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Cladorhiza corona sp. nov. (Porifera: Demospongiae: Cladorhizidae) from the Aleutian Islands (Alaska)

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A new species of Cladorhizidae, from the Aleutian Islands is described and compared with all known species of *Cladorhiza* worldwide. *Cladorhiza corona* sp. nov. has a unique growth form with two planes of differently shaped appendages. Appendages are inserted directly at the stalk; a spherical or conical body at the stalk is lacking. It is the only species reported where different spicule types occur in three morphologically different areas of the sponge. The spiculation of the basal plate is characterized by the occurrence of short, thick anisoxeas and the lack of anisochelae. Anisochelae are found in the stalk and the basal appendages only. Flattened sigmancistras and (sub-)tylostyles are restricted to the crown. The arrangement of spicules is different in the basal plate, the stalk with the basal appendages, and in the distal appendages. The dimensions and combination of spicule types separate *C. corona* sp. nov. from all known members of the genus.

INTRODUCTION

The family Cladorhizidae, introduced by Dendy (1922) is primarily a deep-water taxon, found at depths between 150 and 7000 m in all oceans (Hartman, 1982). One species, *Asbestopluma hypogea* Vacelet & Bourry-Esnault, 1996, occurs in shallow water in Mediterranean caves (17–23 m depth). It lacks choanocyte chambers and gets its nutrition by capturing and digesting small crustaceans. Most or possibly all species in the family are now assumed to be predators for at least part of their nutritional needs. Hajdu & Vacelet (2002) diagnosed the Cladorhizidae as ‘...small, symmetrical...sponges with diagonal, radiating supporting processes and basal root adaptations for living in soft sediments’. Megascleres are monactinal or diactinal spicules that are arranged in long, thick polyspicular tracts in the stalk and diverge in the ‘body’ to support the radiating processes. Microscleres may include anisochelae, isochelae, sigmas, forceps, and micro(sub-)tylostyles. Three genera are considered valid by Hajdu & Vacelet, 2002: *Chondrocladia* Thomson, 1873, *Asbestopluma* Topsent, 1901 and *Cladorhiza* Sars, 1872. The purpose of this publication is to describe a new species of *Cladorhiza* found living attached to hard substrates in deep water along the central Aleutian Islands. The specimens described here were collected with the ROV ‘Jason II’ during a cruise aboard the RV ‘Roger Revelle’ in the Aleutian Islands (Alaska) during July and August 2004.

MATERIALS AND METHODS

Using the deep-diving ROV ‘Jason II’ we collected video footage of the sea-floor and specimens of the benthos along the ridge that supports the central Aleutian Islands. Specimens were transferred on board the

‘Roger Revelle’ into ethanol or were frozen at -10°C . For light microscopy and scanning electron microscopy (SEM) investigations of the spicules, small fragments of sponges were boiled in hypochlorite, and in several steps the spicules were sequentially transferred through distilled water to 95% ethanol with the help of a centrifuge.

For light microscopy, small drops of the spicule–ethanol suspension were transferred onto glass slides and, after evaporation of the ethanol, embedded in Canada balsam. Semi-thin sections obtained with a razor blade were, again after evaporation of the ethanol, also embedded in Canada balsam. For SEM studies, the spicule–ethanol suspension was transferred directly onto stubs, and coated with gold-palladium after the ethanol evaporated. The SEM studies were carried out with a Hitachi S800 at the Zoological Institute I at the Friedrich-Alexander-University in Erlangen, Germany.

SYSTEMATICS

Phylum PORIFERA
Class DEMOSPONGIAE
Order POECILOSCLERIDA
Family CLADORHIZIDAE Dendy, 1922
Genus *Cladorhiza* Sars, 1872
Cladorhiza corona sp. nov.
Figures 1 & 2

Type material

Holotype: J2104-1-1 (51°43.83'N 179°36.00'W, Amchitka Pass, 1011 m depth) US National Museum of Natural History, USNM 1076968.

Paratype: J2095-2-6-9 (51°47.38'N 173°49.87'W, Amlia Island, 1357 m depth) Senckenberg Museum, Frankfurt am Main, Germany, SMF 10320.

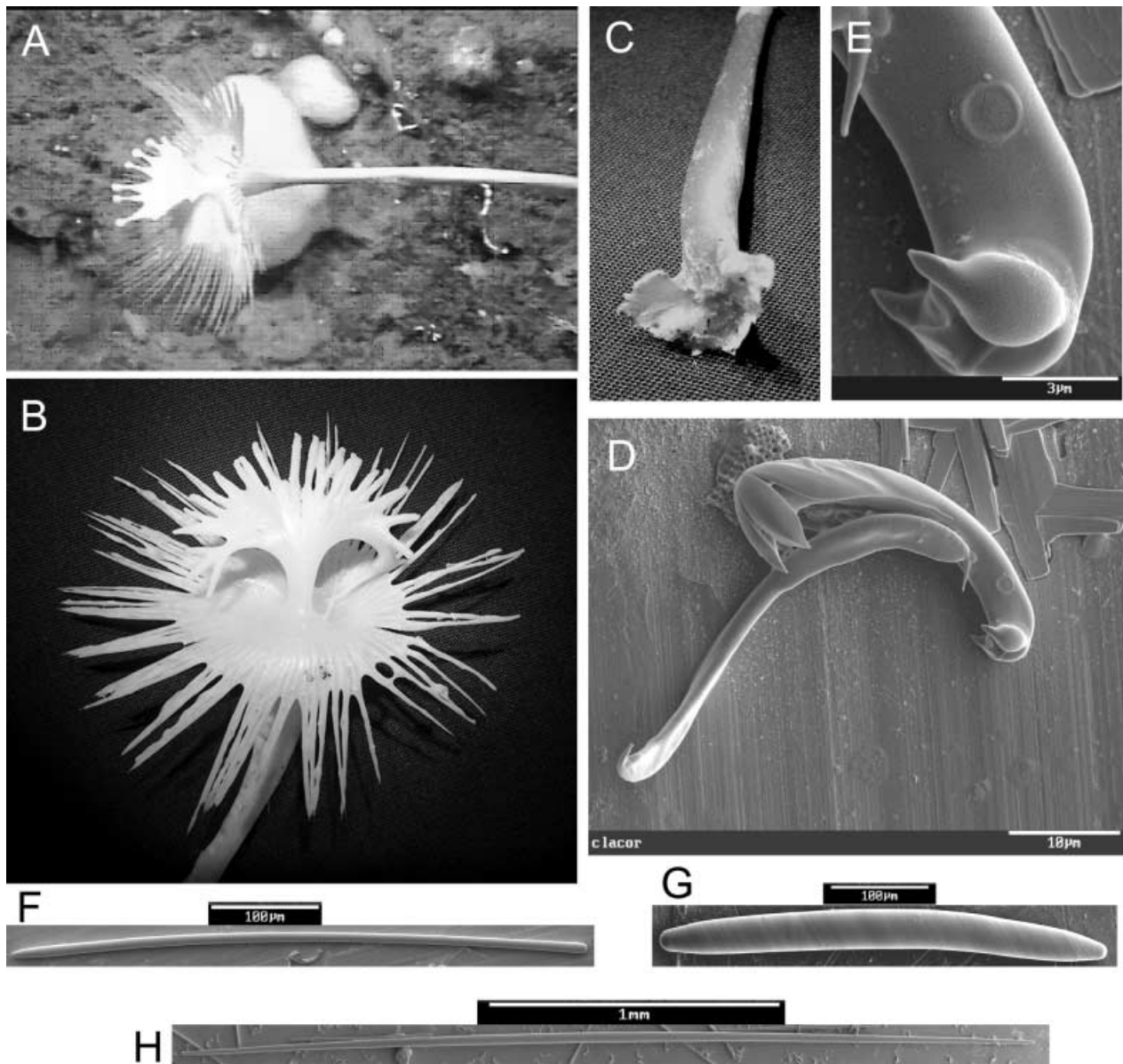


Figure 1. *Cladorhiza corona* sp. nov. (A) *In situ* near Amlia Island, Alaska, 1357 m depth showing stalk with basally connected appendages and crown with distal appendages; (B) holotype, J2104-1-1, upper end of stalk showing detail of appendages and crown. Note that rounded tyles have broken off crown appendages; (C) view of basal plate of holotype; (D) anisochela, present in all sponge structures except the 'crown', and below it a sigmancistra, present in the 'crown' only; (E) claw-like appendages at the small end of anisochelae; (F) small (sub-)tylostyle, present in the 'crown' only; (G) small (anis-)oxea, present in basal plate only; (H) large fusiform style.

Additional material

J2104-1-2 (51°43.83'N 179°36.00'W, Amchitka Pass, 1011 m depth), J2104-1-3 (51°43.83'N 179°36.00'W, Amchitka Pass, 1011 m depth), J2095-2-6-1 (51°47.38'N 173°49.87'W, Amlia Island, 1357 m depth), J2097-1-1 (51°27.73'N 176°14.39'W, Adak Island, 1720 m depth).

Diagnosis

Body consists of stalk with basal plate and two sets of distal appendages, the basal radiating in a full circle more or less in one plane, and the distal forming a quarter circle of triangular-shaped structures oriented in a plane almost perpendicular to the basal appendages.

Distal appendages shorter than basal and terminating in a spherical tyle. Basal plate with short, thick, anisoxeas; otherwise spicules not unusual within the genus.

Description

Growth form: the sponge is attached to the substrate by a basal plate (Figure 1C). Rhizoids, known for many other members of the genus are lacking. The long, almost cylindrical stalk widens somewhat where the basal appendages are inserted. The basal appendages radiate in a full circle more or less perpendicular to the stalk in one plane (Figure 1A,B). They are connected about half way along their length by an ectosomal membrane. At the distal end

Table 1. Morphological characteristics of known species of Cladorhiza. Sizes of spicules in μm .

Cladorhiza species	Author, year	Distribution, depth	Habit/size	Styles	Tylostyles	Other megascleres	Anisochelae	Large sigmas	Small sigmas	Other microscleres
<i>abyssicola</i>	Sars, 1872	Tropical Pacific, 5032.5 m	central axis with rhizoids and branches, over 7 cm height	390–730	none	none	21–25	78–100	sigmancistras, none 40–42	none
<i>artica</i>	Burton, 1946	Kara Sea, Arctic Ocean, 2040–2365 m	clavate, tapering into a stalk, 4 cm high	728–1508×12–36, styles to strongyles, 364–873×6–11	none	acanthoxeas, 135–239×6–8	35–40	none	none	none
<i>bathyrinoides</i>	Koltun, 1955	Okhotsk Sea, North Pacific, 151–3400 m	long stem, semi-spherical head, head 2 cm in diameter	fusiform, 551–2132×10–42	none	cylindrical styles, 550–1100×10–17	35–83	33–111	semicrescent, none 33–44	none
<i>corticocancellata</i>	Carter, 1876	North Atlantic, 631–1157 m	short stem, conical body, size unknown	fusiform, 560–710×15–24	none	none	33–37	150–180	57–74	none
<i>depressa</i>	Kieschnick, 1896	Ternate	laterally flattened, dark brown	large, no measurements given	none	oxeas, no measurements given	present, no measurements given	present, no measurements given	none	none
<i>ephyrula</i>	Lévi, 1964	Near Cape Town, 4350–4470 m	two forms: stalked disk and stalked vase, 1.8–3.5 cm height	large: styles to subtylostyles, 1400–2900×27–35, small styles: 1100–1300×24–25	none	none	75–88	150–200	45–65	none
<i>flosabyssi</i>	Topsent, 1909	Central Atlantic, Cape Verde, 3890 m	long thin stalk, flower-like 'tentacles', 11.5 cm height	3000–5000×70	400–700×4–12	none	24–41	42–47	none	none
<i>fristediti</i>	Lambe, 1900	North Pacific, 110–366 m	pinnate, 6.5 cm height	465–1500×13–20	85–124×6	none	15–20	none	none	none
<i>gelida</i>	Lundbeck, 1905	North Atlantic, North Sea, Arctic, 1535–2394 m	main trunk with lateral branches, 23 cm height	400–770×11–22	none	none	28–34	120–160×6–9	with flattened ends, 44–51	none
<i>grimaldi</i>	Topsent, 1901	Central Atlantic, Cape Verde, 3890 m	pinnate, 12.5 cm height	fusiform, 580–1050×13–30	none	none	30–34	170–180	none	none

(Continued)

Table 1. (Continued).

<i>Cladorhiza</i> species	Author, year	Distribution, depth	Habit/size	Styles	Tylostyles	Other megascleres	Anisochelae	Large sigmas	Small sigmas	Other microscleres
<i>inversa</i>	Ridley & Dendy, 1886	South Atlantic, 37°29'S 27°31'W, 4026 m	conical head with roots, diameter of head 3 mm	2000×37, large size variation	fusiform, 630×19	none	30	none	none	none
<i>linearis</i>	Ridley & Dendy, 1886	South Pacific, Central Pacific, 3570–4364 m	slender axis with tufts of spicules, 8.5 cm height	large: 2500–3000× 11–14; small: 1100–1300×18	none	none	25	175–180	11–14	none
<i>longipinna</i>	Ridley & Dendy, 1886	North Pacific, 14°19'N 152°37'W, 5490 m	stalked with globular body, up to 13 cm height	over 3000×50, blunt ends	rare, see right	smaller styles, rarely tylostyles about 1000×15	30–78	none	none	none
<i>mani</i>	Koltun, 1964	Antarctic, 3700 m	stalked, 1.5 cm high	800–1550×38–50	959–1100×6–7	thin styles 1000–1850×12–14	22–23	28–70	none	none
<i>methanophila</i>	Vacclet & Boury-Esnault, 2002	Barbados Trench, central Atlantic, near methane seeps, 4718–4930 m	pinnate, 20–over 40 cm height	fusiform, 310–680×5–20	none	none	20–25	sigmancistras, 35–55	none	none
<i>microchela</i>	Lévi, 1964	South China Sea, 4330 m	small, thin filament, 5.5 cm height	large: up to 3200×45–50, small category: 1100–1400×12–15	none	none	13–14	none	none	none
<i>minuta</i>	Lambe, 1900	North Pacific, 366 m	thin stalk, laterally compressed head, 1.35 cm height	styles to tylostyles, 327–543×6–8	196–294×5–6	none	18–19	none	none	none
<i>mirabile</i>	Ridley & Dendy, 1886	South Pacific, 39°13'S 118°49'W	conical head with roots, 56 mm high	over 3500	none	none	38	76	none	amphistylers, 23
<i>morulisformis</i>	Ridley & Dendy, 1886	Australian Antarctic ridge, 3568 m	globular head on stalk, 14 mm high	over 2000×50	none	none	63	350×14.5	none	none
<i>nematomorpha</i>	Lévi, 1964	near Madagascar, 3980–4730 m	stalked, spherical, 3.5 cm height	subtylostyles, 1800–2500×30–45, small subtylostyles, 900–1400×15–20	none	none	50–60	195–200	125–150	none

<i>oxeata</i>	Lundbeck, 1905	North Atlantic, 212–761 m	tree-shaped, up to 26 cm height	none	oxeas: 417–800	26–34	90–120	47–54	none
<i>rectangularis</i>	Ridley & Dendy, 1886	Bering Sea, North Pacific, 3812–5005 m	pinnate, up to 7 cm height	none fusiform, 650–2000×14–36	none	18–27	120–170	30–50	none
<i>schistocheila</i>	Lévi, 1993	New Caledonia, 965 m	cylindrical body on stalk, 14 cm height	none large: 2800–3000×30, medium: 1100–1500×18, small: 550–700×8–12	none	60–100	100–125	50	none
<i>septemdentalis</i>	Koltun, 1970	North-west Pacific, 4891–7295 m	brushlike, pinnate, 6 cm height	none fusiform styles, 770–1210×21–32, accessory styles, 610–930×13–18	none	'septemdentate', 33–44	83–187	'falcate', 28–44	none
<i>similis</i>	Ridley & Dendy, 1886	South Pacific, 22°21'N 150°17'W, 4365 m; New Caledonia, 4360 m	conical head with roots, 6 mm high (broken)	none large: up to 3600×50, medium: 650–700×30, small: 250–300×8–10	none	30	none	none	none
<i>tenuisigma</i>	Lundbeck, 1905	Laptev Sea, North Atlantic, 1394–1834 m	main trunk with rhizoids and long 'tentacles', 17 cm height	none 580–1010×14–26	none	24–28	38–48	with flattened ends: 48–56	none
<i>tridentata</i>	Ridley & Dendy, 1886	Antarctic, 2880 m	dome-shaped, 6 mm high	none	700×16	76	90	none	none
<i>corona</i>	sp. nov.	Aleutians, 726–2077 m	stalked, two planes of different appendages, up to 32.5 cm height	none fusiform styles, resembling anisoxeas, 600–4260×10–65	short, thick anisoxeas, 140–660×38–43, restricted to basal plate	30–42, in stalk and basal appendages	none	flattened sigmancistras, 35–42, restricted to crown	none

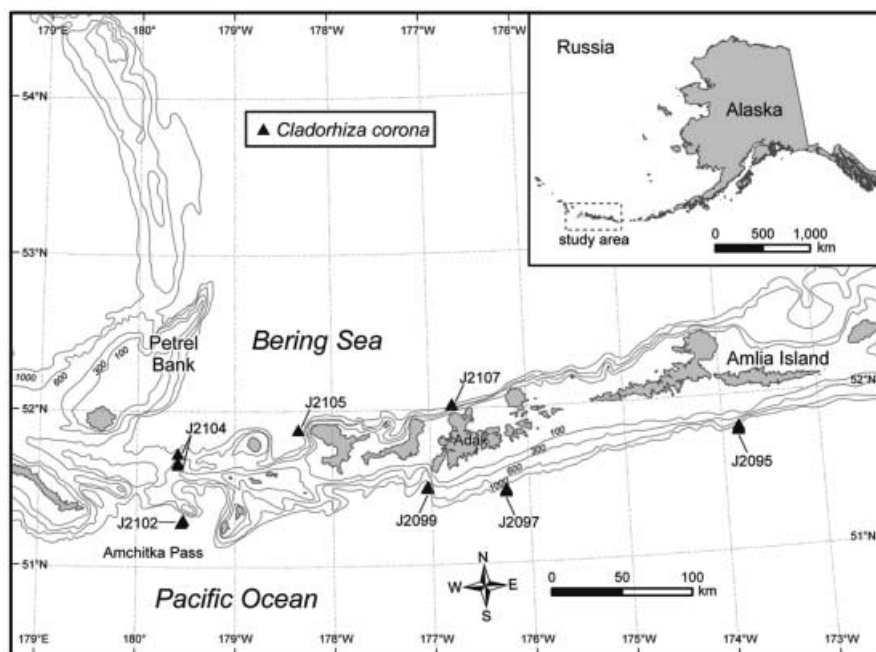


Figure 2. Map of the central Aleutian Islands showing video transects where *Cladorhiza corona* has been observed. Transect numbers correspond to those in Table 2.

Table 2. Locations along video transects where *Cladorhiza corona* has been seen. Transects are labelled in Figure 2. Patch size is an estimate of the number of specimens seen within the view of the video camera. No estimate of density has been made for most patches because of the varying height of the ROV off the sea-floor.

Transect no.	Depth (m)	Latitude (°N)	Longitude (°W)	Patch size
J2095	1547	51.773	173.836	6
J2095	1582	51.778	173.836	1
J2095	1400	51.780	173.836	12
J2095	1356	51.782	173.835	6
J2095	1353	51.790	173.831	2
J2095	1150	51.801	173.831	1
J2097	1718	51.462	176.240	>50
J2097	1600	51.468	176.239	>50
J2097	1565	51.471	176.238	6
J2097	1540	51.472	176.238	12
J2097	1387	51.480	176.236	1
J2099	1615	51.495	177.042	6
J2099	1534	51.497	177.041	3
J2099	1435	51.498	177.040	3
J2099	1416	51.504	177.039	6
J2099	1327	51.507	177.037	6
J2102	1597	51.287	179.549	20
J2102	1194	51.299	179.535	12
J2102	978	51.306	179.529	4
J2104	1010	51.731	179.585	>100
J2104	747	51.675	179.585	1
J2104	726	51.660	179.585	8
J2105	2077	51.884	178.351	1
J2105	2031	51.882	178.348	1
J2107	1563	52.032	176.768	1
J2107	1557	52.031	176.768	12
J2107	1470	52.027	176.768	1
J2107	1371	52.025	176.768	1

of the sponge a second plane of differently shaped appendages is oriented in a quarter circle perpendicular to the plane below. The distal appendages are shorter, have a spherical tyle at the end and are connected by an ectosomal membrane more than half way along their length. The holotype measures 32.5 cm in total length. Specimen J2095-2-6-1 is 26.5 cm in length, the stalk measures $22.5 \times 0.6\text{--}0.9$ cm, basal appendages up to 5×0.1 cm, diameter of the circular plane of basal appendages approximately 8.5 cm, inner circle of the tissue-connected appendages, 4 cm diameter, distance basal appendages to distal appendages, 0.5 cm, radius of the quarter-circle of ectosome-connected distal appendages, 2 cm, unconnected distal appendages about 0.5×0.1 cm long. The tyles at the end of distal appendages are up to 0.3 cm diameter. A spherical, conical, or discoid body where appendages originate, as present in several other species of *Cladorhiza*, is lacking. The appendages insert directly at the stalk. The sponge is yellowish or cream white when alive and in preservative. The consistency is wiry, elastic, with an easily detachable ectosomal membrane.

Skeletal architecture: basal plate, stalk with the basal appendages, and the crown are three distinct parts of the sponge which differ considerably in spicule arrangement and types of spicules present.

Basal plate: the basal plate consists of fusiform styles and shorter anisoxeas with slightly unequal ends, densely packed in one plane parallel to the surface of the substrate. The basal plate has no ectosomal membrane, like that present in all other parts of the sponge and is devoid of microscleres.

Stalk and basal appendages: from the basal plate polyspicular tracts of long fusiform styles run in thick bundles through the centre of the long cylindrical stalk which is covered by an ectosomal membrane, densely packed with

anchorate anisochelae. The consistency of the stalk is firm and elastic. A wire-like interior is surrounded by a softer, easily detachable, relatively thick ectosomal membrane. The basal appendages are constructed in a similar way as the stalk. They are supported internally by polyspicular tracts of styles branching off from the tracts of the stalk. The ectosomal membrane of the appendages is packed with anisochelae, as is the case with the stalk.

Crown: the polyspicular tracts of long fusiform styles reaching the crown fan out in one plane, leaving only little space between the tracts. Single, thin (sub-)tylostyles are arranged more or less perpendicular to the thick, fusiform styles. The ectosomal membrane of the crown is devoid of anisochelae. Flattened sigmancistras with a thin claw-like extension at each end occur instead. The flattened sigmancistras are distributed without recognizable orientation. The thin (sub-)tylostyles and the sigmancistras occur exclusively in the crown.

Spicules. Megascleres: fusiform styles, almost anisoxeas, 600–4260 × 10–65 µm, present in all parts except the ectosomal membrane (Figure 1H); (sub-)tylostyles, 510–1650 × 8–20 µm present in the ectosomal membrane of the ‘crown’ (Figure 1F); thick, short anisoxeas, with slightly unequal, blunt ends, 140–660 × 38–43 µm, present in the basal plate (Figure 1G). Microscleres: anchorate anisochelae, 30–42 µm, present in the ectosomal membrane of the stalk and the basal appendages (Figure 1D,E); sigmancistras, flattened, each end with a thin pointed ‘claw’, 35–42 µm, in the ectosomal membrane of the ‘crown’ (Figure 1D).

Etymology

The distal appendages with their connecting tissue and styles at the end are reminiscent of a crown, hence the name *corona* from the Latin for crown.

DISCUSSION

Cladorhiza corona sp. nov. is distinguished from other species in the genus by the occurrence of two planes of differently shaped appendages, the presence of three regions with different spicule types, and the combination and size of spicules present. With a maximum length of 32.5 cm *C. corona* sp. nov. is one of the largest species of *Cladorhiza* recorded to date. *Cladorhiza gelida* Lundbeck, 1905, with a length of 23 cm, differs from *C. corona* in having a pinnate growth form, shorter styles, a lack of accessory styles, and the presence of two size-categories of sigmas. Most other species reported (Table 1) have one or two size-categories of true sigmas; a spicule type represented in *C. corona* by the described flattened sigmancistras only. *Cladorhiza septemdentalis* Koltun, 1970, and *C. bathyrcinoides* Koltun, 1955, are reported to have flattened sigmoids also. *Cladorhiza septemdentalis* differs from the species described here in its brushlike growth form, shorter styles, septemdentate anisochelae, and the occurrence of large, normal sigmas in addition to the sigmancistras (referred to as falcate sigmas in Koltun, 1970, and semicrescent in Koltun, 1959). *Cladorhiza bathyrcinoides* Koltun, 1955 differs in having a hemispherical body where appendages are inserted, its styles are only half the size of *C. corona*, and it also has true sigmas in addition to sigmancistras. *Cladorhiza longipinna*

Ridley & Dendy, 1886, has a somewhat similar growth form to *C. corona* but it is much smaller, lacks a second plane of appendages, has a hemispherical or discoidal body, and shorter styles and larger anisochelae. Additionally, the accessory styles are strongly fusiform in contrast to the ones in *C. corona*, and it has neither sigmas nor sigmancistras.

In contrast to other *Cladorhiza* species, *C. corona* was always observed where the substrate consisted of bedrock or fragmented bedrock. It appears that the sponge is always attached to the substrate by a basal plate (Figure 1C), as seen in the holotype specimen. In this, and in the possession of the ‘crown’ appendages, it differs from all other known species in the genus. On the other hand, there are no particular features of the spicules that would cause one to move this species to a new genus. Consequently, the generic diagnosis will need to be expanded to include the presence of the basal plate.

Cladorhiza corona was observed in half of the video transects conducted during our study of marine biota and geology of the Aleutian Ridge. Transect locations and *C. corona* records are summarized in Table 2 and Figure 2. For the most part, the species was found in the North Pacific Intermediate Water (1.81 < T < 3.12°C), at depths from 726 to 2077 m on both sides of the Aleutian Ridge. The largest groups of *C. corona*, which we have termed ‘patch size’, occurred at depths of 1000 to 1700 m on the south side of the Aleutian Ridge and in Amchitka Pass (Figure 2).

This species appears to be a predator feeding primarily on calanoid copepods. Notes on the prey and feeding morphology of the species are in preparation.

Many thanks to the crews of the RV ‘Roger Revelle’ and pilots of the ROV ‘Jason II’, whose skilful operation of their respective complex machinery made collection of this interesting animal possible. The National Oceanic and Atmospheric Administration’s Undersea Research Programme and the National Marine Fisheries Service, Alaska Fisheries Science Center, funded this project. Thanks to Dr Wolfgang Heimler, who operated the SEM at the Institute of Zoology in Erlangen Germany.

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