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Occurrence of the parasite *Prosthorhynchus squamatus* (Digenea) in mussels *Mytilus trossulus* from the Gulf of Gdańsk (the southern Baltic Sea)

by

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Abstract

Sporocysts with cercariae of *Prosthorhynchus squamatus* Odhner, 1905 (Digenea, Bucephalidae) have been found for the first time in mussels *Mytilus trossulus* Gould, 1850 from the Gulf of Gdańsk (the southern Baltic Sea). The presented work provides a description and morphometry of larvae of this parasite.

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Mytilus trossulus Gould, 1850 is a marine mussel belonging to the subclass Eulamellibranchia. The species is found in the northern regions of the Pacific and Atlantic Oceans, including the Baltic Sea (Hilbish et al. 2000). *Mytilus trossulus* is a suspension filter-feeder and constitutes an important element of benthic biocenoses. The high primary production and eutrophication observed in the Baltic Sea including the Gulf of Gdańsk favor the development of mussel populations on the sea floor (Pierścieniak et al. 2010; Wołowicz et al. 2006; 2007).

In the course of the study, 390 mussels (length 20.7-39.7 mm, 172♂♂, 205♀♀, sex not determined for 13 specimens) were collected from areas of shallow water in the Gulf of Gdańsk directly by divers and by using bottom dredges deployed by ship (from 4 to 13 m depth) at several sampling locations: the site Mechelinki (54°36'N 18°30'E, from March to August 2012), sites MD, K1, K2, S and near the Orłowo Cliff (54°29'N 18°33'E, from June to August 2012) and the site R (Fig. 1). A total of 120 mussels were sampled at sites MD and R, 60 mussels – at sites K1 and K2 and only 30 specimens at the site S.

The collected mussels were placed in the sea water and subjected to standard parasitological

examinations after being transported to a laboratory. Gonads of one host were entirely occupied by larval stages (sporocysts with cercariae) of *Prostorhynchus squamatus* Odhner, 1905. Trematodes were identified based on the publications of Cole (1935), Čubrik (1952; 1966) and Matthews (1973). The infected mussel was a female (26.3 mm) collected at the site R in August 2012. Larvae of trematodes were taken out of the reproductive tissue and fixed in 70% ethanol. Several parasites were used to prepare histological slides: they were stained in alcohol-borax carmine, dehydrated in a series of alcohol concentrations (from 80 to 99%), then cleared in benzyl alcohol and embedded in the Canada balsam (Rolbiecki 2010).

The Latin and common names of the species follow WoRMS (2015).

Since larvae of *P. squamatus* were found in *M. trossulus* for the first time from the Polish coastal zone of the Baltic, their description and morphological measurements are presented.

Description and measurements of *Prostorhynchus squamatus* (all measurements in µm, unless otherwise stated).

Sporocyst (Fig. 2A)

The body is composed of a mass of dichotomously branched tubules which are dilated into chambers containing cercariae.

Cercaria (n=15, Fig. 2B)

Body 136-257 (mean 204, $\pm SD$ 32) long and 60-91 (mean 73, $\pm SD$ 14) wide. Anterior end with rhynchus well developed, conical or oval in shape, 35-51 (mean 41, $\pm SD$ 7) long, and 31-43 (mean 36, $\pm SD$ 5) wide. Mouth located at 90-170 (mean 124, $\pm SD$ 29) from anterior end; pharynx 20-27 (mean 22, $\pm SD$ 4) long, and 20-30 (mean 25, $\pm SD$ 5) wide. Intestine saccular, blind ended, usually directed anteriorly. Gonads usually developed; ovary oval, 14-20 (mean 18, $\pm SD$ 3) long and 10-16 (mean 12, $\pm SD$ 3) wide, located at the level or below the posterior part of pharynx and in front of the anterior testes; two testes, longitudinally oval, the first one (anterior) 20-31 (mean 23 $\pm SD$ 7) long and 16-20 (mean 18 $\pm SD$ 2) wide, and the second one (posterior) 16-31 (mean 21 $\pm SD$ 7) long and 16-21 (mean 17 $\pm SD$ 2) wide, located below the posterior part of mouth. Trilobed tail stem (one median and two lateral), 30-83 (mean 56, $\pm SD$ 19) long and 94-129 (mean 116, $\pm SD$ 16) wide, with two threadlike appendages (furca) at the end of body; appendages 0.529-1.057 mm (mean 0.755 mm, $\pm SD$ 0.239 mm) long.

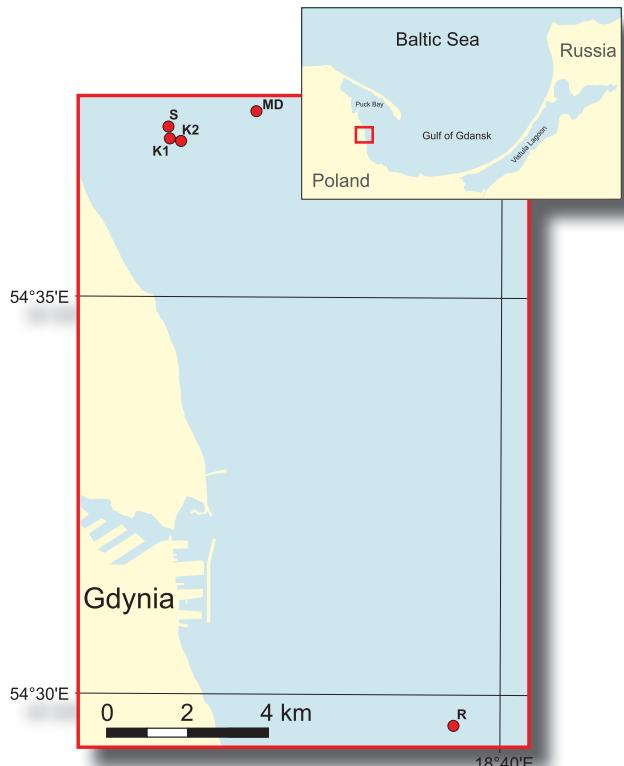


Figure 1

Location of sampling sites



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**Figure 2**

Prostorhynchus squamatus. A) sporocyst containing cercariae, B) cercaria

Prostorhynchus squamatus belongs to the family Bucephalidae. It is a marine species with Arctic-Boreal distribution. The life cycle of this trematode includes mollusks *Mytilus edulis* Linnaeus, 1758, sometimes *M. galloprovincialis* Lamarck, 1819, *M. edulis*-*M. galloprovincialis* complex, *Musculus discors* (Linnaeus, 1767), *M. laevigatus* (Gray, 1824), *Cryptonatica affinis* (Gmelin, 1791) (= *Natica clausa* Broderip et Sowerby, 1829), which play the role of the first intermediate host and various fish species as the second intermediate and final hosts. According to some authors, *M. laevigatus* is considered a synonym of *M. discors* (Brunei et al. 1998). Adult stages of the trematode live in the intestine, stomach and pyloric caeca of fishes of the families Cottidae and Pleuronectidae, which are considered the main final hosts. Metacercariae develop in muscles, fins, and operculum of fishes belonging primarily to the genus *Liparis* and to the family Cottidae. Furthermore, sporocysts with cercariae live in hepatopancreas, gonads, kidneys, and mantle of mollusks. After leaving mollusks, invasive cercariae actively attack fishes. Fishes with metacercariae are then consumed by other predatory fish species; metacercariae become sexually mature inside their bodies (Čubrik 1952; 1966; Zelikman

1966; Matthews 1973; Køie 1984; Coustau et al. 1990; Bower 1992; Gibson 1996).

Individual morphometric features of trematodes found in mussels *M. trossulus* were generally within the ranges published by other authors (Cole 1935; Čubrik 1952; 1966; Matthews 1973). The exception was maximum width of rhynchus and gonads which showed higher variability than documented so far.

The infection rate in *Mytilus* with the trematode *P. squamatus* varies with water salinity, the presence of typical hosts and the size of mussels. The infection level in *M. trossulus* from the Gulf of Gdańsk is very low (0.4%). In typical sea waters, the infection of mussels may reach up to 42-60%. Higher levels of infection were also found in larger mussels (Čubrik 1966; Zelikman 1966; Lauckner 1983). Larger mussels with a higher filtration rate (Winter 1969) have a better "chance" to become infected with free swimming miracidia than smaller specimens (Lauckner 1983).

Sporocysts with cercariae of *P. squamatus* can damage gonads of bivalves and lead to their castration. Infection in *M. edulis* weakens the adductor muscles, which affects the shell-opening ability when exposed to air. Consequently, the survival of mussels

during transport and storing in shops is seriously reduced (Lauckner 1983; Hansson 1998; Coustau et al. 1990; 1991).

P. squamatus was already found in *M. edulis* from other (south Scandinavia) regions of the Baltic Sea (Hansson 1998) and larval and adult stages were recorded in many fishes (Markowski 1933; Rokicki 1975; Køie 1984; Popiołek 2012). It is noteworthy that the status of *M. trossulus* and *M. edulis* is still unclear. Both species are morphologically very similar and molecular markers are usually used for their identification (Hilbish et al. 2000; Väinölä, Strelkov 2011). It cannot therefore be excluded that the previous information about the presence of *P. squamatus* in *M. edulis* may in fact concern *M. trossulus*.

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