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CENOZOIC TYPHINAE (MOLLUSCA:GASTROPODA) OF THE WESTERN ATLANTIC REGION

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I. ABSTRACT

Twenty-six genus-group names have been proposed for the muricid subfamily Typhinae. This study shows that four genera and 17 subgenera are valid, with approximately 125 fossil and Recent species. Of these, three genera, nine subgenera, and 36 species are known from the Cenozoic of the western Atlantic region, including three species from the Eocene, two from the Oligocene, 22 from the Miocene, one from the Pliocene, and four from the Pleistocene and Recent. In addition, four species are known only from the Recent fauna.

In this paper, all of the species are treated systematically, including ten new species: *Typhis (Typhina) palmerae,* from the early middle Eocene Weches and Wautubbee formations of Texas and Mississippi, respectively; *T. (Typhina) mississippiensis,* from

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the lower Oligocene Red Bluff Clay of Mississippi; *T.* (*Rugotyphis*) *keenae*, *T.* (*Typhinellus*) *chipolanus, Pterotyphis* (*Pterotyphis*) *calhounensis*, and *P.* (*Tripterotyphis*) *vokesae*, all from the late lower Miocene Chipola Formation of northwestern Florida; *Typhis* (*Talityphis*) *carmenae,* from the upper Miocene Agueguexquite Formation of Mexico; *Siphonochelus* (*Pilsbrytyphis*) *darienensis* and *S.* (*P.*) *woodringi,* both from the middle Miocene of Panamá; and *Siphonochelus* (*Laevityphis*) *bullisi,* from the Pleistocene Móin Formation of Costa Rica and the Recent Caribbean.

The oldest known typhine in the world is referred to *Siphonochelus* (*Laevityphis*), reported from the lower Eocene of England and France. This earliest form is a well developed typhine, from which it is concluded that the group must have evolved at an earlier time. Among the first Typhinae in the western Atlantic is also a representative of *Siphonochelus* (*Laevityphis*), occurring in the late middle Eocene of Alabama. The oldest reported typhine in the western Atlantic region is *T.* (*Typhina*) *palmerae,* n. sp., from the early middle Eocene of Mississippi and Texas.

Typhinae have shells of less than 50 mm length with a protoconch of one and one-half to five whorls. Tubes are present at the shoulder, either alternating with, or within the varices. The number of varices may vary from two to six, but most forms have four varices and four tubes per whorl. The aperture is ovate and surrounded by a raised rim. The anterior canal is closed in all but one group. Generic and subgeneric units are based primarily upon the nature of the varices, the number of varices per whorl, the placement of the tubes with respect to the varices (just behind the varix, just in front of the varix, midway between the varices, or within the varix), and the direction in which the tubes point.

A summary of the reported ecological data shows that the Typhinae live, for the most part, in shallow water in tropical and subtropical areas.

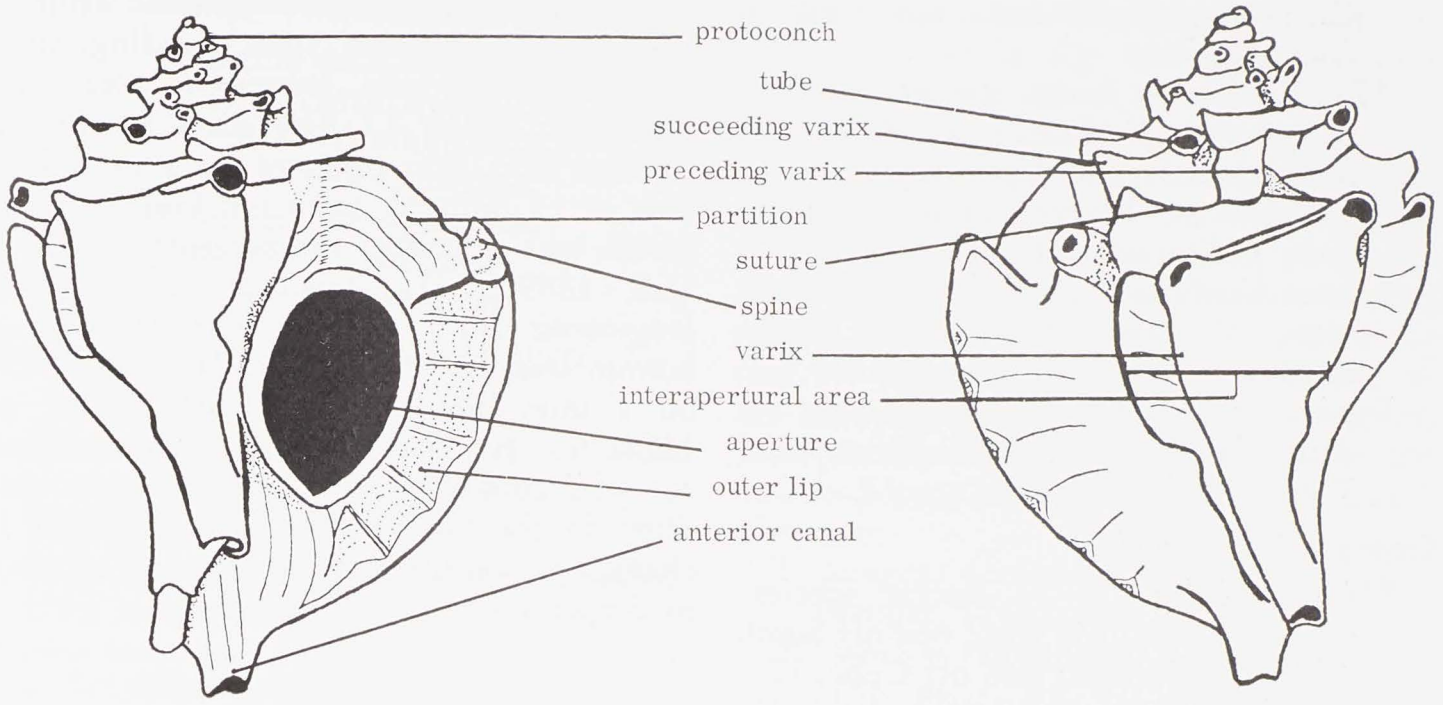
II. Introduction

The genus *Typhis,* established in 1810 by Denys de Montfort, includes those gastropods having a shell of small size, with two to six varices and tubes per whorl, the tubes within or between the varices; the aperture surrounded by a raised rim; anterior canal closed in all but one group; protoconch of one and one-half to five whorls. The type, by original designation, is *"Purpura" tubifer* Bruguière, 1792, from the middle Eocene of the Paris Basin.

Jousseaume (1880, 1882) first divided the typhines into twelve genera. Cossmann (1903) established the subfamily Typhinae, recognizing four genera with eight subgenera. Keen (1944) accepted four genera with 13 subgenera. Vella (1961) included nine genera in the subfamily. In 1964, Keen and Campbell described an unusual new genus, *Distichotyphis* from very deep water (1016 fms.) with only two varices and tubes per whorl. In all, there have been 26 supraspecific names proposed for the Typhinae. Of these the writer recognizes as valid four genera with 17 subgenera.

The problem of genus-groups is especially complex in the Typhinae. At first glance it would appear that there is an overabundance of taxa recognized for a relatively few species. At the present writing there are approximately 125 known species of Typhinae, both fossil and Recent. Of these, Vella described eight from New Zealand in 1961, Keen and Campbell added ten new species in 1964, and the present work adds ten new species from the western Atlantic region. Various other authors have described six more species for a total of 34 new species in the last eight years. This represents about one-quarter of the total number of species and, undoubtedly, many more will be discovered in time to come. It seems obvious that the Typhinae, on the whole, are poorly known and with future work many of the apparent discontinuities in range, both geographic and stratigraphic, will be removed. Seven of Jousseaume's 12 genera were monotypic at the time they were proposed; only one, *Haustellotyphis,* remains so today. Two other monotypic fossil subgenera, *Indotyphis* Keen, 1944, and *Semityphis* Martin, 1931, come from Java, an area where little geologic work has been done. Another monotypic genus is *Distichotyphis,* a very deep water form.

The oldest known species of Typhinae, from the lower Eocene of England and France, is referred to *Siphonochelus* (*Laevi-*



Text figure 1. Terminology applied to typhine shell.

typhis). As *Laevityphis* is a well developed typhine, the subfamily must have evolved at an earlier time, Paleocene or perhaps Cretaceous. As yet, however, none have been recovered from older strata. Among the earliest Typhinae in North America are *S.* (*Laevityphis*) *gracilis* (Conrad, 1833), from the late middle Eocene of Alabama and *S.* (*Laevityphis*) *antiquus* (Gabb, 1864), from the middle or upper Eocene of California. There are species of *S.* (*Laevityphis*) in the upper Eocene of Australia and Peru indicating widespread distribution by early Tertiary time. The subgenera *Typhis* s.s., *Typhina*, *Rugotyphis*, and *Indotyphis* all appear and are widely distributed during the Eocene epoch further substantiating an earlier development. The oldest reported species of Typhinae in the western Atlantic region is a member of the subgenus *Typhina.*

The morphology of the typhine shell (see text figure 1) has been well summarized by Keen (1944, p. 51) in her basic work on the Typhinae. In her classification the tubes bearing the anal siphon are of primary importance in separation of the supraspecific groups; *i.e.,* number of tubes per whorl, placement of tubes with respect to the varices (whether mid-way, or nearer the preceding or succeeding varix, or within the varix), and the direction in which the tubes point (whether toward the aperture, outward, or away from the aperture).

Vella (1961) regarded the type of varix as the most important feature in the classification of the Typhinae, using it to separate groups of related genera. The number of varices per whorl was considered to be of secondary importance, but was used to separate genera within the varix type grouping. Other characteristics, including the number of whorls in the protoconch, placement of the intervarical tubes, shape of the aperture, and orientation of the anterior canal were utilized in distinguishing subgeneric units.

The following is a list of the genera and subgenera as recognized by the writer, the number of species in each subgenus, and any ecologic data that may have been reported. The subgenera that occur in the western Atlantic region (fossil or Recent) are marked with an asterisk. Species indicated as "duplicated" are known both from fossil and Recent.

Genus: *Typhis*

Typhis s.s.—3 Recent species: two off Australia, 15-38 fms., sand; one off Japan, 100-150 fms. 18 fossil species.

**Typhina*—8 Recent species: three off Japan, 50-100 fms.; one off West Africa; two off Australia, 100 fms.; one off New Zealand, 60 fms.; one off West America, 0-45 fms. 8 fossil species.

Haustellotyphis—1 Recent species, tropical West America, 0-7 fms.

**Rugotyphis*—2 Recent species: one off Brazil and West Africa; one from

Caribbean, 33-50 fms., sand-mud. 6 fossil species.

**Typhinellus*—1 Recent species: Mediterranean and Caribbean, 27-60 fms. 4 fossil species (one duplicated).

**Talityphis*—2 Recent species: one off Baja California, 21 fms., sand; one from Caribbean, 17-30 fms., shell-mud-coral. 11 fossil species (one duplicated).

Typhisopsis—4 Recent species: one off Australia, 17 fms., three off tropical West America, 0-14 fms.

Genus: *Siphonochelus*

**Siphonochelus* s.s.—11 Recent species: one off Kenya, 232 fms.; one off South Africa, 40-54 fms.; one off Cuba, 127-400 fms.; eight from Australasia, 21-130 fms. 8 fossil species.

Lyrotyphis—2 fossil species.

Indotyphis—1 fossil species.

Semityphis—1 fossil species.

**Laevityphis*—3 Recent species: one from Indo-Pacific, 18 fms., coral-gravel; one off Zanzibar, 232 fms.; one from Caribbean, 43 fms. 13 fossil species.

**Pilsbrytyphis*—3 fossil species.

Genus *Pterotyphis*

**Pterotyphis* s.s.—2 Recent species: one from the Gulf of California; one from the Caribbean, 0-28 fms. 2 fossil species (one duplicated).

**Tripterotyphis*—6 Recent species: one from Caribbean, 17 fms.; three off tropical West America; two from Australasia. 4 fossil species (two duplicated).

Cinclidotyphis—1 Recent species, tropical West America.

Genus *Distichotyphis*

Distichotyphis s.s.—1 Recent species, off tropical West America, 1016 fms.

Five species, representative of four subgenera of Typhinae, have been reported from the intertidal zone. Most of the reported specimens of the subfamily, however, were dredged from between five and 100 fathoms, with the median depth near 30 fathoms. The deepest reported is *Distichotyphis vemae* Keen and Campbell, 1964, from 1016 fathoms (uncorrected) off the west coast of Panamá.

The literature records Typhinae from a wide range of bottom types including: mud flat, sandy-mud, sand, gravel and coral, and coral reef. *Typhis* (*Typhisopsis*) *grandis* A. Adams, 1855, was reported on a sand bottom, at 14 fathoms, from the Gulf of California with a bottom temperature of 65° F. Dall (1889, p. 216) reported *Siphonochelus longicornis* from 127-400 fathoms, with a bottom temperature between 50° and 55° F, on a mud bottom. Caramagna (1869, p. 168-170) reported *Typhis* (*Typhinellus*) *sowerbii* Broderip, 1833, gregarious on seaweed in the Gulf of Spezia, and stated it changes its locality with the seasons, moving to deeper water in cold weather.

III. Acknowledgments

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IV. Systematic Descriptions

Phylum Mollusca
Class Gastropoda
Subclass Prosobranchia
Order Neogastropoda
Suborder Stenoglossa
Family Muricidae
Subfamily Typhinae

Genus Typhis Montfort, 1810
Subgenus Typhis s.s.

Purpura Bruguière, 1789, Encycl. Méth. (Vers), v. 1, p. xv (genus without species); Bruguière, 1792, Jour. Hist. Nat., Paris, v. 1, p. 28.
Type species: *Purpura tubifer* Bruguière, 1792, by monotypy.

Typhis Montfort, 1810, Conchyl. Syst., v. 2, p. 614-615.
Type species: *Typhis tubifer* (Bruguière), by original designation.

Hirtotyphis Jousseaume, 1880, Le Naturaliste, Année 2, no. 42, p. 336.
Type species: *Typhis horridus* (Brocchi, 1814), by original designation.

Monstrotyphis Habe, 1961, Coloured Illus. Shells of Japan, v. 2, p. 53; App., p. 19.
Type species: *Typhis* (*Monstrotyphis*) *tosaensis* Azuma, 1960, by original designation.

> "Coquille libre, univalve, à spire élevée, varicée et armée; bouche arrondie; columelle lisse; lèvre extérieure tranchante et armée; canal de la base large et soudé; un tube dorsal au milieu de chacun des accroissemens." (Montfort, 1810, p. 615)

Shell with four varices per whorl; tubes abapertural of midpoint between the varices, pointing abaxially and apically; varices armed with small spines; no partition present.

Discussion: The type of the genus *Typhis* was designated by Montfort as "*Typhis tubifer* Bruguière." He placed in his synonymy of this species "*Murex*" *pungens* Solander *in* Brander, as had Bruguière before him. The shell figured by Montfort is neither *Typhis tubifer*, which has four varical spines, nor *T. pungens*, which has three spines. Montfort's illustration shows a shell with seven or eight spines and is probably the species subsequently named *Typhis rutoti* Cossmann, 1882.

Brander (1766) figured two specimens as "*Murex*" *pungens*: pl. 3, fig. 81, the form now accepted as *Typhis pungens*; and fig. 82, which is the same as Bruguière's figured specimen (1792, pl. 2, figs. 3,4). Therefore, we may consider Bruguière as having restricted "*Murex*" *pungens* to the species figured in fig. 81 while renaming the form in fig. 82 as "*Purpura*" *tubifer*. Later, d'Orbigny (1850, p. 364) proposed another name, *Typhis parisiensis*, for "*Murex fistulosus* Brocchi" of Deshayes, 1835, pl. 80, figs. 1-3, and Brander, 1766, pl. 3, fig. 82. The first reference is for yet another species, to which the name *T. parisiensis* may be restricted, deleting the reference to the Brander figure. By way of summary, there are four species of *Typhis* s.s. in the middle Eocene beds of France and England. They are:

T. pungens (Solander *in* Brander, 1766): Brander, 1766, pl. 3, fig. 81.
T. tubifer (Bruguière, 1792): Brander, 1766, pl. 3, fig. 82; Bruguière, 1792, pl. 2, figs. 3, 4; Deshayes, 1835, pl. 82, figs. 26, 27.
T. parisiensis d'Orbigny, 1850: Deshayes, 1835, pl. 80, figs. 1-3.
T. rutoti Cossmann, 1882: Montfort, 1810, p. 614 (text fig.); Deshayes, 1835, pl. 80, figs. 4-6.

Unfortunately, by naming this typine species as "*Purpura*" *tubifer*, Bruguière inadvertently fixed the type of his genus *Purpura* (as listed in the *Tableau Systematique de Vers*, 1789) by monotypy. Although the generic name *Purpura* has had a checkered history it has never been applied to the typhine group and to replace the long accepted generic name *Typhis* with that of *Purpura* would defeat the purpose of stability sought by taxonomists. Therefore, Keen (1964) has requested that the International Commission on Zoological Nomenclature suppress this type designation and declare *Buccinum persicum* Linné as the type of *Purpura*.

Because of the errors of identification of *Typhis pungens* and *Typhis tubifer* many authors have placed the two species in synonymy, but Keen (1944, p. 53) corrected this error. *Typhis pungens* is almost inseparable from *Typhis horridus* (Brocchi, 1814), the type of *Hirtotyphis* Jousseaume, 1880. There is an unbroken line from *T. pungens* in the middle Eocene to *T. horridus* in the Pliocene. There have been two species named for the intermediate members of the line: *T. peyreirensis* Cossmann and Peyrot, 1923 (Aquitanian), and *T. intermedius* Bellardi, 1872 (Burdigalian), but

the differences between them are minimal. Another subgeneric name has been proposed for a Recent species of this group, *T.* (*Monstrotyphis*) Habe, 1961, (type: *T.* (*Monstrotyphis*) *tosaensis* Azuma) but the type species is no more than an especially spinose *Typhis* s.s. and may even be a pathologic shell as it has this appearance and is the only known specimen.

Typhis s.s. is found in the Eocene to Pliocene of western Europe, and in the Oligocene to Recent of the Australasian region. No *Typhis* s.s. are known from the New World.

Subgenus TYPHINA Jousseaume, 1880

Typhina JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335; 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 337.
Type species: *Typhis belcheri* Broderip, 1833, by original designation.

"Coquille fusiforme à spire élevée, tours à varices crénelées, armées en arrière d'une épine saillante et recourbée, et d'un canal tubiforme intermédiaire; ouverture ovale à bords continus; canal long et recourbé." (Jousseaume, 1882)

Shell with four varices and tubes per whorl; tubes midway between varices, pointing abaxially, apically, and abaperturally; spine at shoulder; varices smooth, with flange on posterior portion only; small partition; spiral sculpture often present.

Discussion: The type of *T. belcheri* is not at the British Museum and there is some question as to the identity of the species. Sowerby figures, in the *Conchological Illustrations* (1841, pl. 200, figs. 5, 6), a shell with a small partition and a thin varical flange. It is possible that this specimen is really the juvenile of *T. cleryi* (Petit), which would make *Rugotyphis* a synonym of *Typhina*. However, there is a valid morphological group for which the name *Typhina* has been employed and little would be gained by replacing the name *Typhina* with another new generic name. Until such a time as positive proof of the identity of *T. belcheri* might be discovered the writer will continue to use the established name.

Typhina ranges from the middle Eocene to the Recent, and is represented by 16 species from the Eocene of Java and Texas, the Eocene and Oligocene of Mississippi, the Miocene of Florida, Borneo, and Australia, the Pliocene of India, and the Recent from tropical West America, Australasia, and West Africa.

This study includes three species of *Typhina* ranging from the middle Eocene through the early lower Miocene. The group is never common in the geologic record, and is most widespread and abundant in the Recent.

TYPHIS (TYPHINA) PALMERAE
Gertman, n. sp.
Plate 1, figs. 1a, b

Description: Shell small; protoconch of four and one-half smooth, polished, conical whorls; five post-nuclear whorls; four varices per whorl, varices formed of two parts: a thickened band surrounding the aperture, and a thin flange on the outer edge; flange very weakly crenulated by three faint folds, the posteriormost at the shoulder forming a small spine; interapertural area smooth, of only one part; tubes nearer to succeeding than to preceding varices, pointing abaxially, apically, and abaperturally; shoulder crossed by the former partitions; suture distinct; aperture ovate, pointing abapically, surrounded by a raised rim; anterior canal closed, narrow, long, slightly deflected to the right.

Holotype: Texas Bureau of Economic Geology no. 36638; height 14.6 mm, maximum diameter 8.4 mm.

Type locality: Texas BEG no. 113-T-19, one-half mile northeast of Wheeler Springs School, Houston County, Texas.

Occurrence: Weches Formation, Texas; Wautubbee Formation, Mississippi; early middle Eocene.

Figured specimen: BEG 36638 (holotype). Other occurrences: TU locality nos. 85, 86, 923, 924.

Discussion: This new species from the middle Eocene beds of Texas and Mississippi is the oldest known typhine in the New World. It is also the oldest known *Typhina* in the world and, as such, is marked by a multiwhorled protoconch, which seems to be a typical "primitive" character in the Muricidae (see Vokes, 1967, p. 135). This characteristic is further discussed in this paper under the genus *Siphonochelus*.

T. palmerae is not rare in the Wautubbee Formation of Mississippi, being represented by 14 specimens from 4 localities. The holotype is from the correlative Weches Formation of east Texas and is the only specimen from that formation.

The writer is pleased to name this new species after Dr. Katherine Van Winkle Palmer, of the Paleontological Research In-

stitution, in honor of her work on the Eocene faunas.

Typhis (Typhina) mississippiensis Gertman, n. sp.

Plate 1, figs. 2a, b

Description: Shell moderate in size, stout; protoconch one and one-half whorls, smooth, polished, and rounded; four convex varices per whorl, each crossed by four crenulations, and with a spine at the apical end of the varix; outer lip crossed by four weak spiral ribs not much stronger than the axial growth lines; outer lip narrow and of even width, with a small partition crossing the shoulder; interapertural area of only one part; aperture elongate-ovate, pointed anteriorly, surrounded by a raised rim; tubes midway between varices, pointing abaxially, apically and abaperturally; shoulder slightly depressed and crossed by remnants of former partitions; suture distinct; anterior canal closed, broad, flattened, pointing to the right and abaperturally.

Holotype: USNM 646212; height 19.7 mm, maximum diameter 11.7 mm.

Type locality: TU 226, Chickasawhay River at Hiwannee (3½ miles south of Shubuta), Wayne County, Mississippi.

Occurrence: Red Bluff Clay, Mississippi; lower Oligocene.

Figured specimen: USNM 646212 (holotype).

Discussion: *T. mississippiensis* is recognized by the presence of four crenulations on the varices and four spiral ribs. It is a more inflated shell than the older *T. palmerae* but has a higher spire. It closely resembles *T. patellifer* Martin, 1931, from the upper Eocene of Java, differing principally in that the tubes in *T. mississippiensis* are directed abaperturally but in *T. patellifer* they are directed adaperturally.

This species is known only from the vicinity of the type locality. There are three specimens in the Tulane Collections from the type locality and others in the U. S. National Museum from Red Bluff, which is about two miles north of TU 226.

Typhis (Typhina) siphonifer Dall

Plate 1, figs. 3a, b

Typhis siphonifera Dall, 1915, U. S. Natl. Mus., Bull. 90, p. 77, pl. 13, fig. 9.

Not *Typhis siphonifera* Dall. Anderson, 1929, California Acad. Sci., Proc., (Ser. 4) v. 18, no. 4, p. 138, pl. 9, fig. 8 (= *Typhis* [*Siphonochelus* (*Laevityphis*)] *costaricensis* Olsson, 1922).

Typhis siphonifera Dall. Mansfield, 1937, Florida Geol. Surv., Bull. 15, p. 135.

Typhis (*Typhinellus*) *siphoniferus* Dall. Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 67.

> "Shell small, short, stout-conic, of four whorls, of which the first is smooth and rounded, the others, rapidly enlarging, smooth, angulated by four varices about midway between which, on a subangular shoulder of the whorl, intervene stout tubes slightly backwardly and apically directed, entire and with subcircular orifices, one tube being situated in each interspace; suture distinct, deep, the whorl in front of it to the shoulder subtabulate, the shoulder rounded carinate, the whorl in front rapidly, flattishly attenuated; varices thin, recurved, between the shoulder and the canal with eight or nine crenulations between which and the margin of the aperture the front of the varix is somewhat convex and smooth; aperture rounded-ovate, with an entire, thin, projecting free margin; canal closed, short, stout, wide, slightly curved to the right and backward; siphonal fasciole with three projecting imbrications; the umbilical region deeply grooved, but not perforate." (Dall, 1915)

Description: Shell small; protoconch of one and one-half whorls, smooth and rounded; four varices per whorl; varices convex, weakly ribbed; outer lip narrow, weakly crenulated, narrowed above the aperture; a short, stout spine at the apical end of the varix; interapertural area of only one part; aperture small, rounded-ovate, surrounded by a raised rim; tubes midway between varices, pointing abaxially, apically and slightly abaperturally; shoulder raised, crossed by weak remnants of former partitions; suture distinct, deeply impressed; anterior canal closed, short, flattened, pointing to the right and abaperturally.

Holotype: USNM 165090; height 10.2 mm, maximum diameter 6.6 mm.

Type locality: Ballast Point, Tampa Bay, Florida.

Occurrence: Tampa Limestone, Florida; early lower Miocene.

Figured specimen: USNM 165090 (holotype).

Discussion: Dall (1915, p. 77) considered the Tampa Limestone from which the type specimen of *Typhis siphonifer* was collected to be Oligocene in age, but it is now generally accepted as being lower Miocene (Aquitanian). Keen (1944, p. 56) listed the species as Miocene and emended the name to *T. siphoniferus*. More recently (*in litt.*) she advised the writer that, as the generic name *Typhis* is considered masculine, the correct termination for this species should be *siphonifer*. Actually, a completely new name may be necessary for the species as there is a "*Murex*" *siphoniferus* Lesson,

1844 (Echo Monde Savant, v. 11, no. 24, p. 568), described from Acapulco, Mexico, which from the description is some species of Typhinae. The form was never figured and it is impossible to know exactly what typhine is being described. Therefore, no new name will be proposed for Dall's species inasmuch as it is possible that the genus to which Lesson's species is correctly to be referred is not *Typhis* s.s. but another typhine genus.

Typhis siphonifer should be placed in the subgenus *Typhina* because the varices are only slightly crenulated and the tubes are midway between the varices, rather than adapertural of the midpoint between the varices, their position in *Typhinellus.*

Subgenus RUGOTYPHIS Vella, 1961

Rugotyphis VELLA, 1961, Palaeontology, v. 4, p. 376.

Type species: *Typhis francescae* Finlay, 1924, by original designation.

"Shell large for the subfamily, solid, with 4.2 growth steps per whorl; tubes directed radially or only slightly backwards, nearly horizontal; varices about midway between tubes, broad, elevated, with acute, foliated, crenulated crests, inclined away from the aperture, continued across the shoulder and contiguous with varices of previous whorl, forming four steep, sinistral spiral ridges from body to apex; apertural sides of varices ornamented with irregular, more or less radial ribs; reverse sides of varices and remainder of shell smooth except for growth lines; protoconch not seen." (Vella, 1961)

Discussion: Although *Rugotyphis* was erected for a species from the Miocene of New Zealand, many of the typhine species of the western Atlantic should be referred to this subgenus. It is distinguished from the other similar subgenera by having a large partition unlike *Typhinellus* and *Typhina*, but similar to that of *Talityphis.* It differs from *Talityphis* in lacking the expanded varical flange seen in that group as well as in *Typhina*, *Typhinellus*, and *Typhisopsis*, but has instead narrow crenulated varices. It differs from *Typhis* s.s. by having the large partition as well as by having the tubes almost perpendicular to the axis of the shell rather than parallel. There are two species known from the Miocene of New Zealand and all of the others are from the western Atlantic region, ranging from the upper Eocene Jackson Group to the Recent.

TYPHIS (RUGOTYPHIS) DENTATUS Johnson

Plate 2, figs. 1a, b

Typhis dentatus JOHNSON, 1899, Acad. Nat. Sci. Phila., Proc., v. 51, p. 76, pl. 1, fig. 13.

Typhis (*Typhina*) *dentatus* Johnson. KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 55, 64.

Typhis (*Typhina*) *dentatus* Johnson. PALMER *in* HARRIS and PALMER, 1947, Bulls. Amer. Paleontology, v. 30, no. 117, p. 344, pl. 45, fig. 25 (after Johnson).

Typhis (*Typhina*) *dentatus* Johnson. PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 1009.

"Shell with seven whorls, including the two smooth apical whorls, each whorl with four varices or ribs, those of the body whorl serrated with six, partly open, teeth-like projections, the one at the shoulder large and irregular, the varices in all cases extend more than half-way up the spiral whorls, the large tubular spine at the shoulder midway between the varices extends outward and slightly forward, aperture ovate." (Johnson, 1899)

Description: Shell medium-sized; protoconch smooth, rounded, two whorls; five post-nuclear whorls; four flaring varices per whorl, each bearing six crenulations, that at the apical end of the varix curving apically and abaperturally; tubes midway between the varices, pointing abaxially and abaperturally; outer lip of constant width, a large partition, connecting the varix with that of the preceding whorl; aperture ovate, pointed anteriorly and surrounded by a raised rim; suture sharp, not appressed; interapertural area in two parts: the first including the tube and a small flange beyond it; the second with the remaining portion of the varix; anterior canal broad, closed, pointed slightly to the right and abaperturally; siphonal canal bearing remnants of earlier canals.

Holotype: ANSP 7049; height 15.0 mm, maximum diameter 9.5 mm.

Type locality: Jackson, Hinds County, Mississippi.

Occurrence: Moodys Branch Formation, Mississippi; upper Eocene.

Figured specimen: ANSP 7049 (holotype).

Discussion: This species, the oldest known *Rugotyphis*, is based on four specimens said to be from Jackson, Mississippi. No subsequent specimens have been found and the exact locality is not known.

T. dentatus closely resembles the younger *T. harrisi* Olsson from the upper Miocene beds of Florida, but may be distinguished by the almost smooth forward face of the apertural varix as opposed to the strongly ribbed varical face of all of the younger species such as *T. keenae* Gertman, n. sp., and *T. harrisi.*

TYPHIS (RUGOTYPHIS) KEENAE Gertman, n. sp.

Plate 2, figs. 2a, b, c; 3a, b

Description: Shell large; protoconch smooth, rounded, one and one-half whorls; five post-nuclear whorls; four flaring varices per whorl, each bearing four crenulations; the apical crenulation forming a spine at the top of the varix that curves apically and abaperturally; tubes midway between varices, pointing abaxially and abaperturally; outer lip of constant width around the aperture, joining the varix of the preceding whorl to form a partition on the shoulder; suture sharp, not appressed; aperture ovate, pointed anteriorly and surrounded by a raised rim; interapertural area in two parts: the first, beginning from the old aperture, under the tube, with three ribs close together; the second, on the back of the new varix and continuing over the varix, beginning with four ribs, the posterior rib continuing from the center area and turning apically to form the spine of the new varix; the middle two ribs beginning abruptly at the termination of the middle rib of the center area, and the last rib continuing from the anterior rib of the center area; the last three ribs continuing over the varix to the aperture, forming the three ribs on the front of the varix; some specimens marked with irregular, subdiagonal ridges forming a semi-reticulate pattern on the shell; anterior canal closed, short, narrow, pointing slightly to the right and abaperturally; siphonal canal bearing remnants of three earlier canals.

Holotype: USNM 646214; height 22.4 mm, maximum diameter 14.0 mm.

Paratype: USNM 646215; height 26.6 mm, maximum diameter 16.2 mm; locality TU 547.

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

Occurence: Chipola Formation, Florida; late lower Miocene.

Figured specimens: Fig. 2, USNM 646215 (paratype). Fig. 3, USNM 646214 (holotype). Other occurrences: TU locality nos. 457, 546, 554, 555, 820, 821, 825, 827, 828, 951, 998.

Discussion: This new species from the Chipola Formation of northwestern Florida is unquestionably ancestral to *T. (Rugotyphis) harrisi* from the upper Miocene beds. *T. (R.) keenae* may be distinguished from the younger species by its heavier spiral ribbing, more constricted anterior canal, and stronger partitions on the shoulder. *T. harrisi* is widespread in the upper Miocene beds of Florida but *T. keenae* is confined to the Chipola Formation.

Although most examples of *T. keenae* possess smooth shells there are a few specimens from locality TU 547 that have an ornamentation rare among the Typhinae. The only comparable ornamentation is that found in the species referred to the subgenus *Pilsbrytyphis* Woodring, 1959. As the shells of that group are otherwise more closely related to *Siphonochelus* (*Laevityphis*) the presence of this ornamentation in a *Rugotyphis* apparently represents parallel evolution. It may be some type of environmental response, as the Chipola specimens with this ornamentation all occur at the same locality, which is a fossil coral reef. There are smooth shells found at the same locality so this ornamented shell can be regarded as an "ecotype" at best. The figured paratype (pl. 2, fig. 2) possesses this ornamentation.

It is a great pleasure to dedicate this new species to Dr. A. Myra Keen, the leading worker in the Typhinae.

TYPHIS (RUGOTYPHIS) HARRISI Olsson

Plate 2, figs. 4a, b

Typhis harrisi OLSSON, 1914, Bulls. Amer. Paleontology, v. 5, no. 24, p. 46, pl. 9, figs. 7, 9.

Typhis harrisi Olsson. MANSFIELD, 1930, Florida Geol. Surv., Bull. 3, p. 83, pl. 11, fig. 6.

Typhis (Typhina) harrisi Olsson. KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 55, 65.

"Shell of moderate size; whorls polished; whorls about 5, with 4 large, thick varices, which on the body whorl extend completely across the whorl and onto the anterior canal; between these are shorter varices which continue only to just below the middle of the whorl; the varices carry on the shoulder of the whorls a hollow, recurved spine; these are generally broken off, and represented only by hollow stumps; whorls above the shoulder are irregularly flattened and with the suture appressed; on this area only the smaller varices continue across to the suture; surface of shell smooth with only growth lines which extend up onto the spines; the varix next to the mouth carries about four raised ridges which are placed at right angles to the aperture; on the body whorl resting marks are indicated by raised lines between the varices and representing the aperture and each of the larger varices have on their summit a wavy line formed by raised ridges corresponding to those at the aperture; canal broad and flattened, recurved and ending in hollow stump which probably represents the base of a recurved spine; aperture round or subovate with a raised rim." (Olsson, 1914)

Description: Shell large, stout; protoconch smooth, rounded, of one and one-half whorls; five post-nuclear whorls; four varices per whorl with a spine at the apical end of each varix; outer lip and varices crossed by three or four

ribs; outer lip of even width with a partition above the aperture, crossing the shoulder and connecting each varix with the varix of the preceding whorl; shoulder raised; suture distinct; interapertural area in two parts: the first including the tube and a small flange beyond it; the second including the rest of the varix; tubes closer to the preceding than the succeeding varix, pointing abaxially and abaperturally; shell smooth except for the crenulations on the varices; aperture rounded-ovate, large, and surrounded by a raised rim; anterior canal closed, broad, curving to the right and abaperturally.

Holotype: USNM 370190; height 19.1 mm, maximum diameter 12.8 mm.

Type locality: upper bed at Alum Bluff, Apalachicola River, Liberty County, Florida (= TU 72).

Occurrence: (?) "Silverdale Beds," North Carolina: early lower Miocene. Duplin Marl, North Carolina; Jackson Bluff Formation and Pinecrest Beds, Florida; upper Miocene.

Figured specimen: USNM 646216; height 24.3 mm, maximum diameter 16.0 mm; locality TU 60. Other occurrences: USGS Stations 3672, Hosford, Liberty County, and 8176, "Deadens" Washington County, Florida; Natural Well, North Carolina (= TU 376); TU locality nos. 562 (?), 712, 729, 730, 866 (?), 932.

Discussion: *T. harrisi* is one of the most widespread of the Miocene Typhinae. It occurs in the Duplin Marl of North Carolina and the Jackson Bluff Formation of northwestern Florida where it is moderately common (40 specimens from TU 60); but it is in the southern Florida Pinecrest Beds that it become truly abundant (360 specimens from 3 localities). At the latter localities it occurs with *T. floridanus*, its descendant form. It is possible to observe the gradual replacement of *T. harrisi* by *T. floridanus* at these Pinecrest localities. Along the Kissimmee River, on the north side of Lake Okeechobee, there is an excellent section "exposed" in the spoilbanks created by the U. S. Corps of Engineers in building the "Kissimmee Canal." From north to south the beds become progressingly younger, starting with the oldest beds exposed at the Seaboard Airline Railroad bridge at Fort Basinger (TU 730) and continuing until the Pliocene Caloosahatchee Formation is encountered at the bridge of Florida Highway 70 (TU 770). In the Tulane collections from the northernmost and oldest locality (TU 730) there are 128 specimens of *T. harrisi* but only three of *T. floridanus*. At the next locality farther south (TU 932) there are 75 *T. harrisi* to 20 *T. floridanus*. At the next locality (TU 729), which is a mixture of older strata and the "Brighton facies" of Olsson and Petit (1964, p. 517), actually the uppermost Pinecrest, there are 158 *T. harrisi* to 248 *T. floridanus*. From this point south only *T. floridanus* is found. Evidently *T. harrisi* is confined to the older Pinecrest and only *T. floridanus* occurs in the "Brighton facies." At other localities of this age which are not mixed with older strata (*e. g.*, TU 200, 520, 797) there are no *T. harrisi* found.

In the Tulane collections from the lower Miocene "Silverdale Beds" at Silverdale, North Carolina (Trent Marl of authors), there are two specimens that seem to be referable to *T. harrisi*. Due to the disjunct distribution in time it would seem unlikely that they are actually the same species as there have been no middle Miocene specimens of *T. harrisi* discovered as yet, but only more material can solve this problem.

TYPHIS (RUGOTYPHIS) FLORIDANUS Dall

Plate 2, figs. 5a, b; 6a, b

Typhis floridanus DALL, 1889, Harvard Mus. Comp. Zoology, Bull., v. 18, pt. 2, p. 216; 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 152, pl. 9, fig. 5.

Typhis floridanus Dall. WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 293.

Typhis (Typhinellus) floridanus Dall. KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 64.

Typhis (Typhinellus) floridanus Dall. OLSSON and HARBISON, 1953, Acad. Nat. Sci. Phila., Monograph 8, p. 249, pl. 36, figs. 4, 4a, 4b.

Typhis (Typhinellus) carolinensis OLSSON and PETIT, 1964, Bulls. Amer. Paleontology, v. 47, no. 217, p. 551, pl. 81, figs. 1-1c.

"Shell of five or six whorls exclusive of the nucleus; spire short; varices on each whorl four, expanded, rather thin and sharp-edged, the whorl between flattish; at the shoulder the varix is produced into a slender twisted spine, not pervious, but with its distal end open and rarely perfect, turned toward the axis; whorl behind the shoulder irregularly flattened, appressed, but not much expanded at the suture; from the spine at the shoulder to the whorl between the varix is sometimes filled in by a thin shelly plate, and sometimes the plate is absent or obsolete; tubes moderate, situated midway between the varices or nearer the preceding varix, extending outward and backward; canal short, broad and flattened, with a small perforation; spiral sculpture of a few low ridges extending from the vicinity of the aperture to the summit of the varix, where they appear as serrations or abortive spines, but are obsolete behind the varix, or they

may be absent altogether; aperture subovate, simple, with a plain elevated rim." (Dall, 1890, p. 152)

Description: Shell large, elongate; protoconch bulbous, of one and one-half whorls; five post-nuclear whorls; four slightly crenulated varices per whorl, each crossed by nine ribs; a spine at the apical end of each varix pointing apically, axially, and then adaperturally; when broken the spines appear as hollow tubes, but do not connect with the interior of the shell, are flattened, and smaller in diameter than the tubes; tubes closer to preceding than succeeding varices, pointing abaxially, apically and abaperturally; varices only slightly convex; outer lip crossed by five ribs that connect with the rim of the aperture, three shorter ribs to the anterior of the aperture, and a short one to the posterior; outer lip of constant width; interapertural area of only one part; ribbing on the varices the only ornamentation; aperture ovate, surrounded by a raised rim; a partition above the aperture connecting the new varix to the varix of the preceding whorl; shoulder slightly raised, crossed by remnants of former partitions; suture distinct; anterior canal broad at its base, then tapering and turning slightly to the right and abaperturally.

Holotype: USNM 112184; height 14.7 mm, maximum diameter 7.9 mm.

Type locality: TU 536 (here designated), south bank of Caloosahatchee River about one mile east of LaBelle (Secs. 3 and 4, T43S, R29E), Hendry County, Florida. (Designated as type locality of the Caloosahatchee Formation by Olsson *in* Olsson and Petit, 1964, p. 519.)

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

Figured specimens: Fig. 5, USNM 646217; height 22.5 mm, maximum diameter 13.2 mm; locality TU 536. Fig. 6, USNM 646218; height 27.8 mm, maximum diameter 15.7 mm; locality TU 558. Other occurrences: TU locality nos. 79, 200, 202, 203, 519, 523, 527, 529, 532, 539b, 540, 579, 583, 726, 728, 729, 730, 736, 755, 767, 768, 769, 770, 792, 797, 870, 932, 939, 975.

Discussion: *T. floridanus* is most closely related to, and undoubtedly descended from, *T. harrisi* Olsson, from which it differs in being more elongate, with more numerous crenulations on the outer lip and varices. *T. harrisi* has four ribs crossing the varices, *T. floridanus* has five such ribs, and *T. puertoricensis* Warmke, 1964, the Recent member of the line, has six ribs.

Olsson and Petit (1964, p. 551) described a new species, *Typhis* (*Typhinellus*) *carolinensis*, as differing from *T. floridanus* "by its slimmer body whorl and larger size." The holotype and paratype are slightly larger than any specimens from the Caloosahatchee Formation but smaller topotypes in the Tulane collections agree perfectly with larger specimens of *T. floridanus*. Comparison of specimens of *T. carolinensis* with more than 1000 *T. floridanus* showed them to be well within the range of variation of whorl proportions for that species. Dall (1890, p. 152) noted "the older specimens [of *floridanus*] have a proportionally longer canal and less expanded varices, which makes them appear more slender than the young." No juvenile forms of *T. carolinensis* are reported, which leads the writer to conclude that the smaller specimens have been referred to *T. floridanus*. The type locality of *T. carolinensis* (TU 558) is remarkable for the large size attained by all of the shells found there. Specimens of *Oliva* from 80 to 90 mm in height are common, as are *Glycymeris americana* of over 100 mm in height.

Typhis (Rugotyphis) puertoricensis Warmke

Typhis (*Talityphis*) *puertoricensis* Warmke, 1964, Nautilus, v. 78, no. 1, p. 1, pl. 1, figs. 1-4.

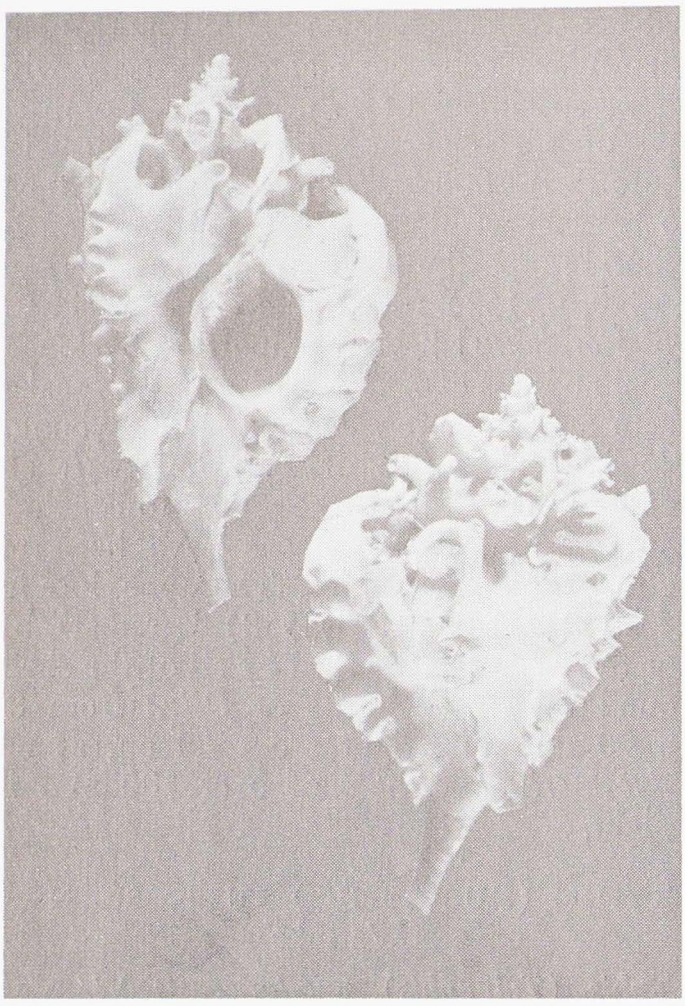
"Shell medium-sized, strong, rosy brown when young; later whorls whitish with a brownish-pink cast. Nucleus with two smooth and glassy whorls, followed by 5 gradually increasing whorls each bearing 4 cylinderical tubes alternating with the 4 rounded varices. Varices terminating in thin, recurved hooks. Tubes placed near the preceding varix, long and backward-pointing before breaking. Whorls parted by an increasing deep suture which is irregularly fluted by upper ends of recurved varices and bases of tubes. Surface sculptured with weak spiral cords that are more prominent on the varices, 6 being visible on the outer lip. Aperture small, oval, smooth internally; varix at outer lip greatly expanded and of nearly uniform width throughout. Suture line between outer lip and unsculptured pad [*i. e.*, partition] above aperture making a 45-degree angle with the sculpture of the outer lip. Anterior canal long, slender, closed in front; pillar with remains of three antecedent canals. Operculum unguiculate, with an apical nucleus." (Warmke, 1964)

Holotype: Stanford University Paleo. Type Coll. no. 9722; height 17.2 mm, maximum diameter 10.0 mm.

Type locality: Off Punta Cadena, north of Mayagüez, on the west coast of Puerto Rico, 33 fms.

Occurrence: Recent only, Caribbean Sea.

Discussion: This Recent member of the *T. harrisi-T. floridanus* lineage differs from



Text figure 2. *Typhis* (*Rugotyphis*) *cleryi* (Petit de la Saussaye). Holotype (× 3). Photograph courtesy of Muséum National d'Histoire Naturelle, Paris.

the fossil species in having more numerous, heavier spiral ribs. Otherwise the three forms are closely related.

TYPHIS (RUGOTYPHIS) CLERYI
(Petit de la Saussaye)
Text figure 2

Murex (*Typhis*) *cleryi* PETIT DE LA SAUSSAYE, 1840, Mag. Zool., v. 3, p. 327; 1842, *ibid.*, pl. 54.

Not *Typhis cleryi* (Petit). G. B. SOWERBY, JR., 1866, Thes. Conch., v. 3, *Typhis*, p. 320, pl. 284, fig. 14 (= *Typhis phillipensis* Watson, 1883).

Murex cleryi Petit. TRYON, 1880, Man Conch., v. 2, p. 137, pl. 30, fig. 301.

Not *Typhis cleryi* Sowerby. TRYON, 1880, Man. Conch., v. 2, p. 137, pl. 30, fig. 302 (after Sowerby, 1866, pl. 284, fig. 14, = *T. phillipensis* Watson).

Not *Typhis cleryi* Sowerby. SMITH, 1939, Cat. Recent species Rock shell, p. 18 (= *T. phillipensis*).

Typhis (*Typhinellus*) *cleryi* (Petit). KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 64.

"Testa pyriformi, rufescente, ventricosa, quadrifarium varicosa; varicibus terminatis in spinam subtilem et curvissimam desinentibus; anfractibus superne angulato-planulatis, spinis fistulosis subrectis, inter varices coronatis; spira exerta, acuta; apertura suborbiculari, producta; labro imbricato, fimbriato, externe reflexo; canali clauso, sobrecurvo, basi attenuato." (Petit de la Saussaye, 1840)

Description: Shell medium-sized, stout; five post-nuclear whorls; four convex varices per whorl; a spine at the top of each varix pointing apically and adaxially; outer lip of two parts; the inner part crossed by five strong ribs, the outer flange crenulate; interapertural area smooth under the tubes and strongly crenulated on the varices; tubes midway between the varices, pointing abaxially and abaperturally; aperture rounded-ovate; partition above the aperture equal in width to the outer lip, crossing the shoulder and joining the varix of the preceding whorl; shoulder slightly raised, suture distinct; anterior canal closed, narrow, pointing to the right and abaperturally.

Holotype: Muséum National d'Histoire Naturelle, Paris; height 18.5 mm, maximum diameter 11 mm.

Type locality: Cabo de São Tomé, [near Rio de Janeiro] Brazil, 40 fms.

Occurrence: Recent only, Brazil and West Africa.

Figured specimen: Holotype.

Discussion: *Typhis cleryi* is another descendant of the *T. harrisi* lineage but differs from *T. puertoricensis* in having a more inflated shell with less pronounced spiral ribs. In shape *T. cleryi* is closer to *T. harrisi* and *T. puertoricensis* is more like *T. floridanus.*

Although *T. cleryi* was described from off the Brazilian coast there is a specimen in the Tulane Collections from Rio de Oro, Spanish Sahara, northwestern Africa. There is also a magnificent specimen, 24 mm in height, in the collection of Crawford Cate, of Los Angeles, from off Mauritania, West Africa, in 33 fms.

Subgenus TYPHINELLUS Jousseaume, 1880

Typhinellus JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335; 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 337.

Type species: *Typhis sowerbiyi* [*sic*] Broderip, 1833 (= *T. sowerbii* Broderip).

"Coquille tétragone à spire élevée, conique, tours très déprimés près de la suture, armés de 4 varices ailées et d'un canal tubiforme intermédiaire; ouverture centrale petite, ovale, à bords détachés et continus; canal large et fermé." (Jouseaume, 1882)

Shell with four varices and tubes per whorl; tubes closer to preceding than succeeding varices, pointing abaxially and abaperturally; varix

at outer lip constricted above the aperture; flaring at anterior canal; faint spiral sculpture common.

Discussion: There are but four species of *Typhinellus* ranging in age from the lower Oligocene (Tongrian) to the Recent. The oldest known form is *T.* (*Typhinellus*) *tetrapterus protetrapterus* Sacco, 1904, from Italy. There is one species, *T. macropterus* Martin, 1884, from the Miocene of Java, and a single species from the Miocene Chipola Formation of Florida. The only Recent species is *T.* (*T.*) *sowerbii* Broderip, type of the genus, known previously from the Mediterranean Sea, but herein also reported from the Caribbean. This species has had two varieties named, neither of which is valid, and has, in addition, four synonyms, all from the Pliocene of Italy.

Typhis (Typhinellus) chipolanus Gertman, n. sp.

Plate 1, figs. 4a, b

Description: Shell small, elongate; five post-nuclear whorls; protoconch smooth, rounded; four slightly convex varices per whorl; spine at top of each varix, curving axially and apically; tubes closer to preceding than succeeding varices, pointing apically, abaxially, and abaperturally; outer lip of two parts, an inner band and a weakly crenulated outer flange; outer lip wider than the partition above the aperture; shoulder crossed by remnants of former partitions, joining each varix to the varix of the preceding whorl; shoulder depressed slightly; suture distinct; aperture oval, surrounded by a raised rim; anterior canal long, narrow, pointing to the right and abaperturally.

Holotype: USNM 646213; height 12.5 mm, maximum diameter 6.7 mm.

Type locality: TU 547, west bank of Chipola River, about 2000 ft. above the mouth of Four Mile Creek (SW ¼ Sec. 29, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida; late lower Miocene.

Figured specimen: USNM 646213 (holotype).

Discussion: All of the four known species of *Typhinellus* are so similar that they could well be placed in synonymy. This new species from the Chipola Formation is the oldest fossil *Typhinellus* from the New World and differs from the others in having a more elongate, narrower shape and a much wider siphonal canal. The species is based on a single specimen from a fossil coral reef (TU 547), which has many other unique species of mollusk also.

Typhis (Typhinellus) sowerbii Broderip

Plate 1, figs. 5a, b, c

Murex fistulatus Risso, 1826, Hist. Nat. Eur. Mérid., v. 4, p. 191. Not *Muricites fistulatus* Schlotheim, 1820.

[?] *Murex labiatus* Cristofori and Jan, 1832, Cat. Mus., Sec. II, Conch. foss., p. 11 (nomen dubium).

Typhis sowerbii Broderip, 1833, Zool. Soc. London, Proc., pt. 2, p. 178.

Murex tetrapterus Bronn, 1838, Lethaea Geogn., v. 2, p. 1077, pl. 41, fig. 13a, b.

Murex syphonellus Bonelli *in* Bellardi and Michelotti, 1841, R. Acc. Sci. Torino, Mem., (Ser. 2) v. 3, p. 129, pl. 3, figs. 3, 4.

Typhis sowerbii Broderip. G. B. Sowerby, Jr., 1841, Conch. Illus., pl. 200, figs. 7, 8, and "var.," 9.

Typhis sowerbyi Broderip. H. and A. Adams, 1853, Genera Recent Mollusca, v. 1, p. 76, pl. 8, figs. 2 (animal), 2a, 2b (operculum), 2c (shell).

Typhis tetrapterus Bronn. Tryon, 1880, Man. Conch., v. 2, p. 136, pl. 30, figs. 290-292 (after Adams, 1853, pl. 8, figs. 2a, b, c.).

Typhis sowerbyi fulva Pallary, 1906, Jour. Conchyl., v. 54, p. 90.

Typhis sowerbyi minor Pallary, 1906, Jour. Conchyl., v. 54, p. 90.

Typhis (*Typhinellus*) *sowerbyi* Broderip. Smith, 1939, Cat. Recent species Rock shells, p. 19, pl. 14, fig. 12.

Typhis (*Typhinellus*) *sowerbyii* Broderip. Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 67.

> "Typhis testa subovata, albida, quadri-vel quinque-fariam varicosa, varicibus laminatis subfrondentibus; tubulis suberectis; canali brevi, subrecurva, gracili." (Broderip, 1833)

Description: Shell medium-sized, elongate; protoconch smooth, rounded, of one and one-half whorls; five post-nuclear whorls; four smooth to weakly crenulated, convex varices per whorl; a spine at the top of each varix, pointing apically; outer lip of two parts: a weakly ribbed inner band of even width, and an outer flange, greatly flaring anteriorly and weakly crenulated; interapertural area smooth, divided only by the remnant of the outer lip flange at the edge of the varix; tubes closer to preceding than succeeding varices, pointing apically, abaxially, and abaperturally; aperture ovate, surrounded by a raised rim; partition above aperture narrower than outer lip, crossing the shoulder and joining the varix to the varix of the preceding whorl; shoulder depressed; suture distinct; anterior canal closed, narrow, curving sharply to the right and abaperturally.

Holotype: not found; height ⅞ inch, diameter ½ inch (*fide* Broderip, 1833).

Type locality: Mediterranean Sea.

Occurrence: (?) Matura shell bed, Trinidad; Astian Stage, Italy; Pliocene. Mediterranean and Caribbean Seas, Recent.

Figured specimen: USNM 696658; height 17.0 mm, maximum diameter 10.0 mm; locality, *Oregon* Station 5070.

Discussion: Although this species has long been known from the Mediterranean, this is the first report from the western Atlantic. The figured specimen was dredged by the U. S. Fish and Wildlife Service M/V *Oregon* near Nevis, Leeward Islands, at 50-60 fms. (*Oregon* Station 5070). One complete specimen plus some fragments were collected by the *Anton Bruun* Cruise 10, at Duarte Cay, north of Porto Bello, Panamá (TU R-100). Another specimen, owned by Mrs. Harold Rathburn of Sarasota, Florida, was dredged off Egmont Key, Florida, in 41 fms., and yet another, in the collection of Mrs. Mildred Tate, of Lake Jackson, Texas, came from 28 fms., off the Texas coast.

Keen (*in litt.*) is of the opinion that this species is not *T. sowerbii* but is new. Her reasons include "the difference in the shape of the anterior end of the aperture, the difference in the way the outer lip turns back, and the contrast in the relative sizes of the tube-spines and varices—the varices as seen in the apical view are relatively much smaller in your shell." The writer, however, feels that these differences are within the range of variation of *T. sowerbii*. More material may well prove him wrong.

As is shown by the synonymy above this species has many names. The earliest is *Murex fistulatus* Risso, 1826 (*fide* Fischer-Piette and Beigbeder, 1943, p. 326), which fortunately is preoccupied by *Muricites fistulatus* Schlotheim, 1820 (*vide* ICZN *Code*, Art. 56b). The second name is *Murex labiatus* Cristofori and Jan, 1832, which Keen (1944, p. 56) regarded as a *nomem dubium*. It is probable that the name *labiatus* was intended for the species subsequently named *T. tetrapterus*, for Cristofori and Jan described their form as "labro alato" with the type locality "C. arq." or Castellarquato, an Italian Pliocene locality where "*T. tetrapterus*" is common. However, *T. fistulosus* (Brocchi, 1814), the other species with which *labiatus* has been synonymized also is common at Castellarquato, so it seems best to follow Keen's suggestion and consider this name as a *nomen dubium*.

The original spelling of *T. sowerbii* without a "y" was used twice by Broderip and subsequently by Sowerby and it is assumed to be the correct original spelling. Presumably it was thought to be better Latin. Subsequent authors have emended this spelling to *sowerbyi*, as it was named for James Sowerby, but the *International Code of Zoological Nomenclature* states (Art. 32a) that the original spelling is to be retained unless it contraves one of the mandatory provisions of the *Code*, which this does not, or unless it is an obvious inadvertent error, which this also is not. In Appendix D of the *Code* (16b) this latinization is not recommended, but it is not forbidden.

As *T. tetrapterus* this species is widely reported in the Pliocene of Italy, but no attempt has been made to include these ref-

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Plate 1

Figures

Page

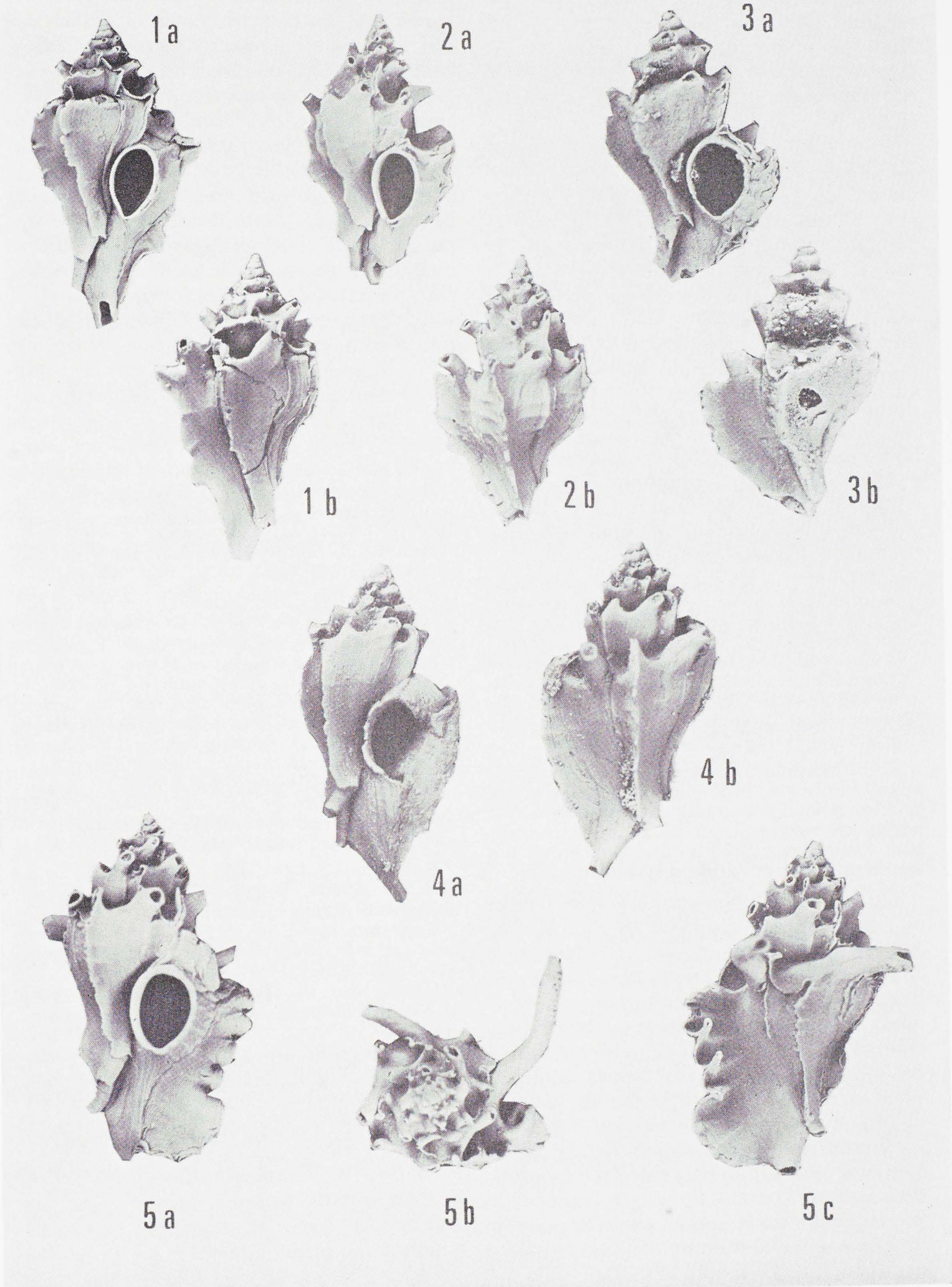


PLATE 1

erences in the synonymy above. It was reported from the Miocene of the Vienna Basin by Hörnes (1856, p. 263) but his figured specimen (*ibid.*, pl. 26, fig. 10) is not the same species, nor even the same subgenus.

In a recent paper Jung (1969, p. 493, pl. 50, figs. 5, 6) has reported a *Typhis* (*Typhinellus*) cf. *quadratus* Hinds from the Pliocene Matura shell bed of Trinidad. All of his specimens are said to be strongly worn and it is difficult to be certain of their identity. From the illustration the species seems to be *T.* (*T.*) *sowerbii*, a not entirely unexpected form connecting the occurrences in the Chipola Formation with the Recent Caribbean representatives.

Subgenus TALITYPHIS JOUSSEAUME, 1882

Talityphis JOUSSEAUME, 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 338.

Type species: *Typhis expansus* Sowerby, 1874, by original designation.

"Coquille épaisse, turbinée, rappelant par la forme le *C.* [*Crassilabrum*] *Talienwahense*, à spire courte, tours ornés de varices frangées et recourbées en arrière, ne s'etendant pas sur le canal antérieur et d'un canal tubiforme intermédiaire placé près de la suture; ouverture ovale à bords continus, canal antérieur court, large à la base, étroit et déjeté à droite en avant." (Jousseaume, 1882)

Shell with four varices and tubes per whorl; tubes closer to preceding than succeeding varices, pointing abaxially, apically, and abaperturally; varix at outer lip greatly expanded, wide throughout, with a partition above the aperture; spiral sculpture may be present.

Discussion: *T. expansus*, the type species of *Talityphis*, was described without locality data. Keen (1944, p. 56) reported that Olsson collected specimens of *T. expansus* from Santo Domingo and this has been taken by subsequent authors to be the locality for the species. Keen did not locate the type specimen at the British Museum (Nat. Hist.) and it is presumed to be lost (Keen, personal communication). Several specimens have been dredged by the U. S. Fish and Wildlife Service M/V *Oregon* off the Surinam coast, which agree well with Sowerby's illustration and so, for the present, *T. expansus* is considered to be the correct name for the Caribbean species.

The 12 species of *Talityphis* range in age from lower Miocene to Recent, and are all found in the Americas. The oldest known species is from the lower Miocene (Aquitanian) of the Atlantic coast of Colombia and Trinidad (*T. precursor* Keen and Campbell, 1964). By middle Miocene time the subgenus had spread to California (*T. lampada* Keen, 1943) and throughout the Caribbean and Gulf region, as far north as Maryland. *T.* (*Talityphis*) *carmenae*, n. sp., is described herein from the upper Miocene of Mexico. *Typhis olssoni* Keen, 1943, the only representative of the subgenus in the Pliocene, is from western Costa Rica. There are two Recent species: *T. expansus* Sowerby, and *T. latipennis* Dall, 1919, from Baja California.

TYPHIS (TALITYPHIS) PRECURSOR
Keen and Campbell

Plate 3, figs. 1a, b; 2a, b

Typhis alatus obesus Gabb. MAURY, 1925, Bulls. Amer. Paleontology, v. 10, no. 42, p. 336, pl. 36, figs. 6, 9 (*not* of Gabb).

Typhis (*Talityphis*) *precursor* KEEN and CAMPBELL, 1964, Veliger, v. 7, no. 1, p. 49, pl. 9, figs. 14, 18, 21, 22.

"Shell large, exceptionally sturdy, with massive tubes and ridge-like varices; teleoconch whorls 5, spire relatively high; varices and tubes 4 per whorl; pad above aperture a little narrower than the outer lip portion of the varix; sculpture almost entirely axial, with weak spiral lines showing only on the face of the outer lip varix, which is festooned slightly by about 6 spiral lines; aperture relatively large, its margin free and entire, standing upward as an oval rim; anterior canal completely sealed along the apertural face, open at end." (Keen and Campbell, 1964)

Holotype: Univ. Calif. Dept. Paleo. Type Coll. no. 15083; height 47.5 mm, maximum diameter 31.0 mm.

Type locality: Univ. Calif. loc. S-8012, on the coast 6 km west of Puerto Colombia, Dept. Atlantico, Colombia.

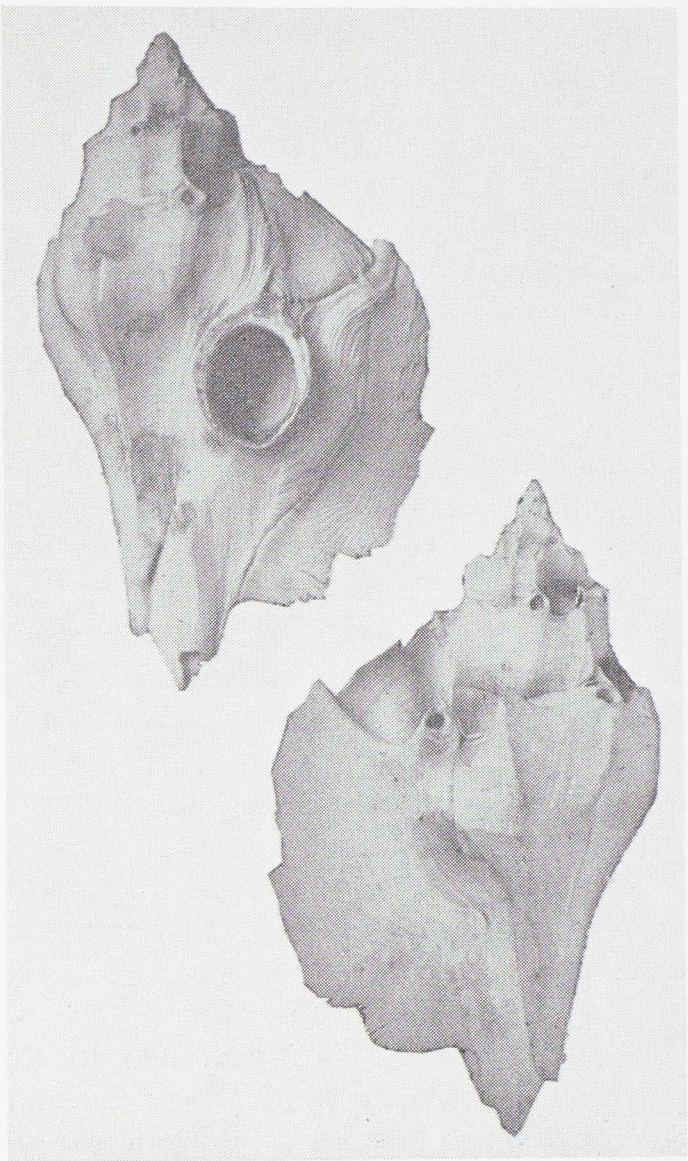
Occurrence: Las Perdices Shale, Colombia; Manzanilla Formation, Trinidad; lower Miocene.

Figured specimens: Fig. 1, UCPDTC 15083 (holotype). Fig. 2, PRI 1057; height 29.0 mm, maximum diameter 20.0 mm; locality, Milepost 11 on Caparo Road, Trinidad (specimen figured by Maury, 1925, pl. 36, fig. 6, 9).

Discussion: Keen and Campbell (1964, p. 49) recently named a species from the Aquitanian beds of northern Colombia, which is the oldest *Talityphis* yet to be discovered. There is another very similar form of almost equivalent age from the lower Miocene Manzanilla Formation of Trinidad that was cited by Maury (1925, p. 336)

as "*T. alatus obesus*." Maury's specimen differs from *T. precursor* in having stronger spiral ornamentation but otherwise the two forms are almost identical. Considering the marked similarities and the nearly correlative ages, Maury's specimen is here referred to *T. precursor*.

This species is unique among the Typhinae in its extremely large size. The holotype of *T. precursor* is 47.5 mm and one hypotype measures 49 mm. This is the largest size ever reported for any species of Typhinae, fossil or Recent. Keen and Campbell (1964, p. 50) discussed the significance of this large size, stating: "The occurrence of a massive shell as the initial stock in a line is unusual in the history of most molluscan groups, for the trend normally is from rather unspecialized forms toward greater size or more elaboration. Here there is smoothness and solidity, and the direction taken by the *Talityphis* stock as it radiated northward, eastward, and northwestward during Miocene time was toward smaller, thinner shells, with a proportionately shorter spire and wider lip varix. The diamond shape of *T. precursor* persists in *T. pterinus* but is replaced by a more triangular outline in *T. lampada* Keen, 1943 from the California Miocene and *T. alatus* Sowerby, 1850 [*i.e.*, *T. obesus* Gabb] from the middle Miocene of the West Indies. In all of the species of *Talityphis*, the anterior canal and pillar area seems to be narrower and more tapering than in the closely related group, *T.* (*Typhisopsis*)."



Text figure 3. *Typhis* (*Talityphis*) *alatus* Sowerby. BM(NH) P.D.-GG 20084 (holotype) (× 2). Photograph courtesy of British Museum (Nat. Hist.)

Typhis (Talityphis) alatus Sowerby

Text Fig. 3

Typhis alatus Sowerby, 1850, Geol. Soc. London, Quart. Jour., v. 6, p. 48, pl. 10, fig. 4.
Typhis alatus Sowerby. Guppy, 1876, Geol. Soc. London, Quart. Jour., v. 32, p. 522 (in part only).
Not *Typhis alatus* Sowerby. Brown and Pilsbry, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 354 (= *T. obesus* Gabb).
Typhis alatus Sowerby. Maury, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 100.
Typhis alatus Sowerby. Pilsbry, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 354.
Typhis alatus Sowerby. Keen, 1943, San Diego Soc. Nat. History, Trans., v. 10, no. 2, p. 33, 53.
Typhis (*Talityphis*) *alatus* Sowerby. Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 63.

"Testa ovato-oblonga, subfusiformis, transversim striata, anfractibus senis, quadrifariam varicosis, costellis brevibus intermediis; varice ultimo lato, tenui, radiatim striato, canali longiusculo, obtecto.

"Distinguished by the tenuity and great extent of the wing-like varix from all known species." (Sowerby, 1850)

Description: Shell elongate; five post-nuclear whorls; four straight varices per whorl; outer lip of two parts: an inner band and a wide, thin, outer flange; a moderately long, recurved spine at shoulder of apertural varix, surrounded by outer lip; large partition, joining the varix to the varix of the preceding whorl; shell surface almost completely smooth, four very faint spiral lines, visible only on apertural face of varices; aperture small, circular, surrounded by a raised rim; tubes closer to the preceding than succeeding varices, pointing abaxially and abaperturally; shoulder depressed; anterior canal closed, narrow, straight.

Holotype: Brit. Mus. (Nat. Hist.) Paleo. Dept.-GG 20084; height 29.5 mm, maximum diameter 18.0 mm.

Type locality: Yaque River, Dominican Republic.

Occurrence: Unknown formation, Dominican Republic.

Figured specimen: BM(NH) P.D.-GG 20084 (holotype).

Discussion: Although this species has been synonymized with *T. obesus* Gabb the two forms are distinct. *T. alatus* is very rare, there being apparently only two examples known, the type and one immature specimen in the Gabb Collection at the Academy of Natural Sciences of Philadelphia (ANSP 3250). Maury's expedition (1917) to Santo Domingo uncovered no specimens and Woodring (1928, p. 294) stated that the U. S. Geological Survey party had not collected any specimens either. In Santo Domingo *T. obesus* is also rare, the type specimen being unique, neither Maury nor the U. S. G. S. discovering any specimens of this form. However, this species is common in other areas so that its variability is well known and the extremely attenuated *T. alatus* is not considered to be within the range of variation of *T. obesus*.

T. alatus is most closely related to the following undescribed species from Panamá, which is soon to be named by Woodring. *T. alatus* is smoother than the Panamanian form and the angle of the shoulder spine is different, but basically *T. alatus* is much more closely related to the Panamanian species than it is to *T. obesus*.

Typhis (Talityphis) sp.

Plate 5, figs. 1a, b

Description: Shell elongate; protoconch of two and one-half smooth whorls; five postnuclear whorls; four straight varices per whorl, each varix crossed by five to eight weak ribs; outer lip wide, of two parts: a thick inner band and an outer flange that recurves abaperturally; a spine at apical end of the varix with a very expanded partition, almost twice the width of the outer lip, joining the varix to the varix of the preceding whorl; interapertural area of two parts: the area under the tube and the area forming the new varix; aperture small, ovate, surrounded by a raised rim; tubes closer to the preceding than succeeding varices, pointing abaxially and abaperturally; shoulder depressed; anterior canal closed, greatly narrowed, straight.

Occurrence: Gatun Formation, Panamá, middle Miocene.

Figured specimen: USNM 646221; height 17.7 mm, maximum diameter 9.2 mm; locality: TU 958.

Discussion: As this new species is soon to be described by Woodring (U. S. G. S. Prof. Paper 306-D, in press), it will only be cited here as "sp." In the interest of completeness it was felt necessary to include the form for comparison with *T. alatus*. There are several specimens known of this new species, all from near Cativa, Panamá.

Typhis (Talityphis) obesus Gabb

Plate 4, figs. 1-4

Typhis obesus Gabb, 1873, Amer. Philos. Soc., Trans., (N.S.) v. 15, p. 203.

Typhis alatus Sowerby. Guppy, 1867, Sci.

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Plate 2

Figures — Page

1. *Typhis (Rugotyphis) dentatus* Johnson (× 3) 150
   ANSP 7049 (holotype); height 15.0 mm, diameter 9.5 mm.
   Locality: Jackson, Mississippi. Moodys Branch Fm., upper Eocene.
2-3. *Typhis (Rugotyphis) keenae* Gertman, n. sp. 151
   (Fig. 2a, b—× 2; fig. 2c—× 4; fig. 3a, b—× 2)
   2. USNM 646215 (paratype); height 26.6 mm, diameter 16.2 mm.
      Locality TU 547. Chipola Fm., lower Miocene.
   3. USNM 646214 (holotype); height 22.4 mm, diameter 14.0 mm.
      Locality: TU 458. Chipola Fm., lower Miocene.
4. *Typhis (Rugotyphis) harrisi* Olsson (× 2) 151
   USNM 646216; height 24.3 mm, diameter 16.0 mm.
   Locality: TU 60. Jackson Bluff Fm., upper Miocene.
5-6. *Typhis (Rugotyphis) floridanus* Dall (× 2) 152
   5. USNM 646217; height 22.5 mm, diameter 13.2 mm
      Locality: TU 536. Caloosahatchee Fm., Pliocene.
   6. USNM 646218; height 27.8 mm, diameter 15.7 mm.
      Locality: TU 558. Waccamaw Fm., Pliocene.

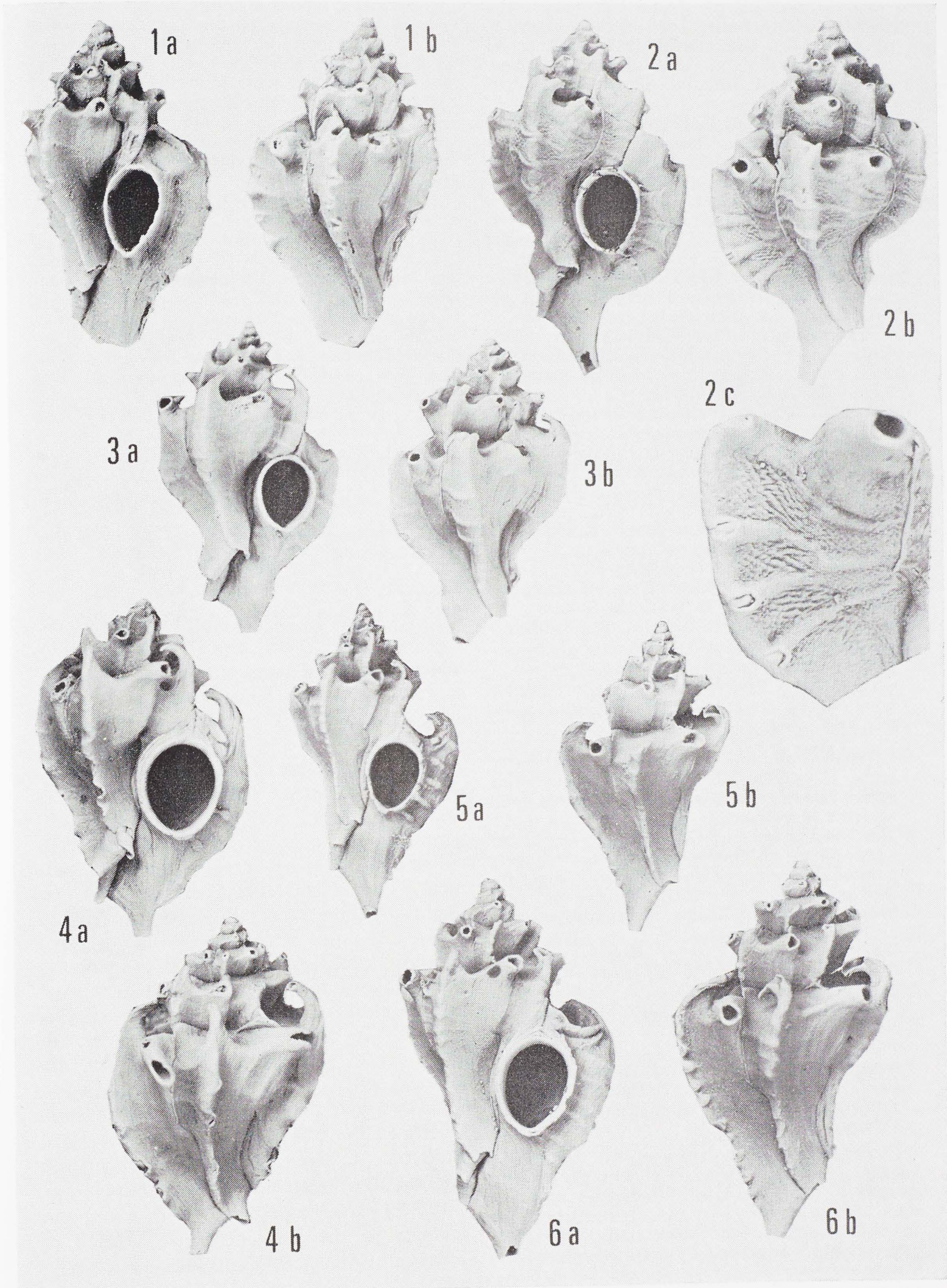

PLATE 2

Assoc. Trinidad, pt. 3, p. 157 (*ex* Harris reprint, 1921, Bulls. Amer. Paleontology, v. 8, no. 35, p. 184); 1873, *ibid.*, v. 2, p. 83 (*ex* Harris, *ibid.*, p. 215): 1876, Geol. Soc. London, Quart. Jour., v. 32, p. 522 (*not* of Sowerby).

Typhis alatus obesus Gabb. DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 151.

Typhis alatus Sowerby. BROWN and PILSBRY, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 354 (*not* of Sowerby).

Typhis obesus Gabb. PILSBRY, 1922, Acad. Nat. Sci. Phila., Proc., v. 73, p. 354, pl. 28, figs. 5, 6 (holotype).

Typhis alatus Sowerby. OLSSON, 1922, Bulls. Amer. Paleontology, v. 9, no. 39, p. 132, pl. 10, fig. 15 (*not* of Sowerby).

Not *Typhis alatus obesus* Gabb. MAURY, 1925, Bulls. Amer. Paleontology, v. 10, no. 42, p. 336, pl. 36, figs. 6, 9 (= *Typhis precursor* Keen and Campbell, 1964).

Typhis (*Talityphis*) *alatus obesus* Gabb. WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 294, pl. 18, figs. 3, 4.

Typhis alatus obesus Gabb. KEEN, 1943, San Diego Soc. Nat. Hist., Trans., v. 10, no. 2, p. 33, 53, pl. 3, figs. 13, 18, 22.

Typhis (*Talityphis*) *obesus* Gabb. KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 66.

Typhis (*Talityphis*) *alatus obesus* Gabb. GARDNER, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 527, pl. 53, figs. 15, 16.

Typhis (*Talityphis*) *alatus obesus* Gabb. WOODRING, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 221, pl. 31, figs. 3, 4.

Typhis (*Talityphis*) *alatus* Sowerby. OLSSON, 1964, Neogene Mollusks from Northwestern Ecuador, p. 141 (*not* of Sowerby).

"Shell short, broad; spire very low; whorls eight, sharply angulated; concave above the suture, sloping convexly below; varices four to each whorl, acute-angular on their margins, and ending in a blunt process on the upper angle of the whorl; tubes moderate, pointed laterally, below each tube the surface of the shell is greatly swollen, and two lines pass anteriorly, one being the margin of the old mouth, the other, in advance of the tube, being similar in character and indicating another arrest in growth. Surface polished, marked by faint lines of growth, and crossed below the angle by a few irregular transverse lines, not ribs. Aperture small, oval, bordered by a prominent, acute raised margin; canal closed, short, recurved; front face of terminal varix marked by five small ribs radiating from the outer lip." (Gabb, 1873)

Description: Shell large, stout; six postnuclear whorls; four convex varices per whorl, crossed by five weak ribs; outer lip of constant width, greatly expanded, consisting of an inner band, and an outer flange; aperture large, ovate, surrounded by a raised rim; tubes closer to preceding than succeeding varices, pointing abaxially, apically, and abaperturally; a partition above the aperture crossing the shoulder and joining the varix to the varix of the preceding whorl; shoulder slightly concave, crossed by remnants of the partitions; suture distinct; interapertural area of three parts: the area under the tube; the wide flange of the new varix, formed with five ribs and a short blunt spine at the apical end; and, the inner band formed within the flange of the varix and crossed by five ribs; anterior canal closed, short, and broad, pointing to the right and abaperturally.

Holotype: ANSP 3251; height 24.8 mm, maximum diameter 18.4 mm.

Type locality: Dominican Republic.

Occurrence: Chipola Formation, Florida; late lower Miocene. Unknown formation, Dominican Republic and Haiti; middle Miocene. Gatun Formation, Panamá and Costa Rica; middle Miocene. Picaderos Formation, Ecuador; middle or upper Miocene. Bowden Formation, Jamaica; (?) upper Miocene. (?) Matura Formation, Trinidad; Pliocene.

Figured specimens: Fig. 1, ANSP 3251 (holotype). Fig. 2, USNM 646219; height 18.0 mm, diameter 13.8 mm; locality TU 554. Fig. 3, USNM 369461, height 23.7 mm, diameter 17.0 mm; locality, Bowden, Jamaica. Fig. 4, USNM 646220; height 27.5 mm, diameter 23.0; locality TU 757. Other occurrences: TU locality nos. 70, 196, 456, 457, 458, 546, 547, 655, 705, 786, 806, 817, 818, 819, 820, 821, 825, 827, 830, 950, 951, 958, 998.

Discussion: In 1873 Gabb reported a new species, *Typhis obesus*, from Santo Domingo, which, he stated, was similar in some respects to *T. alatus* Sowerby from the same area. Guppy (1876, p. 522), after examining both specimens, commented that *T. obesus* "is not specifically distinct from *T. alatus*." Subsequent workers have usually treated the short, stout *T. obesus* as a subspecies of the tall, thin *T. alatus*, but there seems little necessity to make such an assignment. The resemblances between the two forms are subgeneric rather than specific in nature. At none of the many other western Atlantic localities where *T. obesus* occurs in abundance, such as in the Chipola Formation of Florida and the Gatun Formation of Panamá, is there any great variation in spire height and all specimens found are referable to *T. obesus,* none to *T. alatus*.

T. obesus is the most widespread typhine species in the Miocene beds of the western Atlantic. The type of the species is from the middle Miocene of Santo Domingo. Guppy (1876) reported it from Haiti and Jamaica in the Miocene, and Pliocene of Trinidad. Dall (1890) and Gardner (1947) reported it from the late lower Miocene Chipola Formation of northwestern Florida. Brown and Pilsbry (1911) first noted its

appearance in Panamá, and Olsson (1922) and Woodring (1959) further documented this. In the Tulane collections from Panamá there are numerous specimens. Olsson (1964) reported "*T. alatus*" in the middle or upper Miocene Picaderos Formation of northwestern Ecuador and also included the species found at Puerto Limon, Costa Rica, with this form. However, the latter is *T. expansus*.

There is a direct line of descent from *T. obesus* to the Recent *T. expansus*, the only difference being that *T. expansus* has a much higher spire than *T. obesus* (this does not, however, make it the same as *T. alatus* as has been suggested by authors). The shell figured by Woodring from Bowden, Jamaica (here refigured in pl. 4, fig. 3), is intermediate in shape between the middle Miocene *T. obesus* and the Pleistocene and Recent *T. expansus*. The outline is closer to that of *T. obesus* than to *T. expansus* and it is included with that species. The writer has not seen specimens of what Guppy called "*T. alatus*" from the Pliocene of Trinidad but it may well also be *T. expansus*.

Typhis (Talityphis) pterinus Gardner

Plate 5, figs. 2a, b

Typhis pterinus Gardner, 1936, Florida Geol. Surv., Bull. 14, p. 52, pl. 10, fig. 10.
Typhis pterinus Gardner. Keen, 1943, San Diego Soc. Nat. Hist., Trans., v. 10, no. 2, p. 33, 53.
Typhis (Talityphis) pterinus Gardner. Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 66.
Typhis (Talityphis) pterinus Gardner. Gardner, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 528, pl. 53, fig. 14.

"Shell polished, of moderate dimensions for the genus, rather thin and quite slender excepting for the flange-like varices; spire scalariform; body including the varices cuneate; maximum diameter falling a little in front of the median horizontal. Whorls of conch probably 6 in number in the adult, very closely appressed, the posterior margin creeping up a little upon the preceding whorl, acutely angulated at the periphery. Shoulder slightly concave, more or less corrugated by the intervarical tubes; sides of whorls flattened, slightly inclined toward the axis; body somewhat rounded medially, gently concave anteriorly. Sutures linear, inconspicuous zigzaging around the varices. Protoconch known only from the final whorl but apparently small, smooth, and very highly polished. Opening of conch indicated by a change in the texture of the shell and by the initiation of the axial sculpture in the form of obtuse tubercles. Primary varices 4 in number, the terminal varix a rather broad, laminar flange, the other 3 body varices compressed, acutely angulated ridges, terminating at the shoulder in compressed, posteriorly directed tubes; short circular tubes also developed in the intervarical areas directed at right angles to the axis of the shell, perforate at their outer extremities but only the last tube in direct communication with the body cavity. Spiral sculpture restricted to very fine, feeble, rather distant, and more or less irregular lirations, often obsolete altogether upon the spire, strengthening toward the aperture and usually 3 to 5 in number upon the terminal wing, absent upon the anterior canal. Incremental macroscopic, retractive and somewhat arcuate upon the shoulder, flexuous upon the anterior canal and relatively prominent upon the apertural surface of the terminal varix, where they are quite strongly crenulated and are puckered into the fine, sharp spiral lirae. Apertural opening rather small, oval in outline, widening a little posteriorly, the margin elevated slightly above the body surface; peristome continuous, smoothly rounded; inner surface very smoothly glazed; area between the labral varix and that directly behind it filled with a rather thin, trigonal plate. Anterior canal short, compressed, feebly inclined toward the right, the former canals, one to each varix, superimposed but diverging very slightly at their anterior extremities." (Gardner, 1936)

Holotype: USNM 371860; height 18.8 mm, maximum diameter 12.5 mm.

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

Occurrence: Shoal River Formation, Florida; middle Miocene.

Figured specimen: USNM 371860 (holotype). Other occurrences: TU locality nos. 69, 69A.

Discussion: *T. pterinus* is closely related to *T. carmenae* Gertman, n. sp. It differs in having fewer but stronger spiral ribs. *T. pterinus* is known only from the vicinity of the type locality but it is fairly abundant there. There are 21 specimens from the two localities listed.

Typhis (Talityphis) acuticosta (Conrad

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

Murex acuticosta Conrad, 1830, Acad. Nat. Sci. Phila., Jour., (Ser. 1) v. 6, p. 211, 217, pl. 9, fig. 1.
Typhis acuticosta (Conrad). Conrad, 1833, Amer. Jour. Sci., (Ser. 2) v. 23, p. 344; Conrad, 1861, Fossils of the Medial Tertiary of the United States, no. 4, p. 83, pl. 48, fig. 1; 1863, Acad. Nat. Sci. Phila., Proc., v. 14,

p. 560; 1868, Amer. Jour. Conch., v. 4, p. p. 64, pl. 5, fig. 6.
Typhis acuticosta (Conrad). DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 151.
Typhis acuticosta (Conrad). HARRIS, 1893, Amer. Jour. Sci., (Ser. 3) v. 45, p. 30.
Typhis acuticosta (Conrad). MARTIN, 1904, Maryland Geol. Surv., Miocene, p. 201, pl. 51, figs. 1-3.
Typhis harrisi waltonensis MANSFIELD, 1935, Florida Geol. Surv., Bull. 12, p. 38, pl. 5, fig. 9.
Typhis (*Typhina*) *harrisi waltonensis* Mansfield. KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 55, 68.
Typhis (*Typhina*) *acuticosta* (Conrad). KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 68.

"Shell with four or five acute foliated varices ending above in a pointed, compressed spire, alternating with four shorter rounded varices ending above in a tube; aperture oval and entire; margin reflected; beak closed, and slightly recurved." (Conrad, 1830)

Description: Shell large, stout; five postnuclear whorls, with four smooth, thickened, convex varices per whorl; outer lip narrow, of even width with a partition above the aperture crossing the shoulder and joining the varix to the varix of the preceding whorl; a short, blunt spine at the apical end of the varix; interapertural area of only one part; surface of the shell smooth; aperture ovate, pointed anteriorly, surrounded by a raised rim; tubes midway between varices, pointing apically, and abaperturally; shoulder raised, crossed by remnants of former partitions; suture distinct, deeply impressed; anterior canal closed, narrow, rounded, pointing to the right and abaperturally.

Holotype: ANSP 13615; height 24.5 mm, maximum diameter 14.0 mm.

Type locality: Maryland.

Occurrence: Calvert Formation, Choptank Formation, and St. Mary's Formation, Maryland; Choctawhatchee Formation, Florida; middle Miocene.

Figured specimens: Fig. 3, ANSP 13615 (holotype). Fig. 4, USNM 373146 (holotype-*T. harrisi waltonensis* Mansfield); height 17.5 mm, maximum diameter 11.0 mm; locality, Vaughan Creek, Walton County, Florida.

Discussion: *T. acuticosta* was named without any precise locality or stratigraphic data. It has been reported from the St. Mary's, Choptank, and Calvert formations of Maryland so that the type locality cannot be deduced. In addition to the Maryland localities the species also occurs in the late middle Miocene Choctawhatchee Formation of Florida, where it was given the name "*T. harrisi waltonensis*" by Mansfield. Although made a subspecies of *T. harrisi* by Mansfield the two forms are only generically related. Mansfield did not compare his new subspecies with *T. acuticosta* but only noted that the two forms are "closely related." Examination of the two type specimens fails to reveal any specific differences between them and the two are here placed in synonymy.

TYPHIS (TALITYPHIS) SIPHON Woodring

Plate 3, figs. 5a, b

Typhis sp., DALL, 1903, Wagner Free Inst. Sci., Trans., v. 3, pt. 6, p. 1584 (list).
Typhis (*Typhinellus*) *siphon* WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 293, pl. 18, fig. 2.

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PLATE 3

Figures

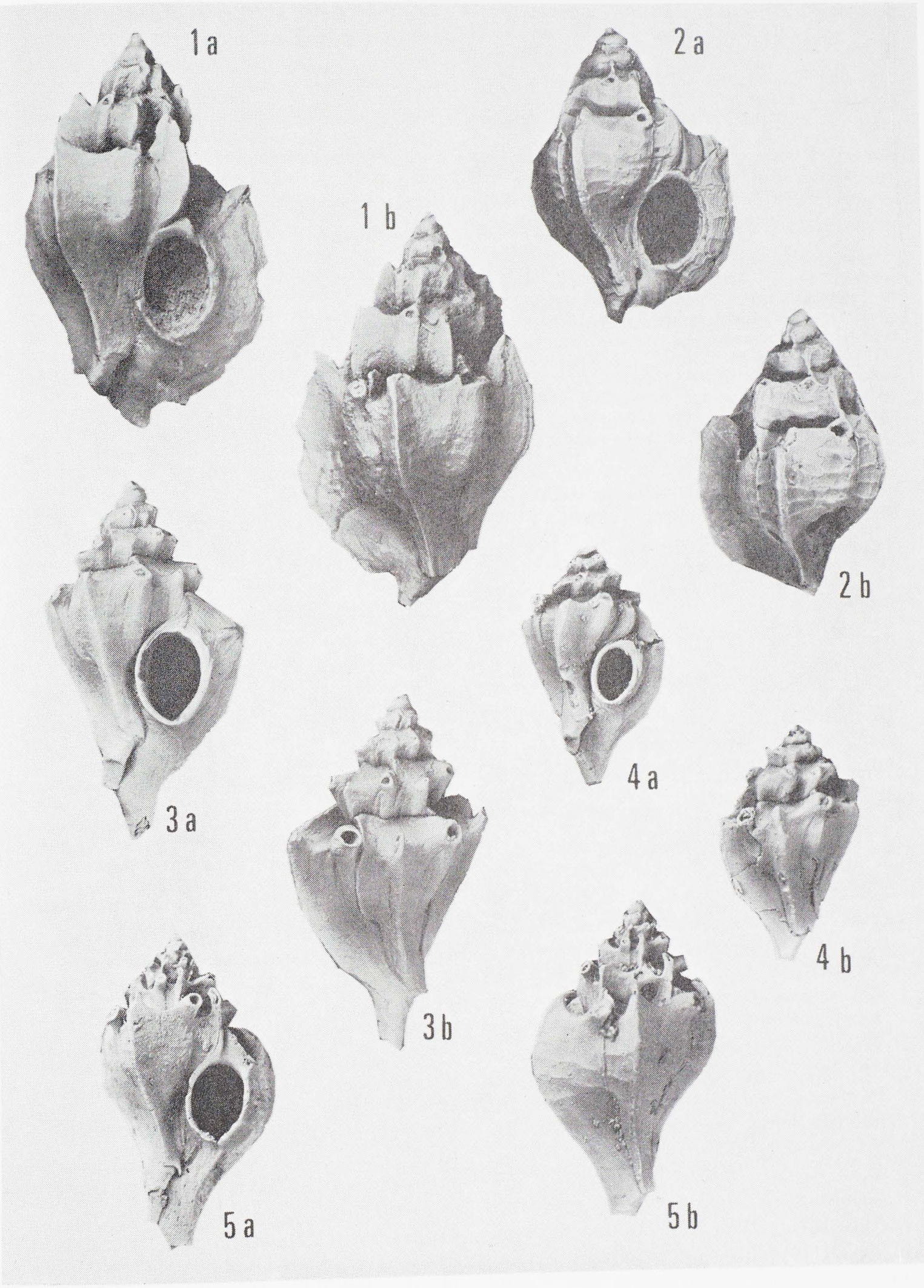

PLATE 3

Typhis (Typhinellus) siphon Woodring. KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 56, 67.

"Shell relatively small, Varix at outer lip slightly expanded. Body whorl bearing five [four] lamellar varices that bear at shoulder an upturned and incurved spine. On latter part of body whorl several indistinct widely spaced spiral threads are visible. Low triangular partitions extend from tubules about halfway up preceding whorl, joining the tubules to a varix." (Woodring, 1928)

Description: Shell small, elongate; five postnuclear whorls; four smooth convex varices per whorl; varices thin and sharp, giving the shell an angular appearance; outer lip smooth, narrow, and constricted above the aperture; interapertural area of only one part with two weak spiral ribs below tubes, bifurcating to four on the varices; aperture small, ovate, surrounded by a raised rim; tubes closer to preceding than succeeding varices; pointing abaxially and abaperturally; shoulder slightly depressed, crossed by remnants of former weak partitions; suture distinct; anterior canal closed, flattened, pointing to the right and abaperturally.

Holotype: USNM 115495; height 15.6 mm, maximum diameter 8.9 mm.

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

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

Figured specimen: USNM 115495 (holotype). Other occurrences: TU locality 705.

Discussion: *T. siphon* is represented by only four immature specimens from the Bowden Formation of Jamaica, two in the type lot and two in the Tulane collections from Bowden. It was compared by Woodring to *T. (Rugotyphis) floridanus* Dall but differs from that species in lacking the crenulated varices typical of the *Rugotyphis* group. Although the extant specimens of *T. siphon* do not possess the wide winged varices of the typical *Talityphis*, as noted by Woodring, the specimens are juveniles and resemble the usual juvenile *Talityphis* condition. This species does not seem to be closely related to any other Caribbean form.

In the original description of the species Woodring noted that the body whorl had "five lamellar varices." The writer believes that he included the last varix of the preceding whorl in his count; the type specimen has but four varices. He followed the same procedure in his discussion of "*Typhis*" (*Pilsbrytyphis*) *gabbi*, Brown and Pilsbry (1959, p. 220), herein referred to *Siphonochelus* (*Pilsbrytyphis*).

TYPHIS (TALITYPHIS) CARMENAE Gertman, n. sp.

Plate 5, figs. 3a, b; 4a, b

Description: Shell medium-sized, stout; protoconch smooth, bulbous, of one and one-half whorls; six post-nuclear whorls; four convex varices per whorl; each varix crossed by seven ribs; outer lip wide, of two parts: an inner band, and an outer flange that curls abaperturally; flange smooth on the ventral side, but a continuation of the varix on the dorsal side, and crossed by seven ribs; a spine at the apical end of the varix; a small partition above the aperture, crossing the shoulder and joining the varix to the varix of the preceding whorl; aperture small, ovate, surrounded by a raised rim; tubes closer to the preceding than the succeeding varices, pointing abaxially and abaperturally; shoulder slightly depressed; interapertural area of four parts: the area under the tube divided into two parts, each with nine ribs; the ribs offset, not forming continuous ridges; the third part forming the new varix, having nine ribs that are offset from those in the area under the tube, the apertural side of the flange smooth and forming the outer margin of the outer lip; the fourth part with nine ribs that cross the inner part of the outer lip to the aperture; outer flange of lip broken off after the varix is abandoned, and ribbing appears continuous on the remnant varices; anterior canal closed, broad, curving abaperturally to the right.

Holotype: USNM 646222; height 20.6 mm, maximum diameter 12.6 mm.

Paratype: Instituto de Geología, Universidad de Mexico (UNAM) no. IGM-2186; height 27.3 mm, maximum diameter 18.5 mm. Locality: Paso Real, near Tuxtepec, Oaxaca, Mexico.

Type locality: TU 638; roadcut and quarry on Mexico Highway 180, 14 miles east of junction with side road into Coatzacoalcos, Veracruz, Mexico.

Occurrence: Agueguexquite Formation, Mexico; upper Miocene.

Figured specimens: Fig. 3, USNM 646222 (holotype). Fig. 4, IGM-2186 (paratype).

Discussion: *T. carmenae* is the last of the high-spired, highly ornamented line of *Talityphis*. The Recent member of the line is a high spired descendant of the smooth *T. obesus* group. This new species is most closely related to the older *T. pterinus* from the middle Miocene Shoal River Formation of Florida but differs in having more numerous spiral ribs.

T. carmenae is common at the type locality with there being 33 specimens in the type lot. In addition, in the collections of the Instituto de Geología, Universidad de Mexico (UNAM), there are two specimens, both larger than any from

the type locality. One of these is here figured as a paratype. The exact age of the beds at Tuxtepec, where these larger specimens occur, is not known but there are many species in common with the Agueguexquite localities near Coatzacoalcos and it is assumed that the two occurrences are directly correlative.

This new species is named in honor of Carmen Perrilliat Montoya, in recognition of her work on the fauna of the Agueguexquite Formation.

TYPHIS (TALITYPHIS) EXPANSUS Sowerby

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

Typhis expansus G. B. SOWERBY, JR., 1874, Zool. Soc. London, Proc. (for 1873), p. 719, pl. 59, fig. 4; 1874, Conch. Icon., v. 19, *Typhis*, pl. 3, fig. 12a, 12b; 1880, Thes. Conch., v. 3, *Typhis* (supplement), pl. 284-b, figs. 24, 25.

Typhis expansis [*sic*] Sowerby. TRYON, 1880, Man. Conch., v. 2, p. 138, pl. 30, fig. 306 (after Sowerby, 1874, fig. 12b).

Typhis melloleitaoi MORRETES, 1940, Arq. Zool. Estdo. São Paulo, v. 2, art. 7, p. 251, pl. 1, figs. 1-3 (juvenile specimen).

Typhis (*Talityphis*) *expansus* Sowerby. KEEN, San Diego Soc. Nat. Hist., Trans., v. 10, no. 2, p. 53, pl. 3, fig. 20; KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 56.

Typhis alatus Sowerby. OLSSON, 1964, Neogene Moll. Northwestern Ecuador, p. 141 (in part, *not* of Sowerby).

Typhis alatus Sowerby. BULLIS, 1964, Tulane Stud. Zool., v. 11, no. 4, p. 107.

> "T. testa subfusiformi, albida, pallide fusco tincta; spira breviuscula, acuminato-turrita; anfractibus transversim obscure liratis, superne angulatis, supra angulum concavis, quadrivaricosis; varicibus tenuibus, ad angulum falcatis, varice ultimo late expanso reflexo; tubis inter varices brevibus, ultima elongata; canali breviusculo; apertura ovali." (Sowerby, 1874)

Description: Shell large, stout; protoconch of one and one-half smooth, bulbous whorls; five post-nuclear whorls; four convex varices crossed by four weak ribs; outer lip wide, of two parts: an inner band and an outer flange that curls abaperturally; a spine at the top of the apical end of the varix; a partition above the aperture crossing the shoulder and joining the varix to the varix of the preceding whorl; interapertural area smooth under the tubes and ribbed on the varices; aperture ovate, surrounded by a raised rim; tubes closer to preceding than succeeding varices, pointing abaxially, abaperturally, and apically; shoulder depressed slightly; anterior canal closed, narrow, curving abaperturally and to the right.

Holotype: not found.

Type locality: Paramaribo, Surinam (Dutch Guiana) (here designated).

Occurrence: Moín Formation, Costa Rica; Pleistocene. Caribbean Sea, Recent.

Figured specimens: Fig. 5, USNM 646223; height 25.7 mm, maximum diameter 18.0 mm; locality TU 954. Fig. 6, USNM 696659; height 21.5 mm, maximum diameter 14.0 mm; locality, *Oregon* Station 2331. Other occurrences: TU locality no. 953.

Discussion: *T. expansus* was named by Sowerby without locality data, but there seems little doubt that the Caribbean shell figured herein is the same species. In the original description the shell was said to be whitish, tinged with brown and this matches our specimens exactly. Bullis (1964, p. 107) reported this species (as *T. alatus*) dredged by the M/V *Oregon* at two stations off the Surinam Coast in 24 and 30 fathoms. The locality of our figured specimen (*Oregon* Station 2331) is here designated as the type locality for *T. expansus*.

In addition to the Recent occurrences of this species, several specimens have been collected from the Pleistocene Moín Formation of Costa Rica. One of these is figured here (pl. 5, fig. 5).

Genus SIPHONOCHELUS Jousseaume, 1880

Subgenus SIPHONOCHELUS s.s.

Siphonochelus JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 335.
Type species: *Typhis avenatus* [*sic*] Hinds, 1843 (= *T. arcuatus* Hinds), by original designation.

Cyphonochelus JOUSSEAUME, 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 337. Emendation?
Type species: *Typhis arcuatus* Hinds, by original designation.

Trubatsa DALL, 1889, Harvard Mus. Comp. Zool., Bull, v. 18, p. 216.
Type species: *Typhis* (*Trubatsa*) *longicornis* Dall, 1888, by monotypy.

Choreotyphis IREDALE, 1936, Australian Mus., Records, v. 19, no. 5, p. 324.
Type species: *Typhina* (*Choreotyphis*) *pavlova* Iredale, by original designation.

Eotyphis TEMBROCK, 1963, Paläontologische Abh., v. 1, no. 4, p. 322.
Type species: *Typhis sejunctus* Semper, 1861, by original designation.

> "Coquille ovale courte, dont le canal tubiforme postérieur est soudé aux varices au lieu de leur être intermédiarires comme dans les autres genres; ouverture petite, ovale, à bords continus et détachés; canal court assez large à la base. (Jousseaume, 1882)

Shell with four varices and tubes per whorl (one species with five); tubes formed within the varix, pointing abaperturally and abaxially; varix smooth and rib-like, no spines, flanges, or other ornamentation; no spiral sculpture.

Discussion: *Siphonochelus* is known from the Oligocene to Pliocene of Europe, and from the Miocene to Recent of the Australasian area. There is a single Miocene species and a single Recent species from the western Atlantic. In general the Recent species occur in deeper water than other species of Typhinae, most of the records being greater than 100 fms. Only the type is somewhat shallower, being known from 40 to 50 fms.

There have been a number of taxa proposed for species that are to be referred to *Siphonochelus*. The first of these was named by Dall (1889) who, after unmercifully castigating Jousseaume for naming "eleven unnecessary synonyms" of *Typhis*, proceeded to name another one which was an unequivocal synonym of one of Jousseaume's genera. Dall included Jousseaume's type species, *T. arcuatus* Hinds, in his new subgenus so it is obvious that he was cognizant of the synonymy but chose rather to ignore it. Dall also made the odd observation that the species of *Trubatsa* were found "in all the northern oceans," overlooking the fact that *T. arcuatus* was described from the Cape of Good Hope. Since Dall's time six more species have been described from the southern oceans. One of these was named as the type of another subgenus, *Choreotyphis* Iredale. This species is unique for the extremely long tube and canal it possesses. It does not differ significantly from the typical *Siphonochelus* but is merely a deep water form.

More recently Tembrock (1963) has named another subgenus, *Eotyphis*, which can be regarded as a synonym of *Siphonochelus*. Tembrock differentiated this subgenus because of the differences in the nuclear whorls of the fossil species and the Recent species of *Siphonochelus*. Her species of *Eotyphis* have from 2½ to 5¼ whorls in the embryonic shell, in general decreasing through time. She noted that according to Thorson this would indicate a pelagic larval stage for the older species as opposed to non-pelagic larvae of the modern species. This trend in decrease of nuclear whorls appears frequently in the Muricidae (see Vokes, 1967, p. 135) and does not seem to be of supraspecific significance.

Tembrock originally named *Eotyphis* as a subgenus of *Lyrotyphis* Jousseaume, 1880, as both forms possess multiwhorled protoconchs. *Lyrotyphis*, here treated as a subgenus of *Siphonochelus*, consists of only two European Oligocene species that have the tubes greatly appressed so that they are soldered to the preceding whorl. These two species also have five tubes to a whorl but this is not thought to be a distinguishing character as there is a Japanese species, *S. japonicus* (A. Adams, 1863), which has five tubes per whorl but otherwise is a good *Siphonochelus*.

SIPHONOCHELUS (SIPHONOCHELUS) CERCADICUS (Maury)

Plate 6, figs. 1a, b

Typhis cercadicus MAURY, 1917, Bulls. Amer. Paleontology, v. 5, no. 29, p. 265, pl. 42, fig. 12.

Typhis cercadicus Maury. WOODRING, 1928, Carnegie Inst. Washington, Publ. 385, p. 294.

Laevityphis (*Laevityphis*) *cercadicus* (Maury). KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 59, 64.

"Shell small, each whorl with four varices and four tubes, the tubes arising slightly behind the varices; on the last whorl are faint indications of about six raised spiral lines; the whorls are shouldered and the varices end at the shoulder; canal wide, covered, former position of canal indicated

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PLATE 4

Figures — Page

1-4. *Typhis* (*Talityphis*) *obesus* Gabb (× 2) 160

1. ANSP 3251 (holotype) height 24.8 mm, diameter 18.4 mm. Locality: Dominican Republic. Unknown formation, middle Miocene.
2. USNM 646219; height 18.0 mm, diameter 13.8 mm. Locality: TU 554. Chipola Fm., lower Miocene.
3. USNM 369461; height 23.7 mm, diameter 17.0 mm. Locality: Bowden, Jamaica. Bowden Fm., (?) upper Miocene.
4. USNM 646220; height 27.5 mm, diameter 23.0 mm. Locality: TU 757. Gatun Fm., middle Miocene.

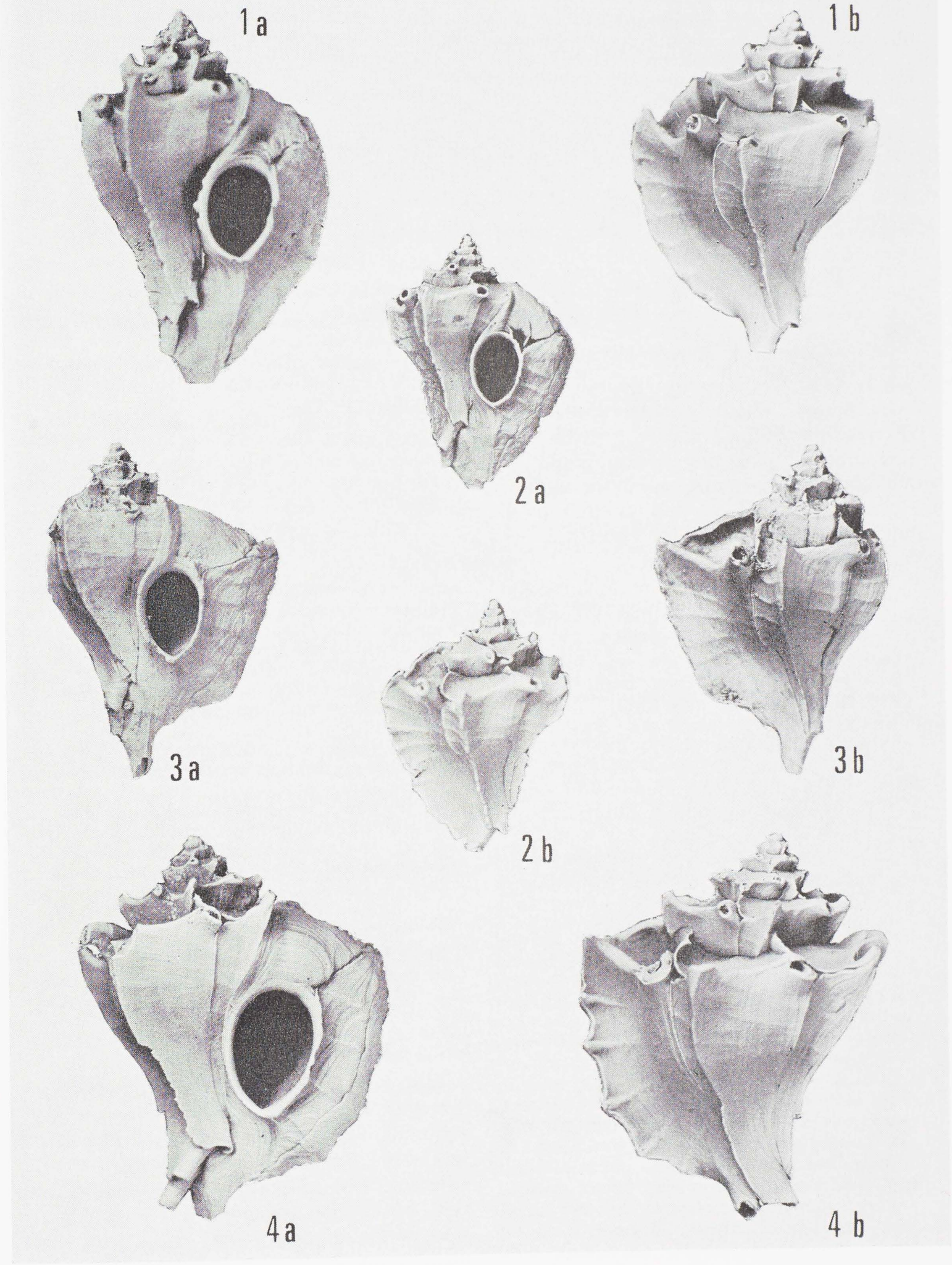

PLATE 4

by a tubular process beside the canal." (Maury, 1917)

Description: Shell small, stout; four post-nuclear whorls; four smooth rounded, convex varices per whorl; outer lip smooth, narrow, and of constant width; interapertural area of only one part; tubes attached to varices, pointing abaxially, apically, and abaperturally; shell smooth; aperture rounded-ovate, surrounded by a raised rim; outer lip narrowing above the aperture; shoulder raised; suture distinct; anterior canal closed, short, narrow, pointing to right and abaperturally.

Holotype: Cornell Paleo. Lab. no. 36813; height 6.6 mm, maximum diameter 3.9 mm.

Type locality: Bluff no. 1, Cercado de Mao, Dominican Republic.

Occurrence: Gurabo Formation,, Dominican Republic; middle Miocene.

Figured specimen: Cornell Paleo. Lab. no. 36813 (holotype).

Discussion: The only extant specimen of *S. cercadicus* is the holotype, a small specimen with only four post-nuclear whorls and undoubtedly a juvenile. Nevertheless it is a good *Siphonochelus* and as such is the only known example in the fossil record of the western Atlantic.

Siphonochelus (Siphonochelus) longicornis (Dall)

Typhis longicornis Dall *in* Agassiz, 1888, Harvard Mus. Comp. Zool., Bull., v. 15, pt. 2, p. 70, fig. 294.

Typhis (*Trubatsa*) *longicornis* Dall. Dall, 1889, Harvard Mus. Comp. Zool., Bull., v. 18, p. 216, pl. 15, fig. 7; pl. 38, fig. 5.

Typhis (*Trubatsa*) *longicornis* Dall. Smith, 1939, Cat. Recent species Rock shells, p. 19, pl. 14, fig. 10.

Siphonochelus (*Siphonochelus*) *longicornis* (Dall). Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 58, 65.

"Shell translucent white when young, waxen with areas of pale rosy brown between the varices in the adult; varices four, ascending the spire nearly in a straight line; tubes tapering, recurved, usually broken off short, but originally long; nucleus subglobular, glassy, followed by seven gradually increasing whorls, obscured by the varices, but somewhat scalar behind; surface with extremely fine spiral striation, stronger lines of growth, and on the tips of the tubes and canals when fresh a glassy polish; varices not fimbriated, with rounded edges, strongly arched forward, subconcave behind; aperture small, subcircular, margin detached from the body, elevated, not sharp; with simple edge and smooth interior; canal long, slender, nearly straight, but bent back as a whole, with three antecedent canals surrounding a sort of umbilical chink. Operculum muricoid." (Dall, 1889, p. 216)

Holotype: Harvard MCZ 3717; height 23.0 mm, maximum diameter 10.0 mm.

Type locality: Off Havana, Cuba, in 127-400 fms.

Occurrence: Recent only, Florida Straits.

Discussion: *S. longicornis* is one of the deeper water typhine species, described from off Cuba. It is closely related to *S. arcuatus* (Hinds), the type of the genus, and could be just a deep water form of that species.

Subgenus Laevityphis Cossmann, 1903

Laevityphis Cossmann, 1903, Essais Paléoconch. Comp., v. 5, p. 59.

Type species: *Typhis coronarius* Deshayes, 1865 (= *Typhis muticus* J. Sowerby, 1834), by original designation.

Neotyphis Vella, 1961, Palaeontology, v. 4, no. 3, p. 375.

Type species: *Typhis tapunagai* Fleming, 1943 (emended, Vella, 1961), by original designation.

"Taille petite; forme oblongue, assez élancée; spire allongée, étagée aux sutures; tours lisses, un peu convexes, se recouvrant parfois en arrière, à sutures profondément canaliculées sous le recouvrement; quatre varices lisses, tranchantes, épineuses en arrière; tubulures non situées au milieu de l'intervalle des varices, chacune étant plus rapprochée de la varice suivante. Dernier tour presque égal aux deux tiers de la hauteur totale, ovale, peu excavé à la base, lisse comme la spire. Ouverture ovale, petite, à péristome continu, sans gouttière postérieure, auguleuse en avant, vers le point de soudure de ses bords; canal clos, assez long, large et peu infléchi, détaché du bourrelet basal qui porte des lamelles correspondant aux varices; labre vertical, bordé par la dernière varice, lisse à l'intérieur; columella excavée, lisse, à bord complètement détaché." (Cossmann, 1903)

Shell with four varices and tubes per whorl; tubes nearer to succeeding than preceding varices, but not attached to the varices, pointing apically or abaperturally; varices slightly crenulated or smooth, thickened, generally a spine at the shoulder of the varix.

Discussion: Cossmann (1903) originally described *Laevityphis* as a "section" of the subgenus *Typhina*. Keen noted that a few species of *Laevityphis* are difficult to discriminate from *Siphonochelus*, but as *Indotyphis* seems to be a subgroup of *Laevityphis*, she proposed that *Indotyphis* be made a subgenus of the genus *Laevityphis*, which she assigned equal rank with the genus *Siphonochelus*. The writer cannot

agree with this ranking, but prefers to place *Laevityphis* as a subgenus of *Siphonochelus* in view of the great similarity between the two forms. The principal difference in the two is that in *Siphonochelus* the tubes are incorporated into the varix but in *Laevityphis* they are distinct.

Vella (1961) proposed *Neotyphis*, a subgenus of *Typhis*, which he stated superficially resembled *Laevityphis* but which was actually closer to *Typhis* s.s. The differences he cited are also seen in well preserved specimens of *S.* (*Laevityphis*) *gracilis* (Conrad), an Eocene species considered by Cossmann to be a "pleisotype" of *Laevityphis* (as *L. alternata* Lea, a synonym of *L. gracilis*) and *Neotyphis* is not considered to be distinct from *Laevityphis*.

Sixteen species of *Laevityphis* are known, ranging in age from lower Eocene to Recent. The oldest known Typhinae (lower Eocene) is a *Laevityphis*, *S. muticus* (J. Sowerby, 1834), of England and France (*S. coronarius* is a synonym). Three species are known from the middle Eocene and by this time they were widely distributed: *S. sinuosus* (Cossmann, 1902) and *S. vaquezi* Cossmann, 1906, France; and *S. gracilis* (Conrad, 1833), Alabama. Another species, *S. antiquus* (Gabb, 1864), is from either the middle or upper Eocene of California. Two other species have been reported from upper Eocene strata: *S. thagus* (Olsson, 1930), Peru; and *S. ludbrookae* (Keen and Campbell, 1964), Australia. The only member of the subgenus known from the Oligocene is *S. curvirostratus* (Conrad, 1848), from Mississippi and Mexico. In the Miocene, *Laevityphis* became widespread in the Caribbean and Gulf of Mexico. From the Miocene strata we have: *S. linguiferus* (Dall, 1890), Florida; *S. costaricensis* (Olsson, 1922), Costa Rica and Colombia; *S. sawkinsi* (Mansfield, 1925), Trinidad; and *S. schencki* (Keen and Campbell, 1964), Colombia. There is a single species known from the Pleistocene of Costa Rica and the Recent Caribbean, *S. bullisi*, n. sp., described herein. There are two other Recent species only, one from East Africa, and one from the Indian Ocean and Japan.

There are seven species of *Laevityphis* in the western Atlantic region, ranging in age from middle Eocene to Recent.

SIPHONOCHELUS (LAEVITYPHIS) GRACILIS (Conrad)

Plate 6, figs. 2a, b

Typhis gracilis CONRAD, 1833, Amer. Jour. Sci., v. 23, p. 344.
Murex alternata LEA, 1833, Contributions to Geology, p. 157, pl. 5, fig. 163.
Typhis alternata (Lea). DE GREGORIO, 1890, Ann. Géol. Paléontologie, livr. 7, p. 96, pl. 7, figs. 38-40.
Typhis alternata (Lea). COSSMANN, 1893, Ann. Géol. Paléontologie, livr. 12, p. 32.
Typhis gracilis Conrad. HARRIS, 1895, Acad. Nat. Sci. Phila., Proc., v. 47, p. 21.
Murex alternata Lea. HARRIS, 1895, Acad. Nat. Sci. Phila., Proc., v. 47, p. 4 (in synonomy with *T. gracilis* Conrad).
Typhis (*Typhina*, sect. *Laevityphis*) *alternatus* (Lea). COSSMANN, 1903, Essais Paléoconch. Comp., v. 5, p. 59, pl. 2, fig. 26.
Typhis gracilis Conrad. WRIGLEY, 1930, Malac. Soc. London, Proc., v. 19, pt. 3, p. 114.
Typhis gracilis Conrad. PALMER, 1937, Bulls. Amer. Paleontology, v. 7, no. 32, p. 271, pl. 36, figs. 1, 5; pl. 85, fig. 12.
Laevityphis (*Laevityphis*) *gracilis* (Conrad). KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 59, 65.
Laevityphis (*Laevityphis*) *gracilis* (Conrad). PALMER and BRANN, 1966, Bulls. Amer. Paleontology, v. 48, no. 218, p. 716.

> "Shell fusiform, elongated, slender, volutions about eight; ribs of the body whorl 4, thickened and slightly reflected; with two or three arched scales on each; margin of the aperture elevated but not reflected." (Conrad, 1833)

Description: Shell medium-sized, very elongate; protoconch one and one-half whorls, smooth, rounded; six post-nuclear whorls, with four convex varices per whorl; varices crossed by three weak crenulations, a spine at the top of each varix pointing axially and abaperturally; outer lip smooth, of even width on the outer margin, but narrowing above the aperture; interapertural area of only one part; aperture elongate-ovate, pointed at the anterior end, surrounded by a raised rim; tubes closer to the succeeding than the preceding varices, pointing apically and abaperturally; surface of shell smooth except for the crenulations on the varices; shoulder raised; suture distinct; anterior canal closed, long, narrow, pointing abaxially and abaperturally.

Lectotype: ANSP 13755; height 16.8 mm, maximum diameter 8.1 mm (selected by Moore, 1962, p. 63).

Type locality: Claiborne Bluff, Alabama River, Monroe County, Alabama (= TU 78).

Occurrence: Gosport Sand, Alabama; late middle Eocene.

Figured specimen: ANSP 13755 (lectotype). Other occurrences: TU locality nos. 78, 306.

Discussion: *S.* (*Laevityphis*) *gracilis*, the oldest species of *Laevityphis* in the western

Atlantic, is closest in form to *S. muticus* (J. Sowerby), from the Eocene of England, from which the former differs by its more elongate, slender shape, and crenulated varices. *S. thagus* (Olsson), upper Eocene, Peru, and *S. antiquus* (Gabb), middle or upper Eocene, California, have a similar shape, but have smooth varices as *S. muticus*.

SIPHONOCHELUS (LAEVITYPHIS) CURVIROSTRATUS (Conrad)

Plate 6, figs. 3a, b

Typhis curvirostratus CONRAD, 1848, Acad. Nat. Sci. Phila., Proc., v. 3, p. 285; 1848, Acad. Nat. Sci. Phila., Jour., (Ser. 2) v. 1, p. 116, pl. 11, fig. 29.

Laevityphis (*Laevityphis*) *curvirostratus* (Conrad). KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 59, 64.

Typhis curvirostratus Conrad. GARDNER, 1945, Geol. Soc. Amer., Mem. 11, p. 189, pl. 14, figs. 1, 2.

> "Subfusiform; volutions 8, scalariform, varices or ribs profound; tubes long; that near the margin of aperture, thick, elongated, beak elongated spiniform, much curved. Length 1-10 [? 7-10]. Not common." (Conrad, 1848)

Description: Shell medium-sized, stout; protoconch smooth, rounded, one and one-half whorls; six post-nuclear whorls; four thickened, convex, smooth varices per whorl; outer lip of constant width, with a short spine at the apical end of the varix; interapertural area of one part; aperture ovate, surrounded by a raised rim; a partition above the aperture connecting the varix to the varix of the preceding whorl; tubes closer to the succeeding than the preceding varices, pointing outward from the shoulder; very weak spiral ribbing on the varices; shoulder slightly depressed, crossed by remnants of former partitions; suture distinct; anterior canal closed, narrow, pointing abaperturally and to the right.

Lectotype: ANSP 13484; height 18.0 mm, maximum diameter 10.6 mm (selected by MacNeil *in* Moore, 1963, p. 52).

Type locality: Vicksburg, Mississippi.

Occurrence: Mint Springs Marl and Byram Marl, Missisippi; unnamed formation, Nuevo León, Mexico; middle Oligocene.

Figured specimen: ANSP 13484a (lectoparatype); height 19.8 mm, maximum diameter 12.2 mm. Other occurrences: TU locality nos. 76, 335, 336.

Discussion: *S.* (*Laevityphis*) *curvirostratus* is similar to, and may be descended from *S. muticus* (Sowerby) from the lower Eocene of England, which species may also be the forerunner of *S. gracilis* (Conrad) and *S. thagus* (Olsson). The latter species, from the upper Eocene of Peru, is more slender and elongate, with smooth convex varices. Of the Miocene forms, *S. curvirostratus* is most like *S. sawkinsi* (Mansfield) of Trinidad, which is more elongate, smaller, and more fragile, but retains the thickened varices, weak ribbing, and general outline of the former.

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PLATE 5

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1. *Typhis* (*Talityphis*) sp. (× 3) 160
   USNM 646221; height 17.7 mm, diameter 9.2 mm.
   Locality: TU 958. Gatun Fm., middle Miocene.
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   USNM 371860 (holotype); height 18.8 mm, diameter 12.5 mm.
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3-4. *Typhis* (*Talityphis*) *carmenae* Gertman, n. sp. 166
   3. (× 2) USNM 646222 (holotype); height 20.6 mm, diameter 12.6 mm.
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   4. (× 1½) IGM 2186 (paratype); height 27.3 mm, diameter 18.5 mm.
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   5. USNM 646223; height 25.7 mm, diameter 18.0 mm.
      Locality: TU 954. Moín Fm., Pleistocene.
   6. USNM 696659; height 21.5 mm, diameter 14.0 mm.
      Locality: *Oregon* Station 2331, Surinam Coast. Recent.

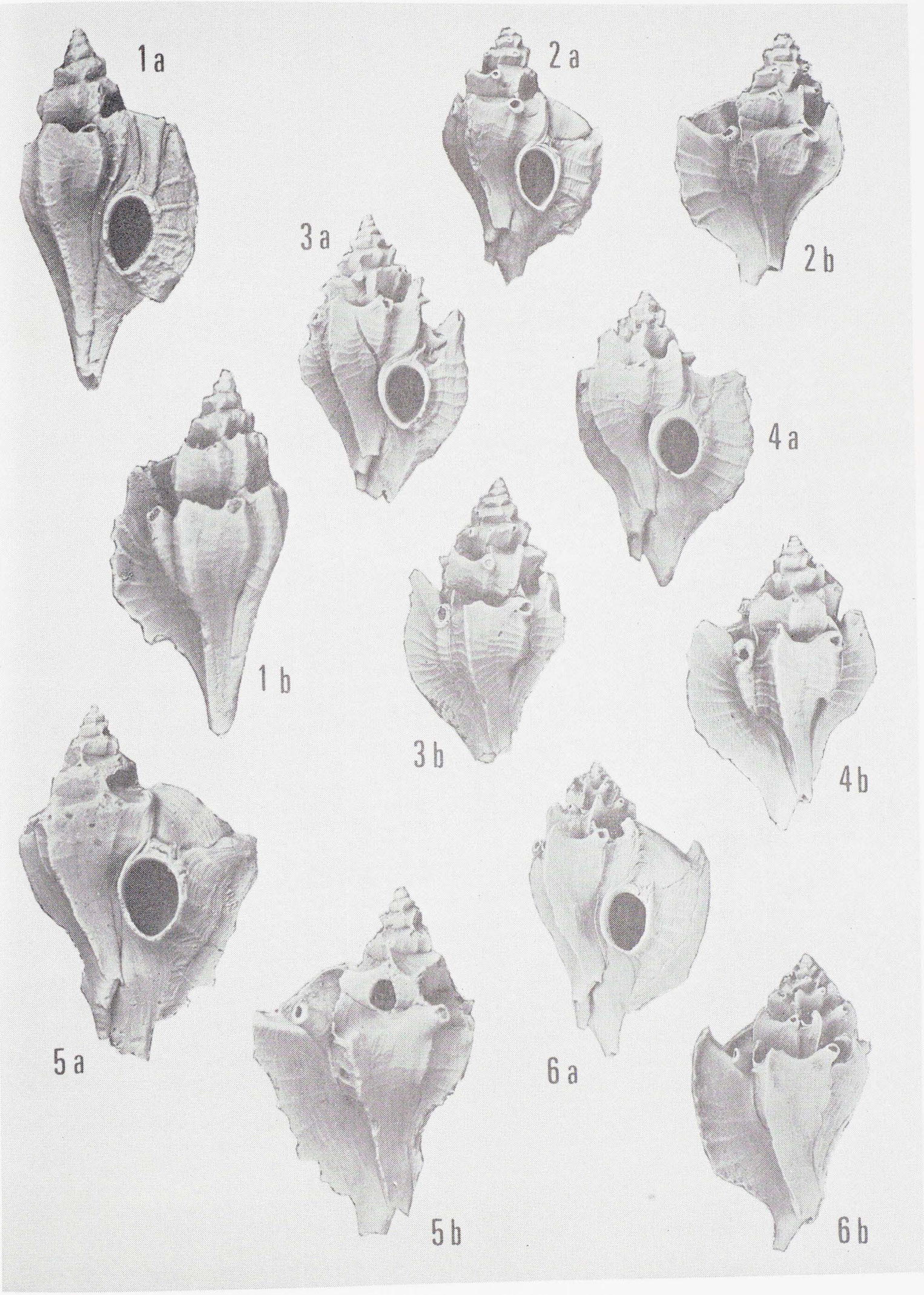

PLATE 5

SIPHONOCHELUS (LAEVITYPHIS) SCHENCKI (Keen and Campbell)

Plate 6, figs. 4a, b

Laevityphis (*Laevityphis*) *schencki* KEEN and CAMPBELL, 1964, Veliger, v. 7, no. 1, p. 53, pl. 9, figs. 16, 20.

"Shell of moderate size, solid, biconic; protoconch partially missing and early spire whorls somewhat worn; shoulder sloping; periphery acute and contracted; body whorl markedly convex contracting sharply at base; varices four per whorl, narrow oblique folds crossing shoulder and joining previous whorl; top of each varix mounted by a long narrow radially directed spine located low on shoulder, bent anteriorly; tubes slightly closer to succeeding varix, joined to it by a buttress, angled slightly forward or ventrally, inclined moderately toward apex; aperture oval; anterior canal broad, reinforced by earlier canals, elongate, closed, inclined obliquely to the left." (Keen and Campbell, 1964)

Holotype: Stanford Univ. Paleo. Type Coll. no. 9723; height 19.0 mm, maximum diameter 15.2 mm.

Type locality: Puerto Colombia (Lat. 11° 03′ N, Long. 75° 00′ W), Dept. Atlantico, Colombia.

Occurrence: Las Perdices Shale, Colombia; early lower Miocene (Aquitanian).

Figured specimen: SUPTC 9723 (holotype).

Discussion: In the original description *S.* (*Laevityphis*) *schencki* was compared with *S. sawkinsi* from the lower and middle Miocene of Trinidad. It differs from that species in having a more sloping shoulder and in having the varical spines located lower on the periphery than the tubes. The holotype, and only known specimen, came from beds that are considered by Keen and Campbell to be Aquitanian in age and thus is slightly older than any of the other Caribbean species.

In their discussion the authors noted that the type specimen was originally labelled in the Stanford University collection as "*Typhis siphonifera* Dall." This was in all probability an error for "*Typhis*" *linguiferus* Dall, a species similar to *S. schencki*. *Typhis* (*Typhina*) *siphonifer* Dall is a completely different form and cannot be compared to *S. schencki* other than at the subfamily level. The error was introduced by Anderson (1929, p. 138) who figured a specimen of *S.* (*L.*) *costaricensis* (Olsson), from Colombia, as "*Typhis siphonifera* Dall." *S. costaricensis* differs from *S. schencki* in having a less sloping shoulder and in having the spines directed vertically rather than outward. *S. schencki* is presumed to be ancestral to *S. costaricensis* but not to *S. sawkinsi*.

SIPHONOCHELUS (LAEVITYPHIS) LINGUIFERUS* (Dall)

Plate 6, figs. 5a, b

Typhis linguiferus DALL, 1890, Wagner Free Inst. Sci., Trans., v. 3, pt. 1, p. 152, pl. 12, fig. 7.

[?] *Typhis linguiferus* Dall. BROWN and PILSBRY, 1917, Acad. Nat. Sci. Phila., Proc., v. 69, p. 34 (probably = *S. costaricensis*).

Not *Typhis linguiferus* Dall. MAURY, 1925, Bulls. Amer. Paleontology, v. 10, no. 42, p. 214, pl. 36, figs. 4, 5 (= *Typhis* [*Siphonochelus*] *sawkinsi* Mansfield).

Laevityphis (*Laevityphis*) *linguiferus* (Dall). KEEN, 1944, Jour. Paleontology, v. 18, no. 1, p. 59, 65.

Typhis linguiferus Dall. GARDNER, 1947, U. S. Geol. Surv. Prof. Paper 142-H, p. 527, pl. 53, fig. 17.

"Shell with two laxly coiled, polished, peripherally-keeled nuclear whorls and six subsequent whorls; surface polished; transverse sculpture of (on each whorl four) strong, thick, rounded varices, which gradually increase from in front backward, each being largest at the shoulder, where it is produced axially into a linguiform, rather pointed spine, between which and the suture the varix is depressed, then rises against the preceding whorl, where it is expanded and appressed; the spines are bent inward and to some extent backward, the varix is strongly marked by the incremental lines and is linked to the tube, which precedes it by a little elevated ridge, but there is no similar connection with the succeeding tube; the ends of these spines are generally broken and they then appear hollow for a short distance, but the spines are not pervious and have no connection with the interior of the shell; the tubes are moderately large and, instead of conforming to the curves of the varices, they curve upward, outward, a little backward and a little downward at last, though often broken; from the base of each tube a narrow ridge extends forward in harmony with the incremental lines, and behind this ridge is perceptible the mark of an old resting stage; suture appressed and undulated by the sculpture; between the suture and the shoulder the whorl is somewhat excavated; other spiral sculpture only of a few irregular lines near the periphery, which give the surface a malleated appearance, but are not elevated enough to be termed threads or form con-

* This name should more correctly be spelled *linguifer*, however, the ICZN *Code* Art. 32(a)ii states that "incorrect latinization" does not constitute an "inadvertent error" and does not require emendation.

tinuous ridges; the roundness of the varices is not interrupted by them; as there are four varices to a whorl, there are usually three old canals discernible beside the one in use; there is no umbilical chink; the canal is wholly closed, slender and attenuated; the aperture small, subovate and simple with an elevated rim." (Dall, 1890)

Description: Shell small, elongate, with a polished surface; protoconch of one and one-half whorls, smooth, flattened, having a keel around the middle that develops into the edge of the shoulder; six post-nuclear whorls; four convex, smooth varices per whorl; a spine at the top of each varix pointing apically, axially and abaperturally; ends of the spines usually broken off and appearing hollow like the tubes, but the openings are smaller, and do not connect with the inside of the shell; outer lip smooth, of constant width; interapertural area of only one part; aperture ovate, surrounded by a raised rim; tubes midway between varices, pointing apically, abaxially, and abaperturally; shell unornamented, axial growth lines visible only under high magnification; shoulder slightly depressed; suture distinct; anterior canal closed, narrow, pointing to the right and slightly abaperturally.

Holotype: USNM 112183; height 15.0 mm, maximum diameter 7.2 mm.

Type locality: USGS 2212, Ten Mile Creek near the Chipola River, Calhoun County, Florida. (? = TU 546).

Occurrence: Chipola Formation and Oak Grove Sand, Florida; late lower Miocene.

Figured specimen: USNM 646224; height 14.0 mm, diameter 7.8 mm; locality: TU 456. Other occurrences: TU locality nos. 70, 91, 196, 457, 546, 554, 655, 708, 709, 710, 786, 787, 810, 817, 830, 831, 949, 951, 998.

Discussion: *S.* (*Laevityphis*) *linguiferus* appears to be descended from *S. curvirostratus* (Conrad, 1848), which it resembles except for the placement of the tubes, smaller size, slightly greater elongation, and more pronounced spine at the apical end of the varix in the Miocene form. *S. linguiferus* also resembles *S. sawkinsi* (Mansfield, 1925), but has less pronounced growth lines, long spines at the top of the varices, and lacks a high partition connecting the varix with the corresponding varix of the preceding whorl.

Pilsbry and Brown reported "*Typhis linguiferus*" from the middle Miocene (Gatun equivalents) of Cartagena, Colombia. The writer questions this identification as *S. linguiferus* is known otherwise only from the Chipola Formation. The description given by Pilsbry and Brown is sketchy, and is not accompanied by a figure, but their specimen is probably *S. costaricensis* (Olsson, 1922).

S. linguiferus is known only from the Chipola Formation and the correlative Oak Grove Sand (late lower Miocene, northwestern Florida), but is represented in the Tulane University collections by more than 500 specimens from 20 localities. It is the most abundant *Laevityphis* in the collections, and second in number only to *Typhis* (*Rugotyphis*) *floridanus* Dall (Pliocene, Florida) among the Typhinae.

Siphonochelus (Laevityphis) sawkinsi (Mansfield)

Plate 7, figs. 1a, b

Typhis linguiferus Dall. Maury, 1925, Bulls. Amer. Paleontology, v. 10, no. 42, p. 214, pl. 47, figs. 4, 5 (*not* of Dall).

Typhis sawkinsi Mansfield, 1925, U. S. Natl. Mus., Proc., v. 66, Art. 22, p. 48, pl. 2, fig. 11.

Laevityphis (*Laevityphis*) *sawkinsi* Mansfield. Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 59, 67.

Typhis (*Laevityphis*) *sawkinsi* Mansfield. Jung, 1965, Bulls. Amer. Paleontology, v. 49, no. 223, p. 525, pl. 70, figs. 7, 8.

"Shell small, solid, fusiform, strongly axially sculptured, with five remaining whorls, tip broken off. Early whorls carinated, later strongly shouldered below the suture. Axial sculpture of (four on the penultimate whorl and five including the strong lip varix on the body whorl) strong varices alternating with weaker axials bearing at their summits moderately strong, protractive tubes. The varices are very strong on the three anterior whorls, offset to the left at the suture and overlap the preceding whorl, terminating at the base of the intervarical tube and lying between the varix and the rib. Between the varices the deep recessed suture is revealed. Each varix bears on its right margin and directly over the suture a short tube. The intervarical ribs extend on the spire whorls from the shoulder to the following suture, and on the last whorl to the base. A few minute axial growth lines overrun the surface. Aperture elongate-ovate, bordered by a raised rim. Anterior canal curved to the right and on the left side strengthened by three anterior curving varices." (Mansfield, 1925)

Description: Shell small, slightly elongate; four strong, smooth varices per whorl; outer lip narrow, of constant width, a large partition above the aperture connecting the varix to that of the preceding whorl; no spine at the apical end of the varix; interapertural area of one part; aperture small, ovate, surrounded by a raised rim; tubes closer to succeeding than preceding varices; shoulder slightly depressed,

crossed by remnants of former partitions; suture distinct; anterior canal closed, narrow, pointing to the right but not abaperturally.

Holotype: USNM 352673; height 14.6 mm, maximum diameter 7.6 mm.

Type locality: Guaico-Tamana Road, 2 chains east of mile 13 from the junction with Eastern Main Road, Trinidad.

Occurrence: Brasso and Moruga Formations, Trinidad; unnamed formation, Paraguaná Peninsula, Venezuela; middle Miocene.

Figured specimen: USNM 352673 (holotype).

Discussion: Maury (1925, p. 214) reported three specimens of Trinidad Typhinae that she thought might be the same as *S. linguiferus* (Dall) from the Chipola Formation of northwestern Florida. Shortly thereafter Mansfield named *"Typhis" sawkinsi* from the same locality. He compared his species with *S. gabbi* (Brown and Pilsbry) from the Gatun Formation of Panamá, but observed that the Trinidad species lacked the wrinkled and pitted sculpture of *S. gabbi*. The writer, among others, refers Maury's specimens to *S. sawkinsi*, as the partition above the aperture crosses the shoulder on the Trinidad specimens unlike that of *S. linguiferus*.

Keen and Campbell (1964, p. 54) suggested that *S. schencki* was probably the precursor of *S. sawkinsi* but the writer disagrees. He believes that *S. sawkinsi* was derived from *S. curvirostratus* (Conrad), Oligocene, Mississippi, which has a depressed shoulder and rounded, thickened varices (as does *S. sawkinsi*) and not from the dissimilar form, *S. schencki* (Keen and Campbell).

S. sawkinsi is known from the Brasso and Moruga Formations, middle Miocene of Trinidad, and from the late middle Miocene of the Paraguaná Peninsula, Venezuela (Jung, 1965, p. 525). Maury (1925) reported this species from the Mechapoorie Formation, lower or middle Miocene, Trinidad, but Mansfield (1925, p. 4) and others have referred it to the Navarro River Member of the Brasso Formation.

Siphonochelus (Laevityphis) costaricensis (Olsson)

Plate 7, figs. 2a, b

Typhis linguliferus [*sic*] *costaricensis* Olsson, 1922, Bulls. Amer. Paleontology, v. 9, no. 39, p. 132, pl. 10, figs. 22, 29.

Typhis siphonifera Dall. Anderson, 1929, California Acad. Sci., Proc., (Ser. 4) v. 18, no. 4, p. 138, pl. 9, fig. 8 (*not* of Dall).

Not *Typhis costaricensis* Olsson, 1942, Bulls. Amer. Paleontology, v. 27, no. 106, p. 228, pl. 25, figs. 5, 8 (= *Typhis* (*Talityphis*) *olssoni* Keen, 1943, new name).

Typhis linguliferus [*sic*] *costaricensis* Olsson. Barrios M., 1960, Bol. Geol., Serv. Geol. Nacl. Colombia, v. 6, p. 279, pl. 9, fig. 9.

"This is a smaller and more delicate species than *T. gabbi* Brown and Pilsbry from the Canal Zone. They agree with the Chipolan *linguliferus* [*sic*] Dall in their general form but differ in their uniformly smaller size and in nearly lacking the spine-like process on the shoulder of the primary varices. It is fairly abundant in the Gatun beds of the Banana River." (Olsson, 1922)

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Plate 6

Figures

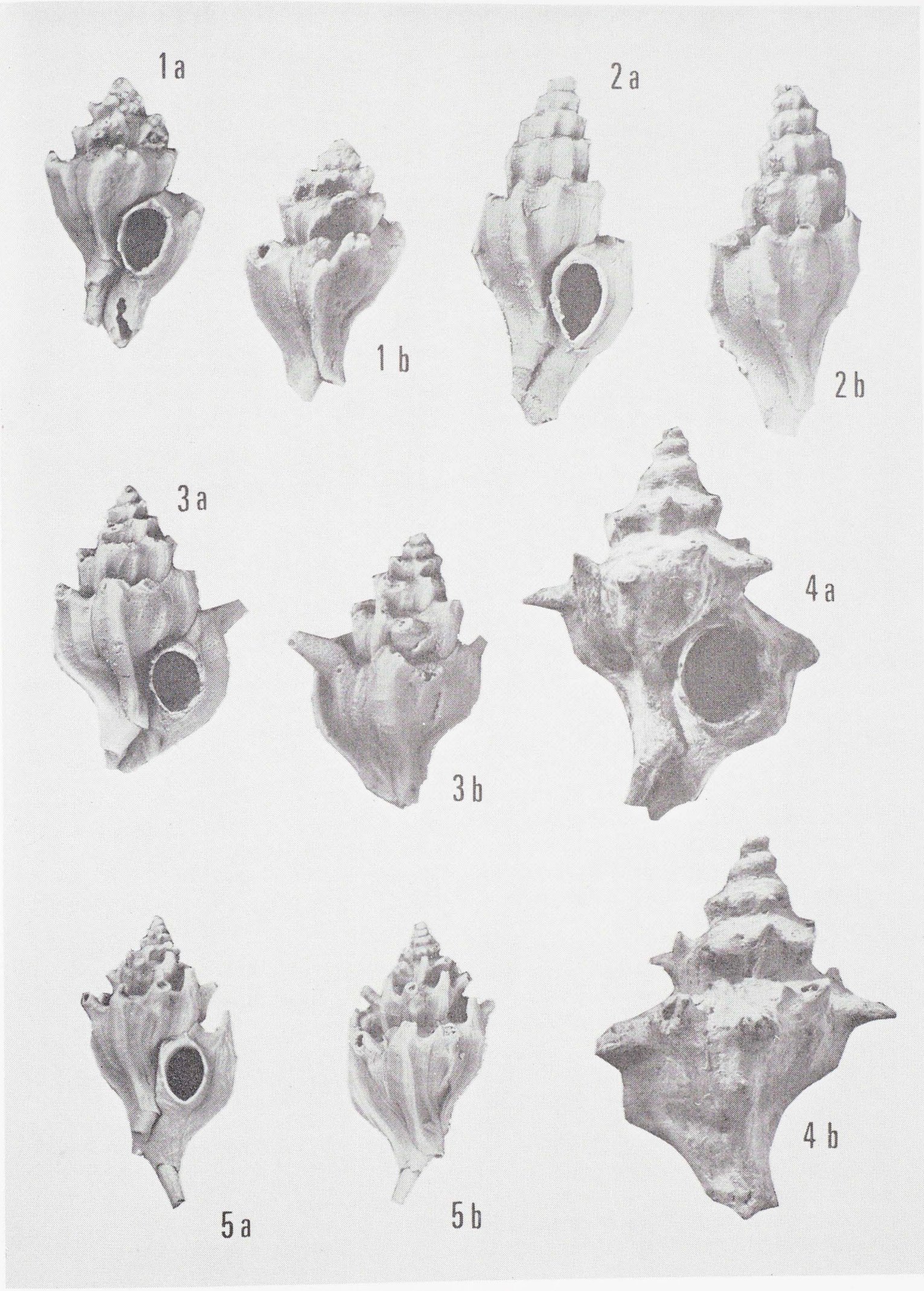

PLATE 6

Description: Shell small, elongate; protoconch smooth, rounded, of one and one-half whorls; five post-nuclear whorls; four smooth convex varices per whorl; outer lip smooth, narrow, of constant width; a partition connecting the varix with the corresponding varix of the preceding whorl; interapertural area of only one part; aperture rounded, surrounded by a raised rim; tubes closer to succeeding than preceding varices, pointing abaxially and apically; surface of the shell smooth; shoulder slightly depressed, crossed by remnants of partitions; suture distinct; anterior canal closed, elongate, narrow, pointing to the right and abaperturally.

Lectotype: PRI 21060; height 12.7 mm, maximum diameter 7.3 mm (here designated).

Type locality: Hill 1A, Banano River, Costa Rica.

Occurrence: Gatun Formation, Costa Rica; Tuberá Group, Colombia; middle Miocene.

Figured specimen: PRI 21060 (lectotype).

Discussion: *S.* (*Laevityphis*) *costaricensis* is closely related to *S. sawkinsi* (Mansfield, 1925). The two forms are similar in having rounded, convex varices, and large partitions crossing the shoulder above the aperture. The two differ in that *S. costaricensis* is more elongate, and has thinner varices. This species differs from *S. linguiferus* (Dall, 1890) by its more elongate shape, partitions above the aperture, and shorter spines at the apical end of the varices. The shoulder is not as depressed in this form as it is in both *S. sawkinsi* and *S. linguiferus*.

This species was figured by Anderson (1929, pl. 9, fig. 8), from the Miocene of Colombia, as "*Typhis siphonifera* Dall," an apparent error for *S. linguiferus*. This error has been copied by subsequent workers with resulting confusion as the two have little in common.

Olsson named this form as a subspecies of *S. linguiferus* but it is no more closely related to *S. linguiferus* than to any other of the Caribbean species of *Laevityphis* and so the subspecific rank is removed. There being two specimens in the type lot, the first one figured by Olsson (1922, pl. 10, fig. 22) is selected as lectotype. It is the specimen now given the Paleontological Research Institution number 21060, the other figured specimen is PRI 21061.

It should also be noted that, although the usual spelling of the type locality of this species has been "Banana River," on the topographic map of the area prepared by the Instituto Geografico de Costa Rica it is spelled *Banano* (Rio Banano sheet, no. HOJA 3545 1).

Siphonochelus (Laevityphis) bullisi Gertman, n. sp.

Plate 7, figs. 3a, b

Description: Shell large; smooth, bulbous protoconch of one and one-half whorls; six post-nuclear whorls; four smooth thickened varices per whorl, each with a spine at the apical end pointing apically and abaxially; outer lip smooth, of constant width, with a strong angle at the base of the body whorl; interapertural area of only one part; aperture ovate, surrounded by a raised rim; tubes midway between the varices, pointing abaxially and abaperturally; area under the tubes raised, forming axial ribs between the varices, shell surface smooth and polished; shoulder raised, suture appressed and indistinct; anterior canal closed, long, narrow, curving to the right and abaperturally.

Holotype: USNM 696660; height 26.7 mm, maximum diameter 13.0 mm.

Type locality: *Oregon* Station 5727, Gulf of Darién, Panamá, 43 fms.

Occurrence: Moín Formation, Costa Rica; Pleistocene. Caribbean Sea, Recent.

Figured specimen: USNM 696660 (holotype). Other occurrences: TU locality no. 953.

Discussion: This new species, the first Recent *Laevityphis* known from the New World, is represented by over 20 specimens from the type locality as well as fragments from the Pleistocene Moín Formation of Costa Rica. As the oldest group of Typhinae it is not too surprising that the Recent distribution is disjunct. The line was once much more widespread with representatives in all parts of the tropics. *S. bullisi* is easily distinguished from all other species of *Laevityphis* (except perhaps *L. schencki*) by the strong angulation at the base of the body whorl.

Subgenus Pilsbrytyphis Woodring, 1959

Pilsbrytyphis Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 220.
Type species: *Typhis gabbi* Brown and Pilsbry, 1911, by original designation.

> "Five [four] varices to a whorl. Tubes midway between varices, slightly bent backwards. All except earliest whorls bearing irregular axially wrinkled and pitted sculpture. Aperture small. Siphonal canal short, moderately bent." (Woodring, 1959)

Discussion: The few species of *Pilsbrytyphis* are undoubtedly derived from a *Laevityphis* ancestor as the morphology of the shell is almost identical, being distinguished

only by the very non-*Laevityphis* nature of the wrinkled shell surface. The latter was characterized most aptly by Woodring as "peanut-shell" sculpture. In contrast, the shell surface of *Laevityphis* and of all the other subgenera of *Siphonochelus* is completely smooth and highly polished.

The members of *Pilsbrytyphis* are confined to the middle Miocene beds of Panamá and it is evident that this bizarre development was a biological failure. This type of the subgenus, *S. gabbi*, occurs in the middle Gatun Formation of the Panamá Canal Zone. In addition, two new species are described herein: *S. (Pilsbrytyphis) woodringi*, from the upper Gatun Formation of the Canal Zone; and *S. darienensis*, from the middle Miocene of the Darién region of eastern Panamá.

Siphonochelus (Pilsbrytyphis) gabbi (Brown and Pilsbry)

Plate 7, figs. 4a, b

Typhis gabbi Brown and Pilsbry, 1911, Acad. Nat. Sci. Phila., Proc., v. 63, p. 354, pl. 26, fig. 6.

Typhis (Typhina) gabbi Brown and Pilsbry. Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 55, 65.

Typhis (Pilsbrytyphis) gabbi Brown and Pilsbry. Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 220, in part only, *not* pl. 32, figs. 2, 3, 5, 7.

> "The shell is fusiform, strong, the last whorl having a peculiar sculpture, the surface shrivelled, wrinkled and pitted. The embryo, of nearly two very convex smooth whorls, forms a short style or pillar. Then the diameter enlarges, and a shoulder-angle appears on the latter part of the third whorl. In the middle of the fourth whorl varices and intervariceal tubes appear on the very prominent shoulder, these structures gradually increasing in size to the last whorl, which bears four varices. These are strong and heavy, rounded, somewhat recurved above the shoulder, where there is a deep pit behind each varix. The tubes are short, midway between the varices, and placed upon low short folds. The aperture is very small, oval, with a raised rim. Anterior canal closed, bent to the right, having three projecting angles on the left side." (Brown and Pilsbry, 1911)

Description: Shell small, stout; five postnuclear whorls; four convex varices per whorl; outer lip of constant width, with only vestigial spines at apical end of varix; a large partition riding up upon the preceding whorl to form a strong buttress-like structure with a deep concavity behind it; shell covered with a semireticulate pattern trending spirally around the shell; interapertural area in two parts: first, the area under the tube, second, the new varix, the two areas being distinguished by an offset in the pattern of the ornamentation; aperture small, ovate-rounded, surrounded by a raised rim; tubes midway between varices, pointing abaxially and apically from the shoulder; shoulder raised; suture distinct; anterior canal closed, narrow, bending to the right and abaperturally.

Holotype: ANSP 1722; height 13.3 mm, maximum diameter 7.6 mm.

Type locality: Gatun Locks excavation, Canal Zone.

Occurrence: Gatun Formation, Canal Zone; middle Miocene.

Figured specimen: ANSP 1722 (holotype).

Discussion: The specimens that Woodring (1959, p. 220, pl. 32, figs. 2, 3, 5, 7) discussed and figured as "*Typhis*" (*Pilsbrytyphis*) *gabbi* Brown and Pilsbry are not this species but a new one described below as (*P.*) *woodringi*. So far as is known there are but the two original specimens of true *S. gabbi*, which came from the middle part of the Gatun Formation at the Gatun Locks excavation. The specimens referred to *S. woodringi* all come from the upper part of the Gatun Formation in the vicinity of Mount Hope, Canal Zone.

Woodring (*ibid.* p. 220) described *S. gabbi* as having five varices per whorl but the writer believes that he included the last varix of the preceding whorl in his count, for the type has but four varices per whorl. He added that by Keen's key (1944, p. 52) it is a member of the subgenus *Typhina*, which has four varices per whorl, with the tubes midway between the varices. On all other grounds, however, the form is more akin to *Laevityphis* except for the unusual surface sculpture, which caused Woodring to erect the new subgenus *Pilsbrytyphis* for the group. Morphologically *S. (Pilsbrytyphis) gabbi* is very close to *S. (Laevityphis) sawkinsi* (Mansfield) from the middle Miocene of Trinidad and Venezuela and probably represents a mutation of this stock.

Siphonochelus (Pilsbrytyphis) darienensis Gertman, n. sp.

Plate 7, figs. 5a, b

Description: Shell large, massive; nucleus of one and one-half smooth whorls; six postnuclear whorls; four thickened, sculptured varices per whorl with a high, hollow spine at the top of each varix, directed apically; these spines usually broken off to mimic tubes; spire high; tubes closer to succeeding than pre-

ceding varices, pointing abaxially, apically, and aperturally; suture appressed; varices joined to preceding whorl by a small partition; entire shell surface covered with axially directed, longitudinal wrinkles that follow the growth pattern of the shell; aperture ovate, surrounded by a raised rim; anterior canal closed, narrow, curving to the right and abaperturally.

Holotype: USNM 646114; height 22.3 mm, maximum diameter 12.6 mm.

Type locality: USGS 8477, Rio Tuira, Darién, Panamá.

Occurrence: "Tuira Formation," Darién, Panamá; middle Miocene.

Figured specimen: USNM 646114 (holotype).

Discussion: Woodring (1959, p. 220), in his discussion of *"Typhis" gabbi,* mentioned that there was another undescribed species of *Pilsbrytyphis* from the Darién region of Panamá. It is the species here described. Although related to *S. gabbi* it is nearer to the other species of *Pilsbrytyphis* described below, which is the *"T. gabbi"* of Woodring, not of Brown and Pilsbry. From that species it differs in its larger size, weaker sculpture, and in having the spines and tubes more well developed at an earlier stage, giving the spire of the shell an especially cororated appearance.

This new species is not rare, in the type lot there are 11 specimens. They were collected by A. A. Olsson on the Rio Turia near Limones, from beds which are equivalent to the Gatun Formation of the Canal Zone. According to the *Lexique Stratigraphique International* (v. 5, Fasc. 2a, Amérique Centrale, p. 317 & 349) the name "Turia Formation" has been proposed for these strata but has not been properly defined. This formation is said to underlie the Pucro Sandstone, which carries a fauna very similar to that of the Gatun near Mount Hope, Canal Zone, from whence comes the type specimen of *S. (Pilsbrytyphis) woodringi* Gertman, n. sp., and it is concluded that *S. darienensis* is slightly older than *S. woodringi.*

Siphonochelus (Pilsbrytyphis) woodringi Gertman, n. sp.

Plate 7, figs. 6a, b

Typhis (Pilsbrytyphis) gabbi Brown and Pilsbry. Woodring, 1959, U. S. Geol. Surv. Prof. Paper 306-B, p. 220 (in part *not* of Brown and Pilsbry), pl. 32, figs. 2, 3, 5, 7.

Description: Shell medium-sized; nucleus of one and one-half smooth whorls, blunt tipped; six post-nuclear whorls; four thickened varices per whorl with a small recurved spine at the top of each varix pointing abaperturally; spire high; tubes closer to succeeding than preceding varices, pointing abaxially, apically, and abaperturally; shoulder appressed at varices, depressed between; suture distinct; varices joined to preceding whorl by a small partition; entire shell covered with axially-oriented wrinkled sculpture; aperture oval, surrounded by a raised rim; anterior canal closed, narrow, curving to the right and abaperturally.

Holotype: USNM 562627; height 20.3 mm, maximum diameter 10.8 mm.

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Plate 7

Figures

Page

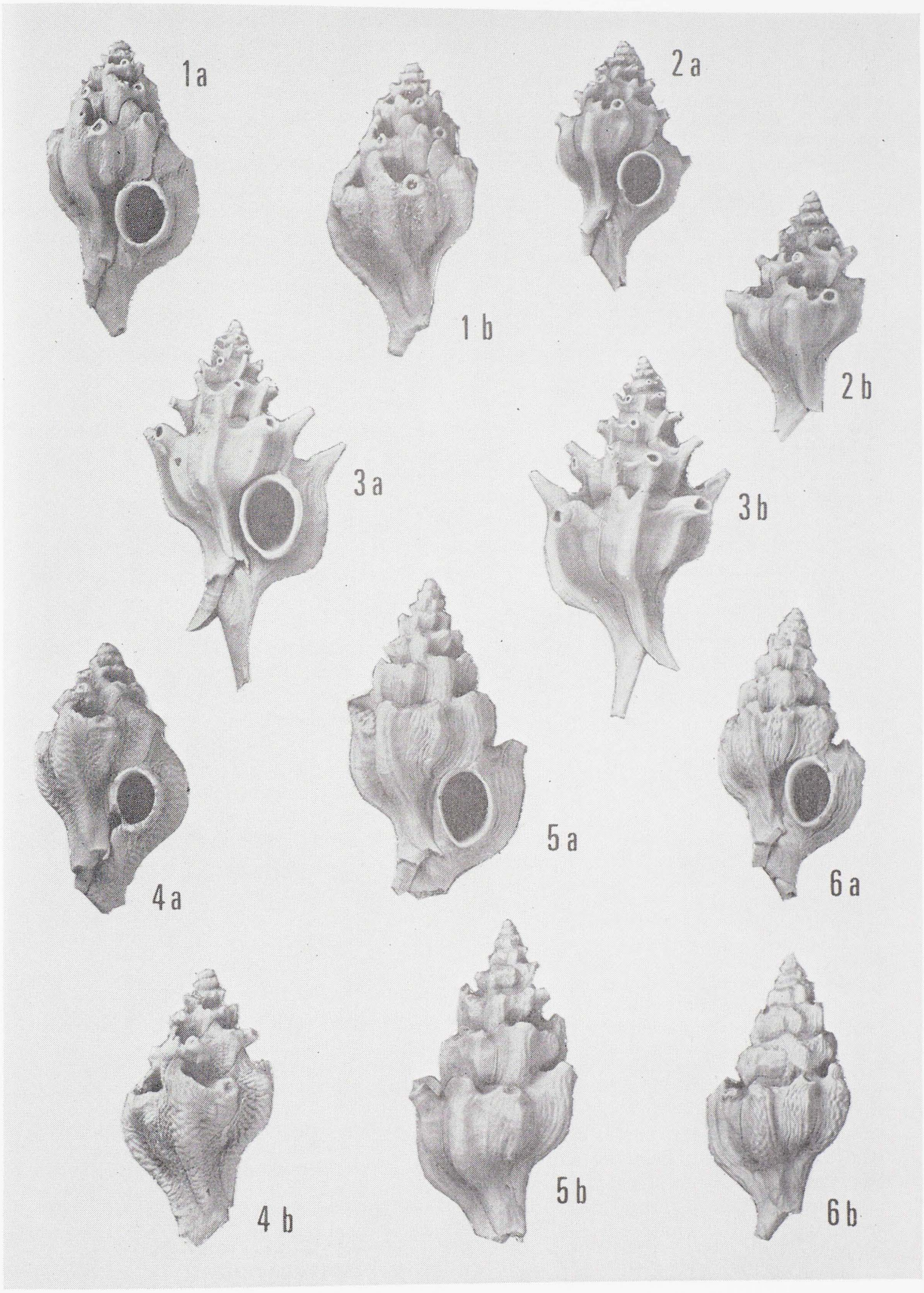

PLATE 7

Type locality: USGS 8410, cuts on west side of East Diversion, Mount Hope, Canal Zone (Woodring locality 175).

Occurrence: Gatun Formation, Canal Zone; middle Miocene.

Figured specimen: USNM 562627 (holotype) (specimen figured by Woodring, 1959, pl. 32, figs. 5, 7).

Discussion: As noted above, the specimens cited by Woodring (1959, p. 220, pl. 32, figs. 2, 3, 5, 7) as *"Typhis"gabbi* Brown and Pilsbry are not that species. The form, here named in honor of Dr. Wendell P. Woodring, differs from the true *S. gabbi* in having the characteristic "peanut-shell" sculpture oriented axially instead of spirally as in *S. gabbi*, and in lacking the pronounced buttress-like partition of that species, having instead small, recurved spines at the top of the varices.

This species is common in the vicinity of the type locality, there being 18 specimens in the USNM collections from near Mount Hope, Canal Zone. Stratigraphically it is the last of the three known species of *Pilsbrytyphis*, occurring in the upper part of the Gatun Formation.

Genus PTEROTYPHIS Jousseaume, 1880
Subgenus PTEROTYPHIS s.s.

Pterotyphis JOUSSEAUME, 1880, Le Naturaliste, Année 2, no. 42, p. 336 (originally spelled as *Perotyphis*, but corrected in errata, Le Naturaliste, Année 3, no. 43, p. 367, 1881); 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 338.
Type species: *Typhis pinnatus* Broderip, 1833, by original designation.

Trigonotyphis JOUSSEAUME, 1882, Rev. Mag. Zool., (Ser. 3) v. 7, p. 339.
Type species: *Typhis fimbriatus* A. Adams, 1854, by original designation.

"Coquille ovale à spire élevée, conique, tours avec des varices saillantes et foliaées et des côtes circulaires; ouverture ovale; canal très court." (Jousseaume, 1882)

Shell with three varices and tubes per whorl; tubes nearer to succeeding than to preceding varices, pointing abaperturally and abaxially; siphonal canal not closed but open by a narrow slit; strong sculpture present.

Discussion: *Pterotyphis* s.s. is a small, but distinctive, group. It is unique among the Typhinae in having the siphonal canal not sealed over. There are but three known species, one in the Gulf of California, *P. fimbriatus* (A. Adams, 1854); one in the Caribbean, *P. pinnatus* (Broderip, 1833), of which *P. fordi* (Pilsbry, 1943) is a synonym; and one fossil species, described herein, from the lower Miocene Chipola Formation of Florida.

From Jousseaume's original description of *Pterotyphis* it is not at all certain that he really knew what he was describing. His description of *Trigonotyphis*, which appeared on the following page, is a much more adequate description of the form, mentioning the resemblance to *Murex triqueter* and the presence of the open canal. The name is indicative of the presence of only three varices. Nevertheless, the selection of *P. pinnatus* as the type of *Pterotyphis*, was sufficient to describe the genus and, as it has two years priority, there is no question of which name is preferable.

DuShane (1969, p. 343) has recently described a new genus of Typhinae, to which the name *Cinclidotyphis* was given. Although compared by the author to *Siphonochelus*, it is obvious that this new form is most closely related to *Pterotyphis*. The only difference between this new West American species, *C. myrae*, the type of the genus, and *P. pinnatus*, type of *Pterotyphis*, is the presence of the more normal four varices and tubes per whorl in the new species. Otherwise, the nature of the cancellate ornamentation, the open siphonal canal, the formation of the tubes, all are virtually identical in the two forms. Because the presence of only three varices has been considered as a generic character in *Pterotyphis* the writer does not place the two taxa in synonymy, but it is strongly felt that the two groups are so closely related that a subgeneric separation is the maximum distinction possible.

PTEROTYPHIS (PTEROTYPHIS) CALHOUNENSIS Gertman, n. sp.
Plate 8, figs. 1a, b

Description: Shell small, highly ornamented; early whorls unknown; three convex varices per whorl, each crossed by eight or nine strong spiral ribs, the two anterior-most of which are composed of three weaker ribs; axial ribbing only slightly less prominent than spiral, giving the shell a cancellate sculpture; tubes just behind and soldered to, the succeeding varix; aperture ovate, with a sinuous outer margin; outer lip crenulated with about seven ribs; anterior canal open by a narrow slit, turned to the right and abaperturally.

Holotype: USNM 646225; height (incomplete) 8.0 mm, maximum diameter 5.5 mm.

Type locality: TU 547, west bank of Chipola River, about 2000 ft. above the mouth of Four

Mile Creek (SW ¼ Sec. 29, T1N, R9W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida; late lower Miocene.

Figured specimen: USNM 646225 (holotype).

Discussion: Although the only specimen known of *P. calhounensis* is incomplete, inasmuch as it is the first known fossil of the subgenus, it was deemed by the writer too important to remain unnamed. Only the body whorl is preserved but all of the characters of the species can be ascertained except the total number of whorls.

P. calhounensis is similar to *P. pinnatus* but differs in the much coarser nature of the cancellate sculpture of the Chipola shell.

Pterotyphis (Pterotyphis) pinnatus (Broderip)

Plate 8, figs. 2 a, b

Typhis pinnatus Broderip, 1833, Zool. Soc. London, Proc., pt. 2, p. 178.

Typhis pinnatus Broderip. G. B. Sowerby, Jr., 1841, Conch. Illus., pl. 200, figs. 10, 11.

Typhis fordi Pilsbry, 1943, Nautilus, v. 57, p. 40, pl. 7, fig. 4.

Pterotyphis (*Pterotyphis*) *pinnatus* (Broderip). Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 59, 66.

> "Typhis testa alba, fusiformi, trifariam pinnata, transversim striata, striis frequentibus, interstitiis punctatis; labri limbo crenulato . . . The sides of the canal in the specimen are broken, but the canal does not appear to have been entire close to the aperture, though the sides of it approximate there very nearly." (Broderip, 1833)

Description: Shell small, elongate; protoconch rounded, smooth, of one and one-half whorls; six post-nuclear whorls; three convex varices per whorl, each crossed by 12 crenulations; outer lip wide, of one part, flanged and crossed by 12 ribs, the anterior ones divided into primary ribs flanked on either side by one weaker rib; shell ornamented by strong spiral sculpture and sharp varices; axial growth lines giving a cancellate appearance to the surface of the shell; tubes nearer to succeeding than preceding varices, attached but not soldered to the varix; tubes made of two parts: an inner circular tube, surrounded by a striated flange that appears to be wrapped around the tube with a distinct suture line on the adapertural side of the tube; tubes pointing abaxially, abaperturally, and apically; aperture ovate, with a sinuous outer margin; anterior canal open with a narrow slit, curving to the right and abaperturally.

Holotype: Not found; height 6/8 inch, diameter 2/8 inch (*fide* Broderip, 1833).

Type locality: New Providence Island (Nassau), Bahama Islands (here designated).

Occurrence: Moín Formation, Costa Rica; Pleistocene. Caribbean Sea and western Atlantic, Recent.

Figured specimen: USNM 646226; height 12.3 mm, maximum diameter 6.4 mm; locality; TU 954. Other occurrences: TU locality nos. R-100, R-101.

Discussion: *P. pinnatus* (Broderip) was named without locality data but there seems no doubt that the western Atlantic shell subsequently named *Typhis fordi* Pilsbry is this species. As no type locality has ever been designated, New Providence Island, Bahama Islands, the type locality of *P. fordi*, is here selected. This species is evidently not rare in the Bahamas as it has been reported by several collectors from that area. Prior to this paper it has never been reported from the Caribbean but in the Tulane Collections there are two specimens from off northern Panamá dredged by the *Anton Bruun* Cruise 10. In addition, the species also occurs in the Pleistocene Móin Formation of Costa Rica.

Subgenus Tripterotyphis Pilsbry and Lowe, 1932

Tripterotyphis Pilsbry and Lowe, 1932, Acad. Nat. Sci. Phila., Proc., v. 84, p. 78.

Type species: *Typhis lowei* Pilsbry, 1931, by original designation.

Nothotyphis Fleming, 1962, Roy. Soc. New Zealand (Zool.), Trans., v. 2, no. 14, p. 116.

Type species: *Pterynotus* (*Nothotyphis*) *norfolkensis* Fleming, 1962, by original designation.

> "Shell with three broad varices continuous from whorl to whorl, ascending the spire in a slowly revolving spiral. Tubes wholly concrescent with the posterior angles of the varices, where they are terminal." (Pilsbry and Lowe, 1932)

Shell with three varices per whorl; tubes within the varices; shell sculptured.

Discussion: Dr. C. A. Fleming, Chief Paleontologist of the New Zealand Geologic Survey, stated (1962, p. 117) his belief that those muricids with varical tubes were to be referred to the Muricinae rather than the Typhinae. He established the subgenus *Nothotyphis*, in the genus *Pterynotus*, for muricids having three varices per whorl with the tubes in the varices. Keen and Campbell (1964, p. 56), in a study of the formation of the varical tubes of *Tripterotyphis* from a growth series, concluded that this development seems to be "closely re-

lated to other Typhinae rather than to the muricine group *Pterynotus* Swainson, 1833." Morphologically *Nothotyphis* is so similar to *Tripterotyphis* that the two taxa must be considered synonymous.

In those forms of Typhinae in which the tubes are developed between the varices their relative position within this interval is variable, and the writer sees no valid reason for excluding from the subfamily those forms in which this variation has reached the stage wherein the tubes are located within the varices. It is to be noted that an intermediate condition is observed in *Siphonochelus* s.s. Here the tubes initially appear as a strongly infolded notch on the back of the varix, which later closes over to form a tube that is situated half within and half behind the varix. Also, in *Tripterotyphis* the anterior canal is closed as it is in the majority of the Typhinae, but none of the Muricinae exhibit this feature.

There is another typhine subgenus, *Semityphis* Martin, 1931, named for an Eocene species from Java, that is superficially similar to *Tripterotyphis*. *Semityphis* also has three varices with the tubes contained within the varices. However, these two forms probably represent parallel evolution for morphologically they appear quite different. *Semityphis* is an almost smooth shell, unlike the cancellate *Tripterotyphis*, and is ornamented only by a strong spiral rib at the periphery, giving the shell a marked biconic outline. The type specimen is a juvenile, measuring only 5.5 mm, and with only three post-nuclear whorls. The siphonal canal is open but this may be due to immaturity or breakage. The tubes are almost flush with the varices much as in the subgenus *Lyrotyphis*. This combined with the smooth shell surface, and the comparable geologic age suggests that *Semityphis* is more nearly related to *Lyrotyphis* than to *Pterotyphis*, in spite of having three varices, and so is herein placed in the genus *Siphonochelus*.

There are eight known species of *Tripterotyphis*, ranging in age from lower Miocene to Recent. *P. (Tripterotyphis) vokesae*, n. sp., from the late lower Miocene Chipola Formation of northwestern Florida is the oldest reported *Tripterotyphis* in the New World. *P. tripterus* (Grateloup, 1833), is known from the lower Miocene of France, and the middle Miocene of Hungary. *P. wenzelidesi* (Hörnes, 1856) is a synonym of *P. tripterus*.

In the Recent fauna there are two species of *Tripterotyphis* from the New Zealand-Australia area, those being the species referred to *Nothotyphis* by Fleming. There are three species from tropical West America: *P. fayae* Keen and Campbell, 1964, from the Pleistocene and Recent of western Mexico, *P. arcana* DuShane, 1969, also from west Mexico, and *P. lowei* (Pilsbry, 1931), described from the reefs at low tide off the Pacific Coast of Panamá. *P. (T.) triangularis* (A. Adams, 1856), described without locality data, is now known to be from the Caribbean region. (The name *Murex cancellatus* Sowerby, 1841, is a homonym and is replaced by *P. triangularis*.) This species also occurs in the Pleistocene of southern Florida.

Pterotyphis (Tripterotyphis) vokesae Gertman, n. sp.

Plate 8, figs. 3a, b

Description: Shell small; protoconch smooth, rounded, two and one-half whorls; five post-nuclear whorls; three narrow, convex varices per whorl, each bearing a thin flange which extends from the tube to the distal end of the siphonal canal; nine crenulations on the outer lip and varices; suture distinct at varices, slightly appressed in the interapertural area; tubes within the varices, pointing apically and abaperturally; aperture ovate, pointed anteriorly surrounded by a raised rim with a sinuous outer margin; spiral ornamentation of moderately strong primary ribs; a secondary rib between each pair of primaries, and a tertiary riblet between the primary and secondary ribs; siphonal fasciole bearing remnants of two former canals; anterior canal closed, broad, pointing to the right and abaperturally.

Holotype: USNM 646227; height 13.5 mm, maximum diameter 6.5 mm.

Type locality: TU 546, Ten Mile Creek, about 1½ miles west of the Chipola River (NE ¼ Sec. 12, T1N, R10W), Calhoun County, Florida.

Occurrence: Chipola Formation, Florida; late lower Miocene.

Figured specimen: USNM 646227 (holotype). Other occurrences: TU locality nos. 951, 998.

Discussion: *Pterotyphis (Tripterotyphis) vokesae* resembles *P. (T.) tripterus* (Grateloup, 1833) from the Miocene of France and Hungary except for the higher spire, weaker apertural lip, the wider base of the tubes, and the more flattened intervarical

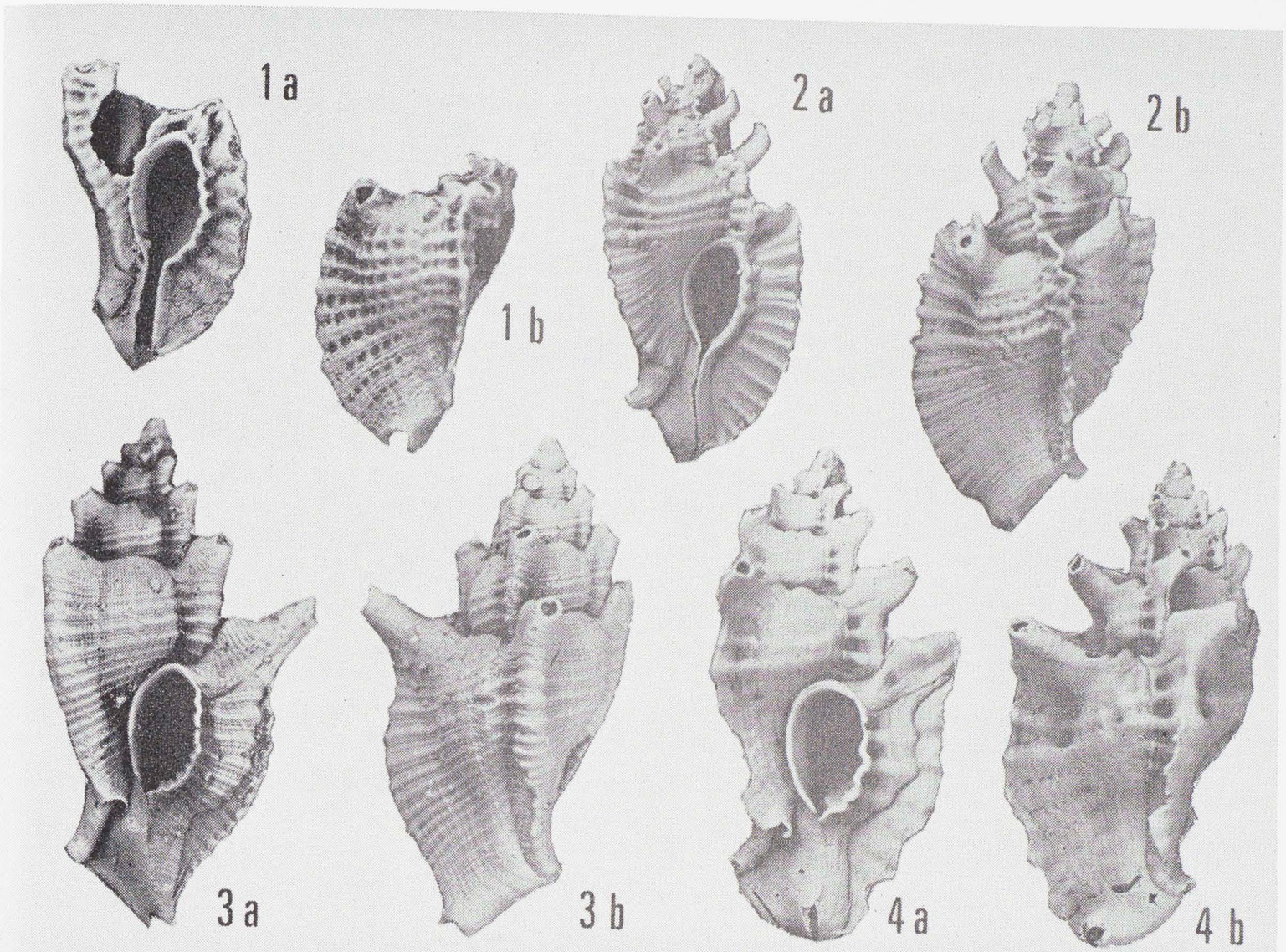

PLATE 8

PLATE 8

Figures

1. *Pterotyphis* (*Pterotyphis*) *calhounensis* Gertman, n. sp. (× 4) 182
   USNM 646225 (holotype); height (incomplete) 8.0 mm, diameter 5.5 mm.
   Locality: TU 547. Chipola Fm., lower Miocene.
2. *Pterotyphis* (*Pterotyphis*) *pinnatus* (Broderip) (× 4) 183
   USNM 646226; height 12.3 mm, diameter 6.4 mm.
   Locality: TU 954. Moín Fm., Pleistocene.
3. *Pterotyphis* (*Tripterotyphis*) *vokesae* Gertman, n. sp. (× 4) 184
   USNM 646227 (holotype); height 13.5 mm, diameter 6.5 mm.
   Locality: TU 546. Chipola Fm., lower Miocene.
4. *Pterotyphis* (*Tripterotyphis*) *triangularis* (A. Adams) (× 3) 186
   USNM 646228; height 17.5 mm, diameter 9.9 mm.
   Locality: TU 759. Unnamed post-Caloosahatchee formation, Pleistocene.

area, which causes the shell to appear more angular. The two species are equivalent in age, but geographically widely separated. Both are known from only a few specimens. The holotype of *P. vokesae* is one of four complete specimens in the Tulane University collections, but there are fragments of seven others.

The writer is pleased to dedicate this new species to Dr. Emily H. (Mrs. H. E.) Vokes in appreciation for her constant encouragement and her patience in putting up with his multitudinous questions.

Pterotyphis (Tripterotyphis) triangularis (A. Adams)

Plate 8, figs. 4a, b

Murex cancellatus G. B. Sowerby, Jr., 1841, Zool. Soc. London, Proc., pt. 8, p. 143; 1841, Conch. Illus., pl. 190, fig. 79 (not *Murex cancellatus* Gmelin, 1791).

Typhis triangularis A. Adams, 1856, Zool. Soc. London, Proc., pt. 23, p. 124.

Typhis cancellatus (Sowerby). Tryon, 1880, Manual of Conchology, v. 2, p. 138, pl. 30, fig. 303.

Typhis (Tripterotyphis) cancellatus Sowerby. Smith, 1939, Cat. Recent species Rock shells, p. 18, pl. 14, fig. 7.

Pterotyphis (Tripterotyphis) "cancellatus" (Sowerby). Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 61, 63.

Pterotyphis (Tripterotyphis) triangularis (A. Adams). Keen, 1944, Jour. Paleontology, v. 18, no. 1, p. 67.

Typhis triangularis Adams. Keen and Campbell, 1964, Veliger, v. 7, no. 1, p. 55.

> "Mur. testa parva, crassiuscula, fusiformi, cancellata, albo-lutescente: spira subproducta; anfractibus quinque; suturis foveolatis; cauda brevi, crassa, lata, ad terminum tortuosa, minime recurva; varicibus tribus, fimbriatis, crassis, costatis, utrinque foveolatis; ramis tubulatis, uno ad angulum crasso, valido, ad medium anfractus, uno brevissimo, caeteris obsoletis: interstitiis trifariam noduloso-costatis: apertura parva, integra, ovali; peritremate laevi; canali nisi ad extremitatem clauso." (Sowerby, 1841)

Description: Shell medium-sized; five postnuclear whorls; three varices and tubes per whorl; tubes within the varices, pointing apically, abaxially, and abaperturally; varices convex, crenulated, crossed by three ribs; outer lip of constant width, crossed by three ribs; a partition above the aperture joining the varix to the corresponding varix of the preceding whorl; shoulder formed only above the varices; suture appressed in the interapertural areas and distinct above the varix; shell crossed by coarse spiral ribs; aperture ovate, pointed anteriorly, surrounded with a raised rim with a sinuous outer margin; anterior canal closed, broad, curving abaperturally.

Holotype: Brit. Mus. (Nat. Hist.).

Type locality: Cabo Catoche, Terr. Quintana Roo, Mexico (here designated).

Occurrence: Unnamed post-Caloosahatchee formation, Florida; Pleistocene. Western Atlantic and Caribbean Sea, Recent.

Figured specimen: USNM 646228; height 17.5 mm, maximum diameter 9.9 mm; locality TU 759. Other occurrences: TU locality nos. 803, R-99.

Discussion: The name *Murex cancellatus* Sowerby, 1841, being a primary homonym of *Murex cancellatus* Gmelin, 1791, the next available name for the form is *Typhis triangularis* A. Adams, 1856. Sowerby (1879, p. 26) declared that "*Murex*" *cancellatus* and "*Murex*" *canaliferus* Sowerby, 1841, were the same species, "the difference is only one of development." If this were the case then *canaliferus* would be available but the writer is of the opinion that Sowerby's two species are not the same and that *M. canaliferus* is probably the shell subsequently named *Pterynotus (Pterochelus) zealandicus iredalei* Fleming, 1962. *M. canaliferus* is definitely a *Pterochelus* at least, for it shows the two varical canals, typical of that group. The illustration given by Sowerby of *M. canaliferus* (1841, pl. 190, fig. 74) also shows a narrower siphonal canal than that of *M. cancellatus* (*ibid.*, pl. 190, fig. 79). Keen (personal communication) has examined the type of "*Typhis*" *triangularis* in the British Museum (Nat. Hist.) and is satisfied that this is the same species as "*Murex*" *cancellatus* Sowerby.

Neither "*Murex*" *cancellatus* nor "*Typhis*" *triangularis* were described with locality data, but it has been established that the form is native to the western Atlantic region. In the Tulane Collections there are numerous beach specimens from the eastern Yucatán Peninsula. One specimen was dredged by the *Anton Bruun* Cruise 10 about 30 miles off Cabo Catoche, Quintana Roo (TU R-99) in 17 fms., and as there are a number of beach specimens from this vicinity, Cabo Catoche is here designated as the type locality. The species also occurs in the Bahama Islands and on the Atlantic Coast of Panamá, and is found in the Pleistocene beds of southern Florida.

P. (T.) triangularis most closely resembles *P. (T.) lowei* Pilsbry, 1931, from the west coast of Panamá. The two differ in that the former has stronger ribbing and a higher spire.

V. Locality Data

The following are Tulane University Department of Geology fossil localities:

60. Jackson Bluff Fm., borrow pits at Jackson Bluff, Ochlockonee River (NW ¼ Sec. 21, T1S, R4W), Leon Co., Florida.
69. Shoal River Fm., type locality, Shell Bluff, Shoal River (NW ¼ Sec. 4, T3N, R21W), about 3½ miles north of Mossyhead, Walton Co., Florida.
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.
75. Moodys Branch Fm., type locality, Jackson, Hinds Co., Mississippi.
76. Mint Springs Marl, type locality, Mint Springs Bayou, just off U. S. Highway 61 (Business), at Vicksburg Natl. Military Cemetery, Vicksburg, Warren Co., Mississippi.
78. Gosport Sand, Claiborne Bluff, east bank of Alabama River, south of bridge of U. S. Highway 84, Monroe Co., Alabama.
79. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, spoil banks north and south side of Caloosahatchee River, at Ortona Lock (Sec. 27, T42S, R30E), Glades Co., Florida.
85. Wautubbee Fm., roadcut on county road four miles northeast of Rose Hill, Jasper Co., Mississippi.
86. Wautubbee Fm., roadcut on east side of Mississippi Highway 15, 0.8 mile north of junction with U. S. Highway 80, Newton Co., Mississippi. (Note: Interstate 20 has subsequently covered this locality and it is no longer available.)
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.
200. Pinecrest Beds, borrow pits about one mile southwest of Acline (Sec. 29, T41S, R23E), Charlotte Co., Florida.
202. Caloosahatchee Fm., south bank of Caloosahatchee River, about two miles west of LaBelle (SE ¼ Sec. 12, T43S, R28E), Hendry Co., Florida.
203. Caloosahatchee Fm., north bank of Caloosahatchee River, about two miles east of Fort Denaud (SW ¼ Sec. 11, T43S, R28E), Hendry Co., Florida.
226. Red Bluff Clay, Chickasawhay River at Hiwannee about 3½ miles south of Shubuta, Wayne Co., Mississippi.
335. Byram Marl, roadcut on U. S. Highway 61 (Business), about one mile north of Vicksburg Natl. Military Cemetery, Vicksburg, Warren Co., Mississippi.
336. Byram Marl, above waterfall on small creek crossing U. S. Highway 61 (Business), about 1½ miles north of Vicksburg Natl. Military Cemetery, Vicksburg, Warren Co., Mississippi.
376. Duplin Marl, "Natural Well," sinkhole on Matthews' farm, on North Carolina Highway 11, 2 miles west of Magnolia, Duplin Co., North Carolina.
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.
458. Chipola Fm., east bank of Chipola River, above Farley Creek (SW ¼ Sec. 20, T1N, R9W), Calhoun Co., Florida.
519. Caloosahatchee Fm., Harney Pond Canal spoil banks, at Florida Highway 78, northwest side of Lake Okeechobee (NW ¼ Sec. 18, T40S, R33E), Glades Co., Florida.
520. Pinecrest Beds, spoil banks, canal 0.9 mile east of Brighton on Florida Highway 70 (Sec. 25, T37S, R32E), Highlands Co., Florida.
523. Pinecrest Beds, Harney Pond Canal spoil banks, six miles northwest of Florida Highway 78, Brighton Indian Reservation (NW ¼ Sec. 22, T39S, R32E), Glades Co., Florida.
527. Caloosahatchee Fm., north shore Lake Okeechobee, Pumping Station no. 127 (NE ¼ Sec. 35, T39S, R33E), Glades Co., Florida.
529b. Caloosahatchee Fm., north bank of Caloosahatchee River, about two miles west of LaBelle (SE ¼ Sec. 12, T43S, R28E), Hendry Co., Florida.
532. Pinecrest Beds, spoil banks 1¾ miles south of Florida Highway 771, on canal 1.3 miles southwest of Port Charlotte Railroad Station (formerly Murdock), (SE ¼ Sec. 24, T40S, R21E), Charlotte Co., Florida.
536. Caloosahatchee Fm., south bank of Caloosahatchee River about one mile east of LaBelle (Secs. 3 and 4, T43S, R29E), Hendry Co., Florida. (Designated as type locality of the Caloosahatchee Formation by Olsson *in* Olsson and Petit, 1964, p. 519.)
539b. Caloosahatchee Fm., Shell Creek (lower beds), about eight miles east of Cleveland (Sec. 30, T40S, R25E), Charlotte Co., Florida.
540. Pinecrest Beds, Miami Canal spoil banks, one to three miles south of pumping station at Palm Beach county line, Broward Co., Florida.
546. Chipola Fm., Ten Mile Creek about 1½ miles west of Chipola River (NE ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.
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.

558. Waccamaw Fm., borrow pits at north end of Crescent Beach Airport, Crescent Beach, Horry Co., South Carolina.

579. Caloosahatchee Fm., Miami Canal spoil banks, four miles north of pumping station at Broward county line, Palm Beach Co., Florida.

583. Caloosahatchee Fm., Miami Canal spoil banks, seven miles north of pumping station at Broward county line, Palm Beach Co., Florida.

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, 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 Mayo Mill Branch (NE ¼ Sec. 11, T1N, R10W), Calhoun Co., Florida.

726. Caloosahatchee Fm., Hendry County rockpit, ½ mile north of Florida Highway 80, three miles west of LaBelle (SE ¼ Sec. 14, T43S, R28E), Hendry Co., Florida.

728. Pinecrest Beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, just across from U. S. Corps of Engineers Structure 65-D (Sec. 33, T36S, R33E), Okeechobee Co., Florida.

729. Pinecrest Beds, spoil banks on west side of Kissimmee Canal and east side of Kissimmee River, approximately ½ mile south of U. S. Corps of Engineers Structure 65-D (S½ Sec. 33, T36S, R33E), Okeechobee Co., Florida.

730. Pinecrest Beds, embankment of Seaboard Airline Railroad, just west of Kissimmee River (NW ¼ Sec. 20, T36S, R33E), Highlands Co., Florida.

736. Pinecrest Beds, spoil banks on south side of Florida Highway 70 and east side of Kissimmee River, Okeechobee Co., Florida.

755. Caloosahatchee Fm., Miami Canal spoil banks, 17.4 miles north of pumping station at Broward county line, Palm Beach Co., Florida.

757. Gatun Fm., roadcut on Boyd-Roosevelt Highway at junction of road to Refineria Panamá, S. A., just east of Cativa, Panamá.

767. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, spoil banks north side of Caloosahatchee River, five miles west of Ortona Lock (NW ¼ Sec. 36, T42S, R29E), Glades Co., Florida.

768. Caloosahatchee Fm. and unnamed post-Caloosahatchee Formation mixed, spoil banks north side of Caloosahatchee River, 5½ miles west of Ortona Lock (NW ¼ Sec. 35, T42S, R29E), Glades Co., Florida.

769. Pinecrest Beds, spoil banks east side of Kissimmee River, 1½ to two miles south of U. S. Corps of Engineers Structure 65-D (NE ¼ Sec. 35, T36S, R33E), Okeechobee Co., Florida.

770. Pinecrest Beds and Caloosahatchee Fm. mixed, spoil banks west side of Kissimmee River, 1½ to 3½ miles north of Florida Highway 70 (Secs. 10, 14, 15, and 28, T37S, R33E), Highlands Co., Florida.

786. Chipola Fm., Ten Mile Creek, about 50 yards upstream from TU 196 or about ¼ mile upstream from bridge of Florida Highway 73 (NE ¼ Sec. 11, T1N, R10W), Calhoun Co., Florida.

787. Chipola Fm., Ten Mile Creek, about 1½ miles west of Chipola River (SE ¼ Sec. 12, T1N, R9W), Calhoun Co., Florida.

792. Caloosahatchee Fm., borrow pits just west of Florida Highway 80, about two miles southwest of LaBelle (SW ¼ Sec. 7, T43S, R29E), Hendry Co., Florida.

797. Pinecrest Beds, material exposed during construction of "Alligator Alley," 13.3 miles east of Florida Highway 29 (T49S, R32E), Collier Co., Florida.

806. Chipola Fm., west bank of Chipola River, about one mile south of powerline crossing (NW ¼ Sec. 20, T1N, R10W), Calhoun 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.

819. Chipola Fm., Farley Creek, 0.2 mile west of bridge of Florida Highway 275 (SW ¼ Sec. 21, T1N, R9W), Calhoun Co., Florida.

820a. Chipola Fm., Farley Creek (upper beds), at 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 beds exposed, slightly less than one mile west of Chipola River (SW ¼ Sec. 7, T1N, R9W), Calhoun Co., Florida.
866. "Silverdale Beds," pit on north side of Webb Creek and east side of unnumbered county highway, Silverdale, Onslow Co. North Carolina.
870. Waccamaw Fm., pits on east side of North Carolina Highway 130, 2.8 miles north of Old Dock School, Old Dock, Columbus Co., North Carolina.
923. Wautubbee Fm., hill on south side of county road paralleling Interstate 20 along north side, 0.3 mile west of Mississippi Highway 15, just north of Newton, Newton Co., Mississippi.
924. Wautubbee Fm., roadcut 2.7 miles east of Mississippi Highway 15 at Newton, on road to Poplar Springs Church, Newton Co., Mississippi.
932. Pinecrest Beds, east side of Kissimmee River (*i.e.*, canal) and ½ mile south of Seaboard Airline Railroad, south of Fort Basinger (SE ¼ Sec. 20, T36S, R33E), Okeechobee Co., Florida.
939. Caloosahatchee Fm. and unnamed post-Caloosahatchee formation mixed, south side of Caloosahatchee River, 5.2 miles west of Ortona Lock (NW ¼ Sec. 36, T42S, R29E), Glades Co., Florida.
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.
953. Moín Fm., type locality, Moín Hill, railroad cut and adjacent ditches on road to Sandoval, 4.5 km west of Puerto Limon, Costa Rica.
954. Moín Fm., hill cut immediately behind Standard Fruit Co. box factory, just west of cemetery at Pueblo Nuevo, about 2 km west of Puerto Limon, Costa Rica.
958. Gatun Fm., hill slope on east side of road from Boyd-Roosevelt Highway to Refineria Panamá, S. A., about ½ km north of junction, just east of Cativa, Panamá.
975. Caloosahatchee Fm., spoil banks, north side Caloosahatchee Canal, 0 to ½ mile west of center of former Lake Hicpochee (now drained), (unmapped area, T42S, R32E), Glades Co., Florida.
998. Chipola Fm., Ten Mile Creek, about 1¼ miles west of Chipola River (SE ¼ Sec. 12, T1N, R10W), Calhoun Co., Florida.

The following are Tulane University Department of Geology Recent localities:

R-99. *Anton Bruun* Cruise 10, dredged off northeastern Yucatán Peninsula, Long. 86° 34′W, Lat. 21° 41′N, 17 fathoms.
R-100. *Anton Bruun* Cruise 10, dredged off Duarte Cays, northwest of Porto Bello, Panamá, Long. 79°40′W, Lat. 9°36′N, 23-27 fathoms.
R-101. *Anton Bruun* Cruise 10, dredged off Holandes Cay, east of Cape San Blas, Panamá, Long. 9°35′N, Lat. 78°48′W, 23-28 fathoms.

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