Cothurnia polydorica sp. nov. (Ciliophora: Peritrichia), a symbiont of shell-boring spionid polychaetes in the Sea of Japan, and a review of ciliates associated with polydorids

Cothurnia polydorica sp. nov. (Ciliophora: Peritrichia), симбионт полихет – спионид, сверлящих раковины в Японском море, и обзор инфузорий, живущих на полидорах

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Small unidentified spionid polychaetes (Polydora sp.) boring in shells of gastropod and bivalve molluscs in the Nakhodka region are hosts of a new species of loricate peritrich named Cothurnia polydorica sp. nov. The large genus Cothurnia can be subdivided into two groups (subgenera or genera) with one or two zooids inside the lorica; C. polydorica is a monozoic (solitary) species; after cell division one of the daughter individuals becomes migratory and swims away. The trophont is not vermiform and thus is not typical of most cothurnids; contraction of fixed specimens is partial, in the adoral half only; the lorica has a second inner layer of material at its base; the stalk is very long as compared with other cothurnids. The migrants adhere to the tips of thick setae of the host but not to its body surface, on which there are scattered small parasitic rhynchodids sucking the host body fluid by short apical tubes. A review of ciliates associated with polydorids is given.

Мелкие неопределенные полихеты-спиониды (Polydora sp.), сверлящие раковины брюхоногих и двустворчатых моллюсков районе Находки, — это хозяева нового вида рако- винных перитрих Cothurnia polydorica sp. nov. Крупный род Cothurnia можно разделить на 2 группы (подроды или роды) с 1 или 2 зооидами внутри раковины; C. polydorica — монозойный вид; после деления клетки одна особь становится мигрантом и уплывает. Трофонт не червеобразный, нетипичный для большинства котурнид; сокращение при фиксации частичное, в антесоме; раковина двойная в основании; стебелек удлинен. Ми- гранты прикрепляются к вершинам щетинок, а не к телу хозяев, где рассеяны мелкие паразитические ринходиды, высасывающие тканевую жидкость с помощью короткой апикальной трубки. Дан обзор цилиат, живущих на полидорах.

Key words: Polychaeta, Spionidae, Polydora, Ciliophora, Peritrichia, Cothurnia, new species

Ключевые слова: Polychaeta, Spionidae, Polydora, Ciliophora, Peritrichia, Cothurnia, новый вид

INTRODUCTION

In 1987 and 1988 periphyton and symbiotic ciliates were studied in the environs of the Biological Station “Vostok” of the Far Eastern Institute of Marine Biology near Nakhodka City, on the Asian coast of the Sea of Japan. Several new species and genera were discovered, including the new species described below which occurred only on “blister-worms,” or shell-boring polychaetes.
MATERIAL AND METHODS

Molluscs were collected in summer 1988 on sublittoral mussel and oyster beds; shells of living bivalves and gastropods were crushed to extract boring worms; some of them were examined alive, and others were fixed in 4–8% formalin diluted with sea water. Drawings of the new species were made without a camera lucida from living and fixed ciliates. The macronucleus was stained by acidified methyl green purified by a simple new method: about 40–50 drops are dried on a white plastic disc placed in a Petri dish to protect it from dust; the methyl violet contaminant is immediately absorbed into the white plastic due to electrophoresis, and when the dried double stain is redissolved in water, only methyl green is dissolved; the traditional use of chloroform for separation of two stains in solution is thus avoided. The dried drops are dissolved before use when needed, so that one Petri dish can be used for 40–50 subsequent stainings.

Order VORTICELLIDA
Family VAGINICOLIDAE
Genus Cothurnia Ehrenberg, 1831

Cothurnia polydorica sp. nov.
(Figs 1–8)

Type material. The type slide is a hapantotype (No. 1988–27); it includes the whole worm with numerous ciliates, in glycerin-formol, framed with black bituminous varnish; this slide and five 10-ml jars containing dozens of worms are stored in the Laboratory of Protozoology of the Zoological Institute of the Russian Academy of Sciences (St Petersburg). One worm, also with numerous ciliates, is stored separately as a xenotype; this is my term for the type specimen of the host which was proposed before the widely accepted term symbiotype of Donald Duszynski. I insist on my priority and will use my terminology below.

Description. Shell elongate, cup-like, thin walled, translucent, symmetrical, with upper margin not folded outwards. Stalk very long (2–2.5 times as long as body), relatively thin, dense and refractile, with distinct longitudinal striation in its upper part that may be wider than stalk distal to it and may bear irregular transverse folds. Length of lorica (in micrometers, ten specimens): 52–58, width of lorica: 25–28, stalk length: 84–98, stalk thickness: about 3.5. Three distinct zones between scopular (lower) body end and tip of stalk may be distinguished with oil immersion: 1) short endostyle, 2) wide low mesostyle, and 3) base of internal shell between these two zones (Figs 6, 8). Stalk attaching to substrate by wide folded basal disc.

Well-fed zooid before fission fills entire shell (Fig. 6); body wide, 60–72 μm long, gray due to numerous mitochondria; its contours not resembling those of typical vermiform cothurnids and zooids of Platycola Kent, 1882 and Thuricola Kent, 1881, species with cylindrical body shape. Peristome of usual type, with thick distinct circular lip, with 1.5 turns of peristomal ciliated spiral and with relatively short vestibulum; contractile vesicle single, below lip. Cilia long; at Fig. 8 only basal parts of cilia are shown. Macronucleus looking like longitudinal curved band, typical of other cothurnids; micronucleus not discernible among numerous refractile mitochondria.
and reserve grains. Pellicular cross-stria-
tions that are distinct in most cothurnids
were not discerned in this species but they
are likely to be present; no silver staining
was made. Unlike mobilids, all the species
of sessilids without exceptions possess ar-
gentophilic striations; the surface reticulum
(like that of *Pseudovorticella* Foissner &
Schiffmann, 1975) is unknown in loricates.

This species has a limited contractility.
Figs 6 and 8 were made from specimens
stored in seawater-formalin; large zooids
do not contract entirely inside shells when
fixed, and remain almost unchanged except
for contraction in their peristomal regions.
Thin myonemes are seen above the scopula
(Fig. 6).

**Comparison.** Two groups of species can
be distinguished in *Cothurnia* s. l., with one
or two active zooids on the joint endostyle.
I have introduced special terms for the
shelled (loricate) peritrichs, distinguishing
*monozoic* and *dizoic* species and genera. The
new species clearly belongs to the monozoic
forms that are united in the genus *Cothurnia*
Ehrenberg, 1831, s. str., as opposed to the
numerous dizoic cothurnids of the genus

*Sinothurnia* Jankowski, 1985. After fis-
sion (Fig. 8), one of the two daughter cells
continues feeding while the other contracts
its peristome, develops a submedial ciliated
ring and after metamorphosis swims away
to settle on free uninhabited tips of setae of
the same or another host. Thus, there can
be no objections to the inclusion of the new
species in *Cothurnia.*

The periphyton at the sampling site in-
cludes only one monozoic cothurnid (*Co-
thurnia maritima* Ehrenberg, 1838) with
a relatively short and thin stalk, and with
different shape of the zooid and lorica.
There is no reason to suppose that it can
settle on the cryptic polydores and change
its shape. Symbionts of polychaetes are host
specific species with definite morphological
caracteristics; this article adds a new type
of loricate symbiont to those previously
known on *Harmothoe* Kinberg, 1856, *Poly-
noe* Savigny, 1818, *Nereis* Linnaeus, 1858
and *Arenicola* Lamarck, 1801.

Cothurnid ciliates were monographed
by Kahl (1935) and Warren & Paynter
(1991); the symbiont of the polydores dif-
fers from all the previously known species.
by its cylindrical body shape and by its extremely long stalk; in both freshwater and marine cothurnids the exostyle is short, only rarely reaching the body length, whereas in the new species it can be twice as long as the body and longer. The cothurnid keys of Warren & Paynter (1991) should be modified to include this long-stalked species.

**Etymology.** The species name is based on the name of its host, the genus *Polydora* Bosc, 1802.

**Host.** The host of the new species is an unidentified spionid of the genus *Polydora* boring in shells of large bivalves *Crenomytilus grayanus* (Dunker, 1853), *Crassostrea gigas* (Thunberg, 1793) and large patellid limpets, an unidentified species of the genus *Acmaea* Eschscholtz, 1833. Almost all the examined worms (near 150 specimens) from the shells of these molluscs bore at least two or three, maximum 45 peritrichs. They were localized on the tips of massive setae of two kinds (Figs 1, 5, 7), never on the body surface, on which small ancistrocomid ectoparasites from the order Rhynchodida were randomly scattered, feeding by sucking body fluids through small rigid apical tubes.

**A review of ciliates associated with the polychaete family Spionidae**

Spionid polychaetes (now near 1000 species) are tiny free-living (usually in dense clusters of mud tubes) and boring worms; the latter ones can be extracted from coralline algal crusts, large barnacles, coral blocks, shells of living molluscs, empty shells and (like *Polydora commensalis* Andrews, 1891) pagurid-inhabited shells (Blake & Evans, 1973); some species are symbionts of sponges (*P. colonia* Moore, 1907, *P. spongicola* Berkeley & Berkeley, 1950), tunicates and other invertebrates. The main polydorid genera are *Polydora* Bosc, 1802, *Dipolydora* Verrill, 1879, *Tripolydora* Woodwick, 1964, *Pseudopolydora* Czerniawski, 1881, *Boccardia* Carazzi, 1893, *Boccardiella* Blake & Kudenov, 1978, *Caraziella* Blake & Kudenov, 1978 (Blake & Kudenov, 1978).

The Russian fauna was treated by Uschakov (1955; outdated monograph), and mainly by Radashevsky (1993, 1994, and a series of previous and subsequent articles), who discovered many new species; for my research area (Peter the Great Bay) he reported, of the strictly polydorid subgroup of Spionidae, the genera *Boccardiella* [*B. hamata* (Webster, 1899)], *Pseudopolydora* [*P. kempi japonica* Imajima & Hartman, 1964, *P. orientalis* (Annenkova, 1937) = *Carazziia orientalis*] and 14 species of the genus *Polydora* including more than 70 species worldwide; four of these were described by Radashevsky. The review of polydorids in Northwest Pacific (Radashevsky, 1993) includes about 30 species. His exciting discovery of *P. vulcanica* Radashevsky, 1994, that makes extensive mats in sulfur-rich volcanic caldera in the Mid-Kuriles reminds us that this group of worms had not attracted due attention of protozoologists; only a few ciliate symbionts were described from this family with worldwide distribution while much more hosts await careful study.

A few examined spionids are hosts of intestinal ciliates (Astomatida), ectoparasitic ancistrocomids (Rhynchodida), urceolarians (Mobilida) and sedentary peritrichs (Sessilida) of two types, with or without lorica. In fact, the associates of spionids are similar to those of sabellids, cirratulids and terebellids, except for the absence of vermigemmid Suctoria which were common on the two latter families in my NW Pacific samples.

A large astome named *Anoplophrya polydorae* De Faria, Da Cunha & Da Fonseca, 1917 was found in the intestine of *Polydora socialis* (Schmarda, 1861) extracted from *Ostrea* Linnaeus, 1758 shells in Brazil (De Faria et al., 1917, 1918); since the type of *Anoplophrya* Stein, 1860 is a dissimilar parasite of nordic earthworms, the generic name of the spionid parasite was later changed (Puytorac, 1954). Puytorac (1955a, 1955b) described a new microsporidian of the ge-
nus Thelohania Henneguy, 1892, that infects both the host tissues and the intestinal astome ciliate Hovassiella polydorae Puytorac, 1955 in Polydora giardi Mesnil, 1896; similar astomes in cirratulids, both freeliving and shell-borers (like Dodecaceria concharum Oersted, 1843), were treated in detail in his monograph of the order Astomatida and in a later article (Puytorac, 1954; Puytorac & Schrevel, 1965: Durchoniella cirratuli Puytorac, 1954 and D. dodecaceriae Puytorac & Schrevel, 1965).

Precht (1935) described a solitary peritrich Scyphidia spionica Precht, 1935 from Pygospio elegans Claparede, 1863 and from some other unidentified spionid in northern Germany. Scyphidia Dujardin, 1841 is a false genus with no determinable type species: S. rugosa Dujardin, 1841 from freshwater benthos was poorly described in an older work (Dujardin, 1841) and was never redescribed; thus the generic position of this symbiont should also be changed. A similar stalkless species with a discoid attachment, but with a compact nucleus, was found by me on polydores on the Murmansk shore of the Barents Sea.

Douglas & Jones (1991) examined nine species of spionids and some other polychaetes in Southern California, including Polydora (3), Boccardia (2) and one species of each of the genera Pseudopolydora, Pygospio Claparede, 1863, Streblospio Webster, 1879 and Scolelepis Blainville, 1828 (subgenus Nerinides Mesnil, 1896). In all, they found 26 species of parasites, including ancirostomoids on all the worms except Boccardia proboscidea Hartman, 1940, one astome species, and (only on Polydora ligni Webster, 1879) one mobilid, possibly urceolarian; three non-polydorids were free of these symbionts. Their illustrations give no possibility of identification of these symbionts. A species of Urceolaria Stein, 1867 occurred on nearly 90% of P. ligni, and its presence was enough for host identification. Astomes infected nearly 50% of P. nuchalis Woodwick, 1953, P. socialis (Schmarda, 1861) and Scolelepis maculata (Hartman, 1961); they may be “Anoplophrya” polydorae or some other species. Ancistrocomids, superficially similar, infected Boccardia hamata (near 100%), Polydora nuchalis (100%), P. ligni (40%), P. socialis (40%), and only 1% of Pseudopolydora paucibranchiata (Okuda, 1937). Three spionids (Boccardia proboscidea Hartman, 1940, Pygospio elegans Claparede, 1863 and Streblospio benediti Webster, 1879) were free of ciliates.

Commensals may be seen on illustrations (light and SEM photographs) of worms, for example on the setae of Dipolydora armata (Langerhans, 1880) boring in the calcareous hydrozoan Millepora complanata Lamarck, 1816 on coral reef in Barbados, West Indies (Lewis, 1998). Fig. 4 A of the cited author shows not “spermatophores, 50 μm long, attached to setae of female worms”, as stated in the legend, but typical small peritrichs on short stalks, with note in the text: 40–50 μm long; with stalk 20–30 μm long; attached by stalk to capillary setae of genital segments of females, occasionly also to body surface (body wall) of females. This is in fact a new undescribed peritrich, perhaps Rhabdostyla sp.

When describing the cosmopolitan spionid Dipolydora armata (Langerhans, 1880) from the epifauna of the gastropod Thais haemastoma (Linnaeus, 1767) from the Ibiza coast of the Mediterranean (extracted from empty shells or those inhabited by pagurids Calcinus Dana, 1851and Clibanarius Dana, 1852), Bick (2001) includes a photograph of a symbiont, with the legend “Fig. 7 B. Peritrichous ciliate (Cothurnia sp.) on capillary /seta/ of postbranchiate notopodium”, and with two in-text notes. Page 181: “Peritrichous ciliates (Cothurnia sp.) were sometimes attached to the notopodial capillaries on setigers immediately following branchiate setigers, both in April and September. Usually one ciliate was attached to a bundle, rarely two specimens”. Page 186: “The occurrence of peritrichous ciliates on the notopodal spines of postbranchiate setigers was remarkable and echoes findings of Williams & Radashevsky (1999) in Polydora.
neocaeca Williams & Radashevsky, 1999. Setae are clearly a suitable substratum for sessile ciliates. The constant water current produced by ciliated branchiae could improve the conditions for feeding and growth of symphoricorytic Ciliophora. The occurrence of sessile unicellular organisms on setae may be a common phenomenon and is worthy of further investigation”.

Unless reflected in the abstracts, such records of symbionts may be easily overlooked in the extensive literature on polydorids and other polychaetes; I will therefore be grateful for such references. The occurrence of an unidentified mobilid Urceolaria sp. was noted in the abstract of a thesis (David, 2011) and in a published article (David & Williams, 2012). This article adds new species to the relatively small order Urceolariida with a restricted number of hosts; SEM shows a small ciliate with several medial rings or folds, which are not typical of urceolarians that have either a smooth or a completely ringed lateral body surface. The host P. colonia Moore, 1907 makes numerous tubes inside sponges in the West Atlantic and in the Mediterranean Sea; the examined worms were extracted from the sponges Microciona prolifera (Ellis & Solander, 1786) and Halichondria bowerbanki Burton, 1930 in New York region, where P. colonia may be an introduced, non-native species.

Small immobile ancistrocomids on polydorids and sabellids may belong to the genus Colligocineta Kozloff, 1965 (Kozloff, 1965, 1976; Raabe, 1970), with the type species C. furax Kozloff, 1965 on sabellids Laonome kroyeri Malmgren, 1866. Besides two species on Sabella pavonina Savigny, 1822 (C. affinis Kozloff, 1976 and C. finleyi Kozloff, 1976), the genus includes also C. scolelepidis Kozloff, 1976 from the spionid Scolelepis fuliginosa (Claparede, 1870). A typical Colligocineta was common in my samples of Polydora ciliata Johnston, 1838, living in mud tubes on sandy littoral (estuarine mudflats) on the Murmansk coast of the Barents Sea.

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REFERENCES


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