Paraedwardsia hadalis, a new ultra-abyssal sea anemone (Actiniaria: Edwardsiidae) from Aleutian Trench

N.P. Sanamyan, K.E. Sanamyan

ABSTRACT: Ultra-abyssal Paraedwardsia hadalis sp.n. is a first species of sea anemones described from Aleutian Trench. It resembles two deep water species P. abyssorum and P. lemchei which differ from other Paraedwardsia species by weak development of tenaculi. Paraedwardsia hadalis sp.n. from 7250 m is a most deep water species of the family Edwardsiidae.


KEY WORDS: Sea anemone, Actiniaria, Aleutian Trench, Edwardsiidae, Paraedwardsia.

Paraedwardsia hadalis, новая ультраабиссальная актиния (Actiniaria: Edwardsiidae) из Алеутского желоба

Н.П. Санамян, К.Э. Санамян

РЕЗЮМЕ: Ультраабиссальный вид Paraedwardsia hadalis sp.n. является первой актинией, описанной из Алеутского желоба. Он сходен с двумя глубоководными видами, P. abyssorum и P. lemchei, которые отличаются от других видов рода Paraedwardsia слабым развитием тенакулей. Paraedwardsia hadalis sp.n., найденная на глубине 7250 м, является самым глубоководным из известных видов в семействе Edwardsiidae.


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Introduction

Very few sea anemones are known from deep water trenches. Carlgren (1956) described six species from the depths exceeding 6000m: Galatheanthemum hadale Carlgren, 1956, G. profundale Carlgren, 1956, Paraedwardsialémchei Carlgren, 1956, Daontesia mielchei Carlgren, 1956, Bathydactylus kroghi Carlgren, 1956 and Hadalanthus knudseni Carlgren, 1956. Galatheanthemum profundale was reported subsequently from many deep water trenches (Cairns et al., 2007) while all other species listed above are known from original descriptions only. Paraedwardsia hadalis sp.n. is a first sea anemone reported from Aleutian trench. In addition, at our disposal is also a specimen of Actinernus, collected at 6057 m in the western end of Aleutian trench, south off Commander Islands, but this material is not published yet.

Material and methods

The specimens were collected by R/V “Vityaz” in 1969, preserved in alcohol and stored in the Institute of Oceanology (Moscow). The methods of preparation of histological sections, measuring size ranges of cnidae and cnidae terminology are the same as in our previous papers (e.g. Sanamyan et al., 2012, 2013). The specimens will be deposited in Zoological Museum of Moscow State University (ZMMU).

Taxonomy

Order Actiniaria
Family Edwardsiidae Andres, 1881
Paraedwardsia Carlgren in Nordgaard, 1905
Paraedwardsia hadalis sp.n.
Table 1; Figs. 1–5.

MATERIAL EXAMINED. Holotype: ZMMU Ec-114, R/V “Vityaz”, cruise 45, station 6145, depth 7250 m, 51°09.7′ N, 174°35.5′ E, 20 June 1969, one specimen. Paratypes: ZMMU Ec-115, same data, two specimens.

DESCRIPTION. Three available specimens were in a very good condition (Fig. 1A). The largest specimen is 16 mm in height and 9 mm in diameter was designated as holotype. Two other specimens, 10 × 5.5 mm and 13.5 × 7 mm were designated as paratypes. The latter specimen had better preserved cuticle and ectoderm and was used for histological sections. The body is pear-shaped with wide round aboral end, divisible into phsy, scapus, scapulus and very short capitulum. The distal part of the column is contracted and deeply invaginated; the tentacles, the capitulum, the scapulus and the distal part of the scapus are not visible from exterior in all specimens. The body wall is thin and eight mesenterial insertions are visible. Contracted retractors with filaments and gonads are located in proximal part of the body (Fig. 1B). The mesogloea of the scapus and phsy is about 30–45 µm in thickness. The endoderm is about 25 µm in thickness and the thickness of the ectoderm varies from 1–2 to 50–70 µm in numerous “protuberances” and patches of thickened ectoderm (Fig. 1C). Some of these high protuberances of the ectoderm are supported by mesogloeal strands and resemble tenaculi (Fig. 1D). The scapus is covered by thin (about 1 µm) gray-brown cuticle encrusted by fine sediment, but not by sand grains and other solid particles. Nemathybomes are not present. The cuticle and the ectoderm is partly abraded (Fig. 1A) and because of this the border between the phsy and the scapus is not clear. However, on histological sections, the phsy is differentiated from the scapus by smooth surface of the ectodermal side of the mesogloea. A ring of eight (?) tiny apertures were observed in one specimen (intact paratype) but we failed to demonstrate them on histological sections. The scapulus is not covered by cuticle, it has eight high, up to 800–900 µm, mesogloeal ridges between the insertions of the macrocnemes (Figs. 1B, 2A). These mesogloeal ridges extend to invaginated part of the scapus. Very short thin-walled capitulum (the thickness of the mesogloea is 3–6 µm) is just at the bases of the tentacles (Fig. 1B). Circular endodermal columnar muscles are well developed.

The tentacles (Fig. 2B), 12 in number, arranged into two cycles, 9 tentacles are in the outer ring and 3 tentacles are in the inner ring,
Table 1. Size ranges (length \times width, in microns) and distribution of cnidae of *Paraedwardsia hadalis* sp.n. Letters in brackets correspond to letters in Fig. 5. Frequencies given are subjective impressions based on all the cnidae seen on the slides.

<table>
<thead>
<tr>
<th>Body region</th>
<th>Cnidae</th>
<th>Size ranges (µm) (holotype)</th>
<th>Size ranges (µm) (paratypes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physa</td>
<td>Basitrichs (rare)</td>
<td>17–21 × 2–3</td>
<td>–</td>
</tr>
<tr>
<td>Scapus</td>
<td>(A) basitrichs (common)</td>
<td>25–48 × 2.5–3</td>
<td>23–35 × 3–4</td>
</tr>
<tr>
<td></td>
<td>(B) holotrichs (few)</td>
<td>–</td>
<td>7–9 × 2.5</td>
</tr>
<tr>
<td>Scapulus</td>
<td>(C) basitrichs (common)</td>
<td>15–18 × 2–2.5</td>
<td>14–19 × 2–2.5</td>
</tr>
<tr>
<td>Capitulum</td>
<td>Basitrichs (common)</td>
<td>–</td>
<td>16–20 × 2–3</td>
</tr>
<tr>
<td>Tentacles</td>
<td>(D) gracile spirocysts (numerous)</td>
<td>15–35 × 2–5</td>
<td>18–30 × 2.5–4</td>
</tr>
<tr>
<td></td>
<td>(E) robust spirocysts (numerous)</td>
<td>18–41 × 3–7</td>
<td>13–41 × 3.5–6</td>
</tr>
<tr>
<td></td>
<td>(F) basitrichs (common)</td>
<td>33–70 × 2–3</td>
<td>35–46 × 3–3.5</td>
</tr>
<tr>
<td>Actinopharynx</td>
<td>(G) basitrichs (common)</td>
<td>24–50 × 2.5–3</td>
<td>34–40 × 2.5–3</td>
</tr>
<tr>
<td>Filaments</td>
<td>(H) basitrichs (common)</td>
<td>33–43 × 2.5–3</td>
<td>33–48 × 3–3.5</td>
</tr>
<tr>
<td></td>
<td>(I) p-mastigophores A (common)</td>
<td>21–28 × 4–6</td>
<td>23–28 × 5–6</td>
</tr>
<tr>
<td>Endoderm of all body regions</td>
<td>(J) basitrichs (few)</td>
<td>15–16 × 5 (only in mesenteries)</td>
<td>15–21 × 4–5.5</td>
</tr>
</tbody>
</table>

One of which arise from endocoel of ventral directives (not visible on Fig. 2B) and two from endocoels of the dorso-lateral pairs of mesenteries. Longitudinal muscles of the tentacles (Fig. 1E) and radial muscles of the oral disc are ectodermal. The mesogloea on the tips of the tentacles is very thin.

The actinopharynx is rather short, has no recognizable siphonoglyphs. It has eight high longitudinal mesogloial ridges corresponding to insertions of the macrocnemes. Four highest ridges, up to 250 µm, correspond to lateral macrocnemes and four smaller, up to 150 µm, correspond to directives. Insertions of the microcnemes are marked by small ridges, up to 50 µm (Fig. 2C). At aboral end of the actinopharynx the mesogloial ridges continue into cingiod glandular tracts of the trilobate filaments, while the ectoderm of the adjacent regions of the actinopharynx form ciliate tracts (Fig. 2F). Reticular tract of the trilobate filaments is derived from endoderm of the actinopharynx. The filaments are present on all macrocnemes.

Eight macrocnemes are arranged as in all Edwardsiids and present along the whole length of the body. Four microcnemes paired with lateral macrocnemes are present in the distal part of the body. They appear at the most distal part of the scapus and extend through the whole length of the scapulus (Fig. 2A), capitulum and present at the distal part of the actinopharynx (Fig. 2C, D). On the transverse sections on the level of the distal part of the actinopharynx the microcnemes are rather long (Fig. 2C) and have a layer of fine non branched longitudinal muscles on their ventral sides (i.e. facing to exocoels) (Fig. 4E). In the region of the scapus and capitulum the microcnemes have flap-like mesogloial thickening on the ventral side. In these regions the microcnemes are lined by fine muscle fibers which are expanded on the body wall (Fig. 4D).

Retractor muscles on macrocnemes are restricted, with 17–22 muscle processes, few of them are weakly branched but many are not. There are no pennons or free flaps on retractors.
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The retractors are situated closer to the actinopharynx (Fig. 2C–F) and attached to the body wall by thin lamellae. At the region of physa the retractors become smaller and the mesogloele lamella connecting the retractors and the parietal muscles become shorter (Fig. 4B) and disappears completely in the most proximal part of the mesenteries (Fig. 4C). The parietal muscles have different appearance in the different regions of the body (Figs. 3, 4A–D). They first appear at the region of capitulum as a thickening of the mesenterial mesogloea lined with longitudinal muscle fibers (Fig. 3A). Toward the scapulus tiny mesogloele muscle processes become apparent. In this region the parietal muscles are not symmetrical, better developed on the same
Fig. 2. *Paraedwardsia hadalis* sp.n., paratype, transverse sections. A — scapulus, introverted; B — section on the level of the tentacles; C–D — distal part of the actinopharynx; E — middle part of the actinopharynx; F — proximal end of the actinopharynx.

Abbreviations: o — oral disc; ph — actinopharynx; s — scapus; sl — scapulus; sr — scapular ridge; t — tentacles; v — ventral pair of the directives; arrows point to microcnemes.

Рис. 2. *Paraedwardsia hadalis* sp.n., паратип, поперечные срезы. A — ввернутый скапулус; B — срез на уровне щупалец; C–D — дистальная часть глотки; E — средняя часть глотки; F — проксимальный конец глотки.

Сокращения: o — оральный диск; ph — глотка; s — скапус; sl — скапулус; sr — скапуллярный гребень; t — щупальца; v — вентральная пара направляющих мезентерий; стрелками указаны микромезентерии.
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Fig. 3. Paraedwardsia hadalis sp.n., paratype, parietal muscles of the macrocnemes. A — in the capitulum; B — in the distal end of the scapulus; C — in the scapulus; D–E — in the middle part of the scapus; F — in the proximal part of the scapus.

Abbreviations: ec — ectoderm.

Fig. 3. Paraedwardsia hadalis sp.n., паратип, парietальные мускулы макромезентериев. A — в капители; B — в районе дистального конца скапулуса; C — в скапулусе; D–E — в средней части скапуса; F — в проксимальной части скапуса.

Сокращения: ec — эктодерма.

side as retractor (Fig. 3B). In the scapulus the parietal muscles are symmetrical and fan shaped (Fig. 3C). In the middle part of the scapus muscle processes are more branched (Fig. 3D) and parietal muscles are triangular on transverse sections (Fig. 3E). In the proximal part of the body parietal part of the mesentery covered by parietal muscles gradually become longer (on transverse sections), its mesogloea become thicker and muscle processes become shorter (Fig. 3F). At the region of physa parietal muscles form small, up to 10 µm, but recognizable flap from the side opposite to retractor (Fig. 4A–B). Parietal muscle fibers are expanded on the body wall.

Two sectioned specimens were males. On the smaller specimen gonads are present on four lateral macrocnemes but we failed to find them on directives. On the larger specimen (holotype) gonads are present on directives too. Spermatzoa are about 3–3.5 × 2–2.5 µm, tip headed, symmetrical, with wide mitochondrial complex (Fig. 4F).

Cnidom includes spirocysts, holotrichs, basitrichs, p-mastigophores A (Tab. 1, Fig. 5). Small sparse holotrichs in the ectoderm of the scapus (Fig. 5B) were detected only on histological sections but we failed find them on macerated samples of ectoderm from the scapus of all three specimens. Basitrichs of the capitulum and endoderm of all regions of the body (Fig. 5J) were seen in histological sections only (in paratype). Ectoderm of the oral disc contains spirocysts and basitrichs (recorded on histolog-
Fig. 4. *Paraedwardsia hadalis* sp.n. A — parietal part of the macrocneme in the physa; B–C — macrocnemes in the physa; D — microcneme in the capitulum; E — microcneme on the level of distal part of the actinopharynx; F — spermatozoa (from holotype).

Abbreviations: ec — ectoderm; en — endoderm.

Рис. 4. *Paraedwardsia hadalis* sp.n. A — париетальная часть макромезентерия на уровне физы; B–C — макромезентерии на уровне физы; D — микромезентерий в капикулуме; E — микромезентерий на уровне дистальной части глотки; F — сперматозоиды (из голотипа).

Сокращения: ec — эктoderма; en — эндо дерма.

We failed to find p-mastigophores in the actinopharynx of two dissected specimens (distal, middle and proximal parts of actinopharynx were examined).

**REMARKS.** The most significant features of the described here species are the absence of nemathybomes, weak development of tenacules and the presence of only 12 tentacles. The arrangement of the tentacles is identical to those shown by Manuel (1988, Fig. 72) for *Edwardsia ivelli* Manuel, 1975. The present record from 7250 m is a most deep water known record of a species belonging to the family Edwardsiidae. Edwardsiidae is a diverse family comprising about 70 species most of which are known from shallow and moderate depths. Very few abyssal
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**Comparison with Other Species of the Genus**

Paraedwardsia lemchei is known only from the original description based on numerous specimens from Java Trench, 7160 m. It differs from *P. hadalis* sp.n. by possessing 14–16 tentacles and by the presence of large p-mastigophores in the actinopharynx.

Paraedwardsia abyssorum is known only from one poorly preserved specimen from Tropical Atlantic, 5610 m. The number of the tentacles, 12, is the same as *P. hadalis* sp.n., but retractor muscles appear to be weaker and have recognizable flap (see Carlgren, 1951, Fig. 2), while in *P. hadalis* sp.n. the flap is totally absent. It has small basitrichs in the filaments (24–28 × 3 µm) which not present in the specimens from Aleutian Trench. Although the variability of reported features and the significance of these differences cannot be accessed without examination of additional specimens, we prefer to treat the specimens from Aleutian Trench as distinct from *P. abyssorum*.

Third deep water species of *Paraedwardsia*, *P. heia*, described from 2650–3065 m off California (Daly, Ljubenkov, 2008), differs from *P. hadalis* sp.n., by well developed tenaculi (photo of intact specimen shows attached sand

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**Table: Paraedwardsia hadalis**

<table>
<thead>
<tr>
<th>Scapus</th>
<th>Scapulus</th>
<th>Tentacles</th>
<th>Actinopharynx</th>
<th>Filaments</th>
<th>Endoderm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
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</table>

Fig. 5. *Paraedwardsia hadalis* sp.n., distribution of cnidae (see Table 1 for size ranges). Рис. 5. *Paraedwardsia hadalis* sp.n., распределение кид (размеры указаны в табл. 1).
grains, see Daly & Ljubenkov, 2008, Fig. 9A), presence of 16 tentacles and much smaller ba-
sitrichs in the tentacles.

Other three hitherto known species of Paraedwardsia – P. arenaria Carlgren in Nor-
dgaard, 1905, P. cretata (Stimpson, 1856) and P. sarsii (Dueben et Koren, 1847) – are relative-
ly shallow water and do not occur in abyssal depths.

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