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CENOZOIC MURICIDAE OF THE WESTERN ATLANTIC REGION PART V—*PTERYNOTUS* AND *POIRIERIA*

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ILLUSTRATIONS

I. ABSTRACT

This paper covers the two, closely related, most ancient muricine genera *Pterynotus*, including the subgenera *Pterochelus* and *Purpurellus*, and *Poirieria*, with the subgenera *Paziella*, *Flexopteron*, *Panamurex*, and a new subgenus *Pazinotus*, here named (type species: *"Eupleura" stimpsonii* Dall, 1889). In the New World *Pterynotus* and *Paziella* appear together in the Paleocene beds of Alabama; *Poirieria* s.s. first occurs in the lower Eocene of Alabama; *Pterochelus* and *Panamurex* are first seen in the Oligocene of Mississippi; and *Pazinotus* is first found in the (?) upper Miocene of Jamaica. All have at least one living representative in the Recent fauna of the western Atlantic region. *Flexopteron* first appears in the Oligocene of Germany and is represented in the New World by a single species from the (?) upper Miocene of Jamaica. There is no living representative of this subgenus. *Purpurellus* first occurs in the lower Miocene of North Carolina and is found in the Recent fauna only off the west coasts of Africa and tropical America.

A total of 42 species are treated systematically. These include twelve assigned to *Pterynotus* s.s., two to *Pterochelus* and one to *Purpurellus*. Two species are assigned to *Poirieria* s.s., seven to *Paziella*, one to *Flexopteron*, two to *Pazinotus*, and fifteen to *Panamurex*. Of the total number ten are new species: *Pterynotus* (*Pterynotus*) *stenzeli*, from the early middle Eocene of Texas; *Poirieria* (*Poirieria*) *woodsensis*, from the lower Eocene of Alabama; *Pterynotus* (*Purpurellus*) *repetiti* from the early lower Miocene of North Carolina; *Pterynotus* (*Pterynotus*) *hoerlei* and *Poirieria* (*Panamurex*) *mauryae*, from the (?) late lower Miocene of Florida; *Poirieria* (*Paziella*) *septima* and *Poirieria* (*Panamurex*) *dubitalis*, from the (?) upper Miocene of Mexico; *Poirieria* (*Pazinotus*) *bowdenensis*, from the (?) upper Miocene of Jamaica; *Poirieria* (*Panamurex*) *gabbi*, from the middle Miocene of the Dominican Republic; and *Poirieria* (*Panamurex*) *velero*, from the Recent off northern South America. In addition, four homonyms are renamed. These are: *Pterynotus* (*Pterynotus*) *havanensis*, for *Murex tristichus* Dall *non* Beyrich; *Pterynotus* (*Pterynotus*) *bushae*, for *Murex pygmaeus* Bush *non* Schlotheim; *Poirieria* (*Paziella*) *harrisi*, for *Murex morulus* Conrad *non* Schröter; and *Poirieria* (*Panamurex*) *macneili*, for *Murex simplex* Aldrich non Philippi.

II. Introduction

PTERYNOTUS: *Pterynotus* is one of the most ancient of the muricine genera. Together with *Poirieria* (*Paziella*) it appears in the Paleocene beds of Alabama. *Pterynotus* is a very conservative group and there has been little change from the Paleocene ancestor to the Recent species. The shell type with three wing-like varices was early recognized as a distinct unit and was among the first of the muricine subgenera to be separated. But there has been a great deal of confusion over which species should be included in the group. There are a number of species in the subfamily Ocenebrinae* that closely mimic the three-winged shape of *Pterynotus* and these almost invariably have been included even though they may be distinguished by the completely closed siphonal canal, by the purpuroid operculum, and by the different radular type. For the paleontologist these two latter characteristics are useless but the sealed canal is present in the fossils. The generic name *Pteropurpura* has been employed as a replacement name for the supposedly preoccupied *Pterynotus* but this name is for the alate members of the Ocenebrinae. The problems of synonymy in the name *Pteronotus* vs. *Pterynotus* has been discussed by several authors, including the writer (Vokes, 1964, p. 14) and most recently by Heppell (*in* Vokes, 1968b, p. 304). In addition to the substitute names proposed, there have been various genera erected that are not to be distinguished from the typical *Pterynotus*. The disposition of these names was covered by the writer in the above-mentioned work. One subgenus originally placed by her in the synonymy of *Pterynotus*, is not, however, to be included in that group. This is *Subpterynotus* Olsson and Harbison, which is now assigned to the genus *Murexiella* (Vokes, 1968a, p. 91).

The modern members of the genus *Pterynotus* are usually deep-water forms and are usually rare. Such is also the case in the fossil record, for although there are numerous species of *Pterynotus*, never are there more than a few specimens known, except during Eocene time when the *Pterynotus* group dominated the muricine world, especially in the Paris and London basins. In the New World they have never achieved a position of numerical importance.

PTEROCHELUS: The subgenus *Pterochelus* differs from *Pterynotus* s.s. in having a channeled spine at the shoulder, surrounded by the wing-like varix. The channel is almost closed in certain extreme species such as *P. angasi* (Crosse, 1863) and mimics the tube of the genus *Typhis*, but it usually remains open on the apertural side by a narrow slit. "*Typhis*" *zealandicus* Hutton, 1873, lacks the slit and also has the siphonal canal completely sealed in the typical typhine manner, but nevertheless seems to be a member of the *Pterochelus* group rather than the Typhinae. (It is not preoccupied by *Murex*

* Formerly Tritonaliinae, the International Commission on Zoological Nomenclature has ruled in Opinion 886 (Bull. Zool. Nomen., v. 26, pt. 3, p. 128, 1969) that the genus *Ocenebra* and subfamily Ocenebrinae are the names to be used for this group.

zelandicus Quoy and Gaimard, 1833, the type of *Poirieria.*) Morphologically this species seems more akin to the other members of *Pterochelus*, such as *P. angasi*, also originally named as *Typhis*, than to the members of *Tripterotyphis* Pilsbry and Lowe, 1932, the group of trivaricate typhines, which bear the tubes within the varix. (*Nothotyphis* Fleming, 1962, is considered a synonym of *Tripterotyphis.*) The shells referred to *Tripterotyphis* are all marked by a strongly cancellate surface unlike the smooth polished shells of *P. zealandicus* and *P. angasi.* The *Typhis*-like tube and closed anterior canal would seem to have arised by convergence, as suggested by Fleming (1962, p. 112). It is very possible that the Typhinae are polyphyletic and certain members of the subfamily are descended from a *Pterochelus* ancestor. As noted below under *Purpurellus*, the members of *Pterochelus* and *Purpurellus* are marked by a series of brown color spots along the margin of the outer lip. These same spots are seen in certain members of the Typhinae, such as *T. coronatus* Broderip, 1833, *T. grandis* A. Adams, 1855, (see Shasky and Campbell, 1964, pl. 21, figs. 1-3) *T. belcheri* Broderip, 1833, *T. sowerbii* Broderip, 1833, (see Sowerby, 1841, pl. 200, figs. 6, 8), and *T. expansus* Sowerby, 1874. All of these species are of the alate subgenera of *Typhis* and may represent a separate line from the spinose groups such as *Typhis* s.s.

Pterochelus first appears in the middle Eocene beds of the Paris Basin with the species "*Murex*" *caillati* Deshayes, 1865, (not preoccupied by *Murex cailleti* Petit, 1856) and also occurs in the upper Eocene and lower Oligocene beds of England and Germany with a similar form, *P. bispinosus* (J. de C. Sowerby, 1823). These two species are closely related but Wrigley (1930, p. 98) observed that *P. caillati* is "broader, with stronger spiral banding which often is granulated; and with five instead of two canals on the face of the varices. These canals, excepting the largest one at the rear, are separated from the aperture by a crimped and denticulated extension of the inner coat of the shell." *P. bispinosus*, as the name implies, has two spines on the apertural face of the varix and this same bispinose condition is present today in the Recent species of the group. The form achieved worldwide distribution in early Cenozoic time for a species, *P. angelus* (Aldrich), which is perhaps identical with *P. bispinosus*, is found in the lower Oligocene beds of Mississippi and *P. manubriatus* (Tate, 1888) occurs in the upper Eocene of Australia. The Recent distribution of the subgenus is principally Australian but there is one western Atlantic species and one eastern Pacific species.

The members of *Pterochelus* were probably shallow water inhabitants during the Eocene and Oligocene but in the New World they subsequently retreated to deeper water in later geologic time. Hence the group is unknown in the New World from the Oligocene until the Recent, although there is a species in the Pliocene Coralline Crag of England. In Australian waters there are several Recent species that live in depths of from 15 to 60 fathoms but there is little ecologic data available on the group as a whole.

PURPURELLUS: In a recent paper Emerson and D'Attilio (1969) have demonstrated that *Purpurellus* does possess a muricine radula as indicated by Thiele (1929, p. 289, fig. 313). In a previous work (Vokes, 1964, p. 26) the writer doubted the validity of Thiele's identification as the shell morphology of *Purpurellus* is more akin to the members of the subfamily Ocenebrinae. Because of the muricine nature of the radula (which is identical to the members of *Murex* s.s., *Chicoreus*, *Hexaplex*, and other "normal" Muricinae genera, but slightly different from the "abnormal" *Pterynotus*, an apparently degenerate form) Emerson and D'Attilio have removed *Purpurellus* from its position as a subgenus of *Pteropurpura* in the Ocenebrinae and placed it as a subgenus of *Pterynotus* in the Muricinae.

The writer (Vokes, 1968, p. 90) experienced a similar problem with the genus *Homalocantha*, which has a muricine shell morphology and radular type but a "purpuroid" (*i.e.*, lateral nucleus) operculum. In this case it was decided that the weight of evidence pointed to placement in the Muricinae in spite of the atypical operculum. In the case of *Purpurellus* the evidence is less clear-cut. The operculum of *Purpurellus* is unlike either the Muricinae or the Ocenebrinae, having an almost central nucleus (*Murex haustellum*, in the Muricinae, has

the only comparable operculum among the related species). The morphology of the shell is similar to both *Pterynotus* and *Pteropurpura* in certain respects, for those two genera are much alike as indicated above, but the nature of the circular aperture and the sealed siphonal canal would appear to be closer to *Pteropurpura* than to *Pterynotus*. It was this fact that caused the writer to make her original decision to place the group in the Ocenebrinae. However, confronted with this incontestable evidence of the radular similarity the group was re-examined from this point of view and it became obvious that the line was derived from a *Pterochelus* ancestor. The clue that pointed the way to this solution is the presence in both forms of the row of brown spots along the length of the outer lip from the suture to the tip of the canal. (Compare Emerson and D'Attilio, 1969, pl. 26, figs. 1, 5, and 7, with Vokes, 1966, pl. 25, fig. 3.) All of the species of *Pterochelus* and of *Purpurellus* seem to have these markings, although their exact *raison d'être* is not known at this time. Such a feature, so seemingly non-adaptive in nature, is highly suggestive of a common ancestor. In addition, there is considerable similarity in overall shell shape, both forms having the tendency toward a disruption in the varical flange at the base of the body whorl (compare Emerson and D'Attilio, 1969, pl. 27, fig. 11 with Vokes, 1966, pl. 25, fig. 1, for example). *Purpurellus* differs from *Pterochelus* in lacking the varical channels but there is a remnant fold at the shoulder. As a group *Purpurellus* is unique among the Muricinae in having a sealed siphonal canal (there are a few isolated species among other subgenera that also possess sealed canals), this apparently representing convergent evolution with the Ocenebrinae. This latter group is in all probability also descended from the *Pterynotus* line as there are no known Paleogene representatives of the Ocenebrinae.

The subgenus *Purpurellus* first appears in the lower Miocene of North Carolina, with the new species *P. (P.) repetiti*, described below. In the middle and upper Miocene and Pliocene of Europe there are several species of *Purpurellus*. In the Recent fauna the distribution is disjunct with the type ("*Murex*" *gambiensis* Reeve) coming from West Africa and the only other known species ("*Murex*" *pinninger* Broderip, 1833, of which "*Centrifuga*" *inezana* Durham, 1950, is a synonym, and *P. macleani* Emerson and D'Attilio, 1969) occurring on the West Coast of tropical America from Ecuador to the Gulf of California. It is not known if the first appearance of the group in the western Atlantic is indicative of its development here or if it is a result of lack of beds of the proper age and facies in the other parts of the world.

POIRIERIA: In a previous work (Vokes, 1964, p. 17) the writer discussed the reasons for distinguishing between the subgenera *Poirieria* s.s. and *Paziella*. Although there is considerable similarity of morphology between the two groups, in the members of *Poirieria* s.s. the outer lip opens directly into the varical spines, but in *Paziella* this labrum is closed and conspicuous denticles are formed. Both groups achieved worldwide distribution in the Eocene, but in the Recent fauna *Poirieria* s.s. is confined to the southern Atlantic and to the Pacific waters of Japan and New Zealand. Kira (1962, p. 65) referred two Japanese species to the subgenus *Bathymurex*, which this writer considers a synonym of *Paziella*. One of these, "*Trophonopsis* (*Bathymurex*)" *gorgon* (Dall, 1913) is especially close to *P. zelandicus* (Quoy and Gaimard, 1833), type of the genus, and is certainly to be referred to *Poirieria*. The second, "*Trophonopsis* (*Bathymurex*)" *echinus* (Dall, 1920), is only slightly less certain. Both are found in deep water off Japan.

Poirieria appears in the lower Eocene beds of Alabama and in the lower Eocene London Clay of England. The two Eocene forms are almost indistinguishable from the Recent *P. zelandicus* and demonstrate that the line had had a long, virtually unchanging, geologic history.

PAZIELLA: In the upper Paleocene of Alabama the species *Poirieria* (*Paziella*) *harrisi* Vokes (new name for *Murex morulus* Conrad non Schröter) occurs with *Pterynotus matthewsensis* (Aldrich). These two species are of two different, yet similar, genera and at this stage of generic divergence it is possible to recognize a common origin for the two groups. The first *Paziella* has six wing-like varices each bearing a strong shoulder

spine; the contemporaneous *Pterynotus* species also has six varices in the early post-nuclear stage but on about the second post-nuclear whorl these become three varices and three low intervarical nodes. Each of the three varices has a strong shoulder spine comparable to that of *Paziella*. The shells of both are smooth, almost totally unornamented except for the varices. Ideally the Cretaceous ancestor should be a small, smooth, multivarixed shell with an extended siphonal canal, but so far it has not been recognized in the New World. However, in the Cretaceous of Saxony there is an ideal prospect for the ancestor in the species named *Murex armatus* Geinitz (1875, Palaeontographica, v. 20, pt. 7, p. 263, pl. 59, fig. 16). This small species (the name of which is unfortunately preoccupied by *M. armatus* A. Adams, 1854, but it will not be renamed here) fits the above description perfectly. It is 6 mm in height, although it has five post-nuclear whorls and must be almost an adult. It has seven varices, each bearing a long spine at the shoulder, but the shell is otherwise smooth and unornamented. The holotype is broken but it clearly had a long, extended canal. This is the only known pre-Tertiary occurrence of a muricine species, although the name "*Murex*" has been applied to other Cretaceous (and even a few Jurassic) species. All of the latter are misidentifications, either as to the nature of the genus or the age of the strata. (For example, there is a good species of *Murex* s.s. that was reported from the "Cretaceous" of Brazil but this has subsequently proved to be Miocene in age.) But "*Murex*" *armatus* does seem to be an indisputable *Paziella* from the lower Pläner beds of Saxony, Cenomanian in age, and as such is the oldest known species of Muricinae.

Although the two subgenera *Poirieria* s.s. and *Paziella* may be separated by the presence of the labral denticles in *Paziella*, there is no such reason to separate two other taxa based on Caribbean species that are very close to *P. pazi* (Crosse, 1869), type of *Paziella*. Indeed, the type of *Bathymurex*, "*Murex*" *atlantis* Clench and Pérez Farfante, 1945, may be a synonym of *P. pazi*. According to Harvey R. Bullis, Jr. (personal communication), of the U. S. Bureau of Commercial Fisheries, there are two "varieties" of *P. pazi*. One is the relatively smooth typical form, which occurs in waters in the vicinity of the Antilles, and the second is a more heavily ornamented form, occurring on the Continental shelf from Texas to Florida. The holotype of *P. atlantis* is much like these ornamented specimens of *P. pazi*, and whether they represent two valid species or not is a subjective matter, but certainly they are of the same subgenus.

P. nuttingi (Dall, 1896), the type of *Dallimurex*, is also not to be separated from the typical *Paziella*. Rehder used his subgenus for forms having strongly developed spiral ornamentation that are herein referred to the subgenus *Panamurex*. Unfortunately his selection of the relatively smooth *P. nuttingi* as type negates this usage.

In the fossil record specimens of *Paziella* are very rare and it probably always has been a deeper water group. In the Recent fauna the species are for the most part confined to depths greater than 100 fathoms. The single known exception to this is the holotype of *P. nuttingi*, which is said to have been taken in 15 fathoms. In the depths these species are not rare, the U. S. Fish and Wildlife Service exploratory vessels have taken *P. pazi* at no less than 25 stations to the writer's knowledge.

FLEXOPTERON: Recently a new genus has been proposed by Shuto (1969, p. 111) for a new species *F. philippinensis*, from the upper Miocene of the Philippine Islands. The type of this new genus bears a remarkable resemblance to "*Murex*" *collatus* Guppy and it would seem that our Caribbean species should be placed herein. Shuto placed his new taxon in the family Coralliophilidae, due to the nature of the "umbilical and apertural features." One of the primary characters of the coralliophilids, however, is a markedly scabrous surface texture completely lacking in *Flexopteron*. For this reason it seems an untenable assignment and, in view of the number of similarities to *Poirieria* and *Paziella*, it would seem more likely that this new genus is most closely allied with these groups. *Flexopteron* differs from *Paziella* in lacking the pronounced shoulder spine, having instead a flanged varix, open at the shoulder. As is usually the case the differences between the two type species is immediately discernable, but in the

intermediate forms the demarcation is less clear-cut.

The oldest species that is referable to this group is "*Murex*" *deshayesii* Duchastel *in* Nyst, 1836, from the Oligocene of Central Europe. Although this species has been confused with "*M.*" *capito* Philippi, 1844, by several authors the forms are completely distinct. "*Murex*" *capito* is a true *Poirieria* with a single long open spine at the shoulder but "*M.*" *deshayesii* has the flanged varix of *Flexopteron*. "*Murex*" *octonarius* Beyrich, 1854, from the upper Miocene of Germany, and "*Murex*" *citimus* and "*M.*" *carcarensis* Bellardi, 1872, from the Miocene of Italy, are other species that should be placed in *Flexopteron*. There are no living species known to the writer.

PAZINOTUS: In this paper a new subgenus is erected for those few species that seem to be intermediate between *Pterynotus* and *Paziella*. They possess a variable number (about four to seven) of winged varices, which are formed by spines with a laminar flange connecting them. The aperture bears denticulations on the outer lip and on the whole the shell looks like a *Paziella* with winged varices. The type of the subgenus, "*Eupleura*" *stimpsonii* Dall, 1889, is found in water of about 100 fathoms depth. There is but a single fossil specimen in the western Atlantic region, from the Bowden Formation of Jamaica, which is thought to represent deep-water deposition. In addition, there are two species from the middle Miocene of Romania: "*Murex*" *giselae* and "*Murex*" *attonans* Boettger, 1901, (see Zilch, 1934, pl. 15), and one from the middle Miocene of France, "*Murex*" *typhioides* Mayer, 1869, to be referred to this group. "*Murex*" *funafutiensis* Hedley, 1899, described from 40 to 80 fathoms at Funafuti Atoll, Ellice Islands, is another Recent representative of the line.

The members of this new subgenus have been variously classified by authors as *Eupleura*, *Muricopsis*, or *Muricidea* (the latter, a virtual admission of ignorance, is a "wastebasket" name for any small muricid otherwise unclassifiable). Most recently Woodring (1959, p. 217) has placed the two American species in the subgenus *Dallimurex* but, as noted above, that name is considered a synonym of *Paziella* and it does not seem applicable to these forms with winged varices.

PANAMUREX: This subgenus was erected by Woodring (1959, p. 217) for those species with strong spiral sculpture, strong elongate denticles or ridges on the interior of the outer lip, and elongate denticles on the basal part of the inner lip. He included only the type species and *P. fusinoides* from the Chipola Formation, with *P. laccopoia* included in the synonymy of *P. fusinoides*. The other species here referred to *Panamurex* were either not considered or were otherwise assigned. All of the fossil species, with one exception, are known from the New World. That one exception is an unrecognized species from the Oligocene of Gaas, France, which in appearance is very close to *Panamurex lychnia* (Gardner) from the Chipola Formation. This European species was originally named *Fusus turbinelloides* by Grateloup (1833, Actes Soc. Linn. Bordeaux, v. 6, no. 32, p. 42), who subsequently changed it (without explanation) to *Turbinella muricina* in the *Atlas* to the *Conchyliologie Fossile du Bassin de l'Adour* (? 1847, Turbinelles, pl. 3, fig. 18). Grateloup's illustration is not immediately recognizable but with a specimen in hand it can readily be identified as a *Panamurex*. This same species is the "*Hexaplex* (*Paziella*) *corniculatus* Vergneau" of Glibert, 1963, Mém. Inst. Roy. Sci. Nat. Belg., (Ser. 2), fasc. 74, p. 8. This name remains nude, appearing only in an unpublished thesis, however Dr. Glibert kindly provided the writer with a photograph of the specimen. There may be other species of European *Panamurex* similarly "lost" in the literature.

The oldest species of *Panamurex* in the New World is *P. macneili* (new name for *Murex simplex* Aldrich *non* Philippi), from the Oligocene of Mississippi. There are numerous species in the Miocene of the entire Caribbean and Florida area. The line was thought by Woodring to be extinct but the Caribbean species here named *P.* (*P.*) *velero* Vokes, n. sp., is certainly to be referred to this group. In addition, a specimen of "*Murex*" *carnicolor* Clench and Pérez Farfante, taken by the U. S. Fish and Wildlife M/V *Oregon* (figured here, pl. 6, fig. 6), shows that species to have the characteristic denticulations on both inner and outer

lip. Although this species was previously assigned to *Murexsul* by Clench and Pérez Farfante (1945, p. 48) it seems to be more closely allied with *Panamurex*. The resemblance between *P. lychnia* and *P. carnicolor* is too striking to be ignored. Today *P. carnicolor* is a deep-water species, the most shallow occurrence known is that of the figured specimen, which is 50-60 fathoms.

With the possible exception of *P. lychnia*, which may have been a deeper water form like *P. carnicolor*, the fossils suggest an ecologic preference for a relatively shallow-water habitation with a fine silty bottom. The beds of the Chipola Formation of northern Florida abound with specimens of four species of *Panamurex*. The majority of the specimens are found in the more silty western exposures of the formation along Ten Mile Creek but *P. lychnia* and *P. mauryae* are more abundant in the calcaranite of the Chipola River and Farley Creek. A few specimens of all four species are found at almost any Chipola locality. The other species of *Panamurex* occur in similar silty strata such as the Jackson Bluff, Agueguexquite and Gatun formations.

In a recent work by McLean and Emerson (in press) it has been suggested that the genus *Calotrophon* should be placed in the Muricinae due to similarities of radula and operculum, and this writer must agree with the placement. These authors observed that the shells of *Calotrophon* have a peculiar chalky outer layer comparable to that so well developed in the genus *Aspella* and its subgenera *Dermomurex* and *Takia*. This same chalky layer is seen in *Panamurex* and it seems not unlikely that the *Calotrophon* line was derived from a *Panamurex*-like ancestor.

In an earlier work the writer described a new species *"Murex (Panamurex)" gilletteorum* (Vokes, 1963, p. 160). At the time the species was compared to *"Murex (Panamurex)" laccapoia* and *"M. (P.)" clarksvillensis* and it was noted that the new species differed in lacking the denticles on the inner lip, characteristic of true *Panamurex*. It is now thought that *gilletteorum* is better referred to the genus *Aspella* (*Takia*) but the relationship between these two groups appears to be closer than it was once held to be. Radular work by Radwin and D'Attilio of the San Diego Natural History Museum (largely unpublished, *in litt.*) shows the *Aspella* group to be more closely related to the Muricinae than to the Trophoninae and the writer now feels that *Panamurex*, *Takia*, and *Calotrophon* are all fairly closely related and should all be placed in the subfamily Muricinae.

This same distinctive chalky layer is also seen in the species of *Poirieria* and *Paziella* to a lesser degree, as well as in *Favartia*, and some species of *Trophon* and *Typhis*. In itself it does not seem to be a valid distinction for subfamiliar separation but suggests that all the species that do possess this layer do have a certain degree of kinship. However, it is felt that placing them all in the family Muricidae expresses this kinship adequately and there is no justification in placing species that morphologically differ in other respects together solely on the basis of this layer.

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IV. Systematic Descriptions

Phylum Mollusca

Class Gastropoda

Subclass Prosobranchia

Order Neogastropoda

Suborder Stenoglossa

Family Muricidae

Genus Pterynotus Swainson, 1833

Subgenus Pterynotus s.s.

Pterynotus Swainson, 1833, Zool. Illus., (Ser. 2) v. 3, expl. to pl. 100.
Type species: *Murex pinnatus* Swainson (= *Purpura alata* Röding), by subsequent designation, Swainson, *ibid.*, pl. 122.
Pteronotus Swainson, 1833, Zool. Illus., (Ser. 2) v. 3, pl. 122. Not *Pteronotus* Rafinesque, 1815, Mamm.
Marchia Jousseaume, 1880, Le Naturaliste, Anneé 2, no. 42, p. 335.
Type species: *Murex clavus* Kiener (= *Murex elongatus* Lightfoot), by original designation.
Timbellus de Gregorio, 1885, Soc. Malac. Ital., Boll., v. 10, p. 275.
Type species: *Murex latifolius* Bellardi, by subsequent designation, Vokes, 1964.
Triplex "Humphrey" Newton, 1891, Edwards Coll. Eocene and Oligocene Moll., p. x, 297.
To be used in place of *Pteronotus* Swainson.
Pterymurex Roverto, 1899, Atti Soc. Ligustica, v. 10, p. 105. New name for *Pteronotus* Swainson.

Pterynotus (Pterynotus) matthewsensis (Aldrich)

Plate 1, figs. 1a, 1b

Murex matthewsensis Aldrich, 1886, Alabama Geol. Surv., Bull. 1, pt. 1, p. 18, 59, pl. 3, fig. 15.
Murex matthewsensis Aldrich. de Gregorio, 1890, Ann. Géol. Paléontologie, livr. 7, p. 94, pl. 7, fig. 27 (after Aldrich, 1886).
Murex (*Pteronotus*) *matthewsoni* [*sic*] Aldrich. Dall, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 142.
Murex (*Pteronotus*) *matthewsensis* Aldrich. Harris, 1896, Bulls. Amer. Paleontology, v. 1, no. 4, p. 215, pl. 20, fig. 2.
Murex matthewsensis Aldrich. Wrigley, 1930, Malac. Soc. London, Proc., v. 19, p. 96.
Murex (*Pteropurpura*) *matthewsensis* Aldrich. Palmer *in* Harris and Palmer, 1947, Bulls. Amer. Paleontology, v. 30, no. 117, p. 344.
Murex (*Pteronotus*) *matthewsensis* Aldrich. Brann and Kent, 1960, Bulls. Amer. Paleontology, v. 40, no. 184, p. 571.
[*Pterynotus* (*Pterynotus*)] *matthewsensis* (Aldrich). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 15.
Pterynotus matthewsensis (Aldrich). Palmer and Brann, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 864.

Diagnosis: "Shell triangular, whorls probably four; angular, smooth between the varices; varices three, longitudinal, prominent; spines of the body whorl elongated and curved upward, the one at the angle of the aperture nearly closed; body whorl angulated on upper part, the other whorls rounded; aperture ovate, outer lip thick with a foliation at the junction with the body whorl running from the spine to the beak; inner lip smooth with a slight lamina; beak short; canal rather wide." (Aldrich, 1886)

Dimensions of holotype: height (incomplete) 13 mm, diameter 8.2 mm.

Holotype: USNM 638751.

Type locality: Matthews Landing, Alabama River, Wilcox County, Alabama.

Occurrence: Matthews Landing Marl, Alabama; Paleocene.

Figured specimen: PRI 24532; height 17.3 mm, diameter 7 mm; locality, Matthews Landing, Alabama River, Wilcox County, Alabama (specimen figured by Harris, 1896, pl. 20, fig. 2). Other occurrences: TU locality no. 325.

Discussion: *P. matthewsensis* is one of the oldest known forms of Muricinae. This species, together with *Poirieria* (*Paziella*) *harrisi* Vokes (new name for *Murex morulus* Conrad *non* Schröter), is found in the Matthews Landing Marl member of the Porters Creek Formation of upper Paleocene age. It is a small species, the specimen figured by Harris and refigured here is the largest specimen seen. To the writer's knowledge there are but three specimens known in collections, but this is probably due to the small size rather than to any special rarity on the part of the fossil.

Pterynotus (Pterynotus) stenzeli E. H. Vokes, n. sp.

Plate 1, figs. 5a, 5b

Diagnosis: Nucleus of three and one-half smooth, conical whorls; seven post-nuclear whorls in adult. Axial ornamentation of six or seven small varices on first two post-nuclear whorls, becoming three varices and three strong intervarical nodes on each of the succeeding whorls. Varices thin and bladelike, forming an almost straight line up the spire. Spiral ornamentation of faint ribs, five on the body whorl.

Where these spiral ribs cross the varices small folds formed, recurving slightly back from the apertural face. Aperture oval, with a marked infolding at the shoulder, forming a spine; however, apertural lip is not channeled into the spine as in *Pterochelus*. Outer lip with six denticles corresponding to interspaces between spiral ribs; columellar lip smooth. Siphonal canal moderately long, open, slightly recurved at distal end.

Dimensions of holotype: height 19 mm, diameter 11.3 mm.

Holotype: Texas Bureau of Economic Geology no. 36637.

Type locality: TBEG no. 173-T-19, four miles west of Chireno; hill on San Augustine road (Texas Highway 21), Nacogdoches County, Texas (= TU 993).

Occurrence: Weches Formation, Texas; early middle Eocene.

Figured specimen: TBEG 36637 (holotype). Other occurrences: TU locality no. 993 and TBEG locality no. 113-T-17, Wheeler Springs School, Houston County, Texas.

Discussion: This new species from the Weches Formation of eastern Texas is not rare in the vicinity of the type locality as there are 22 specimens in the type lot, from two localities. In addition, there are four specimens in the collections of the Philadelphia Academy of Natural Sciences (nos. 9419 and 9738) from near Jewett, Leon County, and from near Alto, Cherokee County, Texas. In all, the line of occurrence stretches for over 100 miles in a slightly arched line trending almost due east-west.

P. stenzeli differs from the other Eocene species of *Pterynotus* in having stronger spiral ornamentation and by having the labral lip folding into the shoulder spine. In this latter trait it resembles the Paleocene *P. matthewsensis* but has much stronger spiral ornamentation. The species attains a larger size than is indicated by the holotype, one unfigured paratype measures 30 mm in height.

The writer is pleased to name this new species in honor of Dr. Henryk B. Stenzel, who collected much of the type material.

Pterynotus (Pterynotus) sabinola (Palmer)

Plate 1, figs. 2a, 2b

Murex veatchi Palmer, 1937, Bulls. Amer. Paleontology, v. 7, no. 32, p. 266, pl. 36, figs. 7, 11, 12. *Non Murex veatchi* Maury, 1910.

Murex sabinola Palmer *in* Brann and Kent, 1960, Bulls. Amer. Paleontology, v. 40, no. 184, p. 572, 989. New name for *M. veatchi* Palmer *non* Maury.

Murex veatchi Palmer. Brann and Kent, 1960, Bulls. Amer. Paleontology, v. 40, no. 184, p. 573.

Murex sabinola Palmer. Palmer and Brann, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 783.

Diagnosis: "Shell elongate; spire elevated; post-nuclear whorls four; anterior canal long; varix sculpture trilobate, with the varices wide and flaring; midway between the varices is a longitudinal fold which is subdued forming a large node on each whorl; the longitudinal sculpture is crossed by spiral lines, widely spaced on the flared varices; on a fragment of an old individual intermediate ribs are developed on the labrum flange and the primary ribs are large and coarse; labrum crenate on the inner margin." (Palmer, 1937)

Dimensions of holotype: height 16 mm, diameter 9 mm.

Holotype: PRI 3012.

Type locality: Sabine River (opposite SE ¼ Sec. 35, T5N, R13W), Sabine County, Texas.

Occurrence: Stone City Beds, Texas; Cook Mountain Formation, Texas and Louisiana; early middle Eocene.

Figured specimen: PRI 3012 (holotype).

Discussion: This species is based on an immature specimen for it has only four post-nuclear whorls; an adult specimen in the collections of the Texas Bureau of Economic Geology has seven post-nuclear whorls and measures 24 mm in height. Nevertheless, the general aspect of the type is that of a mature individual and there is little difference between it and the full grown specimen. The species is known only from a small area near the Sabine River. The type locality (Veatch's locality 21) is in the Stone City Beds of early middle Eocene age. Paratype material is also known from the slightly younger Cook Mountain Formation at Columbus, on the Louisiana side of the Sabine River near the type locality. The above-mentioned Texas Bureau specimen comes from the Wheelock Member of the Cook Mountain Formation at Harper's Chapel, Texas, also near the type locality. Regrettably these few specimens of *P. sabinola* are probably all that will ever be known, for the famous localities along the Sabine River are now beneath the waters of an artificial lake created by a dam at Toledo Bend, just downstream from Columbus. (What price progress!). There is one faint ray of hope, however. In the collections of the Academy of Natural

Sciences of Philadelphia there is a single specimen (no. 9204) from the Cook Mountain Formation at Alabama Bluff, on the Trinity River, Houston County, Texas. Perhaps other localities will be discovered to replace the Sabine River section.

P. sabinola closely resembles *P. tricarinatus* (Lamarck) from the middle Eocene of the Paris Basin. It differs from the European species principally in having stronger denticles on the outer lip and less marked spiral ornamentation. *P. sabinola* has only five to seven faint spiral ribs and *P. tricarinatus* has about nine strong spiral lines, even on specimens of the same small size as the holotype of *P. sabinola.*

Pterynotus (Pterynotus) weisbordi (Palmer)

Plate 1, figs. 3a, 3b

Murex (*Pteropurpura*) *weisbordi* Palmer *in* Harris and Palmer, 1947, Bulls. Amer. Paleontology, v. 30, no. 117, p. 343, pl. 45, figs. 19–21.

Murex (*Pteropurpura*) *weisbordi* Palmer. Brann and Kent, 1960, Bulls. Amer. Paleontology, v. 40, no. 184, p. 574.

Pterynotus weisbordi (Palmer). Palmer and Brann, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 865.

Diagnosis: "Shell slender, spire elevated; nuclear whorls worn; postnuclear whorls, probably first and second, have longitudinal folds extending the length of the whorl; on the third whorl, three of the longitudinal folds become continuous from whorl to whorl forming varices of a trivaricate pattern. The remaining intervening longitudinal folds of the third whorl develop into blunt nodes between the varices on the whorls. The varices are flangelike. The surface of the shell is covered with fine spiral ribs with wide interspaces. Canal is long; outer lip crenulated; inner lip smooth." (Palmer, 1947)

Dimensions of holotype: height 33.5 mm, diameter 15 mm.

Holotype: PRI 4657.

Type locality: Montgomery Landing, Red River, Grant Parish, Louisiana (= TU 99).

Occurrence: Moodys Branch Marl, Louisiana; upper Eocene.

Figured specimen: PRI 4657 (holotype).

Discussion: *P. weisbordi* is known only from the type locality and the vicinity of Gibson Landing, on the Ouachita River, Caldwell Parish, Louisiana. Palmer stated that it differed from its nearest relative, *P. sabinola*, in having the spire whorls larger and the spiral ribs finer in *P. weisbordi. P. weisbordi* is ornamented by numerous fine spiral lines; *P. sabinola* has but five to seven faint, widely spaced spiral ribs. This species bears an even stronger resemblance to *P. tripteroides* (Lamarck) from the middle and upper Eocene beds of the Paris basin. It differs from that species in having a less appressed suture and finer spiral ornamentation.

Pterynotus (Pterynotus) burnsii (Aldrich)

Plate 2, figs. 1a, 1b

Not *Murex* (*Chicoreus*?) *burnsii* Whitfield. Dall, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 141 (nude name).

Murex (*Pteronotus*) *burnsii* Aldrich, 1894 (January), Nautilus, v. 7, p. 98, pl. 4, figs. 4, 4a.

Not *Murex shilohensis* var. *burnsi* Whitfield, 1894 (post-March), U. S. Geol. Surv., Mon. 24, pt. 3, p. 98, pl. 17, fig. 2 (= *Murexiella macgintyi faceta*).

Murex (*Pteronotus*) *grandispinosa* Aldrich, 1895, Bulls. Amer. Paleontology, v. 1, no. 2, p. 66. Unnecessary new name for *M. burnsii* Aldrich.

Not *Murex burnsii* Dall. Dall, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1566 (= *Panamurex heilprini*).

Not *Murex* (*Chicoreus* ?) *burnsii* Whitfield [Dall]. Schuchert, *et al.*, 1905, U. S. Natl. Mus., Bull. 53, p. 419 (= *Panamurex heilprini*)

Murex (*Pteronotus*) *burnsii* Aldrich. Schuchert, *et al.*, 1905, U. S. Natl. Mus., Bull. 53, p. 419.

Not *Murex shilohensis burnsi* Whitfield. Schuchert, *et al.*, 1905, U. S. Natl. Mus., Bull. 53, p. 420 (= *Murexiella macgintyi faceta*).

Not *Chicoreus burnsii* (Whitfield). Dall, 1915, U. S. Natl. Mus., Bull. 90, p. 75 (= *Panamurex heilprini* and *Murexiella macgintyi faceta*).

Not *Murex* (*Chicoreus*) aff. *burnsii* Whitfield. Gardner and Aldrich, 1919, Acad. Nat. Sci. Phila., Proc., v. 71, p. 18 (= *Murexiella macgintyi faceta*).

Not *Muricidea burnsii* (Whitfield). Richards and Harbison, 1942, Acad. Nat. Sci. Phila., Proc., v. 94, p. 212, pl. 19, fig. 10 (= *Murexiella macgintyi faceta*).

Murex (*Pteronotus*) *burnsii* Aldrich. E. H. Vokes, 1963, Tulane Stud. Geol., v. 1, no. 3, p. 1, p. 158.

Diagnosis: "Shell large, with three foliated varices, whorls nine. Nucleus pointed, smooth; whorls convex, appressed at suture, whorls following the nucleus have two ribs on centre, each rib bearing a node which is equidistant

from the foliations; three continuous fin-like varices continued from apex, which revolve in decending, edges of varices dentate. Body whorl with about thirteen distant spiral raised ribs, the two on the periphery bearing a node each between the foliations. Aperture elongate-oval. Outer lip having internally seven plications, inner lip smooth; canal rather long, almost closed posteriorly, widening anteriorly, and bent upwards. Canal of preceding aperture persistent." (Aldrich, 1894)

Dimensions of holotype: height 67.5 mm, diameter 33 mm.

Holotype: USNM 135155.

Type locality: Carson's Creek, 1½ to 2 miles west of Red Bluff (Chickasawhay River), Wayne County, Mississippi.

Occurrence: Red Bluff Clay, Mississippi; lower Oligocene.

Figured specimen: USNM 135155 (holotype).

Discussion: *Pterynotus burnsii* is a direct descendant of the middle and upper Eocene Tethyan species *P. tripteroides* (Lamarck). This latter species has not been reported from the New World but in the Tulane collections there is a single specimen from the Ocala Limestone (TU 449) that is probably referable to *P. tripteroides*, however it is too poorly preserved for one to be certain. *P. burnsii* differs from *P. tripteroides* in having coarser spiral ornamentation and fewer denticles within the outer lip. The type, and only specimen, of *P. burnsii* is also larger than any specimens seen of *P. tripteroides*, which usually measures a maximum of approximately 55 mm.

P. burnsii is involved in a nomenclatorial tangle due to an overlong delay in publication. In 1889 Whitfield submitted a monograph on the fauna of the Miocene of New Jersey in which he described a species as "*Murex shilohensis* var. *burnsi*." In 1890, Dall (p. 141) noted that "the truncated specimen upon which Prof. Whitfield has founded his variety *Burnsii*, belongs, in my opinion, to a different species and subgenus [than *Murex shilohensis*]." But he had seen only Whitfield's manuscript, for the work was not finally published until after March, 1894 (*fide* advertisement, p. vi). In the meantime Aldrich had named his *Murex burnsii* after the same man, Frank Burns of the U. S. National Museum, in the January, 1894, issue of "Nautilus." The following year Aldrich (1895, p. 66) noted that Dall had made Whitfield's "variety *burnsi*" into a distinct species and hence he proposed *Murex* (*Pteronotus*) *grandispinosa* as a replacement name for his *Murex burnsii*. Dall's usage of *M. burnsii* Whitfield can only be construed as a nude name and so this change was unnecessary on Aldrich's part.

PTERYNOTUS (PTERYNOTUS) PROPEPOSTI (Mansfield)

Plate 1, figs. 4a, 4b

Purpura (*Pteropurpura*) *propeposti* MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 51, 131, pl. 5, figs. 8, 10.

Diagnosis: "Shell elongate, with a rather high, turreted spire and long canal. Nucleus poorly preserved. Axial sculpture of three strong, sharp, continuous, marginally broken varices which are spinose at the periphery of the spire whorls and at the shoulder of the body whorl. A rather strong rib lies midway between the varices and an elongate nodule is on either side of this nodule [*sic*]. Body whorl and canal sculptured with about 17 rather strong primaries usually alternating with one secondary spiral. The margin of the outer lip probably is broken away; inner margin of outer lip with 7 strong, rounded entering denticles. Inner lip provided with a callus; canal long and deflected anteriorly; aperture ovate; anterior siphonal canal nearly closed." (Mansfield, 1937)

Dimensions of holotype: height 43 mm, diameter 20 mm.

Holotype: USNM 49545.

Type locality: Blackwater Creek, at crossing of Seaboard Airline Railroad, Hillsborough County, Florida.

Occurrence: Suwannee Limestone, Florida; upper Oligocene.

Figured specimen: USNM 49545 (holotype).

Discussion: This species was attributed with a query to the upper Oligocene Suwannee Limestone by Mansfield, for he believed that at the type locality both the Suwannee and the younger Tampa Limestone occur. As the fossils were in a spoil bank, it would be difficult to ascertain from which formation the specimen came. However, Druid Wilson, of the United States Geological Survey (*in litt.*), advises that it is doubtful if there is any Tampa Limestone at Blackwater Creek. It is simply the long exposed, deeply weathered Suwannee Limestone that carries the silicified fossils. All species that have been identified from this locality are of Oligocene age.

Mansfield (1937, p. 131) suggested that *P. propeposti* might prove to be just a variety of the younger *P. postii* if better specimens

were collected. But the two forms are very different, *P. propeposti* is much more elongate and the siphonal canal is greatly extended in comparison with *P. postii*.

Pterynotus (Pterynotus) rufirupicolus (Dall)

Murex rufirupicolus Dall, 1916, U. S. Natl. Mus., Proc., v. 51, no. 2162, p. 506, pl. 86, fig. 8.

Diagnosis: "Specimen represented by an internal cast with a slightly defective apex; fusiform with over four whorls, a long straight canal, a rounded aperture, the outer lip expanded, thickened, crenulate, with a prominent guttered spine at the shoulder, a large dentiform callosity internally just in front of the suture, and six prominent internal lirations diminishing anteriorly, in front of the groove at the shoulder. There appear to have been two feeble varices or thickenings visible on the internal cast on each of the antecedent whorls, and an expansion of the outer lip continued some distance down on the right margin of the canal." (Dall, 1916)

Dimensions of holotype: height 42 mm, diameter 19 mm.

Holotype: USNM 166725.

Type locality: Red Bluff, west bank of Flint River, seven miles above Bainbridge, Decatur County, Georgia.

Occurrence: Flint River Formation, Georgia; upper Oligocene.

Discussion: This species was based on an internal mold and it is impossible to determine exactly what species it is. However, it bears a strong resemblance to the contemporary *P. propeposti* Mansfield. As that species is based upon a good type specimen it seems best to treat *"Murex" rufirupicolus* as a *nomen dubium* rather than to replace the later, but more certain taxon of Mansfield.

Pterynotus (Pterynotus) postii (Dall)

Plate 2, figs. 2a, 2b

Pteropurpura postii Dall, 1896, U. S. Natl. Mus., Proc., v. 18, no. 1035, p. 44; Dall, 1900, Wagner Free Inst. Sci., Trans., v. 3, pt. 5, pl. 43, fig. 7.

Purpura (*Pteropurpura*) *posti* Dall. Dall, 1915, U. S. Natl. Mus., Bull. 90, p. 76, pl. 7, fig. 9.

Murex (*Pteropurpura*) *posti* (Dall). Dall, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1566.

Purpura (*Pteropurpura*) *posti* (Dall). Mansfield, 1937, Florida Geol. Surv., Bull. 15, p. 131.

Pteropurpura postii Dall. Gardner, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 525.

Diagnosis: "Shell of moderate size, with five whorls, beside the (decollate) nucleus, with three sharp continuous varices extending down the spire and a single prominent intervarical nodule on the interspaces of the whorls; the last varix broader than any of the others, with a posterior angle, the front sculptured with five crenulate imbricated lamellae, the back smooth, except for the ends of the spiral ribbing; spiral sculpture of (about 15 on the last whorl) low spiral ribs most prominent on the intervarical nodules, the rather wide interspaces finely spirally striate; aperture small, subovate, the outer lip with about seven strong teeth; the body with a thin smooth callus; suture appressed, obscure; canal open, narrow, not quite as long as the aperture; on the siphonal fasciole a single projecting remnant of an earlier canal is visible." (Dall, 1896)

Dimensions of holotype: height 38 mm, diameter 21 mm.

Holotype: USNM 130349.

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

Occurrence: Tampa Limestone, Florida: lower Miocene.

Figured specimen: USNM 130349 (holotype).

Discussion: *P. postii* is known from but two examples from the type locality. Although Dall referred this species to the genus *Pteropurpura*, that name is inapplicable because, as was discussed previously, that genus is correctly assigned to the subfamily Ocenebrinae, characterized by a completely sealed-over siphonal canal.

Pterynotus (Pterynotus) hoerlei E. H. Vokes, n. sp.

Plate 2, figs. 3a, 3b

Diagnosis: Nucleus of one and one-half smooth, rounded whorls, ending at a small varix; seven post-nuclear whorls in the adult. Ornamentation on first post-nuclear whorl consisting of nine small varices, no spiral ornamentation. Varices reduced to six on second post-nuclear whorl and to three on third and succeeding whorls. Between each pair of varices one low axial node; intervarical areas unornamented. Spiral ornamentation visible only on the varices where about nine faint spiral ribs are developed on the body whorl. Varices simple, flaring, crenulated by the spiral ribs; each one joined to the corresponding varix of the previous whorl to form a continuous slightly curved line up the spire. Suture greatly appressed. Aperture oval; inner lip smooth, outer lip bearing six strong denticles, which reflect the position of the external ribbing. Canal moderate in length, open, recurved, bearing a lamel-

lar extension of the varices almost its entire length.

Dimension of holotype: height 59 mm, diameter 29.5 mm.

Holotype: USNM 645616.

Type locality: TU 547, west bank of Chipola River (SW ¼ Sec. 29, T1N, R9W), Calhoun County, Florida.

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

Figured specimen: USNM 645616 (holotype). Other occurrences: TU locality no. 555.

Discussion: This rare species is based on four specimens known only from the vicinity of the type locality. It is closely related to *P. postii* from the older Tampa Limestone but has a more elongate, smoother shell. In general outline it more nearly resembles the Oligocene *P. burnsii* (Aldrich) but is also smoother than that species. Likewise, it is closely related to the Recent Indo-Pacific species *P. phyllopterus* (Lamarck) of which *P. rubridentatus* (Reeve) is a synonym. In the Recent form the denticles on the outer lip are tipped with a beautiful rose-pink, hence Reeve's name, making this one of the more strikingly beautiful muricine species. The entire line extends back to the middle Eocene species *P. tripteroides* (Lamarck) in a remarkably persistent shell type.

The writer takes pleasure in naming this exquisite new species in honor of Mr. Robert C. Hoerle, of West Palm Beach, Florida, who cheerfully parted with the type specimen only seconds after he discovered it.

Pterynotus (Pterynotus) havanensis E. H. Vokes, *nom. nov.*

Plate 3, figs. 1a, 1b

Murex (*Pteronotus*) *tristichus* Dall, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 202, pl. 15, fig. 3; Dall, 1889, U. S. Natl. Mus., Bull. 37, p. 120, pl. 15, fig. 3. *Non Murex tristichus* Beyrich, 1854.

Pteropurpura tristica (Dall). Dall, 1927, U. S. Natl. Mus., Proc., v. 70, no. 2667, p. 58.

Murex (*Pterynotus*) *tristichus* Dall. Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 36, pl. 20, figs. 1-4.

[*Pterynotus* (*Pterynotus*)] *tristichus* (Dall). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 15.

Diagnosis: "Shell pure white, thin, polished, delicate, with six rather loosely coiled, rounded whorls; body more slender than in the last species [*P. phaneus*], sutures much deeper and not appressed. Nucleus large, loosely coiled, glassy, white; varices making about one quarter of a revolution around the spire, very thin, edges dentate, prolonged on the shoulder of the whorls into a long pinna with a flat central rib; below there are three other less prominent ribs, which project at the edge of the varix on the last whorl; there is no transverse sculpture except incremental lines, nor any inter-varical ribs; the spiral sculpture is obscure and very faint, except the ribs on the varices; aperture small, pear-shaped; canal open, rather long, bent to the right, the canal belonging to the preceding varix, behind it, persistent and bent to the left." (Dall, 1889)

Dimensions of holotype: height 15.5 mm, diameter 10 mm.

Holotype: Harvard MCZ 7308.

Type locality: *Blake* Station 51, off Havana, Cuba, in 400 fathoms.

Occurrence: Recent only.

Figured specimen: MCZ 7308 (holotype).

Discussion: As with all of the Recent western Atlantic *Pterynotus* the species named *Murex tristichus* by Dall is very rare. There are but three adult specimens known. Dall (1889, p. 202) stated that the type came from a depth of 243-450 fathoms, *Blake* Station 51, off Havana, and the paratype from Station 5 at a depth of 152-229 fathoms. But the labels with the specimens state that the type came from a depth of 400 fathoms and the paratype from the same station at a depth of 450 fathoms. Dall later (1927, p. 58) noted that the *Albatross* had taken one adult and many juvenile shells off the southeastern United States, but no depths were given.

The name *Murex tristichus* of Dall is preoccupied by *Murex tristichus* used by Beyrich for a German Oligocene fossil. It is ironic but the two species are actually very similar in form, each taking their name from the three lines of varices ascending the spire (*tri - stichos*).

Pterynotus (Pterynotus) bushae E. H. Vokes, *nom. nov.*

Plate 3, figs. 2a, 2b

Murex (*Pteronotus*) *pygmaeus* Bush, 1893, Harvard Mus. Comp. Zool., Bull., v. 23, p. 213, pl. 1, figs. 3, 4. *Non Muricites pygmäus* Schlotheim, 1820 (*vide* ICZN Code, Art. 56b).

Murex (*Pterynotus*) *pygmaeus* Bush. Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 36, pl. 20, figs. 7, 8.

Diagnosis: "Shell small, fusiform, rather thin, of a light yellow color. Whorls six, evenly and moderately rounded, ornamented with three high, thin foliaceous varices and covered with coarse revolving threads and microscopic striae.

Aperture nearly round, with a long, curved, tubular canal, and a smooth, lustrous interior. Outer lip with a slightly thickened edge, descending a little obliquely from the suture, forming a slight obtuse posterior angle, below which it is somewhat flaring and curves well round to the base of the canal, where there is another slight angle, then curves gradually outward to the end of the canal. Inner lip formed by a rather narrow, thin, lustrous layer of enamel closely adhering to the body whorl to just above the base of the canal, where it becomes detached and twists forward and over to meet the outer lip, nearly or quite closing the canal its entire length. There is a tube corresponding to a former canal on the left of the present one for about half its length, which projects strongly outward at the end. Operculum thin, horny, amber-colored. Suture distinct, slightly channelled. Varices three, equally spaced, high, very thin, with an irregular slightly notched edge, the last one formed a little before the edge of the outer lip. Each stands a little in front of the corresponding one above, rises above the suture, laps a little on to the preceding whorl, then reaches high above with a re-entrant curve, the greatest height being in a line with the posterior angle of the aperture. When dry, the surface on the back of these and between them is without lustre, and is covered with microscopic revolving striae crossed by inconspicuous lines of growth. There are also a few broad, widely separated, rather indistinct revolving threads, which are most apparent on the varices. These number about eight on the last varix, but the two or three lowest ones are almost imperceptible. The surface on the front of the varices is very lustrous, covered with the very thin, irregular edges of the several layers of growth; the upper revolving threads appear as broad shallow grooves. Nucleus large, of two smooth lustrous whorls, the apical one prominent and decidedly upturned." (Bush, 1893)

Dimensions of holotype: height 16 mm, diameter 8.5 mm.

Holotype: Harvard MCZ 6918.

Type locality: *Blake* Station 319, off Charleston, South Carolina, in 262 fathoms.

Occurrence: Recent only.

Figured specimen: MCZ 6918 (holotype).

Discussion: The species named by Bush as *Murex pygmaeus* is based on a single specimen taken from 262 fathoms off Charleston, South Carolina. It has not been reported by subsequent workers and nothing can be added to the original data. *Murex pygmaeus* is preoccupied by the name *Muricites pygmäus* Schlotheim, for the International Code of Zoological Nomenclature (Art. 56b) states: "A genus-group name formed for use in paleontology by substituting *-ites* . . . for the original termination of a generic name, and applied only to fossils, enters into homonymy." Although not a "German word" (Art. 32(c)i), it was treated as such by Schlotheim and thus should be emended to *pygmaeus*, the correct Latin spelling.

Pterynotus (Pterynotus) phaneus (Dall)

Plate 3, figs. 3a, 3b

Murex (*Pteronotus*) *phaneus* Dall, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 201; Dall, 1889, U. S. Natl. Mus., Bull. 37, p. 120, pl. 42, fig. 1; Dall, 1890, U. S. Natl. Mus., Proc., v. 12, no. 772, p. 330, pl. 11, fig. 1.

Murex (*Pterynotus*) *phaneus* Dall. Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 37.

Diagnosis: "Shell ashy white, elongated, thin, six-whorled. Nucleus translucent, smooth, polished, of about one and a half whorls; whorls slightly convex, appressed to the suture behind them, connected by three continuous fin-like varices which in descending the spire make about half a revolution around it; these varices on the upper whorls were extended backward into a little wing-like point with dentate edges; on the last whorl the lines of growth indicate that the thin margin was rounded, parallel with the whorl. Transverse sculpture of fine growth-lines, and on the last two whorls at the periphery three short little narrow pinched-up riblets between the varices; spiral sculpture of fine rather faint striae and wider undulations, hardly visible except on the varices; of these there are nine or ten on the last varix. Aperture elongate-oval, internally white, thickened, smooth; canal rather long, open, bent back." (Dall, 1889)

Dimensions of holotype: height 17 mm, diameter 7 mm.

Holotype: USNM 93256.

Type locality: *Albatross* Station 2662, off St. Augustine, Florida, in 434 fathoms.

Occurrence: Recent only.

Figured specimen: USNM 93256 (holotype).

Discussion: Much more material is needed before the western Atlantic species of *Pterynotus* are fully understood. Each of the three known species is based on one or two specimens, and no idea of variation can be determined. *P. phaneus* closely resembles *P. havanensis* but differs in the presence of the three intervarical nodes seen in *P. phaneus*. *P. havanensis* is completely smooth between the varices. Whether this is within the range of variation is not known but the two type specimens are approximately the same size so that age is not a consideration. *P. bushae*

even more closely resembles *P. phaneus* but also is smooth between the varices.

There is another species in the western Atlantic that was referred to *Pterynotus* by Clench and Pérez Farfante (1945, p. 38). This is *"Murex" abyssicola* Crosse, 1865, which seems from close examination of the original description and illustration to be a juvenile specimen of *Aspella* (*Dermomurex*). It will be covered with that group.

Subgenus Pterochelus Jousseaume, 1880

Pterochelus Jousseaume, 1880, Le Naturaliste, Année 2, no. 42, p. 335.
Type species: *Murex acanthopterus* Lamarck, by original designation.
Alipurpura "Bayle MS" Fischer, 1884, Man. de Conchyl., p. 641.
Type species: *Murex acanthopterus* Lamarck, by original designation.

Pterynotus (Pterochelus) angelus (Aldrich)

Plate 3, figs. 5a, 5b

Murex (*Pteronotus*) *angelus* Aldrich, 1886, Cincinnati Soc. Nat. Hist., Jour., v. 8, no. 2, p. 145, pl. 2, fig. 2; Aldrich, 1886, Alabama Geol. Surv., Bull. 1, pt. 1, p. 18, pl. 2, fig. 2.
Murex angelus Aldrich. Von Koenen, 1889, Geol. Specialkarte Preuss. Thüring. Staat., Abh., v. 10, no. 1, p. 52.
Murex (*Pteronotus*) *angelus* Aldrich. Dall, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 142.
Murex angelus Aldrich. Wrigley, 1930, Malac. Soc. London, Proc., v. 19, p. 97.

Diagnosis: "Shell, oblong, with three spinous varices; whorls convex, seven; spire, elevated; surface, rough, showing three or four revolving lines on the body whorl; spines, channeled to the tips, nearly closed, small sub-spines between the larger ones; aperture, oval; outer lip, ridged; inner lip, reflected; canal, long, longer than the aperture, curving outward." (Aldrich, 1886)

Dimensions of holotype: height 26 mm, diameter 14 mm.

Holotype: USNM 644608.

Type locality: Red Bluff, Chickasawhay River, Wayne County, Mississippi.

Occurrence: Red Bluff Clay, Mississippi; lower Oligocene.

Figured specimen: USNM 644608 (holotype).

Discussion: This species from the lower Oligocene beds of Mississippi is closely related to, if indeed not identical with, *P. bispinosus* (J. de C. Sowerby) from the upper Eocene and lower Oligocene of western Europe. This similarity was noted by von Koenen (1889, p. 52, pl. 2, figs. 8-10), who figured specimens from the lower Oligocene of northern Germany at Lattorf and by Wrigley (1930, p. 97, pl. 9, fig. 7), who figured a specimen from the upper Eocene of England. The latter author stated (p. 98) "one strongly suspects that the European and American forms are identical." As far as the writer knows there are but three rather poor specimens of *P. angelus* in collections, all at the USNM, and she hesitates to unite the two forms in synonymy without more material.

Pterynotus (Pterochelus) ariomus (Clench and Pérez Farfante)

Murex (*Pterynotus*) *ariomus* Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 39, pl. 20, figs. 5, 6.
[*Pterynotus* (*Pterochelus*)] *ariomus* Clench and Pérez Farfante. E. H. Vokes, 1966, Veliger, v. 8, no. 3, p. 165.

Diagnosis: "Shell about 25 mm (1 inch) in length, rather solid and non-spinose. Whorls six and one-half and moderately globose. Color a dull white. Spire extended. Suture rather deeply impressed. Aperture oblique and oval, porcellaneous white within. Parietal lip adnate above, free and erect below. Palatal lip non-denticulated below. Siphonal canal broad and short, recurved upward at its distal end. Axial sculpture consists of three low and rather thin, laminated varices with a prominent angle rather than a spine at the shoulder area. The laminations are numerous, quite irregular and rather compact. There is a single knob-like ridge in between the varices. Spiral sculpture consists of numerous and rather fine ribs which turn up to sculpture the back side of the varices. The entire surface of the shell is covered with very small scale-like processes other than on the forward or the front side of the varices. At the suture these scales buttress the whorl above. Nuclear whorls one and one-half, small, rounded, smooth, the first whorl slightly twisted. Postnuclear whorls similar to later whorls. Operculum unguiculate and having an apical nucleus. No periostracum." (Clench and Pérez Farfante, 1945)

Dimensions of holotype: height 24 mm, diameter 12.5 mm.

Holotype: Harvard MCZ 164734.

Type locality: Off Hollywood, Florida, in 50 to 60 fathoms.

Occurrence: Recent only.

Discussion: The holotype of *P. ariomus* is the sole representative in the western Atlantic of the *Pterochelus* group, which achieved

worldwide distribution in the Eocene. The type specimen was taken in 50 to 60 fathoms and it is surprising that there are no other specimens of the form presently known. The shell looks very much like a small *P. triformis* (Reeve) from Australia, but the fact that it was taken alive would seem to perclude the possibility of artificial transport from Australia to the Gulf of Mexico. A similar situation occurs with *Pterochelus phillipsi* E. H. Vokes, a species described from the California coast. This species is exceedingly close to *P. duffusi* (Iredale) and were it not taken alive the writer would have had grave doubts concerning the locality data. The extreme similarity of all the Recent and fossil forms suggests that these resemblances are due to the ultraconservatism of the group and not to mistaken locality data. In the Pliocene of England there is another species of *Pterochelus*, *P. elegantula* (Harmer), which is very much like *P. ariomus*, and presumably gave rise to it.

Subgenus PURPURELLUS Jousseaume, 1880

Purpurellus JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.
Type species: *Murex gambiensis* Reeve, by original designation.
Triremis "Bayle MS" FISCHER, 1884, Man. de Conchyl., p. 641.
Type species: *Murex gambiensis* Reeve, by original designation.

PTERYNOTUS (PURPURELLUS) REPETITI E. H. Vokes, n. sp.

Plate 3, figs. 4a, 4b

Diagnosis: Nature of protoconch and early whorls unknown; probably six post-nuclear whorls in adult. Shell surface completely smooth; suture appressed. Axial ornamentation consisting of three rows of flared varices ascending the spire in an almost straight line; a single knob-like projection in each intervarical area. Spiral ornamentation visible only on abapertural side of varices as very faint ribs, reflecting the stronger ribbing on the varical face; varices composed of multiple layers of shell, folded back from a smooth rim; crenulated by ten to twelve strong folds; at the shoulder an open channel produced but covered over by a down-folded flap of shell material and seen only if specimen is broken. Aperture oval, completely surrounded by a smooth, raised peristome. Siphonal canal long, straight, wide, covered over by a widened portion of the columellar lip, which is cemented to the outer lip; after varix is abandoned the point of juncture with this flap and the outer lip remains as an indentation at the base of the body whorl; distal end of siphonal canal slightly recurved.

Dimensions of holotype: height (incomplete) 53.5 mm [estimated total height 60 mm], diameter 28 mm.

Holotype: USNM 646438.

Type locality: TU 866, marl pit on north side of Webb Creek and east side of unnumbered county highway, Silverdale, Onslow County, North Carolina.

Occurrence: "Silverdale Beds," North Carolina; early lower Miocene.

Figured specimen: USNM 646438 (holotype).

Discussion: This new species is the earliest known occurrence of the subgenus *Purpurellus*. It is found at Silverdale, Onslow County, North Carolina, in a fauna that is unique in western Atlantic localities. The fauna at Silverdale, which is thought to be early lower Miocene (Aquitanian) in age*, is more closely allied with the European localities of Miocene age and the Recent west American fauna than with any other western Atlantic fauna. Thus it was not totally unexpected that the only western Atlantic *Purpurellus* should appear here. From the modern disjunct distribution of the group it is obvious that there had to have been passage through the western Atlantic region, as the Recent species are found on the west coast of Africa and the west coast of tropical America but nowhere else. That it is also the earliest occurrence is perhaps fortuitious, but no specimens are reported before the Burdigalian in Europe.

It is difficult to compare this new species with its congeners for all are so very similar that they could quite comfortably be placed in synonymy but this would serve little purpose. Among the European species it is closest to *P. cyclopterus* (Millet, 1866), of which *P. gastaldii* (Bellardi, 1872) is probably a synonym, but differs in having a higher spire and more pronounced sutural indentation. *P. vernayi* (Paulucci) possesses marked spiral ribs, but has approximately the same shell shape as *P. repetiti*. *P. bellardii* (Seguenza), *P. latilabris* (Bellardi)

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* See Vokes, 1967, p. 140, for a discussion of the problems of a formational name for these beds at Silverdale.

and *P. ampistus* (de Gregorio) all differ in having a marked shoulder spine, which reminds one of the *Pterochelus* ancestry. The Recent species seem more akin to those latter forms than to the geographically intermediate *P. repetiti*.

This new species is based upon three, unfortunately all poor, specimens from the type locality. The holotype was collected by the writer and two unfigured paratypes are in the collection of Mr. Richard E. Petit, of Ocean Drive Beach, South Carolina, who kindly loaned them for comparison.

Genus POIRIERIA Jousseaume, 1880

Subgenus POIRIERIA s.s.

Poirieria JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.
Type species: *Murex zelandicus* Quoy and Gaimard, by original designation.

POIRIERIA (POIRIERIA) WOODSENSIS
E. H. Vokes, n. sp.

Plate 4, figs. 1a, 1b, 2a, 2b

Murex morulus Conrad. HARRIS, 1897, Acad. Nat. Sci. Phila., Proc., v. 48, p. 476, pl. 20, fig. 12 (*not* of Conrad).
Phyllonotus morulus (Conrad). HARRIS, 1899, Bulls. Amer. Paleontology, v. 3, no. 11, p. 63, pl. 8, fig. 7 (*not* of Conrad).
Murex morulus Conrad. WRIGLEY, 1930, Malac. Soc. London, Proc., v. 19, p. 105 (in part, *not* of Conrad).
Eupleura morula (Conrad). PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 669 (in part, *not* of Conrad).

Diagnosis: Shell with three, possibly four, smooth conical nuclear whorls, ending at a small but pronounced varix; seven post-nuclear whorls in the adult. Axial ornamentation of seven varices on each post-nuclear whorl from the first to the last. On the whorls of the spire varices simple but bent back sharply into a large spine at the shoulder; on the body whorl three smaller spines between the shoulder and the siphonal canal with one additional spinelet on the canal. Spiral ornamentation almost totally lacking, only faint spiral threads visible in the intervarical areas. Aperture triangular in outline, opening into the shoulder spine and the smaller spines of the apertural varix. Inner lip with a callus, which is appressed at the posterior end but standing free at the anterior end. Both inner and outer lips completely smooth. Siphonal canal moderate in length, open, slightly recurved. In the adult a large false umbilicus is developed.

Dimensions of holotype: height 23 mm, diameter (including spines) 16 mm.
Holotype: ANSP 7059.
Type locality: Woods Bluff, Tombigbee River, Clarke County, Alabama.
Occurrence: Hatchetigbee Formation, Alabama; lower Eocene.
Figured specimens: Fig. 1, ANSP 7059 (holotype). Fig. 2, ANSP 7059a (paratype); height (incomplete) 37 mm, diameter 28 mm; locality same as holotype.

Discussion: The specimen figured by Harris (1897, pl. 20, fig. 12) as *Murex morulus*, from the lower Eocene beds of Alabama, is not that species but is a new species here named *P. woodsensis*. Wrigley (1930, p. 105) noted that this shell as figured by Harris was near *P. subcristatus* (d'Orbigny) from the London Clay, and added that the Midway and the Lignitic forms of "*Murex morulus*" were doubtfully the same. He stated that *P. subcristatus* "has a special importance in giving a clue to the affinities of the species, for in all essential characters it closely resembles the Recent *Murex zelandicus*, Quoy and Gaim., which is the genotype of *Poirieria*, Jousseaume, 1881." Wrigley's evaluation was absolutely correct. It is possible that the European *P. subcristatus* and the American *P. woodsensis* are conspecific and both are so close to *P. zelandicus* that they are scarcely to be distinguished.

In the type lot at the Academy of Natural Sciences of Philadelphia there are four specimens from Woods Bluff, Tombigbee River, Alabama. The largest of these, although incomplete, measures 37 mm in height, considerably larger than any known specimens of *P. harrisi* (new name for *Murex morulus* Conrad *non* Schröter) with which it was confounded by Harris. The aperture is completely lacking in any type of denticles, the chief characteristic separating the two subgenera *Poirieria* s.s. and *Paziella*. *P. harrisi* has five strong denticles on the outer lip.

The holotype of *P. woodsensis* is the smallest specimen in the type lot but is the best preserved and was selected for this reason. In all aspects it is the same as the larger specimens except for the development of a pronounced umbilicus in the largest specimen (see pl. 4, fig. 2). Harris noted that "in this collection there are specimens of various sizes, and they show one marked peculiarity. When small and young the an-

terior canal is long but curved; afterwards it seems to grow no more in length, but becomes extremely bent or twisted, and a large umbilicus is formed." (1897, p. 476).

Another species from the Hatchetigbee Formation of Alabama, also figured by Harris, is *Trophon caudatoides* Aldrich, 1886. Subsequently referred by some authors to the genus "*Murex*" it nevertheless seems more akin to *Trophon* than to *Murex*. The number of varices is more numerous on all whorls, both early and late. Unlike *Paziella*, which has about six varices on the adult body whorl, the type specimen of *T. caudatoides* has ten varices on the broken body whorl and 13 on the penultimate whorl.

Poirieria (Poirieria) clenchi (Carcelles)

Murex clenchi Carcelles, 1953, Mus. Hist. Nat. Montevideo, Comun. Zool., v. 4, no. 70, p. 7, pl. 5, figs. 23-28.

Diagnosis: Shell muriciform, elongate, thin, fragile, porcelaneous white, almost transparent, with 5½ whorls and two nepeonic whorls; the spire is short, the last whorl is twice the rest of the shell, the aperture is semioval (in the complete example), very thin and almost completely separated from the last whorl, except above where it is united by a varical spine; in the broken example the aperture is subpyriform and is completely separated from the whorl. The labral edge is very angular at its posterior end; the columellar edge is thin, smooth and somewhat curved; the siphonal canal slightly deep and narrow, very elongate, being curved at the end, the deflection of the last segment is very accentuated; the sutural line slightly deep but well marked; the strip [anterior prolongation of the columellar lip] is separated from the edge of the canal, the whorls are very angular and from the continuation of the suture can be seen a slightly oblique zone, smooth and with fine growth striae; on the middle part of these whorls long, open (viewed from the front) ascending spines are borne; toward the bottom is noted a zone which has marked regular spiral striae which can be seen at a glance, these stop, truncated by the termination of the growth lines, in the angle of which are borne the spines which measure up to 16 mm in length, five spines may be counted on the last whorl, and seven on the penultimate and antepenultimate. (Carcelles, 1953, *translated*)

Dimensions of holotype: height 51.9 mm, diameter 25 mm.

Holotype: Mus. Nat. Hist. Montevideo no. 25146.

Type locality: Lat. 38° 24′ S, Long. 55° 36′ W, in 89.61 meters (off Bahia Blanca, Argentina).

Occurrence: Recent only, southern Atlantic.

Discussion: *P. clenchi* is a bizarre form, apparently most closely related to the other Southern Hemisphere species *P. zelandicus* from New Zealand. This species is unusual in that there is a marked tendency for the last whorl to become separated from the spire in a manner akin to that seen in the cancellarid genus *Trigonostoma*. This is the only muricine species at present known from the southern Atlantic; but this is probably a result of scant collecting rather than a true reflection of the fauna.

Subgenus Paziella Jousseaume, 1880

Paziella Jousseaume, 1880, Le Naturaliste, Année 2, no. 42, p. 335.
Type species: *Murex pazi* Crosse, by original designation.

Bathymurex Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 41.
Type species: *Murex* (*Bathymurex*) *atlantis* Clench and Pérez Farfante, by original designation.

Dallimurex Rehder, 1946, Nautilus, v. 59, p. 142.
Type species: *Murex nuttingi* Dall, by original designation.

Poirieria (Paziella) harrisi E. H. Vokes, *nom. nov.*

Plate 4, figs. 3a, 3b

Murex morulus Conrad, 1860, Acad. Nat. Sci. Phila., Jour., (Ser. 2) v. 4, p. 293, pl. 47, fig. 28; Conrad, 1865, Amer. Jour. Conch., v. 1, no. 1, p. 16. *Non Murex morulus* Schröter, 1805.

Murex morulus Conrad. Aldrich, 1886, Alabama Geol. Surv., Bull. 1, pt. 1, p. 59.

Murex morulus Conrad. De Gregorio, 1890, Ann. Géol. Paléontologie, livr. 7, p. 95, pl. 7, fig. 35 (after Conrad, 1860).

Murex morulus Conrad. Cossmann, 1893, Ann. Géol. Paléontologie, livr. 12, p. 32.

Trophon morulus (Conrad). Harris, 1896, Bulls. Amer. Paleontology, v. 1, no. 4, p. 214, pl. 20, fig. 1.

Not *Murex morulus* Conrad. Harris, 1897, Acad. Nat. Sci. Phila., Proc., v. 48, p. 476, pl. 20, fig. 12 (= *P. woodsensis* Vokes, n. sp.).

Not *Phyllonotus morulus* (Conrad). Harris, 1899, Bulls. Amer. Paleontology, v. 3, no. 11, p. 63, pl. 8, fig. 7 (= *P. woodsensis*).

Pagodula morula (Conrad). Cossmann, 1903, Essais Paléoconch. Comp., v. 5, p. 193.

Murex morulus Conrad. Wrigley, 1930, Malac. Soc. London, Proc., v. 19, p. 105 (in part = *P. woodsensis*).

Trophon morulus (Conrad). Brann and Kent, 1960, Bulls. Amer. Paleontology, v. 40, no. 184, p. 884.

Murex morulus Conrad. Moore, 1962, Acad. Nat. Sci. Phila., Proc., v. 114, p. 78.

Murex morulus Conrad. E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 15.

Eupleura morula (Conrad.) Palmer and Brann, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 669 (in part = *P. woodsensis*).

Diagnosis: "Fusiform, whirls angular, with distinct spines on the angle, two or three of which are produced; ribs longitudinal, oblique, foliated, acute; angle of body-whirl situated about the middle of the shell; beak sinuous, angle of aperture extending into an elongated, recurved spine." (Conrad, 1860)

Dimensions of holotype: height 15 mm, diameter (including spines) 11 mm.

Holotype: ANSP 14225.

Type locality: (?) Matthews Landing, Alabama River, Wilcox County, Alabama.

Occurrence: Matthews Landing Marl, Alabama; Paleocene.

Figured specimen: ANSP 14225 (holotype). Other occurrences: TU locality nos. 325, 735.

Discussion: This species, together with *Pterynotus matthewsensis*, is found in the Paleocene beds of Alabama, making it one of the oldest known muricine species.* It is not especially rare but it is a small form, the holotype being the largest specimen seen.

Harris (1897, pl. 20, fig. 12) figured a specimen from the lower Eocene Hatchetigbee Formation at Woods Bluff, on the Tombigbee River, Alabama, which he referred to "*Murex morulus*" but it is not the same species. Harris's specimen is here selected as the type of a new species given the name *P. woodsensis*. The name *Murex morulus* of Conrad is preoccupied by that of Schröter, 1805, and, therefore, a new name is here proposed.

* A possibly identical form occurs in the Paleocene of Denmark, "*Murex*" *nanus* Ravn, 1939 (K. Danske Vidensk. Selsk., Biol. Skr., v. 1, no. 1, p. 78, pl. 3, fig. 7). Unfortunately that name is preoccupied by *Murex nanus* Anton, 1839, and thus is not available as a substitute name. Ravn's type material is a juvenile shell 2.8 mm in height so it is not certain that it is a synonym of *P. harrisi*, but it is suspiciously close, and hence will not be renamed here.

Poirieria (Paziella) dominicensis (Gabb)

Plate 4, figs. 4a, 4b

Trophon dominicensis Gabb, 1873, Amer. Phil. Soc., Trans., (N. S.) v. 15, pt. 1, p. 202.

[*Murex*] *dominicensis* (Gabb). Dall, 1896, U. S. Natl. Mus., Proc., v. 19, no. 1110, p. 313.

Murex (*Trophon*) *werneri* Toula, 1911, K.-K. Geol. Reichsanst., Jahrb., v. 61, p. 479, pl. 29, figs. 9a, 9b.

Trophon dominicensis Gabb. Pilsbry, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 354, pl. 28, figs. 2, 3 (lectotype).

"*Trophon*" *dominicensis* Gabb. Woodring, 1928, Carnegie Inst. Washington, Publ. 385, p. 292.

"*Murex* (*Trophon*)" *werneri* Toula. Woodring, 1928, Carnegie Inst. Washington, Publ. 385, p. 292.

[*Paziella* (*Dallimurex*)] *dominicensis* (Gabb). Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217.

[*Paziella* (*Dallimurex*)] *werneri* (Toula). Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217.

[*Poirieria* (*Paziella*)] *dominicensis* (Gabb). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 18.

Diagnosis: "Shell small, broadly fusiform, thin; spire three-fifths the length of the mouth, turriculated; whorls eight, the first three nuclear, round and increasing very little in width, the other five widening more rapidly and angulated. Body whorl truncated above, with a rounded rib on the angle; above this the surface sinuous, convex nearest the suture and concave adjoining the angle; below the angle it is convex in the middle and rounds concavely into a moderate canal. Surface marked by from six to seven blunt varices, each bearing a single spire [*sic*] on the angle of the whorl. Between the varices the surface is shallowly excavated. Crossing both the varices and interspaces, below the angle, there are a few small revolving ribs. Aperture bi-angular posteriorly, narrowed gradually in advance; canal moderate in length, open; outer lip denticulated internally." (Gabb, 1873)

Dimensions of lectotype: height 17.5 mm, diameter (including spines) 11 mm.

Lectotype: ANSP 3252 (selected by Pilsbry, 1922, p. 354).

Type locality: Dominican Republic, exact locality unknown.

Occurrence: Gurabo Formation, Dominican Republic; middle Miocene. (?) Paraje Solo Formation, Veracruz, Mexico; (?) upper Miocene.

Figured specimen: ANSP 3252 (lectotype).

Discussion: The species named *Trophon dominicensis* by Gabb and that one named

Murex (*Trophon*) *werneri* by Toula seem certainly to be the same. The form is rare in both the Dominican Republic, from whence came "*Trophon*" *dominicensis*, and in the Isthmus of Tehuantepec, home of "*Murex*" *werneri*. Gabb had but two specimens in his type lot, one of which was selected by Pilsbry (1922, p. 354) as lectotype. The lectotype measures only 17.5 mm in height but the species attains a larger size for the holotype of "*Murex*" *werneri* is stated to be 30 mm and there is a specimen in the USNM collections that measures 20 mm. This latter specimen comes from the Gurabo Formation at Portrero, Dominican Republic.

The type locality of *Murex werneri* is near Almagres, Veracruz, a station on the Trans-Isthmian Railway, at Kilometer 70, a famous fossil locality in the early days on the railroad. (This is 70 kilometers measured from the terminus at Coatzacoalcos.) There is a great deal of minor faulting in this area and the writer has been unable to find any reference to the stratigraphic horizon exposed at K 70, but it may be the Paraje Solo Formation. This is the same formation in which another species of *Paziella* occurs, *P. septima* Vokes, n. sp. The presence of these two deep-water forms suggests that the Paraje Solo Formation may represent deeper water deposition than is commonly encountered in the fossil record.

Woodring (1959, p. 217) placed this species in the subgenus *Dallimurex* but the writer considers *Dallimurex* to be a synonym of *Paziella* s. s. and sees no reason for the distinction. *P. dominicensis* has about seven varices, which bear a single pointed spine at the shoulder. The spiral ornamentation consists of numerous, very faint spiral ribs and the outer lip is denticulated within.

Olsson (1964, p. 140, pl. 26, figs. 5, 5a) described a species, "*Boreotrophon*" *meridionalis*, from the Neogene (*i.e.*, late Miocene or Pliocene) Esmeraldas Formation of northwestern Ecuador.* This species is closely related to *P. dominicensis*, the principal difference between the Ecuadorian species and *P. dominicensis* being the development in the younger form of two smaller varical spines anterior to the primary spine at the shoulder. Both of these species have but six or seven varices; true *Boreotrophon* (type: *Murex clathratus* Linné) has many more, thinly laminar varices, and does not have the denticulated outer lip of these forms.

* While this paper was in press Emerson and D'Attilio (1970, Veliger, v. 12, p. 271, pl. 39, figs. 3-6) described a Recent species from the Galápagos Islands, "*Murex*" *galapagana*, which is clearly the descendant of *P. meridionalis*. This is the first Recent record of the genus on the west coast of tropical America.

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Plate 1

Figures

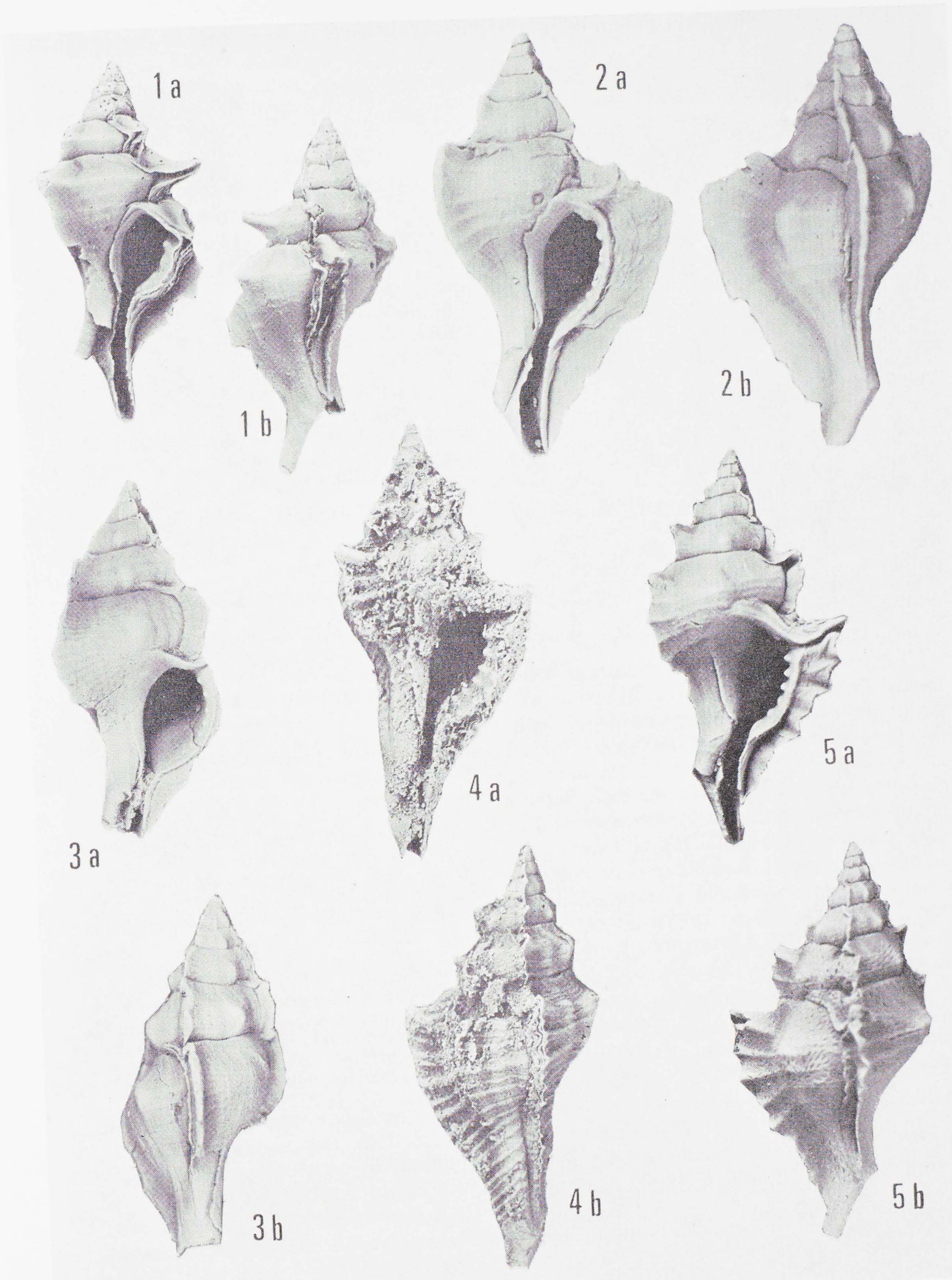

PLATE 1

Poirieria (Paziella) septima
E. H. Vokes, n. sp.

Plate 4, figs. 5a, 5b

Diagnosis: Seven whorls in the adult, nucleus unknown; spire greatly elevated. Axial ornamentation beginning on earliest whorls with seven simple varices, armed with a single sharp spine at the shoulder. Spiral ornamentation lacking on early whorls but gradually developing faint spiral ribs only on anterior portion of whorl; seven ribs on the body whorl, of which the central four are more prominent. Where spiral ribs cross the varices only slight crenulations formed. Nature of aperture not known but by analogy with related forms outer lip almost certainly bearing about a dozen small paired denticles. Siphonal canal open, moderately elongated, recurved, bearing no spinose processes.

Dimensions of holotype: height 33 mm, diameter 17 mm.

Holotype: USNM 646429.

Type locality: USGS 10631, Tuzendepetl [*i.e.*, Tuzantepetl], on Rio Coatzacoalcos, Lat. 18° 1′, Long. 94° 28′; about seven miles east-northeast of Minatitlán, Veracruz, Mexico.

Occurrence: Paraje Solo Formation, Veracruz, Mexico; (?) upper Miocene.

Figured specimen: USNM 646429 (holotype).

Discussion: Although based on four specimens from the Isthmus of Tehuantepec, none of the four is perfect and none has a complete aperture. Three of the specimens are from the collections of the Museum of Paleontology, University of California, Berkeley, and the fourth, the holotype, is from the U. S. National Museum. This new species is closely related to *P. dominicensis*, which occurs in the same area (as *P. werneri*), but may be distinguished by its larger size, higher spire, and less numerous spiral ribs. In general aspect *P. septima* is much like the Recent *P. nuttingi* and *P. oregonia*, lacking, however, the spines on the siphonal canal seen in the Recent forms. *P. dominicensis* is more akin to *P. pazi*, but also lacks the basal spines of the Recent form. This parallel development is interesting in that none of the fossil species of *Paziella* possess these basal spines but most of the Recent species do have them. Only *P. atlantis*, in the Recent fauna, does not have these spines and for this reason was made the type of a new subgenus, *Bathymurex,* by Clench and Pérez Farfante (1945, p. 41). In view of the otherwise almost identical nature of the fossil and Recent species this separation does not seem justified and *Bathymurex* is considered a synonym of *Paziella.*

Poirieria (Paziella) pazi (Crosse)

Plate 5, fig. 1

Murex pazi Crosse, 1869, Jour. de Conchyl., v. 17, p. 183; Crosse, 1870, *ibid.*, v. 18, p. 99, pl. 1, fig. 4.

Murex pazi Crosse. G. B. Sowerby, Jr., 1879, Thes. Conch., v. 4, *Murex*, pl. 22, fig. 208.

Murex (*Phyllonotus*) *pazi* Crosse. Dall, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 199, pl. 15, fig. 1; Dall, 1889, U. S. Natl. Mus., Bull. 37, p. 120, pl. 15, fig. 1.

Murex (*Poirieria*) *pazi* Crosse. Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 44, pl. 23, figs. 1-3.

[*Poirieria* (*Paziella*)] *pazi* (Crosse). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 17, pl. 2, figs. 36, 65.

Diagnosis: "T. breviter fusiformis, sat tenuis, paululum, translucida, unicolor, alba; spira elongata, apice subacute mamillato, laeviusculo; sutura sat profunde impressa, subirregularis varicibus interrupta; anfr. 8-8½ septemvaricosi; primi subangulati, vix aut non spinosi, penultimus varicibus in spinas longiusculas, excavatas desinentibus instructus, ultimus spiram paulo superans, transversim obsoletissime sulcato-striatus, spinis triseriatim dispositis et varicibus correspondentibus ornatus, primis valde elongatis, rectis, ad angulum anfractus, secundis minutis, parum prominulis, versus medium, tertiis longiusculis, subacutis, circa canalem sitis; apertura rotundato-subovata, intus sulcata, alba, in canalem longiusculum, subrecurvum, desinens; perist. album, margine columellari laevigato, subarcuato." (Crosse, 1869)

Dimensions of holotype: height 35 mm, diameter (including spines) 29.5 mm.

Holotype: Collection of Journal of Conchyliologie (Clench and Pérez Farfante, 1945, p. 45).

Type locality: "Maris Antillarum."

Occurrence: Recent only.

Figured specimen: USNM 678944; height 39 mm, diameter (excluding spines) 19 mm; locality, *Silver Bay* Station 2481, off Hollywood, Florida, in 200 fathoms.

Discussion: From the collections made by the U. S. Fish and Wildlife Service M/V *Oregon* and *Silver Bay* it can be seen that there are two forms of *P. pazi.* One of these is the relatively smooth type, as figured by the original author and by Clench and Pérez Farfante (1945, pl. 44, figs. 1-3). The other is a more heavily ornamented shell such as the one figured by Sowerby (1879, fig. 208). The smooth form is apparently confined to the outer side of the Antilles from approxi-

mately north of Havana, Cuba, eastward and along the east Florida coast. The second form is found along the edge of the continental shelf from the Florida Straits around to Honduras. The two forms occur together in the Florida Straits. H. R. Bullis, Jr., Director of the U. S. Bureau of Commercial Fisheries Research Base at Pascagoula, Mississippi, who first noted this division (1964, p. 106), refers to these two forms as "Continental" and "Antillian" (personal communication).

P. pazi is variable in the formation of the apertural lips, both inner and outer. Many specimens do not have these lips and thus resemble *Poirieria* greatly. The specimen here figured shows a completely formed inner and outer lip, marked by denticulations on the outer lip. With these lips developed the resemblance to *P. nuttingi*, type of *Dallimurex*, and *P. atlantis*, type of *Bathymurex*, is more evident. The holotype of *P. nuttingi* (here figured, pl. 5, fig. 4) does not have a complete aperture but other specimens show that when completed the aperture of this species is identical to *P. pazi* and *P. oregonia* (Bullis).

P. pazi is an inhabitant of deep water with records ranging from 112 to 338 fathoms, most being deeper than 200 fathoms (Springer and Bullis, 1956, p. 29; Bullis and Thompson, 1965, p. 15; Clench and Pérez Farfante, 1945, p. 45). It is not rare at these depths being reported from 14 stations by these authors, and it also has been taken at a dozen or more additional stations by the *Oregon* and *Silver Bay*.

Poirieria (Paziella) atlantis (Clench and Pérez Farfante)

Plate 5, figs. 2a, 2b

Murex (*Bathymurex*) *atlantis* Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 41, pl. 21, figs. 3-5.

[*Poirieria* (*Paziella*)] *atlantis* (Clench and Pérez Farfante). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 17, pl. 2, fig. 31.

Diagnosis: "Shell small, about 23 mm (about one inch) in length, rather thin and spinose. Whorls seven and strongly convex. Color a dull white. Spire well extended. Suture deeply impressed. Aperture subcircular, small and porcellaneous white within. Parietal lip smooth, adnate above and very slightly free below. Palatal lip smooth but possessing a series of small denticles below the margin on the lower half of the lip. Siphonal canal narrow, long, recurved upward and angled toward the right near the base. Previous siphonal canals remain as spur-like spines, the last one almost as long as the present canal, making it appear bifurcated. Axial sculpture consists of six low varices, each of which supports a rather long, slightly recurved, single, open spine at the shoulder of the whorl. Below this spine there are a few small knobs where the spiral ribs cross. Spiral sculpture consists of numerous fine and coarse ribs, the coarse ribs forming the little knobs as they pass over the varices. Nuclear whorls one and one-half, small, smooth and rounded, the first whorl moderately twisted. Post nuclear whorls similar to the latter whorls but having the shoulder spine relatively smaller. Operculum unknown. No periostracum." (Clench and Pérez Farfante, 1945)

Dimensions of holotype: height 23.5 mm, diameter (excluding spines) 10.5 mm.

Holotype: Harvard MCZ 164684.

Type locality: *Atlantis* Station 3333, Bahía de Cochinos, Santa Clara Province, Cuba, in 190 to 200 fathoms.

Occurrence: Recent only.

Figured specimen: Harvard MCZ 164684 (holotype).

Discussion: *P. atlantis* is based on a single specimen from the south side of Cuba. The holotype differs from *P. pazi* only in lacking the row of spines encircling the base of the canal. For this reason the species is not placed in synonymy but it is suspected that more material might change this decision.

As was noted above in the discussion of *P. septima* n. sp., *P. atlantis* is the only Recent species lacking the basal row of spines. If *P. atlantis* is a valid species then it represents the more primitive form of *Paziella*. It may be that this single specimen is an aberrant shell for, in spite of large collections made in the western Atlantic region by the U. S. Fish and Wildlife vessels, no more specimens have been taken. However, H. R. Bullis, Jr., Base Director of the U. S. Fisheries Station at Pascagoula, Mississippi, who is in charge of these vessels, has observed (*in litt.*): "Cuba has provided a tremendous number of type localities while remaining one of the most poorly known faunas of the entire western Atlantic as far as I am concerned. It does not seem at all unreasonable that the *atlantis* could as easily turn out to be one of the most common species of the island once it has been properly surveyed."

Poirieria (Paziella) nuttingi (Dall)

Plate 5, figs. 4a, 4b

Murex nuttingi Dall, 1896, University Iowa, Lab. Nat. Hist., Bull., v. 4, no. 1, pt. 2, p. 13, pl. 1, fig. 1.

Murex (*Murexsul*) *nuttingi* Dall. Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 49, pl. 25, fig. 5.

Paziella (*Dallimurex*) *nuttingi* (Dall). Rehder, 1946, Nautilus, v. 59, p. 142.

[*Poirieria* (*Paziella*)] *nuttingi* (Dall). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 17, pl. 2, fig. 30.

Diagnosis: "Shell white with a pale straw-colored epidermis and eight whorls exclusive of the (lost) nucleus; suture deep, whorls rounded (the last) crossed by eight varices, each bearing a rather long grooved spine at the shoulder and anteriorly about six smaller and less conspicuous spinules, each of which corresponds to a more or less distinct revolving thread; at the shoulder and behind it there is no revolving sculpture or only faint traces of it; the apical three or four whorls show angular points, rather than spines, which are partly the result of wear; canal rather long, shorter than the spire, with a wreath midway of long recurved spines, each corresponding to a varix; the siphonal fasciole imbricated by the canal-ends of successive resting-stages; pillar white, moderately callous; canal open; outer lip modified by the sculpture, not lirate; operculum pale-brown, kite-shaped, the nucleus at the acute end which is nearly straight." (Dall, 1896)

Dimensions of holotype: height 44.4 mm, diameter (excluding spines) 20.5 mm.

Holotype: USNM 107372.

Type locality: Eight miles east of Sand Key (near Key West), Florida, in 15 fathoms.

Occurrence: Recent only.

Figured specimen: USNM 107372 (holotype).

Discussion: "*Murex*" *nuttingi* Dall was selected by Rehder (1946, p. 142) to be the type species of a new subgenus, *Dallimurex*, said to differ from *Paziella* "in having stronger laminated varices, which have the spine on the shoulder shorter and stouter, and which bear numerous shorter spines below the shoulder. The whorls below the shoulder have strong irregular spiral ridges, which culminate in the varical spines." The two Recent species he included in this new subgenus are *P. nuttingi* and "*Murex*" *carnicolor*, here referred to *Poirieria* (*Panamurex*). The description of the subgenus was a combination of the features of these two species for the strong spiral ridges seen in *P. carnicolor* are greatly reduced in *P. nuttingi* and although *P. nuttingi* is more spinose than *P. pazi* the differences are of a specific rather than generic degree. Bullis (1964, p. 106) noted that "*Murex pazi* and *M. nuttingi* are more similar in shell characters than has been previously indicated, with the former showing a great range of sculpturing." The fossil species, for which in part the new subgenus was proposed, are *P. lychnia* and *P. fusinoides* from the Chipola Formation, both here placed in the subgenus *Panamurex*, which has strong spiral sculpture.

The type specimen of *P. nuttingi* is said to have come from a depth of 15 fathoms but the species usually lives much deeper. It has been reported only from 110 fathoms (Springer and Bullis, 1956, p. 28) and 200 fathoms (Bullis and Thompson, 1965, p. 15). It also was taken at *Oregon* Station 1255 in 120 fathoms.

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Plate 2

Figures

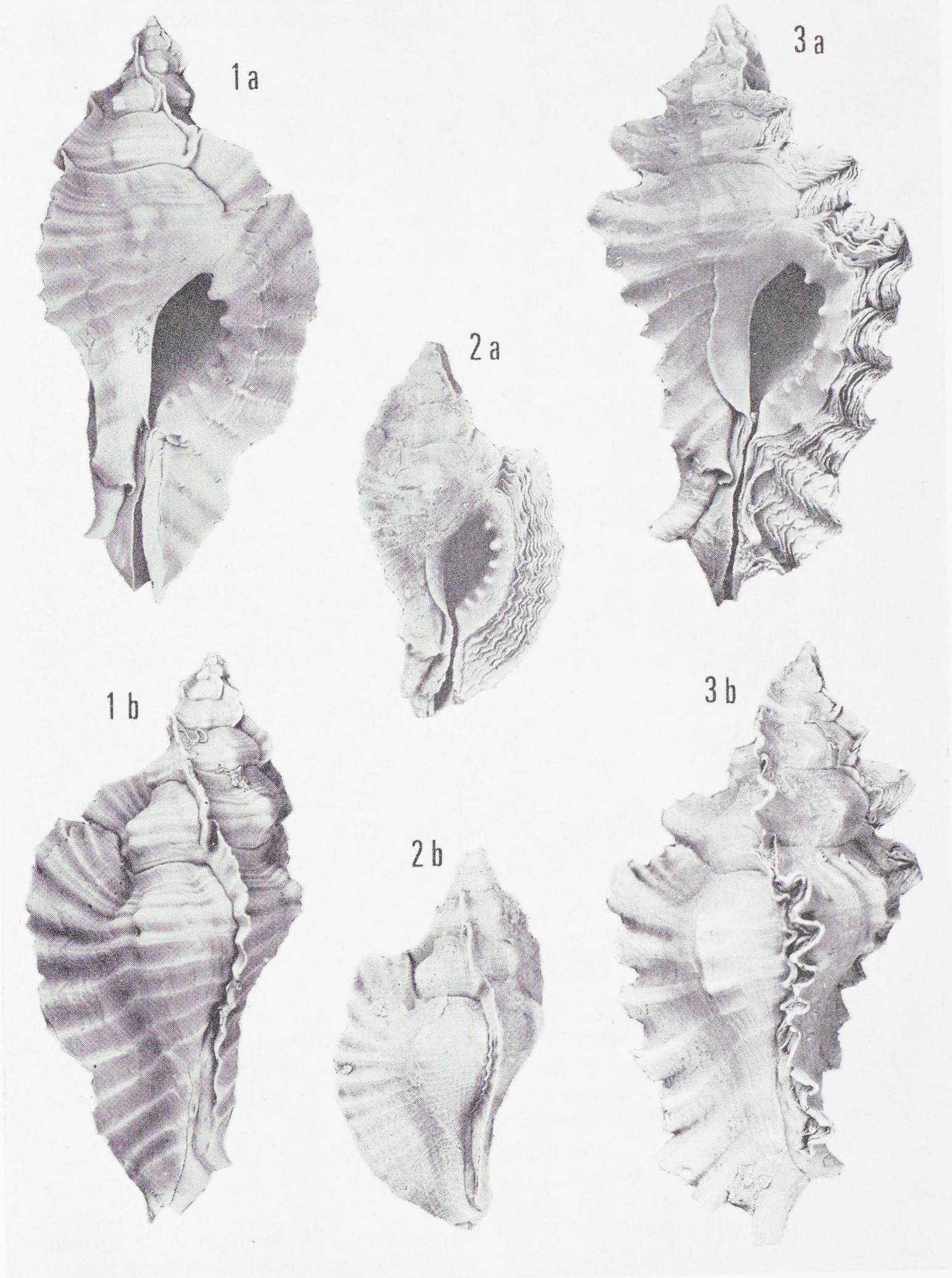

PLATE 2

Poirieria (Paziella) oregonia (Bullis)

Plate 5, fig. 3

Murex (*Poirieria*) *oregonia* Bullis, 1964, Tulane Stud. Zool., v. 11, no. 4, p. 106, figs. 5, 6.

Diagnosis: "Shell heavy, elongate, and strongly sculptured. Apex eroded (as are all mature specimens in the series), 8 whorls remaining. Aperture elongate, leading into an extended siphonal canal. Outer lip flared, sharp, somewhat crenulate on the edge and with 13 teeth on the inner margin; the lip supports a strong, upturned, imbricate and hollowed spine at the shoulder. Parietal wall with a raised, erect, shield-like callus. Spire turreted, with a deep, irregular suture. Spiral sculpturing of eight strong cords between the base and shoulder. Axial sculpture of nine varices supporting eight upturned imbricate spines which correspond to the cords, plus the shoulder spine, and a pair of long spines on the base of the siphonal canal. The penultimate whorl has eight varices with the sub-shoulder spines absent, but with nodules at the crossing of the cords and varices, with three cords left exposed. On the rest of the spire only two cords are exposed. The varices cross the shoulder with a step-like overlapping of the succeeding section. Growth lines in the form of undulating wrinkles are most evident on the shoulder. The eight spines below the shoulder on the last varix are imbricately doubled and not directly connected to the margin of the lip. The second varix is similar but a few of the forward spines directly receive involutions of the former lip. This is more so on the third varix and entirely the case on the fourth. Five previous anterior canals are present. Operculum dark reddish-brown, unguiculate, broadly oval with a terminal apex, and strongly sculptured with growth lines. The radula is large; the rachidian has five cusps of about equal length. The middle and outer two cusps are slightly stouter. The laterals are triangulate and hooked." (Bullis, 1964)

Dimensions of holotype: height 85.2 mm, diameter (excluding spines) 37.8 mm.

Holotype: USNM 635149.

Type locality: *Oregon* Station 2023, 95 miles north of Pte. Mana, French Guiana, in 135 fathoms.

Occurrence: Recent only, from Trinidad south to the Equator along the coast of Brazil.

Figured specimen: USNM 635149 (holotype).

Discussion: *P. oregonia* is closely related to *P. nuttingi* (Dall) but is much larger than that species. It also may be distinguished from *P. nuttingi* by the presence of two rows of spines on the siphonal canal in place of the single row seen in *P. nuttingi.* It is a deep-water form, records ranging from 105 to 275 fathoms; however, it is not rare at these depths for Bullis reported over 175 paratypes, including 150 at one locality.

Subgenus Flexopteron Shuto, 1969

Flexopteron Shuto, 1969, Mem. Fac. Sci., Kyushu Univ., Ser. D, Geol., v. 19, no. 1, p. 111.

Type species: *Flexopteron philippinensis* Shuto, by original designation.

Poirieria (Flexopteron) collata (Guppy)

Plate 4, figs. 6a, 6b

Murex collatus Guppy, 1873, Sci. Assoc. Trinidad, Proc., v. 2, p. 83, pl. 1, fig. 8; Guppy, 1874, Geol. Mag., (Decade 2) v. 1, p. 433, 438; pl. 16, fig. 8.

Muricidea collata (Guppy). Dall, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1584.

"*Muricopsis*" *collatus* (Guppy). Woodring, 1928, Carnegie Inst. Washington, Publ. 385, p. 291, pl. 17, figs. 10, 11 (holotype).

[*Paziella* (*Dallimurex*)] *collatus* (Guppy). Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217.

[*Poirieria* (*Paziella*)] *collatus* (Guppy). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 18.

Diagnosis: "Ovate, rimate, slightly flattened, adorned with numerous thin slightly fimbriate or crenulate varices often doubled, especially the later ones; about seven on the last whorl; their interstices indistinctly crossed by low transverse costae which terminate in points on the varices; the upper point large, acute and projecting, giving an angulate appearance to the shell; varices uniting below to form an irregular and contorted canal. Whorls 6-7, somewhat angulate. Spire sharp. Outer lip expanded and crenulate, obtusely dentate within. Pillar-lip smooth." (Guppy, 1873)

Dimensions of holotype: height 22 mm, diameter 15 mm.

Holotype: USNM 115479.

Type locality: Bowden, Jamaica (= TU 705).

Occurrence: Bowden Formation, Jamaica; (?) upper Miocene.

Figured specimen: USNM 115479a (paratype); height 20 mm, diameter 13 mm, locality same as holotype. Other occurrences: TU locality no. 705.

Discussion: There are two specimens in the type lot of Guppy's "*Murex*" *collatus.* Woodring (1928, p. 291) identified and figured the larger of the two as the holotype but the slightly smaller second specimen is better preserved and shows the fine details of ornamentation missing in the holotype. Therefore, the paratype is here figured. This specimen does not show the strong denticu-

lations seen on the outer lip of the holotype. The species is not especially rare at the type locality, the writer has collected three incomplete examples there, but it is known from nowhere else.

The generic placement of this species has proved difficult to authors, as may be seen in the above synonymy. The writer (Vokes, 1964, p. 18) referred the form to the subgenus *Paziella* with, however, some unexpressed doubt. In a work on the Neogene gastropods of the Philippine Islands, Shuto (1969, p. 111) has proposed a new genus *Flexopteron* with the type a new species, *F. philippinensis*. This new species (*loc. cit.*, p. 112, pl. 8, figs. 1, 2) is very much like "*M.*" *collatus* and it seems reasonable to include the Caribbean species in this new group. Shuto placed *Flexopteron* in the family Coralliophilidae but the relationship seems to lie with the *Poirieria-Paziella* line.

P. collata occurs in the Bowden Formation of Jamaica. The age assigned to this formation by Woodring (1928, p. 39) was upper middle Miocene (Tortonian). This age assignment has been questioned by the writer (Vokes, 1967, p. 154) and it seems probable that the beds are younger, perhaps even Pliocene, in age. The ecology of the Bowden Formation is very unusual. Woodring (*ibid.*, p. 28-38) gave an excellent discussion of the ecologic implications of the genera present and concluded that the formation represents "deposition along an unusually steep slope in which a narrow coastal shelf was cut and (that) at times the sediments at the edge of the shelf and the shells buried in them were washed down the slope and came to rest at a greater depth, where they were mixed with autochthonous material" (*ibid.*, p. 35-36). This is a reasonable explanation for the mixture of shallow and deep water genera found in a matrix of coarse volcanic rock debris, including boulders as much as six inches in diameter. Unfortunately there are no living representatives of the *Flexopteron* line known to the writer so no ecologic information can here be deduced that might help prove or disapprove this deep-water hypothesis.

Subgenus PAZINOTUS E. H. Vokes, n. subgen.

Type species: *Eupleura stimpsonii* Dall, 1889, Recent, off Barbados, B.W.I., 100 fathoms.

Etymology: An arbitrary combination of *Paziella* and *Pterynotus*. *Gender*: Masculine.

Description: Shell small. Axial ornamentation consisting of a variable number of varices, from four to seven; varices formed by lamellar flanges connecting varical spines, which are a reflection of the spiral ribs ornamenting the shell. Spiral ornamentation moderate in development. Aperture bearing strong denticulations on outer lip; smaller denticulations at anterior end of columellar lip. Siphonal canal open, short, slightly recurved.

POIRIERIA (PAZINOTUS) BOWDENENSIS E. H. Vokes, n. sp.

Plate 5, figs. 5a, 5b

"*Muricopsis*" species WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 292, pl. 18, fig. 1.

Dallimurex species WOODRING, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217.

Diagnosis: "Shell small, slender. Anterior canal relatively long, narrow, tip recurved, projecting shelf broken on only specimen. Umbilical opening absent. Interior of outer lip bearing six heavy denticles. Sculpture consisting of lamellar varices (7 on body whorl). Those on spire bearing spines on shoulders; those on body whorl bearing spines on and below shoulder, but the shoulder spines are longest. Between the varices widely spaced low spiral cords." (Woodring, 1928)

Dimensions of holotype: height 13.9 mm, diameter 6 mm.

Holotype: USNM 369621.

Type locality: Bowden, Jamaica (= TU 705).

Occurrence: Bowden Formation, Jamaica; (?) upper Miocene.

Figured specimen: USNM 369621 (holotype).

Discussion: This unique specimen from the Bowden Formation of Jamaica is the only known fossil example of the subgenus *Pazinotus* in the New World. As the Recent species of the group occur in water from 40 to 100 fathoms in depth, the presence of a specimen of *Pazinotus* at Bowden helps to corroborate Woodring's (1928, p. 35-36) deep-water hypothesis for the origin of the formation. (See under *P. collata*, above, for further discussion.)

Woodring (*ibid.*, p. 292) suggested that this specimen is a juvenile but it has six

post-nuclear whorls and must be almost an adult. The type of the Recent *P. stimpsonii* is slightly smaller and has only five whorls.

Poirieria (Pazinotus) stimpsonii (Dall)

Plate 5, figs. 6a, 6b, 7a, 7b

Eupleura stimpsonii Dall, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 204.
Eupleura stimpsoni Dall. Dall, 1889, U. S. Natl. Mus., Bull. 37, p. 120, pl. 42, fig. 3; Dall, 1890, U. S. Natl. Mus., Proc., v. 12, no. 773, p. 331, pl. 11, fig. 3.
Eupleura stimpsoni Dall. M. Smith, 1953, Illus. Cat. Recent Species Rock Shells, p. 17, pl. 13, fig. 24.
Eupleura stimpsoni Dall. Abbott, 1954, American Seashells, fig. 47a (not in text); Abbott, 1968, North American Seashells, p. 126, fig. 9.

Diagnosis: "Shell small, thin, whitish, not polished, with four varices to the whorl and five whorls; nucleus smooth, white; spiral sculpture of extremely fine faint striae, and of (on the last whorl) five low keels, most prominent on the back of the varices. The posterior keel is produced at the shoulder as a spine, which on the front side of the varix looks as if it were holding up the webbing of the varix as a tent-pole holds a tent; the other keels are represented on the front of the varix only by shallow grooves. The transverse sculpture is composed of well marked incremental lines; above the spine on the last whorl the web of the varix extends to the fifth preceding varix; below the spine it follows the outline of the aperture, nearly, and terminates midway down the canal; the margin is even except at the spine and the ends of the grooves; aperture rounded, continuously marginate except at the open narrow canal; there are four teeth inside the outer lip in front of the spine, and three near the front of the inner lip; the canal is slightly recurved, the end of the antecedent canal projecting from it at the left; suture well marked." (Dall, 1889)

Dimensions of lectotype: height 12 mm, diameter 7 mm.

Lectotype (here designated): USNM 87087.

Type locality: *Blake* Station (unnumbered), off Barbados, 100 fathoms.

Occurrence: Recent only.

Figured specimens: Fig. 6, USNM 87087 (lectotype). Fig. 7, MCZ 7310 (lectoparatype); height 11 mm, diameter 7.4 mm; locality same as lectotype.

Discussion: Although this species was referred to the genus *Eupleura* by Dall there are several obvious differences in the two forms. The primary characteristic of the genus *Eupleura* is the development of a single pair of varices on opposite sides of the shell, giving the aspect of an *Apollon*. True *Eupleura* also lacks the flaring trumpet-like parietal lip seen in *P. stimpsonii*, which is identical to that seen in *P. paziella* (compare pl. 5, figs. 1 and 6), as well as the deflected siphonal canal of the latter two species.

In the type lot of this species there are nine specimens; four are at the Harvard University Museum of Comparative Zoology and five at the U. S. National Museum. All were labeled as "types" by Dall, but one specimen, here designated as lectotype, matches his

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Plate 3

Figures

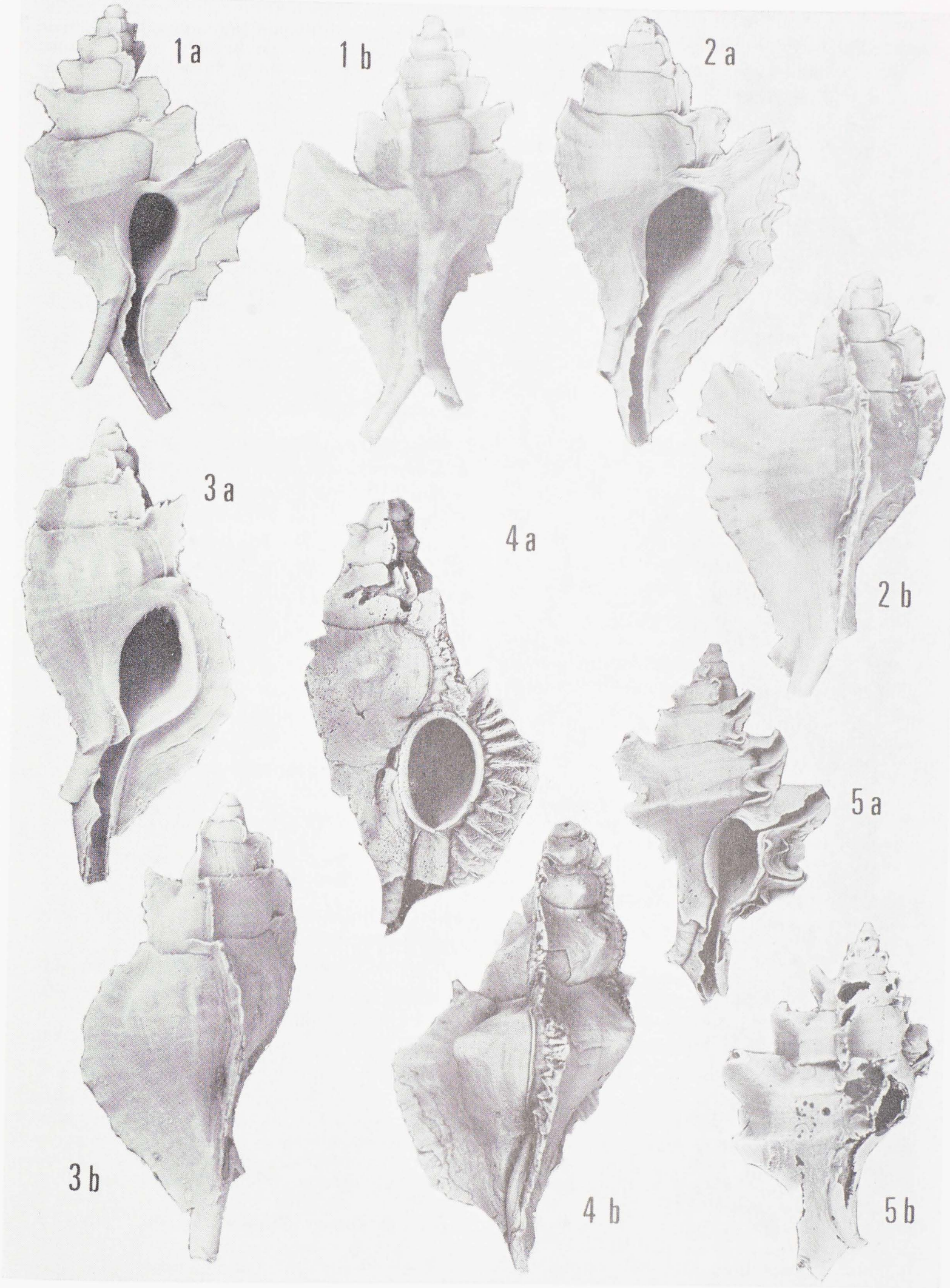

PLATE 3

cited dimensions and was undoubtedly the figured specimen. No others are as large.

Dall described the species as having "four varices to the whorl," but in the type specimen and one other of the type lot there are four and one-half varices to a whorl and in four of the remaining seven lectoparatypes there are five varices on the body whorl. Only two specimens have four varices on the body whorl but each of these has four and one-half on the earlier whorls. One specimen is fragmentary and it cannot be ascertained how many varices it had. In general it can be said that the species has four and one-half to five varices on the body whorl.

Abbott (1968, p. 126) stated that the body whorl of this species has seven or eight varices, but examination of his specimens reveals only five on one, and six on a second. His specimens were taken in 66-70 fathoms, 90 miles southwest of Egmont Key, Florida (at the mouth of Tampa Bay). Numerous specimens have been taken in this same general area by Jim Moore of Palmetto, Florida, who dredges near Anna Maria Key. One of the specimens in the type lot came from 1000 fathoms off Cape San Antonio, at the western tip of Cuba, however this was a dead shell and probably did not live at this extreme depth. Smith's (1953, p. 17) reference to an occurrence off Fernandina, Florida, in 294 fathoms is an error for *Urosalpinx stimpsoni* Dall, a different species.

Subgenus PANAMUREX Woodring, 1959

Panamurex WOODRING, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217.
Type species: *Murex gatunensis* Brown and Pilsbry, by original designation.

POIRIERIA (PANAMUREX) MACNEILI E. H. Vokes, *nom. nov.*

Plate 6, figs. 1a, 1b, 2a, 2b

Murex simplex ALDRICH, 1886, Alabama Geol. Surv., Bull. 1, pt. 1, p. 19, pl. 5, fig. 8. *Non Murex (Typhis) simplex* Philippi, 1841.
Murex simplex Aldrich. MEYER, 1886, Alabama Geol. Surv., Bull. 1, pt. 2, p. 74.
[*Ocinebra (Favartia)*] *simplex* (Aldrich). DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 150.
[*Poirieria (Panamurex)*] *simplex* (Aldrich). E. H. VOKES, 1964, Malacologia, v. 2, no. 1, p. 18.

Diagnosis: "Shell short, stout; whorls probably five; suture deeply impressed; varices numerous, very large and broadly rounded, terminating above near the suture in sharp points; seven on the body whorl, numerous coarse raised revolving lines cover the whorls; aperture small, elliptical, terminating anteriorly in a nearly closed canal; outer lip thickened and crenate within; three folds appear upon the columella." (Aldrich, 1886)

Dimensions of holotype: height 15.5 mm, diameter 9 mm.

Holotype: USNM 644618.

Type locality: "Bryan's Ferry" (*i.e.*, Byram), Hinds County, Mississippi (= TU 66).

Occurrence: Byram Marl, Mississippi; middle Oligocene.

Figured specimens: Fig. 1, USNM 644618 (holotype). Fig. 2, USNM 646432 (topotype); height 23.5 mm, diameter 12.3 mm; locality, Byram, Hinds County, Mississippi.

Discussion: The holotype of *P. macneili* is a juvenile specimen but from other larger specimens in the collections of the U. S. National Museum it can be seen that this species is much like the younger *P. heilprini* and *P. fusinoides*. It is the oldest known form referable to *Panamurex* and bears the characteristic denticulations upon the inner lip.

The name *Murex simplex* of Aldrich is preoccupied by that of Philippi, therefore the writer takes pleasure in renaming this species after F. S. MacNeil, a longtime student of the Oligocene faunas.

POIRIERIA (PANAMUREX) HEILPRINI (Cossmann)

Plate 6, figs. 3a, 3b, 4

Murex spinulosa HEILPRIN, 1887, Wagner Free Inst. Sci., Trans., v. 1, p. 108, pl. 15, fig. 41. *Non Murex spinulosus* Deshayes, 1835.
Murex (Chicoreus?) burnsii Whitfield. DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 141 (in part, *not* of Whitfield).
Muricidea spinulosa (Heilprin). DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 149, pl. 8, fig. 9 (in part = *P. lychnia*).
Muricopsis heilprini COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 34. New name for *Murex spinulosa* Heilprin *non* Deshayes.
Muricidea spinulosa (Heilprin). DALL, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1566.
Chicoreus burnsii (Whitfield). DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 75 (in part, *not* of Whitfield).
Muricidea heilprini (Cossmann). DALL, 1915, U. S. Natl. Mus., Bull. 90, p. 76, pl. 7, fig. 4.
"Muricidea" heilprini (Cossmann). MANSFIELD, 1937, Florida Geol. Surv., Bull. 15, p. 132.

"*Murex spinulosa*" Heilprin. Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 218.

Diagnosis: "Shell elevated, elongated, about equally attenuated to both extremities; whorls strongly angulated superiorly, bearing short, outwardly directed, spines on the shoulder angulation; a row of similar (supra-basal) spines in the siphonal region; aperture about one-half the length of shell, the canalicular portion the longest; umbilicus long and open; surface of shell below the shoulder with a limited number of prominent revolving lines, four on the body-whorl. (Heilprin, 1887)

Dimensions of holotype: "Length, slightly exceeding one inch; width, half-inch." (Heilprin, 1887, p. 108).

Holotype: Wagner Free Inst. Sci. 870.

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

Occurrence: Tampa Limestone, Florida; lower Miocene.

Figured specimens: Fig. 3, USNM 165089; height 23.5 mm, diameter 13 mm. Fig. 4, USNM 112065; height 10 mm, diameter 7 mm. Locality of both, Ballast Point, Tampa Bay, Florida.

Discussion: According to Mansfield (1937, p. 132) this species is "quite common" at the type locality. There are numerous specimens in the collections of the U. S. National Museum but none are well preserved. The small specimen figured here (plate 6, fig. 4) is perhaps the best of the lot. This is the specimen that Dall (1890, p. 141; 1915, p. 75) considered to be a juvenile of "*Murex*" *burnsii* Whitfield. Whitfield's holotype has been recently figured by the writer (Vokes, 1968a, pl. 7, fig. 2) and it can be seen that the two species resemble each other only slightly.

P. heilprini is closely related to the middle Oligocene *P. macneili*, the principal difference in the two species being the stronger, more numerous spiral ribs of the older form. *P. heilprini* has five weak spiral ribs, including that at the shoulder, but *P. macneili* has seven moderately strong ribs. *P. heilprini* is also much like the younger Chipola species *P. fusinoides*. The spiral ornamentation in *P. fusinoides* is stronger than that of *P. heilprini* but because of the poor preservation of the Tampa specimens the differences may not be as great as they appear.

Woodring (1959, p. 218) did not include *P. heilprini* in his subgenus *Panamurex* but stated that it "evidently represents a different muricine genus." In view of the strong similarity between the three species noted above, two of which are definitely to be referred to *Panamurex*, it seems unreasonable not to include *P. heilprini* also.

Poirieria (Panamurex) laccopoia (Gardner)

Plate 7, figs. 1a, 1b

Muricopsis laccopoia Gardner, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 529, pl. 52, figs. 40, 41.

[*Paziella* (*Panamurex*)] *laccopoia* (Gardner). Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217 (in synonymy of *P. fusinoides*).

[*Poirieria* (*Panamurex*)] *laccopoia* (Gardner). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 18.

"*Muricopsis*" *laccopoia* Gardner. Jung, 1965, Bulls. Amer. Paleontology, v. 49, no. 233, p. 524.

Diagnosis: "Shell rather small, biconic. Aperture more than half as long as the entire shell. Spire obscurely scalariform, the posterior ramp broken by the axial sculpture; whorls probably 7 in number in the perfect adult, regularly and rapidly increasing in diameter. Body relatively large, inflated medially, abruptly constricted into the rather slender pillar. Volutions closely appressed, the posterior margin transgressing at the varices upon the preceding whorl. Suture inconspicuous and irregular. Protoconch rather small, smooth, highly polished, subcylindrical; initial whorl strongly inflated medially, immersed at the tip; succeeding volution also convex, though flattening on the last quarter turn; close of protoconch indicated by a slight thickening of the shell. Axials 6, narrow, elevated, sharply rounded on their summits, equal and equispaced, retractive, the varices continuous, each series performing about half a revolution around the axis of the shell, persistent from the earliest whorl of the conch to the anterior fasciole; intervarical areas broadly concave, wider than the varices excepting on the base of the body whorl, where they wedge out; intervarical depressions deepest toward the posterior suture and to the right of the varix, where a curious little pocket is formed—a character perceptible on the third whorl of the conch and strengthening with the growth of the shell. Spirals coarsely threading the entire conch and equally prominent on the axials and the interaxials; primaries 3 on the whorls of the spire and the medial portion of the body, 3 on the base of the body, and 3 or 4 on the pillar, regular in size and spacing, elevated, obtusely $\wedge$-shaped except on the base of the body and the pillar, where they are less elevated and more rounded; separated for the most part by narrower V-shaped channels, though on the base of the body and the pillar the interspaces are flattened and of approximately the same

width as the spirals; one and, on the later whorls, 2 secondaries intercalated between the posterior primary and the suture; secondary spirals may also be intercalated on the base of the body and the pillar; the primary outlining the shoulder and one or more body spirals spinose at the intersection with the axials. Pillar formed by the closely appressed, overlapping varices, the anterior fasciole also bearing the record of successive canals, 1 to each varix. Aperture rather narrow, spatulate, obtusely angulated posteriorly. Labrum varicated a little behind the thin crenate margin, lirate within. Labium excavated at the base of the body, heavily glazed, smooth except for a few rugae on the pillar near the entrance to the canal. Anterior canal of approximately the same length as the wider opening behind it; narrow, with parallel, proximate margins. Anterior fasciole arcuate, built up from the extremities of the successive terminal varices." (Gardner, 1947)

Dimensions of holotype: height 18 mm, diameter 9.8 mm.

Holotype: USNM 371880.

Type locality: USGS 2213, one mile below Bailey's Ferry, Chipola River, Calhoun County, Florida (= TU 457).

Occurrence: Unknown formation, Chiapas, Mexico; (?) lower Miocene. Chipola Formation and Oak Grove Sand, Florida; (?) late lower Miocene. Shoal River Formation, Florida; middle Miocene.

Figured specimen: USNM 645618; height 26 mm, diameter 14 mm; locality TU 458. Other occurrences: TU locality nos. 69A, 91, 196, 456, 457, 546, 554, 655, 709, 787, 810, 817, 825, 827, 830, 831, 950, 998, 999.

Discussion: All of the species of *Panamurex* are closely related and at first glance several seem to be identical. But upon examination it can be seen that each of the named forms is a valid species. *P. laccopoia* is most like *P. gatunensis* and *P. clarksvillensis*. Between *P. laccopoia* and *P. gatunensis* the angle of the shoulder is one of the most obvious differences, that of *P. gatunensis* being sloped down so that the shoulder spines point outward. This gives the shell a diamond-shaped outline, but in *P. laccopoia* the shoulder spines turn up and produce a more oval outline. Both species possess a labral tooth but in *P. gatunensis* this tooth is separated from the shoulder spine by four spiral ribs and in *P. laccopoia* it is separated by only three. *P. gatunensis* also attains a larger size. The specimen figured by Woodring (1959, pl. 35, figs. 6, 7), if complete, would measure about 50 mm; the largest specimen seen of *P. laccopoia* is 33 mm. *P. laccopoia* differs from *P. clarksvillensis* in having a much smaller nucleus. The nuclear whorls of *P. clarksvillensis* are approximately 1 mm in diameter and those of *P. laccopoia* are about

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PLATE 4

Figures Page

1-2. *Poirieria (Poirieria) woodsensis* E. H. Vokes, n. sp. 17
1. (× 2) ANSP 7059 (holotype); height 23 mm, diameter 16 mm.
Locality: Woods Bluff, Tombigbee River, Alabama. Hatchetigbee Fm., lower Eocene.
2. (× 1½) ANSP 7059a (paratype); height 37 mm, diameter 28 mm.
Locality: Woods Bluff, Tombigbee River, Alabama. Hatchetigbee Fm., lower Eocene.

3. *Poirieria (Paziella) harrisi* E. H. Vokes, *nom. nov.* (× 3) 18
ANSP 14225 (holotype-*Murex morulus* Conrad); height 15 mm, diameter (including spines) 11 mm.
Locality: Claiborne Bluff, Alabama River, Alabama. Gosport Sand, middle Eocene.

4. *Poirieria (Paziella) dominicensis* (Gabb) (× 3) 19
ANSP 3252 (lectotype); height 17.5 mm, diameter 11 mm.
Locality: Dominican Republic. Gurabo Fm., middle Miocene.

5. *Poirieria (Paziella) septima* E. H. Vokes, n. sp. (× 2) 22
USNM 646429 (holotype); height 33 mm, diameter 17 mm.
Locality: Tuzantepetl, Veracruz, Mexico. Paraje Solo Fm., (?) upper Miocene.

6. *Poirieria (Flexopteron) collata* (Guppy) (× 2) 26
USNM 115479a (paratype); height 20 mm, diameter 13 mm.
Locality: Bowden, Jamaica. Bowden Fm., (?) upper Miocene.

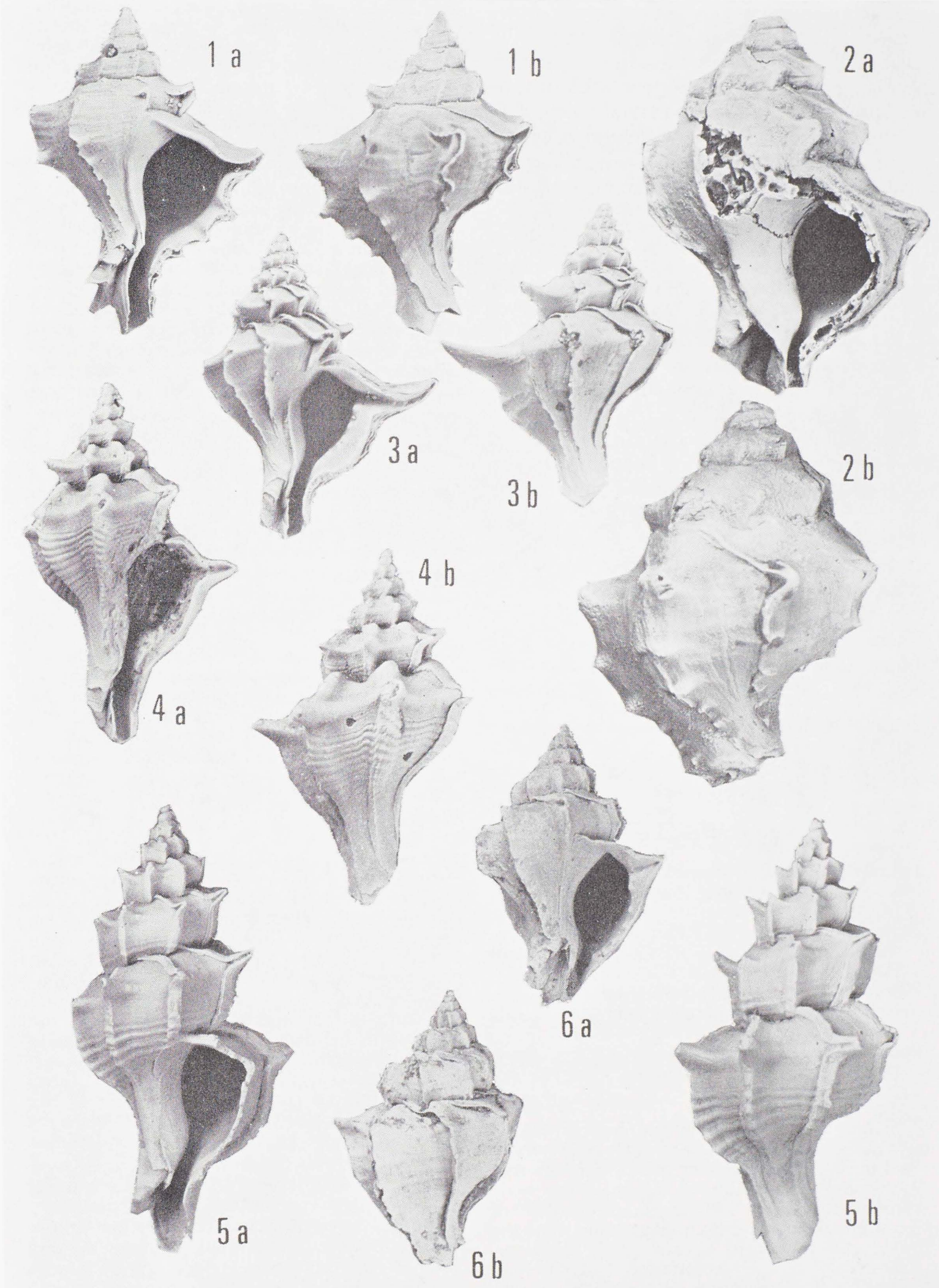

PLATE 4

.4 mm, or less than one-half that of *P. clarksvillensis*. Although Woodring (1959, p. 217) placed *P. laccopoia* in the synonymy of *P. fusinoides* the two species are easily distinguished by the lack of the labral tooth in *P. fusinoides,* by its higher spire and narrower outline, and by the row of spines circling the canal in *P. fusinoides* but lacking in *P. laccapoia.*

P. laccopoia is widespread in the Chipola Formation and is represented in the Oak Grove Sand (TU 91) and the Shoal River Formation (TU 69A). Gardner (1947, p. 530) reported the presence of this species in these two formations also but her material was no better than that in the Tulane collection. In the collections of the Museum of Paleontology, University of California, Berkeley, there is a specimen of *P. laccopoia* from San Gregorio, Chiapas, Mexico, said to be lower Miocene in age. With it is a specimen of *Chicoreus* sp., identical to an undescribed Chipola form, and it seems likely that the Chiapas beds are directly correlative with the Chipola. In northeastern Mexico the Guajalote Formation also carries a Chipola fauna (see Gardner, 1945, p. 19-21) suggesting a seaway between the two extreme occurrences.

Poirieria (Panamurex) fusinoides (Gardner)

Plate 6, figs. 9a, 9b

Paziella (Dallimurex) fusinoides Gardner, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 524, pl. 52, figs. 39, 42.

Paziella [*(Panamurex)*] *fusinoides* Gardner. Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217.

[*Poirieria (Panamurex)*] *fusinoides* (Gardner). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 18.

Paziella (Dallimurex) fusinoides Gardner. Jung, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 524.

Diagnosis: "Shell large and heavy, for the group; fusiform. Aperture about half as long as the entire shell. Whorls of conch probably 8 or 9, regularly increasing in diameter, the early volutions obscurely shouldered, the outline of the later volutions largely determined by the broad and prominent costals. Body whorl inflated, very abruptly constricted into the slender pillar. Sutures inconspicuous, evenly undulated by the costals of the preceding volution. Protoconch like that of *Paziella (Dallimurex) lychnia*, small, smooth, twice-coiled, the initial turn inflated, immersed at the tip, the succeeding whorl well-rounded, flattening toward its close; dividing line between conch and protoconch indicated by a narrow riblike thickening of the shell and by the initiation of the sculpture. Axials on the early volutions narrow but smoothly rounded, feebly retractive, 6 or 7 in number, equisized and equispaced, uniform in elevation from the periphery to the anterior suture but dying out on the ill-defined shoulder; outer margin of the shoulder coronated with short, sharp spines formed by the intersection of the axials with the peripheral spiral. Axials on the later volutions prominent, broadly rounded, varicose but undulatory in character, disappearing rather abruptly a little in front of the posterior suture, thus forming an obscure shoulder; axials persisting, however, to the anterior suture and well down to the base of the body and appearing on the pillar as closely appressed, overlapping folds; component laminae of the varices occasionally free, visible only on the apertural side of the varix and only on the later volutions; sharply frilled by the spirals but not produced into spines except on the shoulder and the medial portion of the pillar; intervarical areas concave and of approximately the same width as the varices. Spiral threading sharp; lirae narrow, elevated, angular, the primaries 3 in number on the early whorls, 4 or 5 on the penultima and antepenultima, and 7 to 9 on the body exclusive of the pillar, separated by flattened interspaces approximately double the width of the spirals; posterior primary outlining the periphery and forming the midrib of the short, varical spines; 1 or, on the later whorls, 2 threadlets intercalated between the periphery and the suture line and undulated in harmony with the suture; a secondary regularly intercalated between the peripheral spiral and the spiral next in front of it; 1 or 2 finer spirals at the extreme base of the body; pillar girded with 3 simple primaries, a series of short spines —one to each varix—parallel to the primaries, and 1 or 2 irregular spirals in front of the spines. Anterior fasciole sharply rounded, laminated by the extremities of the varices, not spirally threaded. Aperture spatulate, oblique, broadest posteriorly, not sulcated at the posterior commissure. Outer lip arcuate, varicated behind the margin, thin and sharply crenate at the margin in harmony with the spirals, lirate within, the lirae usually short and corresponding in position to the interprimary areas. Inner wall of aperture excavated at the base of the body, smoothly and heavily glazed. Pillar moderately long and straight, corrugated just behind the entrance to the canal, with 3 to 6 lirations at right angles to the axis. Anterior canal long and slender, the margins proximate and parallel. Anterior fasciole diverging slightly, leaving a narrow, umbilical chink between the fasciole and the inner margin of the canal." (Gardner, 1947)

Dimensions of holotype: height 36.7 mm, diameter 16.5 mm.

Holotype: USNM 371854.

Type locality: USGS 2564, one mile below Bailey's Ferry, Chipola River, Calhoun County, Florida (= TU 457).

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

Figured specimen: USNM 645619; height 39.4 mm, diameter 27.8; locality TU 951. Other occurrences: TU locality nos. 70, 196, 456, 457, 458, 546, 554, 655, 708, 709, 710, 787, 817, 825, 827, 830, 831, 950, 998.

Discussion: *P. fusinoides* is common in the Chipola Formation but it is usually found at localities along Ten Mile Creek rather than those on the Chipola River and Farley Creek to the east. This species occurs together with *P. laccopoia* but the two forms are easily separated by the lack of a labral tooth in *P. fusinoides* and by the presence of a row of spines circling the base of the siphonal canal in *P. fusinoides*, which is not seen in *P. laccopoia*. *P. fusinoides* also has a more elevated spire than *P. laccopoia*, a more slender outline, and is a much larger species. The largest specimen seen of *P. fusinoides* (TU 950) measures 45 mm in height, the largest specimen of *P. laccopoia* (TU 456) is less than 35 mm in height.

Poirieria (Panamurex) lychnia (Gardner)

Plate 6, figs. 5a, 5b

Muricidea spinulosa Heilprin. Dall, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 149; Dall, 1903, *ibid.*, v. 3, pt. 6, p. 1577 (*not* of Heilprin).

Paziella (*Dallimurex*) *lychnia* Gardner, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 523, pl. 53, figs. 12, 13.

Paziella (*Dallimurex*) *lychnia* Gardner. Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 217.

[*Poirieria* (*Panamurex*)] *lychnia* (Gardner). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 18.

Diagnosis: "Shell of moderate dimensions for the group, rather slender, fusiform, hexagonal. Aperture decidedly more than half as long as the entire shell. Spire elevated, scalar; the rapidly tapering whorls acutely angulated at the periphery; the broad shoulder ramp not far from horizontal, undulated by the varices and slightly concave at the varical spines; the sides of the whorls nearly vertical. Body whorl rounded medially, obliquely constricted into the rather slender pillar. Number of whorls at least 6 and possibly 7 in the perfect adult; coiling very close, the posterior margin creeping up a little on the preceding whorl. Sutures inconspicuous, irregular. Protoconch small, smooth, polished, twice coiled, the initial turn inflated, immersed at the tip, the succeeding volution also well-rounded though flattening somewhat toward its close. Dividing line between conch and protoconch indicated by a slight thickening of the shell and by the abrupt initiation of the axial sculpture. Varices 6, equisized and equispaced, terminating at the peripheral angle in a slender spine curved upward and backward; a single row of spines also girding the pillar; free edges of varical lamellae on the body fluted by the primaries; intervarical areas smoothly concave; varices obsolete on the shoulder except for the closely appressed, overlapping, retractive laminae. Spiral sculpture restricted to low, rounded, equisized and equispaced lirations, 2 or 3 on the whorls of the spire, the posterior liration outlining the periphery, the anterior almost or entirely concealed by the suture, the medial midway between the suture and the periphery; spirals 6 to 8 on the body, even and regular from the periphery to the base; secondaries not intercalated; sculpture on the pillar restricted to the single row of varical spines, without a connecting spiral, girding the pillar midway between the base of the body and the anterior fasciole. Fasciole corrugated by heavy, overlapping lamellae, one to each varix. Aperture narrowly elliptical, exclusive of the canal, which is a little less than half as long as the entire opening; aperture obscurely sulcated at the commissure, emarginate at the periphery. Labrum broadly arcuate in front of the periphery, varicated a little behind the margin, finely crenate at the margin in harmony with the spiral sculpture, lirate within; the lirae corresponding roughly in position to the interspiral areas, tending to alternate in length, the longer of the lirations produced far within the aperture. Labium concave, smoothly and heavily glazed, the margin detached from the pillar wall. Anterior canal compressed, with narrow, proximate margins. Anterior fasciole well differentiated, emarginate at its extremity, flaring away from the labial margin, leaving a narrow cuneate umbilical opening." (Gardner, 1947)

Dimensions of holotype: height 25.5 mm, diameter 15 mm.

Holotype: USNM 371853.

Type locality: USGS 2213, one mile below Bailey's Ferry, Chipola River, Calhoun County, Florida (= TU 457).

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

Figured specimen: USNM 645617; height 20 mm, diameter 11 mm; locality TU 547. Other occurrences: TU locality nos. 457, 458, 546, 554, 555, 817, 950.

Discussion: *P. lychnia* is the least common of the Chipola species of *Panamurex*. It is easily confused with the following species, *P. mauryae* E. H. Vokes, which is a smaller, less foliaceous form. *P. lychnia* is very close to the Recent *P. carnicolor*, the

only difference being that the siphonal canal of *P. carnicolor* is more sharply constricted at the base of the body whorl and the body whorl is somewhat more inflated. *P. carnicolor* is slightly more spinose than *P. lychnia*, with spines being developed on the varices other than just at the shoulder.

The depth range for *P. carnicolor* (from 50 to 162 fathoms) indicates that it is a deeper water species than is usually encountered in the fossil record. *P. lychnia* may have also been a somewhat deeper species, explaining its relative scarcity in the Chipola beds.

Poirieria (Panamurex) mauryae
E. H. Vokes, n. sp.

Plate 6, figs. 8a, 8b

Diagnosis: Shell small for the group, nucleus of one and one-half somewhat flattened whorls; six post-nuclear whorls in adult. Axial ornamentation of ten small simple varices on first post-nuclear whorl, gradually decreasing to six varices on body whorl of adult. Varices low, rounded, marked only by a small open spine at the shoulder, almost obsolete on remainder of shell. Spiral ornamentation of two major ribs with smaller intercalary threads on early whorls, six to eight on the body whorl, depending upon the strength of the intercalaries. One spiral rib on siphonal canal, giving rise to small open spines at the varices. Axial growth lines producing a scabrous texture covering the entire shell surface. Suture greatly appressed, sinuous, riding up over the varices and down into the intervarical areas. Aperture ovate, outer lip thickened, bearing within about seven greatly elongated spiral ridges, which approximate the areas between the exterior spiral ribs. Inner lip marked by four small denticulations, separated into two pairs, at the abapical end and one tooth at the adapical end. Siphonal canal short, open, recurved at distal end; terminations of previous canals forming a small false umbilicus.

Dimensions of holotype: height 16.6 mm, diameter 9 mm.

Holotype: USNM 646431.

Type locality: TU 458, east bank of Chipola River, just above mouth of Farley Creek (SW ¼ Sec. 20, T1N, R9W), Calhoun County, Florida.

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

Figured specimen: USNM 646431 (holotype). Other occurrences: TU locality nos. 453, 456, 457, 546, 547, 554, 555, 655, 817, 818, 820b, 821, 825, 827, 828, 830, 950, 951, 998, 999.

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Plate 5

Figures — Page

1. *Poirieria (Paziella) pazi* (Crosse) (× 1½) 22
   USNM 678944; height 39 mm, diameter (excluding spines) 19 mm.
   Locality: *Silver Bay* Station 2481, off Hollywood, Florida, 200 fms. Recent.
2. *Poirieria (Paziella) atlantis* (Clench and Pérez Farfante) (× 2) 23
   MCZ 164684 (holotype); height 23.4 mm, diameter (excluding spines) 10.5 mm.
   Locality: *Atlantis* Station 3333, Bahía de Cochinos, Cuba, 190-200 fms. Recent.
3. *Poirieria (Paziella) oregonia* (Bullis) (× 1) 26
   USNM 635149 (holotype); height 85.2 mm, diameter (excluding spines) 37.8 mm.
   Locality: *Oregon* Station 2023, off French Guiana, 135 fms. Recent.
4. *Poirieria (Paziella) nuttingi* (Dall) (× 1½) 24
   USNM 107372 (holotype); height 44.4 mm, diameter (excluding spines) 20.5 mm.
   Locality: Off Sand Key, Florida, 15 fms. Recent.
5. *Poirieria (Pazinotus) bowdenensis* E. H. Vokes, n. sp. (× 4) 27
   USNM 369621 (holotype); height 13.5 mm, diameter 7 mm.
   Locality: Bowden, Jamaica. Bowden Fm., (?) upper Miocene.
6-7. *Poirieria (Pazinotus) stimpsonii* (Dall) (× 4) 28
   6. USNM 87087 (lectotype); height 12 mm, diameter 7 mm.
      Locality: Off Barbados, B. W. I., 100 fms. Recent.
   7. MCZ 7310 (lectoparatype); height 11 mm, diameter 7.4 mm.
      Locality: Off Barbados, B. W. I., 100 fms. Recent.

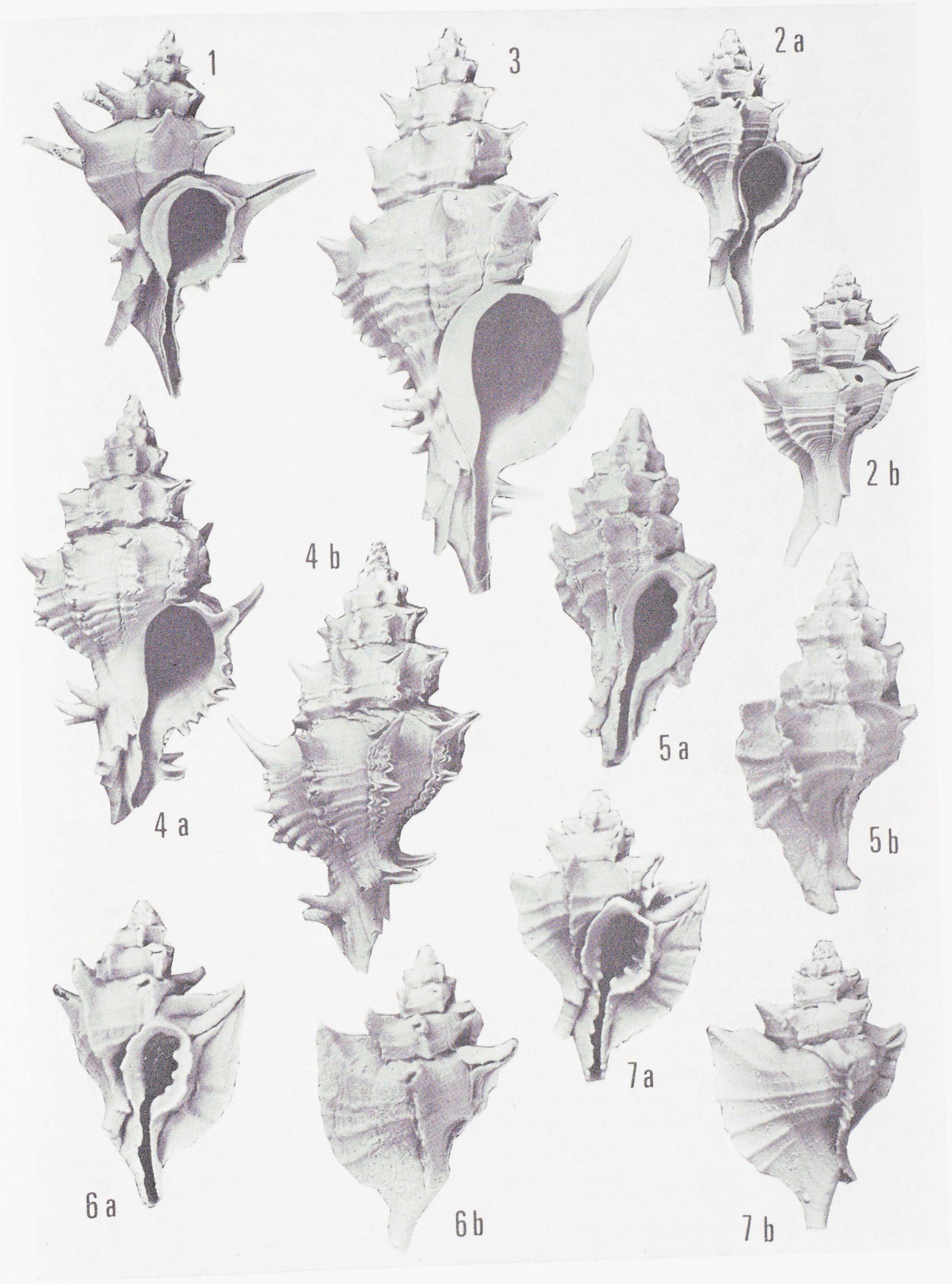

PLATE 5

Discussion: *P. mauryae* is one of the commoner Chipola muricid species, especially in the calcaranite facies of Farley Creek and the Chipola River, but may be easily taken for an abraded specimen of *P. lychnia*. However, it is consistant in its differences from *P. lychnia*, having a smaller, less spinose shell, which is more globose in outline. The largest specimen seen of *P. mauryae* (from TU 951) measures only 20 mm in height with the average size about 15-17 mm, but *P. lychnia* may exceed 30 mm. *P. mauryae* possesses only minute spines, if any, and those only at the shoulder and canal. *P. lychnia* has long spines at shoulder and canal with numerous smaller spines on the varices between the two rows of major spines.

This new species is unquestionably ancestral to *P.* (*P.*) *velero* Vokes, n. sp., discussed below (see Text fig. 1). The two forms are distinguishable by the heavier spiral ornamentation in the Recent species. Also, the angle of the shoulder is more sloping in the fossil shell and the area between the suture and the shoulder spiral is almost smooth, while it is strongly ornamented in the Recent species. The body whorl of *P. mauryae* is somewhat more inflated than that of *P. velero*. Nevertheless, the two forms are strikingly similar and seem to have had identical ecologic requirements. *P.* (*Panamurex*) *mauryae* is most common at the Chipola localities along Farley Creek and the lower Chipola River, where the evidence suggests shallow open water, with corals and reef-dwelling pelecypods, such as *Spondylus* and *Chama*, in great numbers. Abundant miliolids and dasycladacean algae further confirm this diagnosis.

P. mauryae is also closely related to the Oak Grove species named "*Urosalpinx*" *phagon* Gardner, which follows. *P. phagon* is even less spinose, having no spines whatsoever. *P. phagon* is a larger species than *P. mauryae*, both of the specimens figured here (pl. 6, figs. 7 & 8) have six post-nuclear whorls but *P. phagon* is noticeably larger. This species is very rare, there being known but the two specimens in the type lot and a third here figured, so far as the writer is aware. It is possible that *P. mauryae* may prove to be only an ecologic variety of *P. phagon* but without more material the writer prefers to keep the two forms distinct.

Jung (1969, p. 494, pl. 50, figs. 7-9) has recently named a species from the upper Miocene Melajo Clay of Trinidad that is not unlike *P. mauryae*. This species, assigned by Jung to the genus *Calotrophon* with a query, seems to be intermediate between *P. mauryae* and *Pseudosalpinx floridana* (Conrad). *Calotrophon* (?) *hutchisoni*, as it was named by Jung, differs from both the typical *Calotrophon* and from *Pseudosalpinx* in having four marked denticles near the anterior end of the parietal callus and for this reason the species is here referred to *Panamurex*.

Poirieria (Panamurex) phagon (Gardner)

Plate 6, figs. 7a, 7b

Urosalpinx phagon Gardner, 1947, U. S. Geol. Surv. Prof. Paper 147-H, p. 530, pl. 52, figs. 36, 37.

Diagnosis: "Shell rather small, solid, fusiform in outline, the maximum diameter falling not far from the median horizontal. Spire turreted, the whorls increasing regularly and rather rapidly in diameter. Whorls of conch 5 in number, closely appressed, the posterior margin creeping up a little upon the preceding volution. Shoulder very broad and rather steeply sloping, the periphery of the whorls of the spire falling in front of the median horizontal. Sides of whorls approximately parallel to the axis. Body obliquely constricted at the base into the moderately long and slender pillar. Sutures inconspicuous, undulated by the costals of the preceding whorl. Protoconch small, smooth, twice-coiled, the initial turn moderately inflated but flattened behind and immersed at the tip; final whorl convex, flattening on the last half turn; close of protoconch indicated by a slight rib-like thickening of the shell. Axials prominently elevated, running in the holotype 8 to the whorl from the initial turn of the conch to the body, very narrow and sharply rounded upon the posterior volutions, broad and somewhat undulatory in character upon the anterior, uniform in prominence from the periphery to the anterior suture but weakening upon the shoulder; body axials most prominent upon the periphery, more or less obsolete upon the base; intercostal areas concave and usually a little narrower than the costals. Entire surface shagreened with fine incremental laminae, most prominent upon the shoulder, where the fine, sharp edges rasp the surface almost as strongly as in *Coralliophaga* [? *Coralliophila*]. Spiral sculpture subdued; primaries low, rounded, equal and regularly spaced, 2 or 3 in number upon the whorls of

the spire, 6 upon the medial portion of the body; 3 upon the base of the body, and 4 or 5 upon the pillar; posterior spiral outlining the periphery; shoulder free from threading; secondaries fortuitously introduced between the primaries, most frequently upon the body. Anterior fasciole arched and corrugated by the axials but not spirally lirate. Aperture moderately wide, oblique, acutely angulated at the posterior commissure. Outer lip obtusely angulated at the shoulder, obliquely constricted at the base of the body, varicated a little behind the margin, lirate within, the lirae produced far within the aperture and corresponding in position to the spaces between the primaries. Labium excavated at the base of the body, rather heavily and very smoothly glazed, the pillar feebly rugose in the adult; inner margin of pillar sharply rounded at the entrance to the anterior canal. Canal moderately long, bent backward slightly, the margins parallel and proximate. Anterior extremity broadly emarginate. Umbilicus imperforate in the young, the fasciole flaring in the adult so that a narrow chink is left between the fasciole and the inner wall of the canal." (Gardner, 1947)

Dimensions of holotype: height 16.5 mm, diameter 9.2 mm.

Holotype: USNM 371856.

Type locality: Oak Grove, Okaloosa County, Florida (= TU 91).

Occurrence: Oak Grove Sand, Florida; (?) late lower Miocene.

Figured specimen: USNM 646430 (topotype); height 20 mm, diameter 11.5 mm; locality TU 91.

Discussion: Originally assigned to the genus *Urosalpinx* by Gardner this species is better placed with the *Panamurex* group for it possesses the apertural denticulations of that group. The shells of *Urosalpinx* are of a calcitic composition and fossilize with a type of translucence that is characteristic and easily recognized. Shells of *Ecphora* and *Pecten* are perhaps the best examples of this type of shell composition but numerous other groups also possess it to a less striking degree. This transluscence is seen in the other species of *Urosalpinx* named by Gardner from the Oak Grove, *U. xustris*, but not in *P. phagon*.

This species is most closely related to *P. mauryae*, above, and is discussed further there. It is possible that *P. phagon* is a nearshore equivalent of *P. mauryae* but from the limited material of *P. phagon* available the two forms seem to be distinct.

Poirieria (Panamurex) gabbi
E. H. Vokes, n. sp.

Plate 7, figs. 2a, 2b

Diagnosis: Nucleus unknown, seven post-nuclear whorls in the holotype. Axial ornamentation consisting of eight small varices on each of the first three post-nuclear whorls, decreasing then to seven on each of the succeeding whorls, including the last. Varices bearing small open spines only at the shoulder; where other major spiral ribs cross the varices only small ridges are formed. Spiral ornamentation of two ribs on the spire whorls with an intermediary thread appearing on the penultimate; six major spiral ribs on body whorl with three smaller riblets between that at the shoulder and the suture; a row of spines encircling the extended siphonal canal and one faint spiral rib between body and canal spines. Suture sigmoidal, rising up between varices and bending down at the varices. Aperture broken in holotype but at least three small denticles present at the anterior end of the inner lip. Nature of outer lip unknown but almost certainly denticulated; no labral tooth present. Siphonal canal open, moderately long, slightly recurved.

Dimensions of holotype: height 24.7 mm, diameter 14 mm.

Holotype: USNM 646084.

Type locality: USGS 8544, right bank of Rio Gurabo, about 150 meters above middle ford at Gurabo Adentro, Monte Cristi, Dominican Republic.

Occurrence: Gurabo Formation, Dominican Republic; middle Miocene.

Figured specimen: USNM 646084 (holotype).

Discussion: This new species, based on a unique specimen from the Gurabo Formation of the Dominican Republic, is most closely related to *P. fusinoides* (Gardner) from the Chipola Formation. It differs in having a more inflated shell with less pronounced spiral ornamentation. *P. gabbi* also has one less spiral rib than *P. fusinoides*, which has three such ribs on the spire whorls. The spiral threads between the major spiral rib at the shoulder and the suture are stronger in *P. fusinoides* than in *P. gabbi* as are the spiral riblets between the body and the row of encircling spines on the siphonal canal. The canal is shorter in *P. gabbi* and the varices are less scabrous.

Woodring (1959, p. 218) compared this species to *P. gatunensis* from the Gatun Formation of Panamá and noted that it differs from the latter in being more slender and not so strongly sculptured. The two species also differ in the labral tooth seen in *P.*

gatunensis but lacking in *P. gabbi*, as well as the spines on the siphonal canal seen in *P. gabbi* and lacking in *P. gatunensis*.

Poirieria (Panamurex) gatunensis (Brown and Pilsbry)

Plate 7, figs. 6a, 6b

Murex (*Phyllonotus*) *gatunensis* Brown and Pilsbry, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 354, pl. 26, fig. 2; Brown and Pilsbry, 1913, *ibid.*, v. 64, p. 503.

Murex gatunensis Brown and Pilsbry. Pilsbry and Brown, 1917, Acad. Nat. Sci. Phila., Proc., v. 69, p. 34.

Murex (*Phyllonotus*) *gatunensis* Brown and Pilsbry. Vaughan, 1919, U. S. Natl. Mus., Bull. 103, p. 558, 561.

Paziella (*Panamurex*) *gatunensis* Brown and Pilsbry. Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 150, 151, 152, 217, pl. 35, figs. 6, 7, 9, 10.

[*Poirieria* (*Panamurex*)] *gatunensis* (Brown and Pilsbry). E. H. Vokes, 1964, Malacologia, v. 1, no. 2, p. 18, pl. 2, fig. 32.

Paziella (*Panamurex*?) cf. *gatunensis* (Brown and Pilsbry). Jung, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 523, pl. 69, figs. 11, 12.

Diagnosis: "The shell resembles *M. spinulosa* in general form. Embryonic whorls unknown; subsequent whorls about 6, strongly convex, subangular at the shoulder, the last contracted into a narrow but short anterior canal. Sculpture: on the last whorl seven strong varices, each with a short horizontal spine at the shoulder and about half as wide as the intervals; sharp, narrow, unequal spiral ridges over both varices and intervals. These ridges are unequally spaced, and the concave interstices bear numerous weak spiral striae. On the penultimate whorl, two ridges are visible below, and two or three above the shoulder-angle. The aperture is triangular-ovate; outer lip has 11 or 12 short, acute teeth on the submarginal internal callus." (Brown and Pilsbry, 1911)

Dimensions of holotype: height (incomplete) 32 mm, diameter 21 mm.

Holotype: ANSP 1720.

Type locality: Gatun Locks excavation, Canal Zone.

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Plate 6

Figures — Page

1-2. *Poirieria (Panamurex) macneili* E. H. Vokes, *nom. nov.* 30
1. (× 3) USNM 644618 (holotype); height 15.5 mm, diameter 9 mm.
Locality: Byram, Mississippi. Byram Marl, middle Oligocene.
2. (× 2) USNM 646432; height 23.5 mm, diameter 12.3 mm.
Locality: Byram, Mississippi. Byram Marl, middle Oligocene.

3-4. *Poirieria (Panamurex) heilprini* (Cossman) 30
3. (× 2) USNM 165089; height 23.5 mm, diameter 13 mm.
Locality: Ballast Point, Tampa Bay, Florida. Tampa Limestone, lower Miocene.
4. (× 4) USNM 112065; height 10 mm, diameter 7 mm.
Locality: Ballast Point, Tampa Bay, Florida. Tampa Limestone, lower Miocene.

5. *Poirieria (Panamurex) lychnia* (Gardner) (× 2) 35
USNM 645617; height 20 mm, diameter 11 mm.
Locality: TU 547. Chipola Fm., (?) lower Miocene.

6. *Poirieria (Panamurex) carnicolor* (Clench and Pérez Farfante) (× 1½) 46
USNM 679266; height 28 mm, diameter 16 mm.
Locality: *Oregon* Station 5070, off Nevis, Leeward Islands, 50-60 fms. Recent.

7. *Poirieria (Panamurex) phagon* (Gardner) (× 2) 38
USNM 646431 (topotype); height 20 mm, diameter 11.5 mm.
Locality: TU 91. Oak Grove Sand, (?) lower Miocene.

8. *Poirieria (Panamurex) mauryae* E. H. Vokes, n. sp. (× 2) 36
USNM 646430 (holotype); height 16.6 mm, diameter 9 mm.
Locality: TU 458. Chipola Fm., (?) lower Miocene.

9. *Poirieria (Panamurex) fusinoides* (Gardner) (× 1½) 34
USNM 645619; height 39.4 mm, diameter 27.8 mm.
Locality: TU 951. Chipola Fm., (?) lower Miocene.

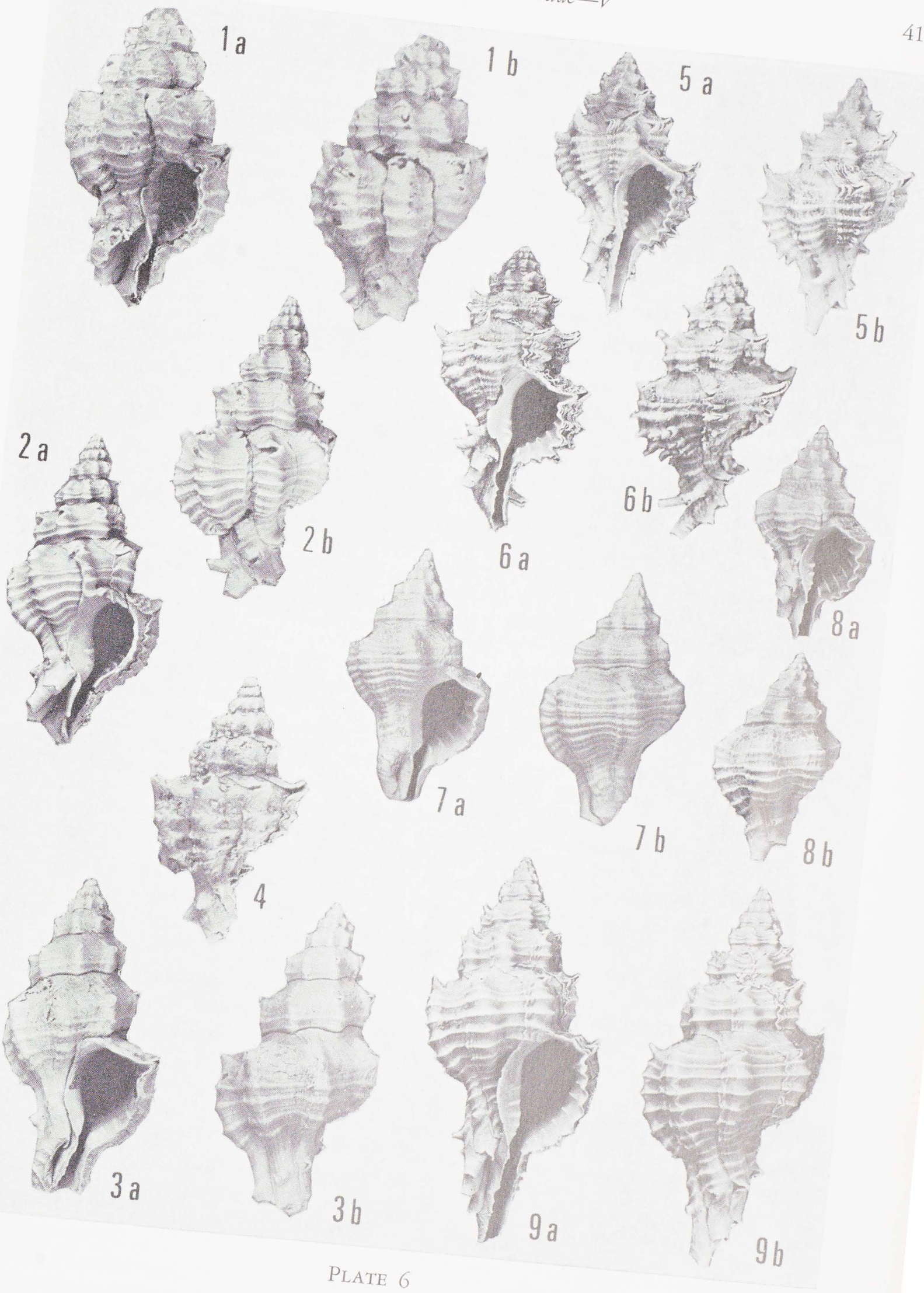


PLATE 6

Occurrence: (?) Emperador Limestone, Panamá; lower Miocene. Gatun Formation, Panamá and Colombia; middle Miocene. Unnamed formation, Paraguaná Peninsula, Venezuela; late middle Miocene.

Figured specimen: USNM 645620; height 40.8, diameter 26.0 mm; locality TU 958. Other occurrences: TU locality nos. 757, 959.

Discussion: Woodring (1959, p. 218) compared *P. gatunensis* with the Chipola species *P. fusinoides*, but as has been discussed above, a closer relationship exists between *P. gatunensis* and *P. laccopoia*. This latter species Woodring placed in synonymy with *P. fusinoides* and this is undoubtedly the reason for his comparison. The differences between the three forms are discussed under *P. laccopoia*.

Brown and Pilsbry (1913, p. 503) listed this species from a locality in the lower Miocene Emperador Limestone of Panamá but this occurrence was not verified by Woodring. These same authors (Pilsbry and Brown, 1917, p. 34) also listed *P. gatunensis* from the "Oligocene" (*i.e.*, Gatun) near Cartagena, Columbia. The writer has examined their specimen and it is *P. gatunensis*. There are specimens in the collection of the Museum of Paleontology, University of California, Berkeley, from near Usiacuri, Dept. of Atlantico, Colombia, not far from Cartagena, in beds that are presumed to be Gatun in age. Jung (1965, p. 523, pl. 69, fig. 11, 12) figured a specimen from Venezuela, which he only compared to *P. gatunensis* as it was a juvenile, but it seems to be identical. Thus this species is one of the most widespread of the group ranging from Panamá to Venezuela in middle Miocene beds.

At the time of Woodring's treatment of this species (1959, p. 218), it was relatively uncommon in collections. He noted that the nine extant adult specimens in the USNM collections were all damaged or fragmentary. Since that time a new excavation near Cativa (TU 958) has yielded numerous fine specimens of *P. gatunensis*. The writer and her husband collected over 50 specimens at this site, the largest of which is the one here figured (pl. 7, fig. 6).

Poirieria (Panamurex) dubitalis E. H. Vokes, n. sp.

Plate 7, figs. 5a, 5b

Diagnosis: Shell large; nature of early whorls unknown, probably seven post-nuclear whorls in adult. Spiral ornamentation on spire whorls of one strong rib at the shoulder, flanked by two smaller ribs on either side. On the body whorl between the strong shoulder rib and the suture three smaller ribs present; on remainder of body whorl six moderately strong spiral ribs with numerous smaller riblets on the extended siphonal canal. Axial ornamentation of six varices on each whorl. Where the shoulder rib crosses the varices one sharp, pointed spine is produced, directed outward from the axis of the shell; at the juncture of the body whorl and the siphonal canal, where the sixth rib anterior to the shoulder crosses the varices a marked labral tooth is developed. Aperture circular, outer lip flaring, with eight small denticulations corresponding to the spaces between the spiral ribs. Inner lip smooth in the holotype but probably with small denticulations usually. Siphonal canal short, broad, succession of previous canals forming a large false umbilicus.

Dimensions of holotype: height 36 mm, diameter (including spines) 27.5 mm.

Holotype: U. N. A. M. Instituto de Geología, Museo Paleontología Invertebrados no. IGM 2187.

Type locality: (?) Tuxtepec, Oaxaca, Mexico.

Occurrence: (?) Agueguexquite Formation, Mexico; upper Miocene.

Figured specimen: IGM 2187 (holotype).

Discussion: In the collections of the Instituto de Geología, Universidad de Mexico (U. N. A. M.), there is a single specimen said to be from Tuxtepec, that seems intermediate between *P. gatunensis* and the next species, *P. alaquaensis*. The shoulder spines point outward in the manner of *P. gatunensis* but the inflated body whorl and heavy ornamentation are more akin to *P. alaquaensis*. There is a large labral tooth present at the base of the body whorl.

The writer visited the Tuxtepec area and an effort was made to locate the spot from whence came this material. A number of localities were found with fossils that correspond to the material described from the region by Böse (1906), now referred to the Concepción Formation, but nowhere was any material seen that matched the species or the preservation of the shell described here. In the same lot of material at the U. N. A. M. there were two specimens of *Typhis carmenae* Gertman (1969, p. 166, pl. 5, fig. 4), which was described from the Agueguexquite Formation. Thus there appears to be little doubt of the Agueguexquite age of this shell but

there does seem to be some considerable doubt as to the locality. The writer strongly suspects that the material did not come from Tuxtepec but rather from somewhere in the Isthmus of Tehuantepec, near Coatzacoalcos.

Poirieria (Panamurex) alaquaensis (Mansfield)

Plate 7, figs. 3, 4a, 4b

Muricidea? *alaquaensis* Mansfield, 1935, Florida Geol. Surv., Bull. 12, p. 39, pl. 3, fig. 9 (holotype); pl. 4, fig. 10 (paratype).
"*Muricidea*?" *alaquaensis* Mansfield. Jung, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 524.

Diagnosis: "Shell small, spire about one-third length of body whorl, axial sculpture stronger than spiral, about 1½ nuclear and 5 post-nuclear whorls. Whorls tabulated in front of the suture. Axial sculpture consists of 6 strong ribs extending from suture to suture on the spire whorls and across the canal on the body whorl. These axials are retractive over the tabulated area and nearly vertical below the periphery and when unbroken bear reflected hollow spines at the periphery on the later whorls. The earliest post-nuclear whorls do not bear spines. Spiral sculpture (on spire 3 and on body 12) of primary cords overrunning axials and interspaces. A medial secondary spiral is present on the body whorl. In addition to the primary and secondary ornamentation, tertiary threadlets are visible on most of the shell. Aperture ovate, widest above. Anterior canal rather long, nearly closed and curved backward and to the right. Outer lip within marked with 9 rather short raised spiral lirations, the posterior liration being larger, more widely spaced, and situated near the center of the posterior area of the aperture. Inner lip with a thin callus, bearing 3 lirations at the anterior third. Anterior canal moderately long and nearly closed. Siphonal fasciole strong and ornamented with lamellae." (Mansfield, 1935)

Dimensions of holotype: height 15 mm, diameter 9 mm.

Holotype: USNM 373148.

Type locality: USGS 12046, Vaughan Creek, about three miles from its junction with Alaqua Creek, about 6½ miles nearly south of De-Funiak Springs, Walton County, Florida.

Occurrence: Choctawhatchee Formation; Florida; Agueguexquite Formation, Veracruz, Mexico; upper Miocene. Concepción Formation, Veracruz, Mexico; (?) upper Miocene.

Figured specimens: Fig. 3, USNM 373148 (holotype). Fig. 4, Univ. California, Museum of Paleontology no. 15978, height 22 mm, diameter 14 mm; locality, Teapa, Veracruz, Mexico. Other occurrences: TU locality no. 638.

Discussion: Mansfield knew this species only from the type locality, but in the collections of the Museum of Paleontology, University of California, Berkeley, there is a fine specimen from Teapa, in southern Veracruz, and the writer has collected a worn specimen from the Agueguexquite Formation of the same area (TU 638). The stratigraphic position of the Teapa shell is not known but it is probably from the Concepción Formation (? = TU locality 1025) of (?) upper Miocene age. The Agueguexquite specimen is badly rolled and could well be a reworked shell, as many examples at the same locality would appear to be, for the Concepción Formation underlies the Agueguexquite in this area. Geographically the two occurrences are only about five miles apart but the associated faunas are so different that they are not thought to be correlative in age.

It is unfortunate that both specimens in the type lot are juvenile but the Mexican shells are adult and from them a better understanding of the species is made possible. *P. alaquaensis* is closely related to the older *P. laccopoia* but differs from it in having a much less sloping shoulder. The suture in *P. alaquaensis* is deeply recessed forming pits between the varices. The body whorl of *P. alaquaensis* is more inflated than *P. laccopoia* and the spire is lower, giving the shell a rotund appearance.

There are two specimens in the type lot of *P. alaquaensis* and in his description Mansfield cited these as "cotypes." However, in the plate description he named the larger specimen as holotype and the smaller paratype so that there is no necessity to select a lectotype.

Poirieria (Panamurex) clarksvillensis (Mansfield)

Plate 7, figs. 7a, 7b

Muricidea clarksvillensis Mansfield, 1937, Jour. Paleontology, v. 11, no. 7, p. 610, pl. 85, fig. 6.
Murex (*Panamurex*) *clarksvillensis* (Mansfield). E. H. Vokes, 1963, Tulane Stud. Geol., v. 1, no. 4, p. 161, pl. 2, figs. 2a, 2b.
[*Poirieria* (*Panamurex*)] *clarksvillensis* (Mansfield). E. H. Vokes, 1964, Malacologia, v. 2, no. 1, p. 18.
"*Muricidea*" *clarksvillensis* Mansfield. Jung, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 524.

Diagnosis: "Shell of moderate size; solid; spire about one-third length of shell; axial sculpture stronger than spiral; consisting of 5 whorls, nucleus decollated. Whorls rounded, weakly tabulated in front of the rather deep suture and rapidly and uniformly expanding. Spiral sculpture consisting of rather strong primary threads (13 on body whorl and canal) over-running axials and interspaces and usually of a secondary intermediate threadlet. Ribs 6, extending from suture to suture on the spire whorls and to the end of the canal on the body whorl. Aperture axially ovate. Outer lip within provided with 8 widely spaced spiral lirations. Inner lip with a thin callus and bearing on its anterior third 3 lirations. Canal rather short and recurved; the raised margin of the canal and the siphonal fasciole separated by a small chink." (Mansfield, 1937)

Dimensions of holotype: height 30 mm, diameter 17 mm.

Holotype: USNM 496424.

Type locality: Four Mile Creek, one half mile northwest of Clarksville, Calhoun County, Florida (= TU 73).

Occurrence: Jackson Bluff Formation and Pinecrest Beds, Florida; upper Miocene.

Figured specimen: USNM 644378; height 31.4 mm, diameter 15 mm; locality TU 60. Other occurrences: TU locality nos. 72, 797.

Discussion: *P. clarksvillensis* is moderately common at Jackson Bluff, Florida (TU 60), but is rare elsewhere. The type locality is near Clarksville, Calhoun County, Florida (TU 73), however no specimens have been taken there by the writer. One specimen has been found in the upper Miocene Pinecrest Beds of southern Florida (TU 797) but this is the only known example outside of the Jackson Bluff Formation.

Poirieria (Panamurex) hutchisoni (Jung)

Calotrophon (?) *hutchisoni* Jung, 1969, Bulls. Amer. Paleontology, v. 55, no. 247, p. 494, pl. 50, figs. 7-9.

Diagnosis: "Shell small, solid. Protoconch consists of 1½ whorls, its last part with a basal angulation. Postnuclear whorls a little more than five. Sculpture starting abruptly, consists of nine axials on early, but of seven on late whorls. Axials usually with a short vaulted spine on the shoulder of the whorls. There are two to four weak spirals above the shoulder, and two stronger ones below. Axials not persistent from suture to suture. Body whorls with numerous spirals below the shoulder; its axials usually reaching down to the prominent siphonal fasciole. Outer lip lirate within, its edge crenulated. Callus of inner lip prominent, with four elongate denticles near the base. Anterior canal short, slightly recurved." (Jung, 1969)

Dimensions of holotype: height 16.6 mm, diameter 9.4 mm.

Holotype: USNM 645494.

Type locality: Melajo River area, west of Matura Bay, Trinidad.

→

Plate 7

Figures

1. *Poirieria (Panamurex) laccopoia* (Gardner) (× 2) 31
   USNM 645618; height 26 mm, diameter 14 mm.
   Locality: TU 458. Chipola Fm., (?) lower Miocene.
2. *Poirieria (Panamurex) gabbi* E. H. Vokes, n. sp. (× 2) 39
   USNM 646048 (holotype); height 24.5 mm, diameter 14.3 mm.
   Locality: Rio Gurabo, Dominican Republic. Gurabo Fm., middle Miocene.

3-4. *Poirieria (Panamurex) alaquaensis* (Mansfield) 43
   3. (× 3) USNM 373148 (holotype); height 15 mm, diameter 9 mm.
      Locality: Vaughan Creek, Florida. Choctawhatchee Fm., upper Miocene.
   4. (× 2) UCMP 15978; height 22 mm, diameter 14 mm.
      Locality: Teapa, Veracruz, Mexico. Concepción Fm., (?) upper Miocene.

5. *Poirieria (Panamurex) dubitalis* E. H. Vokes, n. sp. (× 1½) 42
   IGM 2187 (holotype); height 36 mm, diameter 27.5 mm.
   Locality: (?) Tuxtepec, Oaxaca, Mexico. (?) Agueguexquite Fm., upper Miocene.
6. *Poirieria (Panamurex) gatunensis* (Brown and Pilsbry) (× 1½) 40
   USNM 645620; height 40.8 mm, diameter 26 mm.
   Locality: TU 958. Gatun Fm., middle Miocene.
7. *Poirieria (Panamurex) clarksvillensis* (Mansfield) (× 1½) 43
   USNM 644378; height 31.4 mm, diameter 15 mm.
   Locality: TU 60. Jackson Bluff Fm., upper Miocene.

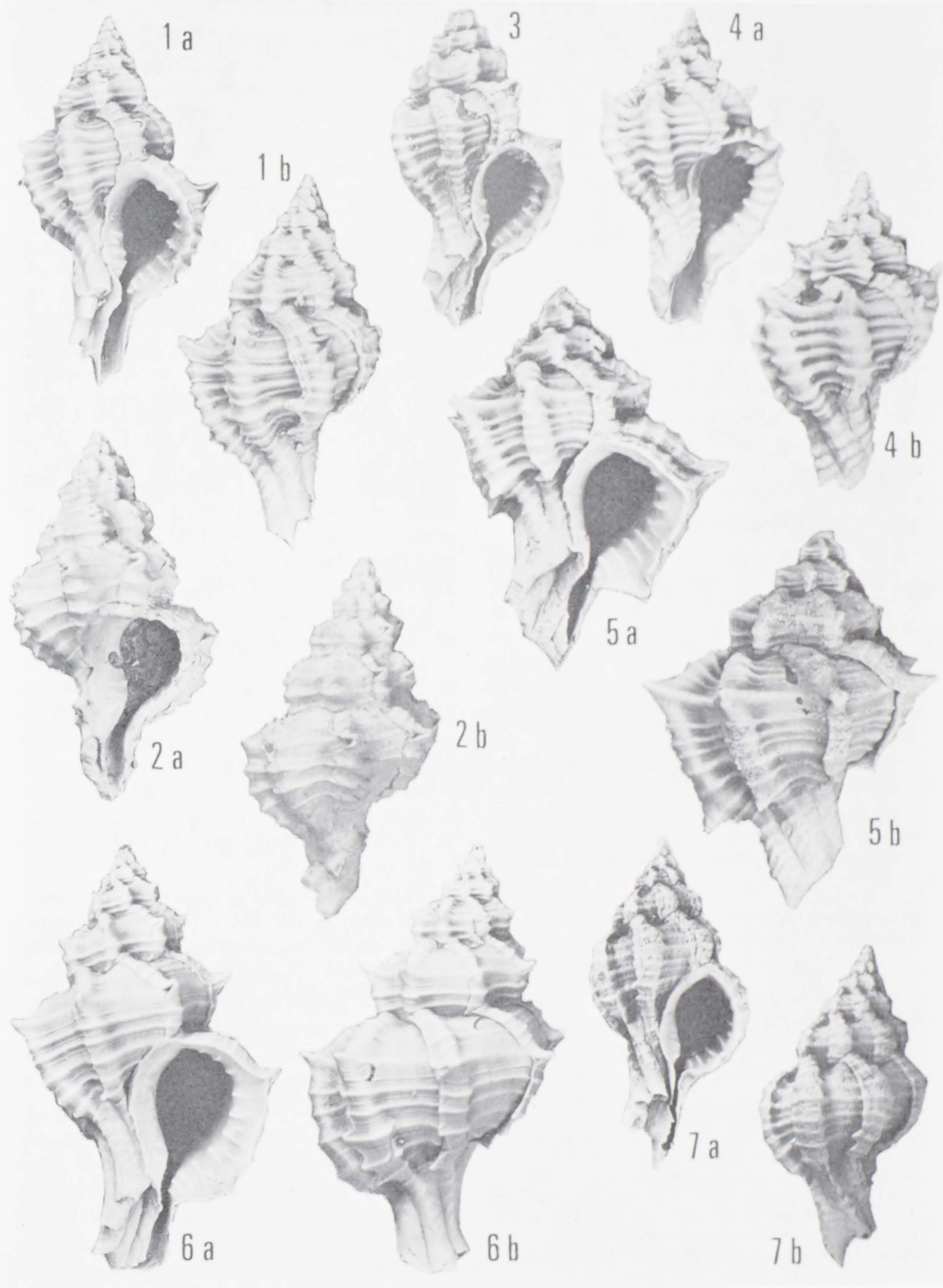


PLATE 7

Occurrence: Melajo Clay, Trinidad; upper Miocene.

Discussion: Assigned with a query to the genus *Calotrophon* by Jung, this species seems better placed in the *Panamurex* group, inasmuch as the principal distinction between *Panamurex* and *Calotrophon* is the presence of the denticles on the inner lip of *Panamurex*. Admittedly this is a somewhat arbitrary distinction, for in overall shell morphology the species is more akin to the *Calotrophon* group, especially in the concave slope of the shoulder. McLean and Emerson (in press) have just shown that *Calotrophon* is to be placed in the Muricinae and this species clearly demonstrates the relationship. However, it is not thought to be the direct ancestor to the *Calotrophon* line as there are members of that genus also present in the upper Miocene of Florida.

Poirieria (Panamurex) carnicolor (Clench and Pérez Farfante)

Plate 6, figs. 6a, 6b

Murex (*Phyllonotus*) *interserratus* Sowerby. Dall, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 199 (*not* of Sowerby, 1879).
Murex (*Murexsul*) *carnicolor* Clench and Pérez Farfante, 1945, Johnsonia, v. 1, no. 17, p. 48, pl. 25, figs. 1-4.

Diagnosis: "Shell small, about 20 mm in length, highly spinose and rather thin. Whorls seven to eight, angulated at the shoulder, which gives rise to a turreted spire. The entire shell has a uniform flesh color. Spire extended. Suture irregular and not distinct, owing to small scale-like lamellae that overgrow it. Aperture ovate and colored similarly but paler than the outside. Parietal lip smooth, adhering above and slightly erect below. Palatal lip finely crenulated and with a few emarginate denticles. Siphonal canal rather short, narrow and slightly recurved upward at the distal end. Previous canals remain only as short overlapping scales. Axial sculpture consists of six to seven rounded varices. Each varix consists of a series of overlapping laminae, the first lamina giving rise to the first series of spines. Successive laminae are produced slightly forward of each other and following the general shape of the previous one formed. The spines are open, scale-like and rather short, except those developed at the shoulder of the whorls. These shoulder spines are rather low, sharply pointed and recurved upward. On the siphonal canal there is a large, spur-like spine corresponding to each varix. Additional axial sculpture consists of numerous low and irregular lamellae. Spiral sculpture consists of strong cords which connect the spines on one varix with the corresponding spines on the next. Nuclear whorls one and one-half, small, rounded, smooth and colored white. [Early] Post-nuclear whorls sculptured the same as all of the later whorls but having more varices. Periostracum absent. Operculum unknown." (Clench and Pérez Farfante, 1945).

Dimensions of holotype: height 20 mm, diameter (excluding spines) 10 mm.
Holotype: Harvard MCZ 7305.
Type locality: *Blake* Station 273, off Barbados, Lesser Antilles, in 103 fathoms.
Occurrence: Recent only.
Figured specimen: USNM 679266; height 28 mm, diameter 16 mm; locality, *Oregon* Station 5070, off Nevis, Leeward Islands, in 50-60 fathoms.

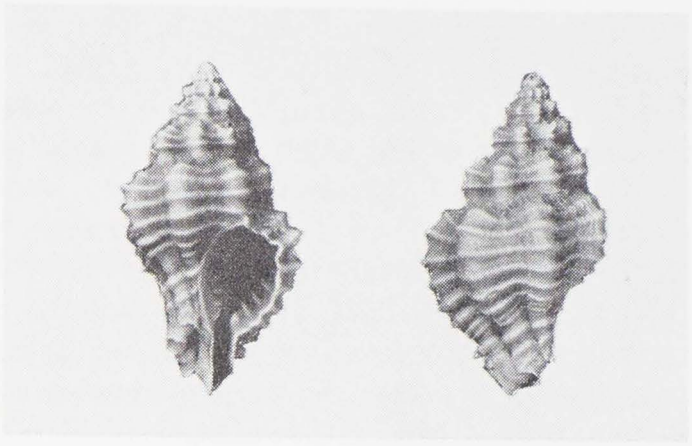
Discussion: The species which Dall (1889, p. 199) cited in the *Blake* Report as "*Murex interserratus* Sowerby" is not that species but a new one given the name *Murex carnicolor* by Clench and Pérez Farfante. At the same time Dall included in his synonymy the figure given by Sowerby (1879, fig. 208) for "*Murex*" *pazi* Crosse, but Sowerby's figure is indeed a good representation of that species and is not *P. carnicolor*.

The *Blake* took *P. carnicolor* in depths of 88 and 103 fathoms, and the U. S. Fish and Wildlife Service R/V *Oregon* has taken one specimen in 162 fathoms (Station 5913) and another, here figured, in 50 to 60 fathoms, which is the shallowest occurrence known. All records are from the Lesser Antilles and this seems to be the extent of the range of the species.

Although assigned to the subgenus *Murexsul* by Clench and Pérez Farfante, this species is more closely allied with the *Panamurex* group, possessing the characteristic denticulations on the inner lip. These denticulations are not developed on the holotype, nor is its outer lip complete. In the specimen figured here (plate 6, fig. 6) the shell is of an adult individual and better demonstrates the affiliations. *P. carnicolor* is exceedingly like the Miocene *P. lychnia* from the Chipola Formation of Florida, the only difference being that *P. carnicolor* is more spinose than the older species, with a more constricted anterior canal.

The species "*Murex*" *interserratus* Sowerby, with which *P. carnicolor* was confused by Dall, is indeed similar to it. However, it is not thought that the two are synonymous.

The holotype of "*M.*" *interserratus* has not been located but from Sowerby's original description there seem to be certain differences in the two species. Sowerby's shell was said to be of a pale grayish-white color, but the flesh-pink color of *P. carnicolor* is very characteristic. The aperture of Sowerby's species is almost circular and does not seem to fold into the shoulder spine in the manner of *P. carnicolor*. The circle of long spines on the siphonal canal of *P. carnicolor* are lacking in "*M.*" *interserratus*. Nevertheless, the two forms are much alike and "*M.*" *interserratus* is almost certainly to be referred to the subgenus *Panamurex*, although the denticulations on the inner lip are not visible in the illustration, nor does Sowerby mention them in his description. As the type locality for this species is not known, little more can be said about it at this time, except to note its affinities with *P. carnicolor*.



Text figure 1. *Poirieria* (*Panamurex*) *velero* E. H. Vokes, n. sp. LACM-AHF 1406 (holotype). (× 2) Height 14.2 mm, diameter 8 mm; locality, two miles southwest of Cabo de la Vela, Colombia, in 21-22 fathoms.

POIRIERIA (PANAMUREX) VELERO
E. H. Vokes, n. sp.
Text figure 1

Diagnosis: Nucleus of one and one-half smooth whorls, six post-nuclear whorls in the adult. Axial ornamentation beginning with 12 small nodes on first postnuclear whorl, diminishing to nine and then to seven on about the fourth and all subsequent whorls. Small open spinelets developed where spiral cord crosses these nodes at the shoulder, beginning on the second and persisting to about the fourth post-nuclear whorl, but disappearing on later whorls. Spiral ornamentation consisting of rounded spiral cords, riding up on the axial nodes to form strong ridges, somewhat weaker in the interspaces; two, then three on early whorls and nine to ten on body whorl. Entire shell surface covered with minute, scabrous, axial growth lines. Suture appressed, sigmoidal in form, rising up in the internodal areas and sinking down below the nodes of the previous whorl. Aperture oval, outer lip bearing about eight strong internal lirae, with four denticles at anterior end of columellar lip. Anterior canal open, slightly recurved, previous canals forming a small fasciole. Shell surface covered with a limy coating, when removed color is revealed to be a light reddish-brown, slightly darker on spiral ridges. Operculum muricoid.

Dimensions of holotype: height 14.2 mm, diameter 8 mm.

Holotype: LACM-AHF 1406.

Type locality: R/V *Velero* III Stations A 13-39 and A 14-39, one to two miles southwest of Cabo de Vela, Guajira Peninsula, Colombia (12°11′N, 72°11′W), in 10-22 fathoms, 8 April 1939, 12 specimens.

Occurrence: Recent only, northern South America.

Figured specimen: LACM-AHF 1406 (holotype).

Discussion: James H. McLean, of the Los Angeles County Museum of Natural History, and William K. Emerson, of the American Museum of Natural History, while engaged in research on the genus *Calotrophon*, discovered in the collections of the Allan Hancock Foundation, now on loan to the Los Angeles County Museum, several specimens of a new muricine species from the northern coast of South America. Recognizing the affinity with the *Panamurex* group, Dr. Emerson kindly passed these specimens on to the writer and she was astounded by the similarity to *P.* (*P.*) *mauryae* Vokes, n. sp. The two forms are very closely related with the most marked difference being in the greater strength of the spiral ribbing in the modern species. This unmistakable likeness gives weight to the ecologic inferences that may be drawn from *P. velero* with respect to the ecology of the Chipola Formation where *P. mauryae* is common. There are more than 20 specimens of *P. velero* known, from four different stations ranging from 2 to 24 fathoms in depth, with a sandy or coralline bottom type. This seems to agree well with the occurrence of *P. mauryae* in the calcarenite facies of the Chipola.

The material for *P. velero* was collected during the Allan Hancock Foundation Atlantic Expedition of 1939, at four Caribbean

stations, ranging from Cabo de la Vela, Colombia, through St. Nicolas Bay, Aruba, to Isla Cubagua, Venezuela. Although this new species occurs in the same general region as *P. (Panamurex) hutchisoni* (Jung), from the upper Miocene of Trinidad, it nevertheless seems more closely related to *P. mauryae* than to *P. hutchisoni*. This may well be a facies control problem as *P. hutchisoni* occurs in a clay but *P. mauryae* occurs in an environment similar to that of *P. velero*.

V. Locality Data

The following are Tulane University fossil locality numbers:

60. Jackson Bluff Fm., borrow pits at Jackson Bluff, Ochlockonee River (NW ¼ Sec. 21, T1S, R4W), Leon Co., Florida.
66. Byram Marl, type locality, west bank of Pearl River, at Byram, Hinds Co., Mississippi.
69A. Shoal River Fm., first ravine upstream from Shell Bluff, Shoal River (NW ¼ Sec. 4, T3N R21W), about 3½ miles north of Mossyhead, Walton Co., Florida.
70. Chipola Fm., Ten Mile Creek, at bridge of Florida Highway 73 (NW ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
72. Jackson Bluff Fm., Alum Bluff (upper beds), Apalachicola River (NE ¼ Sec. 24, T1N, R8W), Liberty Co., Florida.
73. Jackson Bluff Fm., "Dripping Springs," Four Mile Creek, about 1000 ft. upstream from bridge of Florida Highway 73 (NE ¼ Sec. 36, T1N, R10W), Calhoun Co., Florida.
91. Oak Grove Sand, type locality, west bank of Yellow River, about 100 yards below bridge at Oak Grove (NE ¼ Sec. 20, T5N, R23W), Okaloosa Co., Florida.
99. Moodys Branch Marl, Montgomery Landing (also known as Creola Bluff), west bank of Red River (Sec. 20, T8N, R5W), Grant Parish, Louisiana.
196. Chipola Fm., Ten Mile Creek, about ¼ mile upstream from bridge of Florida Highway 73 (NE ¼ Sec. 11, T1N, R10W), Calhoun Co., Florida.
325. Matthews Landing Marl, roadcut on Alabama Highway 10, 8.6 miles northeast of railroad station at Kimbrough, Wilcox Co., Alabama.
449. Ocala Limestone, quarry at Haile, on Florida Highway 235, about two miles north of Newberry, Alachua Co., Florida.
453. Chipola Fm., Alum Bluff (lower beds), Apalachicola River (NE ¼ Sec. 24, T1N, R8W), Liberty Co., Florida.
456. Chipola Fm., Ten Mile Creek, about ¼ mile downstream from bridge of Florida Highway 73 (NW ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
457. Chipola Fm., west bank of Chipola River, about ½ mile below Ten Mile Creek (SW ¼ 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 ¼ Sec. 20, T1N, R9W), Calhoun Co., Florida.
546. Chipola Fm., Ten Mile Creek, about 1½ miles west of Chipola River (NW ¼ 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 ft. above Four Mile Creek (SW ¼ Sec. 29, T1N, R9W), Calhoun Co., Florida.
554. Chipola Fm., east bank of Chipola River at power line crossing (SW ¼ Sec. 17, T1N, R9W), Calhoun Co., Florida.
555. Chipola Fm., east bank of Chipola River, about 1000 ft. above Four Mile Creek (SW ¼ Sec. 29, T1N, R9W), Calhoun Co., Florida.
638. Agueguexquite Fm., roadcut and quarry on Mexico Highway 180, 14 miles east of junction with side road into Coatzacoalcos, Veracruz, Mexico.
655. Chipola Fm., Ten Mile Creek, about 0.1 mile downstream from bridge of Florida Highway 73 (NW ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
705. Bowden Fm., type locality, Bowden, east of Port Morant, Parish of St. Thomas, Jamaica.
708. Chipola Fm., at small waterfall on tributary to Ten Mile Creek, south bank, about ¼ mile downstream from bridge of Florida Highway 73 (NW ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
709. Chipola Fm., south bank of Ten Mile Creek, about ¼ mile downstream from bridge of Florida Highway 73 (NW ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
710. Chipola Fm., Ten Mile Creek, just upstream from mouth of Mayo Mill Branch (NE ¼ Sec. 11, T1N, R10W), Calhoun Co., Florida.
735. Matthews Landing Marl, roadcut on Alabama Highway 10, 10 miles northeast of railroad station at Kimbrough, Wilcox Co., Alabama.
757. Gatun Fm., roadcut on south side of Boyd-Roosevelt Highway at junction of road to "Refinería Panamá, S.A.," just east of Cativa, Prov. of Colón, Panamá.
787. Chipola Fm., Ten Mile Creek, south bank about 1½ miles west of Chipola River (SE ¼ Sec. 12, T1N, R9W), Calhoun 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.

810. Chipola Fm., east bank of Chipola River, opposite mouth of Taylor Branch (SW ¼ Sec. 17, T1N, R9W), Calhoun Co., Florida.
817. Chipola Fm., south side of Ten Mile Creek, large gully on the property of Mr. A. Sexton (1967) (SE ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
818. Chipola Fm., Farley Creek, 0.1 mile west of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W), Calhoun Co., Florida.
820b. Chipola Fm., Farley Creek (lower beds), at bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W), Calhoun Co., Florida.
821. Chipola Fm., Farley Creek, 0.1 mile east of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W), Calhoun Co., Florida.
825. Chipola Fm., Farley Creek at abandoned mill about ¼ mile west of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W), Calhoun Co., Florida.
827. Chipola Fm., Farley Creek, about ½ mile west of bridge of Florida Highway 275 (SE ¼ Sec. 20, T1N, R9W), Calhoun Co., Florida.
828. Chipola Fm., Farley Creek, just upstream from mouth of unnamed tributary about ¾ mile downstream from bridge of Florida Highway 275 (SE ¼ Sec. 20, T1N, R9W), Calhoun Co., Florida.
830. Chipola Fm., Ten Mile Creek, at power line crossing about one mile west of Chipola River (SE ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
831. Chipola Fm., Ten Mile Creek [lowest Chipola beds exposed], slightly less than one mile west of Chipola River (SW ¼ Sec. 7, T1N, R9W), Calhoun Co., Florida.
866. "Silverdale Beds," marl pit on north side of Webb creek and east side of unnumbered county highway, Silverdale, Onslow Co., North Carolina.
950. Chipola Fm., Chipola River, west bank about 2000 ft. above Farley Creek (SW ¼ Sec. 20, T1N, R9W), Calhoun Co., Florida.
951. Chipola Fm., Ten Mile Creek, about 1¼ miles west of Chipola River (SE ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
958. Gatun Fm., hillslope on east side of road from Boyd-Roosevelt Highway to "Refinería Panamá, S. A.," about ½ km north of junction, just east of Cativa, Prov. of Colón, Panamá.
959. Gatun Formation, roadcut on road to "Refinería Panamá S. A.," about 100 mts. south of refinery gate, Prov. of Colón, Panamá.
993. Weches Fm., roadcut and glade on north side Texas Highway 21, 3½ miles west of junction with Texas F. M. 95 at Chireno, Nacogdoches Co., Texas.
998. Chipola Fm., Ten Mile Creek, about 1¼ miles west of Chipola River (SE ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
999. Chipola Fm., Farley Creek, about 1000 yds. downstream from bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W), Calhoun Co., Florida.
1025. Concepción Fm., road cut on east side of road from Nuevo Teapa to Ixhuatlán, 0.5 mile south of junction with Mexico Highway 180, Veracruz, Mexico.

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