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Short communication

Prey or parasite? The first observations of live Euglenida in the intestine of Gastrotricha

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Abstract

Euglenida are an important element in almost all aquatic ecosystems. They are known to parasitize animals such as copepods and flatworms, but have never been found in any other microscopic group. Gastrotrichs, a phylum of small microinvertebrates, are a constant and important element of marine and freshwater ecosystems. During our observation, 72 live gastrotrich specimens were collected from Europe (Poland, Germany) and South America (Brazil) containing active Euglenida of the genus *Heteronema*. Euglenida were found in the intestine of 10.4%, 52.6% and 1% of gastrotrichs, respectively. Taking into consideration the existing parasitism in euglenoids, it may be hypothesized that they either constitute fortuitous feed in the gastrotrich intestine or they are parasites or commensals. These observations suggest a new, so far unknown type of interaction between Gastrotricha and protists.

Keywords: *Chaetonotus*; Commensals; Freshwater; *Ichthydium*; *Lepidodermella*; Parasites

Introduction

It is well known that Euglenida constitute an important element of almost all aquatic ecosystems throughout the world (Sittenfeld et al. 2002). They may play an important role in aquatic ecosystems as purifying agents of sewage and contaminated waters (e.g. Pringsheim 1956). Many species of Euglenida are known to parasitize zooplankton animals, such as copepods (e.g. Michajłow 1978; Wita and Sukhanova 1986; Zalocar et al. 2011). In addition, the species *Euglena leucops* Hall, 1931 is known as a parasite of flatworms (Turbellaria) (Hall 1931). It was previously stated that non-predatory mortality in zooplankton could be attributed to parasites (Tang et al. 2014), but to date nothing is known about the mortality of benthic organisms conditioned by parasites.

Gastrotricha are monophyletic, microscopic, acoelomate metazoans ranging from 50 μm to 3500 μm in size (Kisielewski 1997). Gastrotrichs are divided into two orders, Chaetonotida Remane, 1925 (Rao and Clausen 1970) and Macrodasyida Remane, 1925 (Rao and Clausen 1970), comprising approximately 850 nominal species (Todaro et al. 2014). They are a constant element of marine and freshwater habitats as well as of wet terrestrial ecosystems (e.g., peat bogs, alder woods, riparian forests, etc.) (Kisielewski, 1997; Balsamo et al. 2013). Due to methodological difficulties (e.g., collecting, extracting, preserving and identifying) and the low number of specialists, they belong to the most neglected aquatic metazoans (e.g. Balsamo et al. 2008; Fonseca et al. 2011). Until now, little is known about their biology and, in particular, about their parasites or feeding (Bennett 1978;

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Table 1. Complete list of Gastrotricha with live Euglenida: **NE** – number of Euglenida per gastrotrich individual, **NGE** – number of Gastrotricha with Euglenida. Mouth ring diameter according to own measurements in italics, or non-italicized according to Kisielewski (1997).

Species	Mouth ring diameter (μm)	NE	NGE	Localization
Chaetonotus (Chaetonotus) disiunctus Greuter, 1917	6–8	2–14	28	Astatic eutrophic reservoir, Poland
Chaetonotus (Chaetonotus) poznaniensis Kisielewski, 1981	*3.7–3.8*	4–6	3	Artificial lake, Poland
Chaetonotus (Chaetonotus) sp. 1	*5.8–6.4*	1–5	4	Reservoir at a greenhouse, Poland
Chaetonotus (Chaetonotus) sp. 2	*3.8*	4	1	Artificial lake, Poland
Chaetonotus (Captochaetus) simrothi Voigt, 1909	*11.2–20.6*	?	11	Eutrophic reservoirs, fishponds, and water reservoirs in the alder woods, Poland; eutrophic reservoir, Brazil
Chaetonotus (Hystricochaetonotus) hystrix Mečnikow, 1865	4–5	8	3	Eutrophic reservoir and water reservoirs in the alder woods, Poland
Chaetonotus (Hystricochaetonotus) persetosus Zelinka, 1889	*4.5–4.7*	5–11	2	Artificial lake, Poland
Chaetonotus (Zonochaeta) sp.	*3.8*	2	1	Reservoirs at a greenhouse, Germany
Ichthydium sp.	*3.6*	1	1	
Heterolepidoderma majus Remane, 1927	*4.3–5.0*	1–4	3	
Lepidodermella sp.	*4.1–5.0*	1–9	15	

Kisielewski 1997; Strayer et al. 2010): The only identified parasites of Gastrotricha are Microsporidia that have been found in the intestine of two Macrodasyida marine species (Hummon et al. 1998; Manylov 1999). There are no reports on parasites of Chaetonotida and, until today, live protozoans have never been observed in a gastrotrich intestine. In this paper, we present the first observations of live Euglenida in freshwater gastrotrichs.

Material and Methods

The analyzed material comprised samples from Poland, Germany and Brazil. Samples from Poland were collected in different seasons of the year from an artificial lake, fishponds, eutrophic astatic ponds, ponds in alder forests, mud sedges, and reservoirs in palm houses. Samples from Germany were collected in winter from a palm house in Berlin. Samples from Brazil were collected from eutrophic ponds during different seasons.

The gastrotrichs were analyzed and determined intravitally according to Kisielewski (1981, 1991, 1997). Euglenida specimens found inside the intestine were determined intravitally and based on microphotography. Phase contrast was used for microscopic analysis.

Results and Discussion

Live Euglenida were found in 72 specimens of gastrotrichs (Chaetonotida), which were isolated from samples collected in Europe (Poland and Germany) and South America (Brazil). Four hundred and eighty-nine gastrotrichs were found in the analyzed material from Poland, 51 of which had live Euglenida inside the intestine. From Germany, 38 gastrotrichs were found in the material analyzed, 20 of which had Euglenida. Finally, 100 gastrotrichs were found in the material from Brazil, of which only one specimen had Euglenida in the intestine. Euglenida occurred in 10.4%, 52.6% and 1% of all specimens observed in Poland, Germany, and Brazil, respectively. The gastrotrichs with live Euglenida belonged to three genera: *Chaetonotus* Ehrenberg, 1830; *Ichthydium* Ehrenberg, 1830; and *Lepidodermella* Blake, 1933. In total, live euglenoids were noted in 11 species (Table 1) and their number inside the gastrotrich intestines ranged from 1 to 14. Euglenida were present in the intestine of young specimens as well as adult specimens with a developing egg. The greatest number of Euglenida was found in *Chaetonotus (Chaetonotus) disiunctus* Greuter, 1917 (Table 1). Microscopic observations of live gastrotrichs that the Euglenida were grouped in the anterior part of the intestine, directly at the pharyngeal intestinal junction. During these observations, while the state of the gastrotrich worsened, the Euglenida gradually moved towards the posterior part of the intestine, and once the gastrotrich died, some of them actively moved outside the body through the anal opening or a break in the body wall (Fig. 1).

The Euglenida observed belonged to the genus *Heteronema.* The body length of the specimens found inside the intestine of the gastrotrichs (as measured after the specimens had left the intestine) ranged from 13.4 μm to 31.4 μm and their body width ranged from 3.3 μm to 9.7 μm. Taking into account the width of the mouth ring of the gastrotrichs in which the Euglenida were found, only three species would be able to swallow a fully-developed, adult Euglenida