

A Revision of the Western Atlantic Recent Species of the Genus *Monostiolum* Dall, 1904, and *Bailya* (*Parabailya*) New Subgenus (Gastropoda: Buccinidae)

by

G. THOMAS WATTERS

The Museum of Zoology, The Ohio State University,
Columbus, Ohio 43210, U.S.A.

AND

C. JOHN FINLAY

1024 Daytona Drive NE, Palm Bay, Florida 32905, U.S.A.

Abstract. Western Atlantic species of the buccinid genus *Monostiolum* Dall, 1904, are reviewed: *M. tessellatum* (Reeve, 1844) from Bermuda and most of the Caribbean; *M. auratum* Watters & Finlay, sp. nov., from Puerto Rico and the Lesser Antilles; and *M. rosewateri* Watters & Finlay, sp. nov., from Barbados. The well-known name *swifti* (Tryon, 1881) is shown to be a junior synonym of *tessellatum*. *Caducifer* (*Monostiolum*) *weberi* (Watters, 1983) is removed from *Monostiolum* and selected as the type species of *Bailya* (*Parabailya*) Watters & Finlay, subgen. nov.

INTRODUCTION

The conglomeration of taxa once known as "tritons" has confounded malacologists since the days of Linné. What was once considered a group of conchologically similar species has now been allocated to the muricids, cancellariids, cymatiids, and the buccinids, among others, on the basis of protoconch, radular, and anatomical features. Many unstudied taxa may remain taxonomically misplaced. Perhaps the most misunderstood of these groups is the Buccinidae, which encompasses species showing a range of form and diversity seldom seen in other families of marine gastropods. The species herein referred to the buccinid genus *Monostiolum* Dall, 1904, have had a complicated taxonomic history that includes erroneous or absent locality data for types and incongruous systematic associations. The most common species in this group in the western Atlantic, still referred to as *Colubraria swifti*, has two earlier names and does not belong to *Colubraria*.

Although often associated with *Caducifer* Dall, 1904, the relationship of *Monostiolum* to the New World genus *Bailya* M. Smith, 1944, has largely gone unnoticed. *Bailya* is conchologically similar to *Monostiolum* and shows many of the features of the genus. *Bailya* (*Parabailya*), new subgenus herein described, appears to be derived from *Bailya*, based upon the evidence of fossil species of *Monostiolum* and *Bailya*.

ABBREVIATIONS

AMNH, American Museum of Natural History, New York; ANSP, Academy of Natural Sciences, Philadelphia; BM(NH), British Museum (Natural History), London; DMNH, Delaware Museum of Natural History, Greenville; FURG, Fundação Universidade do Rio Grande, Museu Oceanográfico, Sao Paulo, Brazil; USNM, National Museum of Natural History, Smithsonian Institution, Washington D.C.

SYSTEMATICS

Family BUCCINIDAE Rafinesque, 1815

Subfamily PISANIINAE Tryon, 1880

Genus *Monostiolum* Dall, 1904*Colubraria* (*Monostiolum*) DALL, 1904:136.*Pisania* (*Monostiolum*) Dall: FULTON, 1936:8.*Monostiolum* (*Monostiolum*) Dall: PONDER, 1972:255.*Caducifer* (*Monostiolum*) Dall: CERNOHORSKY, 1975:196.

Type species: *Triton swifti* Tryon, 1881, by original designation.

Description: Shell small, fusiform, with a single terminal varix. Protoconch of $1\frac{1}{2}$ smooth nuclear whorls. Generally 7 postnuclear whorls. Sculptured with spiral cords, threads, and axial ribs which may become weaker on the body whorl. Outer lip with weak denticles, parietal callus partially adherent with a single denticle delimiting the anal canal. Columella distinctly bent at the siphonal canal. Siphonal canal short, open, and weakly set off from body whorl.

Operculum phylliform with a subterminal nucleus.

Radula rachiglossate; central tooth with three cusps, lateral teeth with three medially curving cusps each, the most distal being the largest.

Remarks: DALL (1904:136) erected both *Monostiolum* and *Caducifer* as sections under *Colubraria* Schumacher, 1817, in the Aquillidae. He separated *Caducifer* from *Monostiolum* solely on the basis of the former having $\frac{1}{4}$ of its spire "self-amputated." It is possible that the presence of a decollated spire may be a characteristic of individual species and not of a genus-level taxon. However, we believe that the biogeography and fossil record of *Monostiolum* support Dall's separation of it from *Caducifer*.

PILSBRY & VANATTA (1904) subsequently removed *Caducifer* and *Bailya* from the "Aquillidae" (=Cymatiidae, in part) to the Buccinidae on the basis of the radula, but did not mention any species now assigned to *Monostiolum*. PEILE (1911), among others, has illustrated the radula of *M. tessellatum*, which proved to be virtually identical with those of *Caducifer* and *Bailya*.

This genus bears a strong resemblance to *Colubraria*, but differs in having only a terminal varix (*Colubraria* has several additional, earlier varices), and in possessing a fully functional radula (*Colubraria* has a vestigial radula). *Colubraria* has been placed by some workers in a family apart from the Buccinidae, the Colubrariidae. However, BEU & MAXWELL (1987) have suggested that that group should be included under the buccinid Pisaniinae. They have also shown that several species formerly considered colubrarines are members of the cancellariid subfamily Plesiotritoninae Beu & Maxwell, 1987. *Monostiolum* lacks the non-collabral varix characteristic of that subfamily, although the axial sculpture approaches this condition. Most members of the Plesiotritoninae also possess varices on the spire.

The radula of that subfamily is not sufficiently known to warrant comparison with *Monostiolum*.

The species assigned to *Monostiolum* are a heterogeneous group containing some species better belonging to other genera. For example, KAY (1979:261) listed *Caducifer nebulosa* (Gould, 1860) from Hawaii and states that *Caducifer* is "characterized by the tall spire"; this is a reference to *Monostiolum*, not *Caducifer*. "*Caducifer*" *nebulosa* bears little resemblance to any *Monostiolum* and appears to be a member of the columbellid genus *Aesopus* Gould, 1860, the genus in which Gould originally placed it. Several eastern Pacific species that have been placed in *Monostiolum* by KEEN (1971) appear to belong to other buccinid genera (such as *Prodotia* Dall, 1924, among others): *biliratum* (Reeve, 1846), *cinis* (Reeve, 1846), *thaleia* Pilsbry & Lowe, 1932, and *nigricostatum* (Reeve, 1846).

Range: Apparently limited to the New World tropics and Bermuda, generally in shallow water under stones and rubble.

Monostiolum tessellatum (Reeve, 1844)

(Figures 1, 2, 6F, 7A, D)

Triton tessellatus REEVE, 1844:pl. 19, fig. 91; PEILE, 1911:227, text fig. (radula).

Caducifer (*Monostiolum*) *tessellatus* (Reeve): CERNOHORSKY, 1975:196, fig. 50.

Monostiolum tessellatum (Reeve): BEU & MAXWELL, 1987:59.

Pleurotoma igniflua REEVE, 1845:pl. 24, fig. 214.

Pisania (*Monostiolum*) *igniflua* (Reeve): FULTON, 1936:7, 8.

Triton (*Epidromus*) *swifti* TRYON, 1881:31, pl. 16, fig. 158; FULTON, 1936:8.

Colubraria Swiftii [sic] (Tryon): DALL, 1889a:226 [in part]; DALL, 1889b:132.

Colubraria swiftii [sic] (Tryon): RIOS, 1975:83, pl. 23, fig. 337.

Colubraria (*Monostiolum*) *swifti* (Tryon): DALL, 1904:136; ABBOTT, 1954:233; ABBOTT, 1974:218, fig. 2406.

Monostiolum (*Monostiolum*) *swifti* (Tryon): PONDER, 1972:255, pl. 24, fig. 7, text fig. 1.8 (radula).

Colubraria swifti (Tryon): CLENCH [in] MORRIS, 1973:213, pl. 57, fig. 6; BANDEL, 1984:130, fig. 215.

Caducifer (*Monostiolum*) *swifti* (Tryon): WATTERS, 1983:125, 126, figs. 7-10, 12.

Monostiolum swifti (Tryon): BEU & MAXWELL, 1987:59.

Type depositories: *Triton tessellatum* Reeve, 1844—Lectotype, designated herein, BM(NH) 196747/1; 3 paralectotypes, 196747/2-4.

Pleurotoma igniflua Reeve, 1845—BM(NH)?; apparently lost, *vide* Way (in litt., 29 May 1985). Type locality: unknown.

Triton swifti Tryon, 1881—Holotype ANSP 59208. Type locality: Antigua.

Type locality: "Island of Burias, Philippines (found under stones at low water)" (REEVE, 1844:text to species 91); corrected herein to Barbados (see "Remarks").

Description: The maximum size seen is 18 mm in length. The shell is fusiform, the spire being approximately $\frac{1}{2}$ to $\frac{3}{4}$ the total length. The protoconch is blunt, consisting of $1\frac{1}{2}$ smooth, rounded whorls. There are approximately 7 postnuclear whorls. The spiral sculpture is of regularly spaced, rounded or flattened cords, often with a smaller thread intercalated between these cords; the cords on the siphonal canal are larger and flattened. The axial sculpture consists of rounded ribs, 15–20 on the penultimate whorl. The spiral cords are often nodulose as they pass over the ribs. The ribs on the body whorl are sigmoidal in shape. In Bermuda, the majority of specimens have weak or absent axial ribs on the body whorl; Antillean specimens, and some Bermudan ones, have persistent ribbing on the body whorl, although it is usually weaker than that on the spire. Numerous microscopic threads are apparent between ribs. Adult shells have a single terminal varix over which all sculpture continues. The inside of the outer lip has approximately 9 weak denticles, the strongest one bounding the anal canal. The parietal callus is adherent to the body whorl for its posterior half and erect and thickened for the remainder of its length. It bears a weak denticle delimiting the siphonal canal and a stronger one bounding the anal canal. The siphonal canal is short, notched, and weakly delimited from the body whorl.

The shell color is very variable, ranging from all white to nearly uniform dark brown. Commonly seen patterns are zig-zag flammulations and checkerboard spots; these two patterns grade into one another in many specimens. A broad, white, spiral band is often vaguely evident below the shoulder of the whorl.

Radula: As for the genus. Illustrated by PEILE (1911) and PONDER (1972) (reproduced here, Figure 7A).

Operculum: Phylliform with a subterminal nucleus (Figure 7D).

Anatomy: Not reported.

Remarks: REEVE (1844) described this species from specimens from the Cuming collection and gave the type locality as the "Island of Burias, Philippines." This locality was in error and there can be little doubt that Reeve's illustration depicts the Caribbean species commonly known as *Colubraria swifti*. The specimen illustrated by Reeve is representative of specimens from the Antillean portion of its range, and an examination of the syntype lot reveals no differences between these specimens and those collected in the Caribbean. TRYON (1881) synonymized *Triton tessellatum* with the Philippine *Triton concinnus* Reeve, 1844, but PEILE (1911) and CERNOHORSKY (1975) have shown that *T. concinnus* is a separate species.

The exact nature of *Triton tessellatum* had been unsuspected for 76 years, when PEILE (1911) suggested that the type locality was incorrect based upon the fact that he had collected the species in Bermuda. He did not however equate it with *T. swifti*. Peile apparently had a highly

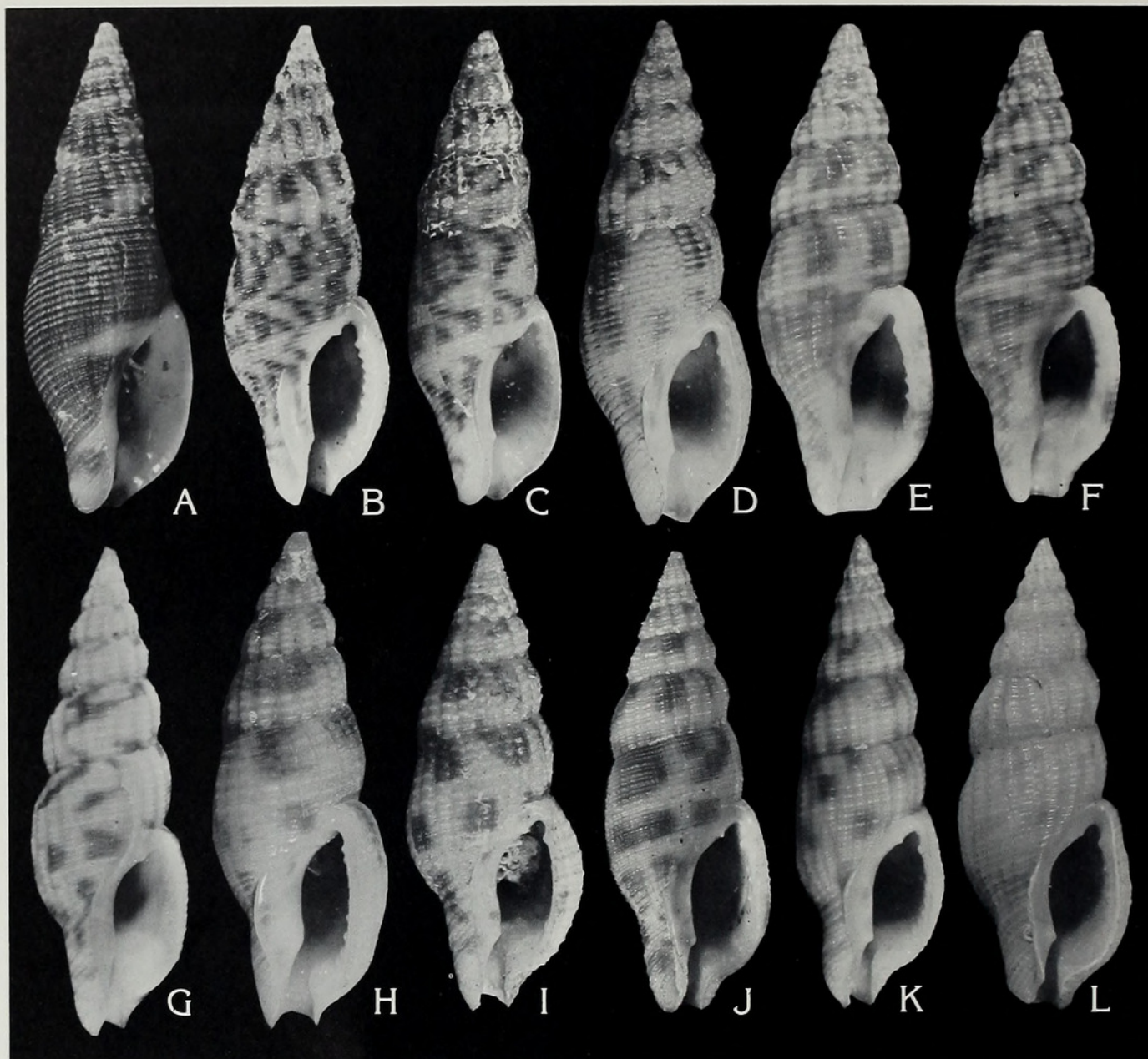
sculptured, checkerboard-patterned morph which, in the absence of intergrades, does not appear conspecific with the smoother, flammulated morph described as *T. swifti*. CERNOHORSKY (1975) also pointed out that Reeve's original type locality was in error. He suggested that *Monostiolium tessellatum* "very closely resembles . . . *swifti*" (p. 196) and "appears to be a finely sculptured variant of . . . *swifti*" (abstract). Although he did not put *T. swifti* directly in his synonymy of *M. tessellatum*, his abstract statement suggests that he apparently believed them to be the same species.

Both Peile and Cernohorsky suggested that Reeve's original type locality was erroneous, but neither designated a corrected one. For that reason the type locality of *Triton tessellatus* is herein emended to Barbados, where specimens very similar to the syntype lot have been collected.

REEVE (1845) described *Pleurotoma igniflua* from an unknown locality. His illustration clearly shows a specimen of the flammulated morph of *Monostiolium tessellatum*, and Reeve commented that this was a "strongly marked species partaking almost as much of the characters of *Triton* as of *Pleurotoma*" (text to pl. 24). Even given the broad definition of *Pleurotoma* in use at that time, this was an unusual assignment. Not surprisingly, this name escaped notice until FULTON (1936) stated that *P. igniflua* was not a turrid, but should be placed in *Pisanina* (*Monostiolium*), and originated from Bermuda. He further suggested that *Pleurotoma igniflua* was "very close to, if not conspecific with, *Triton swifti*" (p. 8). CERNOHORSKY (1975) stated that *T. swifti* was a junior synonym of *P. igniflua*, and that *P. igniflua* was a junior synonym of *M. tessellatum*. The type (or types) of *P. igniflua*, supposedly in the British Museum (Natural History), are apparently lost (Way, *in litt.*, 29 May 1985), although the illustration leaves no doubt that *P. igniflua* is the common Bermudan morph. FULTON's (1936:8) statement that his specimen of *P. igniflua* "comes from Bermuda" is not considered here to be a subsequent type-locality designation, and in view of the fact that the types are lost, it is prudent not to designate a type locality at this time.

TRYON (1881) described *Triton (Epidromus) swifti* from Antigua. The holotype is typical of the highly sculptured Antillean morph but is faded. It bears little resemblance to the Bermudan specimens that are now illustrated in field guides and popular works as *Colubraria swifti*. Tryon, in fact, apparently did not recognize the Bermudan morph as *T. swifti*, or even a relative of that species. He assigned *T. tessellatum* to a Philippine species and placed *Pleurotoma igniflua* in the turrid genus *Daphnella*. Thus, the concept of *T. swifti* of later authors and collectors was that of a morph that Tryon did not recognize as his own species.

BEU & MAXWELL (1987) apparently did not recognize *Monostiolium swifti* and *M. tessellatum* as conspecific and made no mention of "*Pleurotoma*" *igniflua*. Their misunderstanding of the variation of this group may have prompted them to suggest that *Bailya (Parabailya) weberi* was synonymous with *M. tessellatum*.



Explanation of Figures 1 and 2

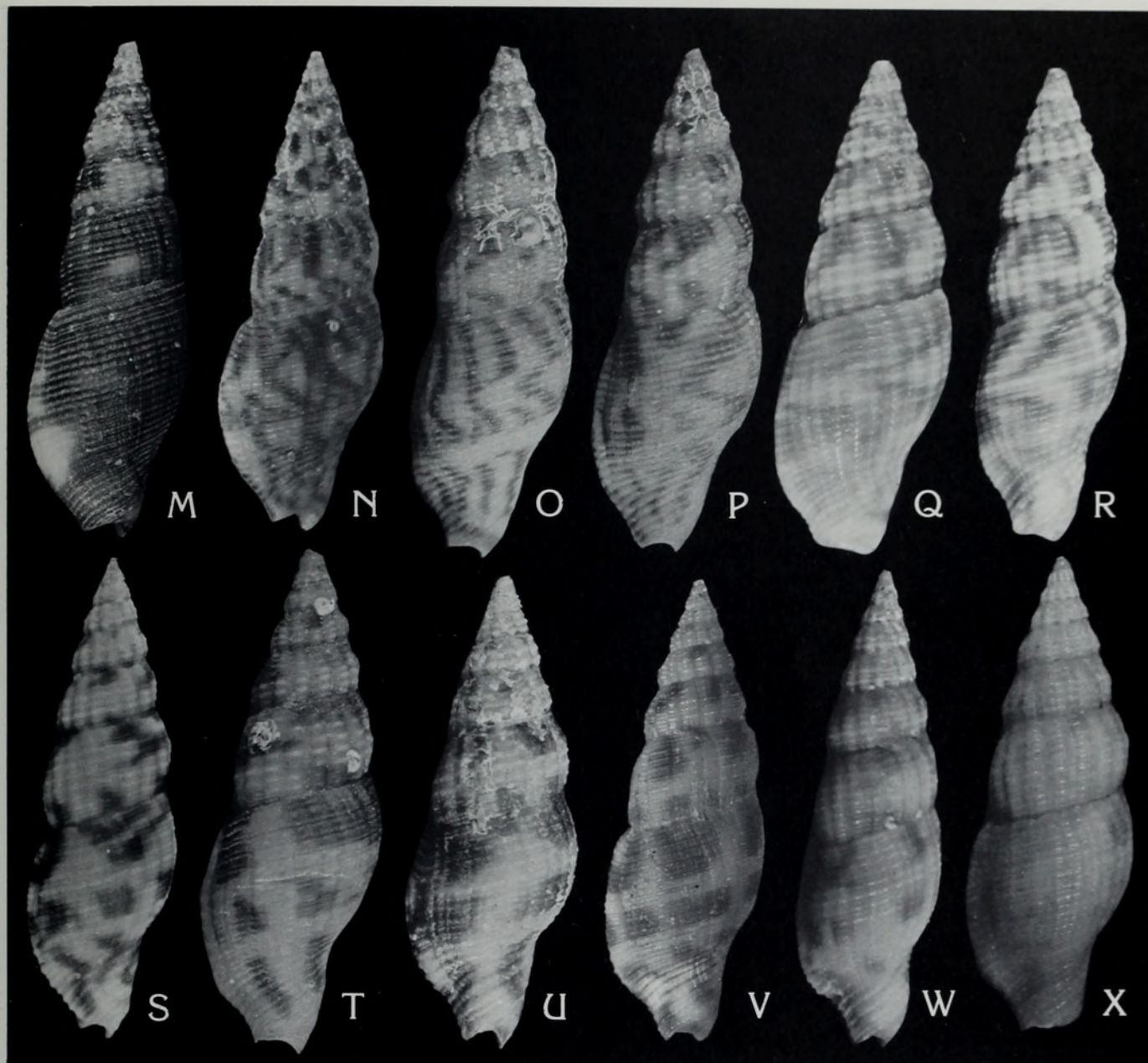
Figures 1 (A-L) and 2 (M-X). *Monostiolium tessellatum* (Reeve, 1844). A, M. DMNH, Coney Island, off Ferry Reach, Bermuda, 16.8 mm. B, N. Bermuda (Watters coll. 4068a), 18 mm. C, O. SW of Whalebone Bay, Bermuda (USNM 835691), 16.9 mm. D, P. Blue Hole, Castle Harbour, Bermuda (USNM 771849), 16.5 mm. E, Q. Grenada

See "Remarks" following the descriptions of *Monostiolium auratum* sp. nov. and *M. rosewateri* sp. nov. for comparisons of *M. tessellatum* with those species.

Distribution and habitat: Common in Bermuda, rare throughout the Bahamas, Greater and Lesser Antilles, and off northern Brazil (Figure 8). With the exception of RIOS' (1975) specimen from off San Luiz, Brazil, we can find no records of this species (or any Recent western Atlantic *Monostiolium*) from any continental coast. It is apparently limited to oceanic islands where it occurs in shallow water under rocks and rubble. SANDER & LALLI (1982) reported living specimens of "*swifti*" from 125 and 225 m off Barbados; we have not seen these specimens and they may represent *M. rosewateri*. The present species is most com-

mon in Bermuda but occurs sporadically in the Greater and Lesser Antilles. The record from San Luiz is a juvenile specimen from 33 m (Figure 6F) and represents a record far removed from the next nearest locale of Tobago. From this it may be surmised that this species will be found along the intervening Brazilian coast.

Specimens examined: BERMUDA: ANSP 10145, 17822, 36217, 36326, 70156; DMNH 24501; USNM 94410, 149864, 221621, 417730, 663420; Watters coll. 4069a (all "Bermuda"); USNM 656480, NW reefs off Somerset; USNM 658971, SW reef off Somerset; ANSP 319019, Hungry Bay; USNM 714206, Tucker's Town; USNM 771849, Castle Harbour, Blue Hole; USNM 807649, St. George's [Id.]; USNM 621601, W end of St. George's Id.;



(Finlay coll.), 13.2 mm. F, R. Buccoo Reef, Tobago (AMNH 193453), 13.8 mm. G, S. Buccoo Reef, Tobago (AMNH 193322), 17.8 mm. H, T. Bermuda (USNM 221621), 14 mm. I, U. 15–20 fm [27–37 m] off Carlisle Bay, Barbados (USNM 500150), 13.8 mm. J, V. Syntype of *Triton tessellatus* Reeve, 1844, (BM(NH) 1967647), "Isle of Burias, Philippines", 16.6 mm. K, W. 122 fm [22 m] off Carlisle Bay, Barbados (USNM 500149), 17.9 mm. L, X. Holotype of *Triton swifti* Tryon, 1881, (ANSP 59208), Antigua, 16.8 mm.

DMNH 51840, Bailey's Bay; ANSP 145957, Shelly Bay; ANSP 88579, USNM 171930, Gibbet Id.; ANSP 183806, USNM 152157, Hamilton; USNM 835691, SW of Whalebone Bay; DMNH, Coney Island, off Ferry Reach. BAHAMAS: USNM 54542, "Bahamas"; USNM 417731, Bimini. GREATER ANTILLES, CUBA: USNM 678505, Guantanamo Bay. JAMAICA: ANSP 36219, 36220, "Jamaica." DOMINICAN REPUBLIC: USNM 42964, Samaná. LESSER ANTILLES, GRENADA: Finlay coll., "Grenada." BARBADOS: AMNH 193322, "Barbados"; USNM 500148, beach; USNM 500145, Needham Pt.; USNM 500149, 22 m, Carlisle Bay; USNM 500150, 4.6–6 m, Carlisle Bay; USNM 500147, 3–6 m, off Pelican Id.; USNM 459598, off Pelican Id., shallow water. TOBAGO: AMNH 193453,

USNM 682304, Buccoo Reef, shallow water; Finlay coll., Arnos Vale beach. BRAZIL: FURG 15.265, Maranhão State, off San Luiz, 33 m.

Monostiolum auratum Watters & Finlay, sp. nov.

(Figures 3, 7E)

Colubraria swifti: WARMKE & ABBOTT, 1961:117, pl. 21i [non Tryon, 1881].

Description: The holotype is 21 mm in length. The shell is fusiform, the spire being approximately $\frac{2}{3}$ the total length. The protoconch is blunt, consisting of $1\frac{1}{4}$ smooth, rounded whorls. The postnuclear whorls are $6\frac{1}{4}$ to $7\frac{1}{2}$ in number, the first 3 strongly nodulose, subsequent whorls

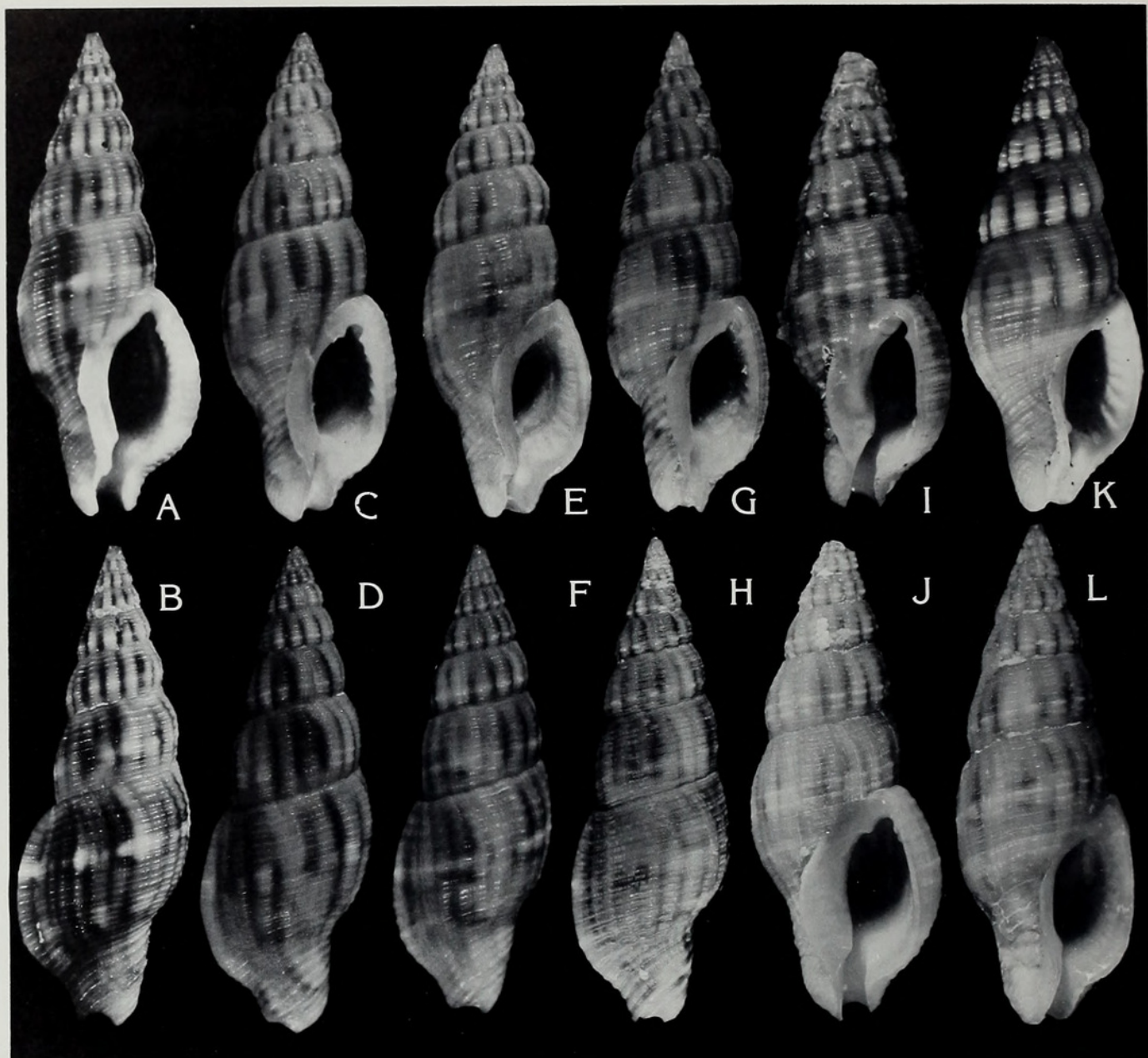


Figure 3

Monostiolum auratum Watters & Finlay, sp. nov. A, B. Paratype, Rincón, Puerto Rico (BM(NH) 1987065), 18.7 mm. C, D. Paratype, beach at Piñones, 4.8 km E of Boca Cangrejos, Puerto Rico (Finlay coll.), 21.4 mm. E, F. Paratype, Rincón, Puerto Rico (Finlay coll.), 17 mm. G, H. Holotype, Rincón, Puerto Rico (USNM 859960), 21.2 mm. I. N of Pigeon Id. Club, Pigeon Id., St. Lucia (USNM 682388), 14 mm. J. Paratype, Rincón, Puerto Rico (DMNH), 17 mm. K. Paratype, beach at Piñones, 4.8 km E of Boca Cangrejos, Puerto Rico (Finlay coll.), 14 mm. L. Paratype, beach at Piñones, 4.8 km E of Boca Cangrejos, Puerto Rico (DMNH), 16.4 mm.

less so. The spiral sculpture consists of regularly spaced, rounded cords over the entire whorl, which are only slightly stronger on the siphonal canal. Between each cord is a single thread. Axial sculpture consists of rounded ribs, stronger on the earlier whorls, very weak on the body whorl; the penultimate whorl has approximately 18 ribs. Those on the body whorl are sigmoidal in shape and do not persist onto the siphonal canal. Between the spiral cords the surface of the shell is microscopically sculptured with axial threads. Adult specimens have a terminal varix

over which all sculpture continues. The inside of the outer lip bears 9–12 irregular denticles just within the lip and several weaker ones deeper within the aperture. The denticles bounding the anal and siphonal canals are strongest. The parietal callus is well developed, adherent to the body whorl along the posterior one-third, erect and thickened anteriorly. Both the anal and siphonal canals are each bounded by a weak denticle. The columella is bent and sharply angled at the posterior canal. The siphonal canal is short and open.

The color of the shell is golden orange with two narrow, interrupted white spiral bands, one at the periphery, one at the base of the body whorl. The spaces between some axial ribs are dark brown, contrasting with the golden ribs. The white spiral bands do not cross these brown axial regions. The aperture is white. Living specimens and fresh shells are a dark grayish green, referring perhaps to a periostracum. No specimens that we have seen have retained that color.

Radula, operculum, and anatomy unknown.

Type depositories: Holotype: USNM 859960.

Paratypes: BM(NH) 1987065, Rincón, Puerto Rico (one specimen); DMNH, Rincón, Puerto Rico (1 specimen); DMNH, beach at Piñones, 4.8 km E of Boca de Cangrejos, Puerto Rico (1 specimen); Finlay coll., Rincón, Puerto Rico (1 specimen); Finlay coll., beach at Piñones, 4.8 km E of Boca de Cangrejos, Puerto Rico (2 specimens); Finlay coll., 9–12 m, Tortuguero Bay [Puerto del Tortuguero], Puerto Rico (1 specimen).

Type locality: Rincón, Puerto Rico, in beach drift, 17°57'N, 66°20'W, H. H. Monroe, 1949 (*ex* J. Finlay coll.).

Other material examined: LESSER ANTILLES, PUERTO RICO: ANSP 228472 "Puerto Rico"; USNM 598298, 24 km E of "Beringuen" [Punta Borinquen]. ST. LUCIA: USNM 682388, Pigeon Id., N of Pigeon Id. Club. BARBADOS: USNM 19534, "Barbados."

Etymology: Latin *auratum*, meaning "golden" or "gilded," in reference to the color of the shell.

Distribution and habitat: This striking species is infrequently found in beach drift in Puerto Rico and is very rare throughout the Lesser Antilles (Figure 8). It has been collected alive only once to my knowledge—from perhaps 9–12 m, off Tortuguero Bay, Puerto Rico, but the depth is not precisely known. Presumably living under rubble.

Remarks: The specimen of "*swifti*" illustrated by WARMKE & ABBOTT (1961:pl. 21i) is this species. The "*swifti*" of ARNOW *et al.* (1963), MESTEY-VILLAMIL (1980), and ORTIZ-CORPS (1983) may also refer to *Monostiolium auratum* but the specimens are not illustrated or are mentioned only in checklists. The only non-Puerto Rican specimens that we have seen are more coarsely sculptured, less fusiform, and darker in color with the brown spaces between the ribs less pronounced. Too few examples are at hand to suggest a clinal variation.

This species tends to be more slender and have a higher spire than either *Monostiolium tessellatum* or *M. rosewateri* sp. nov. The axial ribs of *M. auratum* persist onto the last ¼ of the body whorl but are usually absent or weak in *M. tessellatum*. *Monostiolium auratum* never has the flammulated or tessellated color pattern of *M. tessellatum*. The striking golden color of the shell, with dark brown interstices between the axial ribs, does not occur in any other species of *Monostiolium*.

Monostiolium rosewateri Watters & Finlay, sp. nov.

(Figure 4)

Colubraria Swiftii: DALL, 1889b:226 [in part].

Colubraria (*Monostiolium*) sp.: SANDER & LALLI, 1982:316.

Description: The holotype is 15.7 mm in length. The shell is fusiform, the spire being slightly longer than ½ the total length. The protoconch is blunt, consisting of 1½ smooth, rounded whorls. There are 6–7¼ postnuclear whorls. The spiral sculpture consists of regularly spaced cords with a spiral thread intercalated between them, the sculpture stronger on the axial ribs. The axial sculpture consists of rounded ribs, which are prominent on the earlier whorls, but more subdued on the body whorl. The penultimate whorl has 10–12 axial ribs. Adult specimens have a prominent, heavy terminal varix over which sculpture continues. The inside of the outer lip has 7–9 liriate teeth; the teeth bounding the canals are strongest. The parietal wall is adherent to the body whorl for most of its length. The anal and siphonal canals are bounded on the columella by weak denticles. The columella is bent but not strongly so. The siphonal canal is short, open, and notched.

The color of the shell is cream to yellowish tan with irregular whitish blotches. Two vague white spiral bands may be evident at the periphery and at the base of the body whorl. The holotype has most of the major spiral cords colored brown as they pass over the axial ribs. Paratype AMNH 112353 has less defined brown cords, and additional paratypes show no evidence of this coloration. Aperture white.

Radula, operculum, and anatomy unknown.

Type depositories: Holotype: USNM 87098.

Paratypes: AMNH 112353, W side Barbados (2 specimens); Redpath Museum 16301, *Diadema* Sta. 55, 125 fm [229 m], off St. James and Speightstown, W Barbados, on sand bottom (1 specimen).

Type locality: W Barbados, *Blake* Sta. 272, 76 fm [139 m, approximately 13°10'N, 59°40'W].

Other material examined: *Diadema* Sta. 69, 100 fm [186 m], off Coral Beach, W Barbados, on sand and shell bottom (Redpath Museum [not catalogued]).

Etymology: This species is named after the late Dr. Joseph Rosewater of USNM, in recognition of his many malacological achievements and his enthusiasm and constant willingness to aid amateurs and professionals alike.

Distribution and habitat: The meager evidence available indicates that this species is endemic to offshore Barbados (Figure 8). Specimens have been found from 139 to 229 m depth. SANDER & LALLI (1982) listed shells of an unidentified species of *Monostiolium* from 125 and 175 m, off Barbados. Dr. Sander was kind enough to forward the specimen taken at 175 m to us for examination, but the specimen was crushed *en route* through the Postal Service.



Figure 4

Monostiolum rosewateri Watters & Finlay, sp. nov. A, B. Holotype, Blake Sta. 272, 76 fm [139 m], Barbados (USNM 87098), 15.9 mm. C, D. Paratype, Diadema Sta. 55, 125 fm [227 m], off St. James and Speightstown, W Barbados (Redpath Museum 16301), 14.4 mm. E, F. Diadema Sta. 69, 100 fm [183 m], off Coral Beach, W Barbados (Redpath Museum, not catalogued), 15 mm. G, H. Paratype, W Barbados (AMNH 112353), 19 mm. I, J. Paratype, W Barbados (AMNH 112353), 18 mm.

The fragments indicate that this was a specimen of *M. rosewateri*. We have not seen the specimen collected from 125 m. The habitat is unknown but it has been found on shell-sand substrates. However, these specimens were inhabited by hermit crabs.

Remarks: It does not seem to be closely related to any other member of the genus but its affinities may be to *Monostiolum tessellatum*. This species differs from *M. tessellatum* in its having fewer, more prominent, axial ribs

(15–20 on the penultimate whorl of *M. tessellatum*, 10–12 on *M. rosewateri*). These ribs persist onto the last $\frac{1}{4}$ of the body whorl in *M. rosewateri* but are usually absent or weak on this area in *M. tessellatum*. None of the known specimens of *M. rosewateri* has the flammulated or tessellated color pattern of *M. tessellatum*. *Monostiolum auratum* also has more axial ribs (ca. 18) on the penultimate whorl and a typically higher spire than does *M. rosewateri*. *Monostiolum rosewateri* also lacks the gold and brown color pattern of *M. auratum*. The parietal shield is more

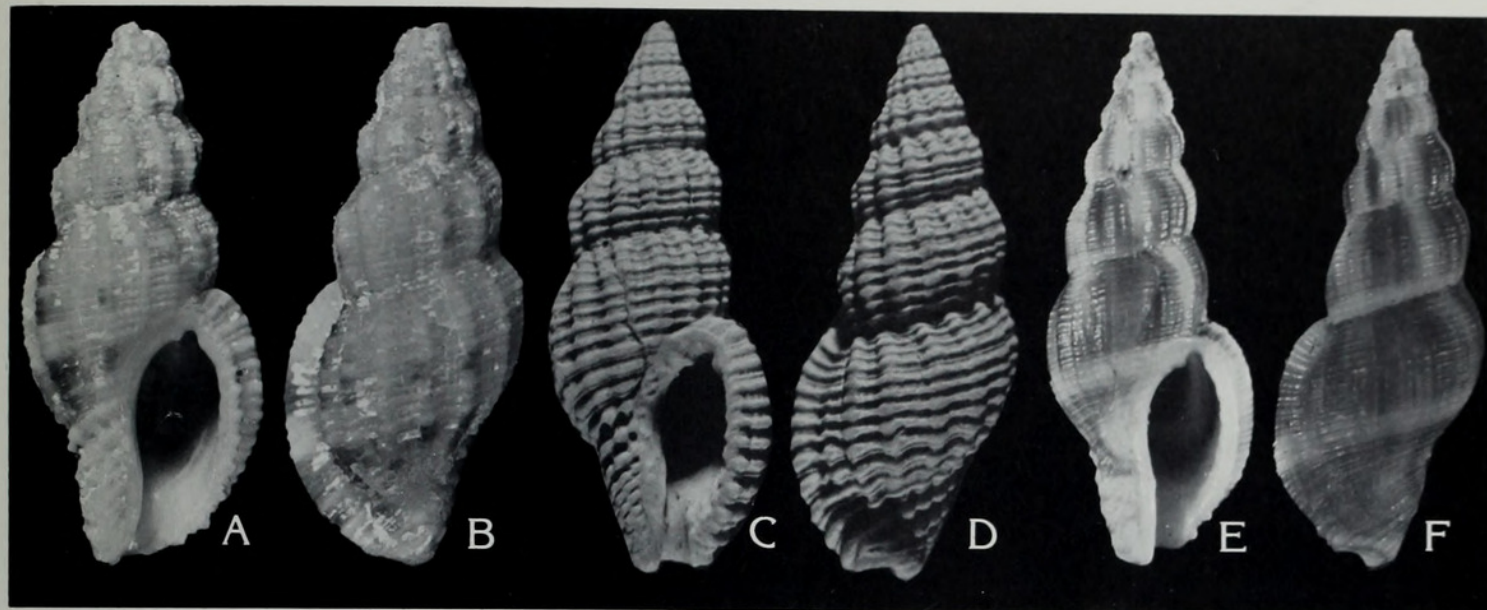


Figure 5

Representative *Bailya* and *Parabailya* Watters & Finlay, subgen. nov. A, B. *Bailya parva* (C. B. Adams, 1850), 0.5 mi N of Governor's house, 7 Mile Beach, Grand Cayman Id. (DMNH 39582), 16 mm. C, D. *Bailya roycei* (M. Smith, 1938), St. Petersburg, Florida (ANSP 19064), 13.4 mm. E, F. *Bailya* (*Parabailya*) *weberi* (Watters, 1983), holotype of *Caducifer* (*Monostiolum*) *weberi* Watters, 1983, 73 m, off Looe Key, Monroe Co., Florida (ANSP 355365), 16 mm.

adherent to the columella in *M. rosewateri* than in the other two species.

Bailya M. Smith, 1944

Parabailya Watters & Finlay, subgen. nov.

(Figures 5E, F)

Type species: *Caducifer* (*Monostiolum*) *weberi* Watters, 1983 (Figures 5E, F).

Description: The shell is small (10–20 mm in length), fusiform, the spire comprising approximately $\frac{3}{5}$ the total length. The protoconch is blunt, consisting of $1\frac{1}{2}$ smooth, rounded whorls. The postnuclear whorls are approximately 7 in number, abruptly arising from the protoconch, the earlier postnuclear whorls being strongly sculptured, becoming less so on successive whorls. The postnuclear sculpture consists of distinct spiral threads separated by grooves of equal width. The axial ribs become less pronounced and more irregularly spaced on later whorls, becoming barely perceptible on the last $\frac{1}{2}$ whorl. The threads do not diminish in strength as they pass over the axial ribs. Several threads on the siphonal canal are distinctly wider and more pronounced than those of the remaining portion of the whorl. The last $\frac{1}{4}$ whorl flares outward to form a terminal varix. The aperture is oval, weakly crenulated, the anal canal being bounded by a tooth on the outer lip and another on the body whorl. The columella is straight,

the inner lip is adherent, terminating in a short, open, siphonal canal; the siphonal canal notch is shallow.

Radula, operculum, and anatomy unknown.

Etymology: *para*, meaning “beside” or “akin to,” and *Bailya*, a genus of tropical, New World buccinids erected by Maxwell Smith in 1944, the type of which is *B. anomala* (Hinds, 1844) from the eastern Pacific.

Remarks: The only known species of *Parabailya* at this time is *Bailya weberi* (Watters, 1983), which the senior author originally placed in *Caducifer* (*Monostiolum*). Since that time the differences between *B. weberi* and other species of *Monostiolum*, and the unnoticed resemblances to *Bailya*, have convinced us of the need for a new subgenus-level taxon for that species. All of the four known species of *Bailya* s.s. have coarse axial and spiral sculpture, and a spire that occupies one-half or less of the total length of the shell. Conversely, *B. weberi* has relatively smooth sculpture and a proportionally higher spire, as do most Recent species of *Monostiolum*. Because of the overall shape of the shell and its sculpture, *B. weberi* closely resembles *Monostiolum*. However, all known members of *Monostiolum* have a columella that is distinctly angled at the point of the juncture of the siphonal canal and the body whorl, and the inner lip is typically only partially adherent along its length. In *Bailya* s.s. and *Parabailya* the columella is not angled and is adherent its entire length. Reconsideration of the apertural features and fossil species suggest that *B.*

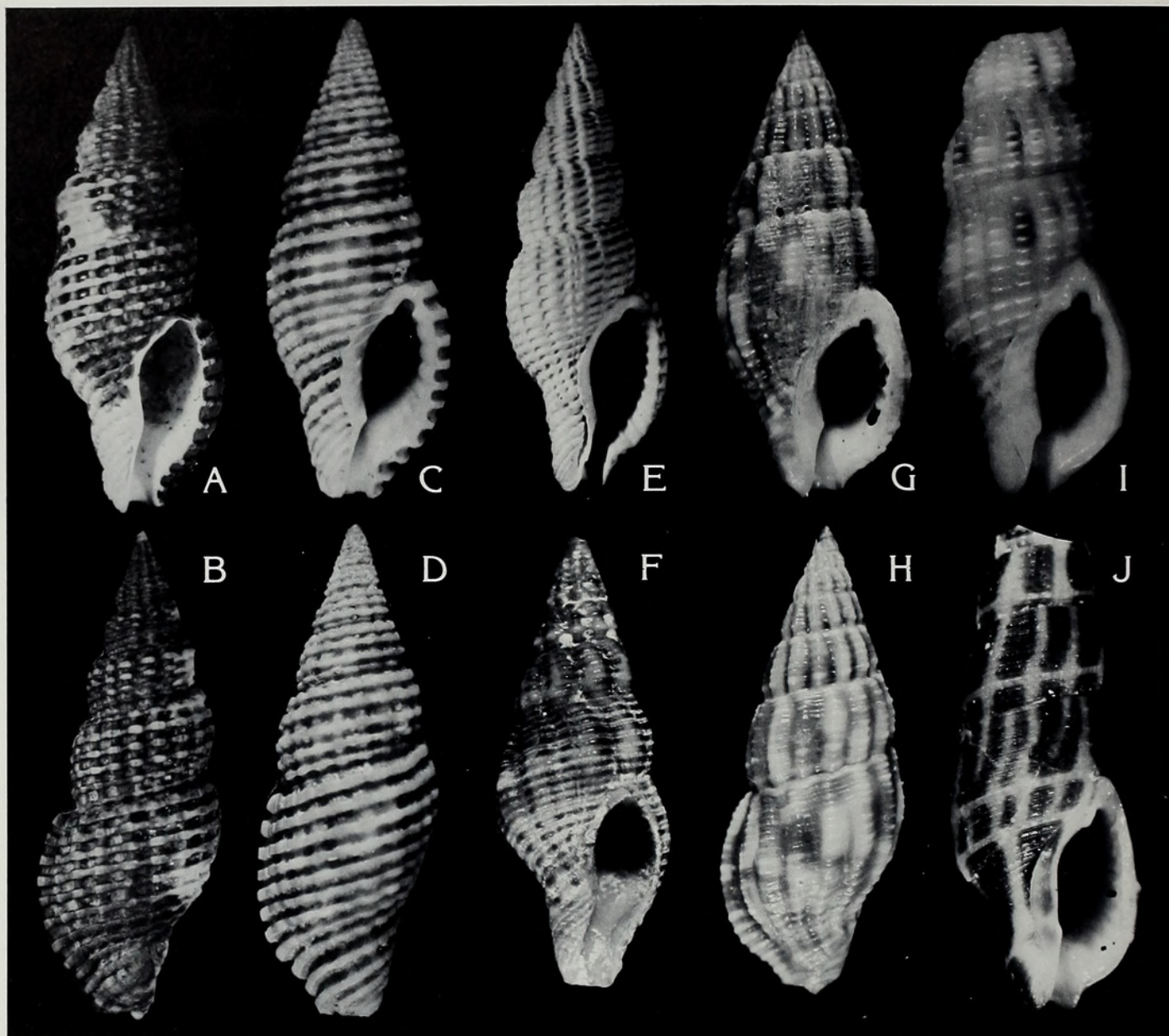


Figure 6

Representatives of *Monostiolium* and *Caducifer*. A, B. *Monostiolium petiti* Olsson, 1967, holotype, Pliocene, Waccamaw beds at Crescent Beach Airport, Horry Co., South Carolina (USNM 645173), 16.4 mm. C, D. *Monostiolium crebristriatum* (Carpenter, 1856), holotype of *Triton crebristriatus* Carpenter, 1856, Panama Bay (BM(NH) 19621120), 17.5 mm. E. *Monostiolium thomasi* Olsson, 1967, holotype, Pliocene, Caloosahatchee River Formation, Unit A, west of Ortona Locks, Glades Co., Florida (USNM 645172), 21 mm. F. *Monostiolium tessellatum* (Reeve, 1844), 33 m, off San Luiz, Maranhão State, Brazil (FURG 15.265), 11.5 mm. G, H. *Monostiolium pictum* (Reeve, 1844), syntype of *Triton pictus* Reeve, 1844, Galápagos Islands BM(NH), 16.4 mm. I. *Caducifer* sp., reef between Turuaimu and Rikumanu, Kapinga [=Kaiping, Liaoning Prov.], China (USNM 622377), 18 mm. J. *Caducifer decapitatus* (Reeve, 1844), Ine, Arno Id., Ratak Chain, Marshall Ids. (USNM 634985), 13.5 mm.

weberi is more similar to *Bailya* and represents a new subgenus exhibiting some *Monostiolium* characteristics.

BEU & MAXWELL (1987:59) incorrectly stated that *Bailya* (*Parabailya*) *weberi* "is almost certainly *M. tessellatum*." However, they were unaware of the true nature of *Monostiolium* in the western Atlantic and did not see the connection between that genus and *Bailya*.

DISCUSSION

Paleontological Record of *Monostiolium* and *Bailya*

DALL & OCHSNER (1928) described a species of *Monostiolium* as *Colubraria pervaricosa* from the Pleistocene of Vilamil, Albemarle Island [Isla Isabela], Galápagos Islands. They stated (p. 108): "This species is not distantly

related to the forms found in the Antilles, as well as many of other parts of the world." It appears to be closely related to *M. auratum* and the Recent Galápagos species *M. pictum* (Reeve, 1844) (Figures 6G, H) in overall form and sculpture. KEEN (1971) has suggested that *M. pervaricosum* is synonymous with *M. pictum*, but we prefer to leave *M. pervaricosum* as a distinct species until more material can be studied.

OLSSON (1967) described two fossil *Monostiolium* from the western Atlantic: *M. thomasi* (Figure 6E) from the Caloosahatchee River formation, Unit A, west of Ortona Locks, Glades County, Florida; and *M. petiti* (Figures 6A, B) from the Waccamaw beds at Crescent Beach Airport, Horry County, South Carolina. Both are believed to be Pliocene in age. The stated differences between the two species are well within the range of variation of any single species of *Monostiolium*, but without more material at hand it would be premature to synonymize them. These taxa bear a striking resemblance to the Recent tropical western American species *Monostiolium crebristriatum* (Carpenter, 1856) (of which *M. tabogensis* Pilsbry & Lowe, 1932, is a synonym) (Figures 6C, D); the latter may represent a descendant of that line.

The species *Phos roycei* M. Smith, 1938 (Figures 5C, D), later placed by M. SMITH (1944) in his genus *Bailya*, was described from the Pliocene of Clewiston, Hendry County, Florida. OLSSON & HARBISON (1953) illustrated a specimen of this species from the Pliocene of St. Petersburg, Florida, remarking (p. 260): "this species is near [*Bailya intricata* (Dall, 1884), specimens of which at ANSP] are more heavily shouldered and the spiral sculpture is sharper than in the fossil species." The spiral sculpture is indeed sharper in the Recent species but not as strong as that in *B. roycei*.

Phylogeny of *Monostiolium*, *Bailya*, and *Parabailya*

Comparison of Recent members of *Caducifer* (Figures 6I, J) with *Monostiolium*, based upon conchological evidence, suggests that the two are closely related. With the exception of a decollated spire, shell characteristics are virtually inseparable between *Caducifer* and western Atlantic species of *Monostiolium*. (As previously mentioned, many of the species assigned to *Monostiolium* do not appear to belong there. The eastern Pacific species in particular represent a polyphyletic group of which few species will probably be found to be in *Monostiolium*. There is also some confusion in the literature concerning the taxonomy of species of *Caducifer*: the names *truncata* Hinds, 1844, *decapitatus* Reeve, 1844; *cylindrica* Pease, 1868; and *decollata* Sowerby I, 1833, have not been uniformly applied to these taxa; while all of these names appear to be referable to *Caducifer*, the status of the nominal species has yet to be adequately documented.) Juvenile specimens of *Caducifer* have a protoconch virtually identical to those of *Monostiolium* and *Bailya* (Figures 7E–G). PILSBRY & VANATTA

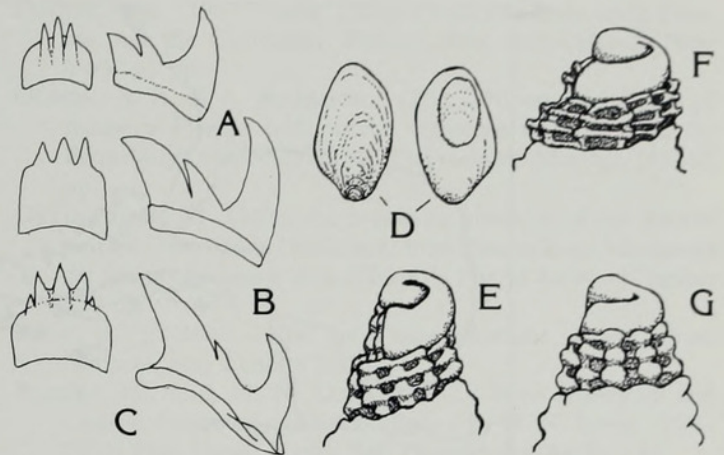


Figure 7

Radulae, operculum, and nuclear whorls. A. Partial radular row of *Monostiolium tessellatum* (Reeve, 1844), redrawn from PONDER (1972:fig. 1.8). B. Partial radular row of *Bailya parva* (C. B. Adams, 1850), redrawn from PILSBRY & VANATTA (1904:fig. 5). C. Partial radular row of *Caducifer decollata* (Sowerby I, 1833), redrawn from PONDER (1972:fig. 1.3). D. Operculum of *Monostiolium tessellatum* (Reeve, 1844), Bermuda (USNM 663420). E. Nuclear whorls of *Monostiolium auratum* Watters & Finlay, sp. nov., Rincón, Puerto Rico, holotype (USNM 859960). F. Nuclear whorls of *Bailya intricata* (Dall, 1884), Sambo Reef, Florida (Watters coll. 5536a). G. Nuclear whorls of *Caducifer* sp., Easter Id. (USNM 638945).

(1904) and PONDER (1972) have illustrated the radulae of *Caducifer*, *Bailya*, and *Monostiolium*; we can find no pertinent differences among them (Figures 7A–C).

The species of *Monostiolium* are restricted to the New World tropics. *Caducifer* is found in the Indo-Pacific tropics, and a species has been found off Brazil: *Caducifer atlantica* Coelho, Matthews & Cardoso, 1970. *Monostiolium* appeared in the western arm of the Tethys Sea in the New World prior to the Pliocene closing of the Isthmus of Panama. A fossil representative of this group is *M. pervaricosum*, and Recent species are *M. tessellatum*, *M. auratum*, *M. pictum*, and perhaps *M. rosewateri*. All Recent species are associated with oceanic islands, rarely on continental margins. The widespread Recent *M. tessellatum* has no known living or fossil relatives with the possible exception of *M. rosewateri*. The Recent Caribbean *M. auratum* is conchologically similar to the Recent eastern Pacific *M. pictum* and the fossil *M. pervaricosum*; the fossil Caribbean *M. petiti* and *M. thomasi* are very similar to the Recent eastern Pacific *M. crebristriatum*.

The earliest known *Bailya*, *B. roycei* from the Florida Pliocene, differs from *Monostiolium* primarily in the features of the columella and the relatively strong sculpture. *Bailya* (*Parabailya*) *weberi*, which possesses several *Monostiolium*-like features, is a smooth-sculptured, high-spined species that is otherwise similar to *Bailya*.

Both *Bailya* and *Monostiolium* have produced lines of

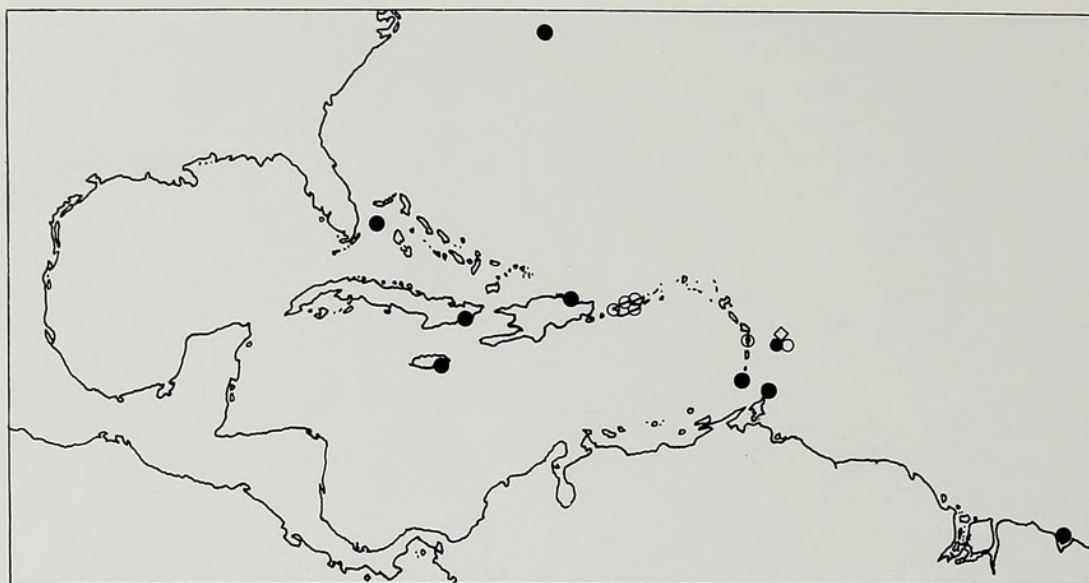


Figure 8

Distribution of western Atlantic *Monostiolum*. Solid circles represent *M. tessellatum* (Reeve, 1844); open circles represent *M. auratum* Watters & Finlay, sp. nov.; diamond represents *M. rosewateri* Watters & Finlay, sp. nov.

heavily sculptured species. *Bailya* species include *B. anomala* in the tropical eastern Pacific, and *B. parva* (C. B. Adams, 1852) (Figures 5A, B), *B. intricata* (Dall, 1884), and *B. roycei* in the western Atlantic. *Monostiolum* includes such heavily sculptured species as *M. petiti* and *M. thomasi* in the western Atlantic and *M. crebristriatum* in the eastern Pacific. No known living descendants of the heavily sculptured *Monostiolum* line exist in the western Atlantic. Both *Bailya* and *Monostiolum* probably produced these lineages prior to the closing of the Isthmus of Panama. These ribbed forms may have evolved in the Cenozoic as part of a general trend in gastropods to develop heavily sculptured, predation-resistant shells (VERMEIJ *et al.*, 1981; VERMEIJ, 1983a). However, most species of *Monostiolum* (as well as of *Parabailya* and *Caducifer*) have evolved smoother shells possibly constructed to withstand peeling of the aperture by predators such as calappid crabs (VERMEIJ, 1982, 1983b). These shells have such features as a narrow aperture bounded by a thick varix and a high-spired shell. It is likely that the relatively smooth sculpture may also make the shell difficult to hold by the predator.

Zoogeography of *Monostiolum*

The zoogeography of the living species of *Monostiolum* appears to be related to plate tectonics in the Cenozoic (see ROSEN, 1985, for a review of Caribbean tectonic models) or habitat differences associated with these plates. The distribution of *M. auratum* is associated with the Caribbean plate where it occurs on the leading edge of the plate at what is now Puerto Rico and the Lesser Antilles. It has been found only on oceanic islands; the similar *M. pervaricosum* and *M. pictum* are also only associated with offshore islands, the Galápagos Islands.

Monostiolum tessellatum is associated with the islands of the North American plate. Both *M. auratum* and *M. tessellatum* occur along islands at the subduction zone where the two plates meet and there has been little dispersal across them. This separation may be due in part to the fact that *Monostiolum* has a paucispiral protoconch, which is indicative of a short-term larval dispersal stage and (or) direct development within the egg case to a juvenile, without a free-swimming stage.

Monostiolum rosewateri is known only from deep water off Barbados and does not appear to be closely related to any other species. It is likely a descendant of the shallow-water *M. tessellatum*, which also occurs there.

The heavily sculptured species *Monostiolum crebristriatum*, *M. petiti*, and *M. thomasi* are all conchologically similar and associated with the North American continent rather than offshore islands. The ancestors of this group were probably distributed along the southern margin of the continent and were subsequently separated by the emergence of Central America. The eastern populations became extinct, leaving only the Recent *M. crebristriatum* in the eastern Pacific.

ACKNOWLEDGMENTS

We would like to thank the following people for allowing us to use the resources of their institutions or for supplying material for study: Dr. M. Harasewych, Dr. R. Houbbrick, Dr. W. Blow, and the late Dr. J. Rosewater (USNM); Mr. Walter Sage (AMNH); Mr. D. Backus, Dr. R. Eng, Dr. R. Turner (MCZ); Dr. R. Robertson, Ms. A. Garback, and Ms. E. Benamy (ANSP); Ms. K. Way (BM(NH)); Mr. R. Jensen (DMNH); Dr. E. Rios (FURG); Mr. V. Conde (Redpath Museum); and Dr. F. Sander (McGill

Univ.). Dr. F. E. Wells (Western Australian Museum, Perth) and Dr. W. F. Ponder (Australian Museum, Sydney) kindly allowed us to reproduce the line drawings of radulae originally published in the *Journal of the Malacological Society of Australia*. Dr. B. Valentine (Ohio State University) and three anonymous reviewers kindly offered suggestions on the manuscript.

LITERATURE CITED

- ABBOTT, R. T. 1954. American seashells. 1st ed. Van Nostrand: New York. xiv + 541 pp.
- ABBOTT, R. T. 1974. American seashells. 2nd ed. Van Nostrand-Reinhold: New York. 663 pp.
- ARNOW, L., F. ST. CLAIR & T. ARNOW. 1963. The Mollusca of a lagoonal area at Playa de Vega Baja, Puerto Rico. *Carib. Jour. Sci.* 3(2-3):163-172.
- BANDEL, K. 1984. The radulae of Caribbean and other Mesogastropoda and Neogastropoda. *Zoologische Verhandlungen, Uitgegeven door het Rijksmuseum van Natuurlijke Historie te Leiden* (214):1-188.
- BEU, A. G. & P. A. MAXWELL. 1987. A revision of the fossil and living gastropods related to *Plesiotriton* Fischer, 1884 (family Cancellariidae, subfamily Plesiotritoninae n. subfam.). *New Zealand Geol. Surv. Paleont. Bull.* 54:1-140.
- CERNOHORSKY, W. O. 1975. Supplementary notes on the taxonomy of buccinid species of the subfamily Pisaninae (Mollusca: Gastropoda). *Rec. Auckland Inst. Mus.* 12:175-211.
- CLENCH, W. J. 1973. In: P. A. Morris, A field guide to shells of the Atlantic and Gulf coasts and the West Indies. Houghton Mifflin: Boston. 330 pp.
- COELHO, A. C. D. S., H. R. MATTHEWS & P. DE S. CARDOSO. 1970. Registro da ocorrência no Brasil do genero *Caducifer* Dall, 1904, com descrição de uma nova especie (Mollusca, Gastropoda, Buccinidae). *Arquivos de Ciências do Mar* 10(2): 185-188.
- DALL, W. H. 1889a [January-June]. Reports on the results of dredging . . . in the Gulf of Mexico (1877-78) and in the Caribbean Sea (1879-80), by the U.S. Coast survey steamer "Blake" . . . XXIX. Report on the Mollusca. Part II. Gastropoda and Scaphopoda. *Bull. Mus. Compar. Zool.* 43:492 pp.
- DALL, W. H. 1889b [December]. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the S.E. coast of the U.S. with illustrations of many of the species. *Bull. U.S. Natl. Mus.* 37:232 pp.
- DALL, W. H. 1904. An historical and systematic review of the frog-shells and tritons. *Smithsonian Misc. Coll.* 47(1475): 114-144.
- DALL, W. H. & W. H. OCHSNER. 1928. Tertiary and Pleistocene Mollusca from the Galapagos Islands, IV. *Proc. Calif. Acad. Sci., ser. 4*, 17(4):89-139.
- FULTON, H. C. 1936. Molluscan notes, VI. *Proc. Malacol. Soc. London* 22(1):7-9.
- KAY, E. A. 1979. Hawaiian marine shells. *Bernice P. Bishop Museum Spec. Publ.* 64(4):xv + 653 pp.
- KEEN, A. M. 1971. Sea shells of tropical west America. 2nd ed. Stanford Press: Stanford, California. xiv + 1064 pp.
- MESTEY-VILLAMIL, V. 1980. Checklist of the classes Gastropoda and Pelecypoda from Cayo Icacos, Puerto Rico. *Science-Ciência* 7(1):19-24.
- OLSSON, A. A. 1967. Some Tertiary mollusks from south Florida and the Caribbean. *Paleont. Res. Inst.: Ithaca, New York*. 61 pp.
- OLSSON, A. A. & A. HARBISON. 1953. Pliocene Mollusca of southern Florida with special reference to those from St. Petersburg. *Acad. Natur. Sci. Philadelphia Monogr.* (8):361 pp.
- ORTIZ-CORPES, E. 1983. An annotated checklist of the Recent marine Gastropoda (Mollusca) from Puerto Rico. *Memorias del Quinto Simposio de la Fauna de Puerto Rico y el Caribe*: 220 pp.
- PEILE, A. J. 1911. Note on *Triton tessellatus*, Reeve. *Proc. Malacol. Soc. London* 9:227.
- PILSBRY, H. A. & H. N. LOWE. 1932. West American and Central American mollusks collected by H. N. Lowe, 1929-1931. *Proc. Acad. Natur. Sci. Philadelphia* 84:33-144.
- PILSBRY, H. A. & E. G. VANATTA. 1904. On certain rhachiglossate Gastropoda eliminated from the Aquillidae. *Proc. Acad. Natur. Sci. Philadelphia* 56:592-595.
- PONDER, W. F. 1972. Notes on some Australian genera and species of the family Buccinidae (Neogastropoda). *Jour. Malacol. Soc. Australia* 2(4):249-265.
- REEVE, L. A. 1843-1846. Monograph of the genus *Pleurotoma*. *Conchologia iconica* 1. London. Pls. 1-369.
- REEVE, L. A. 1844. Monograph of the genus *Triton*. *Conchologia iconica* 2. London. Pls. 1-20.
- RIOS, E. C. 1975. Brazilian marine mollusks iconography. Universidade do Rio Grande, Centro de Ciências do Mar Museu Oceanográfico:331 pp.
- ROSEN, D. E. 1985. Geological hierarchies and biogeographic congruence in the Caribbean. *Ann. Missouri Bot. Garden* 72:636-659.
- SANDER, F. & C. M. LALLI. 1982. A comparative study of mollusk communities on the shelf-slope margin of Barbados, West Indies. *Veliger* 24(4):309-318.
- SMITH, M. 1938. Further notes upon Tertiary and Recent mollusks from Florida, with descriptions of new species. *Nautilus* 51(3):88-91.
- SMITH, M. 1944. Panamic marine shells. Tropical Photographic Laboratory: Winter Park, Florida. xiii + 127 pp.
- TRYON, G. W. 1881. Tritonidae, Fusidae, Buccinidae. *Manual of Conchology* 3. Privately printed: Philadelphia. 310 pp.
- VERMEIJ, G. J. 1982. Gastropod shell form, breakage, and repair in relation to predation by the crab *Calappa*. *Malacologia* 23(1):1-12.
- VERMEIJ, G. J. 1983a. Traces and trends of predation with special reference to bivalved animals. *Paleontology* 26(3): 455-465.
- VERMEIJ, G. J. 1983b. Shell-breaking predation through time. Pp. 649-669. In: M. J. S. Tevesz & P. L. McCall (eds.), *Biotic interactions in Recent and fossil benthic communities*. *Topics Geobio.* 3:837 pp.
- VERMEIJ, G. J., D. E. SCHINDEL & E. ZIPSER. 1981. Predation through geologic times: evidence from gastropod shell repair. *Science* 214:1024-1026.
- WARMKE, G. L. & R. T. ABBOTT. 1961. Caribbean seashells. Livingston Press: Wynnewood, Pennsylvania. 348 pp.
- WATTERS, G. T. 1983. A new species of *Caducifer* (*Monostiolium*) from the western Atlantic (Buccinidae). *Nautilus* 97(4): 125-128.



Watters, G. Thomas and Finlay, C. John. 1989. "A REVISION OF THE WESTERN ATLANTIC RECENT SPECIES OF THE GENUS MONOSTIOLUM DALL, 1904, AND BAILYA (PARABAILYA) NEW SUBGENUS (GASTROPODA, BUCCINIDAE)." *The veliger* 32, 47–59.

View This Item Online: <https://www.biodiversitylibrary.org/item/137792>

Permalink: <https://www.biodiversitylibrary.org/partpdf/96893>

Holding Institution

Harvard University, Museum of Comparative Zoology, Ernst Mayr Library

Sponsored by

Harvard University, Museum of Comparative Zoology, Ernst Mayr Library

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: California Malacozoological Society

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.