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A Review of the Pennatulacean Genus *Stylatula*, with the Description of a New Species from Japan (Cnidaria: Octocorallia)

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Until relatively recently, the pennatulacean genus *Stylatula* was known only from North and South America and the eastern Atlantic Ocean. In 2007, a new species was described from New Zealand. This paper describes an additional species, also from the western part of the Pacific Rim. In addition, historical and taxonomic reviews of the genus are included.

KEYWORDS: Pennatulacea, Virgulariidae, sea pens, *Stylatula*, new species, Japan, key to the Pacific Ocean species of the genus

HISTORICAL PERSPECTIVE.— Verrill (1868:382) established the pennatulacean family Virgulariidae (spelled as Virgularidae by him), which included the two genera *Virgularia* Lamarck, 1816, and *Stylatula*, Verrill, 1864. Kölliker (1880:33–34) distinguished two families – (1) Virgularidae for *Virgularia*, *Scytalium* Herklots, 1858, and the species *Pavonaria finmarchica* (Sars, 1851); and (2) the family Stylatulidae for *Stylatula*, *Dübenia* Koren & Danielssen, 1877, and *Acanthoptilum* Kolliker, 1870. Subsequently, *Dübenia* was considered a junior synonym of *Stylatula* by Kükenthal (1915:67), and *Pavonaria* Kölliker, 1869 was synonymized with *Halipteris* Kölliker, 1869, by Williams (1995:120) since the name *Pavonaria* was previously used by Schweigger, 1820 for a different pennatulacean in the family Funiculinidae. One valid family, Virgulariidae, is currently recognized to incorporate the five genera *Virgularia*, *Scytalium*, *Stylatula*, *Acanthoptilum*, and *Scytaliopsis* Gravier, 1906, while *Halipteris* is viewed as the sole genus of the family Halipteridae (Williams 1995:120–125).

MATERIALS AND METHODS

MATERIAL EXAMINED OF OTHER SPECIES OF *STYLATULA*.— *Stylatula elongata* (CAS 173213) U.S.A., Washington, Squamish Harbor (aka Shine Cove) near Shine, WA; 47°51.582'N 122°39.130'W; 1 August 2010; 13–18 m depth; collector James Murray; two colonies fixed in 90% ethanol, preserved in 95% ethanol. *Stylatula austropacifica* Holotype (CAS 173209); Sta. No. NIWA (NZOI) C306; New Zealand; 36°41.00'S 173°58.00'E, 190 m depth; 24 October 1959; one partial colony preserved in 75% ethanol.

ABBREVIATIONS USED IN THE TEXT.— **AKM** (Asako K. Matsumoto Collection, Japan), **CASIZG** (Invertebrate Zoology and Geology Collections, California Academy of Sciences, San Francisco, California, USA). **SEM** Scanning electron micrographs.

SYSTEMATIC ACCOUNT

Subclass Octocorallia
Order Pennatulacea
Family Virgulariidae Verrill, 1868Genus *Stylatula* Verrill, 1864

GENERIC DIAGNOSIS.— Virgulariid pennatulaceans with slender, bilateral, often vermiform colony shape. Axis present throughout colony length, most often round in transverse section. Polyp leaves subtended by fanlike armatures of spindle-like to needle-like sclerites, which may or may not be three-flanged. Sclerites from other parts of colony inconspicuous to absent.

TYPE SPECIES.— *Virgularia elongata* (Gabb, 1862); subsequent designation by Verrill, 1864; type locality California.

ETYMOLOGY.— The generic name is derived from the Greek *Stylos*: a style, stake, or pillar.

SYSTEMATICS AND PHYLOGENETIC ASSESSMENT.— The genus *Stylatula* contains thirteen described species from the Atlantic and Pacific Oceans (Japan to Norway), between approximately 65° north and 50° south latitude (Fig. 9). With the addition of the new species described here, thirteen species are considered valid; known geographic range Atlantic and Pacific Oceans (Japan to North & South America to Norway and Namibia), 0–1020 m in depth (Williams 1995:122; Williams 2011:6; Williams 2014). The genus *Stylatula* differs from other genera in the family Virgulariidae by the presence of a conspicuous fan-shaped armature subtending each polyp leaf, comprised of relatively robust sclerites. Of the five described genera in the family, only *Stylatula*, *Acanthoptilum*, and *Scytalium* have sclerites in the rachis and polyp leaves, while *Virgularia* and *Scytalopsis* do not.

***Stylatula diminutiva* Williams and Matsumoto, sp. nov.**

Figures 1–9.

SPECIES DIAGNOSIS.— Virgulariid pennatulaceans; mature colonies < 65 mm long; number of polyps per polyp leaf 2–4; number of large sclerites comprising fan-shaped polyp leaf armature < 7; sclerites three-flanged throughout.

MATERIAL EXAMINED.— **HOLOTYPE:** CASIZ 198016; Japan, Iwate Prefecture, Sanriku, Otsuchi Bay; 39°20,710'N x 141°56,923'E; 44 m depth; 28 April 2009; collection number AKM 1414; collector Asako K. Matsumoto on board *R/V Yayoi* with 1 m biological dredge; remarks – mud bottom inside bay, water temperature 9.6° C: one whole specimen preserved in 95% EtOH. **PARATYPES:** CASIZ 198017; same data as holotype. CASIZ 203514; Japan, Iwate Prefecture, Sanriku, east Otsuchi Bay; approximate coordinates 39°24' – 39°34'N, ca. 142°10'–142°41'E; 118–120 m depth; 12 November 1993; collection number AKM 1627 (= 1618b); collector S. Ohta on board *R/V Tansei-maru* KT 93–15 cruise, St. 01 with 1 m biological dredge; remarks – separated from AKM 1618a; one whole specimen fixed in formalin and preserved in 95% EtOH. **OTHER MATERIAL (non-type):** CASIZ 203513; same data as holotype.

DESCRIPTION.— The wet-preserve holotype measures 36 mm in length and 2.5 mm at its widest point (across the second polyp pair from the terminal apex). The internal axis is thin and extends the length of the colony. It is cylindrical, round in cross section, and contains numerous surface pores, which are often narrow and elongated. The composition of the axis is that of radially-arranged, wedge-shaped columns of calcareous matter, as in other pennatulaceans (Figs. 2–4), which is similar to the axial structure of ellisellid gorgonians (Bayer, 1956: 224). Of the approxi-

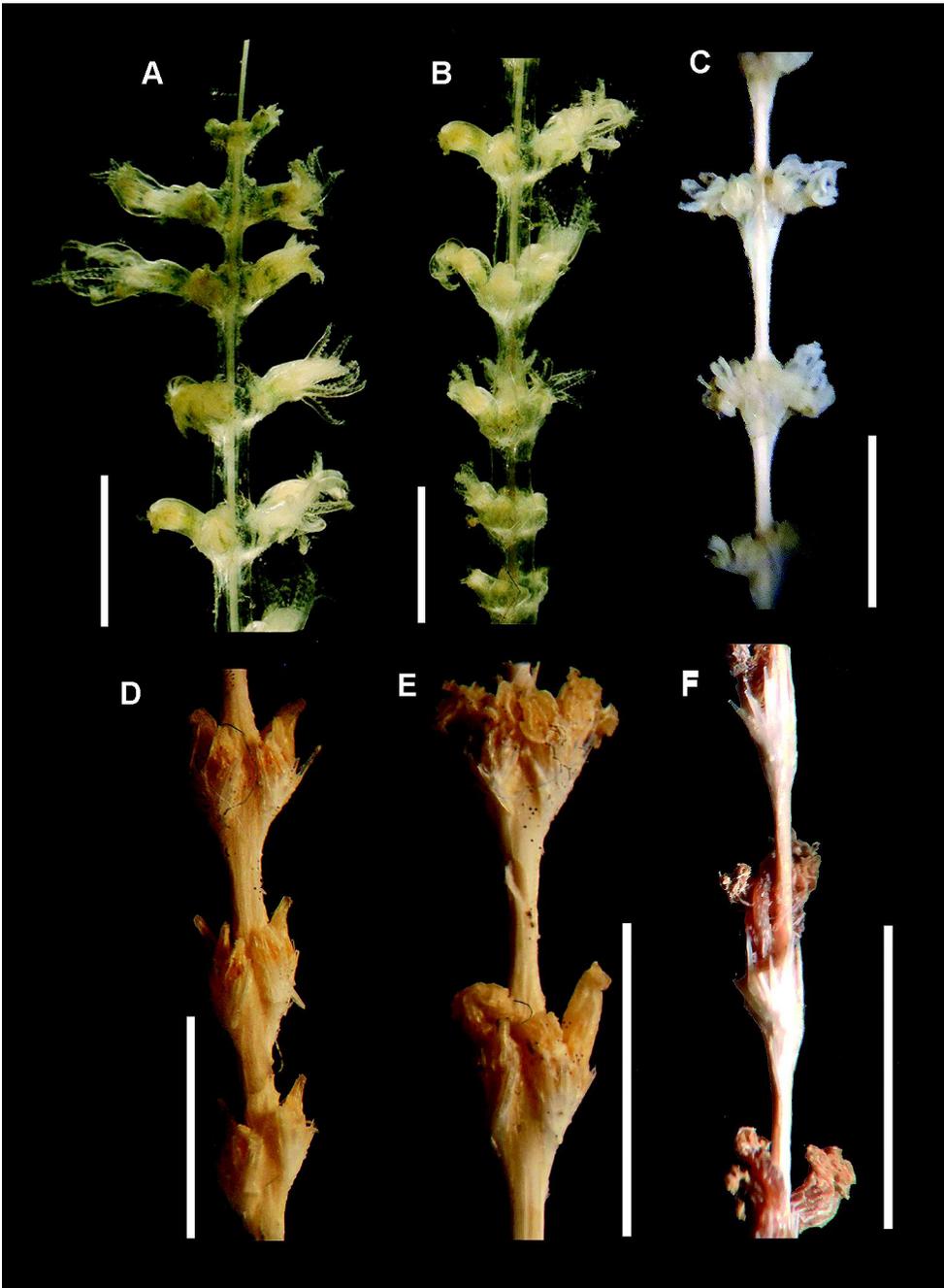


FIGURE 1. *Stylatula diminutiva* sp. nov. A-B. Living colony. C. Wet preserved holotype (CAS 198016). D-F. Wet preserved paratype (CAS 203514). Scale bars = 2.5 mm.

mately thirty-five pairs of polyp leaves that are distinguishable, nine of these at the upper end of the rachis are fully developed, have mature polyps and conspicuous fan-shaped basal armature. The other twenty-six polyp leaf pairs are incipient, or not fully mature, and are not separated from

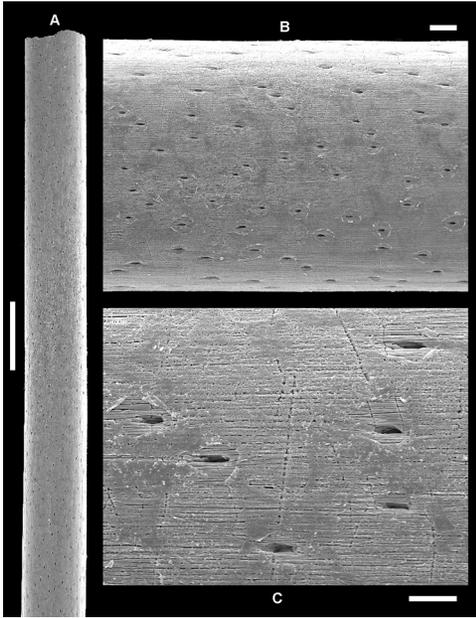


FIGURE 2. *Stylatula diminutiva* sp. nov. SEM of surface of axis (CAS 203513), showing surface pores. A. Portion of axis; scale bar = 0.2 mm. B. Detail of axial surface; scale bar = 0.02 mm. C. Ultrastructural detail of axial surface; scale bar = 0.01 mm.

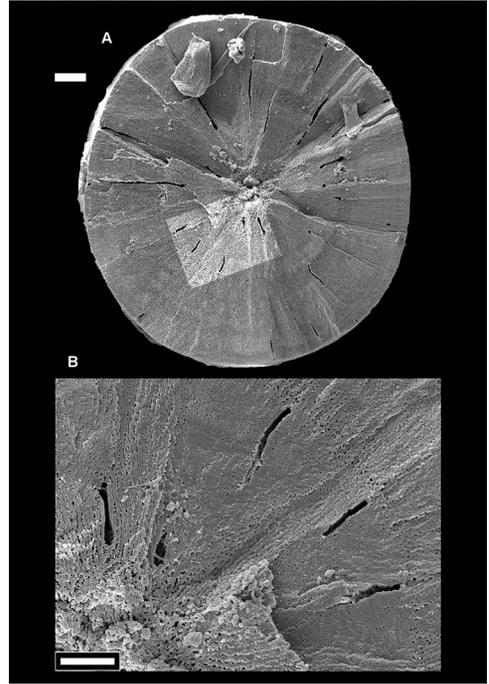


FIGURE 3. *Stylatula diminutiva* sp. nov. SEM of internal morphology of the axis (CAS 203513). A. Transverse section of axis, 0.23 mm in diameter, showing elongated pores; scale bar = 0.02 mm; lightened rectangle is shown enlarged in B below. B. Internal structural detail of axis; scale bar = 0.01 mm.

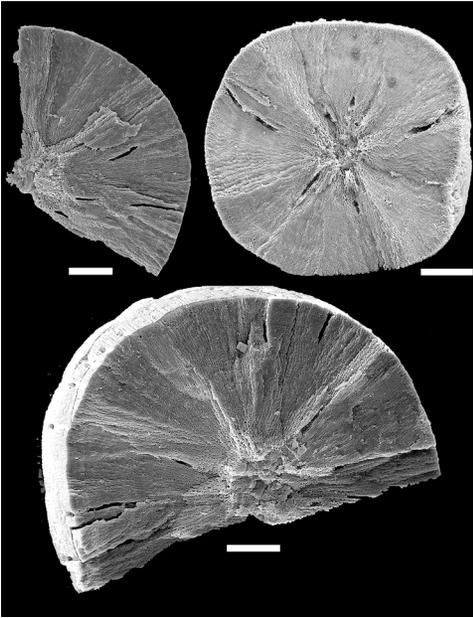


FIGURE 4. *Stylatula diminutiva* sp. nov. SEM of internal morphology of the axis (CAS 203514), showing radial arrangement of calcareous material. Transverse sections of axis; scale bars = 0.02 mm.

adjacent pairs in the proximal region of the rachis, or are separated by < 2 mm of bare rachis in the middle portion of the rachis. The uppermost polyp leaf pairs on the distal part of the rachis are separated from adjacent pairs of polyp leaves by approximately 2 mm of bare rachis (Fig. 1C). In the largest polyp leaves of the upper rachis, there are 2–4 polyps comprising each leaf. The peduncle is approximately 7 mm in length (Fig 7E).

The sclerites are predominantly three-flanged spindles and rods (0.04–0.85 mm in length). Each polyp leaf is subtended by a conspicuous V-shaped or fan-shaped polyp leaf armature of relatively large sclerites (Fig 1). The fan-shaped armature is narrowly V-shaped and gradually tapers proximally. The ends of each sclerite may be acute and pointed or truncated and blunt. Some sclerites are minutely toothed on a portion of the margins or on one terminal

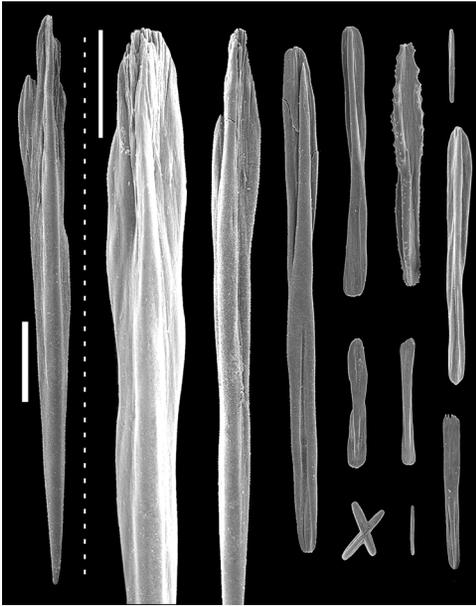


FIGURE 5. *Stylatula diminutiva* sp. nov. SEM of sclerites from region of the polyp leaf armature (Non-type CAS 203513); scale bars = 0.10 mm.

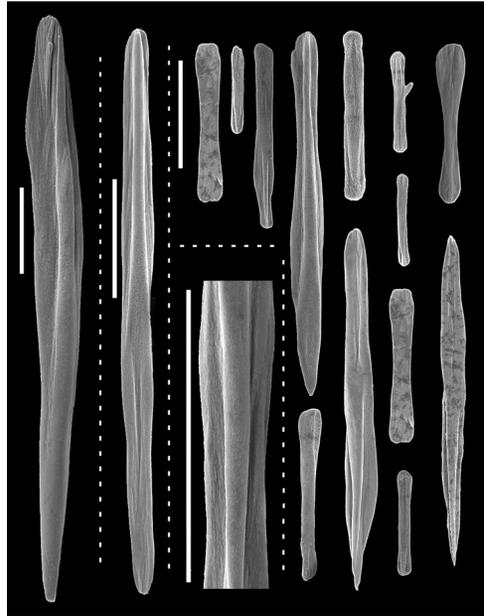


FIGURE 6. *Stylatula diminutiva* sp. nov. SEM of sclerites from region of the polyp leaf armature (Paratype CAS 203514); scale bars = 0.10 mm.

apex. Small, cross-like sclerites may also be present. Some sclerites may also have a short side branch (Figs. 5–6).

ETYMOLOGY.— The specific epithet is derived from the Late Latin, *deminutivum* (indicating small size); in reference to the miniature size of the colonies relative to those of other species in the genus.

DISTRIBUTION.— Otsuchi Bay, Iwate Prefecture, Japan; 44–120 m depth range.

VARIATION.— The polyp leaves that comprise a single pair can be arranged oppositely (as in the holotype CAS 198016) or sub-alternately (as in CAS 203513). The four entire specimens examined ranged in length from 36–60 mm.

DISCUSSION AND CONCLUSIONS

A new species of the pennatulacean genus *Stylatula* is here described from Japan, and represents the most diminutive species in the genus (< 60 mm in length). With the addition of this new species, the genus is comprised of thirteen species that are currently considered valid (Table 1). The known distribution of the *Stylatula* is currently recognized as being restricted to the margins of the Pacific and Atlantic Oceans (Fig. 9). The recent descriptions of *Stylatula austropacifica* from New Zealand and the new species described below from Japan, have extended the range of the genus from the North American west coast to the margins of the western Pacific. Unlike other species of the genus, the sclerites comprising the polyp leaf armature of *Stylatula austropacifica* are not three-flanged (Fig. 8).

The first two species of the genus that were described, *Stylatula elongata* (Gabb, 1862) and *S. gracilis* (Gabb, 1864), were both first described from California. Gabb (1864:120) distinguishes *Stylatula gracilis* from *S. elongata* (both species were originally described by him in the genus *Vir-*



Figure 7. Wet-preserved colonies of Pacific Ocean species of *Stylatula*. A-C. *Stylatula elongata* (CAS 173213); scale bars: A = 40 mm, B & C = 15 mm. D-F. *Stylatula diminutiva* sp. nov.; scale bar = 10 mm. D. (CAS 203513). E. Holotype (CAS 198016). F. Paratype (CAS 198017). G. *Stylatula austropacifica* Paratype (CAS 173209); scale bar = 30 mm.

gularia) by its more slender form, proportionally large polypiferous lobes, cylindrical stem without grooves and comparatively small portion of the stem bearing the lobes. No mention is made of sclerites. Both species have been recorded from Monterey Bay, central California.

Kükenthal (1915: 68) distinguishes the species as follows: *S. elongata* with polyp calyces separate to the base and ≤ 24 polyps per polyp leaf, and *S. gracilis* with polyp calyces fused at the base and 13–18 polyps per leaf. It is uncertain as to Kükenthal's exact meaning regarding the degree of fusion of the polyp cup or calyx as the large sclerites that form the fan-like armature subtending the polyp leaves never fuse, but rather may be in very close proximity or may overlap slightly. In addition, it is difficult to use the number of polyps in a given polyp leaf as diagnostic for species, since variation in colony age and size cannot be assessed by examining a small number of preserved specimens.

Nutting (1909:700) records *Stylatula elongata* from San Diego in the south to as far north as Sausalito in San Francisco Bay. Furthermore, he states that Verrill's specimens (presumably referring to *S. gracilis* Verrill, 1864) were from Panama and Cabo San Lucas, Mexico. He ends with a somewhat confusing statement, "Verrill regards this species of Gabb's as identical with his own *Stylatula elongata*; the priority, however, belongs to the species named by Gabb."

In consideration of the foregoing arguments, it is possible that the two species are synonymous or alternatively that *Stylatula elongata* is a more northern species (at least as far north as British Columbia to San Diego in the south), while *S. gracilis* (if valid) has a more southern distribution (southern tip of Baja California to the Pacific coast of Panama). However, a comparative examination of type material is necessary to make an adequate taxonomic assessment. One additional note: the California Academy of Sciences Invertebrate Zoology collection data base has a total of 68 records for these two species. Of these, 66 are allocated as *Stylatula elongata* and only two are identified as *S. gracilis*. One of the latter is from Panama.

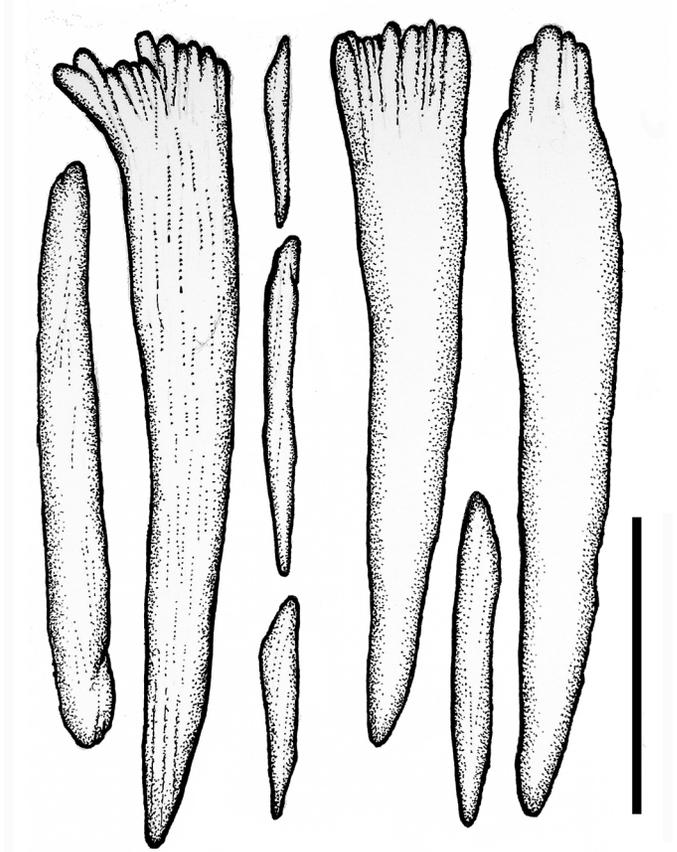


FIGURE 8. *Stylatula austropacifica*, sclerites from the holotype (CAS 173209), showing that they are not three-flanged; scale bar = 0.50 mm.

TABLE. 1. The thirteen species of *Stylatula* currently considered valid (Williams 2014; Williams and Matsumoto, present paper).

Species	Distribution
<i>S. antillarum</i> Kölliker, 1872	Caribbean Sea and Gulf of Mexico
<i>S. austropacifica</i> Williams, 2007	New Zealand
<i>S. brasiliensis</i> (Gray, 1870)	Brazil
<i>S. darwini</i> Kölliker, 1870	Brazil to Argentinian Patagonia
<i>S. diadema</i> Bayer, 1959	Surinam
<i>S. diminutiva</i> Williams & Matsumoto sp. nov.	Japan
<i>S. elegans</i> (Danielssen, 1860)	North Atlantic Ocean
<i>S. elongata</i> (Gabb, 1862)	British Columbia to California; Panama?
<i>S. gracilis</i> (Gabb, 1864)	Central to southern California; Panama?
<i>S. kinbergi</i> Kölliker, 1870	Locality unknown
<i>S. lacazi</i> Kölliker, 1870	Locality unknown
<i>S. macphersoni</i> López-González, Gili & Williams, 2001	Namibia
<i>S. polyzoidea</i> Zamponi & Pérez, 1997	Argentina



FIGURE 9. Map of the Pacific and Indian Oceans showing the known geographic distribution of the genus *Stylatula*. Arrows point to type localities of 11 of the species. Localities of *S. lacazi* and *S. kinbergi* are not known.

Key to the Pacific Ocean Species of *Stylatula*

- 1a. Sclerites of the polyp leaf fans are not three-flanged. Polyps per polyp leaf 4–6
 *S. austropacifica*
- 1b. Sclerites of the polyp leaf fans are conspicuously three-flanged 2
- 2a. Mature colonies < 65 mm in length. Polyps per polyp leaf 2–4. Large needle-like sclerites of the polyp leaf fans less than 7 *S. diminutiva*
- 2b. Mature colonies > 65 mm in length. Polyps per polyp leaf more than 5. Large needle-like sclerites of the polyp leaf fans 9–12 3
- 3a. Number of polyps per polyp leaf up to 18 *S. gracilis*
- 3b. Number of polyps per polyp leaf up to 24 *S. elongata*

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