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## Research article

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# New records and five new species of sipunculans (Sipuncula) from the central and northwestern Mexican Pacific

Julio D. GÓMEZ-VÁSQUEZ 

Laboratorio de Sistemática de Invertebrados Marinos (LABSIM), Universidad del Mar, campus Puerto Ángel, Ciudad Universitaria, Puerto Ángel, Pochutla, Oaxaca, 70902, Mexico.

Departamento de Sistemática y Ecología Acuática, Ecología Acuática, El Colegio de La Frontera Sur, Unidad Chetumal, Chetumal, 77014, Mexico.

E-mail: [gomezvjuliod@gmail.com](mailto:gomezvjuliod@gmail.com)

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**Abstract.** Sipuncula are marine unsegmented worms that can be found in benthic habitats, from shallow to deep-sea waters. In Mexico these worms have been scarcely studied. Among nine studies in the entire Mexican Pacific coasts, seven are from the central and northwestern Mexican Pacific. For over 80 years, only 24 species have been recorded. To improve the knowledge of the sipunculans from the central and northwestern Mexican Pacific, 501 specimens from three scientific collections of Mexico were revised. The specimens were collected by diverse methods from intertidal, subtidal, and bathyal depths (~1000 m), from 27 locations along the central and northwestern Mexican Pacific. Sixteen taxa belonging to nine genera and five families were identified. One species is recorded for the first time in the Mexican Pacific and five new species are described, one from intertidal and shallow subtidal depths: *Phascolosoma (Phascolosoma) azteca* sp. nov.; two from subtidal depths: *Phascolion (Lesenka) salgadoi* sp. nov. and *Sipunculus (Sipunculus) bastidai* sp. nov.; and two from bathyal depths: *Apionsoma (Apionsoma) silviae* sp. nov. and *Apionsoma (Edmondsius) hendrickxi* sp. nov.

**Keywords.** Bathyal, intertidal, morphology, *Phascolosoma*.

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## Introduction

The sipunculans, commonly known as peanut worms, are marine invertebrates without segmentation, with bilateral symmetry, and their body is divided into two regions, an anterior retractile introvert, and a posterior trunk (Cutler 1994). They live in a wide variety of marine habitats, from the intertidal to 7000 m deep (Murina 1984), in unconsolidated sediments, such as sand and mud, or inside shelters, such as mollusk shells or eroding coral and rocks (Stephen & Edmonds 1972; Cutler 1994). Recently, sipunculans have been classified among the annelids by phylogenetic analysis; however, experts do not fully accept this conclusion (Schulze *et al.* 2019).

Along the Pacific coast of Mexico, sipunculans have been scarcely studied. The first known report was made by Steinbeck & Ricketts (1941), who recorded four species from several sites in the Gulf

of California. Later, Fisher (1947, 1952) in two contributions, provided seven records and described nine species from locations off the western coast of the Baja California Peninsula and in the Gulf of California; however, most of them have been synonymized by Cutler (Cutler & Cutler 1987, 1988, 1990) with other known species. Thirty years later, Salazar-Vallejo (1983) gave the first record of a sipunculan from the central Mexican Pacific, *Aspidosiphon* cf. *albus* Murina, 1967. It took another 30 years before four sipunculan species were added to the Mexican Pacific records for the northern Gulf of California (Hermoso-Salazar *et al.* 2013). In a recent study, Morales-Zárate *et al.* (2016) recorded two morphospecies at the generic level, *Phascolion* sp. and *Themiste* sp., from Guerrero Negro Lagoon, western coast of Baja California Sur. Recently, Silva-Morales *et al.* (2019) described a new species of *Antillesoma* from the southern Mexican Pacific, while Galvéz-Zeferino *et al.* (2020) expanded the knowledge of sipunculans by adding five new records from the western coast of Baja California Sur, and Silva-Morales & Gómez-Vásquez (2021) recorded 11 species, including two newly described from the southern Mexican Pacific.

Only seven studies have recorded 24 sipunculan species from the central and northwestern Mexican Pacific during a period of 80 years. Discounting unidentifiable species, there are only 18 valid species for the central and northwestern Mexican Pacific (Table 1), which represents 12% of the richness of sipunculans of the world (Cutler 1994).

The sipunculans are a key component within the community of bioeroders (Alvarado *et al.* 2016), and they also play an important role in the trophic net by being part of the diet of polychaetes, mollusks, crustaceans, echinoderms, sea anemones, fish and even humans (Fischer 1925; Kohn 1975; Saiz-Salinas 1993; Cutler 1994).

The taxonomy of Sipuncula has historically been complex to approach, mainly because of their conserved morphology, leading to the idea that sipunculan species have a wide geographic distribution, resulting in many species having been synonymized (Cutler 1994). It has been observed that geographically separated populations of species show some morphological differences, indicating the possibility of being distinct species, an idea supported by molecular analysis (Kawauchi & Giribet 2010, 2014; Silva-Morales *et al.* 2019; Schulze & Kawauchi 2021), and the same kind of evidence has been used in recent reinstatements of synonymized species (Silva-Morales 2020; Silva-Morales & Gómez-Vásquez 2021).

The aim of this study is to improve our knowledge of the sipunculans present along the Mexican Pacific coast, with new records and the description of new species.

## Material and methods

The study area includes, according to Spalding *et al.* (2007), three marine ecoregions of the Northwest Warm Temperate Pacific province and one marine ecoregion of the Eastern Tropical Pacific province. The examined specimens came from 27 locations in the eight states of the central and northwestern Pacific of Mexico (Fig. 1).

The specimens were collected by free diving and breaking dead coral and rocks from shallow water. For those at subtidal and bathyal depths (20–1079 m), bottom samples were obtained on board oceanographic vessels using cores, dredges and trawl. All specimens were fixed with 4% formalin and later preserved in 70% ethyl and isopropyl alcohol.

The specimens were dissected, handled with fine tweezers and cut with a scalpel. The cuts were made from the anus towards the caudal area. In case the introvert was retracted, the cut was made anterior to the anus. Once the specimens were opened, they were mounted in a Petri dish, previously filled with a thick layer of wax, and fastened with entomological needles to expose the internal anatomy.

**Table 1.** Sipunculans recorded for the central and northwestern Pacific coast of Mexico. Q = questionable record.

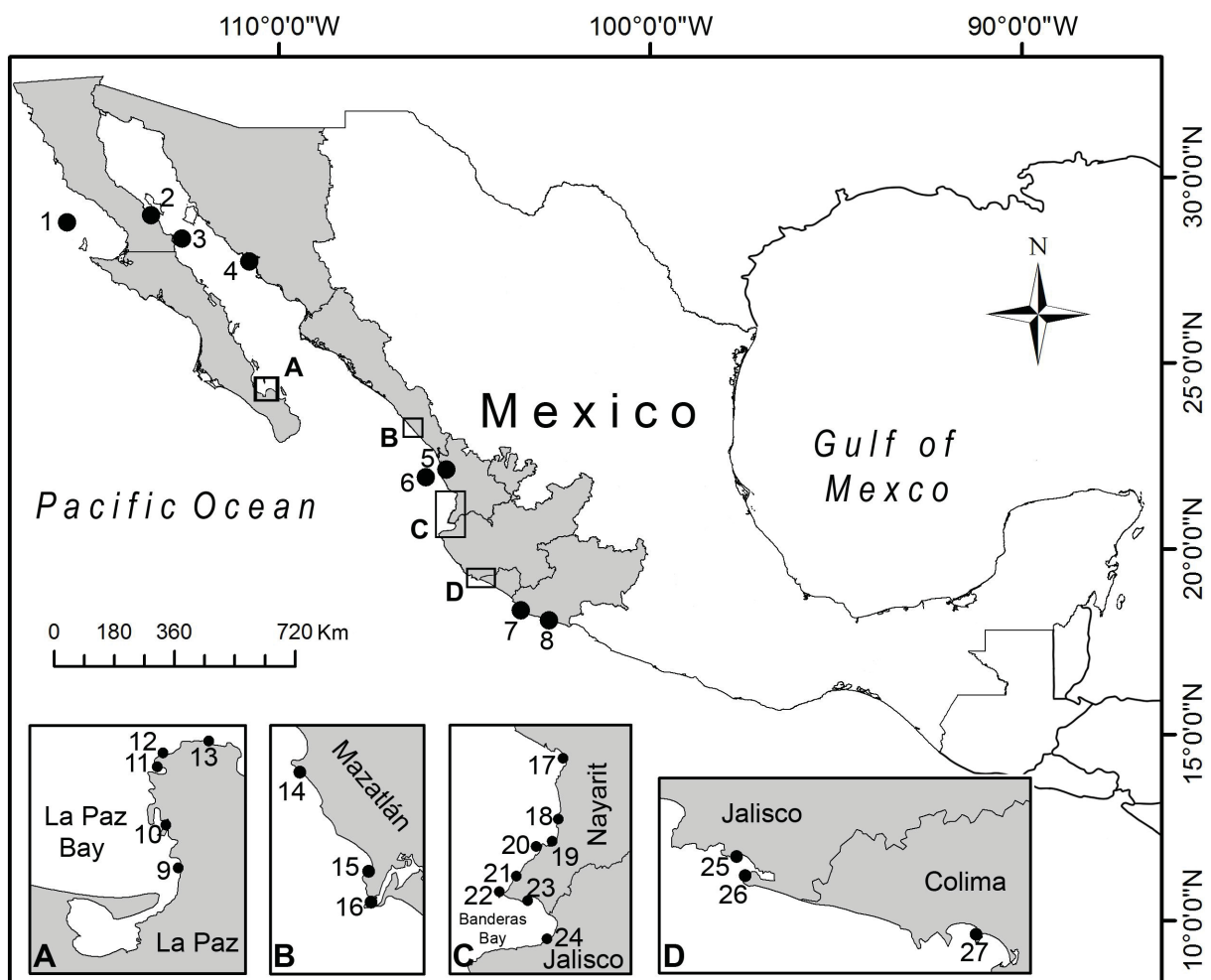
Species	Type locality	Reference
<b>Antillesomatidae Kawauchi, Sharma &amp; Giribet, 2012</b>		
<i>Antillesoma mexicanum</i> Silva-Morales <i>et al.</i> , 2019	Panteón Beach, Oaxaca	Steinbeck & Ricketts (1941)
<b>Aspidosiphonidae Baird, 1868</b>		
<i>Aspidosiphon (Akrikos)</i> cf. <i>albus</i> Murina, 1967	–	Salazar-Vallejo (1983)
<i>A. (A.) albus</i> Murina, 1967 Q	Cuba	Hermoso-Salazar <i>et al.</i> (2013)
<i>A. (Aspidosiphon) elegans</i> (Chamisso & Eysenhardt, 1821)	Radack, Marshall Islands	this study
<i>A. (A.)</i> sp.	–	this study
<i>A. (Paraspidosiphon) pastori</i> Silva-Morales & Gómez-Vásquez, 2021	Panteón Beach, Oaxaca	this study
<b>Golfingiidae Stephen &amp; Edmonds, 1972</b>		
<i>Golfingia (Golfingia)</i> cf. <i>muricaudata</i> (Southern, 1913)	–	this study
<i>Nephasoma (Nephasoma) eremita</i> (Sars, 1851) Q	NE Norway	Fisher (1952)
<i>N. (N.) diaphanes</i> (Gerould, 1813) Q	E North America	Gálvez-Zefrino <i>et al.</i> (2020)
<i>N. (N.) laetmophilum</i> Fisher, 1952	San Diego, CA	Gálvez-Zefrino <i>et al.</i> (2020)
<i>N. (N.) wodjanizkii wodjanizkii</i> (Murina, 1973)	Okhotsk Sea, Russia	Gálvez-Zefrino <i>et al.</i> (2020)
<i>Onchnesoma st. steenstrupii</i> Koren & Danielssen, 1876 Q	Bergen, Norway	Hermoso-Salazar <i>et al.</i> (2013)
<i>Phascolion (Lesenka) salgadoi</i> sp. nov.	Guaymas, Sonora	this study
<i>P. (Phascolion) strombus</i> (Montagu, 1814) Q	Devonshire, England	Gálvez-Zefrino <i>et al.</i> (2020)
<i>Themiste (Themiste)</i> cf. <i>blanda</i> (Selenka <i>et al.</i> , 1883)	Japan	this study
<i>T. (T.) hennahi</i> Gray, 1828	Perú	Fisher (1952)
<i>T. (T.) pyroides</i> (Chamberlin, 1919)	Laguna Beach, CA	Fisher (1952)
<b>Phascolosomatidae Stephen &amp; Edmonds, 1972</b>		
<i>Apionsoma (Apionsoma) hespera</i> (Chamberlin, 1920)	Laguna Beach, CA	Steinbeck & Ricketts (1941)
<i>A. (A.) silviae</i> sp. nov.	N Gulf of California	this study
<i>A. (Edmondsius) pectinatum</i> (Keferstein, 1867)	Pacific Panama	Fisher (1952)
<i>A. (E.) hendrickxi</i> sp. nov.	N Gulf of California	this study
<i>Phascolosoma (Phascolosoma) agassizii</i> Keferstein, 1866	Mendocino, CA	Steinbeck & Ricketts (1941)
<i>P. (P.) perlucens</i> Baird, 1868 Q	Jamaica	Fisher (1952)
<i>P. (P.) puntarenae</i> Grube & Örsted in Grube, 1858	Puntarenas, Costa Rica	Fisher (1952)
<i>Phascolosoma (P.) azteca</i> sp. nov.	Los Arcos, Jalisco	this study
<b>Sipunculidae Rafinesque, 1814</b>		
<i>Sipunculus (S.) bastidai</i> sp. nov.	W Baja California	this study
<i>Sipunculus (S.) nudus</i> Linnaeus, 1766 Q	“European waters”	Steinbeck & Ricketts (1941)
<i>Xenosiphon branchiatus</i> (Fischer, 1894)	Ecuador	Fisher (1947)

The specimens were observed under a stereoscopic microscope (Zeiss Discovery V8) and a compound microscope (Zeiss Scope A1) to observe the hooks and other small features. The photographs were taken with a Canon EOS Rebel T6 camera.

To identify the specimens, the identification keys of Stephen & Edmonds (1972) and Cutler (1994) were used; in addition, the original descriptions and redescrptions of the nominal species were consulted to compare with the specimens found in the central and northwestern Mexican Pacific. The classification follows Kawauchi *et al.* (2012).

The morphological terms used in the text are based on Cutler (1994). The abbreviations used in the descriptions of species are as follows:

- An = anus
- AS = anal shield
- CS = caudal shield
- CVV = contractile vessel villi
- DRM = dorsal retractor muscle
- Es = esophagus
- In = introvert
- It = intestine
- LMB = longitudinal muscle bands



**Fig. 1.** Study area. 1 = Western coast of Baja California; 2 = Bahía de Los Ángeles; 3 = San Miguel Cove; 4 = Guaymas Bay; 5 = Puerta de Palapares; 6 = Isabel Island; 7 = Faro de Bucerías; 8 = Caleta de Campos; 9 = Caimancito Beach; 10 = El Tesoro Beach; 11 = Balandra Beach; 12 = Las Caleras; 13 = Caleritas Beach; 14 = Cerritos Beach; 15 = Pinitos Beach; 16 = Crestón Island; 17 = Aticama; 18 = Chacala; 19 = Rincón de Guayabitos; 20 = Raza Point; 21 = Sayulita Beach; 22 = Punta Mita; 23 = Manzanilla Beach; 24 = Los Arcos Beach; 25 = San Patricio Melaque; 26 = Barra de Navidad; 27 = La Audiencia Beach.

- N = nephridium  
PEL = postesophageal loop  
PR = preanal ring papillae  
R = rectum  
RM = retractor muscle  
VNC = ventral nerve cord  
VRM = ventral retractor muscle

The collector acronyms (used in Material examined sections) are as follows:

- DHP = Dinorah Herrero-Pérezrul  
JLG = Jesús Ángel de León-González  
JPU = Juan Pablo Pérez-Urbiola  
LIB = Laboratorio de Invertebrados Bentónicos  
MTH = María Ana Tovar-Hernández  
NEG = Norma Emilia González  
PSS = Patricia Salazar-Silva  
RBZ = J. Rolando Bastida-Zavala  
SGM = María del Socorro García-Madrigal  
SSV = Sergio I. Salazar-Vallejo

All specimens came from three Mexican scientific collections:

- ECOSUR = Colección de referencia del Bentos Costero (ECO-CH-B), El Colegio de la Frontera Sur, Chetumal, Quintana Roo  
EMU = Colección Regional de Invertebrados Marinos, Instituto de Ciencias del Mar y Limnología (ICML), Mazatlán, Sinaloa  
UMAR = Colección Científica de Invertebrados Marinos, Universidad del Mar, Puerto Ángel, Oaxaca (OAX-CC-249-11)

The holotype of *Sipunculus* (*Sipunculus*) *bastidai* sp.nov is deposited in the collection of UMAR (UMAR-SIPU 129), and the holotypes of *Apionsoma* (*Apionsoma*) *silviae* sp. nov., *Apionsoma* (*Edmondsius*) *hendrickxi* sp.nov., *Phascolosoma* (*Phascolosoma*) *azteca* sp. nov. and *Phascolion* (*Lesenka*) *salgadoi* sp. nov. are deposited in the collection of EMU (EMU-13436, -13437, -13443 and -13448, respectively).

## Results

A total of 501 specimens of sipunculans from the central and northwestern Mexican Pacific were examined. The specimens were identified to the highest possible level, obtaining 16 taxa, belonging to nine genera and five families. Five species were unequivocally identified as species and confirmed for the region, three were left as close to the nominal species, three morphospecies need more evidence to confirm their identity, and five are described as new sipunculan species.

The best represented family was Golfingiidae Stephen & Edmonds, 1972 with six species, followed by Phascolosomatidae Stephen & Edmonds, 1972 with five, Aspidosiphonidae Baird, 1868 with three; Antillesomatidae Kawauchi, Sharma & Giribet, 2012 and Sipunculidae Rafinesque, 1814 are represented by one species each. *Phascolosoma* (*Phascolosoma*) *azteca* sp. nov. was the most abundant and widely distributed species, occurring at several locations in seven states of the central and northwestern Mexican Pacific.

Phylum Sipuncula Sedgwick, 1898  
Family Antillesomatidae Kawauchi, Sharma & Giribet, 2012  
Genus *Antillesoma* Stephen & Edmonds, 1972

*Antillesoma mexicanum* Silva-Morales, López-Aquino, Islas-Villanueva,  
Ruiz-Escobar & Bastida-Zavala, 2019  
Fig. 2

*Antillesoma mexicanum* Silva-Morales, López-Aquino, Islas-Villanueva, Ruiz-Escobar & Bastida-Zavala, 2019: 103–106, fig. 2 (type locality: Panteón Beach, Puerto Ángel, Oaxaca, México; in coral rubble, depth 2 m; southern Mexican Pacific).

*Physcosoma antillarum* (non Grube & Örsted in Grube, 1858). – Steinbeck & Ricketts 1941: 346, pl. 16 fig. 2 (Espíritu Santo Island and La Paz, Baja California Sur).

*Antillesoma antillarum* (non Grube & Örsted in Grube, 1858). – Fisher 1952: 434–436, pl. 39 figs 8–9. — Brusca 1980: 127 (reference from the Gulf of California).

### Material examined

MEXICO – **Baja California Sur** • 1 spec.; La Paz, Calerita Beach; intertidal; 1 Mar. 2006; DHP leg.; UMAR-SIPU 134. – **Sinaloa** • 2 specs; Mazatlan, Pinitos Beach; 23°12'28.02" N, 106°25'32.69" W; 23 Feb. 2004; depth 1 m; PSS and MTH leg.; associated with sabellariid tubes; ECOSUR-S026. – **Nayarit** • 1 spec.; Litigú Cove; 20°47'21" N, 105°31'3" W; 9 Apr. 1996; depth 3 m; EMU-13430 • 3 specs; Sayulita Beach; 20°47'24" N, 105°31'54" W; 10 Apr. 1996; depth 3 m; UMAR-SIPU 135 • 2 specs; Sayulita Beach; 20°52'15" N, 105°26'40.4" W; 28 Nov. 2004; depth 1 m; PSS *et al.* leg.; in rocks; ECOSUR-S0261 • 1 spec.; Banderas Bay, Manzanilla Beach; 20°44'25.49" N, 105°23'24.33" W; 29 Nov. 2004; depth 1 m; PSS *et al.* leg.; in rocks; ECOSUR-0260 • 1 spec.; Mantanchen Bay, Aticama Beach; 21°28'49" N, 105°12'12" W; 4 Nov. 2006; UMAR-SIPU 136. – **Jalisco** • 4 specs; San Patricio Melaque Beach; 19°13'08.82" N, 104°42'50.22" W; 1 Dec. 2004; depth 1 m; PSS *et al.* leg.; in rocks; ECOSUR-S0264 • 1 spec.; San Patricio Melaque Beach; 19°13'12.08" N, 104°42'49.95" W; 2 Dec. 2004; depth 3 m; PSS *et al.* leg.; in rocks; ECOSUR-S0263.

### Description (UMAR-SIPU 136)

Trunk up to 39 mm in length (range: 2.6–39 mm, n: 10), width  $\frac{1}{6}$  as long as trunk length; rough brownish skin, darker on anterior and posterior ends of trunk. Dark brown dome-shaped papillae scattered on entire trunk; packed on anterior and posterior ends. Introvert as long as  $\frac{1}{2}$  of trunk length, light brown; small conical papillae with rounded tip scattered on 80% of posterior introvert. Terminal end of introvert with a collar; with approximately 150 filiform tentacles, encircling nuchal organ.

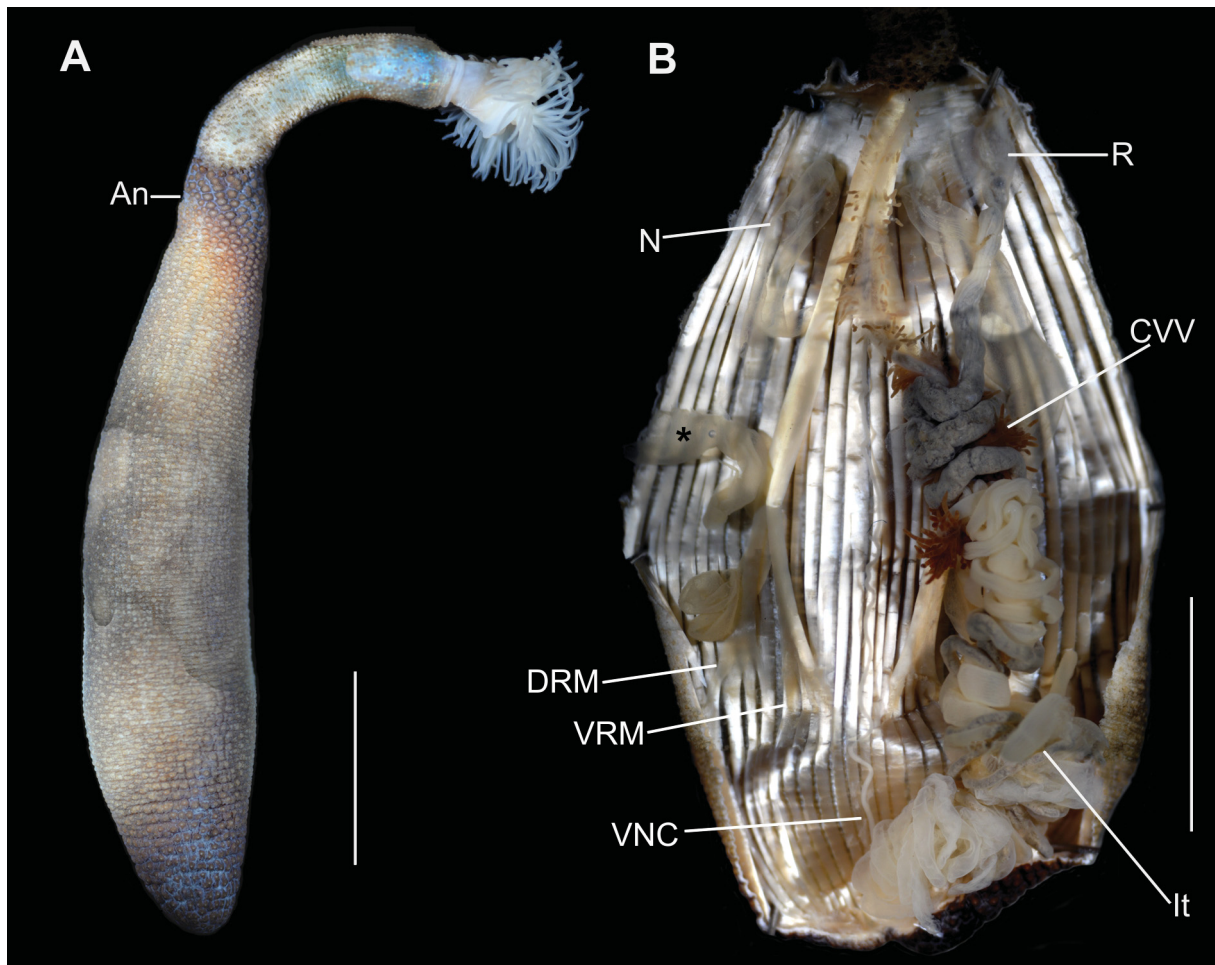
Longitudinal musculature divided into 30 anastomosing bands; two pair of retractor muscles, attached to body wall at 80% of posterior trunk length, dorsal pair thinner than ventral pair. A pair of nephridia occupying  $\frac{2}{3}$  of trunk length, nephridiopores open posterior to anus. Contractile vessel with numerous villi. Spindle muscle attached posteriorly (Fig. 2B).

### Habitat

Intertidal to subtidal (3 m); in rocks, in dead coral and associated with sabellariid tubes.

### Distribution

Mexican Pacific: from Baja California Sur to Oaxaca (Silva-Morales *et al.* 2019).



**Fig. 2.** *Antillesoma mexicanum* Silva-Morales, López-Aquino, Islas-Villanueva, Ruiz-Escobar & Bastida-Zavala, 2019 (UMAR-SIPU 136). **A.** Lateral overview, introvert everted. **B.** Internal anatomy; asterisk shows detached part of nephridium. Abbreviations: see Material and methods. Scale bars = 10 mm.

### Remarks

The specimens coincide morphologically with the descriptions of Steinbeck & Ricketts (1941) and Fisher (1952), which were recorded as *A. antillarum* (Grube & Örsted in Grube, 1858). Recently, Silva-Morales *et al.* (2019) examined specimens from the Southern Mexican Pacific, and using morphological and molecular features they recognized a new species, leaving the populations of *A. antillarum* restricted to the Caribbean. Here, the morphological features of the examined specimens agree with those described by Silva-Morales *et al.* (2019) for *A. mexicanum*.

Family Aspidosiphonidae de Quatrefages, 1865

Genus *Aspidosiphon* Diesing, 1851

Subgenus *Aspidosiphon* (*Aspidosiphon*) Diesing, 1851

*Aspidosiphon* (*Aspidosiphon*) *elegans* (Chamisso & Eysenhardt, 1821)

Fig. 3A–C

*Sternaspis elegans* Chamisso & Eysenhardt, 1821: 351–352, pl. 14 fig. 5a–e (type locality: Radack, Marshall Islands, in dead coral).

*Aspidosiphon exilis* Sluiter, 1886: 497, pl. 3 figs 11–12 (type locality: Tausend Island, Java).  
*Aspidosiphon ravus* Sluiter, 1886: 495–496, pl. 3 figs 9–10 (type locality: Bay of Bantam, Malaya).  
*Aspidosiphon spinosus* Sluiter, 1902: 28, pl. 2 figs 17–19 (type locality: Damar Island, Indonesia).  
*Aspidosiphon brocki* Augener, 1903: 34–36, figs 9–13 (type locality: Polo Ednam, Amboina, Malaya).  
*Aspidosiphon spinalis* Ikeda, 1904: 47–49, fig. 12 (type locality: Koniya, Amami-Osima, Japan).  
*Aspidosiphon coralinus* Sato, 1935: 318–319, pl. 4 fig. 19 (type locality: Arukoron Island, West Caroline Islands).  
*Aspidosiphon homomyarium* Johnson, 1964: 332–334, pl. 8 (type locality: Okha, India).

*Aspidosiphon brocki* – Rice 1970: 44, fig. 8 (Florida, northern Caribbean Sea).  
*Aspidosiphon (Aspidosiphon) elegans* – Fonseca & Cortés 1988: 172–173 (Pacific coast of Costa Rica).  
— Cutler & Cutler 1989: 842–844 (subgenus assignment). — Dean 2001: 89 (Golfo Dulce, Costa Rica). — Silva-Morales & Gómez-Vásquez 2021: 97–99, fig. 11 (Southern Mexican Pacific).

### Material examined

MEXICO – **Baja California Sur** • 5 specs; La Paz, Calerita Beach; 1 Mar. 2006; DHP *et al.* leg.; intertidal; UMAR-SIPU 151. – **Nayarit** • 1 spec.; Punta Mita; 15 Jul. 1990; depth 4 m; JPU leg.; inhabiting *Porites* sp.; UMAR-SIPU 152.

### Description (UMAR-SIPU 151)

Trunk 12 mm in length; whitish, slightly translucent body wall (Fig. 3A); scattered flat oval papillae. Introvert slightly longer than half of trunk length. Twelve small digitiform tentacles, encircling nuchal organ. Anterior hooks 40 µm long, laterally compressed and bidentate (Fig. 3B), arranged in 14 complete rings; posterior scattered, dark unidentate hooks 50 µm long (Fig. 3C), anterior hooks pyramid-shaped, mid and posterior ones conical. Anal shield yellowish, formed by small, packed granules with well-defined margin. Without caudal shield; specimen UMAR-SIPU 151 in asexual reproduction phase, seen by presence of a bud occupying  $\frac{1}{10}$  of trunk length.

Longitudinal musculature in a continuous layer, in bands under anal shield. A pair of retractor muscles, attached to body wall at posterior end of trunk. Two nephridia of 40% of trunk length; nephridiopores open posterior anus. Spindle muscle attaches to intestine anteriorly and trunk posteriorly.

### Habitat

Intertidal to subtidal (4 m); in dead coral.

### Distribution

Pantropical, widespread and common in the Indian and western Pacific Oceans, from south-central Japan to northern Australia, the Red Sea and Israel; in the Caribbean from northern Brazil to the Florida Keys and Bermuda (Cutler 1994). In the eastern Pacific from southern Gulf of California to Costa Rica (Fonseca & Cortés 1988).

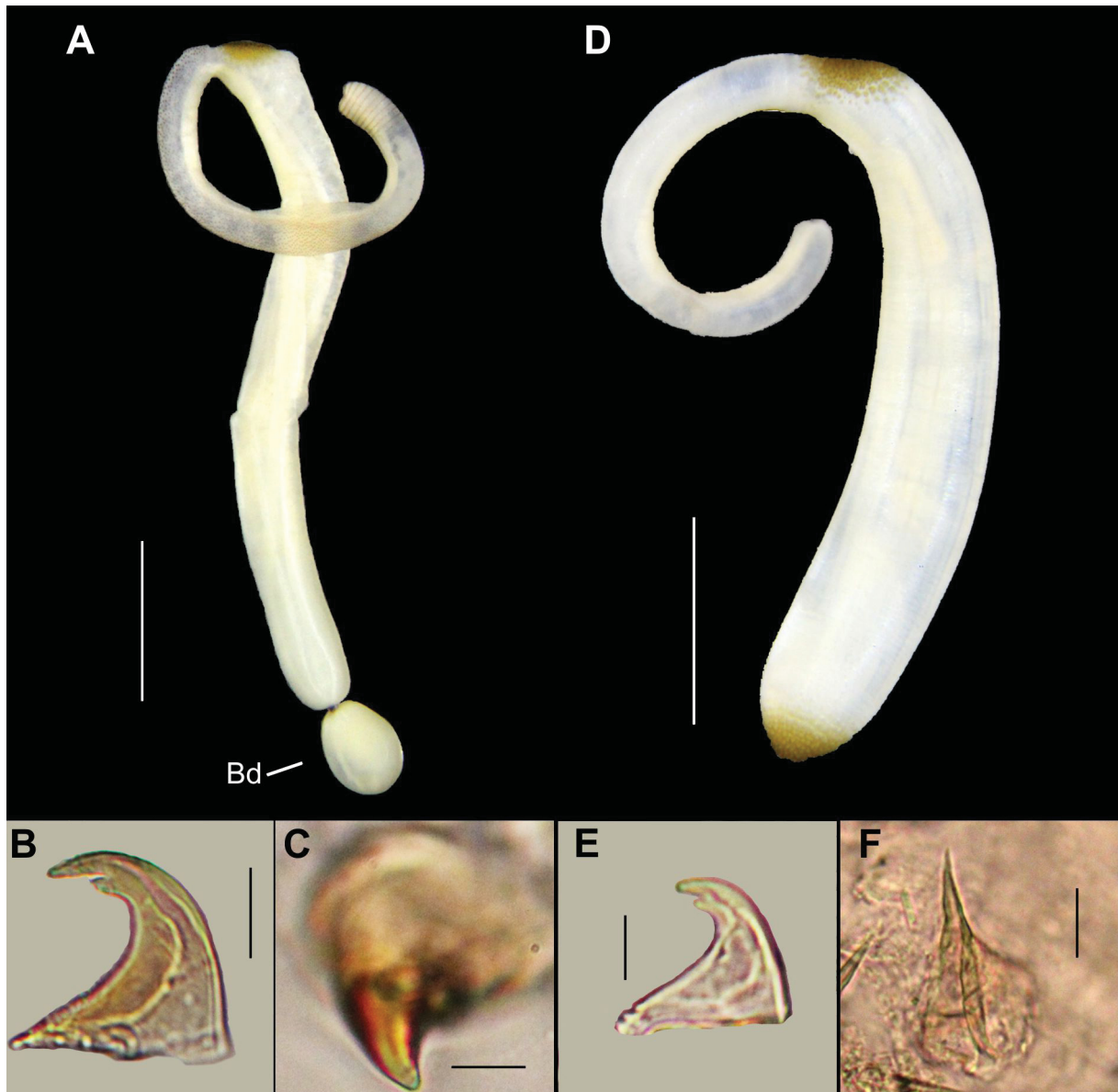
### Remarks

The presence of *A. (A.) elegans* in the eastern Pacific was not discovered (*sensu* Cutler 1994) until Fonseca & Cortés (1988) recorded it from Costa Rica, and Silva-Morales & Gómez-Vásquez (2021) from the southern Mexican Pacific.

Silva-Morales & Gómez-Vásquez (2021) compared specimens identified as *Aspidosiphon (A.) elegans* from the southern Mexican Pacific with those present in the Mexican Caribbean, and no differences in body features were found; however, some differences in the bidentate hooks, regarding both teeth and



internal anatomy, were noted. Also, consulting the descriptions and illustrations of species synonymized with *A. (A.) elegans* (i.e., *A. brocki*, *A. coralinus* and *A. exilis*; Stephen & Edmonds 1972), I found that the configuration of the bidentate hooks is also different from the one seen in specimens from the Mexican Pacific. This may suggest that *A. (A.) elegans* is a species complex, and more detailed examination is required to determine the validity of worldwide records and whether the species is truly pantropical or the synonymized species can be considered as valid, and therefore be reinstated. Between the material of the southern Mexican Pacific and the specimens reviewed here, there are no morphological differences, indicating that there is only one morphospecies in the entire Mexican Pacific.



**Fig. 3.** Aspidosiphonids. **A–C.** *Aspidosiphon (Aspidosiphon) elegans* (Chamisso & Eysenhardt, 1821 (UMAR-SIPU 151). **A.** Lateral overview of specimen with budding. **B.** Anterior bidentate hook. **C.** Posterior conical hook. **D–F.** *Aspidosiphon (Paraspidosiphon) pastori* Silva-Morales & Gómez-Vásquez, 2021 (UMAR-SIPU 154). **D.** Lateral overview, introvert partially everted. **E.** Anterior bidentate hook. **F.** Posterior pyramidal hook. Bd = bud. Scale bars: A, D = 3 mm; B–C = 20 µm; E–F = 10 µm.

With the present records, the distribution of *A. (A.) elegans* is extended to the northern Gulf of California. It has been observed that the species has asexual reproduction by transverse fission in the posterior region of the trunk (Rice 1970; Acik 2008), as was also observed in the specimens examined here (Fig. 3A).

*Aspidosiphon (Aspidosiphon) sp.*

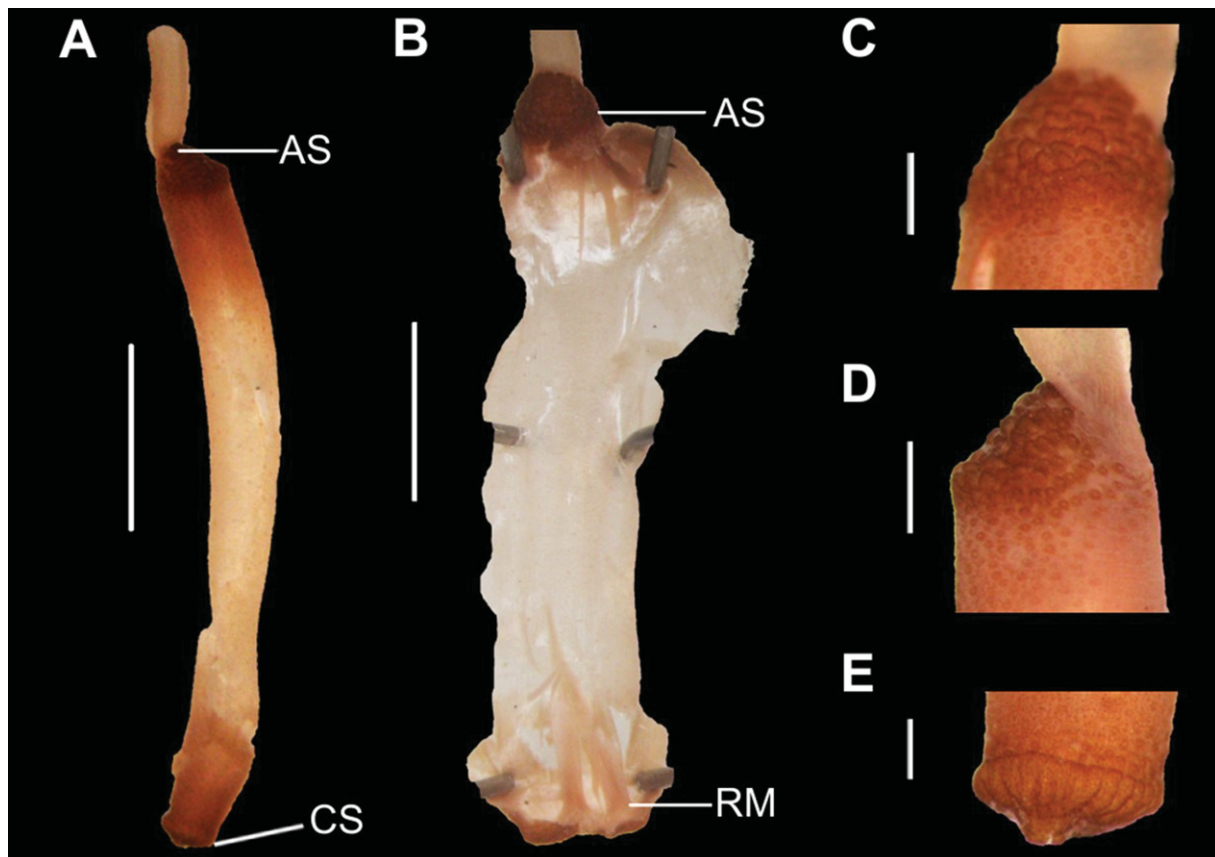
Figs 4–5

**Material examined**

MEXICO • 1 spec.; Baja California, San Miguel Cove; 28°09'04" N, 112°46'06" W; 6 May 1982; depth 30–35 m; Van Veen grab; Cortés stn 19, on board R/V *El Puma*; EMU-13432.

**Description** (EMU-13432)

Trunk 10 mm in length, width  $\frac{1}{10}$  as long as trunk length; smooth yellowish-brown skin; anterior and posterior ends darker (Fig. 4A). Mid trunk with two types of papillae: flat, oval, transversally elongated and small granules with a keratinized appearance, numerous and scattered, forming transverse or longitudinal lines along trunk. Introvert incomplete, anterior hooks 14  $\mu\text{m}$  long laterally compressed and bidentate (Fig. 5A–B), arranged in rings, main tooth sharp; scattered posterior unidentate, pale hooks 16  $\mu\text{m}$  long, with pyramidal base and conical tip (Fig. 5C–D), present towards anal shield; roll-type chitinized structure 16  $\mu\text{m}$  long among scattered unidentate hooks (Fig. 5 E–F). Anal shield well-defined, formed by small, packed granules with ill-defined margins, scattered granules around shield



**Fig. 4.** *Aspidosiphon (Aspidosiphon) sp.* (EMU-13432). **A.** Lateral overview, introvert incomplete. **B.** Internal anatomy. **C.** Anal shield, dorsal view. **D.** Anal shield, lateral view. **E.** Caudal shield. Abbreviations: see Material and methods. Scale bars: A–B = 3 mm; C–E = 0.5 mm.

(Fig. 4C–D). Caudal shield margin protruding, acorn-shaped, with 20 radial grooves ending in a rounded tip (Fig. 4E).

Longitudinal musculature in a continuous layer (Fig. 4B), in bands under anal shield. A pair of retractor muscles attached to body wall at posterior end of trunk; nephridiopores open anterior to anus.

#### Habitat

Subtidal (30–35 m); in muddy sand.

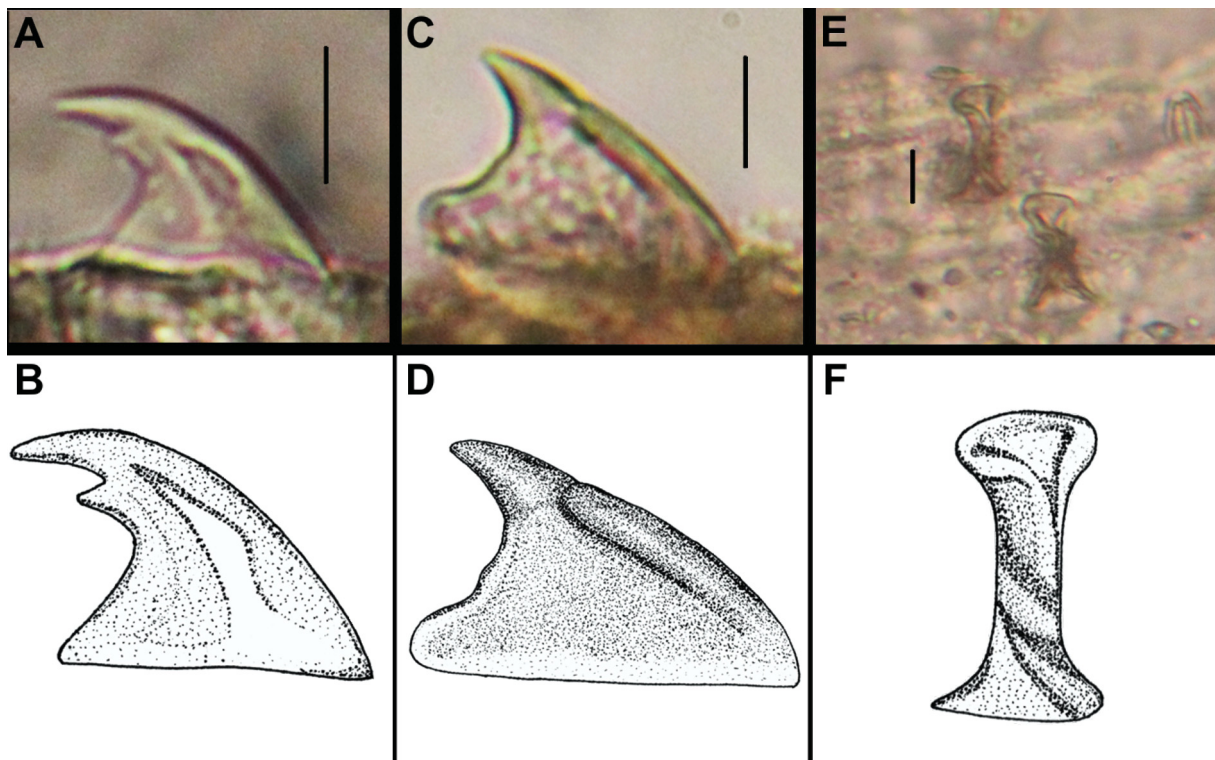
#### Distribution

Sea of Cortez, known only from stn 19 of the Cortés cruise, near Cabo San Miguel, Baja California.

#### Remarks

The unique specimen examined is incomplete, without a substantial portion of the introvert and part of the internal organs, i.e., no nephridia or intestine were present; however, what is observed on the specimen was sufficient to be able to identify it to subgenus.

*Aspidosiphon* (*A.*) sp. is closely related to *A. (A.) misakiensis* Ikeda, 1904 and *A. (A.) muelleri* Diesing, 1852; however, there are some features which make *A. (A.)* sp. different from any other species of the subgenus. Specifically, the presence of unidentate hooks with a pyramidal base and conical tip, the presence of the roll-type chitinized structure, which is not known for any of the species of the subgenus, and the presence of the two types of shields in *A. (A.)* sp., an ungrooved anal shield with packed granules, and an acorn-shaped caudal shield. In *A. misakiensis* both shields consist of granules, as also in *A. muelleri*, where the anal shield is grooved.



**Fig. 5.** *Aspidosiphon* (*Aspidosiphon*) sp. (EMU-13432). **A–B.** Bidentate laterally compressed hook. **C–D.** Unidentate hook with pyramidal base and cylindrical tip. **E–F.** Roll-type hook. Scale bars: A, C, E = 10  $\mu$ m.

Based on the latter, this specimen might represent a new species; however, it is necessary to obtain complete specimens to describe it formally.

Subgenus *Aspidosiphon* (*Paraspidosiphon*) (Stephen, 1964)

*Aspidosiphon* (*Paraspidosiphon*) *pastori* Silva-Morales & Gómez-Vásquez, 2021

Fig. 3D–F

*Aspidosiphon* (*Paraspidosiphon*) *pastori* Silva-Morales & Gómez-Vásquez, 2021: 101–103, fig. 13  
(type locality: Panteón Beach, Puerto Ángel, Oaxaca).

### Material examined

MEXICO – **Baja California** • 12 specs; Cabo San Miguel; 28°10'00" N, 112°47'07" W; 13 Mar. 1985; depth 29–35 m; trawl; Cortés II stn 19, on board R/V *El Puma*; EMU-13433 • 10 specs; Cabo San Miguel; 28°10'00" N, 112°47'07" W; 13 Mar. 1985; depth 25–29 m; trawl; Cortés II stn 19, on board R/V *El Puma*; UMAR-SIPU 153 • 3 specs; Cabo San Miguel; 28°09'04" N, 112°46'06" W; 1 Aug. 1982; depth 30–35 m; Van Veen grab; Cortés III stn 20, on board R/V *El Puma*; EMU-13434. – **Baja California Sur** • 4 specs; La Paz, Cabo Pulmo; 1989; UMAR-SIPU 154 • 1 spec.; La Paz, El Caimancito Beach; 24°12'10.43" N, 110°18'01.09" W; 10 Oct. 1987; depth 2 m; SSV leg.; in rocks; ECOSUR-S0286 • 4 specs; La Paz, El Caimancito Beach; 24°12'15" N, 110°18'02.96" W; 29 Feb. 2004; depth 1 m; PSS and MTH leg.; inhabiting *Porites* sp.; ECOSUR-S0283 • 1 spec.; Calerita Beach; 1 Mar. 2006; DHP *et al.* leg.; intertidal; UMAR-SIPU 155. – **Sinaloa** • 2 specs; Mazatlán Bay; 28 Oct. 1980; Crucero 15, stn 8; EMU-13435. – **Nayarit** • 3 specs; Sayulita Beach; 20°47'24" N, 105°31'54" W; 10 Apr. 1996; depth 2 m; under rocks; UMAR-SIPU 156 • 2 specs; Banderas Bay, Manzanilla Beach, 20°44'25.49" N, 105°32'24.33" W; 29 Nov. 2004; depth 2 m; PSS *et al.* leg.; in rocks; ECOSUR-S0282. – **Jalisco** • 2 specs; San Patricio Melaque Beach; 19°13'08.82" N, 104°42'50.22" W; 1 Dec. 2004; depth 1 m; PSS *et al.* leg.; in rocks; ECOSUR-S0287 • 1 spec.; San Patricio Melaque Beach; 19°13'12.08" N, 104°42'49.95" W; 2 Dec. 2004; depth 3 m; PSS *et al.* leg.; in rocks; ECOSUR-S0285 • 8 specs; Barra de Navidad, Corrales Beach; 19°11'14.08" N, 104°41'42.84" W; 3 Dec. 2004; depth 4 m; PSS *et al.* leg.; in rocks; ECOSUR-S0284. – **Michoacán** • 1 spec.; Caleta de Campos; 17 Dec. 1994; MSGM and RBZ leg.; UMAR-SIPU 157 • 1 spec.; Bucerías Beach; 19 Dec. 1994; MSGM and RBZ leg.; UMAR-SIPU 158.

### Description (UMAR-SIPU 154)

Trunk 10 mm in length; whitish semi-translucent (Fig. 3D). Introvert as long as trunk. Six small digitiform tentacles surrounding nuchal organ. Anterior 40% of introvert length with laterally compressed bidentate hooks (Fig. 3E), 20 µm long, arranged in rings; scattered pale pyramidal hooks on rest of introvert, 30 µm long (Fig. 3F). Anal shield consisting of small dark, packed granules with diffuse margins. Caudal shield of same shape as anal shield, with diffuse margins.

Longitudinal musculature divided in 18 bands along trunk, with high degree of anastomosis. Two retractor muscles attached to body wall at 95% of trunk length. Nephridia 25% of trunk length; spindle muscle attached intestine at both ends of trunk.

### Habitat

Intertidal to subtidal (35 m). In dead coral (*Porites* sp.).

### Distribution

Mexican Pacific: from Gulf of California to Oaxaca.

### Remarks

This species was recently described from the southern Mexican Pacific. The specimens from the central and northwestern Mexican Pacific coincide with the description made by Silva-Morales & Gómez-Vásquez (2021); with this study the range extends from Guerrero State (southern Mexican Pacific) to the Gulf of California.

The specimens of *Aspidosiphon (P.) pastori* are morphologically close to *A. (P.) tenuis* Sluiter, 1886. The main differences are present in the proximal hooks. In *A. (P.) pastori* the pyramidal hooks are pale, whereas *A. (P.) tenuis* instead has unidentate structures with laterally reinforced ridges (Cutler 1994). Another difference is that *A. (P.) pastori* has a shield made of granules with diffuse margins, and *A. (P.) tenuis* has a grooved shield with well-defined margins.

Family Golfingiidae Stephen & Edmonds, 1972

Genus *Golfingia* Lankester, 1885

Subgenus *Golfingia (Golfingia)* Lankester, 1885

***Golfingia* cf. *muricaudata*** (Southern, 1913)

Fig. 6A

### Type locality of nominal species

Ireland (Southern 1913: 21, pl. 4 fig. 5).

### Material examined

MEXICO • 1 spec.; W coast of Baja California; 28°47'15" N, 115°42'57" W; 1 Aug. 2013; depth 1045 m; core; TALUD XVI cruise, on board R/V *El Puma*; EMU-13446.

### Description (EMU-13446)

Trunk 50 mm in length; rough, light brown body wall; scattered thin, cylindrical papillae. Caudal appendage 10% of trunk length, covered with cylindrical papillae. Introvert incomplete, shorter than trunk.

Longitudinal musculature continuous. Four retractor muscles (RM), dorsal RM attached to body wall anteriorly to ventral pair and more separated from ventral nerve cord. Esophagus attached to ventral RM. Two sack-shaped nephridia; nephridiopores open anteriorly anus; without spindle muscle; rectum with six thin lateral muscles; ventral nerve cord ends before internal anterior margin of caudal appendage.

### Habitat

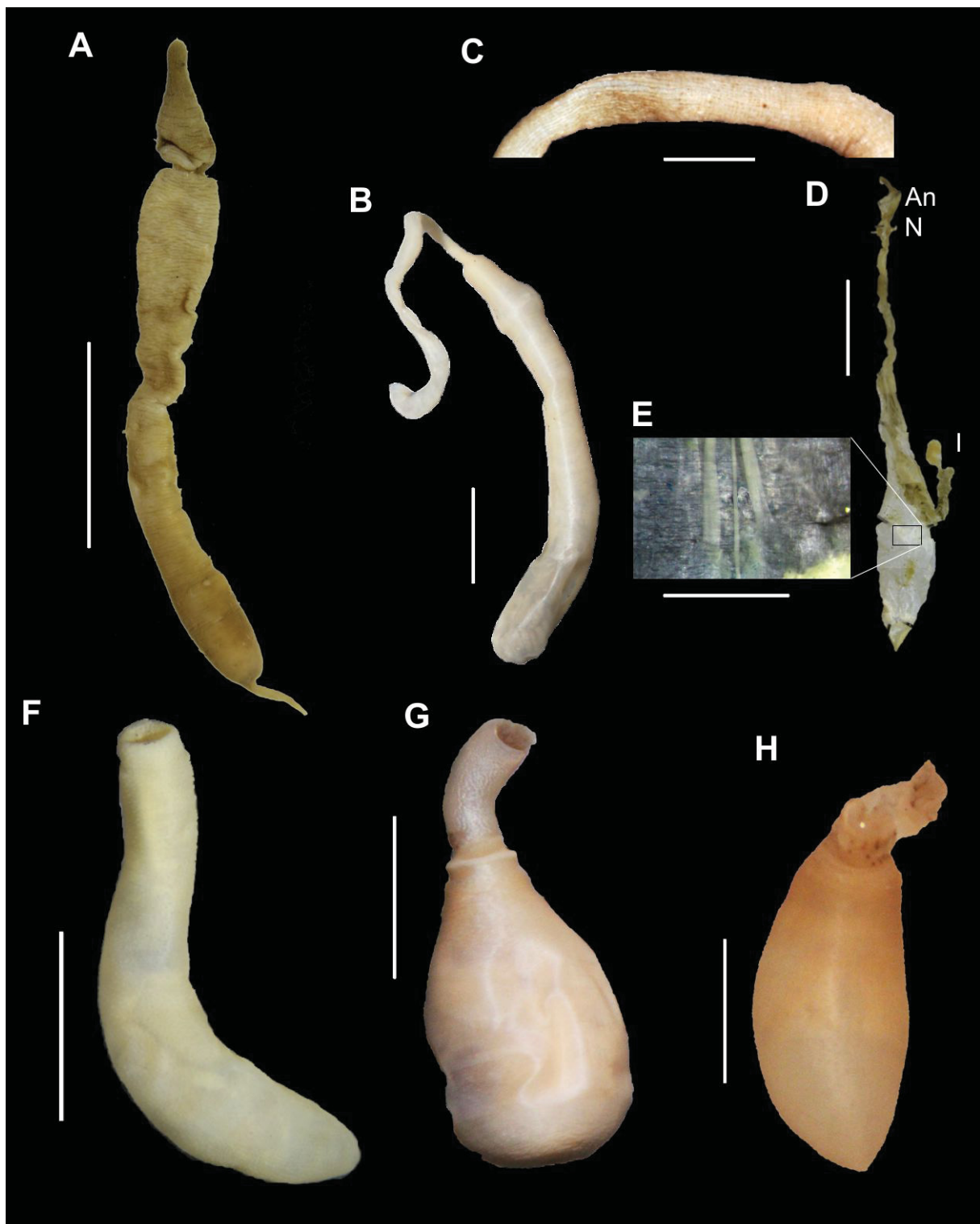
Bathyal (1045 m); muddy sand bottom.

### Distribution

Western coast of Baja California.

### Remarks

Despite the damage to the single specimen examined, it was placed in the subgenus *Golfingia (Golfingia)* because the dorsal retractor muscles are displaced. Within the subgenus only two species have a caudal appendage. One is *G. (G.) anderssoni* (Théel, 1911), described from Antarctica; it has large, bladder-shaped papillae that cover an area of 65–90% of the posterior trunk length (Cutler 1994), while the specimen examined here from Baja California has inconspicuous conical papillae. The other species is *G. (G.) muricaudata*, which also has inconspicuous conical papillae. Unfortunately, since the specimen



**Fig. 6.** Golfingids. **A.** *Golfingia* (*Golfingia*) cf. *muricaudata* (EMU-13446). **B–E.** *Nephasoma* (*Nephasoma*) *wodjanizkii wodjanizkii* (Murina, 1973) (UMAR-SIPU 133). **B.** Lateral overview. **C.** Lateral view of posterior introvert. **D.** Internal anatomy. **E.** Close-up of retractor muscle origins from body wall. **F.** *Themiste* (*Themiste*) cf. *blanda* (ECOSUR-S0256). **G.** *T. (T.) hennahi* Gray, 1828 (ECOSUR-S0255). **H.** *T. (T.) pyroides* Chamberlin, 1920 (UMAR-SIPU 130). Abbreviations: see Material and methods. Scale bars: A = 2 cm; B, H = 2 mm; C, E = 1 mm; D, F = 4 mm; G = 3 mm.

is damaged, the identity of this species cannot be confirmed; more specimens are needed to clarify its status.

The nominal species, *Golfingia (Golfingia) muricaudata* (Southern, 1913), was described from Ireland from depths of 475–1088 m (Southern 1913); it has also been recorded from Japan (Murina 1964) and the North Pacific (Maiorova & Adrianov 2015, 2018).

Genus *Nephasoma* Pergament, 1940  
Subgenus *Nephasoma (Nephasoma)* Pergament, 1940

*Nephasoma (Nephasoma) wodjanizkii wodjanizkii* (Murina, 1973)  
Fig. 6B–E

*Golfingia wodjanizkii* Murina, 1973a: 944–945, pl. 2 figs 5–6 (type locality: Alaska, 55°20'05" N, 134°49'05" W, depth 1100 m).

*Golfingia nicolasi* Thompson, 1980: 951–956, fig. 2a–c (type locality: stn 813, San Nicolás Basin, California, depth 1754 m).

*Golfingia wodjanizkii* – Murina 1973b: 70 (Peruvian-Chilean trench, 1940–2000 m). — Frank 1983: 18–19 (west of Prince of Wales Island, Alaska, 55°20'05" N, 134°49'05" W, 42 m).

*Nephasoma (Nephasoma) wodjanizkii wodjanizkii*. – Cutler & Cutler 1986: 555–566, tab. 1 (new combination and synonymization). — Gálvez-Zeferino *et al.* 2020: 484, fig. 2c (Guerrero Negro Lagoon, Baja California; questionable record from a coastal lagoon).

#### Material examined

MEXICO – **Baja California** • 4 specs; W coast of Baja California, 28°47'15" N, 115°42'57" W; 1 Aug. 2013; depth 1045 m; core; TALUD XVI cruise, stn 4, on board R/V *El Puma*; EMU-13447 • 6 specs; W coast of Baja California, 29°08'15" N, 115°33'43" W; 24 May 2014; depth 1079 m; core; TALUD XVI-B cruise, stn 6, on board R/V *El Puma*; UMAR-SIPU 133.

#### Description (UMAR-SIPU 133)

Slim filiform body, trunk 24 mm in length (Fig. 6B); anterior half of trunk thinner. Smooth, light brown body wall, with short mammillate papillae. Introvert of same length as trunk; posterior end of introvert with approximately 30 longitudinal dark lines (Fig. 6C), extending anteriorly.

Longitudinal musculature continuous; two retractor muscles attached to body wall in posterior fourth of trunk (Fig. 6E). Two small nephridia, sack-like with pointed tip; nephridiopores open posterior to anus; free intestine (Fig. 6D).

#### Habitat

Bathyal (1045–2000 m); in muddy bottom.

#### Distribution

Eastern Pacific: from the Gulf of Alaska to the Peruvian-Chilean Trench. This is the first record of the species from the Mexican Pacific.

#### Remarks

The examined specimens of *Nephasoma (N.) wodjanizkii wodjanizkii* agree with Murina's (1973a) original description. From the region, the closest record was made by Thompson (1980), who recorded the species for southern California.

Frank's subsequent record from Canada should be revisited, since he made it based on a single specimen collected at a depth of 42 m (Frank 1983). Furthermore, Gálvez-Zeferino *et al.* (2020) recorded *N. (N.) wodjanizkii*, similar to Frank's record; it should also be revised, since they recorded a single specimen from a coastal lagoon on the western coast of Baja California Sur, at depths of 5 to 12 m. Two further studies, Murina (1973b) and Thompson (1980), collected their specimens at bathyal depths (1100–2000 m) from the Peruvian-Chilean Trench and California, respectively; therefore, the present specimens from the western coast of Baja California represent an intermediate record of the species made in the marine ecoregion of the Northwest Warm Temperate Pacific.

Genus *Phascolion* Théel, 1875  
Subgenus *Phascolion (Lesenka)* Gibbs, 1985

*Phascolion (Lesenka) salgadoi* sp. nov.  
urn:lsid:zoobank.org:act:3DEAE010-73D3-4FFC-B41C-B81BD6722667  
Fig. 7

### Etymology

Named after the researcher José Salgado-Barragán, a crustacean specialist from the Universidad Nacional Autónoma de México (UNAM) and a good friend who provided the specimens of this species. The epithet is a noun in the genitive case (ICZN 1999, Art. 31.1.2).

### Material examined

#### Holotype

MEXICO • Sonora, Guaymas Bay; 24 Oct. 1991; depth 45 m; inside empty shells of *Polystira* sp.; EMU-13448.

#### Paratypes

MEXICO • 7 specs; same collection data as for holotype; UMAR-SIPU 131 • 6 specs; same collection data as for holotype; EMU-13449 • 7 specs; same collection data as for holotype; EMU-13450.

#### Other material

MEXICO • 4 specs; same collection data as for holotype; UMAR-SIPU 132.

### Description (EMU-13448)

Body coiled to the left; trunk 25 mm in length (Fig. 7A). Light brown skin, translucent at mid trunk. Ventral region of trunk with numerous simple, round and flat papillae, mid trunk with scattered circular papillae with hardened U-shaped border with a tooth (Fig. 7D), denser and smaller on caudal region and on each side of ventral papillae. Introvert partially protruded; 12 short, thin digitiform peripheral tentacles encircling mouth. Scattered claw-shaped, dark hooks (Fig. 7F) of type I (Cutler 1994), 37 µm long, occupying 10% of distal length of introvert. Anus on proximal portion of introvert, near edge of trunk; posterior introvert with bladder-shaped holdfast papillae (Fig. 7E), extending slightly to trunk.

Longitudinal musculature continuous; retractor muscle in a single column, attached to body wall at 90% of posterior trunk length. Esophagus attached to retractor muscle. A single nephridium of approximately 15% of trunk length attached in all its length to body wall; nephridiopore opens posterior to anus. Spindle muscle attached anterior to anus and attached to intestine in caudal region of trunk; intestine without coils, with same torsion as body (Fig. 7B).

### Variation

Some of the hardened holdfast papillae have a U-shaped border. The density of papillae is variable among the specimens.

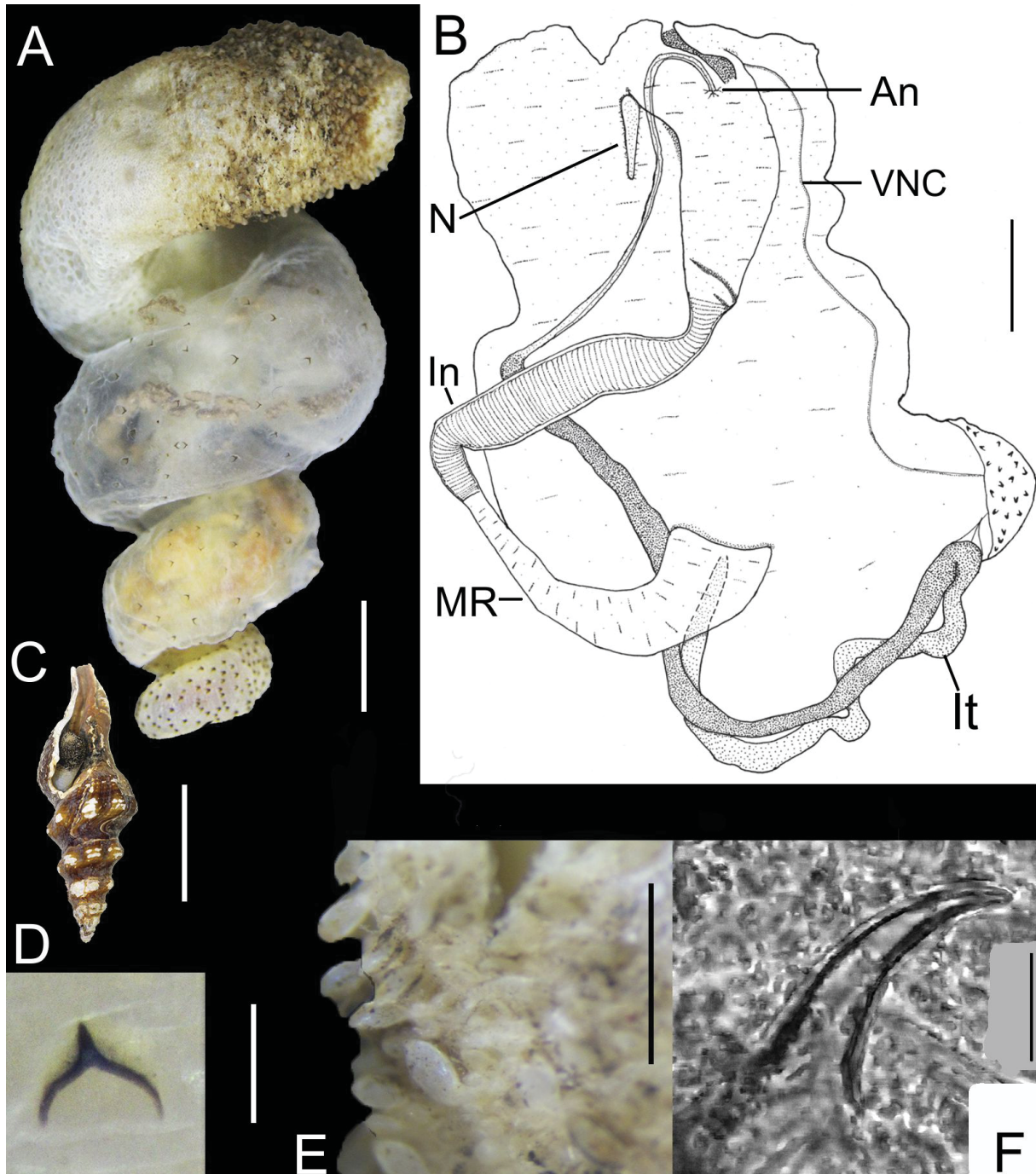


**Habitat**

Subtidal (45 m); inhabiting shells of the gastropod *Polystira* sp. (Fig. 7C).

**Distribution**

Gulf of California: only known from Guaymas Bay, Sonora.



**Fig. 7.** *Phascolion (Lesenka) salgadoi* sp. nov. (EMU-13448). **A.** Trunk overview, introvert contracted. **B.** Internal anatomy. **C.** Shell containing *Ph. (L.) salgadoi*. **D.** Hardened U-shaped holdfast papilla. **E.** Bladder shaped holdfast papillae. **F.** Type I hook. Abbreviations: see Material and methods. Scale bars: A = 3 mm; B = 2 mm; C = 2 cm; D = 0.5 mm; E = 1 mm; F = 15  $\mu$ m.

## Remarks

The specimens can easily be placed in the subgenus *Phascolion* (*Lesenka*) by the presence of a single retractor muscle and by having less than 20 tentacles. *Phascolion* (*L.*) *salgadoi* sp. nov. is similar to two subspecies: *P. (L.) valdiviae valdiviae* Fischer, 1916 (from the Indian Ocean) and *P. (L.) valdiviae sumatrense* Fischer, 1916 (from Sumatra). The two subspecies and the specimens examined here have U-shaped holdfast papillae, in addition to having a single retractor muscle; however, the specimens from the Mexican Pacific are geographically separated from previous subspecies. Also, they have several morphological differences from both subspecies.

*Phascolion* (*Lesenka*) *salgadoi* sp. nov. differs from Fischer's subspecies because they have dark hooks, while *P. (L.) valdiviae valdiviae* has pale hooks and *P. (L.) valdiviae sumatrense* lacks hooks. *Phascolion* (*L.*) *salgadoi* does not show intestinal coils, the intestine instead following the torsion of the body, while the Indian subspecies has 20–22 coils. Regarding habitat, *Ph. (L.) salgadoi* was found at a depth of approximately 45 m, living in an empty shell of the gastropod *Polystira* sp., while the subspecies *P. (L.) valdiviae valdiviae* was obtained at a depth of 158 m, living in shells of the scaphopod *Dentalium* sp., which does not have whorls. The description of *P. (L.) valdiviae sumatrense* did not mention anything about its habitat, except that the species was found at a bathyal depth (750 m) (Fischer 1916).

Comparing *Phascolion* (*Lesenka*) *salgadoi* sp. nov. with other species of the subgenus, the following differences are noted: *P. (L.) collare* Selenka & de Man, 1883 has conical papillae and small type III hooks (Cutler 1994); *P. (L.) cryptum* Hendrix, 1975 has four main tentacles followed by accessory tentacles and it has no hooks; and *P. (L.) hupferi* Fischer, 1894 has the anus at half of the introvert length and, like *P. (L.) rectum* Ikeda, 1904, has neither hooks nor holdfast papillae (Cutler 1994). On the other hand, *P. (L.) salgadoi* possesses flat oval papillae with a hardened U-shaped border, bladder-shaped holdfast papillae, type I hooks, short digitiform tentacles and the anus is situated at the base of the introvert.

Genus *Themiste* Gray, 1828

Subgenus *Themiste* (*Themiste*) Edmonds, 1980

*Themiste* (*Themiste*) cf. *blanda* (Selenka & Man in Selenka *et al.*, 1883)

Fig. 6F

## Type locality of nominal species

Enoshima, Japan (Selenka *et al.* 1883: 85–86, pl. 1 fig. 9, pl. 11 figs 159–162).

## Material examined

MEXICO • 1 spec.; Jalisco, Barra de Navidad, Corrales Beach; 19°11'14.08" N, 104°41'42.84" W; 3 Dec. 2004; depth 4 m; PSS *et al.* leg.; under rocks; ECOSUR-S0256.

## Description (ECOSUR-S0256)

Trunk 8 mm in length; smooth, whitish brown body wall. Introvert with distal tentacular crown surrounding mouth; tentacular crown divided into four stems, each divided symmetrically into two branches; each branch with 10 terminal tentacles and 8 tentacles on inner face of each stem and branches. Introvert with anterior purple collar.

Longitudinal musculature continuous; two retractor muscles attached to body wall at 60% of trunk length; contractile vessel with 20 tubules. Two nephridia, 40% of trunk length; nephridiopores open before anus; spindle muscle anterior to anus, does not attach to intestine at posterior part of trunk.

### Habitat

Shallow subtidal (4 m); under rocks.

### Distribution

Central Mexican Pacific: Corrales Beach, Jalisco.

### Remarks

The nominal species, *Themiste (Themiste) blanda* (Selenka & de Man, 1883), was described from Enoshima, Japan (Selenka *et al.* 1883). Morphologically, the only difference between the description of the nominal species compared to the specimen from Jalisco is that the Japanese species was described as having five or six stems on its tentacular crown, while the Jalisco specimen only showed four stems. This difference may be due to the size of the specimen examined; it might not have completely developed all its stems. However, if this feature is actually indicative of a new species, more specimens are needed to properly study and describe it. It should be noted that studies conducted on the reproduction of other species of the genus (Williams 1972; Rice 1976; Adrianov *et al.* 2009; Adrianov & Maiorova 2010) show that species of *Themiste* have larval development type 3, with larvae living 2–14 days in the water column. This period is not long enough to explain how the species could be transported from the Temperate Western Pacific to the Tropical Eastern Pacific. Thus, the presence of *T. (T.) blanda* in the Mexican Pacific is questionable, at least as long as no more specimens of this taxon are found.

### *Themiste (Themiste) hennahi* Gray, 1828

Fig. 6G

*Themiste hennahi* Gray, 1828: 8, pl.6 fig 4, 4a (type locality: Perú).

*Dendrostoma mythecha* Chamberlin, 1920: 30–31 (type locality: Laguna Beach California, on algae).

*Dendrostoma zostericola* Chamberlin, 1920: 30 (type locality: Laguna Beach, California, within algae).

*Dendrostomum lissum* Fisher, 1952: 419–422, pl. 35 (type locality: Punta Lobos, Espiritu Santo Island, Baja California Sur, intertidal).

*Dendrostomum schmitti* Fisher, 1952: 422, fig. 87f (type locality: Independencia Bay, Perú).

*Dendrostma zostericola* – Fisher 1952: 411–415, pl. 30 fig. 1, pls 31–32 (as *Dendrostomum zostericum*; Ensenada, Baja California, intertidal, algal rhizoids, gravel and sand under rocks, and in muddy sand).

*Themiste (Themiste) hennahi* – Cutler & Cutler 1988: 742, 753–755, table 1 (new combination). — Silva-Morales & Gómez-Vásquez 2021: 86–88, fig. 5 (San Agustín Bay, Oaxaca, inhabiting *Porites* sp.).

### Material examined

MEXICO – **Baja California** • 1 spec.; Los Ángeles Bay; 28°56'55.48" N, 113°33'26.36" W; 25 May 1989; SSV and JLG leg.; ECOSUR-S0255. – **Nayarit** • 21 specs; Banderas Bay, Manzanilla Beach; 20°44'25.49" N, 105°23'24.33" W; 29 Nov. 2004; depth 2 m; PSS *et al.* leg.; under rocks; ECOSUR-S0253. – **Jalisco** • 2 specs; Barra de Navidad, Corrales Beach; 19°11'14.08" N, 104°41'42.84" W; 3 Dec. 2004; depth 4 m; PSS *et al.* leg.; under rocks; ECOSUR-S0254.

### Description

Trunk 6 mm in length, pyriform, caudal region nipple-like; smooth light brown body wall, with small, flat oval papillae. Introvert as long as trunk; tentacular crown with six stems, each one divided into two branches, branches with 10 terminal tentacles; tentacles pigmented in dark patches.

Longitudinal musculature continuous; two retractor muscles attached at 75% of trunk length; contractile vessel with 15 long tubules. Two nephridia 25% of trunk length; nephridiopores posterior to anus. Spindle muscle present, not attached to intestine posteriorly.

### Variations

The specimens examined had a trunk length range between 2 and 12 mm. The number of tentacles varies with length, a specimen with a trunk length of 2 mm having eight terminal tentacles on each branch, while a specimen with a trunk length of 6 mm has 10 terminal tentacles on each branch of the tentacular crown; the largest specimen measured here has a trunk length of 12 mm and it has 14 terminal tentacles on each branch. Considering all specimens, the total amount of tentacles is between 72 and approximately 170.

### Habitat

Intertidal to subtidal (4 m); under rocks, between algal rhizoids, in gravel and muddy sand.

### Distribution

Eastern Pacific: from California to Perú.

### Remarks

The specimens agree with the descriptions made by Gray (1828) and Fisher (1952). This species has previously been recorded from the study area in the Gulf of California.

### *Themiste (Themiste) pyroides* (Chamberlin, 1920)

Fig. 6H

*Dendrostoma pyroides* Chamberlin, 1920: 3 (type locality: Laguna Beach, California; intertidal).

*Dendrostoma pyroides* – Fisher 1952: 406–409, pl. 27 figs 1–2, pl. 28 fig. 2, pl. 29 (Ensenada and San Quintin Bay, Baja California).

*Themiste pyroides* – Adrianov *et al.* 2006: 577–579, figs 1c–d, 7–10 (Vostok Bay, Sea of Japan).

### Material examined

MEXICO – **Baja California Sur** • 1 spec.; La Paz Bay, El Caimancito Beach; 24°12'10.43" N, 110°18'01.09" W; 28 Nov. 1986; depth 2 m; SSV leg.; under rocks; ECOSUR-S0251 • 8 specs; La Paz Bay, El Caimancito Beach; 24°12'15" N, 110°18'02.96" W; 29 Feb. 2004; depth 1 m; PSS and MTH leg.; inhabiting *Porites* sp.; ECOSUR-S0252 • 1 spec.; La Paz Bay, Calerita Beach; 1 Mar. 2006; DHP *et al.* leg.; UMAR-SIPU 130. – **Sinaloa** • 1 spec.; Mazatlan, Pinitos Beach; 23°12'28.022 N, 106°25'32.69" W; 3 Feb. 2004; depth 1 m; PSS and MTH leg.; associated with sabellariid tubes; ECOSUR-S0258.

### Description (UMAR-SIPU 130)

Trunk 12 mm in length, pyriform, caudal region pointed; smooth, light brown body wall, with small, flat oval papillae. Introvert as long as 0.75 of trunk length, with pigmented collar and tentacular crown base; tentacular crown with four stems divided into two branches, stems of ventral pair slightly longer than those of dorsal pair; each branch with eight terminal tentacles. Small, dark, claw-like hooks at posterior introvert.

Longitudinal musculature continuous; two retractor muscles attached to body wall at 50% of trunk length; contractile vessel with 15 tubules. Two nephridia, of 25% of trunk length; nephridiopores before anus. Spindle muscle present, attached to intestine anteriorly and to trunk posteriorly.

### Habitat

Intertidal to subtidal (1–2 m); under rocks, inhabiting *Porites* sp., and associated with sabellariid tubes.

### Distribution

Eastern Pacific: from California to the Gulf of California.

### Remarks

*Themiste (T.) pyroides* may be confused with *T. (T.) blanda* (Selenka & de Man, 1883); however, the main difference between the species concerns the tentacular crown. *Themiste (T.) blanda* has the branches symmetrically divided, in addition to bearing tentacles along the inner face of the stems and branches, whereas *T. (T.) pyroides* only has terminal tentacles and the branches are not divided symmetrically. According to Cutler (1994), *T. (T.) pyroides* is distributed in the eastern Pacific, from southern Alaska (Frank 1983) to the western coast of Baja California (Fisher 1952); however, the Alaska record should be reviewed, because the temperature range tolerance for this species has not been investigated and it seems unlikely that a subtropical species such as *T. (T.) pyroides* would occur at such low temperatures. Furthermore, there are no records of this species farther north than its type locality, apart from Frank's record (Frank 1983). In the northwestern Pacific of Mexico, *T. (T.) pyroides* extends its distribution from the west coast of Baja California to the Gulf of California (Sinaloa).

*Themiste (T.) pyroides* has also been recorded from the Sea of Japan (Adrianov *et al.* 2006, 2008); however, the latter study was based on a molecular analysis and concluded that the eastern and western populations are two distinct clades at the molecular level (Schulze *et al.* 2012). This may suggest that both populations could be part of a species complex, which should be addressed using morphological and molecular evidence.

Family Phascolosomatidae Stephen & Edmonds, 1972

Genus *Apionsoma* Sluiter, 1902

Subgenus *Apionsoma (Apionsoma)* Sluiter, 1902

*Apionsoma (Apionsoma) silviae* sp. nov.

urn:lsid:zoobank.org:act:82A61D62-E27F-4D35-B1F2-85BEC0319CD0

Figs 8–9

### Etymology

This species is named after the author's beloved mother, Silvia Vásquez Martínez, for all the effort and support she has given her sons, which has given them the opportunity to study and dedicate themselves to their favourite interests. The epithet is a noun in the genitive case (ICZN 1999, ART. 31.1.2).

### Material examined

#### Holotype

MEXICO • 1 spec.; Gulf of California; 28°20'57" N, 112°37'16" W; 11 Apr. 2011; depth 310 m; corer; TALUD XIV cruise, stn 16, on board R/V *El Puma*; EMU-13436.

### Description (EMU-13436)

Trunk 8 mm in length; rough, light brown body wall, with numerous scattered, mammillate papillae (Fig. 8A), decreasing in size towards caudal region, with a spiral effect in caudal region (Fig. 8C). Introvert partially everted, four times as long as trunk length, with 10 small digitiform tentacles encircling nuchal organ dorsal to mouth. Hooks 30 µm long, with four basal spinelets, arranged in ten complete rings. Scattered, ventrally and dorsally, Mammillate papillae present ventrally and dorsally, scattered;

two dorsolateral longitudinal lines of papillae at 80% of posterior introvert (Fig. 8B); ventral papillae smaller in size.

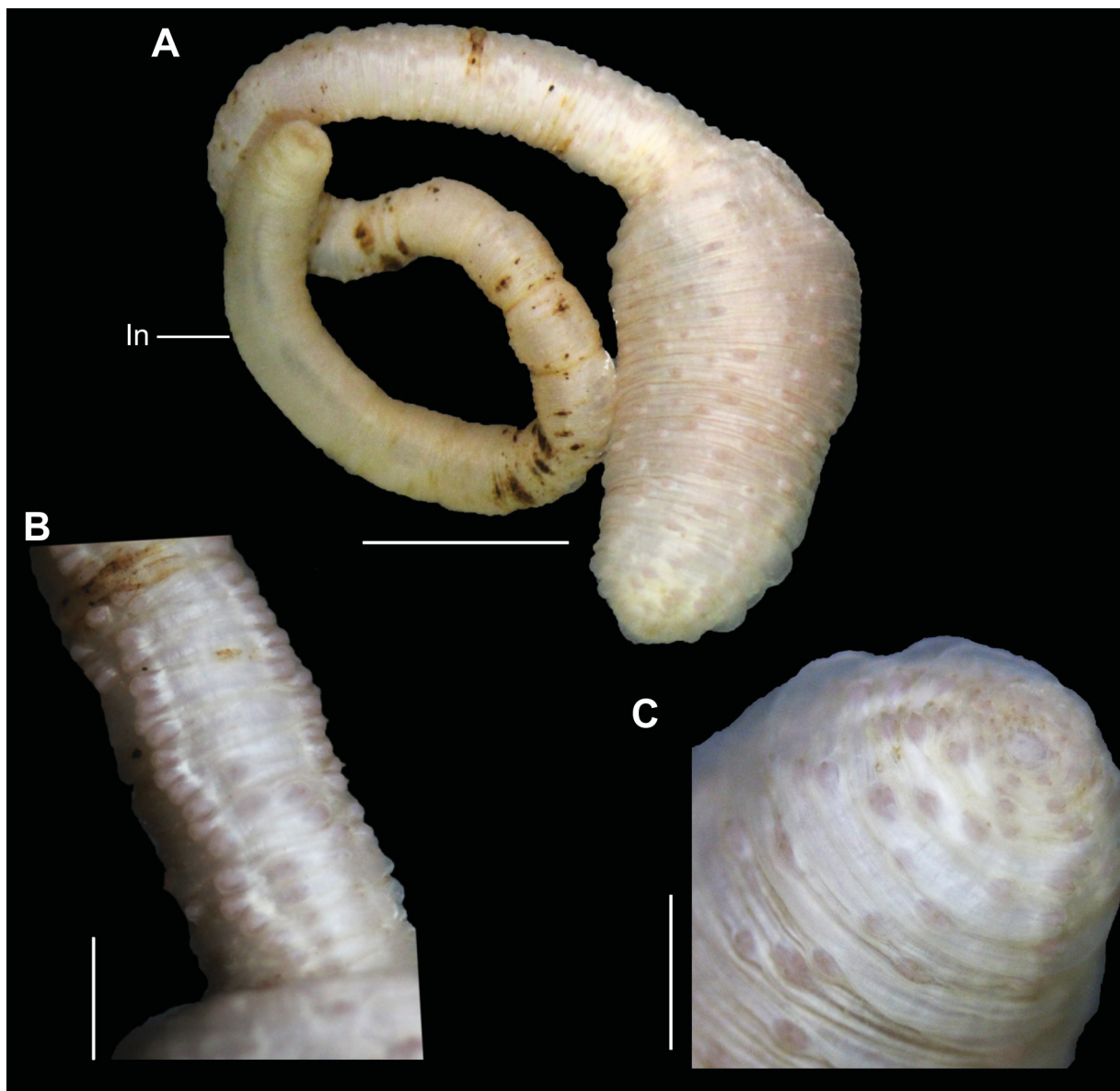
Longitudinal musculature continuous; four retractor muscles attached at 50% of trunk length (Fig. 9A); retractor muscles equally displaced from nerve cord; dorsal retractor muscles anterior to ventral pair. A pair of bilobed nephridia, 3 mm long, anterior lobe one-fifth as long as posterior lobe; nephridiopores anterior to anus. Spindle muscle present; not attached to intestine in caudal region of trunk.

#### Habitat

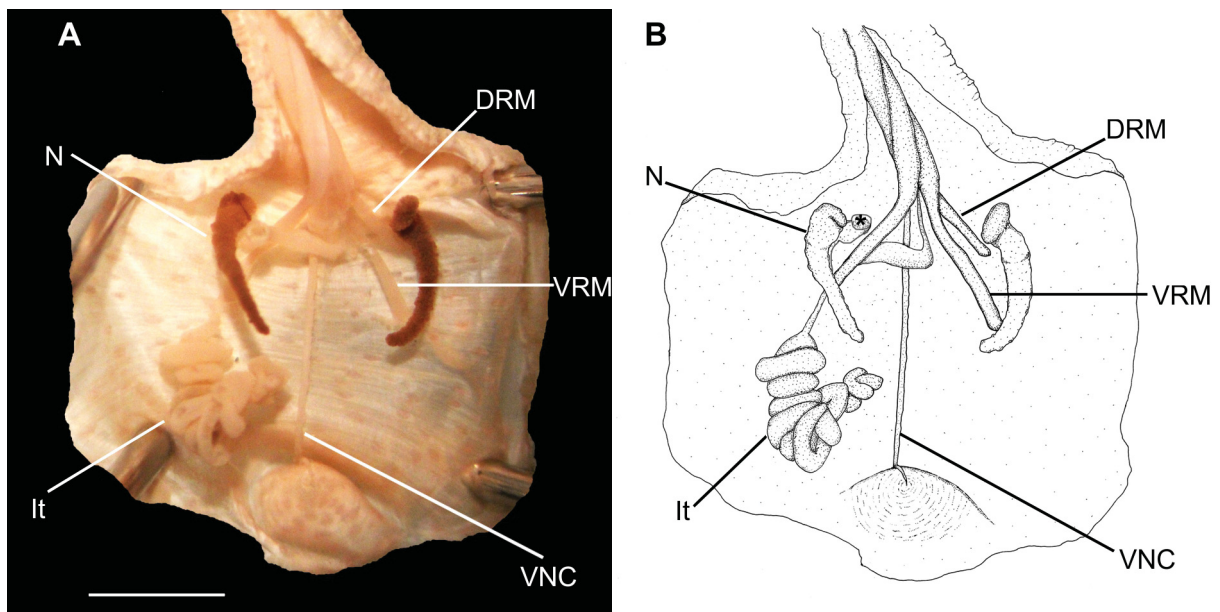
Bathyal (310 m); in muddy sand.

#### Distribution

Only known from stn 16 of the TALUD XIV cruise, near Cabo San Miguel, Baja California.



**Fig. 8.** *Apionsoma (Apionsoma) silviae* sp. nov. (EMU-13436). **A.** Lateral overview, introvert partially everted. **B.** Posterior part of introvert. **C.** Posterior part of trunk. Abbreviation: see Material and methods. Scale bars: A = 3 mm; B–C = 1 mm.



**Fig. 9.** *Apionsoma (Apionsoma) silviae* sp. nov. (EMU-13436). **A.** Internal anatomy. **B.** Illustration of internal anatomy. Abbreviations: see Material and methods. Scale bar = 2 mm.

### Remarks

The sole specimen examined is easily placed in the subgenus *Apionsoma (Apionsoma)* by the presence of a continuous longitudinal musculature, which is very similar to conditions in the two subspecies *A. (A.) murinae murinae* (Cutler, 1969), described from the north-west Atlantic, and *A. (A.) murinae bilobatae* (Cutler, 1969), described from the north Atlantic. However, *A. (A.) silviae* shows differences to both subspecies by having bilobed nephridia and in the arrangement of the papillae on the introvert and on the caudal region.

Subgenus *Apionsoma (Edmondsius)* (Gibbs & Cutler, 1987)

*Apionsoma (Edmondsius) hendrickxi* sp. nov.

urn:lsid:zoobank.org:act:4E699E8D-05D4-4A09-A29E-70D79B1562AC

Figs 10–11

### Etymology

This species is named after the researcher Michel Hendrickx, a carcinologist from the Universidad Nacional Autónoma de México (UNAM), in recognition of his contribution to our knowledge of Mexican marine biodiversity. He also provided the specimens examined here. The epithet is a noun in the genitive case (ICZN 1999, Art. 31.1.2).

### Material examined

#### Holotype

MEXICO • Gulf of California; 28°20'57" N, 112°37'16" W; 11 Apr. 2011; depth 310 m; core; TALUD XIV cruise, stn 16, on board R/V *El Puma*; EMU-13437.

#### Paratype

MEXICO • same collection data as for holotype; UMAR-SIPU 150.

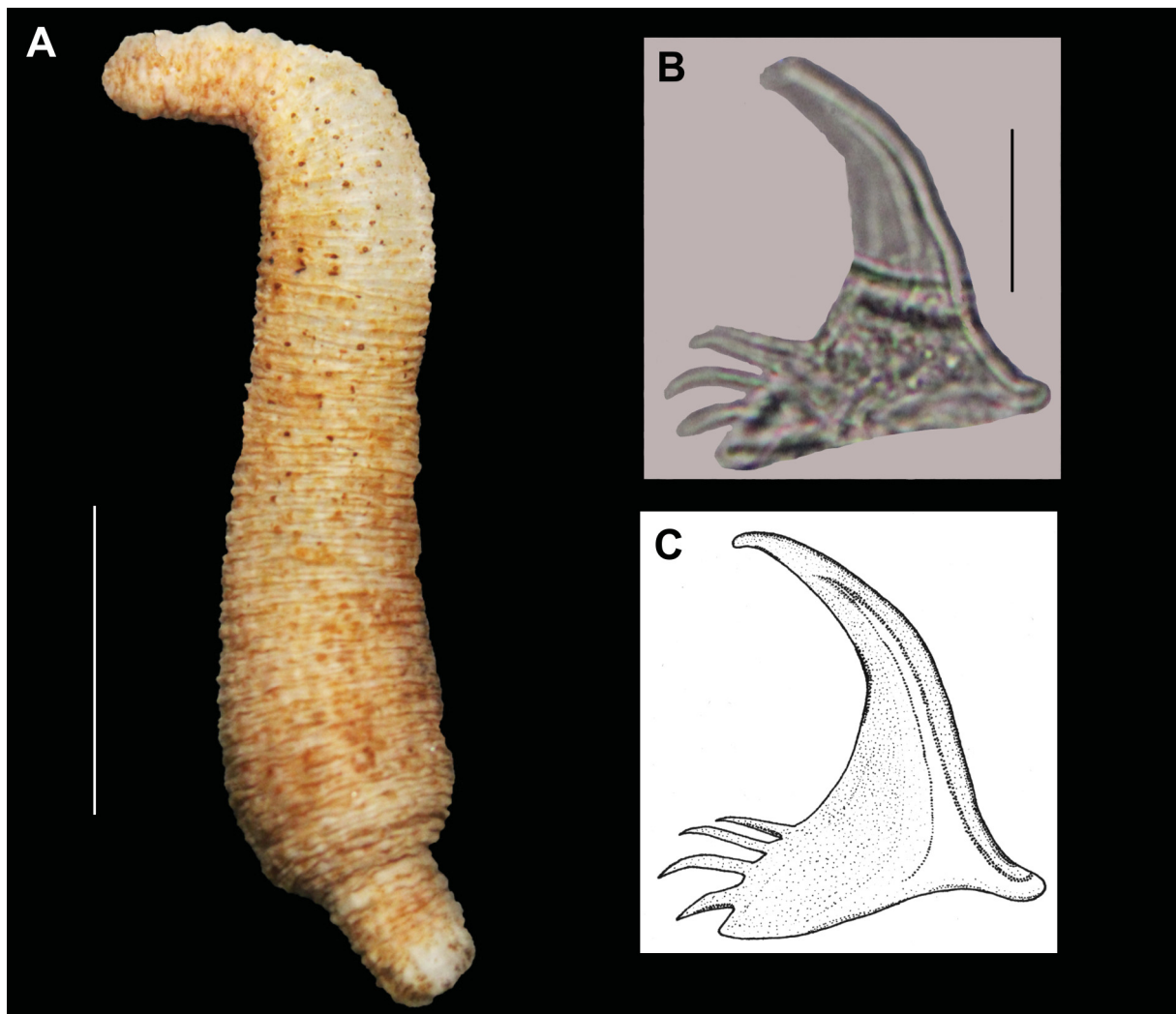
**Description** (EMU-13437)

Trunk 14 mm in length; slender body, six times as long as wide: body wall rough, brownish, with some dark patches (Fig. 10A); scattered mammillate papillae on entire body. Introvert twice as long as trunk, partially protruded; with 10 small digitiform tentacles in an arc surrounding nuchal organ. Hooks 45  $\mu\text{m}$  long, with four basal spinelets (Fig. 10B), arranged in 15 complete rings.

Longitudinal musculature divided into highly anastomosing bands, with a soft appearance; 16 bands at level of ventral retractor muscles. Four retractor muscles, both pairs equally displaced from ventral nerve cord; dorsal pair originating at and attached to body wall anterior to ventral pair. Esophagus attached to right ventral retractor muscle; contractile vessel thick, without bulbs or villi. A pair of bilobed nephridia, with rough surface, 4 mm long; posterior lobe four times as long as anterior lobe; nephridiopores posterior to anus. Spindle muscle attached anterior to anus; free intestine (Fig. 11A).

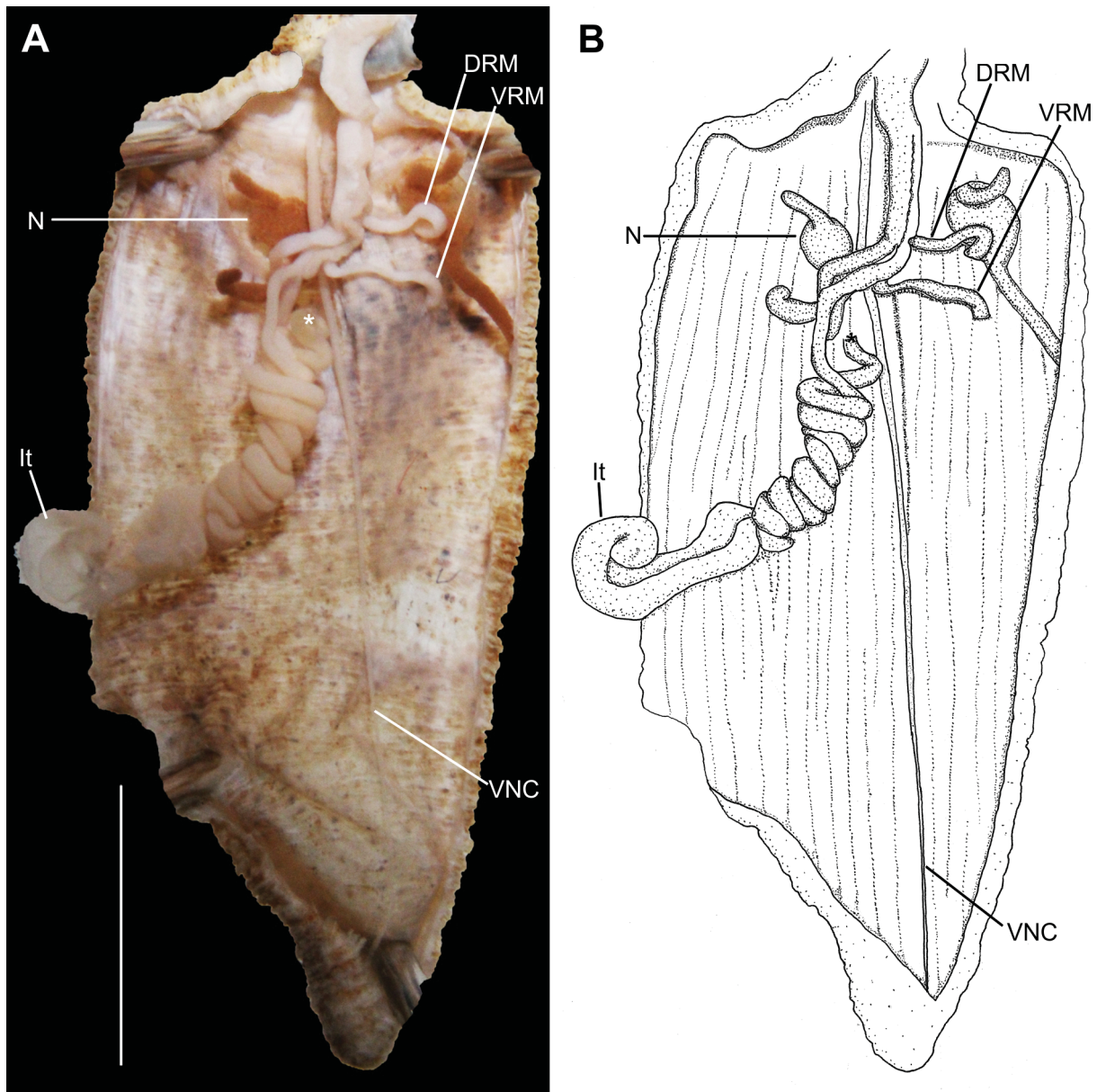
**Habitat**

Bathyal (310 m); in muddy sand.



**Fig. 10.** *Apionsoma (Edmondsius) hendrickxi* sp. nov. (EMU-13437). **A.** Lateral overview, introvert contracted. **B–C.** Hook. Scale bars: A = 5 mm; B = 20  $\mu\text{m}$ .





**Fig. 11.** *Apionsoma (Edmondsius) hendrickxi* sp. nov. (EMU-13437). **A.** Internal anatomy; asterisk indicates ripped part of rectum. **B.** Illustration of internal anatomy. Abbreviations: see Material and methods. Scale bar = 5 mm.

### Distribution

Only known from stn 16 of the TALUD XIV cruise, near Cabo San Miguel, Baja California.

### Remarks

The specimens belong to the monospecific subgenus *Apionsoma (Edmondsius)* by having the longitudinal muscles separated into bands. *Apionsoma (E.) hendrickxi* sp. nov. differs from *A. (E.) pectinatum* (Kefterstein, 1867) by having four basal spinelets on the hooks (Fig. 10B), while *A. (E.) pectinatum* has seven to nine spinelets (Fig. 12C); furthermore, *A. (E.) pectinatum* has much more conspicuous longitudinal muscle bands than those of *A. (E.) hendrickxi* (Fig. 11A). Another difference is in the origin of the retractor muscles: in *A. (E.) pectinatum* all four retractor muscles originate at the same

level, whereas in *A. (E.) hendrickxi* the dorsal muscle pair originates anterior to the ventral one. Finally, *A. (E.) pectinatum* is found from the intertidal to the subtidal zone (depth 5 m) associated with rocks and coral, while *Apionsoma (E.) hendrickxi* sp. nov. was found in the bathyal zone (depth 310 m) on muddy sand bottoms. With the description of *A. (E.) hendrickxi* sp. nov., the subgenus is no longer monospecific.

*Apionsoma (Edmondsius) pectinatum* (Keferstein, 1867)

Fig. 12A, C

*Phascolosoma pectinatum* Keferstein, 1867: 47–48, pl. 6 figs 9–12 (type locality: Pacific of Panamá).

*Siphonides rickettsi* Fisher, 1952: 386–388, pl. 22 (type locality: Punta Lobos, Espíritu Santo Island, Baja California Sur; under rocks; based on specimens reported in Steinbeck & Ricketts 1941 as *Phascolosoma* cf. *gouldii*).

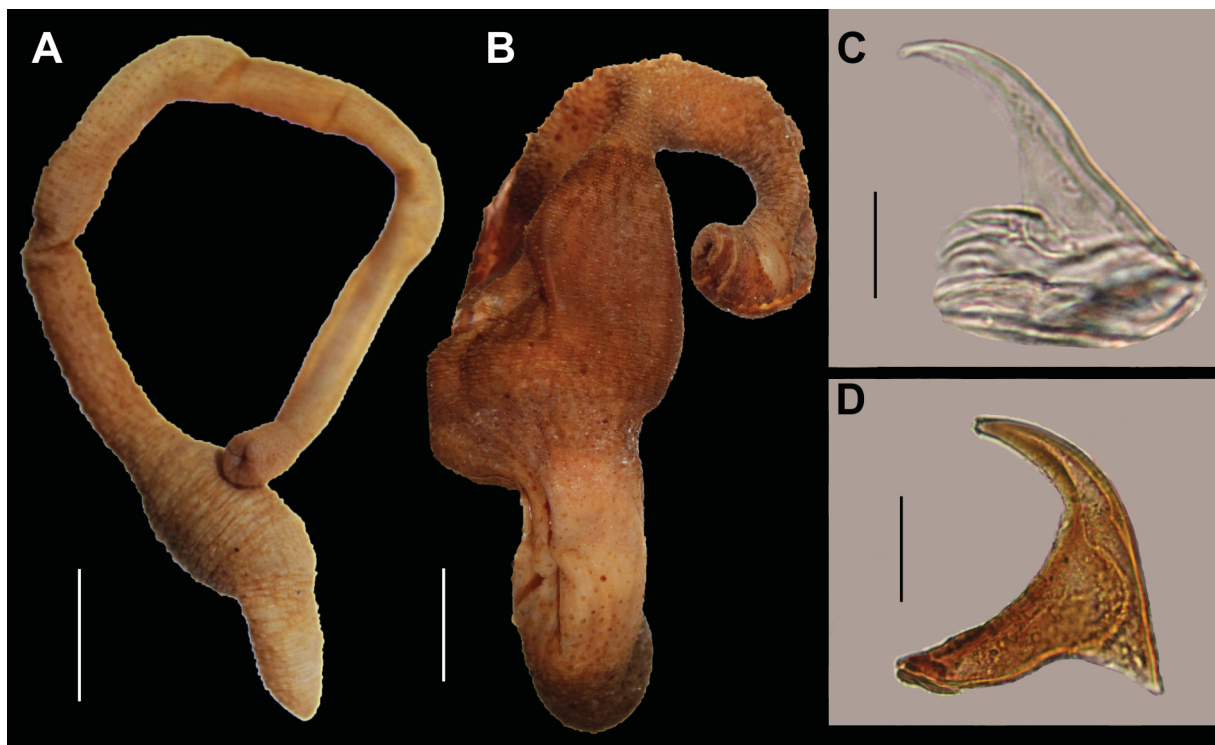
*Phascolosoma* cf. *gouldii* (not de Pourtalès, 1851) – Steinbeck & Ricketts 1941: 345 (Punta Lobos, Espíritu Santo Island, Baja California Sur; under rocks).

*Phascolosoma (Edmondsius) pectinatum* – Gibbs & Cutler 1987: 54–55 (establishment of the subgenus).

*Apionsoma (Edmondsius) pectinatum* – Cutler 1994: 197–198 (generic transfer).

**Material examined**

MEXICO • 1 spec.; Nayarit, Banderas Bay, Manzanilla Beach, 20°44'35" N, 105°23'14.8" W; 26 Nov. 2004; depth 1 m; PSS *et al.* leg.; under rocks; ECOSUR-S0281.



**Fig. 12.** Phascolomatids. **A, C.** *Apionsoma (Edmondsius) pectinatum* (Keferstein, 1867 (ECOSUR-S0281). **A.** Lateral overview, introvert partially contracted. **C.** Hook. **B, D.** *Phascolosoma (P.) puntarenae* Grube & Örsted in Grube, 1858 (UMAR-SIPU 138). **B.** Lateral overview, introvert contracted. **D.** Hook. Scale bars: A–B = 5 mm; C = 20 µm; D = 40 µm.

### Description (ECOSUR-S0281)

Trunk 10 mm in length; rough yellowish brown body wall (Fig. 12A); scattered mammillate papillae on trunk and introvert. Introvert four times as long as trunk, with twenty digitiform tentacles surrounding nuchal organ; with claw-like hooks with seven basal spinelets (Fig. 12C), 40 µm long, arranged in 40 complete rings.

Longitudinal musculature divided in anastomosing bands. Four retractor muscles, attached equally close to ventral nerve cord near anterior quarter of trunk, negating the appellations ventral and dorsal. A pair of bilobed nephridia, posterior lobe twice as long as anterior lobe; nephridiopores open posterior to anus. Spindle muscle attached anterior to anus; free intestine.

### Habitat

Intertidal; under rocks.

### Distribution

Eastern Pacific: from southern Gulf of California to Panamá.

### Remarks

This specimen agrees with the original description in Keferstein (1867) and the redescription in Cutler (1994). Recently, Silva-Morales & Gómez-Vásquez (2021) recorded the species from the southern Mexican Pacific, including a brief discussion of its apparent disjunctive distribution in the Tropical Eastern Pacific. The record of this specimen offers a new location for its distribution in the Eastern Pacific and confirms its continuous distribution in the Mexican Pacific.

Genus *Phascolosoma* Leuckart, 1828

Subgenus *Phascolosoma* (*Phascolosoma*) Leuckart, 1828

*Phascolosoma* (*Phascolosoma*) *azteca* sp. nov.

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Fig. 13

*Phascolosoma dentigerum* (not Selenka & de Man, 1883) – Steinbeck & Ricketts 1941: 345–346. — Fisher 1952: 432–434, pl. 39 figs 4–7 (based on material collected by Ricketts).

### Etymology

This species is named after the ancient Mexican culture of the great Tenochtitlan commonly known as the Aztecs. The epithet in a noun in apposition (ICZN 1999, Art. 31.1).

### Material examined

#### Holotype

MEXICO • Jalisco, Los Arcos Beach; 22 Jan. 2001; depth 2 m; LIB leg.; in dead coral; EMU-13443.

#### Paratypes

MEXICO • 19 specs; same collection data as for holotype; EMU-13444 • 10 specs; same collection data as for holotype; UMAR-SIPU 139 • 7 specs; Sayulita Beach; 21°01'39" N, 105°16'59" W; 19 Feb. 2000; depth 3 m; EMU-13438 • 8 specs; Punta Raza Beach; 21°01'59" N, 105°18'51" W; 11 Apr. 1996; EMU-13439.

#### Other material

MEXICO – **Baja California** • 1 spec.; Los Ángeles Bay; 28°56'55.48" N, 113°33'26.36" W; 25 May 1986; SSV and JLG leg.; ECOSUR-S0272. – **Baja California Sur** • 6 specs; La Paz, Tecolote Beach;

24°20'13.38" N, 110°19'04.7" W; 15 Oct. 1986; SSV and NEG leg.; intertidal; ECOSUR-S0271 • 1 spec.; La Paz, Presidente Beach; 19 Apr. 1987; RBZ leg.; in dead coral; UMAR-SIPU 140 • 3 specs; La Paz, El Caimancito Beach; 24°12'10.43" N, 110°18'01.09" W; 10 Oct. 1987; depth 2 m; SSV leg.; in rocks; ECOSUR-S0275 • 1 spec.; Cabo Pulmo; 1989; in dead coral; UMAR-SIPU 149 • 1 spec.; El Tesoro Beach; 17 Jul. 1996; UMAR-SIPU 142 • 1 spec.; La Paz, Calerita Beach; 18 Jul. 1996; intertidal; EMU-13442 • 1 spec.; La Paz, El Caimancito Beach; 24°12'15.00" N, 110°18'02.96" W; 29 Feb. 2004; depth 1 m; PSS and MTH leg.; inhabiting *Porites* sp.; ECOSUR-S0268 • 10 specs; La Paz, Balandra Beach; 24°19'16.20" N, 110°19'33.54" W; 2 Mar. 2004; depth 1 m; PSS and MTH leg.; on oyster; ECOSUR-S0273. – **Sinaloa** • 35 specs; Mazatlán, Pinitos Beach; 23°12'31.93" N, 106°25'39.77" W; 22 Feb. 2004; depth 2 m; PSS and MTH leg.; on oyster; ECOSUR-S0265 • 3 specs; Mazatlán, Pinitos Beach; 23°12'28.02" N, 106°25'32.69" W; 23 Feb. 2004; depth 1 m; PSS and MTH leg.; associated with sabellariids; ECOSUR-S0274 • 3 specs; Mazatlán, Cerritos Beach; 23°17'49.63" N, 106°29'08.51" W; 27 Feb. 2004; PSS and MTH leg.; on oyster with green and red algae; ECOSUR-S0276. – **Nayarit** • 5 specs; Cabo Litibu; 20°47'21" N, 105°31'03" W; 9 Apr. 1996; depth 3 m; UMAR-SIPU 143 • 18 specs; Sayulita Beach; 20°47'24" N, 105°31'54" W; 10 Apr. 1996; depth 3 m; UMAR-SIPU 144 • 4 specs; Guayabitos Beach; 21°02'06" N, 105°19'14" W; 11 Apr. 1996; depth 3 m; UMAR-SIPU 145 • 8 specs; Punta Raza Beach; 21°01'59" N, 105°18'51" W; 19 Feb. 2000; UMAR-SIPU 146 • 1 spec.; Guayabitos Beach, naval base; 22°08'00" N, 105°31'00" W; 19 Feb. 2000; EMU-13441 • 3 specs; Chacala Beach; 21°09'55" N, 105°13'39" W; 20 Feb. 2002; EMU-13440 • 2 specs; Sayulita Beach; 20°52'15" N, 105°26'40.4" W; 28 Nov. 2004; depth 1 m; PSS *et al.* leg.; under rocks; ECOSUR-0267 • 8 specs; Banderas Bay, Manzanilla Beach; 20°44'25.49" N, 105°23'24.33" W; 29 Nov. 2004; depth 2 m; PSS *et al.* leg.; in rocks; ECOSUR-0277. – **Jalisco** • 21 specs; Los Arcos Beach; 20°32'30" N, 105°18'24" W; 12 Apr. 1996; UMAR-SIPU 147 • 4 specs; San Patricio Melaque Beach; 19°13'12.08" N, 104°42'49.95" W; 2 Dec. 2004; depth 3 m; PSS *et al.* leg.; in rocks; ECOSUR-0266 • 2 specs; Barra de Navidad, Corrales Beach; 19°11'14.08" N, 104°41'42.84" W; 3 Dec. 2004; depth 4 m; PSS *et al.* leg.; in rock; ECOSUR-0269. – **Colima** • 3 specs; La Audiencia Beach; 19°06'11" N, 104°21'01" W; 15 May 2006; EMU-13445 • 2 specs; La Audiencia Beach; 19°06'11" N, 104°21'01" W; 15 May 2006; UMAR-SIPU 148. – **Michoacán** • 3 specs; Bucerías Beach; 19 Dec. 1994; SGM and RBZ leg.; UMAR-SIPU 149.

**Comparative material** (*Phascolosoma* (*Phascolosoma*) *perlucens* Baird, 1868)

MEXICO – **Quintana Roo** • 3 specs; Playa del Carmen, Navega docks; 23 Aug. 2003; MTH leg.; ECOSUR-S0044.

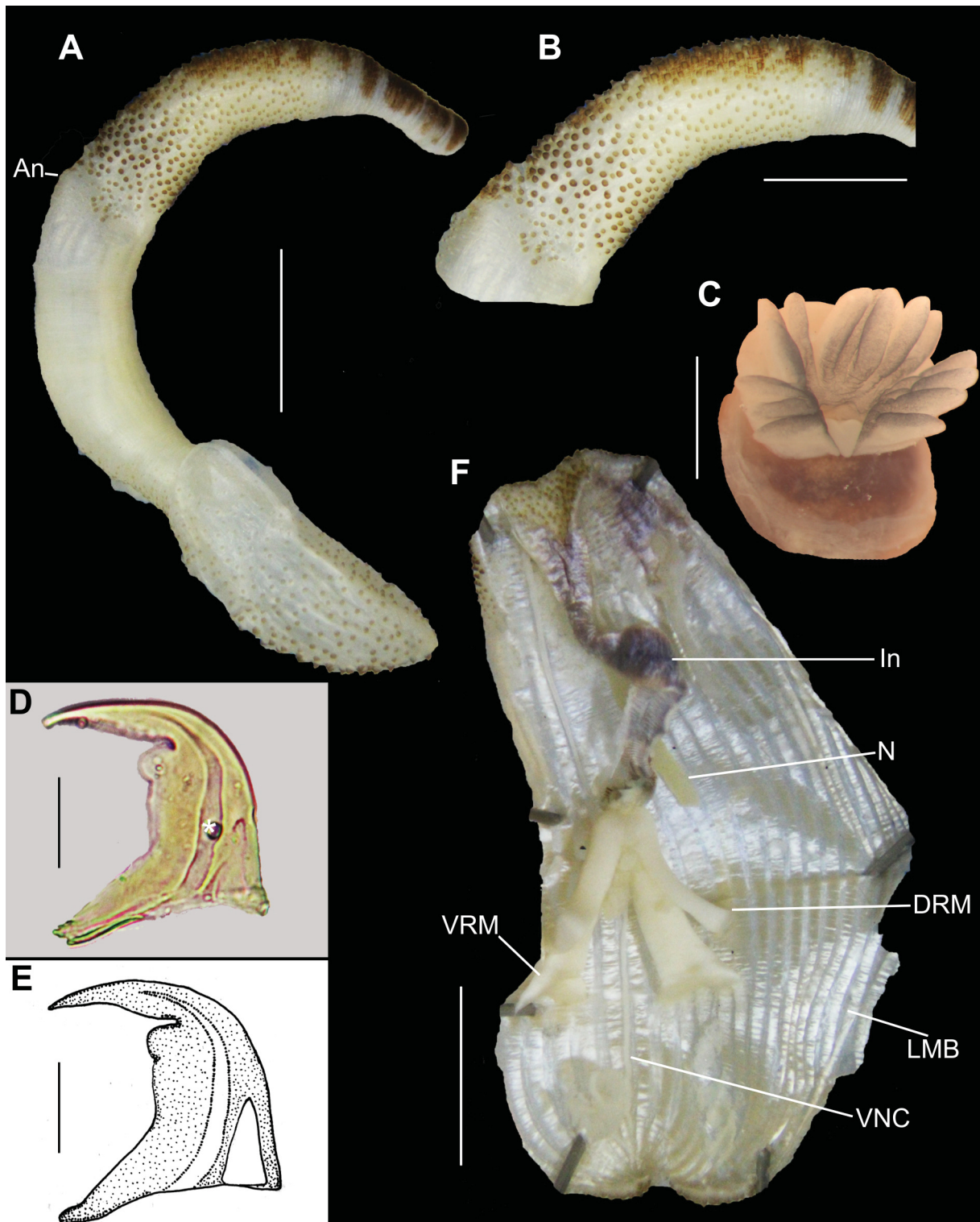
PANAMA • 2 specs; Colón, Portobelo; 4 Jun. 2002; depth 1 m; JC and SSV leg.; in rocks; ECOSUR-S0056.

VENEZUELA • 2 specs; Cumana, Turpialito; 22 Feb. 2002; depth 1.5 m; IL leg.; inhabiting *Millepora* sp.; ECOSUR-S0057.

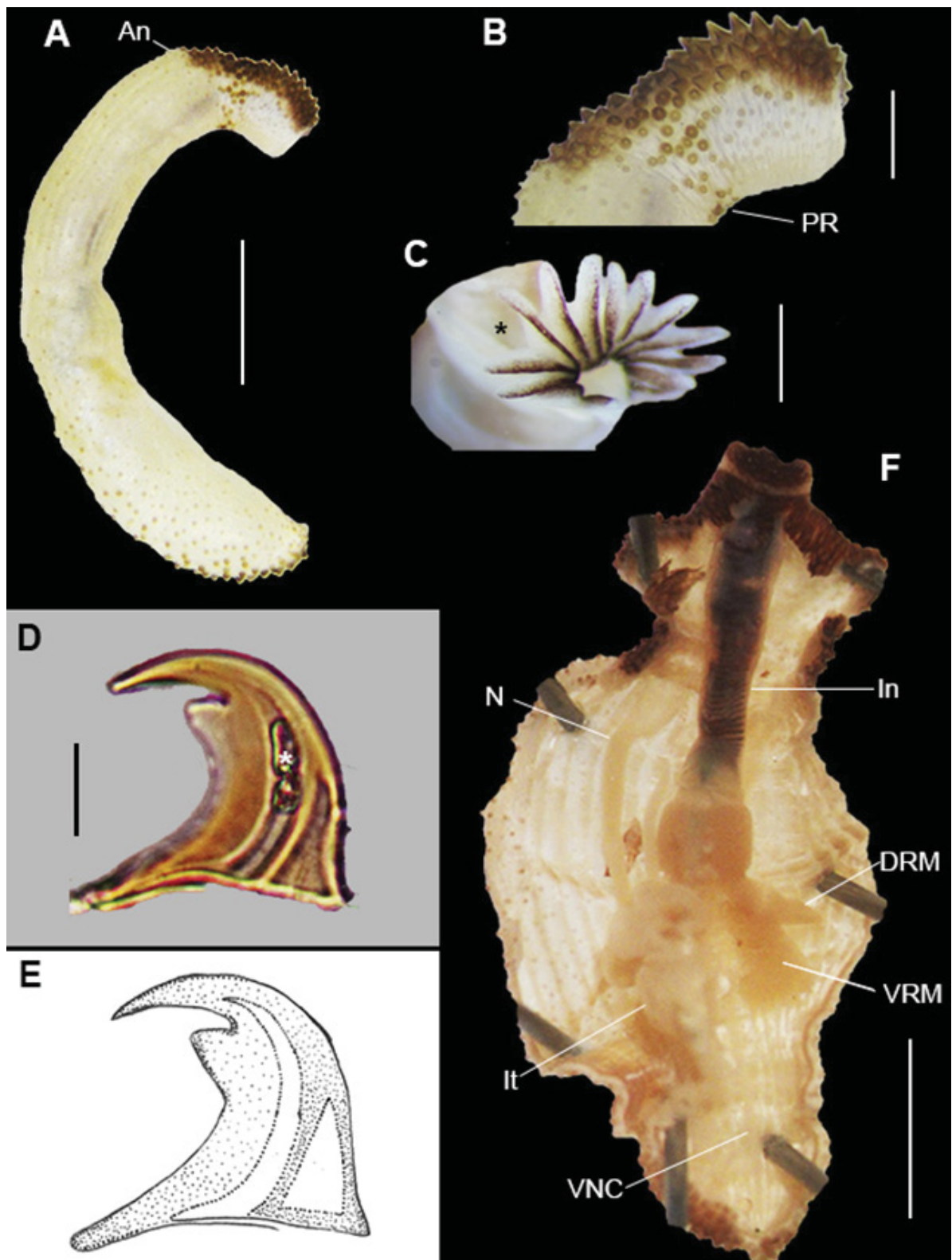
**Description** (EMU-13443)

Trunk 8 mm in length, pale brown body wall with scattered conical papillae (Fig. 13A), larger and denser towards anterior and posterior ends; with pre-anal area of pigmented small, conical papillae (Fig. 13B). Introvert twice as long as trunk; 12 small digitiform tentacles, aboral surface with longitudinal dark pigmented band (Fig. 13C), arranged in arc surrounding nuchal organ, dorsal to mouth; nuchal organ rounded and bilobed. Hooks curved (Fig. 13D–E), 52 µm long, with small secondary tooth, curved streak present, internal triangle separate from streak; hooks arranged in 15 complete rings. Longitudinal dorsal reddish band on posterior 80% of introvert towards anus. Dorsal conical papillae, posteriorly directed, on posterior half of introvert.

Longitudinal musculature in 18 anastomosing bands. Four retractor muscles attached at 50% of trunk length, ventral pair attached to six bands of longitudinal musculature (LMB 2–7), dorsal pair attached to two bands (LMB 6–7), anterior to ventral pair. Paired nephridia approximately 50% of trunk length;



**Fig. 13.** *Phascolosoma (Phascolosoma) azteca* sp. nov. (EMU-13443). **A.** Lateral overview, introvert contracted. **B.** Close-up of introvert base and anal area. **C.** Tentacles. **D.** Mid-posterior hook; asterisk indicates bubble inside clear streak. **E.** Illustration of hook. **F.** Internal anatomy. Abbreviations: see Material and methods. Scale bars: A, F = 2 mm; B–C = 0.5 mm; D–E = 20  $\mu$ m.



**Fig. 14.** *Phascolosoma* (*Phascolosoma*) *perlucens* Baird, 1868 (ECOSUR S0044). **A.** Lateral overview, introvert contracted. **B.** Close-up of introvert base and anal area. **C.** Tentacles; asterisk indicates position of mouth. **D.** Mid-posterior hook; asterisk indicates bubble inside clear streak. **E.** Illustration of hook. **F.** Internal anatomy. Abbreviations: see Material and methods. Scale bars: A, F = 4 mm; B = 2 mm; C = 0.7 mm; D = 20  $\mu$ m.

nephridiopores open anterior to anus. Spindle muscle attaches intestine to rectum anteriorly and to caudal region posteriorly (Fig. 13F).

### Variations

Based on 20 paratypes and the extra material examined, the number of hook rings varies according to the size of the specimen, a specimen with a trunk length of 6 mm having 12 hook rings and a specimen with a trunk length of 10 mm having 20 complete rings. The number of tentacles also varies according to the size of the specimen from 10 to 14.

The Caribbean specimens (Fig. 14) have a greater trunk length, 13 mm long with 12–16 tentacles.

### Habitat

Intertidal to subtidal (12 m); inhabiting *Porites* sp., in rocks, associated with sabellariid tubes, algae and oyster shells.

### Distribution

Mexican Pacific: present along the central and northwestern Mexican Pacific coast, from Baja California to Michoacán.

### Remarks

Specimens of *Phascolosoma (Phascolosoma) azteca* sp. nov. are morphologically close to *P. (P.) perlucens* Baird, 1868. For comparative purposes some specimens of *P. (P.) perlucens* from the Venezuelan coast were examined, and these specimens were consistent with the descriptions and redescriptions of that species (Baird 1868; Rice & Stephen 1970).

Morphological differences were found between specimens from the Caribbean and those from the central and northwestern Mexican Pacific. Specimens of *Phascolosoma (Phascolosoma) perlucens* are larger and have 12–16 tentacles, whereas *P. (P.) azteca* sp. nov. has 10–14. Moreover, *P. (P.) perlucens* has more longitudinal muscle bands, 20–22, while *P. (P.) azteca* has 17–20. Furthermore, the ventral retractor muscles are attached to six longitudinal muscle bands (LMB 2–7) in *P. (P.) azteca* and to five (LBM 2–6) in *P. (P.) perlucens*.

*Phascolosoma (Phascolosoma) perlucens* has pre-anal pigmented papillae on 10–20% of the posterior introvert (Fig. 14B), while in *P. (P.) azteca* sp. nov. they are restricted to 5% of the posterior introvert (Fig. 13B). Finally, the hooks of *P. (P.) perlucens* have a principal tooth that is slightly straight and the secondary tooth is somewhat like a hump (Fig. 14D–E), whereas in *P. (P.) azteca* the hooks have a more curved principal tooth and the inner margin is concave, making the secondary tooth look more projected and slightly acute, rather than like a hump (Fig. 13D–E).

Since the morphology of *Phascolosoma (Phascolosoma) azteca* sp. nov. resembles that of *P. (P.) perlucens*, the newly described species belongs to the *P. (P.) perlucens* species complex, for which, as mentioned by Kawauchi & Giribet (2010), there is evidence of multiple genetic clades, and some morphological differences can be shown between the populations as well. However, the morphological differences listed above indicate that *P. (P.) azteca* from the northwestern Mexican Pacific is a valid species, distinct from *P. (P.) perlucens* from the Caribbean.

*Phascolosoma (Phascolosoma) puntarenae* Grube & Öersted in Grube, 1858  
Fig. 12B, D

*Phascolosoma puntarenae* Grube & Öersted in Grube, 1858: 13 (type locality: Puntarenas, Costa Rica).

*Phascolosoma puntarenae* – Fisher 1952: 430–432, pl. 36 figs 1–2, pl. 37 figs 1–3, pl. 39 fig. 3 (Espíritu Santo Island, Baja California Sur and Miramar Beach, Sonora; in rock). — Silva-Morales & Gómez-Vásquez 2021: 91–92, fig. 7 (Guerrero, Oaxaca; reinstatement).

*Phascolosoma puntarena* – Brusca 1980: 127 (based on Fisher 1952).

*Phascolosoma nigrescens* (not Keferstein, 1865) – Dean 2001: 63 (Costa Rica). — Dean *et al.* 2010: 63 (Costa Rica).

### Material examined

MEXICO – **Baja California Sur** • 1 spec.; El Caimancito Beach; 23 Aug. 1987; RBZ leg.; in dead coral; UMAR-SIPU 138. – **Nayarit** • 1 spec.; Banderas Bay, Manzanilla Beach; 20°44'35" N, 105°23'14.8" W; 26 Nov. 2004; PSS *et al.* leg.; rocks; intertidal; ECOSUR-S0280 • 3 specs; Banderas Bay, Manzanilla Beach; 20°44'25.49" N, 105°23'24.33" W; 29 Nov. 2004; depth 2 m; PSS *et al.* leg.; in rocks; ECOSUR-S0278. – **Jalisco** • 1 spec.; Melaque Beach; 19°13'08.82" N, 104°42'50.22" W; 1 Dec. 2004; depth 1 m; PSS *et al.* leg.; in rock; ECOSUR-S0279.

### Description (UMAR-SIPU 138)

Trunk 30 mm in length (Fig. 12B); body wall slightly rough, dark brown, covered with scattered dome-shaped papillae, denser on posterior trunk. Introvert twice as long as trunk, with black transverse patches and 24 digitiform tentacles; hooks 92.5 µm long, with a wide curved streak (Fig. 12D), arranged in more than 100 complete and incomplete rings.

Longitudinal musculature separated into 24 anastomosing bands. Four retractor muscles, ventral pair attached to body wall at 42% of trunk length, dorsal pair attached anteriorly and more displaced from ventral nerve cord. Two nephridia of 50% of trunk length; nephridiopores open at same level as anus. Intestine spiral anchored at both ends by well-developed spindle muscle.

### Habitat

Intertidal to subtidal (2 m); under rocks and in dead coral.

### Distribution

Eastern Tropical Pacific: from the Gulf of California to Costa Rica.

### Remarks

This species was recently reinstated from synonymy with *P. nigrescens* after differences were noted in their hooks (Silva-Morales & Gómez-Vásquez 2021). The specimens examined here show all the features of the species indicated by Silva-Morales & Gómez-Vásquez (2021).

Family Sipunculidae Rafinesque, 1814

Genus *Sipunculus* Linnaeus, 1766

Subgenus *Sipunculus* (*Sipunculus*) Cutler & Cutler, 1985

*Sipunculus* (*Sipunculus*) *bastidai* sp. nov.

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Fig. 15, Table 2

### Etymology

This species is named after the researcher J. Rolando Bastida-Zavala, who has been my mentor and friend, as a token of appreciation for his kindness and teaching about different taxonomic groups, and for his remarkable work on polychaetes. He also collected the specimens examined here. The epithet is a noun in the genitive case (ICZN 1999, Art. 31.1.2).



## Material examined

### Holotype

MEXICO • W coast of Baja California Sur; 26°17'25" N, 112°56'39" W; Feb. 1989; depth 54 m; RBZ leg.; Van Veen grab; subtidal muddy/sand bottom; EP-8902 cruise, stn E21, on board R/V *El Puma*; UMAR-SIPU 129.

### Paratypes

MEXICO • 70 specs; same collection data as for holotype; UMAR-SIPU 001 • 5 specs; same collection data as for holotype; ECOSUR-313 • 5 specs; same collection data as for holotype; EMU-13451 • 5 specs; same collection data as for holotype; EMU-13452.

### Other material

MEXICO • 64 specs; W coast of Baja California Sur; 26°17'25" N, 112°56'34" W; Feb. 1989; depth 62 m; RBZ leg.; EP-8902 cruise, stn E22, on board R/V *El Puma*; UMAR SIPU-002.

## Description (UMAR-SIPU 129)

(Based on holotype.) Trunk 80 mm in length; pinkish brown body wall, slightly iridescent (Fig. 15A). Trunk skin squared; middle trunk with protruding globose skin bodies on each square (Fig. 15B), present on approximately half of trunk length; first 35% and last 15% of trunk length free of skin bodies. Glans region on last 8% of trunk length, not distinctly differentiated from trunk, caudal tip with a notch. Introvert  $\frac{1}{4}$  of trunk length, with scattered triangular, rounded tip papillae. Short crenulated tentacles surrounding mouth (Fig. 15D).

Longitudinal musculature divided into 35 bands. Four retractor muscles attached to body wall at same level, at 25% of trunk length; ventral pair attached to two muscle bands (LMB 3–4), dorsal pair attached to three muscle bands (LMB 12–14). Brain oval, 1 mm in length, wider than long, with main tubular process (Fig. 15E). Post-esophageal loop of same length as intestine, reaches glans region. Pair of nephridia 20 mm in length, with granulated surface; nephridiopores open anterior to anus. Anus located at 25% of trunk length; rectum with a pair of wing muscles; single sack-like caecum present, attached to spindle muscle. Spindle muscle well developed, attached anteriorly to rectum, subdivided along entire intestine in various stringy muscles, not attached posteriorly (Fig. 15C).

## Variations

(Based on 25 specimens from paratype material.) The trunk length of the smallest specimen is 58 mm, while the largest is 115 mm long. The proportion of the body occupied by globose skin bodies is  $\frac{1}{2}$  of the trunk length, with a range from  $\frac{1}{3}$  to  $\frac{2}{3}$ .

Regarding the longitudinal muscle bands (LMB), the majority (52%) of the specimens have 35, 20% have 36, 16% have 37, one specimen has 33 and one has 34 LMBs. Almost all specimens analyzed have the ventral retractor muscles (RM) attached to two LMBs (LMB 3–4), but one specimen has the ventral RM attached to three LMBs (LMB 3–5); in most of the specimens the dorsal RMs are attached to three LMBs (LMB 12–14), but some specimens have the dorsal RM attached to four LMBs (LMB 12–15); a few other specimens have the dorsal RM start their attachment to LMB 11–13, resulting in six possible combinations observed: attached to three LMBs (11–13, 12–14 or 13–15) or attached to four LMBs (11–14, 12–15 or 13–16), where the last three combinations are the rarest.

## Habitat

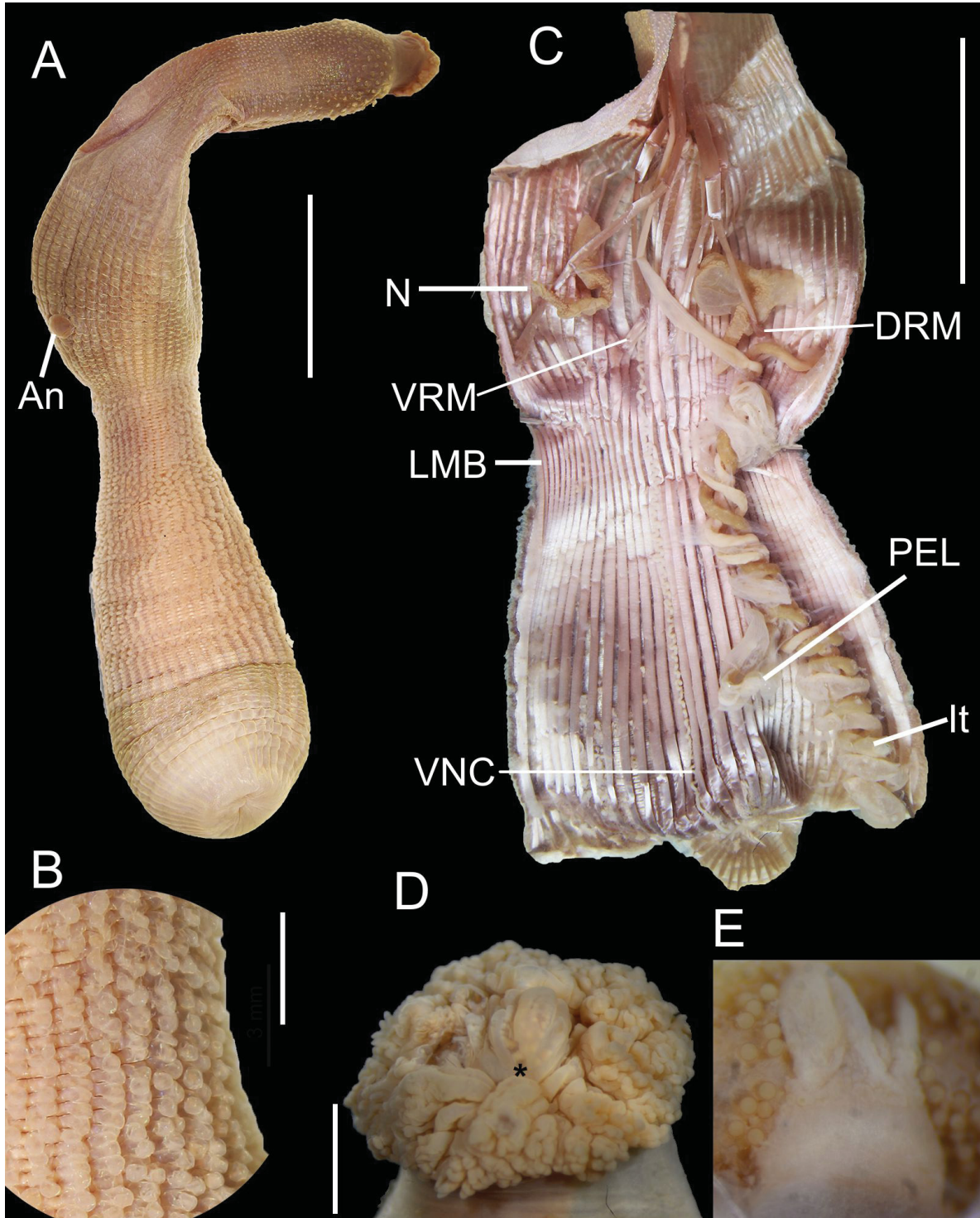
Subtidal (54–62 m); in muddy/sandy bottom.

## Distribution

Only known from the western coast of Baja California Sur.

### Remarks

Specimens of *Sipunculus (Sipunculus) bastidai* sp. nov. from Baja California Sur resemble *S. (S.) phalloides phalloides* (Pallas, 1774) from the island of Granada, Antilles, and *S. (S.) phalloides inclusus*



**Fig. 15.** *Sipunculus (Sipunculus) bastidai* sp. nov. (UMAR-SIPU 129). **A.** Lateral overview, introvert with tentacular crown. **B.** Close view of mid-trunk papillae. **C.** Internal anatomy. **D.** Tentacles; asterisk indicates mouth. **E.** Cerebral ganglia. Abbreviations: see Material and methods. Scale bars: A, C = 20 mm; B = 3 mm; D = 2 mm.

**Table 2.** Morphological comparison of the two subspecies of *Sipunculus* (*Sipunculus*) *phalloides* (Pallas, 1774), *S. (S.) ph. phalloides* (Pallas, 1774) and *S. (S.) ph. inclusus* Sluiter, 1902, with *Sipunculus* (*S. bastidai* sp. nov. Abbreviations: LMB = longitudinal muscle bands; RM = retractor muscles.

	<i>S. (S.) ph. phalloides</i>	<i>S. (S.) ph. inclusus</i>	<i>S. (S.) bastidai</i> sp. nov.
Type locality	Granada (West Atlantic)	Indonesia, Indo-Western Pacific	W coast of Baja California Sur, Mexican Pacific
LMB	35–41	32–39	33–37
LMB where RM (ventral, dorsal) attach	2 (3–4), 5 (11–15)	4 (2–5), 5 (10–14)	2 (3–4), 3 (3–5); 3 (12–14, 11–13 or 13–15), 4 (11–14, 12–15 or 13–16)
Globose skin bodies	absent	absent	present
Rectal caecum	absent	absent	present

Sluiter, 1902 from Indonesia by having between 35 and 41 longitudinal muscle bands and by having the origin of the retractor muscles separated. However, specimens of *S. (S.) bastidai* have a series of morphological characters that are different from those of the two subspecies of *S. phalloides*. In their descriptions and illustrations (Pallas 1774; Sluiter 1902), neither of the subspecies of *S. phalloides* has skin bodies on the trunk, which are clearly observed as globular projections in specimens of the new species; the range of number of longitudinal muscle bands (LMB), regardless of the size of the specimens, is also different: 33–37 in *S. (S.) bastidai*, 35–41 in *S. (S.) phalloides phalloides* and 32–39 in *S. (S.) phalloides inclusus*. Furthermore, according to Cutler & Cutler (1985), who reviewed Sluiter's type material, *S. (S.) phalloides inclusus* has LMBs that separate and rejoin each other along the trunk, unlike *S. (S.) bastidai*, where the LMBs maintain the same number throughout the trunk.

Other morphological features that separate *Sipunculus* (*Sipunculus*) *bastidai* sp. nov. from the subspecies of *S. (S.) phalloides* are the number and position of the LMBs to which the retractor muscles are attached (Table 2). Stephen & Edmonds (1972) mentioned that both subspecies of *S. (S.) phalloides* do not have a caecum in the rectum, whereas the species from Baja California Sur does. Due to this set of morphological differences, there is enough evidence to consider *S. (S.) bastidai* as a valid new species. Regarding molecular analyses, it has been shown in a species of the same genus (*Sipunculus nudus* Linnaeus, 1766) that there is evidence of multiple genetic clades, invalidating the idea of cosmopolitan species (Kawauchi & Giribet 2014).

## Discussion

Of the 19 taxa previously recorded from the central and northwestern Mexican Pacific, only four species were rediscovered: *Themiste* (*T.*) *hennahi*, *T. (T.) pyroides*, *Apionsoma* (*E.*) *pectinatum* and *Phascolosoma* (*P.*) *puntarenae*, species previously recorded by Steinbeck & Ricketts (1941) and Fisher (1952). Also, this study recorded sipunculans from bathyal depths (up to 1079 m) for the first time in the Mexican Pacific: *Nephasoma* (*N.*) *wodjanizkii wodjanizkii*, *Apionsoma* (*A.*) *silviae* sp. nov. and *Apionsoma* (*E.*) *hendrickxi* sp. nov. (the latter two from 310 m). The latter reflects our poor knowledge of the sipunculans from deep waters, especially in Mexico.

The study by Hermoso-Salazar *et al.* (2013) was the only one so far to record deep-water sipunculans for México (217 m), recording eight taxa, only three of which were identified to the specific level, but these records are considered to be questionable due to their large distribution ranges (Silva-Morales & Gómez-Vásquez 2021); none of them were found in the present study. In shallower waters, Salazar-Vallejo (1983) recorded a morphospecies close to *Aspidosiphon* (*Akrikos*) *albus* Murina, 1967; however, he questioned whether the species could be widely distributed. The records of *A. (A.) albus* (Hermoso-

Salazar *et al.* 2013) and of *A. (A.) cf. albus* from the northwestern Mexican Pacific could be considered the same species, despite their being from the northern Gulf of California and Colima, respectively. However, more efforts should be made to confirm the identity of this species, which is likely to be new, distinct from the actual *A. (A.) albus*.

Compared to previous records, *Themiste (T.) hennahi* expands its distribution for Mexico, from Baja California to Jalisco; Silva-Morales & Gómez-Vásquez (2021) recorded the species for Oaxaca, increasing its distribution in Mexico, so it is assumed that *T. (T.) hennahi* has a distribution along the entire Mexican Pacific coast (Fisher 1952; Silva-Morales & Gómez-Vásquez 2021).

Since molecular tools have been included in recent taxonomic studies, some questions have been formulated, such as, “How similar are the populations of species from different regions of the world?” In this sense, research studies have been conducted for supposedly cosmopolitan species, such as *Phascolosoma (P.) perlucens*, and within the genus *Sipunculus*, such as *Sipunculus nudus*. Kawauchi & Giribet (2010, 2014) invalidated the idea that *P. perlucens* and *S. nudus* are cosmopolitan, highlighting that there is some morphological evidence that could support the differentiation found in molecular analyses.

Unfortunately, the specimens used in the present study were fixed in formalin when collected, hindering DNA sequencing. However, they offered enough morphological evidence to describe them and establish some of them as new species. The new species belong to three families of Sipuncula, Phascolosomatidae (*Apionsoma (Apionsoma) silviae* sp. nov., *Apionsoma (Edmondsius) hendrickxi* sp. nov. and *Phascolosoma (Phascolosoma) azteca* sp. nov.), Golfingiidae (*Phascolion (Lesenka) salgadoi* sp. nov.) and Sipunculidae (*Sipunculus (Sipunculus) bastidai* sp. nov.). Of these new species, *Phascolosoma (Phascolosoma) azteca* has previously been recorded as *P. dentigerum* (Steinbeck & Ricketts 1941; Fisher 1952); the arguments that support the idea that this is a new species are given above.

A total of 17 species have previously been recorded from the Warm Temperate Northeast Pacific (WTNP) (Gálvez-Zeferino *et al.* 2020; listed in Silva-Morales & Gómez-Vásquez 2021); adding the new records found in this study, there are a total of 27 species. A total of 34 species have been recorded from the Tropical Eastern Pacific (TEP) (Silva-Morales & Gómez-Vásquez 2021); with this study three species are added, bringing the total to 37 species from the TEP. Six species were previously known to be shared between the two provinces: *Antillesoma mexicanum*, *Aspidosiphon elegans*, *A. albus*, *Apionsoma pectinatum*, *Phascolosoma puntarenae* and *Phascolion strombus*; with this study two species have been added: *Aspidosiphon pastori* and *Phascolosoma azteca* sp. nov. Since this contribution includes both provinces, it provides a picture of a transition zone between them, for which the sipunculan fauna can be seen as a proxy.

Thus, considering the valid species previously recorded and by adding those found in the present study, the species of the central and northwestern Pacific of Mexico represent about 30% of the total number present in both marine provinces.

Our results emphasize the importance of scientific collections, not only in Mexico but also in the entire world, since they provide material for comparison with newly collected material. Speaking specifically of deep-sea sipunculans, thanks to the scientific collections of Mexico it was possible to obtain a first approximation of the bathyal sipunculans from Mexico. The collected material is valuable, since exploration in deep waters demands special tools and the costs of transportation and equipment rentals are very high, making this material unique.

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