

The Recent *Tripterotyphis* (Gastropoda: Muricidae: Tripterotyphinae) from the eastern Pacific with the description of two new species

Shawn Gregory WIEDRICK*
 Museum Associate, Malacology Department
 Natural History Museum of Los Angeles County
 900 Exposition Boulevard, Los Angeles, California, 90007, U.S.A.
 shawnwiedrick@hotmail.com

Roland HOUART
 Research Associate
 Institut royal des Sciences naturelles de Belgique
 and
 Institute of Systematics, Evolution, Biodiversity (ISYEB), Muséum national d'Histoire naturelle (MNHN), CNRS, SU, EPHE, UA, CP 51, 57 rue Cuvier, 75005 Paris, France
 roland.houart@skynet.be

* Corresponding author

KEYWORDS. Eastern Pacific, Muricidae, *Tripterotyphis*, new species.

ABSTRACT. The *Tripterotyphis* species in the eastern Pacific are here presented with the description of *Tripterotyphis galapagosensis* n. sp. from the Galapagos Islands, Ecuador and *T. jamesmacleani* n. sp. from northern Mexico. The new species are compared with *T. arcana* (DuShane, 1969), *T. fayae* (Keen & Campbell, 1964) and *T. lowei* (Pilsbry, 1931).

INTRODUCTION

Tripterotyphis Pilsbry & Lowe, 1932 is one of the many genera proposed in the twentieth century within the muricid subfamilies Tripterotyphinae and Typhinae, once thought to comprise the family Typhidae (D'Attilio & Hertz, 1988). Systematic and morphological characteristics within the subfamily Tripterotyphinae have been extensively discussed among modern malacologists (Keen, 1944: 50–72; Keen & Campbell, 1964: 46–57; DuShane, 1969: 343–344; Keen, 1971: 542; D'Attilio, 1975: 53–60; 1976: 27–30; 1982: 94–98; D'Attilio & Hertz, 1988: 1–73; Vokes, 1996: 4–6). Recent techniques used to more accurately identify qualitative features (Merle, 1999; 2001; 2005; Merle & Houart, 2003) have provided the analytical tools necessary for separating species by malacologists focused on muricid taxa. Specimen lots examined from the ANSP, LACM, SBNHM and the authors collections' have brought to light the extension of known ranges and new species. Based on morphological and ontogenetic features, the two new species here proposed are from the Panamic Province, one currently recorded as an endemic to the Galapagos Islands, Ecuador and the other from the northern Panamic Province.

A phylogenetic analysis of the Muricidae (Barco et al., 2010) did not include members of the Tripterotyphinae. However, an unpublished study by Russini et al. (2019) in Russini (2019) places Tripterotyphinae in the clade Aspellinae/Muricopsinae. This position needs to be verified by further analysis

the results of which will be published later. We maintain the currently accepted classification in MolluscaBase (2021).

Tripterotyphis here follows D'Attilio & Hertz (1988) who detailed the worldwide fauna of this muricid group. *Tripterotyphis vokesae* (Gertman, 1969) from the Lower Miocene of Florida is likely the ancestral link to the two North American lineages, *Pterotyphis* Jousseume, 1880 and *Tripterotyphis* Pilsbry & Lowe, 1932. *Tripterotyphis vokesae* is the first known New World representative to exhibit a functional tube on the varix, likely giving rise to the subsutural tube prior to the varix, as seen in *Pterotyphis* Jousseume, 1880.

The genus *Tripterotyphis* was once regarded as a subgenus of *Pterotyphis* (Vokes, 1996: 5) although that genus has a distinctly different morphology including an abapically flaring final lip, especially anteriorly, much more numerous and finer spiral cords, with a far less projecting functional tube, distinctly placed far behind the final varix, suggesting a distinct lineage, divergent from *Tripterotyphis*.

Ten species are currently assigned to the genus *Tripterotyphis*, including two new species described herein, which comprise five taxa from the eastern Pacific: *T. arcana* (DuShane, 1969), *T. fayae* (Keen & Campbell, 1964), *T. lowei* (Pilsbry, 1931), *T. galapagosensis* n. sp. and *T. jamesmacleani* n. sp.; one from the western Atlantic: *T. triangularis* and four from the western and southern Pacific: *T. colemani* (Ponder, 1972), *T. norfolkensis* (Fleming, 1962), *T. robustus* (Verco, 1895) and *T. tenuis* Garrigues, 2020.

The eastern Pacific species are reviewed below.

Material and methods

Material examined

Specimens analyzed for this study are deposited in the Academy of Natural Sciences of Drexel University, Philadelphia, U.S.A., the Natural History Museum of Los Angeles County, California, U.S.A., the Santa Barbara Museum of Natural History, California, U.S.A. and the research collections of the authors. Unenumerated specimen lots were carefully examined by the senior author and localities were verified to be from within the distributions provided.

Morphology

The characters used to describe shell morphology address the general aspect of the shell including its shape, size, and colour, the shape of the spire, including the number and features of the protoconch and teleoconch whorls, details of the suture and of the subsutural ramp, the structure and pattern of the intritacalx, details of axial and spiral sculpture, the aperture, and the siphonal canal.

Abbreviations

Repositories

AMNH: American Museum of Natural History, New York City, New York, U.S.A.

ANSP: Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania, U.S.A.

CASIZ: California Academy of Sciences, San Francisco, California, U.S.A.

HD: collection of Helen DuShane. See under *Tripterotyphis arcana* (DuShane, 1969).

LACM: Natural History Museum of Los Angeles County, California, U.S.A.

NHMUK: Natural History Museum, London, England, United Kingdom.

RH: collection of the second author.

SBNHM: Santa Barbara Natural History Museum, California, U.S.A.

SGW: collection of the first author.

Spiral cords morphology

Terminology used to describe the spiral cords and the apertural denticles following Merle (2001, 2005) and Merle & Houart (2003). Features that are variable within a species are enclosed in parentheses.

Ab: abapical: away from shell apex toward base along axis or slightly oblique to it; abapertural: away from shell aperture; Ad: adapical: toward shell apex along axis or slightly oblique to it; adapertural: toward shell

aperture; P: primary spiral cord; s: secondary spiral cord; t: tertiary spiral cords.

Subsutural area

abis: abapical infrasutural secondary cord; adis: adapical infrasutural secondary cord; IP: infrasutural primary cord;

Convex part of teleoconch whorl

P1: shoulder cord;

P2–P6: other abapical primary cords;

s1–s6: secondary cords (example: s1: secondary cord between P1 and P2; s2: secondary cord between P2 and P3, etc.);

t1–t6, tertiary cord (example t1: tertiary cord between P1 and s1 or between s1 and P2); t2: tertiary cord between P2 and s2 or s2 and P3, etc.).

Siphonal canal

ADP: adapertural primary cord on the siphonal canal;

ads: adapertural secondary cord on the siphonal canal;

MP: median primary cord on the siphonal canal; ms:

median secondary cord on the siphonal canal; ABP:

abapertural primary cord on the siphonal canal.

Aperture

D1 to D6: abapical denticles.

SYSTEMATICS

Family **MURICIDAE** Rafinesque, 1815

Subfamily **TRIPTEROTYPHINAE** D'Attilio & Hertz, 1988

Genus *Tripterotyphis* Pilsbry & Lowe, 1932

Type species by original designation: *Typhis lowei* Pilsbry, 1931, Bahía Montijo, Veraguas Province, Panama.

Note: Keen (1971: 542) incorrectly stated the type species of *Tripterotyphis* as *T. triangularis* (A. Adams, 1855).

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

Diagnosis

Shell up to 26.6 mm in length. Protoconch paucispiral of 1.5–2 whorls. Teleoconch whorls with three varices per whorl from first to last whorl. Shoulder spine tube-like, ventrally sealed along its entire length. Aperture small, ovate. Shell covered by thin, whitish intritacalx. Siphonal canal short, ventrally sealed. Operculum strongly ovate with apical nucleus.

Tripterotyphis arcana (DuShane, 1969)

Figs 1; 3A–D

Pterotyphis (Tripterotyphis) arcana DuShane, 1969: 344, pl. 54, figs 4–6; Gertman, 1969: 184; Sphon, 1971: 19; Keen, 1971: 542, fig. 1056; Abbott, 1974:

193, no. 2026; Draper, 1980: 22; Vokes, 1989: 83; Skoglund, 2002: 112, fig. 1056.

Tripterotyphis arcana — D'Attilio, 1976: 29; Radwin & D'Attilio, 1976: 17 & 202, pl. 30, figs 8–9; D'Attilio & Hertz, 1988: 18, 42, fig. 31a–c; Hutsell et al., 1997: 68; Pisor, 2008: 100; Garrigues, 2020: 41, pl. 1, figs 4a–b & 5–6.

Typhis arcana — Galindo, 1977: 492.

Pterotyphis arcana — Goto & Poppe, 1996a: 75, no. 14241; 1996b: 330, no. 14241.

Not *Tripterotyphis arcana* — D'Attilio & Hertz, 1988: 42, figs 31a–c; Wiedrick, 2012: 91 (= *Tripterotyphis jamesmacleani* n. sp.).

Type material. Holotype, LACM 1195, length 16.1 mm, width 8.1 mm; paratype, AMNH 222053; two paratypes, HD. The two paratypes cited as in DuShane collection (1907–2002) could not be located and the whereabouts of these specimens are unknown to the authors.

Type locality. Mazatlan, Sinaloa, Mexico, 23°11'00" N, 106°26'00" W, on rocky reef.

Other material examined. No additional material was examined.

Distribution. Mazatlan, Sinaloa, Mexico, to Bahía Banderas, Jalisco, Mexico (DuShane, 1969; Hendrickx et al., 2005; Brusca & Hendrickx, 2008; Houart & Hendrickx, 2020), intertidal (Fig. 1).

Description. Shell length to 21.6 mm, width to 10.4 mm (Draper, 1980), medium sized for genus, rhomboid shaped, sharply triangulate, spire tall, acute, subsutural ramp tabulate, functional tubes short, outward projecting, pitting indistinct in holotype, except in varices where it is strong. Spiral cords strong, projecting, varices moderately strong, color off white to light yellow with several brown lines, one below the shoulder, an additional line at the base; intritacalx absent in holotype. Last teleoconch whorl spiral cord morphology with P1, s1, t, P2, P3, P4, s4, P5, s5, P6, ADP and MP. Aperture ovate, columellar wall thick, wide near axis, heavily calloused near posterior end, slightly projecting throughout, except near parietal wall, with D1 strong, D2 and D3 subtly split, D4–D6 weak. Siphonal canal comparatively narrow, short, 21% of total shell length in holotype, ventrally sealed, dorsally bent at tip.

Discussion. The geographical distribution is known from the original description and verified by others (see Distribution section above) which ranges from Mazatlan, Sinaloa to Bahía Banderas, Jalisco, Mexico. *Tripterotyphis arcana* is different than other eastern Pacific species in lacking an IP cord, multiple split P1 cords, but having one tertiary cord after s1 and six apertural denticles. Although *T. fayae* also has six denticles, that species has s2, s3, s6, ads, ms, ABP and

three additional tertiary cords, all characters not seen in *T. arcana*.

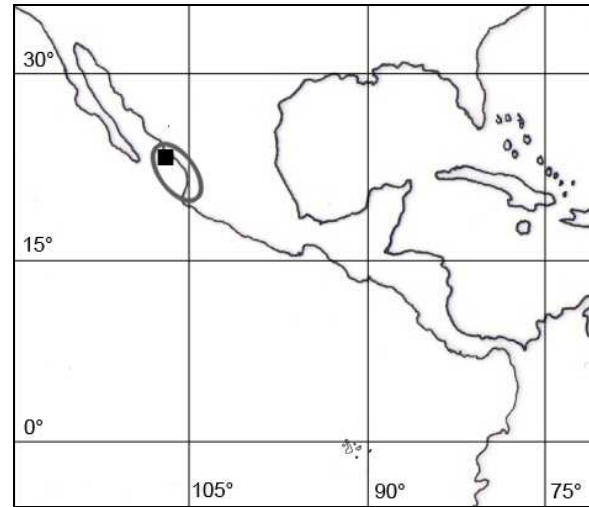


Figure 1. Distribution of *Tripterotyphis arcana* (DuShane, 1969)

Square: type locality.

Tripterotyphis fayae (Keen & Campbell, 1964)
Figs 2; 3E–H

Typhis lowei (non Pilsbry, 1931) — Pilsbry, 1939: 66, pl. 8, fig. 4.

Pterotyphis (*Tripterotyphis*) *fayae* Keen & Campbell, 1964: 54–56, pl. 11, figs 39–40 & 43–44, text fig. 1; DuShane, 1969: 344; Gertman, 1969: 184; Sphon, 1971: 19; Keen, 1971: 542, fig. 1057; Ponder, 1972: 220; Abbott, 1974: 193, no. 2025; Vokes, 1989: 84; Skoglund, 2002: 112, no. 1057.

Tripterotyphis fayae — D'Attilio, 1976: 29; Radwin & D'Attilio, 1976: 17 & 202–203, pl. 30, figs 10–11; D'Attilio, 1979: 52; Abbott & Dance, 1982: 157, figured; Draper, 1980: 23; D'Attilio & Hertz, 1988: 7, 23 & 42, figs 2 & 32a–c; Hutsell et al., 1997: 68; Pisor, 2008: 105; Robin, 2008: 281, fig. 8; Wiedrick, 2012: 92; Garrigues, 2020: 41, pl. 1, figs 1a–b & 2–3.

Typhis fayas [sic] — Galindo, 1977: 493.

Pterotyphis fayae — Goto & Poppe, 1996a: 292, no. 14245; 1996b: 330, no. 14245.

Type material. Holotype SBNHM 15999, length 19.9 mm, width 10.8 mm; paratypes, SBNHM 11385, 12317, 15858, 15859, 20132, 35464, 113855, 361839; paratypes, CASIZ 63819, 64683, 64684, 64685.

Type locality. Barra de Navidad, Jalisco, Mexico, 19°17'00" N, 104°48'00" W.

Other material examined. 23 lots from LACM; five specimens (RH).

Distribution. Punta Lobos, Todos Santos, Baja California Sur (Wiedrick, 2012: 92) southeast to Cabo Pulmo, Baja California Sur (D'Attilio & Hertz, 1988;

Hendrickx et al. 2005; Brusca & Hendrickx, 2008) south to Isla Maria Cleofas, Islas Tres Marias to mainland Sayulita, Nayarit and south to Zihuatanejo, Guerrero, Mexico (Pilsbry, 1939: 66), intertidal (Fig. 2).

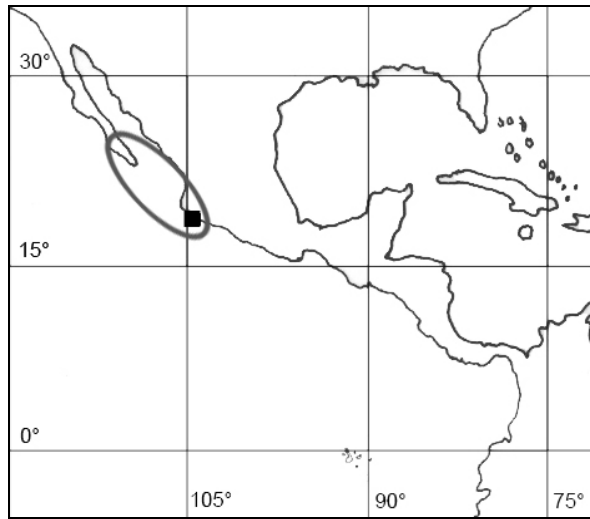


Figure 2. Distribution of *Tripterotyphis fayae* (Keen & Campbell, 1964)
Square: type locality.

Description. Shell length to 26.6 mm (Pisor, 2008), width to 13.9 mm (Draper, 1980), medium to large sized for genus, shape somewhat ovate, spire moderately tall, apex blunt, functional tubes progressively longer posteriorly, final tube extremely long, upward projecting, pitting absent, with strong microscopic growth lines. Color waxy white, often with several solid brown lines between the shoulder and base with faint brown lines between spiral cords, some specimens lack these strong distinctions and have subtle blotches. Intraacalx not available for examination. Last teleoconch whorl with IP, P1, s1, P2, s2, t, P3, (t), s3, P4, s4, (t), P5, s5, (t), P6, s6, ADP, ads, MP, ms, ABP, (abs). Aperture small, ovate, denticles extremely weak, D1 and D5 split, D2–D4 and D6 equally as faint, columellar wall thick, narrow, fused to axis, wider near axis. Siphonal canal broad, short, 26–27% of total shell length, ventrally sealed, dorsally bent at tip.

Discussion. *Tripterotyphis fayae* is considerably different from other *Tripterotyphis* species in having an extremely long functional tube, more numerous spiral cords and more restricted aperture. Most akin to *T. arcana*, this species has four secondary cords with *T. arcana* having only one. Pilsbry (1939) illustrated a specimen that matches this species, both in form and coloration, which is here recognized as the southernmost record. It appears Skoglund (2002: 112) mistakenly cited D'Attilio & Hertz (1984) as extending the distribution of this species north to Cabo Pulmo, Baja California Sur, Mexico but this extension should be attributed to D'Attilio & Hertz (1988: 42). This species is also known from the Pleistocene of Oaxaca, Mexico (Keen & Campbell, 1964: 55).

Tripterotyphis lowei (Pilsbry, 1931)
Figs 3I–L; 4

Typhis lowei Pilsby, 1931: 72; Pilsbry & Lowe, 1932: 77–78, pl. 4, figs 11–11a; Smith, 1944: 25, fig. 314; Galindo, 1977: 493.

Pterotyphis (Tripterotyphis) lowei — Keen, 1944: 59, 61 & 65–66, fig. 3; Vella, 1961: 378; Keen & Campbell, 1964: 55–56; Dushane, 1969: 344; Gertman, 1969: 183–184 & 186; Keen, 1971: 542, fig. 1058; Abbott, 1974: 192–193, no. 2027; Vokes, 1989: 83–84.

Typhis (Tripterotyphis) lowei — Keen, 1958: 367, fig. 383.

Tripterotyphis lowei — D'Attilio & Radwin, 1971: 346, fig. 2; D'Attilio, 1975: 60, figured; D'Attilio, 1976: 27, lower, far left figure, [sic] as right figure; Radwin & D'Attilio, 1976: 17 & 202–203, pl. 30, fig. 5, text fig. 148; Hertz, 1977: 40; D'Attilio, 1979: 51–52; D'Attilio, 1982: 95 & 97, fig. 3 & 13; Draper, 1980: 23; D'Attilio & Hertz, 1988: 3, 6–7, 26 & 43, figs 5 & 33a–c (only); Wilson, 1994: 54–55; Goto & Poppe, 1996a: 463, no. 14445; 1996b: 334, no. 14445; Robin, 2008: 281, fig. 9; Wiedrick, 2012: 91–92, figs 2–3; Garrigues, 2020: 41–42, pl. 3, figs 8a–b & 9a–e.

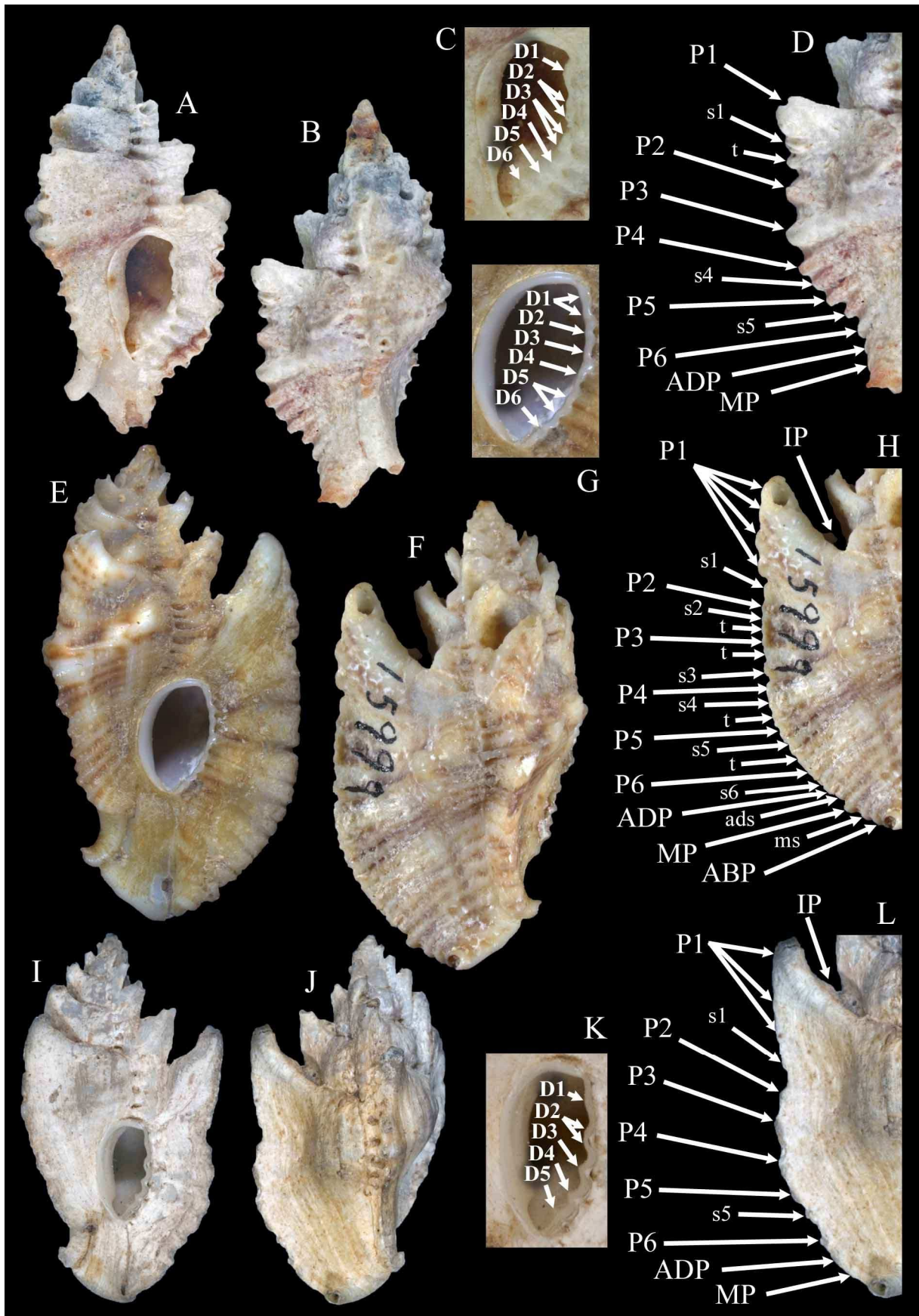
Pterotyphis (Tripterotyphis) lowei lowei — Ponder, 1972: 220–221; Kaiser & Bryce, 2001: 24, pl. 36, fig. 4; Skoglund, 2002: 112, no. 1058.

Figure 3

A–D. *Tripterotyphis arcana* (DuShane, 1969), holotype LACM 1195, length 16.1 mm, width 8.1 mm, Mazatlán, Sonora, México. A. Ventral view. B. Dorsal View. C. Denticles morphology. D. Spiral cords morphology.

E–H. *Tripterotyphis fayae* (Keen & Campbell, 1964), holotype SBNHM 15999, length 19.9 mm, width 10.8 mm, Barra de Navidad, Jalisco, México. E. Ventral view. F. Dorsal view. G. Denticles morphology. H. Spiral cords morphology.

I–L. *Tripterotyphis lowei* (Pilsbry, 1931), lectotype ANSP 155330, length 14.5 mm, width 7.8 mm, Mariato, Veraguas Province, Panamá. I. Ventral view. J. Dorsal view. K. Denticles morphology. L. Spiral cords morphology.



Tripterotyphis lowei lowei — D’Attilio & Hertz, 1984: 51–52, figs 3–4; Kaiser, 1997: 35, no. 1058.

Pterotyphis lowei — Shasky, 1989: 74.

Pterotyphis lowei lowei — Kaiser, 2001: 5, table 1.

Tripterotyphis arcana (non Dushane, 1969) — Robin, 2008: 281, fig. 6.

Not *Typhis lowei* (non Pilsbry, 1931) — Pilsbry, 1939: 66, pl. 8, fig. 4 (= *T. fayae*).

Not *Tripterotyphis lowei* (non Pilsbry, 1931) — Hertz, 1977: 40, figured; D’Attilio, 1979: 51, figs 2, 5–6 (far right); Wiedrick, 2012: fig. 1 (= *T. jamesmacleani* n. sp.).

Not *Pterotyphis* (*Tripterotyphis*) *lowei* (non Pilsbry, 1931) — Shasky & Campbell, 1964: 116, pl. 21, fig. 4 (= *T. jamesmacleani* n. sp.).

Not *Tripterotyphis lowei* (non Pilsbry, 1931) — Radwin & D’Attilio, 1976: pl. 30, fig. 6; D’Attilio, 1979: 51–52, figs 3 & 5–6 (middle left); D’Attilio & Hertz, 1984: 52–53, fig. 7; Finet, 1985: 19; D’Attilio & Hertz, 1988: 9, fig. 4; 43, fig. 33 d–e (only); Finet, 1994: 50, no. 284; Hutsell et. al., 1997: 68; Pisor, 2008: 108; Wiedrick, 2012: fig. 4; Garrigues, 2020: 41 (= *T. galapagosensis* n. sp.).

Not *Pterotyphis lowei lowei* (non Pilsbry, 1931) — Kaiser, 2001: 5, table 1 (= *T. galapagosensis* n. sp.).

Type material. Lectotype ANSP 155330, length 14.5 mm, width, 7.8 mm; paralectotype ANSP 156882.

Pilsbry & Lowe (1932: 77) mention, "paratypes in Lowe collection", of which only one, now paralectotype, was located at ANSP.

Type locality. Mariato, Bahía Montijo, Veraguas Province, Panama, under rocks at low tide.

Other material examined. 35 lots from SBNHM; 18 lots from LACM; four specimens (RH).

Distribution. 4.8 km north of Puertecitos, Baja California, Mexico south; Punta San Antonio, Sonora, Mexico south to Isla de Malpelo, Colombia (Kaiser & Bryce, 2001), intertidal to 12.1 m (Wiedrick, 2012: 92) (Fig. 4).

Description. Shell length primarily 14.0 mm and under (Wiedrick, 2012), extremely large specimens up to 19.2 mm, width 11.5 mm (coll. RH), medium sized for the genus, shape ovate, spire tall, indented near suture of previous whorl, functional tubes long, pits shallow, weak or even absent, well-spaced, final varices thin, expanded, cords rounded at intersection. Intritacalx longitudinally lirate, squamous, shell color chalky white. Final whorl with (IP), P1, s1, (t), P2, P3, P4, P5, (s5), P6, ADP, MP, (ABP). Aperture elongate-ovate to ovate, columellar wall thick, projecting throughout, except near parietal wall. Apertural denticles D1–D5; denticles D1 broad, D2 and D3 occasionally both split, D4 and D5 small, low.

Siphonal canal broad, short, 23–24% of total shell length, ventrally sealed, dorsally bent at tip.

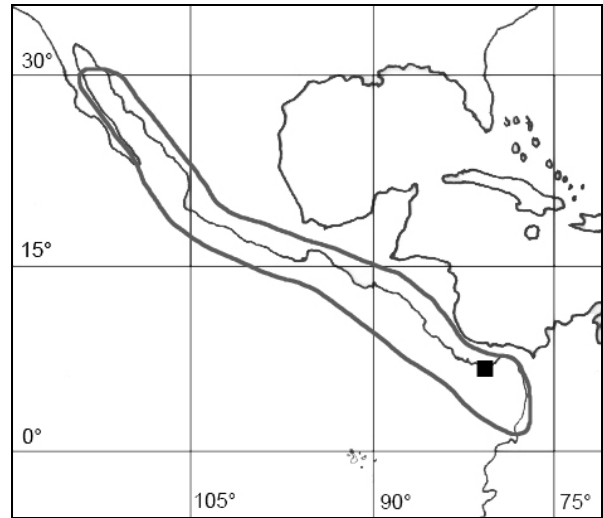


Figure 4. Distribution of *Tripterotyphis lowei* (Pilsbry, 1931)

Square: type locality.

Discussion. The original, untypified description of *Tripterotyphis lowei* from Panama was noted as being 14.5 mm in length, 8.0 mm in width, a typical size for this mainland species. The specimen in ANSP, was noted as, "Type 155330 ANSP.; paratypes in Lowe collection" in Pilsbry & Lowe (1932: 77). Pilsbry (1931) never designated a holotype, therefore, the ANSP specimen is here considered a lectotype designated by Pilsbry & Lowe (1932) following ICZN article 74.5.

A recent specimen figured by Garrigues (2020: fig. 8a–b), labeled as a holotype is not the "holotype" nor the lectotype, and is of unknown origin. The ANSP type number referenced by the author, "(ANSP 84: 77)" appears to reference the ANSP Proceedings publication and pagination numbers (Pilsbry & Lowe, 1932: 77–78), not an actual lectotype number. Additionally, a protoconch figure (Ibid.: fig. 9b) was omitted in the caption and is also of unknown origin. The maximum depth of 250 m provided by Garrigues (2020: 41) is inconsistent with specimens analyzed in this study and no specific specimen data was cited and therefore needs confirmation. An examination of records in the LACM collection reveal a maximum depth of 12.1 m for this species. D’Attilio (1976) inadvertently reversed captions for the figured specimens illustrated on the lower left specimens, the left specimen morphologically matches *T. lowei* and is here recognized as such. The Islas Cocos, Costa Rica and Isla de Malpelo, Colombia are closer in proximity and distance from the mainland, compared to the extreme distance of Islas Galapagos, Ecuador. Therefore, Islas Cocos specimens previously listed (Shasky, 1989: 74; Kaiser, 2001: 5) are a likely match to the Isla de Malpelo specimen figured by Kaiser &

Bryce (2001: pl. 36, fig. 4) and are included above in the chresonymy for this species. The specimen figured as *T. arcana* by Robin (2008: 281, fig. 6) appears to be a juvenile specimen that matches *T. lowei*. Compared to the most similar species, *T. galapagosensis*, this species are lighter in weight, has an s5 cord, is absent of an ABP cord, is smaller in size and has a much less dramatic and sometimes absent IP cord.

***Tripterotyphis galapagosensis* n. sp.**

Figs 5; 7A–F

Tripterotyphis lowei (non Pilsbry, 1931) — Radwin & D’Attilio, 1976: pl. 30, fig. 6; D’Attilio, 1979: 51–52, figs 3 & 5–6 (middle left); D’Attilio & Hertz, 1984: 52–53, fig. 7; Finet, 1985: 19; D’Attilio & Hertz, 1988: 9, fig. 4; 43, fig. 33 d–e (only); Finet, 1994: 50, no. 284; Hutsell et. al., 1997: 68; Pisor, 2008: 108; Wiedrick, 2012: fig. 4; Garrigues, 2020: 41.

Pterotyphis lowei lowei (non Pilsbry, 1931) — Kaiser, 2001: 5, table 1.

Type material. Holotype SBNHM 211567, length 26.1 mm, width 13.8 mm; one paratype SBNHM 211568; two additional paratypes, LACM 3769 and LACM 3770.

Type locality. Isla Floreana, Islas Galapagos, Ecuador, 1°15'00" S, 90°19'58" W, under coral at 10–25 m, 15 Feb 1988, collected by Donald R. Shasky.

Material examined. Holotype, SBNHM 211567 (Fig. 7A–D); one paratype, SBNHM 211568 (Fig. 7E–F), Bahía Academy, Isla Santa Cruz, Islas Galapagos, Ecuador, 0°45'00" S, 90°20'00" W, intertidal in sea anemones, Sep 1963; one paratype, LACM 3769 from Bahía Bartolomé, Isla Bartolomé, Islas Galapagos, Ecuador, 0°17'16" S, 90°33'29" W, at 0.6–3.0 m, 10–11 Mar 1971 [ex LACM 1971–51]; one paratype, LACM 3770 from Bahía Post Office, Isla Santa Maria, Islas Galapagos, Ecuador, 1°14'36" S, 90°28'08" W, on rock at 27 m, R/V *Velero III*, 19 Jan 1934 [ex LACM 1934–40]; one specimen, Bahía Sullivan, Isla Bartolomé, Isla Galapagos, Ecuador, 0°17'18" S, 90°33'37" W, in rubble at 0–3 m, 10 Mar 1971 [SBNHM 152431]; one specimen, Bahía Academy, Isla Santa Cruz, Isla Galapagos, Ecuador, 0°45'00" S, 90°20'00" W, intertidal [SBNHM 211569]; one specimen, north tip of Isla Baltra, Islas Galapagos, Ecuador, 0°26'00" N, 90°16'00" W, under rock at 10–25 m, 13 Feb 1988 [SBNHM 211570]; one specimen, Roca Cousins, Isla Santiago, Islas Galapagos, Ecuador, 0°11'00" S, 90°40'00" W, under rock at 10–25 m, 19 Feb 1988 [SBNHM 211571]; one specimen, Isla Jervis, Isla Rabida, Islas Galapagos, Ecuador, 0°24'00" S, 90°42'00" W, at 10–25 m, 24 Mar 1971 [SBNHM 211600].

Distribution. Known only from the Islas Galapagos, Ecuador, intertidal to 27 m (Fig. 5).

Description. Shell large sized for genus, length up to 26.1 mm, width 13.8 mm (holotype), specimens mature no less than 18.0 mm in length, shape stout, thick, heavy, spire squat, short, low profile, functional tubes somewhat short, recurved, flange large, thick, widely flaring, continuous from one whorl to the next, pits deep, wide, closely set, especially prominent on varices. Intraoralx relatively thick, chalky with distinct growth lines. Color mostly off white with some brown between cords and on both siphonal canal and functional tubes.

Spire high with an unknown protoconch and teleconch up to 4.5 whorls. Last whorl spiral morphology with IP, P1, s1, P2, P3, P4, P5, s5, P6, ADP, MP and ABP. Aperture ovate, columellar wall thick, projecting, extending away from previous whorl. Apertural denticles consisting of small D1, D2 and D3 always split, D4 & D5 more subtle, but distinct, angled toward axis, anterior end blunt, rounded, nearly flat at anterior end. Siphonal canal short, 22 % of total shell length (holotype), very broad, ventrally sealed, slightly convex near previous whorl, cord and final varices intersection concave, acutely pointed.

Discussion. *Tripterotyphis galapagosensis* n. sp. is easily distinguishable on the basis of its large size, weight, different spiral morphology and the locality to which it is endemic. This species exceeds 18.0 mm at maturity, has a thickness and very heavy weight unlike other species and contains only a s1 cord unlike other species of this genus, with additional secondary cords, or in the case of *T. jamesmacleani*, which lacks secondary cords.

This species was thought to be potentially new by D’Attilio as was stated by Finet (1985: 19) and additionally was suspect to the senior author (Wiedrick, 2012: 92) in the review of Panamic specimens analyzed. Although unillustrated, a specimen recorded as attaining a length of 23.6 mm from the Islas Galapagos, Ecuador (Pisor, 2008: 108) conforms with other specimens reviewed in this study and is here assumed to be a specimen of this species. Specimens of large size have historically been noted as coming from the Islas Galapagos (D’Attilio, 1979: 51; D’Attilio & Hertz, 1984: 52; Wiedrick, 2012: 92), a notable morphological characteristic, as well as being geographically isolated to this eastern Pacific archipelago. The radula of this species was illustrated by D’Attilio & Hertz (1988: fig. 4) and morphological features are distinctly different from those of the most allied species, *Tripterotyphis lowei* (Fig. 3I–L) (Ibid., fig. 5) in addition to *T. lowei* having a much thinner shell, narrower functional canal, a more acute siphonal canal, far less distinct spiral cords, a narrow aperture, having s5 and lacking ABP. Unfigured specimens from Islas Galapagos (Finet, 1985: 19; Kaiser, 2001: 5; Garrigues, 2020: 41), with size measurements

omitted, are here regarded as *T. galapagosensis* n. sp. based on their locality, and the fact that no specimens of *T. lowei* have been detected from this locality.

Etymology. Named for the Islas Galapagos, Ecuador, name masculine in the nominative case.

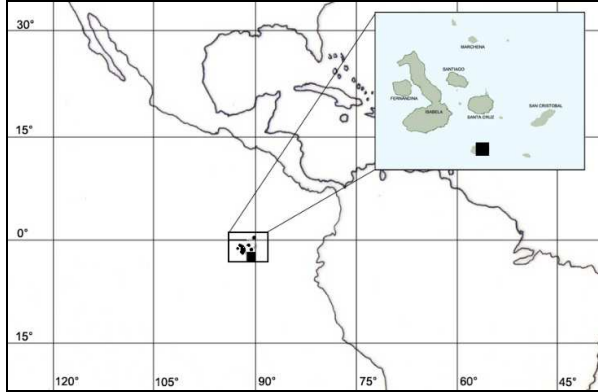


Figure 5. Distribution of *Tripterotyphis galapagosensis* n. sp. Square: type locality.

Tripterotyphis jamesmacleani n. sp.
Figs 6; 8A–F

Pterotyphis (*Tripterotyphis*) *lowei* (non Pilsbry, 1931) — Shasky & Campbell, 1964: 116, pl. 21, fig. 4. *Tripterotyphis lowei* (non Pilsbry, 1931) — Hertz, 1977: 40, figured; D'Attilio, 1979: 51, figs 2, 5–6 (far right); Wiedrick, 2012: fig. 1.

Tripterotyphis arcana (non DuShane, 1969) — D'Attilio & Hertz, 1988: 42, figs 31a–c; Wiedrick, 2012: 91.

Type material. Holotype LACM 3771 (Fig. 8A–D), length 11.1 mm, width 5.1 mm.

Type locality. La Cruz de Juanacaxtl, Bahía Banderas, Nayarit, México, 20°43'30" N, 105°25'00" W, intertidal to 2.4 m, collected by J. H. McLean and J. Margetts, 25 May 1971.

Other material examined. Two specimens from 1.0 km south of Punta Armenta, Bahía Concepcion, Golfo de California, Baja California Sur, Mexico, 26°37'02" N, 111°48'11" W, intertidal on rocks, 28 Dec 2009 (SGW 139).

Distribution. Known from Isla Smith, Bahía de Los Angeles, Baja California, Mexico (Hertz, 1977: 40) south to near Manzanillo, Colima, Mexico, intertidal to 31 m (D'Attilio & Hertz, 1988: 42) (Fig. 6).

Description. Shell length to 13.1 mm, width to 6.0 mm (Fig. 8E–F), average sized for genus. Shape elongate, tall, shell somewhat thin, compact, spire tall. Functional tubes comparably short, base concave, pits relatively deep, more rectangular than square, final varices weak, not expanding, intersection of cords rounded in shape, large in size. Shell color white, occasionally with a light brown band on base. Infratacalx chalky white, growth lines closely set, spacing unequal in width.

Spire very high, protoconch bulbous, erect, teleoconch up to 5.5 whorls. Last teleoconch whorl with initial IP cord low profile, flat, with P1, P2, P3, P4, P5, P6, ADP, ads, MP, ABP and abs cords, P2–P4 stronger, P5 and P6 weak. Aperture ovate, columellar wall non-projecting, except on outer lip. Apertural denticles consisting of D1–D5, D1–D3 large, D4 and D5 weak, anterior end thin, narrow. Siphonal canal short, 22% of total shell length (holotype), acute, pointed.

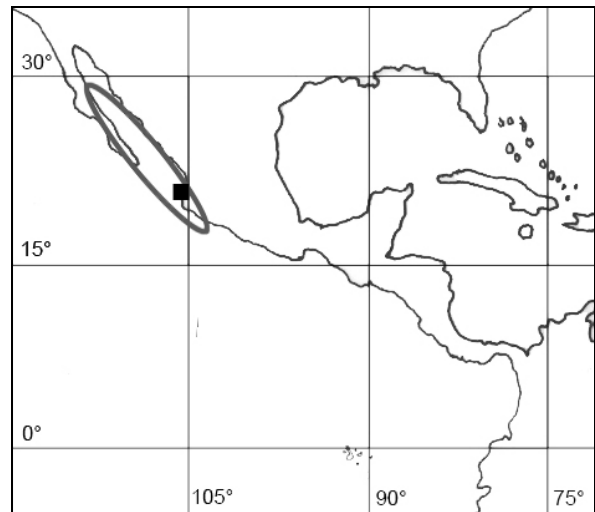


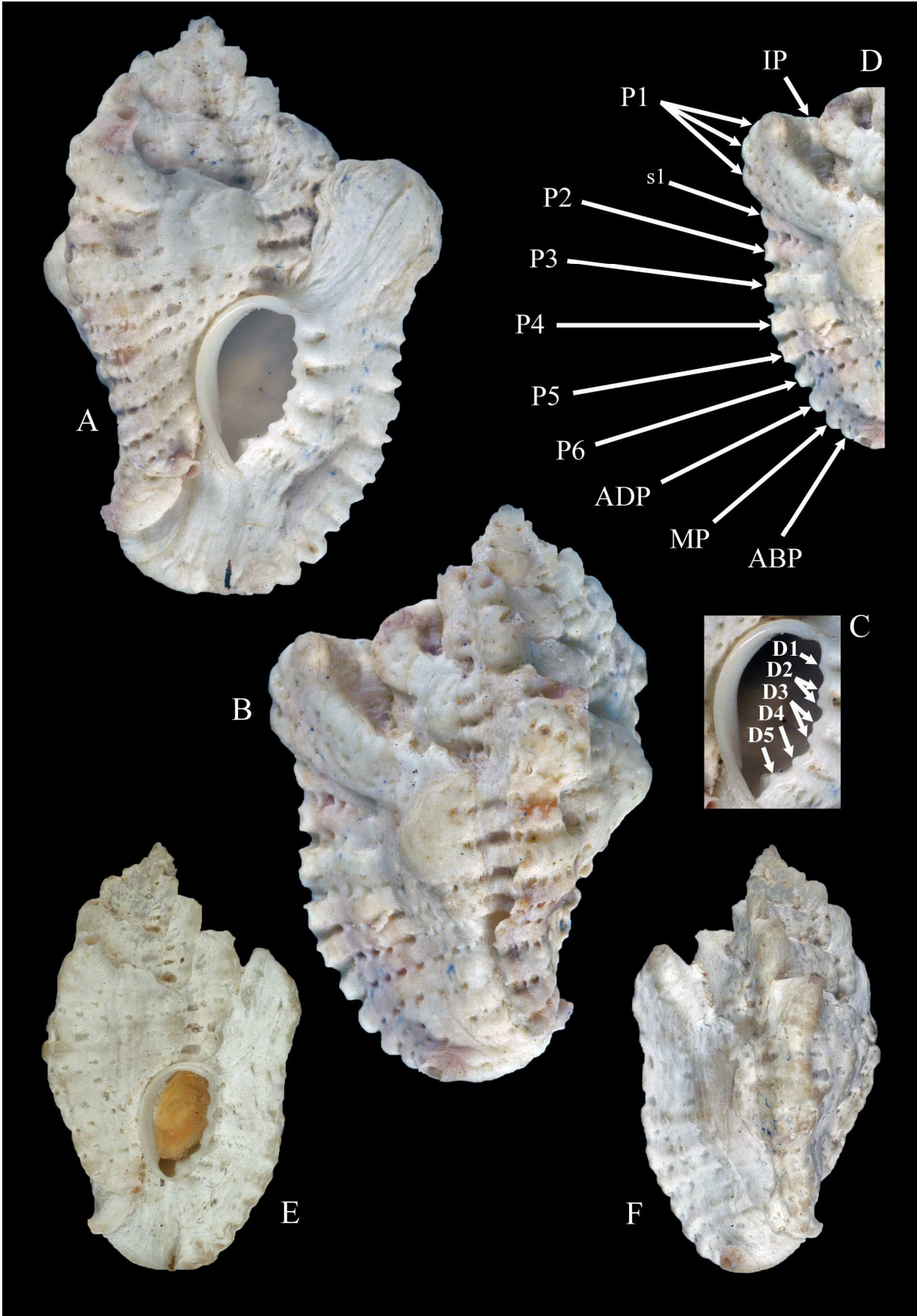
Figure 6. Distribution of *Tripterotyphis jamesmacleani* n. sp. Square: type locality.

Figure 7

A–F. *Tripterotyphis galapagosensis* n. sp.

A–D. Holotype SBNHM 211567, length 26.1 mm, width 13.8 mm, Isla Floreana, Islas Galapagos, Ecuador. A. Ventral view. B. Dorsal view. C. Denticle morphology. D. Spiral cords morphology.

E–F. Paratype SBNHM 211568, length 19.3 mm, width 11.7 mm, Isla Santa Cruz, Islas Galapagos, Ecuador. E. Ventral view. F. Dorsal view.



Discussion. This previously figured species (Hertz, 1977; D'Attilio, 1979; D'Attilio & Hertz, 1988) is most morphologically allied to *Tripterotyphis lowei* (Pilsbry, 1931) (Fig. 3I–L). The specimen figured by Hertz (1977: 40) matches the holotype in having far fewer cords than the similar *T. lowei* and lacking the wide spanning final whorl varix, two characteristics evident in this species. The specimen figured by D'Attilio & Hertz (1988: figs 31a–c), and labeled *T. arcana*, was also determined to be *T. arcana* by Wiedrick (2012: 91), despite the morphology matching the type specimen of *T. jamesmacleani*. An additional specimen figured by Robin (2008: 281, fig. 6) as *T. arcana* from Panama, resembles *T. jamesmacleani*, but that specimen is immature, and the exact identification is questionable.

Superficially this species is similar to both *T. lowei* and *T. galapagosensis* n. sp. *T. lowei* has s1 and s5 and is absent of ads, ABP and abs, all characters present in *T. jamesmacleani* n. sp. *Tripterotyphis galapagosensis* n. sp. is much larger, heavier, has denticles D2 and D3 split, an s1 cord, while *T. jamesmacleani* lacks an ads and abs cord and has a longer siphonal canal.

Compared to *T. jamesmacleani*, *T. arcana* is larger in size, has much stronger projecting cords at varices intersection, absent of an IP cord, presence of s1, followed by a tertiary cord, s4, s5 and the absence of ads, ABP and abs cords. The chalky intritcalx has not been detected in specimens of *T. arcana*, which is clearly evident in *T. jamesmacleani*.

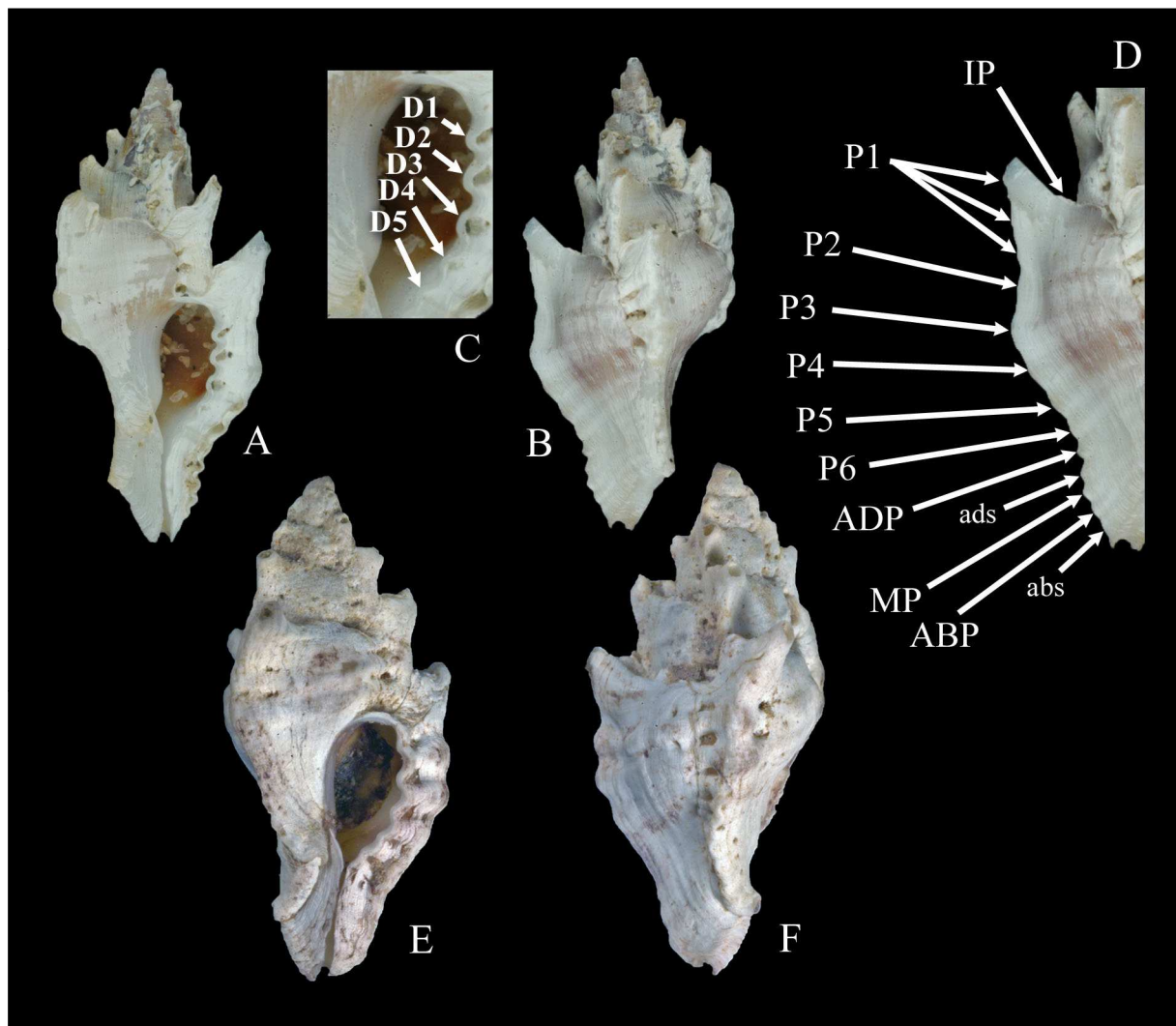


Figure 8

A–F. *Tripterotyphis jamesmacleani* n. sp.

A–D. Holotype LACM 3771 (ex LACM 71–81), length 11.1 mm, width 5.1 mm, Bahía Banderas, Nayarit, México. A. Ventral view. B. Dorsal view. C. Denticles morphology. D. Spiral cords morphology.

E–F. Hypotype SGW 139, length 13.1 mm, width 6.0 mm, 1.0 km south of Punta Armenta, Baja California Sur, México. E. Ventral view. F. Dorsal view.

Etymology. Named in the honor of the late Dr. James Hamilton McLean who collected the holotype specimen and called attention to this species being new to science to the senior author. The name is masculine in the genitive case.

ACKNOWLEDGMENTS

We are indebted to the late Dr. James (Jim) Hamilton McLean for his extensive and exhaustive efforts in understanding malacological fauna worldwide, but more appropriately for eastern Pacific fauna. His great insight and advice have greatly influenced the senior author in his professional development. We also wish to thank Dr. Daniel Geiger (Curator of Invertebrate Zoology) and Vanessa Delnavaz (Collection Manager of Invertebrate Zoology) at the Santa Barbara Museum of Natural History for their assistance with loaned material, holotype imagery and verifying data associated with other specimens in published literature. Additionally, Lindsey Groves (LACM Collections Manager, Malacology Department) who was especially helpful in allowing the senior author access to the LACM museum collections for analyzing specimens and for access to photography devices and necessary literature. Finally, we are grateful to Paul Callomon (ANSP Collection Manager of Malacology and General Invertebrates) for a lengthy discussion regarding the lectotype designation of *Typhis lowei* Pilsbry, 1931 and to the ANSP Malacology Department for the image of that specimen. We also thank the two referees for their constructive comments which helped to improve this manuscript.

REFERENCES

- Abbott, R.T. 1974. *American seashells: The marine Mollusca of the Atlantic and Pacific coasts of North America*, second edition. Van Nostrand Reinhold Company, New York, New York, U.S.A., 663 pp.
- Abbott, R.T. & Dance, S.P. 1982. *Compendium of seashells: A color guide to more than 4200 of the world's marine shells*. E. P. Dutton, Inc., New York, New York, U.S.A., 411 pp.
- Adams, A. 1855. Descriptions of two new genera and several new species of Mollusca, from the collection of Hugh Cuming, Esq. *Proceedings of the Zoological Society of London* 23: 119–124.
- Barco, A., Claremont, M., Reid, D.G., Houart, R., Bouchet, P., Williams, S.T., Cruaud, C., Couloux, A. & Oliverio, M. 2010. A molecular phylogenetic framework for the Muricidae, a diverse family of carnivorous gastropods. *Molecular Phylogenetics and Evolution* 56: 1025–1039.
- Brusca, R.C. & Hendrickx, M.E. 2008 and onward. The Gulf of California Invertebrate Database: The Invertebrate Portion of the *Macrofauna Golfo*. <http://www.desertmuseum.org/center/seaofcor tez/database.php>. Accessed on 23 March 2021.
- D'Attilio, A. 1975. The typhine shell: theme development and elaboration. *The Festivus* 6(9): 53–60.
- D'Attilio, A. 1976. Recent and fossil Typhinae of the new world. *The Festivus* 7(5): 27–30.
- D'Attilio, A. 1982. Convergence in the typhine form. *The Festivus* 14(8): 94–98.
- D'Attilio, A. & Radwin, G.E. 1971. The intritacalx, an undescribed shell layer in mollusks. *The Veliger* 13(4): 344–347, figs 1–8.
- D'Attilio, A. & Hertz, C. 1988. An illustrated catalogue of the family Typhidae Cossmann, 1903 (Gastropoda: Muricacea). *The Festivus* 20, supplement, 73 pp.
- Draper, B.C. 1980. Lost Operculum Club, list of champions: Marine shells of the Eastern Pacific Alaska to Chile. *The Conchological Club of Southern California*, Los Angeles, California, U.S.A., 43 pp.
- DuShane, H. 1969. A new genus and two new species of Typhinae from the Panamic Province (Gastropoda: Muricidae). *The Veliger* 11(4): 343–344, pl. 54.
- Fair, R.H. 1976. *The Murex book, an illustrated catalogue of Recent Muricidae (Muricinae, Muricopsinae, Ocenebrinae)*. Sturgis Printing Co., Honolulu, Hawaii, 138 pp.
- Finet, Y. 1985. Preliminary faunal list of the marine mollusks of the Galapagos Islands. Institut royal des Sciences naturelles de Belgique. *Documents de Travail* 20: 50 pp.
- Finet, Y. 1994. *The marine mollusks of the Galapagos Islands: A documented faunal list*. Museum d'Histoire Naturelle de Geneve, Switzerland, 180 pp.
- Galindo, E.S. 1977. *Index and register of seashells (with cross references)*. Libreria de Porrua Hermanos y Cia, Mexico, 524 pp.
- Garrigues, B. 2020. Description d'une nouvelle espèce des Philippines appartenant au genre *Tripterotyphis* (Muricidae: Tripterotyphinae). *Xenophora Taxonomy* 28: 36–42.
- Goto, Y. & Poppe, G.T. 1996a. *A listing of living Mollusca* 1(1). L'Informatore Piceno, Ancona, Italy, 1–469.
- Goto, Y. & Poppe, G.T. 1996b. *A listing of living Mollusca* 2(1). L'Informatore Piceno, Ancona, Italy, 1–520.
- Hendrickx, M.E.R., Brusca, R.C. & Findley, L.T. (eds.) 2005. A distributional checklist of the macrofauna of the Gulf of California, Mexico, part 1, Invertebrates [*Listado y distribución de la macrofauna del Golfo de California, México, parte 1, invertebrados*]. Arizona-Sonora Desert Museum and Conservation International, 429 pp.
- Hertz, J. 1977. Minute Shells. *The Festivus* 8(6): 40, fig. 1–2.

- Houart, R. & Hendrickx M., 2020. Three new species of Muricidae (Ocenebrinae, Pagodulinae) from the Gulf of California, Mexico and update of the living muricids from the area. *Novapex* 21(1): 17–33.
- Hutsell, K.C., Hutsell, L.L. & Pisor D.L. 1997. *Hutsell and Pisor's registry of world record size shells*. Snail's Pace Productions, San Diego, California, U.S.A., 100 pp.
- Kaicher, S.D. 1978. *Card catalogue of world-wide shells*, Muricidae 3, pack 16. Kaicher, St. Petersburg, Florida, U.S.A.
- Kaiser, K.L. 1997. The Recent molluscan marine fauna of the Islas Galapagos. *The Festivus* 24, supplement, 67 pp.
- Kaiser, K.L. 2001. Comments on four muricoidean (Mollusca) species formerly endemic to Isla del Coco found at Isla de Malpelo. *The Festivus* 33(1): 3–7, figs 1–6.
- Kaiser, K.L. & Bryce C.W. 2001. The Recent molluscan fauna of Isla de Malpelo, Columbia. *The Festivus* 33, occasional paper 1, 149 pp.
- Keen, A.M. 1944. Catalogue and revision of the gastropod subfamily Typhinae. *Journal of Paleontology* 18(1): 50–72.
- Keen, A.M. 1958. *Sea shells of Tropical West America, marine mollusks from Lower California to Colombia*. Stanford University Press, Stanford, California, U.S.A., 624 pp.
- Keen, A.M. 1971. *Sea shells of Tropical West America, marine mollusks from Baja California to Peru*, second edition. Stanford University Press, Stanford, California, U.S.A., 1064 pp.
- Keen, A.M. & Campbell, G.B. 1964. Ten new species of Typhinae (Gastropoda: Muricidae). *The Veliger* 7(1): 46–57.
- Merle, D. 1999. *La radiation des Muricidae (Gastropoda: Neogastropoda) au Paléogène: approche phylogénétique et évolutive*. Paris, France Thèse de doctorat du Muséum national d'Histoire naturelle: i–vi, 499 pp.
- Merle, D. 2001. The spiral cords and the internal denticles of the outer lip in the Muricidae: terminology and methodological comments. *Novapex* 2(3): 69–91.
- Merle, D. 2005. The spiral cords of the Muricidae (Gastropoda, Neogastropoda): Importance of ontogenetic and topological correspondences for delineating structural homologies. *Lethaia* 38: 367–379.
- Merle, D. & Houart, R. 2003. Ontogenetic changes of the spiral cords as key innovation of the muricid sculptural patterns: The example of the *Muricopsis-Murexul* lineages (Gastropoda: Muricidae: Muricopsinae). *C. R. Palevol.* 2: 547–561.
- MolluscaBase eds. 2021. MolluscaBase. Tripterotyphinae D'Attilio & Hertz, 1988. <https://www.molluscabase.org/aphia.php?p=taxdetails&id=405942>. Accessed on 2021-02-24
- Pilsbry, H.A. 1931. *Typhis lowei*, n.sp. *The Nautilus* 45(2): 72.
- Pilsbry, H.A. 1939. A banded variety of *Typhis lowei*. *The Nautilus* 53(2): 66.
- Pilsbry, H.A. & Lowe, H.N. 1932. West Mexican and Central American mollusks collected by H. N. Lowe 1929–1931. *Proceedings of the Academy of Natural Sciences of Philadelphia* 84: 33–144, pls. 1–17.
- Pisor, D.L. 2008. *Pisor's registry of world record size shells*, fifth edition. Conchbooks, Hackenheim, Germany, 207 pp.
- Radwin, G.E. & D'Attilio, A. 1976. *Murex shells of the world, an illustrated guide to the Muricidae*. Stanford University Press, Stanford, California, U.S.A., 284 pp.
- Robin, A. 2008. *Encyclopedia of marine gastropods*. ConchBooks, Hackenheim, Germany, 480 pp.
- Rosenberg, G.F., Moretzsohn, F. & García, E.F. 2009. Gastropoda (Mollusca) of the Gulf of Mexico. In Felder, D.L. & Camp, D.K. (eds.), *Gulf of Mexico: Origins, waters, and biota* 1, biodiversity: 579–699.
- Russini, V., Houart, R., Barco, A., Puillandre N., Lozouet P. & Oliverio M. 2019. Whelks, rock-snails and allied: the evolution of larval development within a new phylogenetic framework for the family Muricidae (Mollusca: Gastropoda): 144–166. In: Russini, V. 2019. *Evolution of larval development in marine gastropods*. Unpub. MS thesis, Sapienza University of Rome. <http://hdl.handle.net/11573/1359737>
- Shasky, D.R. 1989. My last seven years at Cocos Island. *The Festivus* 21(8): 72–75.
- Shasky, D.R. & Campbell, G.B. 1964. New and otherwise interesting species of mollusks from Guaymas, Sonora, Mexico. *The Veliger* 7(2): 114–120.
- Skoglund, C. 2002. Panamic Province molluscan literature additions and changes from 1971 through 2001, Gastropoda III. *The Festivus*, supplement 33, 286 pp.
- Smith, M. 1939. *An illustrated catalog of the Recent species of rock shells: Muricidae Thaisidae and Coralliophilidae*. Tropical Laboratory, Latana, Florida, U.S.A., 83 pp., pls. 1–21.
- Smith, M. 1944. *Panamic marine shells: Synonymy, nomenclature, range and illustrations*. Beal-Maltbie Shell Museum, Rollins College, Winter Park, Florida, U.S.A., 127 pp., figs 1–912.
- Sphon, G.G. 1971. Type specimens of recent mollusks in the Los Angeles County Museum of Natural History. *Contributions in Science* 213: 1–37.
- Tryon, G.W. 1880. *Manual of conchology: Structural and systematic, with illustrations of the species, vol. 2, Muricinae, Purpurinae*. Tryon, Philadelphia, Pennsylvania, U.S.A., 289 pp., pls. 1–70.

-
- Vokes, E.H. 1989. Neogene Paleontology in the northern Dominican Republic 8, the family Muricidae (Mollusca: Gastropoda). *Bulletin of American Paleontology* 97(332): 5–94
- Vokes, E.H. 1996. One last look at the Muricidae. *American Conchologist* 24(4): 4–6.
- Wiedrick, S.G. 2012. Comments on *Tripterotyphis lowei* (Gastropoda: Muricidae: Tripterotyphinae) with new distribution ranges of the genus from the Panamic Province. *The Festivus* 44(8): 91–93, figs 1–4.