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SHORT COMMUNICATION

On the presence of *Distichoptilum gracile* Verrill, 1882 (Octocorallia: Pennatulacea), in the southeastern Pacific

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Abstract The two-lined sea pen *Distichoptilum gracile* Verrill, 1882, the type and only species that is considered valid in the genus *Distichoptilum* Verrill, 1882, is a rather large deep-water pennatulacean found in soft bottoms. Its deep red colonies are conspicuously long (1 m or more) and thin, with autozooids arranged alternately in simple rows on each side. This species has an almost cosmopolitan but fragmentary distribution, with sparse records from the Atlantic, Indian and Pacific Oceans. In the Pacific Ocean, its occurrence has been scarcely reported: from off Mexico, the Galapagos Archipelago and off New Zealand. The present record of this rare species is based on a collected colony that was entangled in a longline used in the fisheries of the Patagonian toothfish *Dissostichus eleginoides* Smitt, 1898, off Chañaral (26°S), Región de Atacama, along the continental margin of northern Chile. *Distichoptilum gracile* is the third species of the entire order Pennatulacea to be recorded in Chile, being also the first record of the family Protoptilidae Kölliker, 1872, and of the genus *Distichoptilum* Verrill, 1882 for Chile. The presence of this species confirms the need not only for further studies of the bycatch of commercial fisheries, but also for inventories to document the diversity of deep-water anthozoans in the southeastern Pacific.

Keywords Sea pens · Protoptilidae · Chile · South America · Deep-water fauna · Bycatch · Range extension

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Introduction

Pennatulacean octocorals, a group of cnidarians commonly referred to as sea pens or sea feathers, includes about 200 extant valid species in 35 genera, which are widely distributed around the world, both geographically and bathymetrically (Williams 2011). The pennatulaceans form colonies with bilateral (rarely radial) symmetry and polyp dimorphism or polymorphism (Williams et al. 2012). They are formed by a very large polyp called the oozooid, on the wall of which the coenenchyme spreads with numerous small (secondary) polyps; the large primary polyp may be additionally supported by a horny or calcium carbonate axis (Breedy and Cortés 2008). Literature on this order in the southeastern Pacific is scarce, with only two recorded species, both of them sea pansies of the endemic American genus *Renilla* Lamarck, 1816: *Renilla chilensis* Philipi, 1892, and *R. koellikeri* Pfeffer, 1886 (Riveros 1948; Zamponi and Pérez 1995; Pérez 1996; Pérez and Zamponi 1999; Uribe et al. 2014). This low species number in the southeastern Pacific may not truly represent an absence of the entire order in the area, but merely a lack of sampling effort in the Peruvian biogeographical province, as demonstrated for other recently studied

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anthozoan groups, which have revealed several new records and species (van Ofwegen et al. 2006, 2007; Breedy and Guzman 2014; Araya et al. 2016b, c).

The family Protoptilidae Kölliker, 1872, encompasses the genera *Distichoptilum* Verrill, 1882, and *Protoptilum* Kölliker, 1872. Both genera are characterized as having long, thin and whip- or staff-like colonies, with autozooids arranged in one to three longitudinal series, retractile into spiculate calyces, covered with numerous three-flanged, spindle-shaped sclerites (Williams 1990). The two genera differ regarding the presence of autozooids on the ventral side, being absent in *Distichoptilum* and present in *Protoptilum* (see Mastrototaro et al. 2015). Terminal teeth in the calyces are also characteristic (Kukenthal 1915; Williams 1995). The monospecific genus *Distichoptilum* Verrill, 1882, is represented by *D. gracile* Verrill, 1882, a large, whip-like and bright red deep-water pennatulacean (Williams 1995). In the present work, as part of ongoing studies reviewing the bycatch fauna of commercial fisheries off northern Chile (Araya 2013, 2016; Reiswig and Araya 2014; Araya et al. 2016d), we present the first record for *Distichoptilum gracile* in Chile and the Pacific coast of South America; being also the first record of the family Protoptilidae Kölliker, 1872, and of the genus *Distichoptilum* Verrill, 1882, for Chile, and the third record of a pennatulacean species for Chile.

Materials and methods

A large partial colony of *Distichoptilum gracile* (lacking the peduncle) was collected entangled in a longline at about 1800–2000 m depth, as bycatch in the fishing of the Patagonian toothfish *Dissostichus eleginoides* about 32 km off Chañaral (27°01′20″ S; 70°48′24″ W), Región de Atacama, northern Chile. The taxonomic identification was made following the original description of Verrill (1882), complemented with further works (Deichman 1936; Williams 1990). For the study of the sclerites, a small piece of the colony was dissected and macerated in commercial bleach and washed in distilled water. The sclerites were subsequently examined by light microscopy and scanning electron microscopy (SEM). A voucher specimen (fragment of the colony) was deposited in the collections of the Museo de Zoología de la Universidad de Concepción, Concepción, Chile (MZUC 37639).

Systematics

Phylum Cnidaria Verrill, 1865
Class Anthozoa Ehrenberg, 1834
Subclass Octocorallia Haeckel, 1866
Order Pennatulacea Verrill, 1865

Family Protoptilidae Kölliker, 1872
Genus *Distichoptilum* Verrill, 1882

Type species: *Distichoptilum gracile* Verrill, 1882 (by monotypy).

***Distichoptilum gracile* Verrill, 1882**

(Figure 1a–d)

Distichoptilum gracile Verrill, 1882: 362. Jungersen 1904: 62, pl. I, Figs. 12–14. Thomson and Henderson 1906: 87, pl. IV, Fig. 7; pl IX, Fig. 2. Kukenthal 1915: 39. Deichman 1936: 265. Williams 1990: 72, Figs. 18, 19H-I, 40. López-González et al. 2001: 63. Wareham and Edinger 2007: 296, Fig. 1a. Williams 2011: 3, Fig. 6A.

Distichoptilum verrillii Studer, 1894: 59. Nutting 1909: 713, pl. LXXXVIII, Fig. 10. Hartman and Barnard 1960: 76, pl.1, Fig. 2.

Juncoptilum Alcocki Thomson and Henderson, 1905: 555.

Helicoptilum rigidum Nutting, 1912: 51, pl. 7, Figs. 2, 2a; pl. 18, Fig. 5. Belcik 1977: 51.

Description. Colony very elongate, slender and whip-like (examined specimen about 148 cm in length and 4.5 mm in maximum width, without the peduncle). Rachis bilateral throughout; axis calcareous, cylindrical, smooth, thin (up to 2.5 mm in width), diminishing in thickness and present throughout the length of the colony. Polyp leaves absent. Autozooids arranged bilaterally along rachis, opposing polyps disposed alternately or subopposite ly. The surfaces of the rachis between the longitudinal polyp rows are free of autozooids. Anthocodiae retractile into permanent spiculiferous calyces. Calyces with two to six obscure to distinct terminal teeth. Calyces with axial sides appressed to lateral margin of rachis. Siphonozooids 2–3 on the rachis directly above each autozooid. The bright red sclerites (0.4–0.9 mm) are three-flanged spindles or rods, densely covering the calyces. The peduncle was not present in the examined specimen, but it should end in a curved hook according to Jungersen (1904).

Distribution. Distichoptilum gracile was described originally from samples taken in the outer banks of the Southern Coast of New England, off Nantucket in 700 fathoms (about 1280 m) (Verrill 1882). This deep-water species is otherwise found in soft bottoms at depths from 793 to 4300 m (Williams 1990), and it exhibits a nearly worldwide but patchy distribution (Table 1), with records in the Atlantic (e.g. Jungersen 1904; Deichman 1936), the Indian Ocean (Thomson and Henderson 1906; Williams 1990) and the Pacific Ocean (Studer 1894; Williams et al. 2014).

Remarks. The associated fauna includes only a large specimen of the euryalid ophiuroid *Asteronyx loveni* Müller & Troschel, 1842, which was found firmly attached to the rachis. This species is known to cling on deep-water pennatulids and gorgonians (Fujita and Ohta 1988). The present specimen represents the second record for the species in the Southeastern Pacific off Chile (see also Manso 2010).

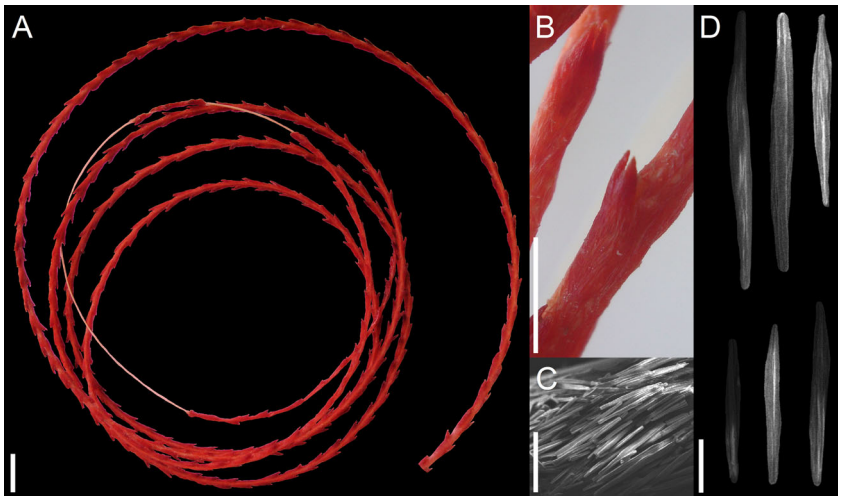

Fig. 1 *Distichoptilum gracile* Verrill, 1882, off Chañaral (27°01′20″ S; 70°48′24″ W), 1800–200-m depth, Región de Atacama, northern Chile. **a** Entire colony, lacking the peduncle (scale bar: 1 cm). **b** Detail of different parts of rachis showing calyces (scale bar: 1 cm). **c** Detail of sclerites covering the rachis (scale bar: 0.5 mm). **d** Sclerites of calyx (scale bar: 0.2 mm)

Discussion

Distichoptilum gracile, being a quite distinctive elongated pennatulacean, is clearly different from most other deep-water sea pens by its bilaterally placed strongly appressed calices with two large teeth, and by the small siphonozooids between the rachis and the opening of the calyx (Deichman 1936). Apart from its larger size, the colony examined herein shows little difference from previous descriptions for the species (Verrill 1882; Deichman 1936; Williams 1990). The reddish-colored calycular sclerites, which give the characteristic bright reddish color to the entire colony, have average sizes somewhat similar to those reported by Jungersen (1904), and smaller and larger than those reported by Kukenthal (1915) and Williams (1990), respectively. The length of the colony is also the largest mentioned in the published literature, and it would be larger still with the peduncle still present.

The scarcity of records for pennatulaceans in the area (and for several other deep-water macroinvertebrates) probably arises from the scarce exploration efforts in the deep sea in general, rather than representing true absence of this entire order of octocorals in the southeastern Pacific. This has been exemplified by the several new records and new species described in recent works dealing with marine invertebrates from northern Chile and Peru (e.g. Uribe et al. 2014; Araya and Aliaga 2016; Araya and Araya 2015a, b; Araya et al. 2016a; Labrín et al. 2015). In fact, the presence of several

Table 1 Overview of records for *Distichoptilum gracile* Verrill 1882

Area	Coordinates	Depth (m)	Reference
Atlantic Ocean[a]			
Baltimore Canyon	38°05′ N; 73°40′ W	1400	Maciolek et al. 1987
SW Nantucket Island	39°59′45″ N; 68°54′ W	1280	Verrill 1882
Oceanographer Canyon	40°00′ N; 68°00′ W	1100–1799	Hecker et al. 1980
W Greenland	63°06′ N; 56° W	2193	Jungersen 1904
S Iceland	61°39′ N, 17°10′ W	2277	Jungersen 1904
South Africa	33°49′ S; 16°30′E	2744	Williams 1990
South Africa	29°22′ S; 14°12′ E	1098	López-González et al. 2001
Indian Ocean			
SW India	07°34′30″ N; 76°08′23″ E	1529	Thomson and Henderson 1906
Pacific Ocean			
SW California	32°29′30″ N; 118°05′ W	1829	Nutting 1909
S Gulf of California	23°59′ N; 108°40′ W	1820	Studer 1894
N Galapagos Islands	00°04′ S; 90°24′30″ W	1618	Studer 1894
N Ecuador	01°07′ N; 80°21′ W	2877	Studer 1894
E New Zealand	40–50°S; 170° W to 170° E	–	Williams et al. 2014
N Chile	27°01′20″ S; 70°48′24″ W	1800–2000	This study

[a] Extensive records from the northwest Atlantic Ocean are provided by Bachman et al. (2012)

hexactinellid and cladorhizid sponge species, an antipatharian, and a few anthozoan species in the same hauls as where the present specimen of *D. gracile* was found indicates the presence of appreciable deep-water bottom currents. Upwelling currents in particular, which are known to occur in the area (Thiel et al. 2007), may also explain the abundance of this fauna. In conclusion, the present record extends the known distribution of *Distichoptilum gracile* in the Pacific Ocean, where it is possible that the range of this species may be continuous along the continental shelf in the southeastern Pacific, from the Galapagos Archipelago to northern Chile. Further sampling and research in similar areas is thus essential, and may reveal the presence of other unrecorded organisms.

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