

A new carnivorous shallow-water sponge from McMurdo Sound, Antarctica (Porifera, Poecilosclerida)

Rob W. M. van Soest · Bill J. Baker

Received: 18 August 2010 / Revised: 4 October 2010 / Accepted: 12 November 2010 / Published online: 1 December 2010

© The Author(s) 2010. This article is published with open access at Springerlink.com

Abstract A new shallow-water representative of the carnivorous sponge genus *Asbestopluma* is described from the southernmost Antarctic region of McMurdo Sound. *Asbestopluma* (*Asbestopluma*) *vaceleti* n.sp. is a white, thin, sparingly branched sponge fringed by filaments along its entire length, with a slight thickening at the top of the branches. It was collected at 30 m depth by SCUBA divers from under densely populated overhangs of rocky substrata. The new species stands out among Antarctic *Asbestopluma* by the possession of forceps microscleres, a feature shared with several species from Arctic–Boreal waters (bathyal to deep-sea) and one from the Kermadec Trench (deep sea), but not previously reported from Antarctic species. A unique trait of the new species distinguishing it from all forceps-bearing *Asbestopluma* is a second category of reduced anisochelae. The new species is most similar to *A. hypogea*, a shallow-water cave species from the Mediterranean, which differs in having a smooth stalk and a filament-bearing ovoid body. A comparison is made with descriptions of Antarctic *Asbestopluma* species and all species possessing forceps microscleres.

Keywords Antarctica · Carnivorous sponge · *Asbestopluma* · New species

Introduction

Carnivorous sponges, family Cladorhizidae, are unique in the phylum Porifera in possessing a combination of skeletal and organic tissue properties allowing them to catch small prey animals such as copepods and cladocerans (Vacelet and Boury-Esnault 1995). With the exception of the genus *Chondrocladia* Thomson (1873), the sponges of this family lack an aquiferous system. The overwhelming majority of carnivorous sponges occur in deep sea soft bottom habitats, and their deviating feeding strategy and accompanying physical features are explained as an adaptation to paucity of filter feeding biomass in oligotrophic deep sea habitats. The carnivorous feeding strategy was first detected in *Asbestopluma hypogea* Vacelet and Boury-Esnault (1996), which in contrast to most other cladorhizids lives in a shallow-water rocky habitat (caves near Marseille). Nevertheless, this habitat is considered similarly oligotroph and considered a displaced deep sea environment allowing the colonization of deep sea specialist sponges. Recently, SCUBA exploration of Antarctic rocky habitats near McMurdo Sound, yielded approximately 45 species of sponges (B. Baker, personal communication). Among these shallow-water sponges, surprisingly, a species of *Asbestopluma* was found growing in a richly populated semi-open cave habitat at 30 m depth. The genus *Asbestopluma* counts 31 species (Van Soest et al. 2008), including two species of the subgenus *Helophloeina* Topsent (1929). Comparison with descriptions of *Asbestopluma* species from Antarctic waters and elsewhere led to the conclusion that the species is new to science. It is the purpose of this study to describe and name this species. The presumed oligotrophy cannot be confirmed for the habitat of this species which calls for additional considerations concerning the carnivorous feeding strategy.

R. W. M. van Soest (✉)
Zoölogisch Museum Amsterdam,
Netherlands Centre for Biodiversity,
P.O. Box 94766, 1090 GT, Amsterdam, the Netherlands
e-mail: R.W.M.vanSoest@uva.nl

B. J. Baker
Department of Chemistry, University of South Florida,
Tampa, FL 33620, USA
e-mail: bjbaker@usf.edu

Materials and methods

Sponge material studied here is deposited in the collections of the Zoological Museum of the University of Amsterdam (ZMA). For microscopic examination, a fragment of the sponge was dissolved in concentrated nitric acid and the residue was rinsed several times in distilled water. The resultant spicule suspension was mounted on SEM stubs for examination under a JEOL Scanning Electron Microscope and on several glass slides for light microscopic examination. In addition, thick sections were mounted on glass slides for the study of the skeleton structure. Digital images of the spicules were assembled on a black background and aligned and cleaned up using Adobe Photoshop CS3. Thick sections were

photographed using a Nikon photomicroscope. Spicule sizes (smallest–average–largest) were determined from 25 light microscopy measurements for each spicule category.

Systematic Descriptions

Class Demospongiae

Order Poecilosclerida

Suborder Mycalina

Family Cladorhizidae

Genus *Asbestopluma* Topsent, 1901

Subgenus *Asbestopluma* Topsent, 1901 sensu Vacelet, 2006

Asbestopluma (*Asbestopluma*) *vaceleti* n.sp.

Figs. 1, 2, 3

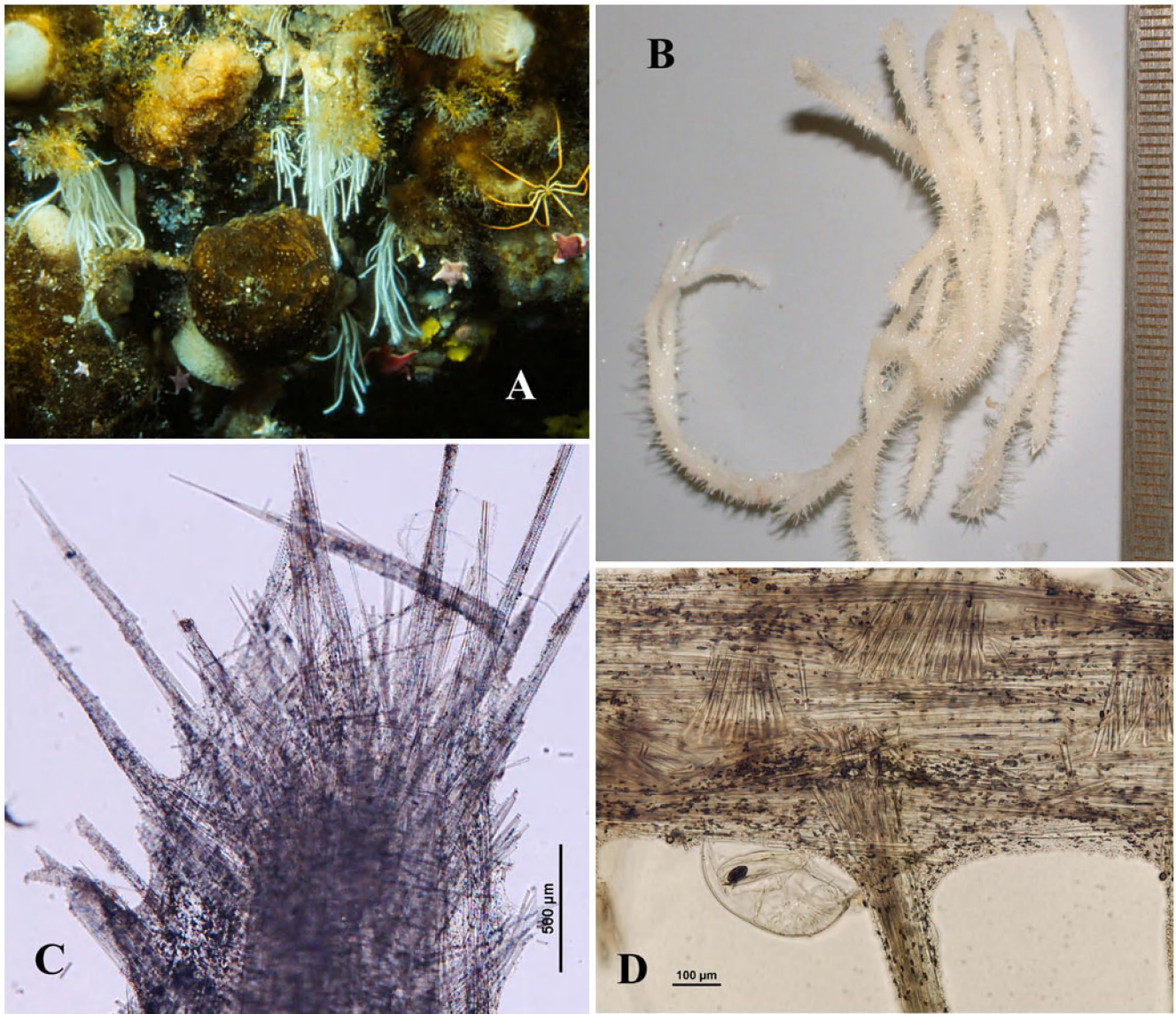


Fig. 1 *Asbestopluma* (*Asbestopluma*) *vaceleti* n.sp. **a** Sponge in situ at Turtle Rock, McMurdo Sound, 30 m (photo, B. Baker), **b** holotype ZMA Por. 13264, habit, **c** ending of one of the holotype branches

showing skeletal 'filaments' (scale bar 500 μm), **d** detail of surface showing trapped cladoceran (scale bar 100 μm)

Fig. 2 *Asbestopluma*
(*Asbestopluma*) *vaceleti* n.sp.
Detail of branch ending and
swollen apices of filaments of in
situ specimen (photo, Shawn
Harper)



Synonymy *Asbestopluma* aff. *lycopodina* (sic); Brueggeman 1998: 9.

Material examined Holotype ZMA Por. 13264, Antarctica, McMurdo Sound, Turtle Rock, 30 m, coll. B. Baker, nr. ASC-VI-97-093, SCUBA, June 1997.

For comparison ZMA Por. 19989, identified as *Asbestopluma lycopodium*, SE Rockall Bank, 573 m, coll. R.W.M. van Soest during BIOSYS 2005, from boxcore sample BX153, 11 July 2005.

Description

Tangled white stalks hanging down from rocky overhangs (Fig. 1a), with regular fringing surface projections ('filaments') arranged in bottle brush fashion. Size of individual branches of in situ specimens up to approx. 15 cm × 3–5 mm; in the preserved holotype branches (Fig. 1b) are approx. 50 × 3 mm. Filaments are 1–1.2 mm in length and lie at distances of 0.3–0.5 mm. At the top stalks are slightly swollen, some more so than others, and filaments on and near the top show swollen apices. Basal branching is indistinctly visible (Fig. 1a), but further along the branches there is only occasional division and predominantly branches are undivided. Overall impression is single hanging stalks with little variation in length or diameter. Colour a bright shining white.

Although the collected material did not contain any basal attachments, the in-situ photograph (Fig. 1a; small sponge in the middle part) shows rather indistinctly that the holdfast is small and is not an extensive root system.

Skeleton (Figs 1c, d): long styles are arranged parallelly in the centre of the stalks surrounded by tissue containing forcipes and chelae. At the surface, there is a dense lining of chelae. From the central axis at regular intervals, bundles of styles are sticking out at right angles forming the axis of the filaments (Fig. 1d). At the top of the stalk, the central axis fans out slightly and forms a dense bush of short spicule bundles sticking out beyond the surface (Fig. 1c).

The swollen endings of the terminal filaments (Fig. 2) have become shrunken in the preserved material to the extent that they are no longer clearly visible on the filaments. However, whereas most surfaces have a lining of anisochelae, we observed a slight amassing of anisochelae in distal parts of many of the filaments near the top of a branch. Conceivably, the swollen endings of the filaments were lined with anisochelae and, when they collapsed after the sponge was taken out of the water, they caused this increased amount of anisochelae near the end of the filaments.

Spicules Styles in two size classes, chelae in two shapes, forcipes.

Styles of the central axis (Fig. 3a), with narrow rounded heads and slightly swollen along the shaft ('fusiform styles'), length × width 1,210–1,408.2–1,645 × 11–18.3–30 μm.

Styles of the surface bundles (Fig. 3b), similar in shape but frequently with a faint tyle, 271–561.6–822 × 4–11.0–18 μm.

Forceps (Fig. 3c), arranged in rosette-like groups, legs often tangled or trailing to either side, legs provided with a terminal knob (Fig. 3d), 33–45.6–69 μm.

Anisochelae in two shapes that were initially assumed to be growth stages of a single microscelere category. However, no real intermediates of the two types were found and their frequency of occurrence, though different, was high for both. Type 1 palmate anisochelae of the usual *Asbestopluma* type (Fig. 3e), with lateral upper alae entirely fused with the shaft, and with the lower alae serrated, of closely uniform size, 13–14.9–16 μm. Type 2 sigma-like palmate anisochelae (Fig. 3f) with reduced upper alae and peculiar sharply chiseled lower alae, of closely similar size and shape, slightly smaller than the normal chelae, 12–12.8–14.5 μm.

Ecology Occurring in semi-open overhangs among densely crowded hard substrate communities at shallow depth (30 m). This is one of the carnivorous sponges sequestering small crustaceans (see Fig. 1d) from the ambient water by the sticky fringed surface. There are two photos of live individuals on the Scripps Ross Island and McMurdo Sound website (Brueggeman 1998), which are here reproduced in Fig. 1a and Fig. 2.

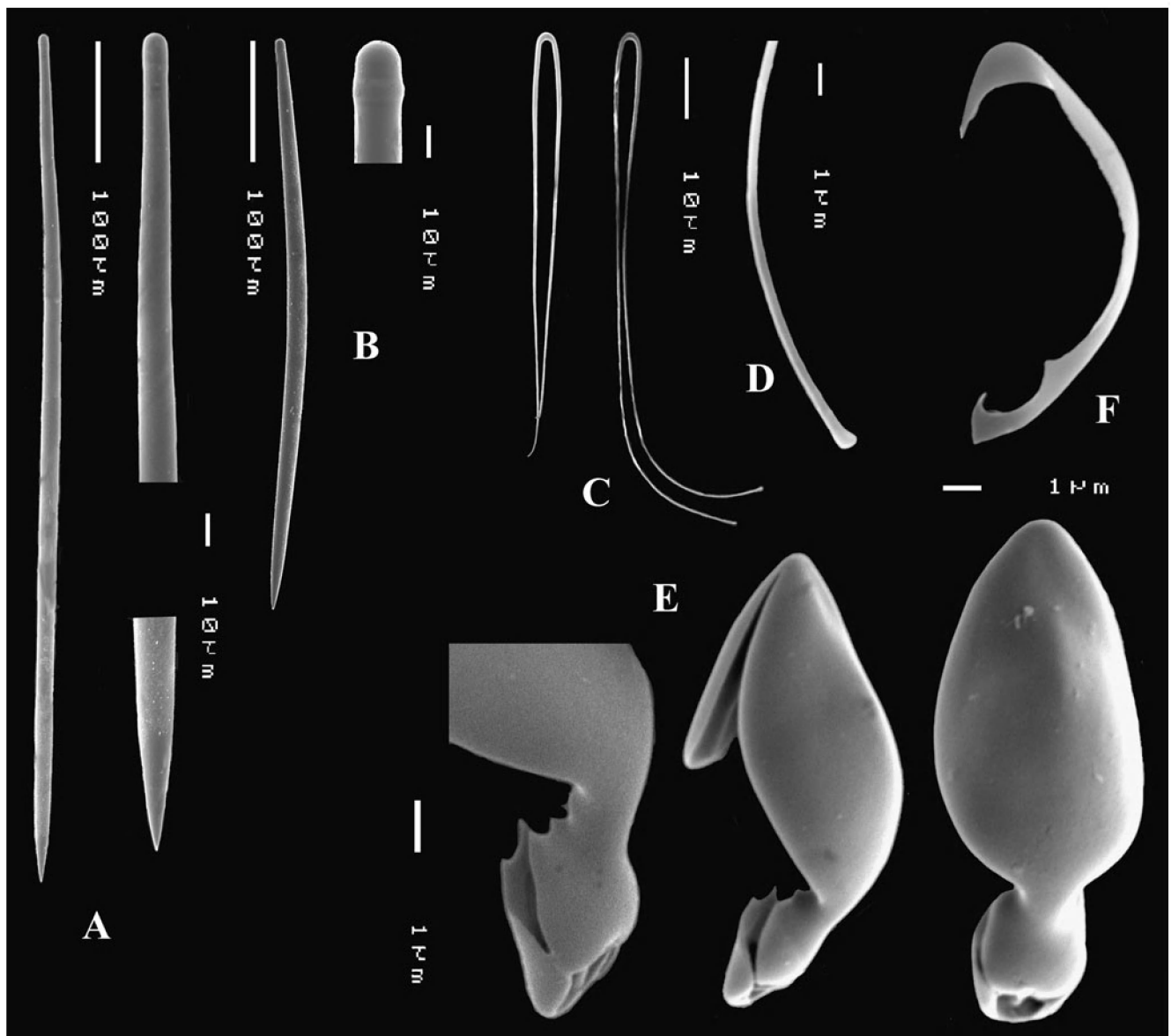


Fig. 3 *Asbestopluma* (*Asbestopluma*) *vaceleti* n.sp. **a** Style of the central axis, and details of apices, **b** style of the surface bundles and detail of tyled head, **c** forceps with straight and trailing legs, **d** detail

of swollen end of forceps leg, **e** anisochelae 1 from side and back, and detail of serrated lower ala, **f** sigma-like anisochela 2

Distribution So far only known from the type locality in McMurdo Sound, Antarctica.

Etymology Named to acknowledge Jean Vacelet for his pioneering work on carnivorous sponges.

Remarks

No other Antarctic *Asbestopluma* species has the combination of characters described above. The shape, but especially the possession of forceps microscleres, is so far unique for this region. Forceps supposedly are associated

with sperm productions (Vacelet and Boury-Esnault 1996), so it could be speculated that—although unlikely—they may have been overlooked in previously reported Antarctic *Asbestopluma* species.

Table 1 lists all the reported *Asbestopluma* species from the Antarctic region. *A. callitrix* Hentschel (1914) is the only species that appears overall close. The habit is club-shaped with a smooth stalk but the ovoid ‘body’ appears somewhat similar to our new species although relatively much more swollen. The megascleres are up to 4 mm long, much longer than those of *A. (A.) vaceleti* n.sp. and the chelae are only 11–12.5 μm. No forceps are reported and depth occurrence is 350–385 m. *A. calyx* Hentschel (1914)

Table 1 Spicule data of Antarctic *Asbestopluma* specimens

Species	Long styles	Small styles	Anisochelae	Other	Depth
<i>Asbestopluma</i> n.sp.; tangled branches	1,210–1,645 × 11–30	217–822 × 4–18	(1) 13–16 (2) Reduced 12–14.5	Forceps 33–69	30
<i>A. belgicae</i> Topsent 1901; tangled branches	800–1,400 × 12–28	250 × 10–12	10–12	(1) Sigmas 27–33 (2) Microtylostyles 200 × 2.5–3	370–569
<i>A. callitrix</i> Hentschel 1914; club-shaped	4,000 × 16	400 × 16	11–13	–	350–385
<i>A. calyx</i> Hentschel 1914; stalked cup	456–600 × 8–9	200–390 × 6	14–21	–	46–540
<i>A. obae</i> Koltun 1964; single stalk	1,100–1,750	330–650	10	(1) Sigmas 23–25 (2) Microstyles 85–170	2,250
<i>Asbestopluma</i> sp. Koltun 1964	1,600–2,900 × 20–32	580–1,500 × 10–16	14–17	–	4,350

is a stalked cup and differs in having smaller styles and larger anisochelae. Likewise no forceps are mentioned and depth occurrence is bathyal. *A. belgicae* (Topsent 1901) is similar in habit to *A. (A.) vaceleti* n.sp. forming long stalks with filaments along the entire stalk, but filaments are distinctly longer (13 mm) and more entangled than those of

A. vaceleti n.sp. Spiculation differs sharply by the possession of rugose microtylostyles and sigmas and depth occurrence is bathyal. *A. obae* Koltun (1966) is in most aspects similar to *A. belgicae*, but it apparently lacks filaments (fragmentary specimen). A further unnamed specimen reported from abyssal depth by Koltun (1966)

Table 2 Spicule data of *Asbestopluma* species possessing forceps microscleres

Species	Long styles	Small (tylo) styles	Anisochelae	Forceps	Distribution
<i>A. vaceleti</i> n.sp.; tangled stalks	1,210–1,645 × 11–30	217–822 × 4–18	(1) 13–16 (2) Reduced 12–14.5	33–69	Antarctic
<i>A. cupressiformis</i> (Carter 1874; Lundbeck 1905); stalk with elongate swelling	500–900 × 8–14	350–500 × 8–14	23–25	38–48	North Atlantic
<i>A. lycopodium</i> (Levinsen 1887); tangled stalks	600–1,500 × 7–21	238–600 × 7–21	14–17	50–56	North Atlantic
<i>A. lycopodium</i> present study; tangled stalks	640–1,410 × 6	270 × 8	9–11	18–32	Rockall Bank, North Atlantic
<i>A. infundibulum</i> (Levinsen 1887); stalked fans/cups	300–830 × 5–11	(1) 170–300 × 5–11 (2) 149–220 × 6	18–27	75	North Atlantic
<i>A. infundibulum</i> sensu Boury-E. et al. 1994; stalked fans/cups	1,034 × 12	(1) 168 × 1 (2) 60–85 × 2–6	14–25	42–48	Gulf of Cadiz
<i>A. occidentalis</i> (Lambe 1893); tangled stalks	1,390	410–680	13	32	NE Pacific
<i>A. occidentalis</i> sensu Koltun 1955; fringed stalk	700	100	10	25	NW Pacific
<i>A. versatilis</i> (Topsent 1892); stalk and ovoid body	580	–	27	76	North Atlantic
<i>A. gracilis</i> Koltun 1955; stalk with elongate swelling	1,200	140	14	27	NW Pacific
<i>A. hadalis</i> Lévi 1964; stalk swollen midway	1,500–3,200 × 25–35	700–850 × 20–22	14–16	65–75	Kermadec Trench
<i>A. hypogea</i> Vacelet & Boury-E. 1996; stalk & ovoid body	350–920 × 2–7	385–780 × 3–7	9–13	25–34	Mediterranean

has indistinct habit and clearly larger megascleres than *A. (A.) vaceleti* n.sp.

Originally, this species was provisionally identified as *A. lycopodium* Levinsen (1887) because of overall similarity with this Arctic–Boreal deep sea species. Probably as a result of a misspelling, this identification was changed to *Asbestopluma* aff. *lycopodina* Lundbeck (1905) in Brueggeman (1998), an incorrect name because the subgenus *Lycopodina* was erected by Lundbeck for a group of similar species including *A. lycopodium*, but there is no species named *lycopodina*. We were able to compare the present material with a small fragmentary specimen, ZMA Por. 19989, identified as *A. lycopodium* from Rockall Bank deep sea coral reefs, W of Ireland (Van Soest et al. 2007). The two are similar in habit and megasclere spiculation (see Table 2), but *A. lycopodium* lacks a second shape category of anisochelae and the microsclere sizes were clearly different (smaller forcipes and chelae). The latter difference may not be significant, as microsclere sizes for this species provided in the literature are different again from both the Antarctic and the Rockall Bank specimens. In fact, *A. lycopodium* is probably not the most similar *Asbestopluma* to our new species. The shallow water Mediterranean *A. hypogea* Vacelet and Boury-Esnault (1996) conforms to our new species in almost all aspects, but it has a smooth stalk and ovoid body, unlike *A. (A.) vaceleti* n.sp., smaller megascleres, smaller forcipes not arranged in rosettes, and the second category of reduced anisochelae is lacking.

From Table 2, it can be concluded that forceps microscleres occur so far almost exclusively in the northern hemisphere. An exception is *A. hadalis* Lévi (1964) from the Kermadec Trench. This differs from our new species in shape (swollen body midway in the stalk) and by having much larger long styles (up to 3,200 µm). Furthermore, Janussen and Plotkin (personal communication, not mentioned in Table 2) collected a possibly new species of *Asbestopluma* from the deep Weddell Sea (c. 4400 m depth), which has unusually thick forceps and anisochelae clearly different in shape from those of *A. (A.) vaceleti* n.sp.

Discussion

The shallow-water occurrence of our new species parallels that of the Mediterranean *A. hypogea*, but there is one clear difference: *A. hypogea* occurs in a ‘displaced deep sea’ environment, comparable in trophic aspects to a true deep sea environment, whereas *A. (A.) vaceleti* n.sp. was found in a densely populated habitat with all the characteristics of high nutrient content (see Fig. 1a). Nevertheless, from indirect indications, it is likely that *A. (A.) vaceleti* n.sp. still maintains its carnivorous feeding strategy of being sticky and absorbing small invertebrates (see cladoceran fixed to

the surface of the sponge in Fig. 1d). If this is corroborated by more direct observations, then we must assume that the carnivorous life strategy is firmly established in *Asbestopluma*, as it is maintained in *A. (A.) vaceleti* n.sp. even though a suspension feeding strategy would be more warranted in its habitat. The carnivorous feeding strategy occurring in shallow-water habitats represents a form of niche partitioning with a distinct advantage towards others members of the sessile community.

Acknowledgments A grant from the US National Science Foundation’s Office of Polar Programs (OPP-9526610) facilitated collection of the sponge material and is gratefully acknowledged. Mr Shawn Harper (USAP Scientific Diver) allowed us to use Fig. 2 to illustrate the new species. Elly Beglinger (ZMA) assisted in making the SEM and light microscopy illustrations.

Open Access This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.

References

- Boury-Esnault N, Pansini M, Uriz MJ (1994) Spongiaires bathyaux de la mer d’Alboran et du golfe ibéro-marocain. Mem Mus Natl Hist Nat 160:1–174
- Brueggeman P (1998) Underwater field guide to Ross Island and McMurdo Sound, Antarctica. Scripps Institution of Oceanography Library, UC San Diego, USA. Available online at <http://escholarship.org/uc/item/6rt8r68s>. Accessed 1 June 2010
- Carter HJ (1874) Descriptions and figures of deep-sea sponges and their spicules from the Atlantic Ocean, dredged up on board H. M.S. ‘Porcupine’, chiefly in 1869; with figures and descriptions of some remarkable spicules from the Agulhas Shoal and Colon, Panama. Ann Mag Nat Hist 14:207–221, 245–257
- Hentschel E (1914) Monaxone Kieselschwämme und Hornschwämme der Deutschen Südpolar-Expedition 1901–1903. Deutsche Südpolar-Expedition, 1901–03 15(1):35–141
- Koltun VM (1955) [Sponges. In: Atlas of the Invertebrate Fauna of the Far-Eastern Seas of the USSR.] [In Russian] Akademiya Nauk SSSR, pp 45–50
- Koltun VM (1964) Sponges of the Antarctic. 1 Tetraxonida and Cornacuspongida. In: Pavlovskii EP, Andriyashev AP, Ushakov PV (eds) Biological reports of the Soviet Antarctic Expedition (1955–1958), Akademiya Nauk SSSR [English translation (1966), Israel Program for Scientific Translation], pp 6–133, 443–448
- Lambe LM ((1893) [1894]) Sponges from the Pacific coast of Canada. Proc Trans R Soc Can 11(4):25–43
- Lévi C (1964) Spongiaires des zones bathyale, abyssale et hadale. Galathea Report Scientific Results of The Danish Deep-Sea Expedition Round the World (1950–52) 7:63–112
- Levinsen GMR (1887) Kara-Havets Svampe (Porifera). Dijnphna-Togtets zoologisk-botaniske Udbytte 1:339–372
- Lundbeck W (1905) Porifera. (Part II) Desmacidonidae (pars). The Danish Ingolf-Expedition 6(2):1–219
- Thomson CW (1873) The Depths of the Sea. Macmillan. London
- Topsent E (1892) Contribution à l’étude des Spongiaires de l’Atlantique Nord (Golfe de Gascogne, Terre-Neuve, Açores).

- Résultats des campagnes scientifiques accomplies par le Prince Albert I Monaco 2:1–165
- Topsent E (1901) Spongiaires. Résultats du voyage du S.Y. 'Belgica' en 1897-99 sous le commandement de A. de Gerlache de Gomery. Expédition antarctique belge Zoologie 4:1–54
- Topsent E (1929) Notes sur *Helophloeina stylivarians* n.g. n.sp., Mycaline à desmes des Canaries. Bull Inst Océanogr Monaco 533:1–8
- Vacelet J (2006) New carnivorous sponges (Porifera, Poecilosclerida) collected from manned submersibles in the deep Pacific. Zool J Linn Soc 148:553–584
- Vacelet J, Boury-Esnault N (1995) Carnivorous sponges. Nature 373:333–335
- Vacelet J, Boury-Esnault N (1996) A new species of carnivorous sponge (Demospongiae: Cladorhizidae) from a Mediterranean cave. In: Willenz P (ed) Recent Advances in Sponge Biodiversity Inventory and Documentation. Bull Inst R Sci Nat Belg Biol 66, pp 109–115
- Van Soest RWM, Cleary DFR, De Kluijver MJ, Lavaleye MSS, Maier C, Van Duyl FC (2007) Sponge diversity and community composition in Irish bathyal coral reefs. Contrib Zool 76:121–142
- Van Soest RWM, Boury-Esnault N, Hooper JNA, Rützler K, de Voogd NJ, Alvarez B, Hajdu E, Pisera AB, Vacelet J, Manconi R, Schönberg C, Janussen D, Tabachnick KR, Klautau M, Picton B (2008) World Porifera database. <http://www.marinespecies.org/porifera>. Accessed 1 June 2010.