Deep-water Hydrozoa (Cnidaria: Medusozoa) in the Sea of Japan, collected during the 51st Cruise of R/V Akademik M.A. Lavrentyev, with description Opercularella angelikae, sp. nov.

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Abstract
A report is given about Hydrozoa collected at depths between 455 and 3666 m in the Sea of Japan during the Russian-German expedition on R/V Akademik M.A. Lavrentyev. Ten species were found, with four of them being typical bathyal–abyssal and abyssal zones. A new species, Opercularella angelikae, is described, and it was the dominant hydroid in samples from 970 to 3660 m. Four eurybathic species characteristics of the Sea of Japan were sampled between 455 and 582 m. Abyssal (pseudoabyssal after Andriashev, 1979) hydroid fauna in the Sea of Japan is reported. The hypothesis that an exclusively deep-water fauna is lacking in abyssal regions of the Sea of Japan is disputed. The author’s personal opinion considered concerning the borders of 1000 m between shallow and deep hydrozoan species in the Sea of Japan.

1. Introduction
Maximum depths in the Sea of Japan reach about 3700 m. In 2010, a deep-sea expedition was undertaken on board R/V Akademik M.A. Lavrentyev to investigate the deep-sea benthos of the Sea of Japan from lower bathyal to abyssal depth (Malyutina and Brandt, this issue). Hydrozoans were collected at depths between 455 and 3666 m, offering an opportunity to compare the hydrozoan fauna of the shelf to that of the bathyal and abyssal area in the Sea of Japan.


At present, many more species of Medusozoa (Sheiko and Stepanjants, 1997) including several species of Siphonophora, Scyphozoa and Staurozoa are known from the entire Sea of Japan. This is nearly double the number of species of Hydrozoa reported earlier from the northwestern Sea of Japan (Naumov, 1960, 1969). Notably, most species from the northwestern and the entire Sea of Japan comprise Medusozoa of the shelf zone. Of 12 species included amongst the deep-water hydrozoan fauna by Naumov (1960: p. 124, 1969), none has been reported in the Sea of Japan. However, this likely reflects the sampling bias (lack of study) and scarcity of knowledge of the deep-sea fauna in this area rather than absence of species at bathyal and abyssal depths.

It was common sense that deep-sea regions of the Sea of Japan are inhabited by eurybathic hydroboid species and that a “specific abyssal fauna” is completely absent there (Naumov, 1960, 1969). The same accepted concerning other invertebrate groups (Derjugin, 1915, 1933; Vinogradov, 1968; Andriashev, 1974, 1979). Vinogradov (1968) following Derjugin (1933) and foreshadowing the ideas of Andriashev (1979) called the Sea of Japan an “aberrant region” of the ocean. Of pelagic siphonophora cnidarian Dimophyes arctica (Chun, 1897) is known from bathyal depth of the Sea of Japan below 1000 m (Vinogradov, 1968).

Material collected during the Russian-German expedition on board of R/V Akademik M.A. Lavrentyev demonstrates the vertical distribution of hydroids in the Sea of Japan which are presented here. An interpretation of the vertical distribution of hydroids in that basin different from our former knowledge is presented here on the basis of the newly collected material.

2. Material and methods
Material from the expedition with R/V Akademik M.A. Lavrentyev in August 2010 to the Sea of Japan was examined using a MSP-2 (LOMO) stereomicroscope. Photographs of colonies and constituent
parts were prepared with an MSP-2 device (LOMO) and a digital camera IK 5100. For SEM (Zeiss EVO 40), fragment of colony was dehydrated through a series of acetone, then dried in a critical point dryer, before being mounted on a stub and coated with platinum–palladium alloy.

Ten species of Hydrozoa were found in the samples (Table 1). As many specimens were poorly preserved (only skeletal remains, or they were much contracted) identification was not always possible. Thus, some material could only be identified with a question mark, or to genus level only (Table 1).

The type material is deposited in the Museum of A.V. Zhirmunsky Institute Marine Biology FEB RAS, Vladivostok (MIMB), Zoological Institute Marine Biology FEB RAS, St. Petersburg (ZIN), Russia and the Zoological Museum of Hamburg (ZMH), Germany.

### 3. Systematics

**Class Hydrozoa Owen, 1843**

**Subclass Hydroidolina Ord. Anthoathecata Fam. Pandeidae**

1. *Garveia arborea* (Browne, 1907)

**Family Corymphidae Euphyssa (bigelowi?)**

(Maas, 1965; actinulae)

**Ord. Leptotheccata Fam. Phialellidae**

3. *Opertcularella angeliage sp. nov.*

Ocylanthe geniculata (Allman, 1888)

**Genus Opercularella**

For three species of the genus *Opercularella* a new genus *Racemoramus* Calder, 2012 was described (Calder, 2012). It is very difficult to find distinct morphological differences of colonies of representatives of this genus: *R. panicula* (G.O. Sars, 1874), *R. denticulata* (Clarke, 1907), *R. indivisa* (Fraser, 1948) from those of typical *Opercularella*. The grape-like cluster arrangement of a number of hydrotheca on hydrocaulus at regular distances from each other and frequently in different planes can be regarded as the major difference. However, because such an arrangement of hydrotheca does not always occur, it is very difficult to identify the genus. The second difference, in the opinion of Calder (2012), is the presence of free medusae, their morphology remaining unknown until now. Gonotheccae oval-elongated, on articulated short pedicel.

**Opercularella angeliage, sp. nov.** (Figs. 1–5).

**Material examined**

*Holotype:* MIMB 27401 St. D2–8, 1.09.2010; 42 06.6051–42 06.655N; 131 21.0149–131 20.9308E, depth 2653–2683 m. Entire colony (Fig. 1).

*Schizoholotype:* ZIN 1/11225 St. D2–8, 1.09.2010; 42 06.6051–42 06.655N; 131 21.0149–131 20.9308E, depth 2653–2683 m. Fragment of colony.

*Paratype 1:* ZMH C12152 St. D6–8, 16.08.2010; 44 18.6270–44 18.4712N; 137 24.0985–137 24.3985E; depth 2545–2555 m.

### Table 1

Species list of Hydrozoa found during the expedition on R/V Akademik M.A. Lavrentyev.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Total vertical distribution in m</th>
<th>Station number, depth in m</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Corymphidae Euphyssa (bigelowi?)</em> (Maas, 1965; actinulae)</td>
<td>Abys; 970–3666; data of this expedition</td>
<td>B6–6; 970–994</td>
</tr>
<tr>
<td><em>Phialellidae</em> 3. <em>Opertcularella angeliage sp. nov.</em></td>
<td>Abys; 970–3666; data of this expedition</td>
<td>C1–8; 2670–2681</td>
</tr>
<tr>
<td><em>Opertcularella angeliage sp. nov.</em></td>
<td>Abys; 970–3666; data of this expedition</td>
<td>A7–9; 3340–3347</td>
</tr>
<tr>
<td><em>Opertcularella angeliage sp. nov.</em></td>
<td>Abys; 970–3666; data of this expedition</td>
<td>A6–8; 2545–2555</td>
</tr>
<tr>
<td><em>Opertcularella angeliage sp. nov.</em></td>
<td>Abys; 970–3666; data of this expedition</td>
<td>D2–8; 2653–2683</td>
</tr>
<tr>
<td><em>Opertcularella angeliage sp. nov.</em></td>
<td>Abys; 970–3666; data of this expedition</td>
<td>C3–4; 3427–3431</td>
</tr>
<tr>
<td><em>Opertcularella angeliage sp. nov.</em></td>
<td>Abys; 970–3666; data of this expedition</td>
<td>B1–7; 3665–3666</td>
</tr>
<tr>
<td>Fam. Zygophylacidae 5. Zygophylax convallaria (Allman, 1877)?</td>
<td>Eurybat; 70–994 m (Hirohito, 1995)</td>
<td>A2–10; 455–465; B6–6; 970–994; A2–8; 582</td>
</tr>
<tr>
<td><em>Thiuri articulta</em> (Pallas, 1766)</td>
<td>Eurybat about 11–582 m (Naumov, 1960, 1969; Cornelius, 1995; Schuchert, 2001)</td>
<td>A6–8; 582</td>
</tr>
<tr>
<td>Allman, 1874</td>
<td>Eurybat (Cornelius, 1995; Stepanjants, 1988, 1998)</td>
<td>A6–8; 2545–2555; A7–9; 3340–3347</td>
</tr>
</tbody>
</table>
Colony fragments in the form of clew of hydrotheca pedicels (Fig. 2).


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Colony fragments in the form of clew of hydrotheca pedicels.
42°15.7357N; 136°43.2772–136°43.3044E; depth 3665–3666 m.
Separate hydranths, entangled by their pedicels in a clot, and
sometimes two hydranths arising from the hydrorhiza.

Description of holotype: The colony occurs on wood. Hydro-
rhiza, a dense network extending over substrate, giving rise to
unbranched pedicels approximately 10–15 times longer than
hydrotecta, each pedicel with a terminal hydranth encased in
a hydrotecta having thin, transparent perisarc. Apical part of
hydrotectal wall costate. Tip of hydrotectal cone-shaped when
closed. Frequently aperture of hydrotecta is open, and in this case
the costate pattern in the region of the apical part of hydrotectal
wall is distinct. Hydrotecta walls along these ribs often diverge
the costate pattern in the region of the apical part of hydrotectal
wall are much shorter (about 0.7 mm). To judge by the structure of
hydrotecta and hydrotectal pedicel of Opercularella sp. such a possibility is not
inconceivable although sizes of these parts of skeleton of Oper-
cularella sp. are much smaller.

Etymology: The species is named after Dr. Angelika Brandt, the
leader of the German scientific party of the Russian-German
expedition on RV Akademik M.A. Lavrentyev.

Larvae
In samples from maximum depths studied by this expedition
(2545–2555 m and 3340–3347 m) larvae of representatives of
some Hydrozoa taxa have been found. Because of minute sizes of
larvae and their poor preservation it is impossible to clarify
morphology of these organisms; however, an approximate iden-
tification to a family or a genus is attempted.

Subclass Hydroidolina Collins, 2000
Order Anthoathecata Cornelius, 1992
Suborder Capitata Kühn, 1913
Family Corymorphidae Allman,1872
Euphysora (bigelowi?) (Maas, 1905)? Larvae (Figs. 6, 7)
Sampled between 3340 and 3347 m depth
Larvae in the form of slightly developed young polyps (1 mm height) with two whorls of tentacles. Oral tentacles are
arranged on a relatively long hypostome in several random
rows (Figs. 6 and 7). Between the whorls of tentacles of one
actinula there are undeveloped buds of gonophores the
structure of which is impossible to understand. Tentacles of
the oral whorl bear weak traits of capitate structure. Tentacles
of the basal whorl are filiform. The rounded base of the polyp
has the small nodule, which might become an elongated and
produced pedicel of a polyp with rhizoids. External skeleton is
absent.

In only one species of the genus Euphysora (bigelowi?) polyp is
known. At present the majority of authors are inclined to reduce
Euphysora in a synonym of the genus Corymora (Sassamann and
Rees, 1976; Schuchert, 2010). However, the polyps have char-
acters permitting to regard Euphysora valid genus: oral tentacles of
polyp are capitate (in Corymora they are filiform); arrange-
ment of oral tentacles in several random whorls (in polyps
Corymora oral tentacles are arranged in an ordered whorl).
Based on the above characters the actinulae found here are placed
in the genus Euphysora, presumably in species E. bigelowi
(Maas, 1905).

Subclass Trachylina Collins, 2000?
Order Narcomedusae Haeckel, 1879
Family Solmarisidae? Haeckel, 1879 (Figs. 8 and 9).
Caught at depth of 2545–2555 m and 3340–3347 m two minute
larvae, approximately 1 mm in diameter of the primordial bell.
No characteristic features of morphology have been established
except for the presence of 21–22 marginal tentacles arranged not
at the very edge of the bell, but slightly higher than that from the
side of the exumbrella (Fig. 8), which is characteristic of Narcomedusae.
It can be seen that the presence of marginal lobes of the bell (Fig. 9)
is also regarded as a character of Narcomedusae.

4. Discussion

Hydrozoan fauna from bathyal and abyssal depth of the Sea of
Japan has not been studied until recently. The references to
discoveries of separate hydroid species in general articles or
publication of non-hydrozoan invertebrates dealing with faunal
studies need verification.1

1 For example, report that the deep-sea nudibranch mollusk Dorisunculus
unicus from the Sea of Japan (3000–3620 m) feeds on hydroids Egumnella sp.
(=Oplorhiza sp.) (Martynov and Rogniakaya, 2005). According to S. Stepajants

Fig. 5. Base of hydrotecta pedicel of Opercularella angelikae sp. nov. structure.
As mentioned above, of the 12 deep-water hydroid species mentioned by Naumov (1960, 1969) none have been reported for the Sea of Japan. From collections of the expedition on board the R/V Akademik M.A. Lavrentyev between 455 and 3666 m, 10 hydrozoa species have been found in the Sea of Japan; however, their vertical distribution can be regarded as specific. In terms of overall frequency in the samples, *O. angelikae*, sp. nov., was considered dominant. It was particularly well-represented by dense colonies at depths greater than 2500 m. Five other species were found at depth of more than 900–1000 m (Table 1). Five of these (*Euphysora* sp. (*bigelowi*)? juv, *Garveia arborea* (Browne, 1907), *Stegolaria* geniculata (Allman, 1888), *Zygophylax convallaria* (Allman, 1877), and the narcomedusa of the family Solmarisidae juv.) are previously unknown both in the Sea of Japan and in the adjacent Russian seas. The distribution of hydrozoan species at deep ocean depth in the Sea of Japan is documented in Table 1. From 455 m to approximately 1000 m, four eurybathic species known from upper sublittoral to bathyal zones occur. Between 1000 and 3666 m, three typical abyssal (“pseudoabyssal” on Andriashev’s terminology conformably to the Sea of Japan) species unknown for the shelf were found. The 1000 m isobath is therefore considered to be a
boundary between shallow and deep hydrozoan species in the Sea of Japan.

This conforms with the earlier conclusions that at the depth of the ocean there “archibenthal transit” (446–940 m) and “upper abyssal” (940–2635 m) zones (Menzies et al., 1973 – after Vinogradova, 1977). The boundary between them passes at a depth of approximately 1000 m. This conforms to the earlier assertion of Vinogradova (1977) that the presence of such abyssal forms allows one to speak about specificity of deep water fauna of different areas of the World Ocean.

Another hypothesis regarding geographic distribution of deep-water fauna is that abyssal species inhabit only one ocean (Vinogradova, 1979). Data obtained from study of deep-sea species in the Sea of Japan refute this belief. S. geniculata Allman, 1888, discovered at a depth of 1699 m in the Sea of Japan, is known to occur at bathyal—upper abyssal depths (about 1000–1300 m) of the eastern North Atlantic.

The discovery of larval stages of some hydrozoan species (see above) in the depth of the Sea of Japan. Actinulae of the family Caryophyllidae, most probably E. bigelowi, belonging to a shelf genus have been found in the abyssal. This conforms to the theory of Mileykovsky (1973, 1977) that pseudopopulations of shelf species might inhabit in bathyal and abyssal. In the opinion of Mileykovsky (1977) pseudopopulations allow the benthic species to use dietary resources of the entire area occupy new biotopes and expand their area reproduction.

5. Conclusions

The following conclusions are drawn after examination of Hydrozoa obtained from bathyal and abyssal depths in the Sea of Japan:

1. The current opinion that deep regions of the Sea of Japan are inhabited by eurybiatic species, and that a true deep-sea fauna is absent there, is refuted bathyal and abyssal species were found during this study. Examples include S. geniculata Allman, 1888.

2. The theory that species of deep-sea macrobenthos are limited to a particular ocean (Vinogradova, 1979) is not supported by our data on Hydrozoa.

3. At depths between 900 m to 3660 m, hydrozoan species are rare and few in number and typical bathyal or abyssal in their vertical distributions. This accords previous studies on vertical zonation of hydrozoans from near-surface waters to the abyssal zone (Calder, 1996, 1998).

4. Actinula larvae of the family Caryophyllidae found at abyssal depths of the Sea of Japan probably belong to shelf species E. bigelowi, which confirms the hypothesis of Mileykovsky (1977) of species distribution over wide bathymetric ranges due to larval transport.

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References


