Zootaxa 3786 (2): 101–123
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3786.2.1
http://zoobank.org/urn:lsid:zoobank.org:pub:9C3B70D0-4092-4ACC-A134-1CEC31E232C7

Four new species of Cladorhizidae (Porifera, Demospongiae, Poecilosclerida) from the Northeast Pacific

LONNY LUNDSTEN[1,5], HENRY M. REISWIG[2,3] & WILLIAM C. AUSTIN[4]

[1]*Monterey Bay Aquarium Research Institute, 7700 Sandholdt Drive, Moss Landing, California 95039, USA*
[2]*Department of Biology, University of Victoria, Victoria, British Columbia V8P 5C2, Canada*
[3]*Natural History Section, Royal British Columbia Museum, Victoria, British Columbia V8W 9W2, Canada*
[4]*Khoyatan Marine Laboratory, North Saanich, British Columbia V8L 5G5, Canada*
[5]*Corresponding author*

Abstract

Interest in cladorhizid sponges has grown rapidly in the past 19 years since a unique feeding strategy, carnivory, was described by Vacelet and Boury-Esnault in 1995. Since that time, 31% of the 133 extant cladorhizids have been described. Previously, seven species of cladorhizid sponges were known from the Northeast Pacific. Here we describe four additional species, including two species of *Asbestopluma* and two species of *Cladorhiza.* We report on species ranges, habitat, and ecology, including one from a chemosynthetic environment that appears to be using methane-oxidizing bacteria as a nutrient source. In fact, three of the four species described here were found in chemosynthetic habitats. The presence of small crustacean prey was also documented for three of these species.

Key words: Porifera, Cladorhizidae, Deep Sea Ecology, Deep Sea Biology, taxonomy

Introduction

Interest in carnivorous sponge biology has grown considerably since carnivory was first described in a population of deep-sea sponges, *Asbestopluma hypogea*, that were discovered inhabiting a shallow marine cave in the Mediterranean by Vacelet and Boury-Esnault (1995). Carnivory in sponges is understood to be an adaptation to living in the food-poor, deep-sea environment where, presumably, the cost of filter feeding outweighs the benefit; most carnivorous sponges are deep-sea dwellers, although a few have been described from shallow water (Lambe, 1893; Vacelet and Boury-Esnault, 1995; van Soest & Baker, 2011). Recent molecular analysis (Vargas et al., 2012) agrees with a previous hypothesis that *Abyssocladia* belongs within the Cladorhizidae, yet the evolutionary lineage of carnivory is not certain. A description of two new *Chondrocladia* species revealed a new spicule type, a trochirhabd (Vacelet *et al.*, 2009). These spicule types were previously known only from early Jurassic and Miocene sediments, suggesting that *Chondrocladia* and, therefore, carnivory in sponges, is ancient.

There are currently 133 species recognized from seven cladorhizid genera (van Soest *et al.*, 2013). However, it is uncertain that carnivory is monophyletic as several species within two other Poecilosclerida families (Guitarridae and Esperiopsidae) appear to be carnivorous as well (Vacelet, 2007). Interpretations of this information are 1) recent independent development of carnivory along several lines of evolution within the Poecilosclerida and 2) carnivory developed early within the Poecilosclerida and is a symplesiomorphic trait (Vacelet, 2007).

Of the 133 extant cladorhizids, 41 species have been described since 2002, nearly 31% of recognized species. The occurrence of methane oxidizing symbionts has been described in one species, *Cladorhiza methanophila* (Vacelet *et al.*, 1996), however, carnivorous sponges have often been collected in the vicinity of chemosynthetic communities (Vacelet, 2007). Common among carnivorous sponges is a lack of aquiferous system and choanocyte chambers except for species of *Chondrocladia.*

Accepted by E. Hajdu: 19 Feb. 2014; published: 9 Apr. 2014

what is considered the Northeast Pacific, including *C. corona* (Lehnert, Watling & Stone, 2005) from the Aleutian Islands, *C. linearis* (Ridley & Dendy, 1886) Panama to central South Pacific, and *C. rectangularis* (Ridley & Dendy, 1886) north central Pacific, south of Aleutian Islands.

Although these new species don't present novel morphologies or spicules, they do increase the number of known cladorhizids in the Northeast Pacific considerably. Certainly *A. rickettsi* is notable in being only the second species of cladorhizid identified as consuming methane-oxidizing bacteria. *Asbestopluma monticola* is notable for its large size and abundance at both Davidson Seamount and in Monterey Canyon, where it is a successful member of a suspension feeding guild at these locations. The presence of numerous prey on *C. caillieti,* in close proximity to hydrothermal venting indicate that these sponges may be able to utilize both methane-oxidizing bacteria and small crustacean prey as nutrient sources. The same may be true for *C. evae* and, perhaps, all cladorhizids. Numerous additional cladorhizid sponges from the Northeast Pacific await description (seen and collected by the authors), and many more, likely, await discovery. Future work should include better understanding of species geographic and depth distribution, food sources and preferences, and observation of food capture in situ for deep-sea species. Additional surveying, collecting, and identification of species from various locales will aid in these discoveries.

Acknowledgments

We are grateful for support from the pilots of the ROVs *Doc Ricketts* and *Ventana* and the crews of the R/Vs *Western Flyer* and *Rachel Carson*. We thank J. Barry, D. Clague, A. DeVogelaere, and R. Vrijenhoek for use of video observations and collected specimens. We thank K. Buck, C. Piotrowski, S. Tanner, and P. Whaling for technical support as well as S. Goffredi and V. Orphan for information on methane-oxidizing bacteria. We appreciate the comments from anonymous reviewers who greatly improved this manuscript. This work was partially supported by the David and Lucile Packard Foundation's funding of MBARI.

References

Cairns, S.D. (2007) Calcaxonian octocorals (Cnidaria: Anthozoa) from eastern Pacific seamounts. *Proceedings of the California Academy of Science,* 58, 511–541, 15 pls.

Clague, D., Lundsten, L., Hein, J., Paduan, J. & Davis, A. (2010) Spotlight 6: Davidson Seamount. *Oceanography,* 23 (1), 126–127.
http://dx.doi.org/10.5670/oceanog.2010.78

De Laubenfels, M.W. (1935) Some Sponges of Lower California (Mexico). *American Museum Novitates,* 779, 1–14.

Dendy, A. (1922) Report on the Sigmatotetraxonida collected by H.M.S. "Sealark" in the Indian Ocean. *Transactions of the Linnean Society of London,* 18, 1–164.

Duffy, G.A., Lundsten, L., Kuhnz, L.A. & Paull, C.K. (2013) A comparison of megafaunal communities in five submarine canyons off Southern California, USA. *Deep Sea Research Part II: Topical Studies in Oceanography*, in press.
http://dx.doi.org/10.1016/j.dsr2.2013.06.002

Hajdu, E. & Vacelet, J. (2002) Family Cladorhizidae Dendy, 1922. *In*: Hooper, J.N.A. & van Soest. R.W.M. (Eds.), *Systema Porifera: A guide to the classification of sponges*. Kluwer Academic/Plenum Pub., N.Y., pp. 636–641.

Hajdu, E., Van Soest, R.W.M. & Hooper, J.N.A. (1994) Proposal for a phylogenetic subordinal classification of poecilosclerid sponges. *In*: van Soest, R.W.M., van Kempen, Th. M.G. & Braekman,J.-C. (Eds.), *Sponges in Time and Space* Balkema, Rotterdam. pp. 123–139.

Kelly, M. & Vacelet, J. (2011) Three new remarkable carnivorous sponges (Porifera, Cladorhizidae) from deep New Zealand and Australian (Macquarie Island) waters. *Zootaxa,* 2976, 55–68.

Koltun, V.M. (1959) Siliceous sponges (Cornacuspongida) from the southern region of the Kurile Island and waters, washed up on the southern Sakhalin. [In Russian]. *Issledovaniya dal'nevestochnykh morei* , SSSR 5, 42–77. Koltun, V.M. (1972) Sponge fauna of the Northwestern Pacific from the shallows to the hadal depths. *In*: Bogorov, V.G. (Ed.), Fauna of the Kurile-Kamchatka Trench and its environment. *Proceedings of the Shirshov Institute of Oceanology*, 86, pp. 179–233. [translated from Russian by the Israel Program for Scientific Translations, Jerusalem 1972]

Lambe, L.M. (1893) Sponges from the Pacific coast of Canada. *Proceedings and Transactions of the Royal Society of Canada*, 11 (4), 25–43, pls II–IV.

Lee, W.L., Reiswig, H.M., Austin, W.C. & Lundsten, L. (2012) An extraordinary new carnivorous sponge, *Chondrocladia lyra*, in the new subgenus *Symmetrocladia* (Demospongiae, Cladorhizidae), from off of northern California, USA. *Invertebrate*

Biology. 131 (4), 259–284.
http://dx.doi.org/10.1111/ivb.12001

Lehnert, H., Watling, L. & Stone, R. (2005) *Cladorhiza corona* sp. nov. (Porifera: Demospongiae: Cladorhizidae) from the Aleutian islands (Alaska). *Journal of the Marine Biological Association of The United Kingdom*, 85, 1359–1366.
http://dx.doi.org/10.1017/s0025315405012531

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, pls. II–XI.

Lopes, D.A., Bravo, A. & Hajdu, E. (2011) New carnivorous sponges (Cladorhizidae: Poecilosclerida: Demospongiae) from off Diego Ramírez Archipelago (south Chile), with comments on taxonomy and biogeography of the family. *Invertebrate Systematics*, 25, 407–443.
http://dx.doi.org/10.1071/is11015

Lopes, D.A. & Hajdu, E. (2013) Carnivorous sponges from deep-sea mounds in the Campos Basin (SW Atlantic), with the description of six new species (Cladorhizidae, Poecilosclerida, Demospongiae). *Marine Biology Research,* 10, 329–356.
http://dx.doi.org/10.1080/17451000.2013.797587

Lundbeck, W. (1905) Porifera. (Part II.) Desmacidonidae (pars.). *In*: *The Danish Ingolf-Expedition*, 6 (2), pp. 1–219, pls I–XX.

Lundsten, L., Barry, J.P., Cailliet, G.M., Clague, D.A., DeVogelaere, A.P. & Geller, J.B. (2009a) Benthic Invertebrate Communities on Three Seamounts off Southern and Central California, USA. *Marine Ecology Progress Series*, 374, 23–32.
http://dx.doi.org/10.3354/meps07745

Lundsten, L., McClain, C.R., Barry, J.P., Cailliet, G.M., Clague, D.A. & DeVogelaere, A.P. (2009b) Ichthyofauna on Three Seamounts off Southern and Central California, USA. *Marine Ecology Progress Series*, 389, 223–232.
http://dx.doi.org/10.3354/meps08181

Lundsten, L., Johnson, S.B., Cailliet, G.M., DeVogelaere, A.P. & Clague, D.A. (2012) Morphological, molecular, and in situ behavioral observations of the rare deep-sea anglerfish *Chaunacops coloratus* (Garman 1899), Order Lophiiformes, in the eastern North Pacific. *Deep-Sea Research I*, 68, 46–53.
http://dx.doi.org/10.1016/j.dsr.2012.05.012

Mah, C., Nizinski, M. & Lundsten, L. (2010) Phylogenetic Revision of the Hippasterinae (Goniasteridae; Asteroidea): Systematics of Deep Sea Corallivores, including one new genus and three new species. *Zoological Journal of the Linnean Society*, 160, 266–301.
http://dx.doi.org/10.1111/j.1096-3642.2010.00638.x

McClain, C.R., Lundsten, L., Ream, M., Barry, J.P. & DeVogelaere, A.P. (2009) Endemicity, Biogeograhy, Composition, and Community Structure On a Northeast Pacific Seamount. *PLoS ONE*, 4 (1), e4141.
http://dx.doi.org/10.1371/journal.pone.0004141

McClain, C.R., Lundsten, L., Barry, J.P. & DeVogelaere, A.P. (2010) Assemblage structure, but not diversity or density, change with depth on a northeast Pacific seamount. *Marine Ecology*, 31 (Suppl. 1), 1–12.
http://dx.doi.org/10.1111/j.1439-0485.2010.00367.x

Paull, C.K., Schlining, B., Ussler III, W., Paduan, J.B., Caress, D. & Greene, H.G. (2005) Distribution of chemosynthetic biological communities in Monterey Bay, California, *Geology*, 33, 85–88.
http://dx.doi.org/10.1130/g20927.1

Reiswig, H.M. & Browman, H.I. (1987) Use of membrane filters for microscopic preparations of sponge spicules. *Transactions of the American Microscopical Society*, 106 (No. 1), 10–20.
http://dx.doi.org/10.2307/3226280

Reiswig, H.M. & Lee, W.L. (2007) A new species of *Cladorhiza* (Porifera: Cladorhizidae) from S. California (USA). *In*: Custódio, M.R., Lôbo-Hajdu, G., Hajdu, E. & Muricy, G. (Eds.), *Porifera Research: Biodiversity, Innovation and Sustainability.* Museu Nacional, Rio de Janeiro, Brazil, pp. 517–523,

Ridley, S.O. & Dendy, A. (1887) Report on the Monaxonida collected by H.M.S. 'Challenger' during the years 1873–1876. *Report on the Scientific Results of the Voyage of H.M.S. 'Challenger', 1873–1876.Zoology,* 20 (59), i–lxviii, 1–275, pls. I–LI, 1 map.

Schlining, B. & Jacobsen Stout, N. (2006) MBARI's video annotation and reference system. Proceedings of the Marine Technology Society/Institute of Electrical and Electronics Engineers Oceans Conference, Boston, MA. pp. 1–5.

Schlining, K., von Thun, S., Kuhnz, L.A., Schlining, B., Lundsten, L., Jacobsen Stout, N., Chaney, L. & Connor, J. (2013) Debris in the deep: Using a 22-year video annotation database to survey marine litter in Monterey Canyon, central California, USA. *Deep Sea Research Part I: Oceanographic Research Papers*, 79, 96–105.
http://dx.doi.org/10.1016/j.dsr.2013.05.006

Sollas, W.J. (1885) A classification of the Sponges. *Scientific Proceedings of the Royal Dublin Society (new series),* 5, 112.

Stone, R.P., Lehnert, H. & Reiswig, H.M. (2011) A guide to the deep- water sponges of the Aleutian Island Archipelago. *NOAA Professional Paper National Marine Fisheries Service*, 12, 1–187.

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, pls. I–VI.

Topsent, E. (1909) Etude sur quelques *Cladorhiza* et sur *Eucheliplum pristina* n. g. et n. sp. *Bulletin de l'Institut océanographique, Monaco,* 1909 (151), 1–23, pls I–II.

Topsent, E. (1928) Spongiaires de l'Atlantique et de la Méditerranée provenant des croisières du Prince Albert ler de Monaco. *Résultats des campagnes scientifiques accomplies par le Prince Albert I. Monaco,* 74, 1–376, pls. I–XI.
Vacelet, J. & Boury-Esnault, N. (1995) Carnivorous sponges. *Nature,* 373, 333–335. http://dx.doi.org/10.1038/373333a0
Vacelet, J., Fiala-Medioni, A., Fisher, C.R. & Boury-Esnault, N. (1996) Symbiosis between methane-oxidizing bacteria and a deep-sea carnivorous cladorhizid sponge. *Marine Ecology Progress Series,* 145, 77–85. http://dx.doi.org/10.3354/meps145077
Vacelet, J. (2006) New carnivorous sponges (Porifera, Poecilosclerida) collected from manned submersibles in the deep Pacific. *Zoological Journal of the Linnean Society,* 148, 553–584. http://dx.doi.org/10.1111/j.1096-3642.2006.00234.x
Vacelet, J. (2007) Diversity and evolution of deep-sea carnivorous sponges. *Porifera research: biodiversity, innovation and sustainability. Série Livros*, 28, 107–115.
Vacelet, J. (2008) A new genus of carnivorous sponges (Porifera: Poecilosclerida, Cladorhizidae) from the deep N-E Pacific, and remarks on the genus *Neocladia*. *Zootaxa* 1752, 57–65.
Vacelet, J., Kelly, M. & Schlacher-Hoenlinger, M. (2009) Two new species of *Chondrocladia* (Demospongiae: Cladorhizidae) with a new spicule type from the deep south Pacific, and a discussion of the genus *Meliiderma*. *Zootaxa*, 2073, 57–68.
van Soest, R.W.M. & Baker, B.J. (2011) A new carnivorous shallow-water sponge from McMurdo Sound, Antarctica (Porifera, Poecilosclerida). *Marine Biodiversity,* 41, 495–501. http://dx.doi.org/10.1007/s12526-010-0076-6
van Soest, R.W.M., Boury-Esnault, N., Hooper, J.N.A., Rützler, K., de Voogd, N.J., Alvarez de Glasby, B., Hajdu, E., Pisera, A.B., Manconi, R., Schoenberg, C., Janussen, D., Tabachnick, K.R., Klautau, M., Picton, B., Kelly, M., Vacelet, J., Dohrmann, M. & Díaz, M.C. (2013) World Porifera Database. Available from: http://www.marinespecies.org/porifera (accessed 19 November 2013)
Vargas, S., Erpenbeck, D., Göcke, C., Hall, K.A., Hooper, J.N.A. & Janussen, D. (2012) Molecular phylogeny of *Abyssocladia* (Cladorhizidae: Poecilosclerida) and *Phelloderma* (Phellodermidae: Poecilosclerida) suggests a diversification of chelae microscleres in cladorhizid sponges. *Zoologica Scripta,* 42, 106–116. http://dx.doi.org/10.1111/j.1463-6409.2012.00560.x
Williams, G.C. & Lundsten, L. (2009) The nephtheid soft coral genus *Gersemia* (Marenzeller, 1878) with the description of a new species from the northeast Pacific and a review of two additional species (Octocorallia: Alcyonacea). *Zoologische Mededelingen. Leiden*, 83 (34), 1067–1081.