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# Deep-sea epibiotic hydroids from the abyssal plain adjacent to the Kuril–Kamchatka Trench with description of *Garveia belyaevi* sp. nov. (Hydrozoa, Bougainvilliidae)

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## ABSTRACT

Examination of material collected by the German–Russian KuramBio Deep-Sea Expedition to the abyssal plain adjacent to the Kuril–Kamchatka Trench revealed about 17 hydroid species, including two species presumably new to science. Before the KuramBio Expedition only fragments of the unidentified hydroids and *Cryptolaria* sp. were collected in the Kuril–Kamchatka Trench from depths exceeding 3000 m. Descriptions of three species of epibiotic hydroids (including one new species, *Garveia belyaevi* sp. nov.) are presented herein. A colony of *G. belyaevi* sp. nov. (the third deep-sea and deepest species of the wide distributed genus *Garveia*) was attached to the spines of unidentified irregular sea urchins from depths 5217 to 5229 m. *Halitholus* (?) sp. (Hydrozoa, Anthoathecata) colonized the skin of spoon worms (*Echiura*) but could not be identified to species level because the mature medusa stage was absent in the material. An unidentified juvenile polyp (Pandeidae) was found on the bryozoan *Triticella minini* attached to spines of irregular sea urchins *Echinisigra amphora*. Colonial sedentary organisms inhabiting abyssal plains with soft bottoms may colonize invertebrates which are seldom used as substrates for epibiota in shallow waters. Epibiosis among abyssal colonial invertebrates, though extremely poorly studied, appears to be rather frequent.

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## 1. Introduction

Data on benthic deep-sea hydrozoans of the North Pacific have been presented in various forms in several dozen publications. According to Zenkewitch et al. (1955), trawling at a depth of ca. 1000–1060 m in the Kuril–Kamchatka Trench yielded about 15 unidentified species of Hydrozoa; at a depths of ca. 4000 m only a few fragments of hydroids were found; at 4500–5140 m no hydroids were found, the hauls containing scyphopolyps of the genus *Stephanoscyphus* (?) (Nausithoidae?). At a depths of 6860 and 7230 m, fragments of a deep-sea hydroid *Cryptolarella* sp. were found. From these data, the species diversity of Hydrozoa in this region decreases sharply down the depth interval from 1000 to 3000 m, and these cnidarians appear to be very scarce below 4000 m. Hydrozoans were found in a few samples from the hadal of the Kuril–Kamchatka Trench (depth range 6000–8400 m), based on the materials from expeditions on the R/V *Vitjaz* in 1950–1970s. These species were either not identified or represented by *Cryptolaria* sp.

(Belyaev, 1966, 1989). The paucity of hydrozoan species at the abyssal and hadal depths is attributed to a complex of factors such as water temperature, pressure, sediment, and food chains (Sokolova, 1969; Turpaeva, 1977; Vinogradova, 1977).

Examination of material collected by the German–Russian KuramBio (Kuril–Kamchatka Biodiversity Study) Deep-Sea Expedition to the abyssal plain adjacent to the Kuril–Kamchatka Trench, aboard R/V *Sonne* in the summer of 2012, revealed several epibiotic hydroids including a new species of the genus *Garveia* Wright, 1859. The present paper is devoted to the description of these hydroids. Other materials from the study are under examination. Preliminary results show that the samples contain two species of scyphopolyps questionably referable to the family Nausithoidae, two hydroid species from the subclass Trachylina, and about 15 species from the subclass Hydroidolina, including two species presumably new to science.

## 2. Materials and methods

Samples containing hydrozoans were dredged with a modified camera-epibenthic sledge (EBS; see Brandt et al., 2013). They were

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fixed and preserved in 95% ethanol. Specimens were photographed in ethanol with an AxioCam digital camera attached to Leica DMLS-2 and Zeiss Discovery V12 stereomicroscopes or with an AxioCam HR3 digital camera attached to a Leica DM4500B compound microscope. For confocal laser scanning microscopy (CLSM), colony fragments were stained with DAPI at room temperature for 4 h. All pieces were washed in PBS, immersed in glycerol, and mounted on glass slides. These preparations were examined with a LSM-780 confocal microscope (Carl Zeiss, Germany).

### 3. Systematic part

#### Class Hydrozoa Owen, 1843

#### Subclass Hydroidolina Collins, 2000

#### Order Anthoathecata Cornelius, 1992

#### Suborder Filifera Kühn, 1913

#### Family Bougainvilliidae Lütken, 1850

Genus *Garveia* Wright, 1859

Type species: *Garveia nutans* Wright, 1859.

**Diagnosis:** Colonies with stems monosiphonic or polysiphonic, branched or unbranched. Hydranths fusiform, hypostome conical, with one (rarely two) distal whorls of short filiform tentacles, encased in a pseudohydrotheca often reaching up to tentacle bases. Tentacles, if contracted, immersed in pseudohydrothecal cavity, with only tips protruding. Pseudohydrothecal perisarc wrinkled or encrusted with sand. Gonophores cryptomedusoid (subumbrella cavity present, marginal larval tentacles sometimes seen), arising from colony branches or hydrorhiza.

#### 3.1. *Garveia belyaevi* sp. nov.

**Material:** Holotype No 28683 (museum of the A.V. Zhirmunsky Institute of Marine Biology, Vladivostok); 01 September 2012, R/V *Sonne*, stations 12–5, Agassiz trawl, start (on ground) 39°43.47'N, 147°10.11'E, end (off ground) 39°42.54'N, 147°09.51'E, depths 5229–5217 m, on spines of unidentified irregular sea urchin.

**Etymology:** The species is named after Georgy Mikhailovich Belyaev (1913–1994), a famous Russian researcher of the deep-sea fauna.

**Diagnosis:** A single colony very small, stolonial and slightly branched. Stolon creeping, giving rise to monosiphonic pedicels bearing well-developed or immature hydranths and medusoids. Male medusoid, when almost mature, cryptomedusoid. Hydranths, when contracted, fully contained within pseudohydrothecal cavity together with tentacles, with only their tips exposed. Perisarc of hydranths and pedicels wrinkled, encrusted with sand and mud.

**Description:** Colony small; incipient branching clearly present. Stolon creeping, giving rise to 8 hydranths and 3 gonophores: one gonophore well-developed, the other two immature (Fig. 1A). Hydranths with pedicels narrowed basally and apical part broadened; when contracted, almost entirely covered by pseudohydrotheca; pseudohydrothecal perisarc encrusted with sand grains and dead diatoms (Fig. 1C and F). Perisarc of pseudohydrotheca and pedicel much wrinkled. Tentacle tips only seen in most hydranths of this colony; counting their number as well as the number of rows therefore problematic, but likely not less than 10 tentacles. In a single non-contracted hydranth, tentacles sticking together and also impossible to count. Based on “see-through” examination, tentacles presumably arranged in one row around a rounded-cylindrical hypostome (Fig. 1F). The only almost mature (male) medusoid appearing cryptomedusoid (Fig. 1B and D), with incipient subumbrellar cavity and incipient marginal tentacles (Fig. 1E). Nematocysts, as with other Bougainvilliidae, represented by desmonemes and microbasic euryteles.

**Dimensions:** Length from tip to base of non-contracted hydranth up to 165.4  $\mu$ m; length of stolon about 0.5 mm; length of pedicel of non-contracted hydranth 2.6 mm; length of polyp body without pedicel 1.9–2 mm; pseudohydrotheca length 0.3 mm; pseudohydrotheca maximal diameter 0.5 mm; medusoid maximal length with pedicel 426.9  $\mu$ m; maximal medusoid diameter 231.4  $\mu$ m. Nematocysts: microbasic euryteles 6.4–6.8  $\mu$ m in length and 3.3–3.4  $\mu$ m in diameter; desmonemes 3.8–4.3  $\mu$ m in length and 2.7–2.9  $\mu$ m in diameter.

**Distribution:** Known only from type locality.

**Comparison:** The genus *Garveia* comprises 14 or 21 valid species (Bouillon et al., 2006; Schuchert, 2014). Not all of them are valid on Stepanjants' opinion and most of them are shallow water. We compare here *G. belyaevi* with two species – *Garveia arborea* (Browne, 1907) which having been reported from a depth range of 420–3100 m (Stepanjants and Zhuravleva., 2012), and *Garveia* sp. (Stepanjants in lit as *G. polarsterni*) was found in the Laptev Sea at a depth of 2300–2400 m (Stepanjants and Zhuravleva., 2012, but remains undescribed) and can be considered a deep-sea species. *Garveia belyaevi* clearly differs from both these species in having a weakly branched colony and a non-polysiphonic stem as well as in the fact that its hydranths, when contracted, are almost completely covered by pseudohydrothecae. The new species has the smallest colonies, which is undoubtedly associated with its deep-sea habitat as well as, possibly, with its substrate – sea urchin spines.

#### Family Bougainvilliidae Lütken, 1850

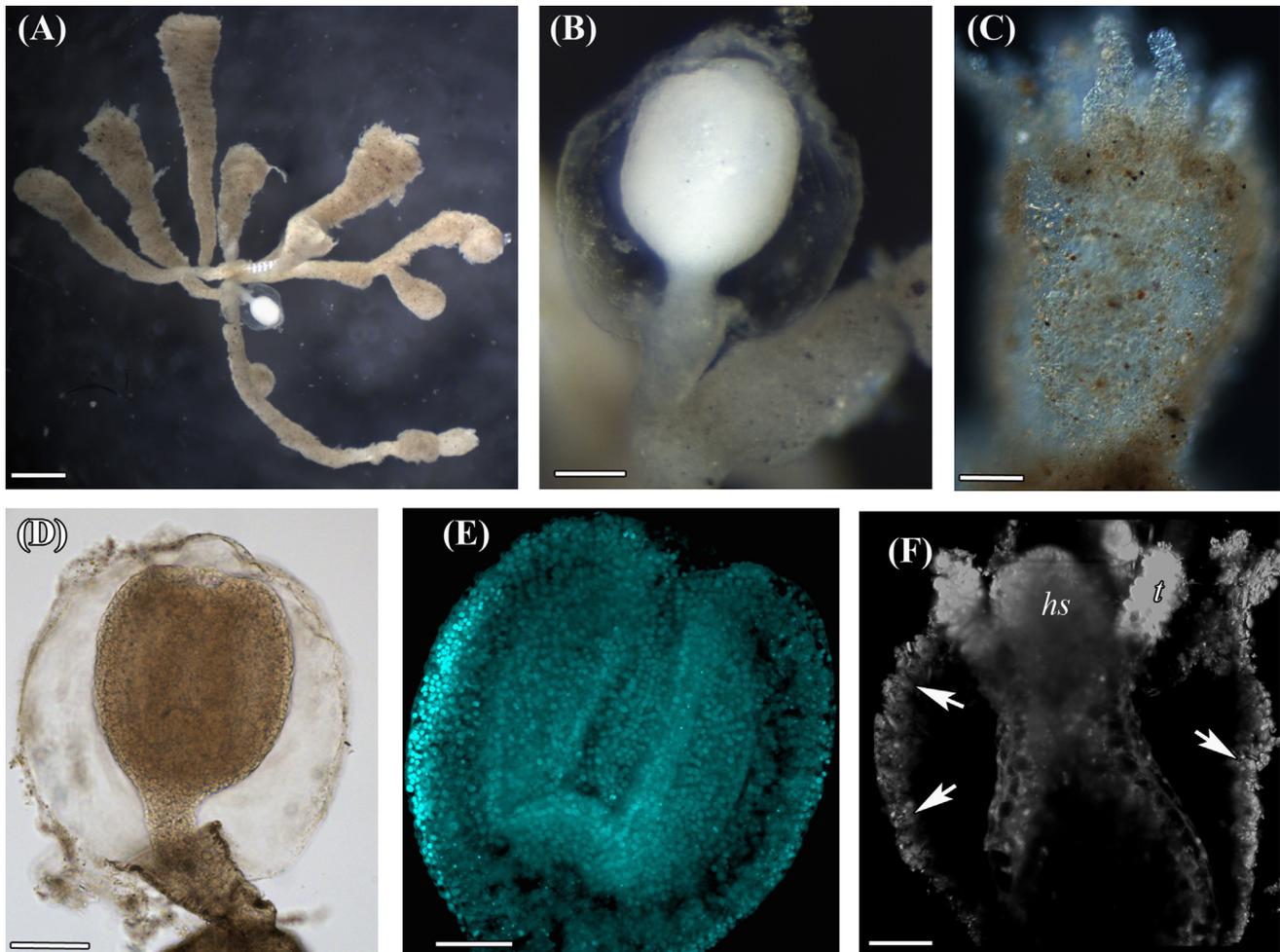
#### 3.2. *Halitholus* (?) sp.

**Material:** about 12 colonies, 05 August 2012, R/V *Sonne*, station 3–9, epibenthic sledge, 47°14.66'N–47°14.76'N, 154°42.88'E–154°43.03'E, depths 4987–4991 m, on the skin of spoon worms (Echiura, Bonelliidae). A few colonies were deposited in the Zoological Museum of Hamburg (No. ZMH C 12385).

**Description:** Colonies creeping, usually stolonial (Fig. 2A and B); small “daughter polyps” sometimes seen on pedicels (Fig. 2C and D). Pedicels rather long, tapering towards base. Pseudohydrotheca covering hydranth body up to tentacle bases. Tentacles pointed, 10–12 in number, arranged in one row. Hypostome dome-shaped, cylindrical. Perisarc of pseudohydrotheca semitransparent, that of pedicels and stolons solid. The only medusoid present arising from hydrorhiza (Fig. 2D and E); immature but with outlines of medusa manubrium showing in gonophore; wrinkled gonad lobes possibly starting to form on manubrium. One spoon worm served as substrate for a colony with 4–8 hydranths. The colony was always situated at the base of the worm's proboscis. Colonial ciliates were often seen on the colony surface. Two-thirds of all the spoon worms in the examined sample had hydroid colonies on their surface.

**Dimensions:** Hydranth and pedicel length up to 1.6 mm; pseudohydrotheca length 526–570  $\mu$ m; pseudohydrotheca diameter 333–355  $\mu$ m; tentacle length about 165  $\mu$ m; medusoid height 505  $\mu$ m; medusoid diameter 308  $\mu$ m. Nematocysts: microbasic euryteles 5.2–5.5  $\mu$ m long; desmonemes 3.2–3.4  $\mu$ m long.

**Notes:** Colonial hydrozoans from the families Bougainvilliidae and Pandeidae with incompletely deciphered life cycles (that is, with polyp structure known and medusa structure unknown) cannot be precisely identified to genus and species level (Stepanjants and Svoboda, 2013). For example, the species *Perigonimus yoldiaearcticae* Birula, 1897 (now in *Halitholus*) was described based on the polyp structure only and should be considered as a *nomen dubium*. Epibiotic polyps described in the present paper are morphologically similar to those described in



**Fig. 1.** *Garveia belyaevi* sp. nov. (A) colony; (B and D) male medusoid; (C) polyp; (E) CLSM micrograph, z-projection of longitudinal sections showing cryptomedusoid; (F) CLSM micrograph, z-projection of longitudinal sections of the polyp (arrows indicate pseudohydrotheca). Abbreviations: hp, hypostome; t, tentacle. Scales: (A) 500  $\mu$ m; (B) 200  $\mu$ m; (C–E) 50  $\mu$ m; (F) 20  $\mu$ m.

the literature as belonging to the genera *Perigonimus* M. Sars, 1846, *Halitholus*, *Leuckartiara* Hartlaub, 1914 and some others (fam. Pandeidae). The genus *Perigonimus* is now invalid (its type species has been assigned to *Bougainvillia* Lesson, 1830) and its species have been transferred to other genera with deciphered life cycles. Gonophore character in *Leuckartiara* is easily recognizable by the presence of distinct marginal tentacles of the future medusa inside them. Examination of the only (immature) gonophore present in our material showed that its morphology corresponded to that of the genus *Halitholus* (for many species of this genus either a polyp or a medusa remained unknown for a long time). Incipient larval marginal tentacles and an incompletely formed manubrium could be seen in the medusoid under study. Based on this, we provisionally attribute the hydroid in question to the genus *Halitholus*. Three *Halitholus* species are currently known: *H. cirratus* Hartlaub, 1913, *H. pauper* Hartlaub, 1913, and *H. intermedius* Browne, 1902. All of them inhabit shallow water areas not deeper than 150 m. Only *H. pauper* is known from the Pacific (British Columbia and South Kamchatka) (Arai and Brinckmann-Voss, 1980). Polyps of *Halitholus pauper* and *H. intermedius* have not been described. Polyps of *H. cirratus* mostly colonize bivalve shells, although the type colony was found on an isopod crustacean of the genus *Idothea* (Hartlaub, 1913). Thus, *Halitholus* colonies, though not obligatory epibionts, do not shun live substrates. No colonies of *Halitholus* have been reported in the literature to live on the surface of deep-sea invertebrates. The species that we studied may

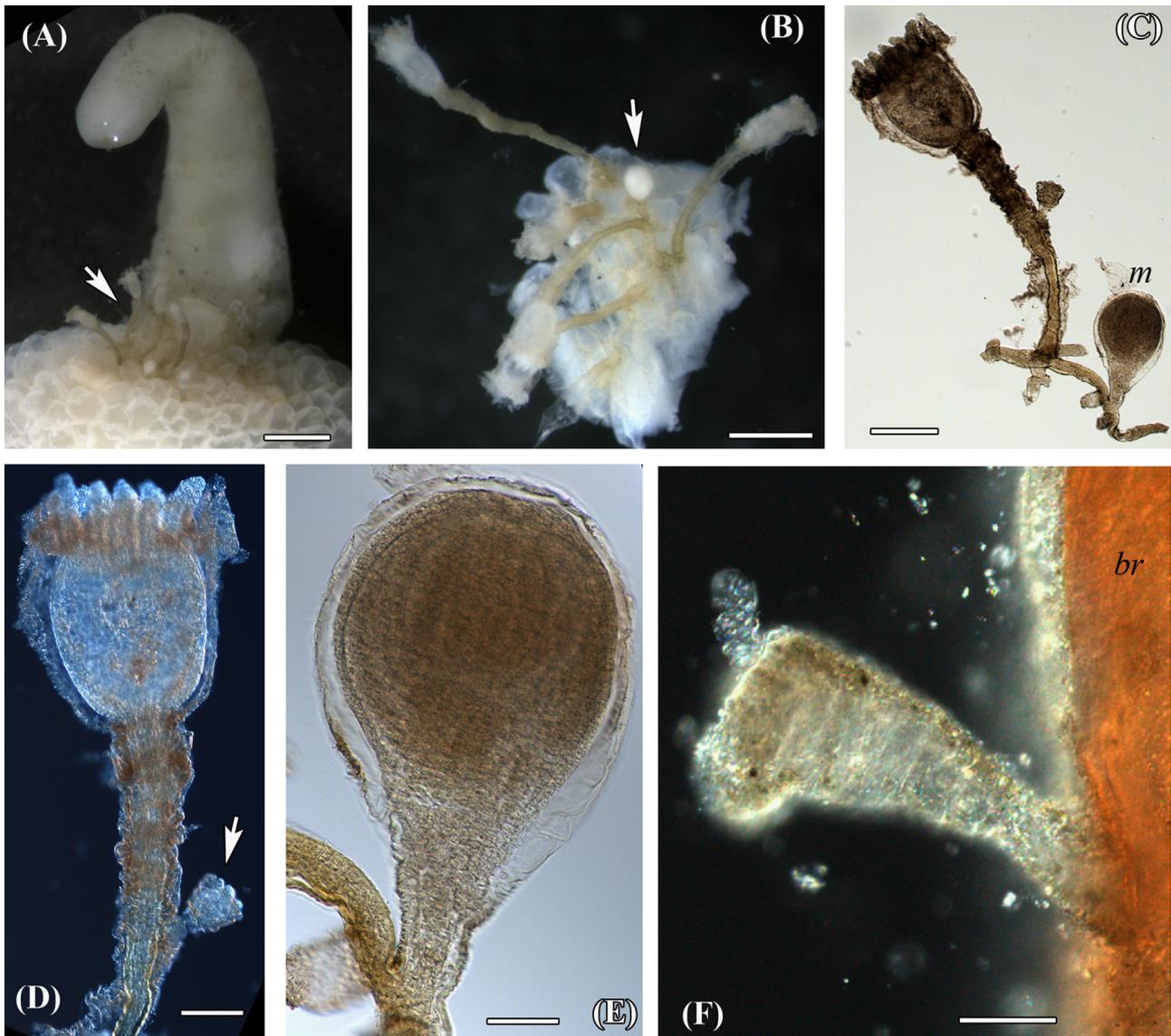
turn out to be new to science, but can only be described after its medusae are found and characterized.

Single small “daughter polyps” observed on the colony of *Halitholus* sp. are reminiscent of those found in some other representatives of Anthoathecata (e.g., some species of *Zyzyzus* Stechow, 1921, *Bouillonionia* Petersen, 1990, *Monocaulus* Allman, 1872, etc.). It has been suggested that the formation of such “daughter polyps” could give rise to the so-called “aggregate” colonies – evolutionary predecessors of colonial structure in Medusozoa (Stepanjants et al., 2002; Svoboda et al., 2006).

### 3.3. Pandeidae gen. sp.

**Material:** One juvenile polyp, R/V *Sonne*, 29 August 2012, stations 11–9, epibenthic sledge, 40°12.49'N, 148°05.40'E to 40°12.37'N, 148°05.43'E, depth 5263–5362 m.

**Description:** One juvenile hydropolyp 184  $\mu$ m in length was found on an epibiotic bryozoans (*Tricitella minini* Grischenko and Chernyshev) colonizing the irregular sea urchin *Echinisigra amphora* Mironov, 1974. The hydroid lacks any distinct morphological characters except a single small tentacle protruding from the pseudohydrotheca. The other tentacles of the polyp have presumably not yet developed. Nematocysts were represented by desmonemes and microbasic euryteles, which means that this polyp could belong either to the family Bougainvilliidae or to the family Pandeidae. This young polyp may actually belong to the newly described species *Garveia belyaevi*,



**Fig. 2.** *Halitholus* (?) sp. (A–E) and Pandeidae gen. sp. (F). (A) colony (indicated by arrow) on a spoon-worm; (B) the same colony (arrow indicates medusoid); (C), polyp and medusoid; (D) polyp (arrow indicates “daughter polyp”); (E), medusoid; (F), polyp on bryozoan. Abbreviation: br, bryozoans; m, medusoid. Scales: (A) 0.5 mm; (B) 0.2 mm; (C) 0.2 mm; (D and E) 50  $\mu$ m; (F) 20  $\mu$ m.

whose colony was found only on a sea urchin spine. The nematocyst capsules in this polyp – desmonemes 2.9–3.2  $\mu$ m; microbasic euryteles 5–6  $\mu$ m – are somewhat smaller than those in *Garveia belyaevi*. This may be explained by the fact that the capsules of this juvenile individual are still underdeveloped.

#### 4. Discussion

Many hydroid species are facultative or obligatory epibionts of other marine invertebrates such as corals, polychaetes, molluscs, crustaceans, sponges, etc. Most of these epibiotic hydroids live in shallow waters, although a few deep water species are known. For instance, *Opercularella angelikae* Stepanjants, 2013 in the pseudoabyssal of the Sea of Japan may colonize polychaete tubes and solitary ascidians, though this epibiosis is facultative (our unpublished data). An instance of obligatory epibiosis is provided by *Hydractinia ingolfi* Kramp, 1932 (in the Arctic, see Calder, 1996, 1997, 1998) and *H. vallini* Jäderholm, 1926 (in the Antarctic, see Stepanjants, 1979; Smirnov and Stepanjants, 1980; Svoboda et al., 1997), which colonize brittle stars of the deep-sea family

Ophiolepididae (Smirnov and Stepanjants, 1980; Svoboda et al., 1997). Therefore, the finding of hydroids engaged in epibiotic relationships with three different invertebrates (spoon-worms, sea urchins, and bryozoans) in our relatively small material is noteworthy. The bottom of the abyssal plain is usually silt-covered, making it inhospitable for small attached epibenthic organisms such as hydroids, bryozoans, and kamptozoans. This problem may be solved by epibiosis on other invertebrates, common substrate being mollusk shells and stalks of glass sponges. In our study, careful examination of mollusk shells showed them to be free of any metazoan epibionts. In the KuramBio samples a new bryozoan *Tricitella minini* (Grischenko and Chernyshev, 2015) was found on the spines of the irregular sea urchin *Echinosisigra amphora* and a new kamptozoan *Loxosomella profundorum* was found on a corallimorpharian (Borisnova et al., 2015). Epibiosis among abyssal colonial invertebrates, though extremely poorly studied, appears to be rather frequent. In particular, the species of *Hydractinia* mentioned above (*H. ingolfi* and *H. vallini*) are specific epibionts of ophiolepidid brittle stars. The newly described *Garveia belyaevi* may turn out to be a specific epibiont of an irregular sea urchin. In view of the fact that the chemicals produced by the “live substrates” may

facilitate the settlement of hydroid larvae (see Zelikman, 1977), the relationship between the epibionts and their substrates may become quite intricate. For instance, a hydroid identified as *Syncoryne* sp. in the abyssal overgrows the tube of the sedentary polychaeta *Potamilla symbiotica* in order to hold it (as well as its own colony) in a vertical position, presumably by fashioning a supporting rosette out of its own coenosarc at the tube base (Filatova, 1977). The small size of the deep-sea epibiotic colonies found is likely to be associated with the small area of the “live substrate”. In case of sea urchins, only the spines can be colonized, the rest of the surface being unsuitable for colonization. In spoon worms only the skin around the base of the proboscis can be colonized, the rest of the body being buried in silt.

## 5. Conclusion

Abyssal benthic Hydrozoa have only recently become the object of detailed taxonomic studies aimed to reveal the changes, if any, in their species composition from the bathyal to the abyssal. Based on the materials of the KuramBio Expedition, we can be fairly sure that hydroids are not a mass group in the true abyssal. However, the situation is different in the pseudoabyssal of the Sea of Japan, where *Opercularella angelikae* may form aggregations at a depth of 2.5–3.6 km (Stepanjants, 2013). Further sampling and research are necessary to elucidate the role of hydroids in deep-sea bottom communities.

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