosa is uncertain. We have been unable to find this remarkable locality but, as noted in the Dominican Republic report (Vokes, 1989b, p. 47), beds in the near vicinity have been dated by Dr. Akers as Late Miocene (N.17) and are here referred to the unit informally named the Medias Aguas Beds by Akers (1980, p. 497). There are no muricids in common with the younger (N.20) Agueguexquite Formation to which these beds were referred by Perrilliat.

CHICOREUS (SIRATUS) SPRINGERI (Bullis)
Plate 8, figure 11

Murex (Siratus) springeri BULLIS, 1964, Tulane Stud. Zoology, v. 11, no. 4, p. 104, text-figs. 7, 8.

Chicoreus (Siratus) springeri (Bullis). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 197.

Siratus senegalensis (Gmelin). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 107 [in part, not of Gmelin], pl. 17, fig. 1 only.

Siratus springeri (Bullis). FAIR, 1976, The Murex Book, p. 78, pl. 6, fig. 70 (holotype); PETUCH, 1987, New Caribbean Moll. Faunas, p. 87, pl. 18, fig. 6 (holotype).

Holotype: USNM 635148; height 70 mm, diameter 32.7 mm.

Type locality: *Oregon* Station 2289, 95 mi north-northeast of Surinam [Suriname] River entrance, Suriname, 75-80 fms (147-146 m).

Occurrence: Moín Formation, Costa Rica. Recent, northern South America.

Figured specimen: USNM 450375; height 46 mm, diameter (excluding spines) 25.7 mm; locality TU 1240.

Discussion: Although not reported previously as fossil, we have many specimens of *C.(S.) springeri* from the Pleistocene Moín Formation, Costa Rica (all from locality TU 1240). These specimens strongly resemble *C.(S.) domingensis* (Sowerby), and differ only in the less appressed suture, the varices being deeply excavated on the abapertural side, and the stronger shoulder spine. Thus, *C.(S.) springeri*, with its relatively short siphonal canal, is more likely the true descendant of *C.(S.) domingensis* than species with extremely long siphonal canals, such as *C.(S.) formosus* (Sowerby) as previously treated in the Dominican report.

Radwin and D'Attilio (1976, p. 108) considered this species a "more coarsely sculptured form" of *C.(S.) senegalensis* (Gmelin), but the resemblance seems to be only of subgeneric importance (compare pl. 8, figs. 11 and 12). The type specimen of *C.(S.) springeri* is a somewhat "atypical" gerontic individual 70 mm in height. Most examples (including several paratypes) are less than 60 mm and resemble the shell figured by Radwin and D'Attilio (1976, pl. 17, fig. 1).

CHICOREUS (SIRATUS) THOMPSONI (Bullis)
Plate 8, figure 13

Murex (Murex) thompsoni BULLIS, 1964, Tulane Stud. Zoology, v. 11, no. 4, p. 103, text-figs. 3, 4.
Chicoreus (Siratus) thompsoni (Bullis). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 197.
Siratus thompsoni (Bullis). FAIR, 1976, The Murex Book, p. 81, pl. 5, fig. 67 (holotype); PETUCH, 1987, New Caribbean Moll. Faunas, p. 89, pl. 20, fig. 3 (holotype).
Siratus briskasii (Verrill). PETUCH, 1987, New Caribbean Moll. Faunas, p. 89, pl. 18, figs. 5, 6, pl. 21, fig. 13 (not of Verrill).

Holotype: USNM 635147; height 35.8 mm, diameter 18.9 mm.

Type locality: *Oregon* Station 2321, 75 mi north-northeast of Pte. Mana, French Guiana, 34 fms (62 m).

Occurrence: Recent only, northern South America.

Figured specimen: USNM 878010 (paratype); height 33.7 mm, diameter 16.6 mm; locality, *Oregon* Sta. 2061, off mouth of Amazon River, 55-60 fms (100-110 m).

Discussion: Abbott (1974, p. 172) rejected this species as a specimen of *Murex woodringi* "in which the siphonal canal has been broken off and then repaired" and Radwin and D'Attilio (1976) completely overlooked it. Nevertheless, it is a valid form that is another descendant of the *C.(S.) domingensis* line. It differs from the ancestral species in having a narrower shell, with only two or three intervarical nodes in contrast to the three or four in the older form, but in many ways it is closer to *C.(S.) domingensis* than to *C.(S.) springeri*, which comes from the same area.

Bullis (1964, p. 103) observed that the holotype was "somewhat more exotic" than the remainder of the type lot, which generally have a more slender and elongate shell, without spines (see pl. 8, fig. 13). Perhaps this is what caused Petuch (1987, p. 89) to think he had rediscovered the "lost species" *C.(S.) briskasii* (Verrill).The latter is probably a synonym of *C.(S.) motacilla* (Gmelin) but Petuch's figured specimens (1987, pl. 18, figs. 5, 6; pl. 21, fig. 13) are typical examples of *C.(S.) thompsoni*. This serves to extend the range of the species to Venezuela.

CHICOREUS (SIRATUS) BEAUII (Fischer and Bernardi)

Murex (Murex) beauii Fischer and Bernardi. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 14, pl. 7, figs. 1, 2.
Murex (Siratus) beauii Fischer and Bernardi. VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 111; BAYER, 1971, Bull. Mar. Sci., v. 21, no. 1, p. 155, text-fig. 27.
Siratus beauii (Fischer and Bernardi). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 104, pl. 17, fig. 8; FAIR, 1976, The Murex Book, p. 24, pl. 5, fig. 55.

Synonyms:

Murex percoides LOEBBECKE, 1879, Deutsch. Malak. Gesell., Jahr., v. 7, p. 79, pl. 3, fig. 1.
Murex (Murex) branchi CLENCH, 1953, Johnsonia, v. 2, no. 32, p. 360, pl. 179.

Holotype: In the collections of the Journal de Conchyliologie (*fide* Clench and Pérez Farfante, 1945, p. 15); height 120 mm, diameter (including spines) 51 mm.

Type locality: Island of Marie Galente, French West Indies.

Occurrence: Post-Pleistocene, Louisiana. Recent, western Atlantic from Florida to Uruguay.

Discussion: Probably the best known and most unmistakable member of *Siratus*, this species is common in deeper water (173-463 meters, Clench and Pérez Farfante, 1945, p. 15; 201-366 meters, Bullis, 1964, p. 104; 115-275 meters, Bayer, 1971, p. 157; 170-235 meters, Radwin and D'Attilio, 1976, p. 105). Therefore, the several examples collected in relatively shallow water material from "Mud-lump 90" at the mouth of the Mississsippi River (TU 977) were unexpected. According to Morgan *et al.* (1963, p. 41) this material was deposited in depths of approximately 60 meters. These specimens, dated at about 15,000 YBP, are the only reported fossil occurrence of the species.

The variation in varical webbing in this species was noted by Bullis (1964, p. 104), who observed that contrary to popular belief neither depth nor bottom type had any effect on the presence of elaborate webbing. This was dramatically demonstrated by Bayer (1971, text-fig. 27), who figured two extreme examples from the same dredge haul.

CHICOREUS (SIRATUS) SENEGALENSIS (Gmelin)
Plate 8, figure 12

Murex (Siratus) senegalensis Gmelin. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 24, pl. 13, figs. 1, 2.
Chicoreus (Siratus) senegalensis (Gmelin). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4,

p. 195; VOKES, 1968, Tulane Stud. Geol., v. 6, no. 1, p. 39, text-fig. 2.

Siratus senegalensis (Gmelin). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 107, pl. 7, fig. 7 only [fig. 1 = *C.(S.) springeri* (Bullis)]; FAIR, 1976, The Murex Book, p. 76, pl. 5, fig. 65.

Holotype: Museum de Hist. Nat. National, Paris; height 58 mm, diameter 34 mm (*fide* Fischer-Piette, 1942, p. 222, pl. 6, fig. 8 – "Le Sirat" Adanson, on which Gmelin's species is based).

Type locality: "Senegal."

Occurrence: Recent only, Brazil.

Figured specimen: USNM 878009; height 44.4 mm, diameter 27.7 mm; locality, Cabo Frio, State of Rio de Janiero, Brazil, 5 meters.

Discussion: Although the type species of the subgenus, *C.(S.) senegalensis* is a most unusual species of *Siratus*, in that it is the only shallow-water Recent form. It is relatively common along the coast of Brazil, ranging from Espirito Santo to Santa Catarina (Rios, 1985, p. 84). How Adanson (1757, p. 125, pl. 8, fig. 19) got the type specimen of "Le Sirat," upon which this species is based, from Senegal remains a mystery to this day. His specimen has been figured by Fischer-Piette (1942, pl. 6, fig. 8) and there is no question about its identity.

Chicoreus (Siratus) tenuivaricosus (Dautzenberg)

Murex calcar KIENER, 1843, Coquilles Vivantes, v. 7, p. 107, pl. 36, fig. 2 (*non Murex calcar* J. de C. Sowerby, 1823, *nec* Scacchi, 1835).

Murex tenuivaricosus DAUTZENBERG, 1927, Res. Camp. Sci. Prince de Monaco, fasc. 72, p. 94 (*n.n. pro Murex calcar* Kiener *non* Sowerby); VOKES, 1969, Tulane Stud. Geol. Paleont., v. 7, no. 2, p. 84.

Chicoreus (Siratus) carioca VOKES, 1968, Tulane Stud. Geol., v. 6, no. 1, p. 39, text-fig. 1 (*n.n. pro Murex calcar* Kiener *non* Sowerby).

Siratus tenuivaricosus (Dautzenberg). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 108, pl. 17, fig. 16; FAIR, 1976, The Murex Book, p. 80, pl. 5, fig. 57.

Holotype (*Murex calcar* Kiener): Museum de Hist. Nat. National, Paris; height 57 mm (*fide* Fischer-Piette and Beigbeder, 1943, p. 206).

Type locality: Unknown.

Occurrence: Recent only, Brazil.

Discussion: An endemic Brazilian species, *C.(S.) tenuivaricosus* is similar to the shallow-water *C.(S.) senegalensis*. The two forms were compared and figured earlier (Vokes, 1968a), at which time a new name for the preoccupied *Murex calcar* Kiener was proposed. Shortly thereafter the older name *Murex tenuivaricosus* was discovered (Vokes, 1969) and since that time the latter name has become established in the literature. According to Rios (1985, p. 84), this species has the same geographic range (Espirito Santo to Santa Catarina) as the shallow water *C.(S.) senegalensis*, but in depths of 30 to 60 meters (Rios, 1975, p. 85).

Chicoreus (Siratus) motacilla (Gmelin)

Murex (Murex) motacilla Gmelin. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 21, pl. 11; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96 (as *motacillus*).

Chicoreus (Siratus) motacillus [*sic*] (Gmelin). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 195.

Siratus motacilla (Gmelin). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 106, pl. 17, fig. 14; FAIR, 1976, The Murex Book, p. 60, pl. 5, fig. 63.

? Synonym:

Murex briskasii VERRILL, 1953, Mins. Conch. Club So. California, no. 128, p. 2, text-figure.

Not *Siratus briskasii* (Verrill). PETUCH, 1987, New Caribbean Moll. Faunas, p. 89, pl. 18, figs. 5, 6, pl. 21, fig. 13 [= *C.(S.) thompsoni* (Bullis)].

"Type figure": Chemnitz, 1788, Conchylien-Cab., v. 10, pl. 163, fig. 1563 (designated by Clench and Pérez Farfante, 1945, p. 22).

Type locality: Barbados, Lesser Antilles (designated by Clench and Pérez Farfante, 1945, p. 22).

Occurrence: Recent only, Lesser Antilles.

Discussion: A well-known species, this form has never been confused with any other. It appears to be confined to the Lesser Antilles; Radwin and D'Attilio (1976, p. 107) record it from Dominica to Barbados. In earlier papers I incorrectly "latinized" the name, which is a noun, *motacilla* – the yellow wag-tail (a bird) – and does not take a masculine termination to agree with the genus.

There are four closely related species living in deeper waters of the Caribbean that are much alike in having the siphonal canal extremely deflected, more so than the other species assigned to this subgenus. These four, *C.(S.) motacilla*, *C.(S.) cailleti*, *C.(S.) perelegans*, and *C.(S.)*

aguayoi, differ from each other in the nature of the varical ornamentation, ranging from none in *C. perelegans* to extremely long in *C. aguayoi*, and the number of intervarical nodes, with two in *C. motacilla* and *C. perelegans*, two to four in *C. cailleti* and four in *C. aguayoi*.

The species *Murex briskasii* Verrill, 1953, has never been recognized and the holotype cannot be located. In the collections of the Academy of Natural Sciences, Philadelphia, there is a specimen (ANSP 241569) labeled *Murex briskasii*, from the type locality (Dominica, B.W.I., 100 fms), which is simply a dark colored example of *C.(S.) cailleti*. But the original illustration given by Verrill looks more like a specimen of *C.(S.) motacilla*, with short spines at the shoulder and base of the siphonal canal and a lower spire than is typical in *C. (S.) cailleti*. I suspect the Philadelphia specimen is simply a misidentification by a subsequent collector.

Chicoreus (Siratus) cailleti (Petit de la Saussaye)

Murex (Murex) cailleti Petit de la Saussaye. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 17 [in part, not references to *Murex elegans* Beck = *C.(S.) perelegans* Vokes or *Murex trilineatus* Reeve = *C. (S.) ciboney* (Clench and Pérez Farfante)], pl. 9, figs. 3, 4 only [figs. 5, 6 = *C.(S.) perelegans* Vokes); VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96.

Chicoreus (Siratus) cailleti (Petit de la Saussaye). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 195.

Siratus cailleti (Petit de la Saussaye). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 105, pl. 17, figs. 4-6; FAIR, 1976, The Murex Book, p. 28, pl. 5, figs. 62, 66 (as *S. perelegans* Vokes).

Synonym:

Murex (Murex) cailleti var. *kugleri* CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 19, pl. 9, figs. 1, 2; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96; VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 195.

Holotype: In the collections of the Journal de Conchyliologie (*fide* Clench and Pérez Farfante, 1945, p. 19); height 60 mm.

Type locality: Guadeloupe, French West Indies.

Occurrence: Recent only, Florida to Barbados.

Discussion: This species was rather badly treated by Clench and Pérez Farfante (1945, p. 17), who included in the synonymy two species that do not belong and separated as a "variety" a form that is synonymous. They give a wide range of depths from 46 to 366 meters; the species is commonly taken off Barbados in fish-traps at 100 meters.

Chicoreus (Siratus) perelegans Vokes

Murex (Murex) cailleti Petit de la Saussaye. CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 17 [in part, not of Petit de la Saussaye], pl. 9, figs. 5, 6.

Chicoreus (Siratus) perelegans VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 196 (*n.n. pro Murex elegans* Beck *in* Sowerby, 1841, *non M. elegans* Donovan, 1804, *nec* Wood, 1828).

Siratus perelegans (Vokes). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 107, pl. 17, fig. 11; FAIR, 1976, The Murex Book, p. 66, not pl. 5, fig. 66 [= *C.(S.) cailleti* (Petit de la Saussaye)].

Lectotype: Brit. Mus. (Nat. Hist.), specimen figured by Reeve, 1845, pl. 24, fig. 99 (designated by Vokes, 1965a, p. 196).

Type locality: Island of St. Domingo, West Indies [Hispaniola] (Reeve, 1845, pl. 24) (designated by Vokes, 1965a, p. 196).

Occurrence: Recent only, Hispaniola to Barbados.

Discussion: Although this species was considered a synonym of *C. (S.) cailleti* by Clench and Pérez Farfante (1945, p. 17) and Abbott (1974, p. 173), it may be distinguished by its heavy appearance, the prominent spiral brown lines, and, especially, by the complete lack of any varical spines and only the most minimal of varical flanges.

Chicoreus (Siratus) aguayoi (Clench and Pérez Farfante)

Murex (Murex) aguayoi CLENCH and PÉREZ FARFANTE, 1945, Johnsonia, v. 1, no. 17, p. 15, pl. 8, figs. 1-3; VOKES, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 96.

Chicoreus (Siratus) aguayoi (Clench and Pérez Farfante). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 195.

Siratus aguayoi (Clench and Pérez Farfante). FAIR, 1976, The Murex Book, p. 19, pl. 6, fig. 71 (holotype).

Holotype: Harvard Mus. Comp. Zool., MCZ 174286; height 65 mm, diameter (excluding spines) 24 mm.

Type locality: *Atlantis* Station 3415, off Punta Alegre, Camagüey Province, Cuba.

Occurrence: Recent only, Bahamas to Cuba.

Discussion: Although compared to "*Murex antillarum*" [= *C.(S.) formosus* (Sowerby)] by Clench and Pérez Farfante (1945, p. 17) and placed in synonymy with *C.(S.) formosus* by Radwin and D'Attilio (1976, p. 106) this species may be distinguished by two important criteria. One is the unusual protoconch, which is large, bulbous, of two whorls with the first noticably larger than the second and rotated at an angle to the rest of the shell. The second criterion is the extremely deflected siphonal canal, which is closer to the group of *C.(S.) motacilla* than to *C.(S.) formosus*. If it were not for the unusual protoconch, I would suggest that *C.(S.) aguayoi* is only an extremely spinose form of *C.(S.) cailleti* var. *kugleri*, which is otherwise similar.

CHICOREUS (SIRATUS) CAROLYNAE Vokes

Murex chrysostoma Sowerby, var? RIOS, 1970, Coastal Brazilian Seashells, p. 77, pl. 21; RIOS, 1975, Brazilian Marine Moll. Icon., p. 84, pl. 24, fig. 339.

Murex chrysostoma Sowerby. RIOS, 1985, Seashells of Brazil, p. 81, pl. 29, fig. 354 (not of Sowerby).

Chicoreus (Siratus) carolynae VOKES, 1990, Nautilus, v. 103, no. 4, p. 126, text-figs. 1-6.

Holotype: USNM 860504; height 52.8 mm, diameter 24.4 mm.

Type locality: Ilha de Itaparica, Bahia, Brazil, at low tide.

Occurrence: Recent only, Bahia, Brazil.

Discussion: This species was confounded by Rios with *Haustellum chrysostoma*, but the resemblance is only superficial, as both have three essentially nonspinose varices and brown color bands. There is a closer relationship to the members of the *C.(S.) motacilla* group but the siphonal canal of *C.(S.) carolynae* is not so strongly deflected.

The species does closely resemble an aberrant form of *Haustellum messorius* (Sowerby) with a recurved siphonal canal and it may be a case of "ontogeny reversing phylogeny," if, as I suspect, the origin of the *Haustellum* line was a derivative form of *Siratus* in which the siphonal canal became straightened.

Subgenus PHYLLONOTUS Swainson, 1833

Phyllonotus SWAINSON, 1833, Zool. Illus., (Ser. 2) v. 3, expl. to pl. 100.

Type species: *Murex imperialis* var. *a* Swainson, 1833, by subsequent designation, Swainson, 1833, pl. 109 (*M. imperialis* var. *a* = *M. imperialis* Swainson, 1831, *non M. imperialis* Fischer von Waldheim, 1807, = *M. margaritensis* Abbott, 1958).

Discussion: As with the subgenus *Siratus*, the history of development of the subgenus *Phyllonotus* also is rather uncertain. The earliest species in the entire *Chicoreus* complex is one from the Middle Eocene Weches Formation of Texas, here named *C.(P.) initialis*. It most closely resembles the later species *C.(P.) folidodes* (Gardner) and *C.(P.) aldrichi* (Gardner), and for this reason is here placed in *Phyllonotus*. It is similar to *Siratus* with its flanged varices, but the canal is too short for assignment to *Siratus*. However, it almost certainly is ancestral to *C.(S.) stetopus* (de Gregorio) (see above). Also, it is close to the early members of *Chicoreus* s.s., such as *C. dujardinoides* (Vokes) and *C. lepidotus* (Vokes), but the siphonal canal is shorter and more sharply recurved and the varical ornamentation is not divided into discrete spines. It even resembles the subgenus *Naquetia* but again the canal is too short and too recurved and the varical flange is not so elaborately fimbriated as in that group. Thus, in *C.(P.) initialis*, we have a good candidate for the ancestor of all of these groups: giving rise to *Siratus* by lengthening the canal; to *Chicoreus* by dividing the flange into fronds; to (pseudo-) *Naquetia* (see more below) by elaborating the varical flange; and, to *Phyllonotus* by developing a rugose, expanded parietal shield.

CHICOREUS (PHYLLONOTUS) INITIALIS Vokes, n. sp.

Plate 9, figures 1, 2

Description: Shell with six teleoconch whorls and a protoconch of probably five conical whorls [not completely preserved in any specimen], ending at a small varix. Spiral ornamentation on earliest teleoconch whorls worn but about four equal spiral cords, gradually increasing in number and intercalating smaller secondary cords. Body whorl and siphonal canal with 12

primary cords; between each of these one secondary cord, flanked by tertiary threads; entire surface of adult shell covered with a recurring pattern of primary, tertiary, secondary, tertiary, primary cords. Axial ornamentation on first teleoconch whorl of 12 equal ridges; on about fourth teleoconch whorl certain of the ridges enlarged into varices, with others remaining as intervaricial nodes; exact pattern somewhat irregular but by fifth and succeeding whorls usually two nodes between each pair of varices. Each varix formed as an expanded flange of shell material, with successively smaller flanges laid down on the adapertural side of the previous ones, giving a multi-layered appearance to the varical face; this flange undulated by the spiral cords but no part extended as spines. Suture deeply incised, giving a rounded appearance to each whorl. Aperture oval, inner lip narrow, smooth, appressed at posterior end, free-standing at anterior end. Inner side of outer lip with eight heavy denticles, corresponding to the space between the major spiral cords. Siphonal canal short, broad, strongly recurved, previous canals fused into succeeding canals forming a twisted fasciole.

Holotype: USNM 450376; height 29.2 mm, diameter 16 mm.

Type locality: TU 1258, Weches Formation; west side of spillway and dam of Lake Nacogdoches, north side of Texas Highway FM 225, 10 mi west of Texas Highway 224 Bypass, at Nacogdoches, Nacogdoches County, Texas.

Etymology of name: *initialis* (L.) = first, original.

Occurrence: Weches and Stone City formations, Texas.

Figured specimens: Fig. 1, USNM 450376 (holotype). Fig. 2, USNM 450377 (paratype); height 18.7 mm, diameter 10.5 mm; locality TU 1527. Additional locality: TU 61.

Discussion: As noted above, *C.(P.) initialis* is an ideal ancestor for all branches of the genus *Chicoreus;* but, it cannot readily be assigned to any one of these branches. It is most similar to members of the subgenus *Phyllonotus,* with a short, strongly recurved siphonal canal but it differs from that group in lacking the rugose, expanded parietal shield. However, this expanded shield is a later development of the group and the early members do not possess this feature. By the latest Oligocene, species in the Tampa and Silverdale formations show the rugae on the inner lip and in the Early Miocene *C.(P.) infrequens* the labium is beginning to expand.

The only species this new form resembles are *C.(P.) folidodes,* from the Early Miocene, and *C.(P.) aldrichi,* from the Middle Miocene. Both of these later species lack the expanded varical flange of *C.(P.) initialis.*

The type and paratype specimens of *C.(P.) initialis* were originally collected by Thomas G. Andrews, Jr., at the time a graduate student at Stephen F. Austin State University, Nacogdoches, Texas. He included the species in his thesis, as "*Chicoreus (Phyllonotus)* n. sp." (Andrews, 1975, pl. 10, figs. 3, 4), but he had no further interest and gave the specimens to me to describe.

CHICOREUS (PHYLLONOTUS) MISSISSIPPIENSIS (Conrad)
Plate 9, figure 3

Chicoreus (Phyllonotus) mississippiensis (Conrad). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 136, pl. 1, figs. 6, 7; MACNEIL and DOCKERY, 1984, Mississippi Bur. Geol., Bull. 124, p. 122, pl. 18, figs. 17-19, pl. 31, figs. 12-14, pl. 51, fig. 7 [as *C.(P.) mississippiensis*?].

Murex mississippiensis Conrad. DOCKERY, 1982, Mississippi Bur. Geol., Bull. 123, Appendix 1, p. 232, reprint of Conrad's 1848 plates, with pl. XI, fig. 30, *Murex mississippiensis.*

Chicoreus (Phyllonotus) stetopus (de Gregorio). MACNEIL and DOCKERY, 1984, Mississippi Bur. Geol., Bull. 124 [in part, not of de Gregorio], pl. 4, fig. 17 only.

Lectotype: Acad. Nat. Sci. Philadelphia, ANSP 13482 (designated by MacNeil *in* Moore, 1962, p. 77).

Type locality: (?)Byram Formation, Vicksburg, Mississippi.

Occurrence: Red Bluff, Mint Springs, and Byram formations, Mississippi; unnamed formation, Nuevo Leon, Mexico.

Figured specimen: USNM 645427; height 20 mm, diameter 11 mm; locality TU 76. Additional localities TU 1458, 1460.

Discussion: The relationship between the various forms of *Chicoreus* from the Oligocene of Mississippi is not much better understood than when I originally studied the group (Vokes, 1967b). However, numerous additional specimens from the Early Oligocene Red Bluff Formation have caused me to separate *C. stetopus* as an early form of *Siratus* rather than *Phyllonotus,* where I originally placed it (Vokes, 1967b, p. 138). It occurs with, and is difficult to separate from, the more coarsely ornamented *C.(P.) mississippien-*

sis (compare MacNeil and Dockery, 1984, pl. 4, figs. 16 and 17, for example).

Based on material in the Tulane collections, *C.(S.) stetopus* and *C.(P.) mississippiensis* occur in both the Red Bluff and the Mint Springs formations; and *C.(P.) mississippiensis* and *C.(P.) dormani* occur in the Mint Springs and Byram formations. Perhaps *C.(S.) stetopus* gave rise to *C.(P.) dormani* – both are smooth and have a varical flange. If so, this is an amazing case of convergence because *C. dormani* also intergrades with *C. mississippiensis* and is difficult to separate at times. It is awkward

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PLATE 9

Figures

1, 2. *Chicoreus (Phyllonotus) initialis* Vokes, n. sp. 56
1. (X 1 1/2) USNM 450376 (holotype); height 29.2 mm, diameter 16 mm.
Locality: TU 1258, Texas; Weches Formation.
2. (X 2) USNM 450377 (paratype); height 18.7 mm, diameter 10.5 mm.
Locality: TU 1527, Texas; Weches Formation.

3. *Chicoreus (Phyllonotus) mississippiensis* (Conrad) (X 2) 57
USNM 645427; height 20 mm, diameter 11 mm.
Locality: TU 76, Mississippi; Mint Springs Formation.

4. *Chicoreus (Phyllonotus) dormani* (Vokes) (X 2) 60
ANSP 13483; height 24.7 mm, diameter 15 mm.
Locality: Vicksburg, Mississippi; Byram Formation.

5. *Chicoreus (Phyllonotus) davisi* (Richards) (X 1) 60
USNM 645425; height 46 mm, diameter 27 mm.
Locality: TU 562, North Carolina; Silverdale Beds.

6. *Chicoreus (Phyllonotus) trophoniformis* (Heilprin) (X 1 1/2) 60
USNM 165085; height 30 mm, diameter 16.5 mm.
Locality: Ballast Point, Tampa Bay, Florida; Tampa Limestone.

7. *Chicoreus (Phyllonotus) tritonopsis* (Heilprin) (X 2) 61
USNM 643748; height 23.5 mm, diameter 16 mm.
Locality: Ballast Point, Tampa Bay, Florida; Tampa Limestone.

8, 9. *Chicoreus (Phyllonotus) louisae* Vokes, n. sp. (X 3) 61
8. USNM 371878 (paratype); height 14.5 mm, diameter 8.3 mm.
Locality: USGS2211, Alum Bluff, Florida; Chipola Formation.
9. USNM 450378 (holotype); height 16.4 mm, diameter 9.2 mm.
Locality: TU 453, Florida; Chipola Formation.

10. *Chicoreus (Phyllonotus) infrequens* (Vokes) (X 1 1/2) 61
USNM 323860; height 29.6 mm, diameter 15.6 mm.
Locality: TU 1364, Dominican Republic; Baitoa Formation.

11. *Chicoreus (Phyllonotus) folidodes* (Gardner) (X 2) 62
USNM 450379; height 25.9 mm, diameter 18 mm.
Locality: TU 546, Florida; Chipola Formation.
(Color pattern under ultraviolet light)

12. *Chicoreus (Phyllonotus) aldrichi* (Gardner)(X 1) 62
USNM 481841; height 45.8 mm, diameter 25.9 mm.
Locality: USGS 9908, Las Cahobas, Haiti; Thomonde Formation.

13. *Chicoreus (Phyllonotus) pyknos* (Gardner) (X 1 1/2) 63
USNM 115771 (holotype); height 32 mm, diameter 20.8 mm.
Locality: USGS 2615, Florida (= TU 69); Shoal River Formation.

14. *Chicoreus (Phyllonotus) millvillensis* (Richards and Harbison) (X 1 1/2) 63
USNM 498975 (holotype); height 32.5 mm, diameter 19 mm.
Locality: Millville, New Jersey; Kirkwood Formation.

15. *Chicoreus (Naquetia) compactus* (Gabb) (X 1 1/2) 70
USNM 323866; height 32.5 mm, diameter 19 mm.
Locality: TU 1230, Dominican Republic; Cercado Formation.

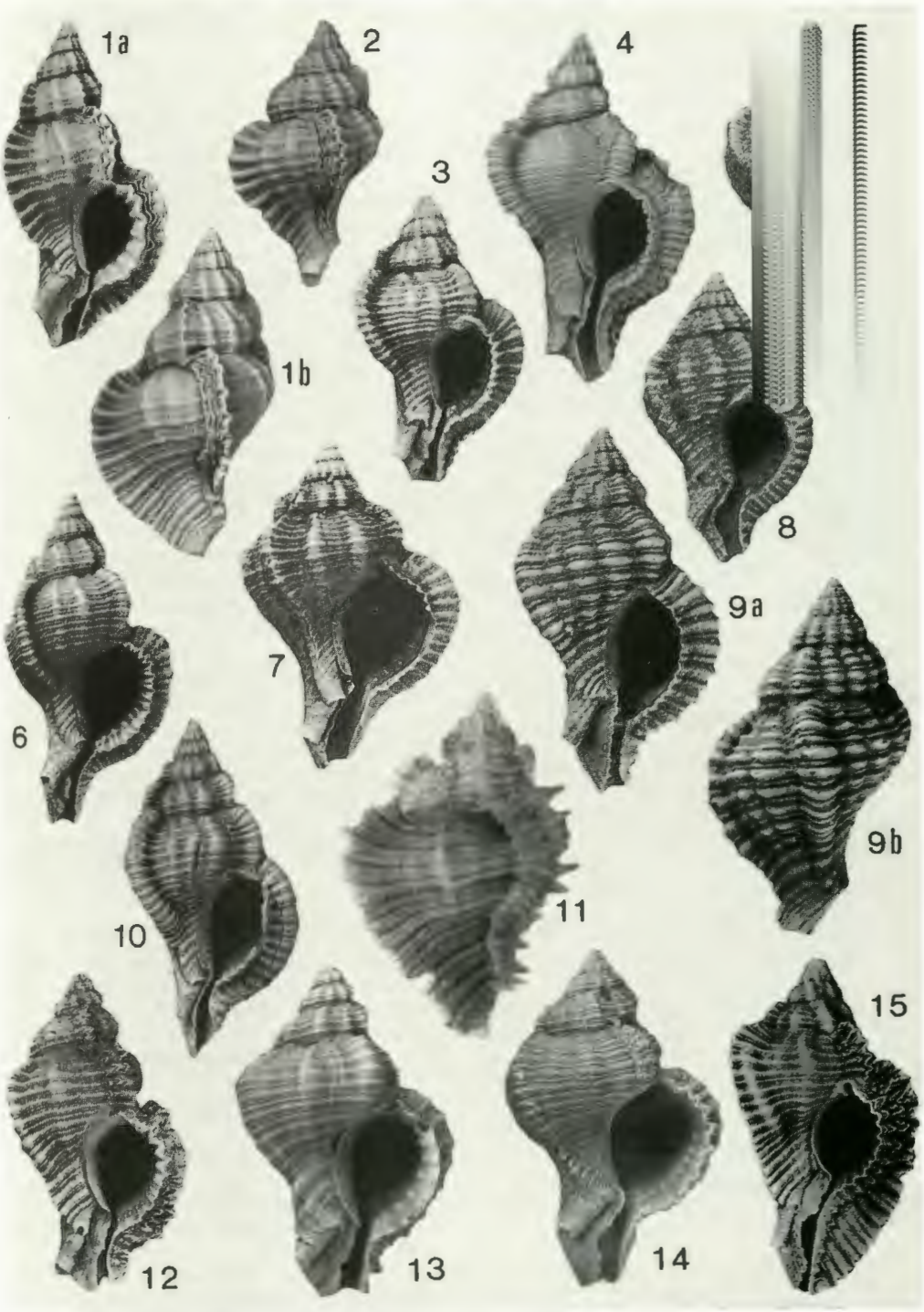


PLATE 9

to place two species into different subgenera when one can barely separate them into two species. Therefore, the arrangement presented here is somewhat arbitrary, but represents the best that can be done at this time. Almost certainly, the problems caused by trying to distinguish these three species are due to the highly plastic nature of these early forms when evolution is rapidly taking place and different variants are appearing simultaneously.

CHICOREUS (PHYLLONOTUS) DORMANI (Vokes)
Plate 9, figure 4

Chicoreus (Phyllonotus) dormani (Vokes). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 139, pl. 1, figs. 8, 9; MACNEIL and DOCKERY, 1984, Mississippi Bur. Geol., Bull. 124, p. 123, pl. 31, figs. 9-11.

Holotype: USNM 644373; height 22 mm, diameter 14.8 mm.

Type locality: (?)Byram Formation; Vicksburg, Mississippi.

Occurrence: Byram Formation, Mississippi.

Figured specimen: ANSP 13483; height 24.7 mm, diameter 15 mm; locality, Vicksburg, Mississippi. Additional locality: TU 1203.

Discussion: Chicoreus (Phyllonotus) dormani is closer in appearance to *C. (S.) stetopus* than to *C.(P.) mississippiensis*. If not an example of parallelism, then *C.(P.) dormani* also should be transferred to the subgenus *Siratus*. However, I believe that *C.(P.) dormani* is just a smooth variant of *C.(P.) mississippiensis*, as previously considered. There does seem to be a stratigraphic component to the appearance of *C.(P.) dormani*, which is confined to the Byram Formation.

All three species are obviously very closely related, all have identical protoconchs (see MacNeil and Dockery, 1984, pl. 51, fig. 7, for a beautiful example), and only the development of the varical flange has prompted me to separate the *C.(S.) stetopus* variant as ancestral to the *Siratus* lineage. Of the three species, *C.(P.) dormani* is most similar to Late Oligocene members of *Phyllonotus* from the Tampa and Silverdale formations, offering some assurance that this is the correct phylogenetic sequence.

CHICOREUS (PHYLLONOTUS) DAVISI
(Richards)
Plate 9, figure 5

Chicoreus (Phyllonotus) davisi (Richards). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 140, pl. 2, fig. 2.

Holotype: Acad. Nat. Sci. Philadelphia, ANSP 15836; height 45 mm, diameter 29 mm.

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

Occurrence: Silverdale Beds, North Carolina.

Figured specimen: USNM 645425; height 46 mm, diameter 27 mm; locality TU 562.

Discussion: As noted in the Stratigraphic Correlation section (above), the age of the beds at Silverdale is now considered to be Chickasawhayan Stage or latest Oligocene rather than Early Miocene, as originally dated (Vokes, 1967b, p. 140).

This species is noteworthy for it is the first to show the free-standing anterior portion of the inner lip, on which small rugae may be developed. The function of these rugae is uncertain, but through time they become an increasingly visible characteristic in this subgenus.

CHICOREUS (PHYLLONOTUS) TROPHONIFORMIS
(Heilprin)
Plate 9, figure 6

Chicoreus (Phyllonotus) trophoniformis (Heilprin). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 140, pl. 2, figs. 7, 8.

Holotype: Wagner Free Institute of Science, Philadelphia, no. 869; height (incomplete) 30.5 mm, diameter 20.3 mm.

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

Occurrence: Tampa Limestone, Florida.

Figured specimen: USNM 165085; height 30 mm, diameter 16.5 mm; locality, Ballast Point, Tampa Bay, Florida.

Discussion: This species occurs in beds that are now thought to be Chickasawhayan in age, or slightly older than previously believed. The inner lip remains very narrow, but even more than in *C.(P.) davisi* the labial rugae are a conspicuous ornament in the aperture. This trend continues into the next species of this lineage, the Early Miocene *C.(P.) infrequens*, which occurs in the Baitoa and Chipola formations.

Although Heilprin's *Explorations on the West Coast of Florida* is dated as 1887, Petit and Wilson (1986, p. 95) have shown that pp. 65-127 were distributed originally in 1886 and the earlier pages were "unavoidably delayed" and published the next year.

Thus, the date of publication for the Heilprin species of *Phyllonotus*, both on p. 107, should be 1886 and not 1887, as previously cited.

CHICOREUS (PHYLLONOTUS) TRITONOPSIS
(Heilprin)
Plate 9, figure 7

Chicoreus (Phyllonotus) tritonopsis (Heilprin). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 141, pl. 2, figs. 1, 5.

Holotype: Wagner Free Institute of Science, Philadelphia, no. 868; height 30.5 mm, diameter 17.8 mm.

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

Occurrence: Tampa Limestone, Florida.

Figured specimen: USNM 643748; height 23.5 mm, diameter 16 mm; locality, Ballast Point, Tampa Bay, Florida.

Discussion: Although occurring with *C.(P.) trophoniformis* at Ballast Point, *C.(P.) tritonopsis* may be distinguished by the more regular appearance of the varices and the heavier spiral ornamentation. It is ancestral to the Middle Miocene species *C.(P.) pyknos* (Gardner) and *C.(P.) millvillensis* (Richards and Harbison), both of which have a similar general appearance but differ in minor details of ornamentation.

CHICOREUS (PHYLLONOTUS) LOUISAE
Vokes, n. sp.
Plate 9, figures 8, 9

Chicoreus (Phyllonotus) cf. *tritonopsis* (Heilprin). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 142, pl. 2, fig. 6.

Description: Shell with only five teleoconch whorls in all material studied but almost certainly more in an adult; protoconch of one and one-half smooth whorls, ending at a small varix. Spiral ornamentation on the earliest teleoconch whorls of three or four narrow sharp cords, increasing in strength and number up to 12 on the body whorl and siphonal canal. Smaller secondary cords gradually intercalated, with on some specimens an additional secondary cord on the subsutural ramp. Axial ornamentation on first teleoconch whorl of about 15 small equal ridges, decreasing to 12 on second and succeeding teleoconch whorls; on about fourth whorl every third ridge somewhat enlarged to form a small rounded varix, the others remaining as rounded intervarical ridges, normally two between each pair of varices. Varices ornamented only by the spiral cords forming slight welts as they pass over. Suture undulated by the axial ornamentation. Aperture oval, inner lip thin, appressed over its entire length; crenulated by underlying spiral cords, but also with numerous rugae superimposed on top of this pattern. Inner side of outer lip with eight heavy denticles, corresponding to the spaces between the major spiral cords. One strong denticle on the posterior end of the inner lip, forming a small anal notch, not visible from exterior. Siphonal canal short, recurved, open by a narrow slit; terminations of preceeding canals fused into succeeding canal, forming a small fasciole.

Holotype: USNM 450378; height 16.4 mm, diameter 9.2 mm.

Type locality: TU 453, Chipola Formation; Alum Bluff (lower beds), Apalachicola River (NE 1/4 Sec. 24, T1N, R8W), Liberty County, Florida.

Etymology of name: Named in honor of Louise (Mrs. W. D.) Compton, Marietta, Georgia, who kindly donated the holotype specimen.

Occurrence: Chipola Formation, Florida.

Figured specimens: Fig. 8, USNM 371878 (paratype); height 14.5 mm, diameter 8.3 mm; locality USGS 2211, Alum Bluff, Florida. Fig. 9, USNM 450378 (holotype). Additional locality: TU 830.

Discussion: This new species was cited by Gardner (1947, p. 522) as "Incertae sedis," as she had only the paratype specimen (USNM 371878) to examine and it does not offer many diagnostic characteristics. However, an additional three specimens (the holotype and two unfigured paratypes) in the collections of Mrs. Louise Compton, of Marietta, Georgia, from the type locality, and one from the lower beds of the Chipola Formation on Tenmile Creek are now available. All are small (the holotype is the largest) but the species likely attained a larger size. That most examples come from the lower beds at Alum Bluff indicates a shallow-water habitat.

As indicated by the citiation "*C.(P.)* cf. *tritonopsis*," previously used (Vokes, 1967b, p. 142), there is a marked resemblance to the older *C.(P.) tritonopsis* but the new species is much narrower in outline, and lacks the almost diamond-shaped outline of *C.(P.) tritonopsis*.

CHICOREUS (PHYLLONOTUS) INFREQUENS
(Vokes)
Plate 9, figure 10

Chicoreus (Phyllonotus) infrequens (Vokes). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 143, pl. 1, fig. 10; VOKES, 1972, Earth Sci., v. 25, no. 3, p. 124, pl. 2, fig. 5; VOKES, 1989,

Bulls. Amer. Paleontology, v. 97, no. 332, p. 39, pl. 2, fig. 5.

Holotype: USNM 644374; height 36 mm, diameter 19 mm.

Type locality: TU 458, Chipola Formation; Chipola River above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida; Baitoa Formation, Dominican Republic.

Figured specimen: USNM 323860; height 29.6 mm, diameter 15.6 mm; locality TU 1364. Additional localities: TU 459, 555, 786, 820, 825, 830, 950, 951, 998, 1048, 1098, 1196.

Discussion: In the years since *C.(P.) infrequens* was described we have collected it at a number of localities but, as the name implies, it is never common. Rarely do we have more than one or two specimens from any locality but it occurs in every Chipola facies, from Tenmile Creek, Farley Creek, and the Chipola River. In addition, we collected three examples in the Baitoa Formation, Dominican Republic (TU 1364); one is figured here (pl. 9, fig. 10).

CHICOREUS (PHYLLONOTUS) FOLIDODES
(Gardner)
Plate 9, figure 11

Chicoreus (Phyllonotus) folidodes (Gardner). VOKES, 1965, Tulane Stud. Geol., v. 5, no. 3, p. 143, pl. 3, fig. 1; VOKES, 1972, Earth Sci., v. 25, no. 3, p. 124, pl. 2, fig. 1.

Holotype: USNM 371852; height 43.3 mm, diameter 25 mm.

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

Occurrence: Chipola Formation, Florida.

Figured specimen: USNM 450379; height 25.9 mm, diameter 18 mm; locality TU 546. Additional localities: TU 655, 810, 830, 951, 1020, 1050, 1098.

Discussion: In the previous discussion of *C.(P.) folidodes* (Vokes, 1967b, p. 144), it was noted that the species had been collected only along the Chipola River or at the eastern end of Tenmile Creek where the beds are similar in facies to those on the river. Though a great deal more material has been collected from a large number of additional localities, this still holds true. Parker (1948, p. 93) had reported a specimen from under the bridge at Tenmile Creek (= TU 70). We have now collected just one fragment from a nearby locality (TU 655) but this is our only record in the upper beds along Tenmile Creek.

In 1967 the nature of the protoconch was unknown, but additional material shows a polished, conical protoconch of three and one-half whorls. The color pattern of *C.(P.) folidodes* (as revealed by ultra-violet light, pl. 9, fig. 11) is typical of the group, with wide dark bands at the shoulder, the periphery, and base of the body whorl, much like the Recent *C.(P.) pomum*. However, it is also marked by darker threads topping the major spiral cords, in a manner seen only in the Indo-Pacific species *Murex superbus* Sowerby, 1889, type of the subgenus *Chicomurex* Arakawa, 1964.

The subgenus *Chicomurex* is closely allied with *Phyllonotus*, to the point that Radwin and D'Attilio (1976) placed most of the species that I would place in *Chicomurex* into *Phyllonotus*. In my intrepretation, the subgenus *Phyllonotus* is confined to the New World, and is characterized by a rugose, expanded parietal shield. The subgenus *Chicomurex* is confined to the Old World and has a smooth, narrow inner lip.

Should *C.(P.) folidodes* and *C.(P.) aldrichi*, with their smooth, narrow inner lips, therefore, be placed in *Chicomurex*? I do not think so. As noted above, the expanded parietal shield is a late development in the subgenus *Phyllonotus*. None of the species prior to the *C.(P.) globosus* complex have this distinctive inductura, and it is confined to the members of this particular species-complex. Today this species-complex dominates the present makeup of the subgenus, with the majority of the Recent species belonging to this group.

In the Dominican Republic report (Vokes, 1989b, p. 42) I discussed the ancestry of *C. (Naquetia) compactus* (Gabb), which is presumed to be derived from *C.(P.) folidodes* and concluded that there is a great deal of interweaving and overlapping of the supposed subgenera of the genus Chicoreus. Presumably, the ancestral *Phyllonotus* type gave rise not only to "pseudo-*Naquetia*" in the New World, as in *C. compactus*, but also generated a form that is repeated in the Indo-Pacific subgenus *Chicomurex*.

CHICOREUS (PHYLLONOTUS) ALDRICHI
(Gardner)
Plate 9, figure 12

Murex (Phyllonotus) compactus Gabb. WOODRING, BROWN, and BURBANK, 1924, Geol. Rep. Haiti, p. 183 (not of Gabb).

Chicoreus (Phyllonotus) aldrichi (Gardner). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 144, pl. 3, fig. 2.

Holotype: USNM 645424; height 53.5 mm, diameter 31.5 mm.

Type locality: Aldrich Coll. 3472, Shoal River Formation; Shell Bluff, Shoal River, Walton County, Florida (= TU 69).

Occurrence: Shoal River Formation, Florida; Thomonde Formation, Haiti.

Figured specimen: USNM 481841; height 45.8 mm, diameter 25.9 mm; locality USGS 9908, Rivière l'Ayaye, Arrondissement of Las Cahobas, Haiti.

Discussion: There is no additional Florida material available of *C. (P.) aldrichi*, since Gardner first described her unique specimen. Thus, it was a pleasant surprise to discover among material collected in eastern Haiti by members of the U. S. Geological Survey (U.S. National Museum collections), a second example of this rare species. It was cited as *Murex (Phyllonotus) compactus* Gabb by Woodring *et al.* (1924, p. 183), which is not surprising, as I consider *C.(P.) aldrichi* ancestral to *C.(N.) compactus*.

As *C. folidodes* is the species of this lineage that occurs in the late Early Miocene Chipola Formation, and *C. aldrichi* occurs in the Middle Miocene Shoal River Formation, the presence of the latter species in the Thomonde Formation may indicate a Middle Miocene age, not late Early Miocene as considered by Cooke *et al.* (1943).

The differences between *C.(P.) folidodes* and *C.(P.) aldrichi* are minor. The older species is triangular, as a result of the subsutural slope being more nearly at right angles to the suture, and the intervarical nodes are small, tightly compressed, and project as distinct knobs in larger specimens. In contrast, *C.(P.) aldrichi* is more rounded in outline and the intervarical ornamentation is more ridge-like. The spiral ornamentation is much stronger in *C.(P.) aldrichi;* larger specimens of *C.(P.) folidodes* are almost smooth.

CHICOREUS (PHYLLONOTUS) PYKNOS (Gardner)
Plate 9, figure 13

Chicoreus (Phyllonotus) pyknos (Gardner). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 145, pl. 2, fig. 4.

Holotype: USNM 115771; height 32 mm, diameter 20.8 mm.

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

Occurrence: Shoal River Formation, Florida.

Figured specimen: USNM 115771 (holotype).

Discussion: There is no new information on this species, which occurs rarely in the Shoal River Formation.

CHICOREUS (PHYLLONOTUS) MILLVILLENSIS (Richards and Harbison)
Plate 9, figure 14

Chicoreus (Phyllonotus) millvillensis (Richards and Harbison). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 146, pl. 2, fig. 3.

Holotype: USNM 498975; height 32.5 mm, diameter 19 mm.

Type locality: Kirkwood Formation; Millville, New Jersey.

Occurrence: Kirkwood Formation, New Jersey.

Figured specimen: USNM 498975 (holotype).

Discussion: There is no additional information for this species, which was described from a well, at depths of 460 and 505 feet (140 and 154 meters), and attributed by the authors to the Kirkwood Formation, of Middle Miocene age.

CHICOREUS (PHYLLONOTUS) POMATUS Vokes
Plate 10, figure 1

Chicoreus (Phyllonotus) pomatus VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 39, pl. 2, figs. 1, 2.

Holotype: USNM 323857; height 52.8 mm, diameter 32.3 mm.

Type locality: TU 1215, Gurabo Formation; Río Gurabo, bluffs on both sides, from the ford on the Los Quemados-Sabaneta road upstream to approximately 1 km above the ford, Dominican Republic (= Zone D of Maury, 1917).

Occurrence: Cercado and Gurabo formations, Dominican Republic.

Figured specimen: USNM 323857 (holotype).

Discussion: This newly discovered species is probably ancestral to the Recent Brazilian species *C.(P.) oculatus* (Reeve, 1845) and the eastern Pacific *C.(P.) peratus* (Keen, 1960). This conclusion is based on the nature of the protoconch, of three and

one-half conical whorls, common to all three species, plus the fact that the three share a less expanded inductura than is typical of the other members of the group.

Occurring in the Late Miocene Cercado Formation and the Early Pliocene Gurabo Formation, *C.(P.) pomatus* is the oldest species yet known of the modern morphotype of *Phyllonotus*. Whether it also is ancestral to the *C.(P.) globosus* species-complex (see below) is uncertain; however, there is no other likely candidate.

CHICOREUS (PHYLLONOTUS) RIPARIUS (Vokes)
Plate 10, figure 2

Chicoreus (Phyllonotus) riparius (Vokes). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 147, pl. 3, fig. 4.

Holotype: USNM 644375; height 22.5 mm, diameter 12 mm.

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

Occurrence: Jackson Bluff Formation and Pinecrest Beds, Florida.

Figured specimen: USNM 644375 (holotype). Additional localities: TU 1000, 1524.

Discussion: Although *C.(P.) riparius* was originally described from the "Choctawhatchee Formation" (the "*Cancellaria* Faunizone" of the Choctawhatchee Formation, which has been elevated to the Choctawhatchee Group, now known as the Jackson Bluff Formation), we have collected several specimens from the correlative Pinecrest Beds in the vicinity of Sarasota, Florida.

If *C.(P.) pomatus* is the first of the "new" line of modern species of *Phyllonotus*, then *C.(P.) riparius* is the last of the old line. It has the smooth, narrow inner lip characteristic of the older species, and it is relatively small. All of the specimens from northern Florida are less than 25 mm in height, but from the Sarasota area we have one example almost 40 mm in height.

CHICOREUS (PHYLLONOTUS) LEONENSIS Vokes
Plate 10, figures 3, 4

Chicoreus (Phyllonotus) leonensis VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 147, pl. 6, figs. 1, 2.

PLATE 10

Figures Page

1. *Chicoreus (Phyllonotus) pomatus* Vokes (X 1 1/4) 63
   USNM 323857 (holotype); height 52.8 mm, diameter 32.3 mm.
   Locality: TU 1215, Dominican Republic; Gurabo Formation.
2. *Chicoreus (Phyllonotus) riparius* Vokes (X 2) 64
   USNM 644375 (holotype); height 22.5 mm, diameter 12 mm.
   Locality: TU 60, Florida; Jackson Bluff Formation.
3, 4. *Chicoreus (Phyllonotus) leonensis* Vokes 64
   3. (X 3/4) USNM 450380; height 81.5 mm, diameter 53.4 mm.
   Locality: TU 1000, Florida; Pinecrest Beds.
   4. (X 10) USNM 450381; height 27.5 mm, diameter 15.3 mm.
   Locality: TU 1000, Florida; Pinecrest Beds.
5, 6. *Chicoreus (Phyllonotus) globosus* (Emmons) 66
   5. (X 3/4) USNM 878011; height 94 mm, diameter 58.2 mm.
   Locality: Bahía de Mochina, Venezuela; Recent.
   6. (X 1) USNM 450382; height (as is) 72 mm, diameter (as is) 44.5 mm.
   Locality: TU 965, Panama; Gatun Formation.
7. *Chicoreus (Phyllonotus) pomum* (Gmelin) (X 1) 67
   USNM 323859; height 65 mm, diameter 44.8 mm.
   Locality: TU 1352, Dominican Republic; Mao Formation.
8. *Chicoreus (Phyllonotus) oculatus* (Reeve) (X 3/4) 69
   USNM 792359; height 67.9 mm, diameter 43.2 mm.
   Locality: Salvador, Bahia, Brazil; Recent.
9. *Chicoreus (Phyllonotus) margaritensis* (Abbott) (X 3/4) 68
   UCMP 38655; height 87.8 mm, diameter 73 mm.
   Locality: UCMP S-113, Araya Peninsula, Venezuela; Cumaná Formation.

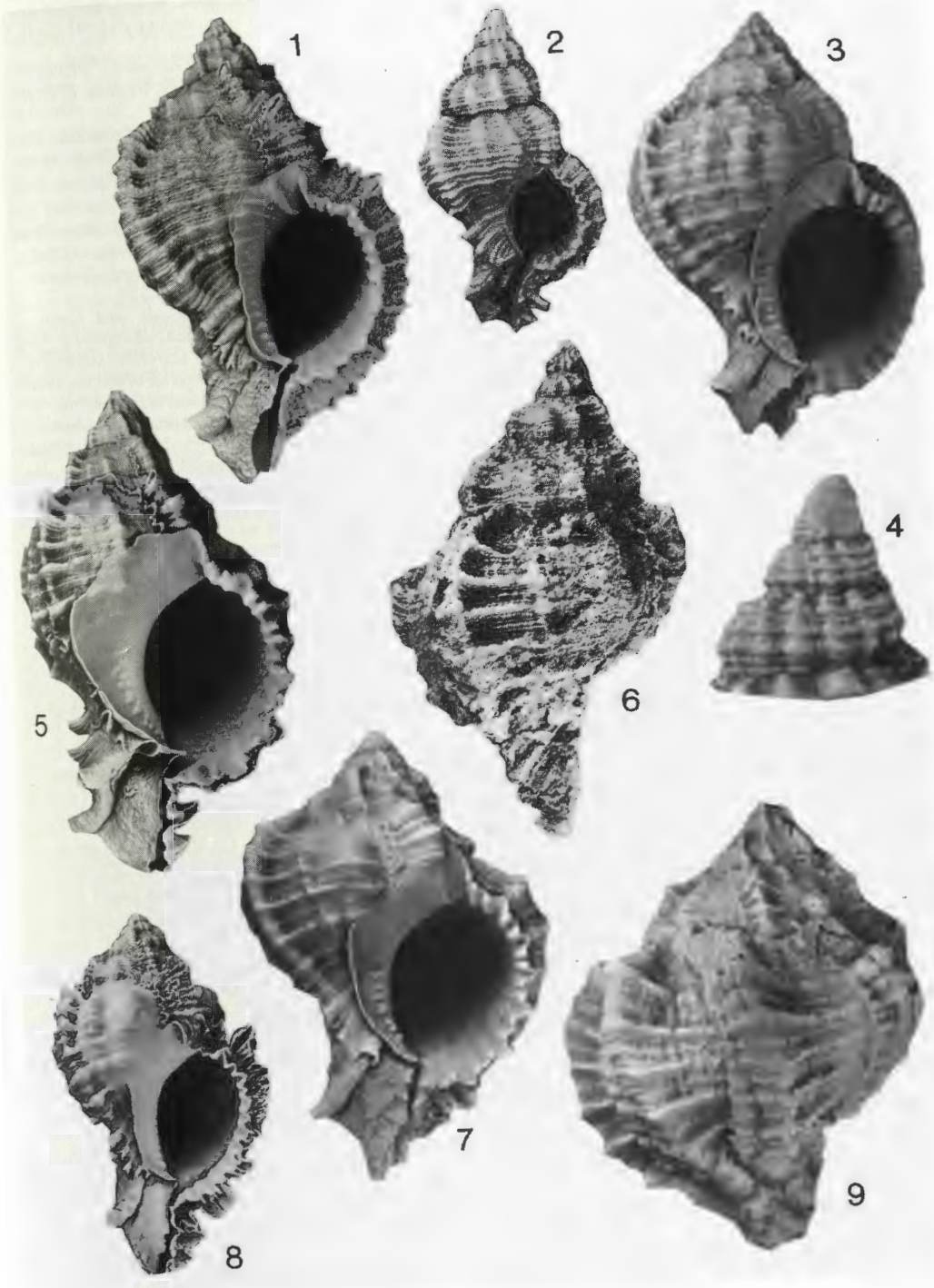


PLATE 10

Holotype: USNM 370189; height 79 mm, diameter (incomplete) 40 mm.

Type locality: Jackson Bluff Formation; Harvey's Creek, 0.5 mi above abandoned mill (Florida Geological Survey Coll.)

Occurrence: Jackson Bluff Formation and Pinecrest Beds, Florida.

Figured specimen: Fig. 3, USNM 450380; height 81.5 mm, diameter 53.4 mm; locality TU 1000. Fig. 4, USNM 450381; height 27.5 mm, diameter 15.3 mm; locality TU 1000. Additional locality: TU 1349.

Discussion: This species, also described from the "Choctawhatchee Formation" (now the Jackson Bluff Formation), likewise has been collected in the Pinecrest Beds in the vicinity of Sarasota. It occurs with the more abundant *C.(P.) globosus* but may be distinguished by the lack of any varical spines in *C.(P.) leonensis*, by the relatively low intervarical ridges, and by the rounded varices, which are deeply excavated on the abapertural side. The inductura is narrower in *C.(P.) leonensis*, much like that of *C.(P.) pomatus*. From the latter species it differs in having a more subdued ornamentation, in lacking any spinose processes even on the early whorls, and also a larger size (the largest specimen seen of *C. pomatus* is only 55 mm in height). From *C.(P.) pomum*, which occurs only in younger beds in Florida, it differs in having a narrower inductura, more subdued ornamentation, and more rounded whorls. At the time of the original description, the nature of the protoconch was unknown. Now, material from the Pinecrest Beds shows the protoconch to be of three and one-half cylindrical whorls (see pl. 10, fig. 4), similar in general shape to that of *C.(P.) pomum* (see Radwin and D'Attilio, 1976, text-fig. 54) but with more whorls.

Chicoreus (Phyllonotus) globosus (Emmons)
Plate 10, figure 5, 6

Chicoreus (Phyllonotus) globosus (Emmons). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 148, pl. 4, figs. 1-3, pl. 5, figs. 1-3; VOKES, 1988, Tulane Stud. Geol. Paleont., v. 21, no. 1, p. 21, pl. 3, figs. 1, 2.

Phyllonotus globosus (Emmons). PETUCH, 1976, Veliger, v. 18, no. 3, p. 322, text-figs. 3, 5, 6; FAIR, 1976, The Murex Book, p. 46, pl. 9, fig. 120; KAICHER, 1979, Card Cat. World-Wide Shells, no. 20 - Muricidae IV, no. 1968.

Phyllonotus margaritensis (Abbott). RADWIN and D'ATTILLIO, 1976, Murex Shells of the World, p. 90 [in part, not of Abbott], pl. 16, fig. 6.

Phyllonotus cf. *globosus* (Emmons). PETUCH, 1987, New Caribbean Moll. Faunas, p. 89, pl. 19, figs. 1, 2.

[?] *Phyllonotus* cf. *globosus* (Emmons). PETUCH, 1988, Neogene History Trop. Amer. Moll., p. 157, pl. 37, fig. 6.

Holotype: Not found.

Type locality: "Miocene of the Cape Fear River." (?)Waccamaw Formation; (?)Neills Eddy Landing, Cape Fear River, Columbus County, North Carolina (= TU 559).

Occurrence: Pinecrest Beds and Caloosahatchee Formation, Florida; Waccamaw Formation, North and South Carolina; Gatun Formation, Panama; Cumaná Formation, Venezuela; (?)Imperial Formation, California; Esmeraldas Beds, Ecuador. Recent, Venezuela.

Figured specimen: Fig. 5, USNM 878011; height 94 mm, diameter 58.2 mm; locality, Isla Larga, Bahía de Mochina, Edo. de Sucre, Venezuela. Fig. 6, USNM 450382; height (as is) 72 mm, diameter (as is) 44.5 mm; locality TU 965. Additional localities: TU 932, 933, 939, 974, 975, 982, 985, 991, 1000, 1023, 1177, 1397, 1399, 1491, 1512, 1524.

Discussion: This, the most widespread and abundant species of *Phyllonotus* in the Pliocene, is a large, distinctive form with an extremely expanded inductura. It gave rise to the living species on the West Coast of tropical America – *C.(P.) erythrostomus* (Swainson, 1831) and *C.(P.) regius* (Swainson, 1821). In Vokes, 1967b (p. 149), I noted material from the Pliocene Imperial Formation of southern California (Museum of Paleontology, University of California, Berkeley, collections). In the same collection there is a single battered specimen from the Cumaná Formation at locality UCMP S-112, Isla Cubagua, Edo. de Nuevo Esparta, Venezuela, together with several examples of *C.(P.) margaritensis*. We have one incomplete shell referable to this species from the Gatun Formation, Panama (pl. 10, fig. 6), and we have collected incomplete examples in the Early Pliocene Esmeraldas beds of Ecuador (see Vokes, 1988, p. 21, pl. 3, fig. 1). In the Pleistocene Bermont Formation of Florida and Moín Formation of Costa Rica, *C.(P.) globosus* is not present but instead the derivative species *C.(P.) pomum* occurs.

Living today along the coast of northern South America there is a group of *Phyl-*

lonotus that truly deserves the title "species-complex." Cipriani (1990) has studied the Venezuelan distribution of these different forms and sums up the problem in these words: "Due to some individuals of *Chicoreus (Phyllonotus)* species showing highly variable shell characters in different localities, analysis of shell meristic characters and Raupian coiling parameters has been applied to descriminate all their shell forms."

Some individuals have five varices and are unmistakably *C.(P.) margaritensis;* some have four varices and may be assigned to *C.(P.) globosus* (for example, that figured by Kaicher, 1979, no. 1968; and pl. 10, fig. 5, herein); but others defy assignment (for example, that figured by Petuch, 1987, pl. 19, figs. 1, 2). Most specimens have either pink or yellow apertures, but some have the typical "pomum" dark blotches around the edge of the parietal shield (for example, that figured by Radwin and D'Attilio, 1976, pl. 16, fig. 6); others have only three varices (like *pomum*) but have pink or yellow apertures. We know from ultra-violet studies that the Pliocene specimens of *C.(P.) globosus* had a light-colored aperture for the dark blotches would show up strikingly under ultra-violet light. However, the potential for a dark aperture must have been present, as demonstrated by *C.(P.) regius* and *C.(P.) eversoni* (D'Attilio, Myers, and Shasky, 1987). Pragmatically, I identify those specimens with five varices as *C.(P.) margaritensis* and those with three or four varices as *C. (P.) globosus* – regardless of the color of the aperture. *Chicoreus (Phyllonotus) pomum* is smaller, invariably with three varices, and dark blotches on the greatly enlarged parietal shield. This latter trait serves to separate it from *C. (P.) oculatus,* which also occurs rarely in the same area (Puerto Frances and Chirimena, and the Archipelago Los Roques: Cipriani, 1990).

Petuch (1976) has reported on a molluscan assemblage from the coast of Venezuela that is dominated by *C.(P.) globosus,* which he noted "was the most voracious predator." He states that "all specimens of *P. globosus* observed were grazing upon *Turritella [variegata* (Linné, 1758)] beds – every specimen collected (over 80) had a *Turritella* tightly held to its mouth" (1976, p. 322). Cipriani (1990) notes that all three species of *Phyllonotus* live on sandy bottoms and *Thalassia* beds, in areas of high concentration of *Arca zebra* (Swainson, 1833).

CHICOREUS (PHYLLONOTUS) POMUM (Gmelin)
Plate 10, figure 7; text-figure 2a

Chicoreus (Phyllonotus) pomum (Gmelin). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 149, pl. 4, figs. 4, 5, pl. 5, figs. 4, 5.

Phyllonotus pomum (Gmelin). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 91, pl. 16, fig. 8, text-fig. 54 (protoconch); FAIR, 1976, The Murex Book, p. 68, pl. 10, fig. 126.

"Type figure": Martini, 1777, Conchylien-Cab., v. 3, pl. 109, fig. 1023 (designated by Vokes, 1967b, p. 152).

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

Occurrence: Mao Formation, Dominican Republic; (?)Agueguexquite Formation, Mexico; Caloosahatchee, Bermont and Fort Thompson formations, Florida; Mare Formation, Venezuela; Bowden Formation, Jamaica; Moín Formation, Costa Rica. Unnamed Late Pleistocene formations in Panama, Cuba, South Carolina, and Louisiana. Recent, western Atlantic from North Carolina to Amapá, Brazil.

Figured specimen: USNM 323859; height 65 mm, diameter 44.8 mm; locality TU 1352. Additional localities: TU 638, 731, 792, 953, 954, 973, 974, 977, 978, 1023, 1174, 1239, 1366, 1495, 1496.

Discussion: Chicoreus (Phyllonotus) pomum is "the most abundant and widespread muricine species in the western Atlantic" (Vokes, 1967b, p. 152) but it is not so widespread as formerly believed. Records of *C.(P.) pomum* from the coast of Brazil (e.g., Rios, 1985, p. 82 – "Ceara to Rio de Janiero") are based upon *C.(P.) oculatus* (Reeve), which was shown by Houart (1987) to be unequivocally different. Dr. Rios (written communication, September 22, 1988) advises that he has examined all of the specimens in the collection of the Museu Oceanográfico da FURG, Rio Grande, Brazil, and the only specimens of true *C. pomum* are those collected off Cassipore, Amapá, and Cabo Norte, Amapá (both lots collected by the Oceanographic Vessel *Almirante Saldanha*). All others are *C.(P.) oculatus*.

However, what was lost in Recent distribution, is made up in the Pliocene. We now have four good examples of *C.(P.)*

pomum from the Middle Pliocene Mao Formation, Dominican Republic (pl. 10, fig. 7) and in the Agueguexquite Formation, Mexico (TU 638), we have a number of fragments that may be referable to *C.(P.) pomum* and not to *C.(P.) globosus*, although the quality of the material available is poor. In addition, we have good specimens from the Pleistocene Moín Formation, Costa Rica.

In the Dominican Republic report (Vokes, 1989b, p. 41), I included the Gatun Formation, Panama, in the distribution of this species. However, closer study has caused me to place the specimen from locality TU 965 into *C.(P.) globosus* (see pl. 10, fig. 6) rather than *C.(P.) pomum*. The material from TU 964 also mentioned in that report, is so poorly preserved that I would rather not use it as the basis for stating that *C.(P.) pomum* occurs in the Gatun Formation. But it certainly is present in the Recent fauna of Panama, we have hundreds of specimens from locality TU R-109.

In Vokes, 1967b (p. 154), it was noted that with one exception *C. (P.) pomum* was not known from before the Pliocene. That "exception" was the Bowden Formation, Jamaica, where Woodring figured an unquestionable specimen of *C.(P.) pomum* (1928, pl. 17, fig. 9) from beds he dated as Middle Miocene in age. However, now the Bowden has been dated, using planktic foraminifera, as basal Pleistocene.

In 1967 the Pinecrest and Jackson Bluff (= "Choctawhatchee Formation") beds were considered Late Miocene in age and the first occurrence of *C.(P.) pomum* in the Caloosahatchee Formation was taken to indicate that the species did not appear before the (then) Early Pliocene. We now have specimens in beds of the same age as the Pinecrest and Jackson Bluff (Zone N.20) in more southern areas of the Caribbean (Mao Formation, Dominican Republic; Agueguexquite Formation, Mexico). Thus, my intrepretation that "*C. pomum* evolved in the warmer southern waters and moved into Florida with the advent of warmer Pliocene seas" (Vokes, 1967b, p. 154) is confirmed. Only the timing is slightly changed, and the "warmer seas" become Late Pliocene rather than Early Pliocene as once believed.

CHICOREUS (PHYLLONOTUS) MARGARITENSIS (Abbott)

Plate 10, figure 9

Chicoreus (Phyllonotus) margaritensis (Abbott). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 156, pl. 3, fig. 3.

Phyllonotus margaritensis (Abbott). FAIR, 1976, The Murex Book, p. 57, pl. 11, fig. 135.

Not *Phyllonotus margaritensis* (Abbott). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 90, pl. 16, fig. 6 [= *C.(P.) globosus* (Emmons)].

Holotype: Not found.

Type locality: "Island of Margarita," Venezuela.

Occurrence: Cumaná Formation, Venezuela. Recent, Venezuela, principally offshore islands, including Netherland Antilles.

Figured specimen: UCMP 38655; height 87.8 mm, diameter 73 mm; locality UCMP S-113, 4 kms west of Manicuare, Araya Peninsula, Edo. de Sucre, Venezuela.

Discussion: Previously, I noted (Vokes, 1967b, p. 158) that in the collections of the Museum of Paleontology, University of California, Berkeley, there were several specimens (10 in all from four localities) of *C.(P.) margaritensis* from the Cumaná Formation, Venezuela, then considered to be Late Pliocene in age. As mentioned above, under Stratigraphic Correlation, these beds are now considered by some to be Early Pleistocene. One of the larger Cumaná specimens is figured (pl. 10, fig. 9) and it can be seen to have six varices. Another large shell has six varices also but all of the smaller specimens have five varices. It would seem that through time the number of varices is decreasing in this species causing it to resemble *C.(P.) globosus* and this may be part of the reason we have difficulty in separating the two forms.

Separating Recent specimens of *C.(P.) margaritensis* from *C.(P.) globosus* is admittedly difficult and somewhat ambiguous. In general, the shells of *C.(P.) globosus* have three or four varices per whorl and normally two (rarely one) intervarical node between each pair of varices. The shell is light in weight and the varices may be ornamented with short open spines or, more commonly, with high raised ridges where the spiral cords cross. Those specimens assigned to *C.(P.) margaritensis* are massive and heavy (for example,

that figured by de Jong and Coomans, 1988, pl. 36, fig. 394), with four varices in the younger stages and one single large intervarical node between each pair; but in the adult stage the varices and nodes merge together and the shell has five varices with no nodes between them.

The two forms do occur together, however, and this raises questions. Is *C.(P.) margaritensis* an extremely variable species that may have three, four, or five varices? May it have either heavy massive shells or light delicate shells? Is there some ecologic reason for what appear to be specific differences? For now, as stated above for *C.(P.) globosus*, I will continue to treat them as different species until I have better data.

Chicoreus (Phyllonotus) oculatus (Reeve)

Plate 10, figure 8; text-figure 2b

Chicoreus (Phyllonotus) oculatus (Reeve). VOKES, 1967, Tulane Stud. Geol., v. 5, no. 3, p. 158, pl. 6, fig. 3; HOUART, 1987, Apex, v. 2, no. 1, p. 7, text-figs. 1-4 (fig. 4, protoconch).

Murex (Phyllonotus) pomum Gmelin. RIOS, 1970, Coastal Brazilian Seashells, p. 78 [in part, not of Gmelin], pl. 22.

Phyllonotus pomum (Gmelin). RIOS, 1975, Brazilian Mar. Moll. Icon., p. 85 [in part, not of Gmelin], pl. 24, fig. 347; RIOS, 1985, Seashells of Brazil, p. 82 [in part, not of Gmelin], pl. 29, fig. 360.

Phyllonotus oculatus (Reeve). FAIR, 1976, The Murex Book, p. 64, pl. 11, fig. 137.

Murex pomum (Gmelin). SUTTY, 1986, Seashell Treasures of the Caribbean, p. 56 [in part, not of Gmelin], text-figs. 58, 59.

Lectotype: Brit. Mus. (Nat. Hist).; height 80 mm, diameter 47 mm.

Type locality: Dominica, Lesser Antilles (designated by Vokes, 1967b, p. 160).

Occurrence: Recent only, Florida Keys, Lesser Antilles to northern South America, and to Rio de Janiero, Brazil.

Figured specimen: USNM 792359; height 67.9 mm, diameter 43.2 mm; locality, Salvador, Bahia, Brazil, 6 meters.

Discussion: Although *C.(P.) oculatus* has been synonymized with *C.(P.) pomum* by many authors, I have always considered it an easily separable, distinct species (Vokes, 1967b, p. 160). This separation was confirmed when Houart (1987) showed that the two forms have completely different protoconchs (text-fig. 2).

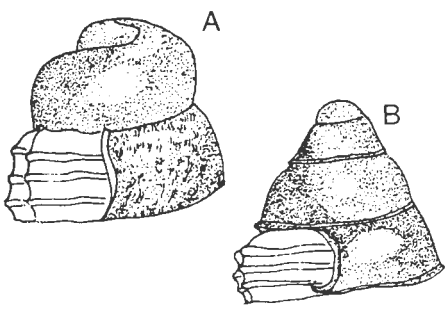
In addition, the two differ in the development of the inductura – the parietal shield, which is greatly expanded in *C.(P.) pomum*, as is typical of the *globosus*-complex (see above), but relatively narrow in *C.(P.) oculatus*. The eastern Pacific *C.(P.) peratus* (Keen, 1960) has generally been considered the Pacific cognate species of *C.(P.) pomum* but in some ways it is more akin to *C.(P.) oculatus* with both having a multiwhorl protoconch and a narrow inductura, although that of *C.(P.) peratus* is more developed than that of *C.(P.) oculatus*.

This species has an extensive range, from the Florida Keys (where it occurs on reefs, in about 6 meters, Kevan Sunderland collection) through the Lesser Antilles (Dominica, Vokes, 1967b, pl. 6, fig. 3; and Guadeloupe, Sutty, 1986, figs. 58, 59), to northern South Amnerica. De Jong and Coomans (1988, p. 72, pl. 36, fig. 393) record the species from the Dutch Antilles (as *Phyllonotus pomum* subspecies *oculatus)*. As discussed under *C.(P.) pomum*, all specimens of "*C. pomum*" taken from south of Amapá, in northernmost Brazil, to Rio de Janiero (Rios, 1985, p. 82) are to be referred to *C.(P.) oculatus*. This is the principal area from which most specimens are collected today.

Subgenus NAQUETIA Jousseaume, 1880

Naquetia JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.

Type species: *Murex triqueter* Born, 1778, by original designation.



Text-figure 2. Protoconchs of (A) *Chicoreus (Phyllonotus) pomum* and (B) *Chicoreus (Phyllonotus) oculatus* (from Houart, 1987, figures 4 and 6).

Discussion: The Indo-Pacific subgenus *Naquetia* is characterized by an elaborate extension of the varical flange along the siphonal canal, which gives some of its members a certain resemblance to the subgenus *Siratus*. This is particularly true, for example, in specimens of the Indo-Pacific *C.(Naquetia) annandalei* (Preston, 1910) and the Caribbean *C.(S.) consuela*, which are so similar in overall aspect that the two species have often been confused.

Separating these two subgenera is difficult, but in general, *Siratus* develops some type of spinose processes on the varices (although greatly reduced in the case of *consuela* or *perelegans)* and members of *Naquetia* do not. The varical flange is more developed on the siphonal canal than on the body whorl in *Naquetia*, and this proportion is reversed in *Siratus*. In general, the spire is greatly elongated in *Naquetia*, as compared to *Siratus;* but, again, there are exceptions, as in the Red Sea species *C.(N.) jickelii* (Tapparone-Canefri, 1875). The most reliable criterion is the presence of rugae on the inner lip in species of *Siratus*, which are not present in *Naquetia*.

As discussed at length in the Dominican Republic report (Vokes, 1989b, p. 42) lines of distinction between the various subgroups *Siratus, Naquetia, Phyllonotus,* and *Chicomurex* are extremely blurred and the assignment of species is based as much on geography as on morphology. Nevertheless, *C. compactus*, with its varical flange most expanded along the siphonal canal, with no spinose processes, and its smooth inner lip, is better assigned to *Naquetia* than to *Phyllonotus* (from whence it was derived) or *Siratus*, even though the resemblance is due purely to convergence and not to close relationship.

CHICOREUS (NAQUETIA) COMPACTUS (Gabb)
Plate 9, figure 15

Not *Murex (Phyllonotus) compactus* Gabb. WOODRING and VAUGHAN *in* VAUGHAN, *et al.*, 1921, Geol. Surv. Dom. Rep., Mem., v. 1, p. 147 [= *C.(C.) corrigendum* Vokes].

Not *Murex (Phyllonotus) compactus* Gabb. WOODRING, BROWN, and BURBANK, 1924, Geol. Rep. Haiti, p. 183 [= *C.(P.) aldrichi* (Gardner)].

Chicoreus (Chicoreus) compactus (Gabb). VOKES, 1965, Tulane Stud. Geol., v. 3, no. 4, p. 187, in part, not pl. 2, fig. 3 [= *C.(C.) corrigendum* Vokes].

Chicoreus (Naquetia) compactus (Gabb). VOKES, 1989, Bulls. Amer. Paleontology, v. 97, no. 332, p. 42, pl. 3, figs. 1, 2.

Holotype: Acad. Nat. Sci. Philadelphia, ANSP 3258; height 56.4 mm, diameter 32.3 mm.

Type locality: TU 1230, Cercado Formation; Río Cana, east bank, just above the ford at Caimito on Los Quemados-Sabaneta road, Dominican Republic (= Zone H of Maury, 1917) (restricted by Vokes, 1989b, p. 42).

Occurrence: Cercado and Gurabo formations, Dominican Republic.

Figured specimen: USNM 323866; height 32.5 mm, diameter 19 mm; locality TU 1230. For additional localities in the Dominican Republic, see Vokes, 1989b, p. 43.

Discussion: As was discovered in the course of preparing the Dominican Republic report (Vokes, 1989b), the shell figured in my original treatment of *C.(C.) compactus* is another species, described as *C. (C.) corrigendum*. The two forms are only superficially similar and may be distinguished by the lack in the latter of the broad expanded varical flange on the anterior portion of the varices. It is this flange that gives *C.(N.) compactus* the aspect of the subgenus *Naquetia*, where it is assigned in spite of geographic and phylogenetic contraindications.

Originally I suggested (Vokes, 1965a, p. 188) that *C. compactus* is intermediate between the Chipola species of *Chicoreus* s.s. and the group of *C.(C.) floridanus*. However, *C.(C.) corrigendum* is the intermediary species and not *C.(N.) compactus*, which is the terminal member of the lineage of *C.(P.) folidodes–C.(P.) aldrichi*.

Genus HEXAPLEX Perry, 1810

Hexaplex PERRY, 1810, Arcana, expl. to pl. 23 (genus without species); 1811, Conchology, pl. 8.

Type species: *Hexaplex foliacea* Perry, 1811 (= *Murex cichoreum* Gmelin, 1791), by subsequent designation, Iredale, 1915.

Discussion: In Part IV of *Cenozoic Muricidae* (Vokes, 1968b) I included along with *Hexaplex*, three other supraspecific taxa that are no longer placed in the subfamily Muricinae. These are: *Murexsul* Iredale, 1915; *Murexiella* Clench and Pérez Farfante, 1945; and *Subpterynotus* Olsson and Harbison, 1953. All three are now placed in the subfamily Muricopsinae

and will be reconsidered at such a time as that group is revised, following Part IX (Muricinae – *Pterynotus, Poirieria*, etc.).

Most of the species in the western Atlantic referred to the genus *Hexaplex* are Eocene forms, which resemble the living Mediterranean *Hexaplex trunculus* (Linné, 1758). The latter has been named the type species of several taxa (*Polyplex* Perry, 1810; *Truncularia* Monterosato, 1917; *Truncullariopsis* Cossmann, 1921; and *Murithais* Grant and Gale, 1931). As discussed previously (Vokes, 1968b, p. 86), I do not believe the differences between *H. trunculus* and *H. cichoreum*, type of the genus, are sufficient to separate the two groups at the subgeneric level. As I noted (*ibid.*, footnote) the oldest valid name for the group of *H. trunculus* is *Polyplex*, due to Baily's ill-advised action in designating *Polyplex purpurescens* Perry, 1811, as type. This was set aside by the International Commission on Zoological Nomenclature, in Opinion 911 (1970), and *Polyplex bulbosa* Perry, 1811 (= *Buccinum geversianum* Pallas, 1769) designated as type, making *Polyplex* a synonym of *Trophon* Montfort, 1810.

Likewise, the generic name *Muricanthus* Swainson, 1840, is often employed, especially for species on the west coast of tropical America. In Opinion 886 (1969), the International Commission on Zoological Nomenclature declared the Panamanian species, *Murex radix* Gmelin, 1791, the type of *Muricanthus*. As discussed at length (Vokes, 1988, p. 24), I believe that these species should not be separated from the Indo-Pacific type of the genus.

The result of removing *Murexsul* as a subgenus of the genus *Hexaplex*, plus rejection of *Truncullariopsis* and *Muricanthus* as valid subgenera, leaves no other subgeneric taxa included with *Hexaplex* and no necessity to cite it as *Hexaplex (Hexaplex)*.

In the Neogene faunas of the western Atlantic, only a few species of *Hexaplex* lived at any given time. Today, the only certain species is the large, common *H. fulvescens* (Sowerby, 1834), most closely related to the West African fauna. Another, named from the West Indies as *Murex (Aaronia) strausi* Verrill, 1950, is almost certainly conspecific with the Panamanian *H. radix*.

Hexaplex texanus Vokes
Plate 11, figure 1

Hexaplex (Hexaplex) texanus VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 94, pl. 1, fig. 1.

Hexaplex texanus Vokes. GIVENS and KENNEDY, 1976, Jour. Paleontology, v. 50, no. 5, p. 970.

Holotype: Paleont. Resh. Inst., PRI 3000; height 13 mm, diameter 7 mm.

Type locality: Weches Formation; Smithville, Bastrop County, Texas (= TU 243).

Occurrence: Weches Formation, Texas.

Figured specimen: PRI 3000 (holotype).

Discussion: In the original description I stated that this species differs from the slightly younger *H. vanuxemi* by its much higher spire and especially by the denticles on the inner lip. In 1976, Givens and Kennedy (p. 969, pl. 3, figs. 1-6) described from the Eocene of California, *Muricopsis vistaensis*, a species very similar to *H. texanus*, causing them to suggest that *H. texanus* is not closely related to *H. vanuxemi*, and that both *H. texanus* and the younger *H. silvaticus*, should be removed from *Hexaplex* and placed into *Muricopsis*.

They may be correct about *H. texanus*. However, the species that I (Vokes, 1968b, p. 96) called *Hexaplex silvaticus* (Palmer, 1937) is better referred to *Poirieria (Pazinotus)* and may be distinguished from both *Hexaplex* and *Muricopsis* by the smooth shell surface between the major spiral cords. In contrast, *H. texanus*, *H. vanuxemi* and *H. katherinae* all have elaborately ornamented shells. The difference between *H. texanus* and the other two is the presence of columellar denticulations in *H. texanus*. These denticulations are lacking in *H. vanuxemi* and *H. katherinae*. Nevertheless, these three species are so similar that I cannot place them in two different subfamilies.

Hexaplex vanuxemi (Conrad)
Plate 11, figures 2, 3

Hexaplex (Hexaplex) vanuxemi (Conrad). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 94, pl. 1, fig. 3; DOCKERY, 1980, Mississippi Bur. Geol., Bull. 122, p. 99, pl. 35, figs. 2, 3.

Hexaplex vanuxemi (Conrad). GIVENS and KENNEDY, 1976, Jour. Paleontology, v. 50, no. 5, p. 970.

?Synonym:

Murex septemnarius CONRAD, 1834, Acad. Nat. Sci. Phila., Jour., (Ser. 1) v. 7, p. 154; PALMER, 1937, Bulls. Amer. Paleontology, v. 7, no. 32, p. 269; MOORE, 1962, Acad. Nat. Sci. Phila., Proc., v. 114, p. 95; PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 783.

Holotype: Acad. Nat. Sci. Philadelphia, ANSP 13756; height 20 mm, diameter 12 mm.

Type locality: Gosport Sand; Claiborne Bluff, Alabama River, Monroe County, Alabama (= TU 78).

Occurrence: Cook Mountain Formation, Louisiana, Mississippi (= Wautubbee Formation), and Texas (= Crockett Formation); Yegua Formation, Texas; Gosport Sand, Alabama.

Figured specimens: Fig. 2, USNM 450383; height 19.2 mm, diameter (including spine) 13.5 mm; locality TU 1511. Fig. 3, USNM 450384; height 17.5 mm, diameter (including spine) 12.2 mm; locality TU 86.

Discussion: As originally noted (Vokes, 1968b, p. 95), *Hexaplex vanuxemi* occurs in Early and Late Middle Eocene beds from Texas to Alabama. The Early Middle Eocene beds from Texas to Alabama have had a variety of local names. The Wautubbee Formation in Mississippi is now referred to the Cook Mountain Formation (Dockery, 1980, p. 39). In Texas, the beds that Stenzel *et al.* (1957, p. 37) called the Cook Mountain have been referred to the Crockett Formation.

The original illustration (Conrad, 1865, pl. 20, fig. 4) shows small denticulations on the inner side of the outer lip, which can be seen faintly in the specimens figured by

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PLATE 11

Figures Page

1. *Hexaplex texanus* Vokes (X 4) 71
   PRI 3000 (holotype); height 13 mm, diameter 7 mm.
   Locality: Smithville, Bastrop County, Texas (= TU 243); Weches Formation.
2, 3. *Hexaplex vanuxemi* (Conrad) (X 2 1/2) 71
   2. USNM 450383; height 19.2 mm, diameter (including spine) 13.5 mm.
      Locality: TU 1511, Louisiana; Cook Mountain Formation.
   3. USNM 450384; height 17.5 mm, diameter (including spine) 12.2 mm.
      Locality: TU 86, Mississippi; Cook Mountain Formation.
4. *Hexaplex katherinae* Vokes (X 2) 74
   James Allen Collection; height 27 mm, diameter 19 mm.
   Locality: TU 99, Louisiana; Moodys Branch Formation.
5, 6. *Hexaplex engonatus* (Conrad) 74
   5. (X 1 1/4) USNM 645608; height 42.3 mm, diameter 26.6 mm.
      Locality: Allen's Branch, Sowtilpa Creek, Clarke Co., Alabama; Gosport Sand.
   6. (X 1 1/2) Alabama Geol. Surv. no. 72 (holotype – *Murex gosportensis* Aldrich *in* Palmer); height 32 mm, diameter 17 mm.
      Locality: Claiborne, Monroe Co., Alabama; Gosport Sand.
7, 8. *Hexaplex marksi* (Harris) (X 2) 75
   7. USNM 645609; height 26 mm, diameter 17 mm.
      Locality: TU 99, Louisiana; Moodys Branch Formation.
   8. James Allen Collection; height 24.5 mm, diameter 15 mm.
      Locality: TU 99, Louisiana; Moodys Branch Formation.
9. *Hexaplex supernus* (Palmer) (X 2 1/2) 75
   USNM 645610; height 20 mm, diameter 11 mm.
   Locality: Danville Landing, Ouachita River, Catahoula Parish, Louisiana; Danville Landing Member, Yazoo Formation.
10. *Hexaplex colei* (Palmer) (X 2) 75
    PRI 3002 (holotype); height 23 mm, diameter 13.5 mm.
    Locality: Orangeburg, Orangeburg County, South Carolina (= TU 354); McBean Formation.
11. *Hexaplex veatchi* (Maury) (X 1 1/2) 75
    USNM 645611; height 30 mm, diameter 18.5 mm.
    Locality: TU 951, Florida; Chipola Formation.

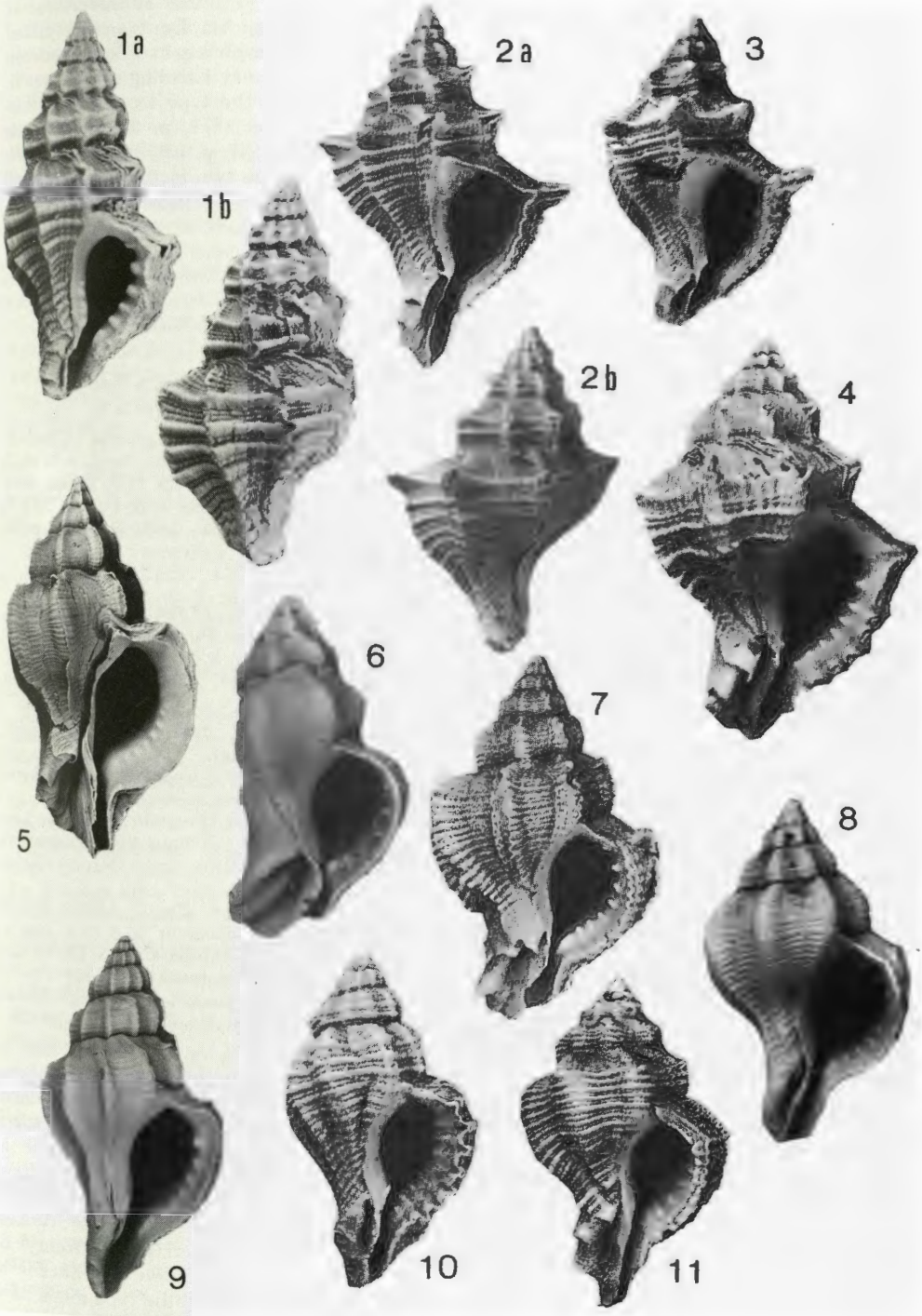

PLATE 11

Dockery (1980, pl. 35, figs. 2, 3). They are not present on either the specimen figured by Palmer (1937, pl. 35, fig. 9) or by Vokes (1968b, pl. 1, fig. 3a); therefore, a specimen with well developed denticulations (although otherwise rather poor) is figured here (pl. 11, fig. 3). All three species of the *H. texanus–H. vanuxemi–H. katherinae* complex have the same pattern of denticulations on the inside of the outer lip. It is the presence of denticulations on the columellar lip that distinguishes *H. texanus* from the other two.

In 1834 Conrad named another species from Claiborne, Alabama as *Murex septemnarius*. Both Palmer (1937, p. 269) and Moore (1962, p. 95) have noted that the holotype is lost and the species was never figured by Conrad. His description reads much like *H. vanuxemi:* "seven varices, and prominent subscabrous striae, with a fine line between; shoulder with prominent, acute, foliated spines". However, the size ("one inch") is slightly larger than any known specimen of *H. vanuxemi*. Should *M. septemnarius* ever be shown to be *H. vanuxemi*, it would be the prior name by almost 30 years. Although Conrad mentioned *Murex vanuxemi* in a list in 1834, he did not actually describe the species until 1865.

HEXAPLEX KATHERINAE Vokes
Plate 11, figure 4

Hexaplex (Hexaplex) katherinae VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 100, pl. 1, fig. 4; DOCKERY, 1977, Mississippi Geol. Surv., Bull. 120, p. 67.

Holotype: Paleont. Resh. Inst., PRI 4648; height 21 mm, diameter 14.3 mm.

Type locality: Moodys Branch Formation; Town Creek, Jackson, Hinds County, Mississippi (= TU 917).

Occurrence: Moodys Branch Formation and Danville Landing member, Yazoo Formation, Mississippi and Louisiana.

Figured specimen: James Allen Collection; height 27 mm, diameter 19 mm; locality TU 99. Additional localities: TU 544, 1173.

Discussion: The Late Eocene species *H. katherinae* is clearly the descendant of *H. vanuxemi* but has a larger, more massive, more coarsely ornamented shell. Although described from the Moodys Branch Formation at Jackson, Mississippi (= TU 917) we have not collected it there, nor at Montgomery Landing, on the Red River, Grant Parish (TU 99). However, James Allen, of Alexandria, Louisiana, permitted me to photograph his excellent specimen from Montgomery Landing (pl. 11, fig. 4). In addition to the type locality in Mississippi, Dockery (1977, p. 25; after Harris and Palmer, 1947, p. 339) has reported *H. katherinae* from two localities in Caldwell Parish, Louisiana: Bunker Hill (= TU 544, where we also have it); and Gibson Landing, on the Ouachita River. We have the species from the Danville Landing member of the Yazoo Formation, near Bunker Hill, also in Caldwell Parish (TU 1173).

HEXAPLEX ENGONATUS (Conrad)
Plate 11, figures 5, 6

Hexaplex (Hexaplex) engonatus (Conrad). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 97, pl. 2, fig. 1; VOKES, 1970, Tulane Stud. Geol. Paleont, v. 8, no. 1, p. 51; DOCKERY, 1980, Mississippi Bur. Geol., Bull. 122, p. 99, pl. 35, fig. 4.

Synonym:

Murex gosportensis ALDRICH *in* PALMER, 1937, Bulls. Amer. Paleontology, v. 7, no. 32, p. 268, pl. 36, fig. 3; PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 782.

Holotype: Acad. Nat. Sci. Philadelphia, ANSP 31386 (missing).

Type locality: (?)Gosport Sand, Claiborne Bluff, Monroe County, Alabama.

Occurrence: Cook Mountain Formation, Louisiana, Mississippi (= Wautubbee Formation); (?)Lisbon Formation and Gosport Sand, Alabama.

Figured specimens: Fig. 5, USNM 645608; height 42.3 mm, diameter 26.6 mm; locality, Allen's Branch, Sowtilpa Creek, Clarke Co., Alabama. Fig. 6, Alabama Geol. Surv. no. 72 (holotype – *Murex gosportensis);* height 32 mm, diameter 17 mm; locality, Claiborne, Alabama.

Discussion: Originally (Vokes, 1968b, p. 98), I observed that, although *H. engonatus* was described from "Claiborne, Alabama," we had never collected any specimens in the Gosport Sand, either at Claiborne Bluff (TU 78) or at Little Stave Creek (TU 306), another famous Gosport locality. In a subsequent note (Vokes, 1970b, p. 51), I reported that Dr. Henryk B. Stenzel, an authority on the Eocene of Texas, suggested that the type might have come from the Lisbon Formation, exposed

below the Gosport Sand at Claiborne Bluff (= localities TU 285, 424).

However, the holotype of *Murex gosportensis* Aldrich, named from the "Gosport Sand, Claiborne, Ala. Eocene" (Palmer, 1937, p. 268), is almost certainly a worn example of *H. engonatus* (compare pl. 11, figs. 5 and 6) and a beautiful specimen is here figured (pl. 11, fig. 5) from the Gosport Sand at Sowtilpa Creek, Clarke County, Alabama (U.S. National Museum collection).

The species is relatively common in the Cook Mountain (= Wautubbee Formation) of Mississippi. Dockery (1980, pl. 35, fig. 4) has figured a peculiar example that appears to be pathologic, with only four varices on the body whorl, instead of the normal five or six.

HEXAPLEX MARKSI (Harris)
Plate 11, figures 7, 8

Hexaplex (Hexaplex) marksi (Harris). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 98, pl. 2, fig. 3; DOCKERY, 1977, Mississippi Geol. Surv, Bull. 120, p. 67, pl. 9, figs. 6, 8; DOCKERY, 1980, Mississippi Bur. Geol., Bull. 122, p. 99, pl. 58, fig. 8.

Holotype: USNM 135148; height 23.5 mm, diameter 15 mm.

Type locality: Whites Bluff Formation; one mi northeast (in a well) of Pansy Post Office, Cleveland County, Arkansas.

Occurrence: Moodys Branch Formation, Louisiana and Mississippi; Whites Bluff Formation, Arkansas.

Figured specimens: Fig. 7, USNM 645609; height 26 mm, diameter 17 mm; locality TU 99. Fig. 8, James Allen Collection; height 24.5 mm, diameter 15 mm; locality TU 99.

Discussion: In addition to the type locality in Arkansas, and the two localities I originally reported (TU 99, 917: Vokes, 1968b, p. 98), Dockery (1977, p. 67; 1980, p. 100; both after Harris and Palmer, 1947, p. 341) has reported this species from three other localities in Louisiana: Bunker Hill (= TU 544) and Gibsons Landing, in Caldwell Parish [his no. P118 is an error for P1118]; and Montgomery Landing, Grant Parish (= TU 99).

In this variable species, some specimens have expanded varices and others, at the same locality, have only rounded ribs (compare pl. 11, figs. 7 and 8). The same variation is present in the older *H. engonatus*, which led to the unnecessary synonym, *Murex gosportensis* Aldrich.

HEXAPLEX SUPERNUS (Palmer)
Plate 11, figure 9

Hexaplex (Hexaplex) supernus (Palmer). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 100, pl. 2, fig. 2; DOCKERY, 1977, Mississippi Geol. Surv., Bull. 120, p. 67.

Holotype: Paleont. Resh. Inst., PRI 4653; height 20.5 mm, diameter 11 mm. Type locality: Moodys Branch Formation; Bayou Toro, Vernon Parish, Louisiana (= TU 545).

Occurrence: Moodys Branch Formation (upper beds) and Danville Landing Member, Yazoo Formation, Louisiana and Mississippi.

Figured specimen: USNM 645610; height 20 mm, diameter 11 mm; locality, Danville Landing, Ouachita River, Catahoula Parish, Louisiana. Additional localities: TU 1099, 1173.

Discussion: Hexaplex supernus is the youngest member of the species complex *H. engonatus–H. marksi–H. supernus*. It is most common in the Danville Landing beds, now considered to be the uppermost member of the Yazoo Formation, Jackson Group, according to Dockery (1980, p. 22).

HEXAPLEX COLEI (Palmer)
Plate 11, figure 10

Hexaplex (Hexaplex) colei (Palmer). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 96, pl. 2, fig. 4.

Holotype: Paleont. Resh. Inst., PRI 3002; height 23 mm, diameter 13.5 mm.

Type locality: McBean Formation, about 3 mi WNW of Orangeburg, Orangeburg County, South Carolina (= TU 354).

Occurrence: McBean Formation, South Carolina; Weches Formation and Stone City Beds, Texas.

Figured specimen: PRI 3002 (holotype).

Discussion: The Middle Eocene species, *H. colei*, is more closely related to the Early Miocene Chipola species *H. veatchi* than to any other known Eocene species.

HEXAPLEX VEATCHI (Maury)
Plate 11, figure 11

Hexaplex (Hexaplex) veatchi (Maury). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 101, pl. 3, figs. 3, 5; VOKES, 1972, Earth Sci., v. 25, no. 3, p. 122, pl. 1, fig. 10.

Lectotype: Paleont. Resh. Inst., PRI 3462 (designated by Brann and Kent, 1960, p. 573); height 21 mm, diameter 13 mm.

Type locality: Chipola Formation; "Bailey's Ferry, Florida" = TU 554, east bank of Chipola River, at power line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun County, Florida (designated by Vokes, 1968b, p. 101).

Occurrence: Tampa Limestone and Chipola Formation, Florida.

Figured specimen: USNM 645611; height 30 mm, diameter 18.5 mm; locality TU 951. Additional localities: TU 458, 459, 546, 548, 555, 950, 998, 999, 1048, 1196.

Discussion: The unusual species *H. veatchi* is never common, but it occurs rarely at almost every locality in the Chipola Formation and in every facies, on Tenmile Creek, on Farley Creek, and on the Chipola River.

HEXAPLEX ISTHMICUS Vokes, n. sp.
Plate 12, figure 3

Description: Shell with six teleoconch whorls preserved, protoconch and earliest teleoconch whorls not preserved. Spiral ornamentation on earliest whorls of many fine threads. On body whorl five broad raised welts, with between each pair one thin sharp spiral cord, also five in number; entire shell surface covered by shagreened tertiary threads. Axial ornamentation on each whorl of five or six rounded varices; between each pair one sharply defined intervarical ridge; where spiral welts and cords cross varices, short open spines produced; those at the welts larger, at the cords smaller in size. Suture markedly appressed, giving almost no definition to the individual whorls but forming a deep angular anal notch. Aperture elongate-oval. Inner lip narrow, smooth, appressed along entire length. Margin of outer lip crenulated by sharp forward-directed projections, corresponding to the spaces between the spines, both major and minor; smooth on the inner side. Nature of siphonal canal unknown but assumed to be broad, moderately long, and recurved at the distal end.

Holotype: USNM 450386; height (incomplete) 51.9 mm, diameter 44.1 mm.

Type locality: TU 1433, Gatun Formation; north side of Boyd-Roosevelt Highway, clearing behind Urbanization San Martin, approximately 0.5 km east of junction of road to Refinería Panamá, S.A., at Cativá, Prov. of Colón, Panama.

Etymology of name: *isthmus* (L.) = narrow neck of land, referring to type locality in Isthmus of Panama.

Occurrence: Gatun Formation, Panama.

Figured specimen: USNM 450386 (holotype).

Discussion: This new species, represented by a single incomplete specimen, is so distinctive that I have no hesitation in describing it. Superficially similar to *H. etheringtoni*, from the Tubará Group (see below), it is readily distinguished by the presence of the strong intervarical ridges not present in the Colombian shell, and by the appressed suture, which gives it a biconic appearance. Other than *H. etheringtoni*, there is no species, fossil or Recent, with which this this unusual form may be compared.

PLATE 12

Figures

1. *Hexaplex etheringtoni* Vokes (X 1 1/4) 78
   UCMP 33837 (holotype); height 62 mm, diameter (incomplete) 32 mm.
   Locality: UCMP S-66, Punta Pua, Colombia; Tubará Group.
2. *Hexaplex hertweckorum* (Petuch) (X 1) 78
   USNM 645613; height 64 mm, diameter 43.5 mm.
   Locality: TU 797, Florida; Pinecrest Beds.
3. *Hexaplex isthmicus* Vokes, n. sp. (X 1 1/4) 76
   USNM 450386 (holotype); height (incomplete) 51.9 mm, diameter 44.1 mm.
   Locality: TU 1433, Panama; Gatun Formation.
4. *Hexaplex fulvescens* (Sowerby) (X 1) 78
   USNM 678100; height 81 mm, diameter 63.5 mm.
   Locality: TU R-60, off Florida; Recent.
5, 6. *Murex williamsi* Maury (X 2) 6
   5. Mus. Nacl. Rio de Janiero, DNPM 556 (holotype); height 29.4 mm; diameter 15.3 mm.
      Locality: Rio Pirabas, Para, Brazil; Pirabas Limestone.
   6. Maury, 1925, pl. 6, fig. 8.

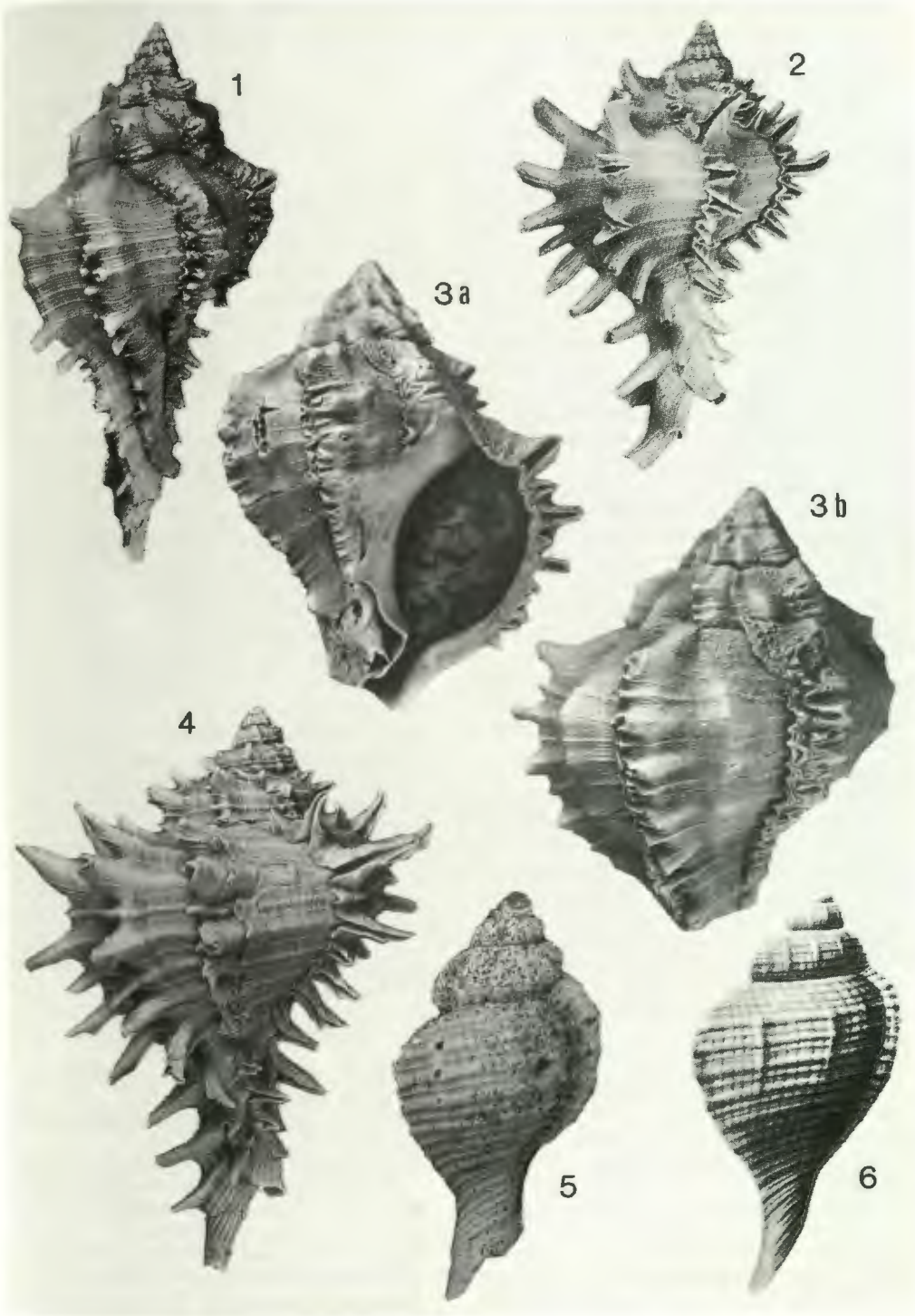

PLATE 12

HEXAPLEX ETHERINGTONI Vokes
Plate 12, figure 1

Hexaplex (Hexaplex) etheringtoni VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 102, pl. 4, fig. 2.

Holotype: Museum of Paleontology, University of California, Berkeley, UCMP 33837; height 62 mm, diameter (incomplete) 32 mm.

Type locality: UCMP S-66, Tubará Group; Punta Pua, about 15 mi (24 km) northeast of Cartegena, Depto. de Bolívar, Colombia.

Occurrence: Tubará Group, Colombia.

Figured specimen: UCMP 33837 (holotype).

Discussion: This unique specimen from the Tubará Group is now considered to be Pliocene or even Pleistocene in age rather than Late Miocene, as when the species was described. At the same locality (UCMP S-66) there are specimens of *Haustellum olssoni* (Vokes), described from the Moín Formation, and *Dermomurex alabastrum* (A. Adams, 1864) otherwise known only from the Recent fauna. Thus, the probability of a Pleistocene age is strongly indicated.

Otherwise, there is nothing to add to the original discussion. Of interest, however, is the discovery of *H. isthmicus,* n. sp., a similar form from the Gatun Formation of Panama, described above, more closely related to this species than to any other. It is presumed to be ancestral to *H. etheringtoni.*

HEXAPLEX HERTWECKORUM (Petuch)
Plate 12, figure 2

Muricanthus ambiguus (Reeve). OLSSON, 1964, Neogene Moll. Northwest. Ecuador, p. 138, pl. 29, fig. 5 (not of Reeve); VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 87.

Hexaplex (Hexaplex) fulvescens (Sowerby). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 104 [in part, not of Sowerby], pl. 3, fig. 1, pl. 4, figs. 1, 3 only.

Muricanthus hertweckorum PETUCH, 1988, Bull. Paleomalac., v. 1, no. 1, p. 18, pl. 3, figs. 1-3; PETUCH, 1988, Neogene History Trop. Amer. Moll., pl. 12, figs. 1, 2, pl. 17, fig. 6.

Hexaplex hertweckorum (Petuch). VOKES, 1988, Tulane Stud. Geol. Paleont., v. 21, no. 1, p. 24, pl. 1, figs. 7, 8.

Holotype: USNM 424261; height 40 mm, diameter 35 mm.

Type locality: APAC Pit (Macasphalt Pit # 0800826), Sarasota, Sarasota County, Florida (= TU 1000).

Occurrence: Esmeraldas Beds, Ecuador; Pinecrest Beds, Florida.

Figured specimen: USNM 645613; height 64 mm, diameter 43.5 mm; locality TU 797. Additional localities: TU 728, 729, 730, 769, 796, 933, 1000, 1493.

Discussion: Originally (Vokes, 1968b, p. 104), I considered this species as the living *H. fulvescens.* With the discovery of numbers of specimens at Sarasota, Florida (TU 1000) it became clear that the two forms are not the same. A new name was proposed by Petuch, who noted that the Pliocene form differs from the Recent in "having a thinner, more inflated shell with a distinctly rounded shoulder, by having more ornate, recurved varical spines, and by having finer, less developed spiral cords on the intervarical areas" (1988a, p. 20).

The shell that Olsson (1964, p. 138, pl. 29, fig. 5) reported from the Esmeraldas Beds of Ecuador as "*Muricanthus ambiguus* (Reeve)" is the same as *H. hertweckorum,* and is among the four muricid species that occur in both the Esmeraldas and the Pinecrest beds (Vokes, 1988, p. 9).

In the Esmeraldas study, it was noted that *H. hertweckorum* is more closely related to the West African *H. duplex* (Röding, 1798) than to *H. fulvescens;* the sole difference being the lack of a small secondary spine between the shoulder spine and the suture in the African species (compare Vokes, 1988, pl. 1, figs. 7 and 9). As the Pliocene members of *Hexaplex* in the western Atlantic differ so strikingly from the older species, it is assumed that this group originated in West Africa and migrated via northern South America, through the Bolivar Trough to the eastern Pacific. In the process some individuals made their way north to Florida.

HEXAPLEX FULVESCENS (Sowerby)
Plate 12, figure 4

Hexaplex (Hexaplex) fulvescens (Sowerby). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 104 [in part, not Pinecrest localities], pl. 3, fig. 4, pl. 4, fig. 4 only.

Muricanthus fulvescens (Sowerby). RADWIN and D'ATTILIO, 1976, Murex Shells of the World, p. 76, pl. 12, fig. 3; PETUCH, 1988, Bull. Paleomalac., v. 1, no. 1, p. 20.

Hexaplex fulvescens (Sowerby). FAIR, 1976, The Murex Book, p. 4, pl. 12, fig. 143.

Holotype: Not found.

Type locality: South Carolina (designated by Kiener, 1843, p. 50, for *Murex spinicosta* Valen-

ciennes, a synonym).

Occurrence: Unnamed Pleistocene formations, Louisiana, Florida, South Carolina. Recent, southeastern U. S., from North Carolina to Texas and northern Yucatán Peninsula.

Figured specimen: USNM 678100; height 81 mm, diameter 63.5 mm; locality TU R-60. Additional fossil localities: TU 1, 578, 977.

Discussion: In 1968 there was but a handful of "Miocene" (*i.e.*, Pinecrest Beds) specimens of *Hexaplex* known from southern Florida. These I placed in the Recent species *H. fulvescens*, stating that the species occurred at "several different Miocene localities in the vicinity of Lake Okeechobee" but had not been taken at any Pliocene (*i.e.*, Caloosahatchee Formation) localities (Vokes, 1968b, p. 104). With the discovery of hundreds of specimens in the excavations near Sarasota, Florida (TU 1000), I recognized the fossil species as new. But my statement about the Pliocene beds is still relevant: neither *H. hertweckorum* (Petuch, 1988), as the Pinecrest species was subsequently named, nor *H. fulvescens* has been taken in the Caloosahatchee or Bermont formations (unless locality TU 578, in St. Lucie County, should be placed in one of these units).

The fossiliferous beds in the general vicinity of St. Lucie County have been placed in the Pamlico Formation of Late Pleistocene age. However, the fauna at TU 578 is unlike any other locality that we have collected in the area. There are numerous specimens of an arcacean pelecypod that is indistinguishable from the North Carolina species *Noetia (Eontia) limula* (Conrad, 1832) (see Blackwelder, 1981, pl. 8, fig. 5, for a good illustration). According to MacNeil (1937, p. 19) this species is restricted to the "Croatan Sand" (= James City Formation), a time equivalent of the Waccamaw Formation of North and South Carolina and the Caloosahatchee Formation of Florida. MacNeil (1937, p. 21) noted that in the U. S. Geological Survey collections from Fellsmere, St. Lucie County [Indian River County], and other localities in eastern Florida, there are specimens that "appear to be closely related to *E. limula*" and he illustrates one from Volusia County (USNM 496526) as *Eontia* cf. *E. variabilis* MacNeil (1937, pl. 2, fig. 16) that appears to be the same as ours from TU 578. Occurring with these unexpected northern *Eontia* specimens are also several examples of *Busycon carica* (Gmelin, 1791), which today occurs from Cape Cod to Cape Canaveral, Florida (Abbott, 1974, p. 222), and in the fossil record from the Late Pliocene to the Recent (Blackwelder, 1981, p. 4).

Are these beds in St. Lucie, Indian River, Brevard, and Volusia counties the time equivalent of the more northern James City Formation? This seems unlikely, as the correlative Caloosahatchee and Waccamaw formations surrounding this anomalous fauna are obviously representative of much warmer water. A more likely explanation is that this northern fauna moved south during the period of cooler water that caused the demise of the Waccamaw and Caloosatatchee faunas. This cool-water fauna is probably the same age as the Late Pleistocene beds in South Carolina, from whence Holmes (1860, pl. 10, fig. 2) figured a similar specimen of *H. fulvescens* (as *Murex spinicostatas* [*sic*]). Olsson and Harbison (1953, p. 7) report large numbers of specimens of *H. fulvescens* taken in the Pleistocene beds near Largo, Pinellas County.

Thus, *H. fulvescens* is known only in the Late Pleistocene and Recent faunas. Its range is extremely limited in the Recent fauna, but it is abundant within that small area. Wells (1958) described the eating habits of the species, which opens oysters with the outer lip but drills clams and mussels. This flexibility permits an individual to consume 3.5 clams/week.

In 1968, I included (with a query) the species described from "Santo Domingo" as *Murex pudicus* Reeve, 1845, in the synonymy of *H. fulvescens*. Later, Kaicher (1980, no. 2504) figured the type (BMNH 197498), which is a West African species with only a generic similarity to *H. fulvescens*.

HEXAPLEX STRAUSI (Verrill)

Hexaplex (Hexaplex) strausi (Verrill). VOKES, 1968, Tulane Stud. Geol., v. 6, no. 3, p. 105.

Hexaplex strausi (Verrill). FAIR, 1976, The Murex Book, p. 79, text-fig. 59 (after Verrill); SUTTY, 1986, Seashell Treasures of the Caribbean, p. 57, text-fig. 57; VOKES, 1988, Tulane Stud. Geol. Paleont., v. 21, no. 1, p. 24 (as ? = *H. radix*).

Holotype: Not found; height 50-59 mm, diameter 36-40 mm (*fide* Verrill, 1950c, p. 5; larger specimen illustrated is probably 59 mm).

Type locality: Dominica, Lesser Antilles.

Occurrence: Recent only, Lesser Antilles.

Discussion: The species described by Verrill (1950c, p. 4) as *Murex (Aaronia) strausi* was so similar to *H. radix* (Gmelin, 1791) that it was universally ignored until 1986 when Sutty reported two more examples off Martinique. Verrill's specimens ("three adult and two young shells") were said to have been taken (?alive, illustrations show opercula in place) in a fish trap at 75 to 100 fathoms (= 137-183 meters), considerably deeper than members of this group ordinarily live. This did not help in the acceptance of his species. However, Sutty's specimens were alive and came from 6.4 meters (21 ft), a more realistic depth. This causes wonder as to why no one else has taken any specimens of the species. Unlike Verrill's crude drawings, Sutty's color photographs (1986, text-fig. 57) are excellent – but the shells still look to me like juvenile specimens of *H. radix!* There may be a colony of *H. radix* established in the Lesser Antilles, but I cannot help but believe that they have been introduced in some fashion.

VI. LOCALITY DATA

The following are Tulane University fossil locality numbers:

1. Unnamed formation, material dredged from depth of 15 to 30 feet for construction of Interstate 10, south of Lake Pontchartrain, between Downman Road and Paris Road, New Orleans, Orleans Parish, Louisiana.
60. Jackson Bluff Fm., borrow pits at Jackson Bluff, Ochlockonee River (NW 1/4 Sec. 21, T1S, R4W), Leon Co., Florida.
61. Stone City Beds, type locality, Stone City Bluff on Brazos River, at crossing of bridge of Texas Highway 21, Burleson Co., Texas.
69. Shoal River Fm., type locality, Shell Bluff, Shoal River (NW 1/4 Sec. 4, T3N, R21W), about 3 1/2 miles north of Mossyhead, Walton Co., Florida.

69A. Shoal River Fm., first ravine upstream from Shell Bluff, Shoal River (NW 1/4 Sec. 4, T3N, R21W), about 3 1/2 miles north of Mossyhead, Walton Co., Florida.

70. Chipola Fm., Tenmile Creek, at bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
76. Mint Springs Fm., 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 Bermont Fm. mixed, spoil banks north and south side of Caloosahatchee River, at Ortona Lock (Sec. 27, T42S, R30E), Glades Co., Florida.
86. Wautubbee Fm.[= Cook Mountain Fm.], roadcut on east side on Mississippi Highway 15, 0.8 mile north of junction with U. S. Highway 80, Newton Co., Mississippi. (Note: Interstate 20 has subsequently covered this locality and it is no longer available.)
91. Oak Grove Sand, type locality, west bank of Yellow River, about 100 yards below bridge at Oak Grove (NE 1/4 Sec. 20, T5N, R23W), Okaloosa Co., Florida.
99. Moodys Branch Fm., Montgomery Landing (also known as Creola Bluff), west bank of Red River (Sec. 20, T8N, R5W), Grant Parish, Louisiana.
196. Chipola Fm., Tenmile Creek, about 1/4 mile upstream from bridge of Florida Highway 73 (NE 1/4 Sec. 11, T1N, R10W), Calhoun Co., Florida.
201. Bermont Fm., spoil banks at pit just south of Belle Glade (at Belle Glade Camp), Palm Beach Co., Florida.
226. Red Bluff Fm., west bank Chickasawhay River, approximately one mile southwest of Hiwannee (SW 1/4 Sec. 28, T10N, R7W), Wayne Co., Mississippi.
243. Weches Fm., Colorado River, 625 feet downstream from bridge of Texas Highway 71 at Smithville, Bastrop Co., Texas.
283. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks on cross-canal 1.3 miles southwest of Port Charlotte Railroad Station (formerly Murdock), on south side of Florida Highway 771 and Seaboard Air Line Railroad (Sec. 12, T40S, R21E), Charlotte Co., Florida.
285. Lisbon Fm., Claiborne, east bank of Alabama River, below bridge of U. S. Highway 84, lowest water level, Monroe Co., Alabama.
306. Gosport Sand, Little Stave Creek, northeast of Jackson, Clarke Co., Alabama.
354. McBean Fm., roadcut on U.S. Highway 21, 1.9 miles north of junction with U.S. Highway 178 Bypass, at Orangeburg, Orangeburg Co., South Carolina.
424. Lisbon Fm., Claiborne, east bank Alabama River, below bridge of U. S. Highway 84 (same as TU 285 but bed immediately above; locality is on sloping beach down-

stream from bridge at low water, while TU 285 is at very edge of river channel almost under the bridge), Monroe Co., Alabama.

453. Chipola Fm., Alum Bluff (lower beds), Apalachicola River (NE 1/4 Sec. 24, T1N, R8W), Liberty Co., Florida.

456. Chipola Fm., Tenmile Creek, about 1/4 mile downstream from bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

457. Chipola Fm., west bank of Chipola River, about 1/2 mile below Tenmile Creek (SW 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 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

459. Chipola Fm., east bank of Chipola River, steep bank about 1500 feet above the mouth of Taylor Lake Branch (NW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

520. Pinecrest Beds, spoil banks, canal 0.9 mile east of Brighton on Florida Highway 70 (Sec. 25, T37S, R32E), Highlands Co., Florida.

531. Caloosahatchee Fm., spoil banks on cross-canal 1.3 miles southwest of Port Charlotte Railroad Station (formerly Murdock), on north side of Florida Highway 771 and Seaboard Air Line Railroad (Sec. 12, T40S, R21E), Charlotte Co., Florida.

536. Caloosahatchee Fm., south bank of Caloosahatchee River about one mile east of La Belle (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. Bermont Fm., Shell Creek (upper beds), about 8 miles east of Cleveland (Sec. 30, T40S, R25E), Charlotte Co., Florida. (Designated as type locality of the Bermont Formation by DuBar, 1974, p. 221.)

539B. Caloosahatchee Fm., Shell Creek (lower beds), about 8 miles east of Cleveland (Sec. 30, T40S, R25E), Charlotte Co., Florida.

544. Moodys Branch Fm., Bunker Hill, on south side of Ouachita River (N 1/2, Sec. 24, T12N, R4E), about 8 miles southeast of Columbia, Caldwell Parish, Louisiana.

545. Moodys Branch Fm., east bank of Bayou Toro (NW 1/4 Sec. 6, T3N, R11W), Vernon Parish, Louisiana.

546. Chipola Fm., Tenmile Creek, about 1 3/4 miles west of Chipola River (NE 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 2000 feet above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

548. Chipola Fm., west bank of Chipola River, at bend about 1800 feet south of mouth of Farley Creek (NW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

549. Chipola Fm., east bank of Chipola River, about 1/4 mile below Fourmile Creek (NE 1/4 Sec. 32, T1N, R9W), Calhoun Co., Florida.

552. Chipola Fm., east bank of Chipola River, about 1 1/2 miles below Tenmile Creek (NE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

553. Chipola Fm., mouth of Farley Creek, at Chipola River (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

554. Chipola Fm., east bank of Chipola River at power line crossing (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.

555. Chipola Fm., east bank of Chipola River, about 1000 feet above Fourmile Creek (SW 1/4 Sec. 29, T1N, R9W), Calhoun Co., Florida.

558. Waccamaw Fm., borrow pits at north end of Crescent Beach Airport, Crescent Beach, Horry Co., South Carolina.

559. Waccamaw Fm., "Neill's Eddy Landing", south bank of Cape Fear River near Acme, Columbus Co., North Carolina.

562. Silverdale Beds, Onslow County marl pit on south side of Webb Creek, near Silverdale, Onslow Co., North Carolina.

578. Unknown formation, "Rim Ditch" spoil banks, 1/2 mile south of Florida Highway 68 (Sec. 8, T35S, R38E), St. Lucie Co., Florida.

579. Caloosahatchee Fm., Miami Canal spoil banks, 4 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

580. Bermont Fm., North New River Canal spoil banks, one mile south of South Bay, Palm Beach Co., Florida.

583. Caloosahatchee Fm., Miami Canal spoil banks, 7 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

589. Rio Banano Fm., Rio Banano, north bank, about 0.6 to 0.8 km above the railroad bridge at La Bomba, Limón Province, Costa Rica.

635. Encanto Fm., roadcut on Mexico Highway 185, 2.3 km south of bridge over Rio Jaltepec, at Oaxaca-Veracruz state line, Mexico.

638. Agueguexquite Fm., roadcut, pipeline cut, and quarry on Mexico Highway 180, 23 km east of junction with side road into Coatzacoalcos, Veracruz, Mexico.

642. Red Bluff Fm., Hiwannee, Chickasawhay River, about 1/2 mile upstream from loc. TU 226 (NE 1/4 Sec. 28, T10N, R7W), Wayne Co., Mississippi.

655. Chipola Fm., Tenmile Creek, about 0.1

mile downstream from bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

704. Silverdale Beds, Gillette's Marl Pits (old pit) 1/3 mile from junction of roads to Stella and Swansboro at Silverdale, Onslow Co., North Carolina.
705. Bowden Fm., type locality, Bowden, east of Port Morant, Parish of St. Thomas, Jamaica.
708. Chipola Fm., at small waterfall tributary to Tenmile Creek, south bank, about 1/4 mile downstream from bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
709. Chipola Fm., Tenmile Creek, about 1/4 mile downstream from bridge of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
711. Chipola Fm., west bank of Chipola River, about 1/4 mile up from Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
725. Bermont Fm., North New River Canal spoil banks, 3 miles south of South Bay, at Okeelanta, Palm Beach Co., Florida.
726. Caloosahatchee Fm., Hendry County rock pit, 1/2 mile north of Florida Highway 80, three miles west of La Belle (SE 1/4 Sec. 14, T43S, R28E), Hendry Co., Florida.
727. Bermont Fm., 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 1/2 mile south of U.S. Corps of Engineers Structure 65-D (S 1/2 Sec. 33, T36S, R33E), Okeechobee Co., Florida.
730. Pinecrest Beds, embankment of Seaboard Air Line Railroad, just west of Kissimmee River (NW 1/4 Sec. 20, T36S, R33E), Highlands Co., Florida.
731. Bermont Fm., West Palm Beach Canal spoil banks, at Twenty Mile Bend Recreation area just east of junction of U.S. Highways 441 and 98, Palm Beach Co., Florida.
733. Bermont Fm., North New River Canal spoil banks, one mile north of Florida Highway 80, at South Bay, Palm Beach Co., Florida.
736. Pinecrest Beds and Caloosahatchee Fm. mixed, 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-12A, at "Forty-Mile Bend," U.S. Highway 41, Dade Co., Florida.
740. Pinecrest Beds, levee fill, L-28, 3.6 miles west and 2.6 miles south of pumping station on Miami Canal at Broward-Palm Beach county line, Broward Co., Florida.
742. Pinecrest Beds, levee fill, L-28, 3.6 miles west and 5.6 miles south of pumping station on Miami Canal at Broward-Palm Beach county line, Broward Co., Florida.
743. Bermont Fm., spoil banks on drainage canal 7 miles east of U.S. Highway 27, 15 miles south of South Bay, Palm Beach Co., Florida.
746. Bermont Fm., 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. Bermont Fm., North New River Canal spoil banks, 2 miles south of South Bay, Palm Beach Co., Florida.
748. Bermont Fm., Lake Okeechobee levee, 2 miles north of South Bay, Palm Beach Co., Florida.
750. Bermont Fm., spoil banks cross-canal 3.1 miles south of Lake Harbor on Miami Canal, Palm Beach Co., Florida.
751. Bermont Fm., North New River Canal spoil banks, 1 1/2 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 1/4 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, Port Charlotte Development, spoil banks west side of Elkcan Waterway, 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.
757. Gatun Fm., roadcut on south side of Boyd-Roosevelt Highway at junction of road to "Refinería Panamá, S.A.," just east of Cativá, Prov. of Colón, Panama.
759. Bermont Fm., spoil banks north side of Caloosahatchee River, 2 miles west of Ortona Lock (NE 1/4 Sec. 29, T42S, R30E), Glades Co., Florida.
767. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks north side of Caloosahatchee River, 5 miles west of Ortona Lock (NW 1/4 Sec. 36, T42S, R29E), Glades Co., Florida.
768. Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks north side of

Caloosahatchee River, 5 1/2 miles west of Ortona Lock (NW 1/4 Sec. 35, T42S, R29E), Glades Co., Florida.

769. Pinecrest Beds, spoil banks east side of Kissimmee River, 1 1/2 to 2 miles south of U.S. Corps of Engineers Structure 65-D (NE 1/4 Sec. 35, T36S, R33E), Okeechobee Co., Florida.

770. Pinecrest Beds and Caloosahatchee Fm. mixed, spoil banks west side of Kissimmee River, 1 1/2 to 3 1/2 miles north of Florida Highway 70 (Secs. 10, 14, 15, and 28, T37S, R33E), Highlands Co., Florida.

786. Chipola Fm., Tenmile Creek, 1/4 mile upstream from bridge of Florida Highway 73 (NE 1/4 Sec. 11, T1N, R10W), Calhoun Co., Florida.

787. Chipola Fm., Tenmile Creek, about 1 1/2 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

788. Pinecrest Beds and Bermont Fm. mixed, Port Charlotte Development, spoil banks at U-shaped canal on north side of Florida Highway 771, 3.4 miles southwest of U.S. Highway 41 (Sec. 15, T40S, R21E), Charlotte Co., Florida.

791. Bermont Fm., spoil banks, Florida Cross State Barge Canal, 1 1/2 miles west of U.S. Highway 19 at Inglis, Citrus Co., Florida.

792. Caloosahatchee Fm., borrow pits just west of Florida Highway 80, about 2 miles southwest of La Belle (SW 1/4 Sec. 7, T43S, R29E), Hendry Co., Florida.

796. Pinecrest Beds, material exposed during construction of "Alligator Alley," 12.8 miles east of Florida Highway 29 (T49S, R32E), Collier 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.

801. Caloosahatchee Fm., spoil banks south side of Caloosahatchee River, 2 3/4 miles west of Ortona Lock (NW 1/4 Sec. 29, T42S, R30E), Glades Co., Florida.

802. Pinecrest Beds, Caloosahatchee Fm. and Bermont Fm. mixed, spoil banks south side of Caloosahatchee River, 4 1/4 miles west of Ortona Lock (SE 1/4 Sec. 25, T42S, R29E), Glades Co., Florida.

803. Bermont Fm., spoil banks south side of Caloosahatchee River, 2 miles west of Ortona Lock (NE 1/4 Sec. 29, T42S, R 30E), Glades Co., Florida.

810. Chipola Fm., east bank of Chipola River, opposite mouth of Taylor Branch (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.

816. Caloosahatchee Fm. and Bermont Fm. 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.

817. Chipola Fm., south side of Tenmile Creek, large gully on the property of Mr. A. Sexton (1967) (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

818. Chipola Fm., Farley Creek, 0.1 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

819. Chipola Fm., Farley Creek, 0.2 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

820. Chipola Fm., Farley Creek, at bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

821. Chipola Fm., Farley Creek, 0.1 mile east of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

822. Chipola Fm., Farley Creek, 1/4 mile east of bridge on Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

823. Chipola Fm., Farley Creek, about 2000 feet east of bridge of Florida Highway 275 (SE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

824. Chipola Fm., Farley Creek, about 1/2 mile east of bridge of Florida Highway 275 (SE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

825. Chipola Fm., Farley Creek at abandoned mill about 1/4 mile west of bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

826. Chipola Fm., Farley Creek, about 0.1 mile west of abandoned mill, which is 1/4 mile west of bridge of Florida Highway 275 (on section line between Sec. 20 & 21, T1N, R9W), Calhoun Co., Florida.

827. Chipola Fm., Farley Creek, about 1/2 mile west of bridge of Florida Highway 275 (SE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

828. Chipola Fm., Farley Creek, just upstream from mouth of unnamed tributary about 3/4 mile downstream from bridge of Florida Highway 275 (SE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.

830. Chipola Fm., Tenmile Creek, at power line crossing about one mile west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

831. Chipola Fm., Tenmile Creek [lowest Chipola beds exposed], slightly less than one mile west of Chipola River (SW 1/4 Sec. 7, T1N, R9W), Calhoun 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.

917. Moodys Branch Fm., Town Creek, just east of Gulf, Mobile, and Ohio Railroad bridge; about one block east of State St. and two blocks north of U.S. Highway 80, Jackson, Hinds Co., Mississippi.

932. Pinecrest Beds, east side of Kissimmee Canal and 1/2 mile south of Seaboard Air Line Railroad, south of Fort Basinger (SE 1/4 Sec. 20, T36S, R33E), Okeechobee Co., Florida.
933. Pinecrest Beds, material exposed during construction of "Alligator Alley," 21.5 miles east of Florida Highway 29, Collier Co., Florida.
939. Caloosahatchee Fm. and Bermont Fm. mixed, south side of Caloosahatchee River, 5.2 miles west of Ortona Lock (NW 1/4 Sec 36, T42S, R29E), Glades Co., Florida.
950. Chipola Fm., Chipola River, west bank about 2000 feet above Farley Creek (SW 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
951. Chipola Fm., Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
953. Moín Fm., type locality, Moín Hill, railroad cut and adjacent ditches on road to Sandoval 4.5 km west of Puerto Limón, Costa Rica.
954. Moín Fm., hill cut immediately behind Standard Fruit Co. box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limón, Costa Rica.
956. Moín Fm., hill slope behind Baptist Church on Highway C.R. 32 between Puerto Limón and Pueblo Nuevo, Costa Rica.
958. Gatun Fm., hillslope on east side of road from Boyd-Roosevelt Highway to "Refinería Panamá, S. A.," about 1/2 km north of junction, just east of Cativá, Prov. of Colón, Panama.
959. Gatun Formation, roadcut on road to "Refinería Panamá S. A.," about 100 m south of refinery gate, Prov. of Colón, Panama.
960. Gatun Fm., top of hill, just east of "Refinería Panamá S.A." at Isla Payardi (= Woodring loc. no. 139E), Prov. of Colón, Panama.
961. Gatun Fm., roadcuts both sides of Boyd-Roosevelt Highway, just east of Cativá (= Woodring loc. no. 138), Prov. of Colón, Panama.
964. Gatun Fm., road from Cativá to Samba Bonita Island, about 1.2 km north of Cativá, Prov. of Colón, Panama.
965. Gatun Fm., river bank just below spillway at Gatun Lock, Panama Canal, to the southwest of the lock (= Woodring loc. no. 160, 160a), Canal Zone.
967. Río Banano Fm., Río Banano, south bank, just above railroad bridge at La Bomba, Limón Province, Costa Rica.
973. Bermont Fm., spoil banks on canal L-38W, 0.8 mile south of Terrytown (which is at Broward-Palm Beach county line), on U.S. Highway 27, Broward Co., Florida.
974. Caloosahatchee Fm. and Bermont Fm. mixed, north side Caloosahatchee River, 2 1/2 to 3 1/2 miles west of center of former Lake Hicpochee (now drained) (unmapped area, T42S, R32E), Glades Co., Florida.
975. Caloosahatchee Fm., spoil banks north side Caloosahatchee River, 0 to 1/2 mile west of center of former Lake Hicpochee (now drained) (unmapped area, T42S, R32E), Glades Co., Florida.
977. Unnamed post-Pleistocene formation, Mudlump no. 90, mouth of South Pass, Mississippi River delta, Plaquemines Parish, Louisiana.
978. Bermont Fm., spoil banks at pit on south side of waterworks, about 1 1/2 miles northeast of South Bay, Palm Beach Co., Florida.
980. Pinecrest Beds, Port Charlotte Development, spoil banks on north side U.S. Highway 41, on canal 3.3 miles northwest of Florida Highway 771 (Sec. 3, T40S, R21E), Charlotte Co., Florida.
982. Pinecrest Beds, Port Charlotte Development, spoil banks on northwest side of Florida Highway 771, on canal 3 1/2 miles southwest of junction with U.S. Highway 41 (Sec. 15, T40S, R21E), Charlotte Co., Florida.
985. Pinecrest Beds, Port Charlotte Development, spoil banks about 1/2 mile northeast of Florida Highway 771, on U-shaped canal 3.3 miles southwest of junction of U.S. Highway 41 (Sec. 10, T40S, R21E), Charlotte Co., Florida.
990. Anastasia Fm., Powell rock pit, west of Florida Highway 7, between Lake Worth and Lantana, Palm Beach Co., Florida.
991. Caloosahatchee Fm., Cochran rock pit, 2 1/2 miles west of La Belle, on north side of Florida Highway 80, Hendry Co., Florida.
998. Chipola Fm., Tenmile Creek, about 1 1/4 miles west of Chipola River (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.
999. Chipola Fm., Farley Creek, about 300 yards downstream from bridge of Florida Highway 275 (SW 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.
1000. Pinecrest Beds, APAC pits at east end of 17th street about 8 miles east of U.S. Highway 301 [now northwest of Fruitville Rd. exit, I-75] at Sarasota, (T36S, R19E), Sarasota Co., Florida.
1020. Chipola Fm., small tributary (not shown on USGS topographic map) on east bank of Chipola River about 1/2 mile below power line crossing (NE 1/4 Sec. 20, T1N, R9W), Calhoun Co., Florida.
1021. Chipola Fm., Tenmile Creek, about 2200 feet east of bridge on Florida Highway 73 (NW 1/4 Sec. 12, T1N, R9W), Calhoun Co., Florida.
1023. Caloosahatchee Fm. and Bermont Fm. mixed, pits on U.S. Highway 441, at inter-

section of Florida Highway 717, about one mile east of Pahokee, Palm Beach Co., Florida.

1028. Concepcion Inferior Fm., roadcut on east side Nueva Teapa-Ixhuatlan road 1.6 km south of junction with Mexico Highway 180, Veracruz, Mexico.

1044. Pinecrest Beds, spoil banks, west side of L-28 Interceptor Canal, 3 1/2 miles north of junction with Hendry County Highway 833, north side of Big Cypress Indian Reservation (T47S, R33E), Hendry Co., Florida.

1046. Agueguexquite Fm., roadcuts on both sides of Mexico Highway 180, 12 km east of junction with side road into Coatzacoalcos, Veracruz, Mexico. (This locality is that described in Perrilliat Montoya, 1960, p. 5).

1048. Chipola Fm., Farley Creek, about 0.8 mile east of bridge of Florida Highway 275 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

1050. Chipola Fm., west bank of Chipola River immediately below power line crossing, and directly across river from loc. TU 554 (SW 1/4 Sec. 17, T1N, R9W), Calhoun Co., Florida.

1051. Chipola Fm., Tenmile Creek, just downstream from large gully on property of Mr. A. Sexton (1967) (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

1097. Chipola Fm., Tenmile Creek, recently [1972] cut-off meander, 500 yards east of Florida Highway 73 (NW 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

1098. Chipola Fm., Tenmile Creek, just below power line crossing (and just below TU 830) (SE 1/4 Sec. 12, T1N, R10W), Calhoun Co., Florida.

1099. Danville Landing Beds, Danville Landing, west bank Ouachita River, 1 1/2 miles upstream from Duty Ferry (NE 1/4 Sec. 22, T11N, R5E) (mile 82.2 on river markers), Catahoula Parish, Louisiana.

1173. Danville Landing Beds, head of large gully running into Ouachita River, due east of Copenhagen, which is about 5 miles airline south-east of Columbia (NE 1/4 Sec. 14, T12N, R4E), Caldwell Parish, Louisiana.

1174. Caloosahatchee Fm., spoil banks along canals north of Florida Highway 858, 1.3 miles east of junction with Florida Highway 846 (SE 1/4 Sec. 13, T48S, R27E), east of Naples and south of Immokalee, Collier Co., Florida.

1175. Pinecrest Beds and Caloosahatchee Fm. mixed, spoil banks along canals south of Florida Highway 858, 2 miles east of junction with Florida Highway 846 (SE 1/4 Sec. 24, T48S, R27E), east of Naples and south of Immokalee, Collier Co., Florida.

1177. Pinecrest Beds and Caloosahatchee Fm. mixed, Mule Pen Quarry, north side of Florida Highway 846, 9.1 miles east of U.S. 41 at Naples Park (SE 1/4 Sec. 24, T48S, R26E), Collier Co., Florida.

1196. Chipola Fm., Farley Creek, about 0.8 mile east of bridge on Florida Highway 275, approximately 500 feet upstream from TU 1048 (NE 1/4 Sec. 21, T1N, R9W), Calhoun Co., Florida.

1203. Byram Fm., quarry of Mississippi Valley Portland Cement Co., on east side of Mississippi Highway 3, 2.8 miles north of junction with U.S. Highway 61 at Redwood, Warren Co., Mississippi.

1211. Gurabo Fm., Rio Gurabo, west bank, second bluff below the ford on Los Quemados-Sabaneta road, Dominican Republic.

1215. Gurabo Fm., Rio Gurabo, bluffs on both sides, from the ford on Los Quemados-Sabaneta road, upstream to approximately 1 km above the ford, Dominican Republic.

1219. Gurabo Fm., Rio Amina, bluffs on east side of river immediately upstream from ford that is 2 km west of Potrero and about 3 km downstream from "La Represa," Dominican Republic.

1227. Gurabo Fm., Arroyo Zalaya, which crosses road to Jánico from Santiago de los Caballeros, 11 km south of bridge over Rio Yaque del Norte at Santiago, Dominican Republic.

1230. Cercado Fm., Rio Cana, east bank, just above the bridge at Caimito on Los Quemados-Sabaneta road, Dominican Republic.

1239. Moín Fm., hill cut above Standard Fruit Co. box factory at Pueblo Nuevo (same as TU 954 but stratigraphically about 10 m higher – above coral horizon), Puerto Limón, Costa Rica.

1240. Moín Fm., Barrio Los Corales, top of hill at end of road that passes Standard Fruit Co. box factory (see TU 954), 1.8 km north of main highway at Pueblo Nuevo, which is 2 km west of Puerto Limón, Costa Rica.

1241. Rio Banano Fm., Quebrada Chocolate, 6.6 km west of junction of Costa Rica Highway 32 (to San Jose) and Aeropuerto Rd. at southwest edge of Puerto Limón, Costa Rica.

1250. Gurabo Fm., Rio Verde, south bank, just above the ford at the crossing of a side road that connects Duarte Highway and La Vega-Moca Highway, about 10 km north of La Vega, Dominican Republic.

1258. Weches Fm., west side of spillway and dam of Lake Nacagdoches, on north side of Texas Highway FM 225, 10 miles west of Bypass 224, west of Nacogdoches, Nacogdoches Co., Texas.

1269. Cantaure Fm., series of arroyos about 500 m south of "Casa Cantaure" [which is literally one house and which is about 400 m south of older, now abandoned, house that was the "Casa Cantaure" of Jung, 1965, and others], 14 km (by road) west of Pueblo Nuevo, Paraguaná Peninsula, Venezuela.
1288. Red Bluff Fm., type locality, east bank Chickasawhay River, about 1 1/2 miles south of Shubuta (NE 1/4 Sec. 16, T10N, R7W), Wayne Co., Mississippi.
1289. Red Bluff Fm., east bank Chickasawhay River, about 3/4 mile south of Hiwannee (SW 1/4 Sec. 28, T10N, R7W), Wayne Co., Mississippi.
1290. Red Bluff Fm., "Carson Sand Creek", at crossing of county road 1 1/2 miles east of Hiwannee (SW 1/4 Sec. 26, T10N, R7W) [possibly Aldrich's Carson Creek loc.], Wayne Co., Mississippi.
1293. Gurabo Fm., Rio Mao, west bank, bluff just below Paso Chorrera, or about 12 km (by road) south of Mao, Dominican Republic.
1307. Moín Fm., hilltop approximately halfway between Puerto Limón and Barrio Los Corales, 0.5 km north of Highway (C.R. 32) at Pueblo Nuevo, Costa Rica.
1321. Concepcion Inferior Fm., "Kilometer 70" (of Toula, 1911), which is K 70 on Trans-Isthmus railroad south of Coatzacoalcos, K 70 is 5 km north of Almagres, Veracruz, Mexico.
1347. Agueguexquite Fm., pipeline cut, which parallels Mexico Highway 180, 12 km miles east of junction with side road into Coatzacoalcos, Veracruz, Mexico (due north of TU 1046).
1349. Pinecrest Beds, Proctor road-metal pit, off I-75, south of Sarasota, (Sec. 7, T37S, R18E), Sarasota Co., Florida.
1352. Mao Fm., Rio Gurabo, east bank at first bluff above ford that is approximately 1 km south of Gurabo Afuero, Dominican Republic.
1354. Gurabo Fm., Cañada de Zamba, a tributary on the west side of the Rio Cana, approximately 2.5 km east of the village of Zamba, which is 7 km north of Cruz de Santiago (Santiago Rodriguez), on road to Guayubin; or 4.5 km (airline) below the ford at Caimito, Dominican Republic.
1364. Baitoa Fm., Boca de los Rios, below the waterfall in Arroyo Hondo, which enters Rio Yaque del Norte from the east, just below the confluence with Rio Bao, downstream from Baitoa, Dominican Republic.
1366. Mao Fm., Rio Gurabo, west bank, aproximately 4.5 km (airline) below the ford on Los Quemados-Sabaneta road, Dominican Republic.
1397. Esmeraldas Beds, Quebrada Camarones, cut-bank on east side of canyon, which is at east edge of village of Camarones, 20 km (by road) east of bridge over Rio Esmeraldas, at Esmeraldas, or approximatley 10 km east of mouth of Rio Esmeraldas, Prov. of Esmeraldas, Ecuador.
1398. Esmeraldas Beds, roadcut at mouth of Quebrada Camarones, east side of bridge at village of Camarones, which is 20 km (by road) east of bridge over Rio Esmeraldas, at Esmeraldas, Prov. of Esmeraldas, Ecuador.
1399. Esmeraldas Beds, roadcut on west side of village of Camarones, which is 20 km (by road) east of bridge over Rio Esmeraldas, at Esmeraldas, Prov. of Esmeraldas, Ecuador.
1422. Cercado Fm., Arroyo Bellaco (or Beyaco on topographic maps), which is a tributary of Rio Cana from the east, coral reef that is exposed for approximately 1 km below the ford at Las Caobas Adentro, 3 km southwest of Las Caobas, Dominican Republic.
1431. Gatun Fm., hilltop construction site, 0.5 km northwest of intersection of Boyd-Roosevelt Highway and road to Puerto Pilon, at Sabanita, Prov. of Colón, Panama.
1432. Gatun Fm., north side Boyd-Roosevelt Highway, clearing behind Residential Martin Luther King (formerly Palo Quemado) approximately 1.5 km east of junction of road to Refinería Panamá, S.A., at Cativá, Prov. of Colón, Panama.
1433. Gatun Fm., north side Boyd-Roosevelt Highway, clearing behind Urbanization San Martin, approximately 0.5 km east of junction of road to Refinería Panamá, S.A., at Cativá, Prov. of Colón, Panama.
1458. Mint Springs Fm., stream-bed on Andrew W. Rees farm, north of Cleary, Rankin Co., Mississippi.
1460. Byram Fm., stream-bed north side of West Tallahatta Creek, east of first bridge on road south from Sylvarena, Smith Co., Mississippi.
1491. Pinecrest Beds, North Ft. Meyers, pits open during construction of Cape Coral, northwest of intersection of U.S. Highway 41 and Florida Highway 78, Lee Co., Florida.
1492. Caloosahatchee Fm., approximately 4 miles southeast of Clewiston (1 mile east and 3 miles south on road to U. S. Sugar Co. mill), Palm Beach Co., Florida.
1493. Pinecrest Beds, Arvita Pit, on Bird Road (= W. 40th St.), approximately 5 miles west of Florida Turnpike, on west side of Coral Gables, Dade Co., Florida.
1495. Moín Fm., north side San Jose-Puerto

Limón Highway (C.R. 32), 1 km east of old road to Moín, or 4.7 km west of junction with highway to Cahuita (C.R. 36), at Puerto Limón, Costa Rica.

1496. Moín Fm., north side of San Jose-Puerto Limón Highway (C.R. 32), 2 km east of old road to Moín, or 3.7 km west of junction with highway to Cahuita (C.R. 36), at Puerto Limón, Costa Rica.

1507. Angostura Fm., large point just east of Rio Verde, or approximately 30 km east of Rio Esmeraldas, Prov. of Esmeraldas, Ecuador.

1511. Cook Mountain Fm., roadcut on north side Louisiana Highway 155, 2.5 miles west of Quitman (Sec. 27, T16N, R4W), Bienville Parish, Louisiana.

1512. Caloosahatchee Fm. and Bermont Fm. mixed, DeSoto Mining Company, pits 2 miles east of Florida Highway 31, about 12 miles south of Arcadia (T39S, R25E), DeSoto Co., Florida.

1514. Concepcion Inferior Fm., roadcut 0.8 km south of junction of old Mexico Highway 180 (now side road to old bridge at Coatzacoalcos; junction is 7.3 km east of old bridge), and new bypass, Veracruz, Mexico.

1515. Concepcion Inferior Fm., roadcut just south of intersection of old Mexico Highway 180 (now side road into Coatzacoalcos; junction is 7.3 km east of old bridge), and new bypass, Veracruz, Mexico.

1524. Pinecrest Beds, Quality Aggregate Pit, off Richardson Road, north side of Fruitville Road and east of highway I-75, east of Sarasota, Sarasota Co., Florida.

1527. Weches Fm., roadcut on west side of U.S. Highway 259, 3.2 miles north of overpass over U.S. Highway 59, north of Nacogdoches, Nacogdoches Co., Texas.

The following are Tulane University Recent locality numbers:

R-42. Anna Maria Key, off Sarasota, Florida; dredged in approximately 46 m, by James Moore, Bradenton, Florida.

R-60. Steel pilings, "Texas Tower - Stage I", 12 miles off Panama City, Bay Co., Florida; 17 fms (31 m).

R-101. Off Holandes Cay, east of Cape San Blas, Panama; dredged in 42-51 m (23-28 fm), *Anton Bruun* Cruise 10.

R-109. Bahia de las Minas, Isla Payardi, Prov. of Colon, Panama (7000 YBP).

R-503. Roatan Island, south side of Oak Ridge, Islas de la Bahia (Bay Islands), Honduras.

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VIII. APPENDIX I: ALPHABETICAL LIST OF SPECIES INCLUDED IN THIS PART

The following list includes all species treated systematically, as well as certain synonyms not repeated from previous parts. Thus, this is a complete list of names for all western Atlantic species, fossil and Recent, valid or invalid, referred to the genera *Murex* s.s., *Haustellum, Chicoreus,* or *Hexaplex.*

All species were originally named as "*Murex*" unless otherwise noted in brackets following the name. Those species names in ALL CAPS are new taxa described herein. The generic assignment that follows the name of the author is that one to which the species is referred in this paper. Those names without a generic assignment are considered synonyms of some other species.

adelosus Vokes, 1989. ?HAUSTELLUM

aguayoi Clench and Pérez Farfante, 1945. CHICOREUS (SIRATUS)

aldrichi Gardner, 1947. CHICOREUS (PHYLLONOTUS)

amplius [Chicoreus] Vokes, 1989. CHICOREUS (SIRATUS)

anniae M. Smith, 1940. HAUSTELLUM

antillarum Hinds, 1844. ? = *articulatus*

antillarum Gabb, 1873. = *yaquensis*

approximatus Sowerby, 1879. = *brevifrons*

arenarius Clench and Pérez Farfante, 1945. = *dilectus.*

argo Clench and Pérez Farfante, 1945. = *spectrum*

articulatus Reeve, 1845. CHICOREUS (SIRATUS)

beauii Fischer and Bernardi, 1857. CHICOREUS (SIRATUS)

bellegladeensis Vokes, 1963. HAUSTELLUM

bellus Reeve, 1845. ? = *chrysostoma*

blakeanus Vokes, 1967. HAUSTELLUM

branchi Clench, 1953. = *beauii*

brasiliensis Sowerby, 1834. = *senegalensis*

brevifrons Lamarck, 1822. CHICOREUS s.s.

briskasii Verrill, 1953. = *motacilla*

bullisi [Chicoreus] Vokes, 1974. CHICOREUS s.s.

burryi Clench and Pérez Farfante, 1945. = *fulvescens*

cabritii Bernardi, 1859. HAUSTELLUM

cailleti Petit, 1856. CHICOREUS (SIRATUS)

calcar Kiener, 1842. = *tenuivaricosus*

calcitrapa Lamarck, 1822. = *brevifrons*

carioca [Chicoreus] Vokes, 1968. = *tenuivaricosus*

carolynae [Chicoreus] Vokes, 1990. CHICOREUS (SIRATUS)

chipolanus Dall, 1890. CHICOREUS (SIRATUS)

chrysostoma Sowerby, 1834. HAUSTELLUM

ciboney Clench and Pérez Farfante, 1945. CHICOREUS (SIRATUS)

citrinus M. Smith, 1940. = *rubidus*

sp. cf. *clausii* Dunker, 1879. CHICOREUS s.s.

colei Palmer, 1937. HEXAPLEX

coltrorum [Chicoreus] Vokes, 1990. CHICOREUS (SIRATUS)

compactus Gabb, 1873. CHICOREUS (NAQUETIA)

consuela Verrill, 1950. CHICOREUS (SIRATUS)

cornurectus Guppy, 1876. CHICOREUS s.s.
corrigendum [Chicoreus] Vokes, 1989. CHICOREUS s.s.
cosmani [Chicoreus] Abbott and Finlay, 1979. CHICOREUS s.s.
costatus Gmelin, 1791. = *senegalensis*
cracherodi Sowerby, 1879. = *rubidus*
dasus Gardner, 1947. = *gilli*
davisi Richards, 1943. CHICOREUS (PHYLLONOTUS)
delicatus M. Smith, 1940. = *rubidus*
denegatus Jung, 1966. CHICOREUS (SIRATUS)
dilectus A. Adams, 1855. CHICOREUS s.s.
domingensis Sowerby, 1850. CHICOREUS (SIRATUS)
donmoorei Bullis, 1964. HAUSTELLUM
dormani Vokes, 1963. CHICOREUS (PHYLLONOTUS)
dujardinoides Vokes, 1963. CHICOREUS s.s.
dunni [Chicoreus] Petuch, 1987. CHICOREUS s.s.
elegans Beck *in* Sowerby, 1841. = *perelegans*
elusivus [Chicoreus] Vokes, 1974. CHICOREUS s.s.
emilyae [Chicoreus] Petuch, 1987. = *florifer*
engonatus Conrad, 1833. HEXAPLEX
enigmaticus [Chicoreus] Vokes, 1989. CHICOREUS s.s.
etheringtoni [Hexaplex] Vokes, 1968. HEXAPLEX
eumekes [Chicoreus] Vokes, 1989. CHICOREUS (SIRATUS)
finlayi Clench, 1955. = *articulatus*
floridanus [Chicoreus] Vokes, 1965. CHICOREUS s.s.
florifer Reeve, 1846. CHICOREUS s.s.
folidodes Gardner, 1947. CHICOREUS (PHYLLONOTUS)
formosus Sowerby, 1841. CHICOREUS (SIRATUS)
fulvescens Sowerby, 1834. HEXAPLEX
funiculatus Reeve, 1845. = *messorius*
garciai Petuch, 1987. = *messorius*
gardnerae [Alectrion] Dall, 1915. = *trophoniformis*
gardnerae Vokes, 1963. = *juliagardnerae*
gilli [Fusus] Maury, 1910. HAUSTELLUM
globosus Emmons, 1858. CHICOREUS (PHYLLONOTUS)
gosportensis Aldrich *in* Palmer, 1937. = *engonatus*
gundlachi Dunker, 1883. = *articulatus*
gustaviensis Nowell-Usticke, 1969. = *messorius*
HABROS *[Chicoreus]* Vokes. CHICOREUS (SIRATUS)
hertweckorum [Muricanthus] Petuch, 1988. HEXAPLEX
imbricatus Higgins and Marrat, 1877. = *spectrum*
imperialis Swainson, 1831. = *margaritensis*
incertum Nowell-Usticke, 1969. = *brevifrons*
infrequens Vokes, 1963. CHICOREUS (PHYLLONOTUS)
INITIALIS *[Chicoreus]* Vokes. CHICOREUS (PHYLLONOTUS)
ISTHMICUS *[Hexaplex]* Vokes. HEXAPLEX
juliagardnerae [Chicoreus] Vokes, 1970. CHICOREUS (SIRATUS)
JUNGI *[Chicoreus]* Vokes. CHICOREUS s.s.
katherinae [Hexaplex] Vokes, 1968. HEXAPLEX
kugleri Clench and Pérez Farfante, 1945. = *cailleti*
leonensis [Chicoreus] Vokes, 1967. CHICOREUS (PHYLLONOTUS)
lepidotus Vokes, 1963. CHICOREUS s.s.
LOUISAE *[Chicoreus]* Vokes. CHICOREUS (PHYLLONOTUS)
lindajoyceae Petuch, 1987. = *anniae*
maculatus Verrill, 1950. MUREX s.s.
marcoensis Sowerby, 1900. = *rubidus*
margaritensis Abbott, 1958. CHICOREUS (PHYLLONOTUS)
marksi Harris, 1894. HEXAPLEX
mergus [Chicoreus] Vokes, 1974. CHICOREUS s.s.
messorius Sowerby, 1841. HAUSTELLUM
mexicanus Petit, 1852. = *pomum*
migus de Gregorio, 1890. = *stetopus*
millvillensis Richards and Harbison, 1942. CHICOREUS (PHYLLONOTUS)
MILTOS *[Chicoreus]* Vokes. CHICOREUS (SIRATUS)
MIMIWILSONI *[Haustellum]* Vokes. HAUSTELLUM
mississippiensis Conrad, 1848. CHICOREUS (PHYLLONOTUS)
motacilla Gmelin, 1791. CHICOREUS (SIRATUS)
nicholsi Gardner, 1947. CHICOREUS (SIRATUS)
nigrescens Sowerby, 1841. = *messorius*
nodatus Reeve, 1845. = *articulatus*
oculatus Reeve, 1845. CHICOREUS (PHYLLONOTUS)
olssoni Vokes, 1967. HAUSTELLUM
pennae Maury, 1925. HAUSTELLUM
percoides Loebbecke, 1879. = *beauii*
perelegans [Chicoreus] Vokes, 1965. CHICOREUS (SIRATUS)
polynematicus Brown and Pilsbry, 1911. HAUSTELLUM
pomiformis Mörch, 1852. = *pomum*
pomatus [Chicoreus] Vokes, 1989. CHICOREUS s.s.
pudoricolor Reeve, 1845. ? = *cosmani*
pulcher A. Adams, 1853. = *consuela*
purpuratus Reeve, 1846. = *brevifrons*
pyknos Gardner, 1947. CHICOREUS (PHYLLONOTUS)

quirosensis F. Hodson, 1931. CHICOREUS (SIRATUS)

rachelcarsonae [Chicoreus] Petuch, 1987. = *dilectus*
reevei [Chicoreus] Vokes, 1965. = *ciboney*
riparius Vokes, 1963. CHICOREUS (PHYLLONOTUS)
rubidus Baker, 1897. HAUSTELLUM
rufus Lamarck, 1822. = *florifer*

sallasi Rehder and Abbott, 1951. HAUSTELLUM
salleanus A. Adams, 1854. ? = *florifer*
samui Petuch, 1987. = *messorius*
senegalensis Gmelin, 1791. CHICOREUS (SIRATUS)
septemnarius Conrad, 1834. ? = *vanuxemi*
sexangulus [Fusus] Conrad, 1834. = *engonatus*
sexcostata Emmons, 1858. = *floridanus*
SEXTONI *[Chicoreus]* Vokes. CHICOREUS (SIRATUS)
shirleyae [Chicoreus] Vokes, 1966. CHICOREUS s.s.
similis Sowerby, 1841. = *cailleti*
sirat d'Orbigny, 1841. = *senegalensis*
spectrum Reeve, 1846. CHICOREUS s.s.
spinicosta Kiener, 1842. = *fulvescens*
spinicostata Reeve, 1845. = *fulvescens*
springeri Bullis, 1964. CHICOREUS (SIRATUS)
stetopus de Gregorio, 1890. CHICOREUS (SIRATUS)
strausi Verrill, 1950. HEXAPLEX
sunderlandi Petuch, 1987. ? = *tryoni*
supernus Palmer, 1937. HEXAPLEX
surinamensis Okutani, 1982. MUREX s.s.
sutilis White, 1887. = *messorius*

teruivaricosus Dautzenberg, 1927. CHICOREUS (SIRATUS)
texanus [Hexaplex] Vokes, 1968. HEXAPLEX
thompsoni Bullis, 1964. CHICOREUS (SIRATUS)
tingarus de Gregorio, 1890. = *stetopus*
toreia Maury, 1925. ? = *yaquensis*
toupiollei Bernardi, 1860. = *brevifrons*
triangularis Jung, 1965. = *denegatus*
trilineatus Reeve, 1845. = *ciboney*
tritonopsis Heilprin, 1886. CHICOREUS (PHYLLONTOUS)
trophoniformis Heilprin, 1886. CHICOREUS (PHYLLONOTUS)
tryoni Hidalgo *in* Tryon, 1880. HAUSTELLUM
vanuxemi Conrad, 1865. HEXAPLEX
veatchi Maury, 1910. HEXAPLEX
venezuelanus F. Hodson, 1931. CHICOREUS s.s.
VERONICA *[Chicoreus]* Vokes. CHICOREUS s.s.
woodringi Clench and Pérez Farfante, 1945. = *messorius*
xestos [Chicoreus] Vokes, 1974. CHICOREUS s.s.
yaquensis Maury, 1917. CHICOREUS (SIRATUS)
yumurinus Sarasúa and Espinosa, 1978. = *ciboney*

IX. APPENDIX II: STRATIGRAPHICAL LIST OF SPECIES INCLUDED IN THIS PART

The following list is arranged in approximately ascending stratigraphical order, with all of the species recognized as occurring in each formation.

MIDDLE EOCENE
Weches Formation, Texas
Chicoreus (Phyllonotus) initialis, n. sp.
Hexaplex texanus
Hexaplex colei
Stone City Beds
Chicoreus (Phyllonotus) initialis, n. sp.
Hexaplex colei
Cook Mountain Formation, Louisiana, Texas (= Crockett Formation), and Mississippi (= Wautubbee Formation); Lisbon Formation and Gosport Sand, Alabama.
Hexaplex vanuxemi
Hexaplex engonatus
Yegua Formation, Texas
Hexaplex vanuxemi
McBean Formation, South Carolina
Hexaplex colei

LATE EOCENE
Moodys Branch Formation, Louisiana and Mississippi
Hexaplex marksi
Hexaplex supernus
Hexaplex katherinae
Danville Landing Member, Yazoo Formation, Louisiana
Hexaplex katherinae
Hexaplex supernus
Whites Bluff Formation, Arkansas
Hexaplex marksi

EARLY AND MIDDLE OLIGOCENE
Red Bluff Formation, Mississippi
Chicoreus (Siratus) stetopus
Chicoreus (Phyllonotus) mississippiensis
Mint Springs Formation, Mississippi
Chicoreus (Siratus) stetopus
Chicoreus (Phyllonotus) mississippiensis
Bryam Formation, Mississippi
Chicoreus (Phyllonotus) mississippiensis
Chicoreus (Phyllonotus) dormani

LATE OLIGOCENE - EARLY MIOCENE
Tampa Limestone, Florida
Chicoreus (Phyllonotus) trophoniformis
Chicoreus (Phyllonotus) tritonopsis
Hexaplex veatchi
Silverdale Beds, North Carolina
Chicoreus (Phyllonotus) davisi

(?) EARLY MIOCENE
Pirabas Limestone, Brazil
Haustellum messorius
Haustellum pennae
Chicoreus (Chicoreus) cornurectus
(?) *Chicoreus (Siratus) sextoni*, n. sp.
(?) *Chicoreus (Siratus) yaquensis* (as *toreia*)

LATE EARLY MIOCENE
Cantaure Formation, Venezuela
Haustellum gilli
Chicoreus (Chicoreus) corrigendum
Chicoreus (Chicoreus) cornurectus
Chicoreus (Siratus) denegatus
Chicoreus (Siratus) quirosensis
La Rosa Formation, Venezuela
Chicoreus (Siratus) quirosensis
Baitoa Formation, Dominican Republic
Haustellum messorius
(?) *Chicoreus (Chicoreus) dujardinoides*
Chicoreus (Chicoreus) corrigendum
Chicoreus (Chicoreus) cornurectus
Chicoreus (Phyllonotus) infrequens
Chipola Formation/Oak Grove Sand, Florida
Haustellum gilli
Chicoreus (Chicoreus) lepidotus
Chicoreus (Chicoreus) dujardinoides
Chicoreus (Chicoreus) elusivus
Chicoreus (Siratus) chipolanus
Chicoreus (Siratus) juliagardnerae
Chicoreus (Siratus) sextoni, n. sp.
Chicoreus (Phyllonotus) louisae, n. sp.
Chicoreus (Phyllonotus) infrequens
Chicoreus (Phyllonotus) folidodes
Hexaplex veatchi

MIDDLE MIOCENE
Thomonde Formation, Haiti
Haustellum messorius
Chicoreus (Phyllonotus) aldrichi
Las Cahobas Formation, Dominican Republic
Haustellum messorius
Kirkwood Formation, New Jersey
Chicoreus (Phyllonotus) millvillensis
Grand Bay Formation, Carriacou, W. I.
Chicoreus (Chicoreus) jungi, n. sp.
Shoal River Formation, Florida
Chicoreus (Chicoreus) brevifrons
Chicoreus (Siratus) nicholsi
Chicoreus (Phyllonotus) aldrichi
Chicoreus (Phyllonotus) pyknos
Encanto Formation, Mexico
Haustellum messorius
Chicoreus (Chicoreus) brevifrons

LATE MIOCENE
Cercado Formation, Dominican Republic
Haustellum messorius
Haustellum pennae
?*Haustellum adelosus*
Chicoreus (Chicoreus) enigmaticus
Chicoreus (Chicoreus) cornurectus
Chicoreus (Phyllonotus) pomatus
Chicoreus (Naquetia) compactus
(?) Medias Aguas Beds, Mexico
Chicoreus (Siratus) domingensis
Chicoreus (Siratus) articulatus
Angostura Formation, Ecuador and Columbia [East Pacific]
Haustellum polynematicus

PLIOCENE
Melajo Clay, Trinidad
Haustellum chrysostoma
Chicoreus (Chicoreus) cornurectus
Courbaril Beds, Trinidad
Chicoreus (Chicoreus) cornurectus
Punta Gavilan Formation, Venezuela
Haustellum donmoorei
Chicoreus (Chicoreus) brevifrons
Chicoreus (Siratus) domingensis
Urumaco Formation, Venezuela
Chicoreus (Chicoreus) venezuelanus
Gatun Formation, Panama
Haustellum messorius
Haustellum polynematicus
Chicoreus (Chicoreus) cornurectus
Chicoreus (Chicoreus) venezuelanus
Chicoreus (Siratus) formosus
Chicoreus (Phyllonotus) globosus
Hexaplex isthmicus, n. sp.
Esmeraldas Beds, Ecuador [East Pacific]
Haustellum polynematicus
Chicoreus (Phyllonotus) globosus
Hexaplex hertweckorum
Bahía Formation, Ecuador [East Pacific]
Haustellum chrysostoma
Río Banano Formation, Costa Rica
Haustellum messorius
Haustellum mimiwilsoni, n. sp.
Chicoreus (Chicoreus) venezuelanus
Gurabo Formation, Dominican Republic
Haustellum messorius
Haustellum pennae
?*Haustellum adelosus*
Chicoreus (Chicoreus) cosmani
Chicoreus (Chicoreus) cornurectus
Chicoreus (Siratus) amplius
Chicoreus (Siratus) eumekes
Chicoreus (Siratus) yaquensis
Chicoreus (Siratus) domingensis
Chicoreus (Phyllonotus) pomatus
Chicoreus (Naquetia) compactus
Mao Formation, Dominican Republic
Haustellum messorius
Chicoreus (Chicoreus) cornurectus

Chicoreus (Chicoreus) sp. cf. *clausii*
Chicoreus (Siratus) formosus
Chicoreus (Siratus) articulatus
Chicoreus (Phyllonotus) pomum

Unnamed Mao Formation equivalent, Haiti
Chicoreus (Siratus) articulatus
Chicoreus (Siratus) ciboney

Quebradillas Limestone, Puerto Rico
Haustellum messorius
(?) *Chicoreus (Chicoreus) cornurectus*

Concepcion Inferior Formation, Mexico
Chicoreus (Siratus) miltos, n. sp.

Agueguexquite Formation, Mexico
Haustellum bellegladeensis
Chicoreus (Chicoreus) dilectus
Chicoreus (Chicoreus) veronica, n. sp.
Chicoreus (Siratus) habros, n. sp.
(?) *Chicoreus (Phyllonotus) pomum*

Pinecrest Beds, Florida
Haustellum rubidus
Chicoreus (Chicoreus) xestos
Chicoreus (Chicoreus) shirleyae
Chicoreus (Chicoreus) floridanus
Chicoreus (Phyllonotus) riparius
Chicoreus (Phyllonotus) leonensis
Chicoreus (Phyllonotus) globosus
Hexaplex hertweckorum

Jackson Bluff Formation, Florida
Chicoreus (Chicoreus) floridanus
Chicoreus (Phyllonotus) riparius
Chicoreus (Phyllonotus) leonensis

Imperial Formation, California [East Pacific]
(?) *Chicoreus (Phyllonotus) globosus*

PLIO-PLEISTOCENE

Tubará Group, Colombia
Haustellum messorius
Haustellum olssoni
Chicoreus (Chicoreus) brevifrons
Hexaplex etheringtoni

Cumaná Formation, Venezuela
Haustellum messorius
Haustellum chrysostoma
Haustellum mimiwilsoni, n. sp.
Chicoreus (Phyllonotus) globosus
Chicoreus (Phyllonotus) margaritensis

Mare Formation, Venezuela
Haustellum chrysostoma
Haustellum donmoorei
Chicoreus (Chicoreus) brevifrons
Chicoreus (Phyllonotus) pomum

Bowden Formation, Jamaica
Haustellum messorius
Chicoreus (Siratus) domingensis
Chicoreus (Siratus) formosus
Chicoreus (Siratus) articulatus
Chicoreus (Phyllonotus) pomum

Caloosahatchee Formation, Florida
Haustellum rubidus
Haustellum bellegladeensis (rare)
Chicoreus (Chicoreus) floridanus
Chicoreus (Phyllonotus) globosus
Chicoreus (Phyllonotus) pomum

Waccamaw Formation, North and South Carolina
Chicoreus (Chicoreus) floridanus
Chicoreus (Phyllonotus) globosus

PLEISTOCENE

Unnamed formation, Barbados
Haustellum messorius
Chicoreus (Chicoreus) brevifrons

Moín Formation, Costa Rica
Haustellum rubidus
Haustellum olssoni
Haustellum cabritii
Chicoreus (Chicoreus) prolixus
Chicoreus (Siratus) consuela
Chicoreus (Siratus) springeri
Chicoreus (Phyllonotus) pomum

Bermont Formation, Florida
Haustellum rubidus
Haustellum anniae
Haustellum bellegladeensis
Chicoreus (Chicoreus) dilectus
Chicoreus (Phyllonotus) pomum

Late Pleistocene formations, Florida
Chicoreus (Chicoreus) dilectus
Chicoreus (Phyllonotus) pomum
Hexaplex fulvescens

RECENT [West Atlantic]

(?) *Murex (Murex) surinamensis, maculatus*

Haustellum messorius, chrysostoma, rubidus, donmoorei, olssoni, anniae, bellegladeensis, sallasi, cabritii, blakeanus, tryoni (+ sunderlandi)

Chicoreus (Chicoreus) cosmani, dilectus, florifer, dunni, mergus, bullisi, brevifrons, spectrum

Chicoreus (Siratus) consuela, coltrorum, ciboney, formosus, articulatus, springeri, thompsoni, beauii, senegalensis, tenuivaricosus, motacilla, cailleti, perelegans, aguayoi, carolynae

Chicoreus (Phyllonotus) globosus, pomum, margaritensis, oculatus

Hexaplex fulvescens, ?strausi