Not too big for its mouth: direct evidence of a macrodasyidan gastrotrich preyed in nature by a dileptid ciliate

M. A. Todaro & P. Luporini

To cite this article: M. A. Todaro & P. Luporini (2022) Not too big for its mouth: direct evidence of a macrodasyidan gastrotrich preyed in nature by a dileptid ciliate, The European Zoological Journal, 89:1, 785-790, DOI: 10.1080/24750263.2022.2095048

To link to this article: https://doi.org/10.1080/24750263.2022.2095048
Not too big for its mouth: direct evidence of a macrodasyidan gastrotrich preyed in nature by a dileptid ciliate

M. A. TODARO & P. LUPORINI

1Department of Life Sciences, University of Modena and Reggio, Modena, Italy, and 2Department of Biosciences, University of Camerino, Camerino, Italy

(Received 28 March 2022; accepted 22 June 2022)

Abstract

Nearly ubiquitous and usually speciose in most aquatic habitats, the meiofaunal-sized gastrotrichs are recognized as an important component of marine and freshwater ecosystems. The common observations that gastrotrichs feed on bacteria, microalgae and biodetrimitus strongly imply that they play a relevant role in linking the microbial loop to the higher trophic levels. Which are the organisms that in turn prey on gastrotrichs is, however, a substantially unexplored question. Inspecting meiofauna samples collected from shallow sites of the Tyrrhenian coast, we had the chance to spot a wild case of a macrodasyidan gastrotrich predated by a dileptid ciliate. This case is documented here with a set of in-vivo photos, jointly with an unequivocal taxonomic identification of the preayed gastrotrich with Paraturbanella teissieri and a tentative identification of the predator ciliate with Pseudomonilicaryon marinus.

Keywords: Benthos, Gastrotricha, Ciliophora, Meiofauna, Prey/Predator Interactions

Introduction

Gastrotrichs, commonly referred to as hairybellies or hairybacks, form a phylum of microscopic (0.05–3.0 mm in length), benthic invertebrates living in every aquatic ecosystem. Over 800 accepted species are traditionally subdivided between Macrotrasyida, distributed in marine and brackish waters, and Chaetonotida, colonizers of marine and freshwater waters (Todaro et al. 2019a, 2022; Kieneke & Todaro 2021). Although perversively distributed (Balsamo et al. 2014; Kieneke & Schmidt-Rhaesa 2015), it is probably in the marine sandy environment that gastrotrich communities thrive more abundantly and diversified (Leasi et al. 2018; Curini-Galletti et al. 2020). In the interstitial habitats, gastrotrichs may reach densities up to 10^5 individuals/m^2 and, in general, represent the meiofaunal taxon which is third in abundance only to nematodes and harpacticoid copepods (Hummon 1976). However, cases in which they rank first in numerical dominance appear to be all but rare (Coull et al. 1985; Hochberg 1999). An instructive example of the high species diversity that is intrinsic to marine gastrotrich communities is provided by the compendium of the Italian marine gastrotrichs (Todaro et al. 2001). Over a total of 256 locations sampled, it was calculated a mean of 8.5 species/location with peaks of 29 synchronous (littoral + sublittoral) and 25 sympatric (sublittoral) species counted in sites of the beach of Ischia Porto.

Considering the large interest that gastrotrichs are increasingly rising in reason of their abundance, morphological diversity, reproductive biology and phylogeny (Todaro & Rocha 2004; Todaro et al. 2012, 2019b; Hochberg et al. 2014; Martínez et al., 2019, 2020; Araujo & Hochberg 2021), it stands odd how little we known about their ecological role in marine ecosystems in particular. Essentially observing their gut lumen, usually filled with biodetrimitus, bacteria and microalgae, gastrotrichs have been proposed to constitute a link between the microbial loop and the higher trophic levels.
(Balsamo & Todaro 2002; Kieneke & Schmidt-Rhaesa 2015; Balsamo et al. 2020). This “link” hypothesis is here supported by a rare in vivo observation, related to a survey of meiofauna from the Tyrrhenian coast, that the consumer macroaspidyan gastrotrichs may in turn be a substantial food source for their ecological counterparts such as the predatory dileptid ciliates.

Material and methods

The material of this study was isolated from one of several samples of sandy-bottom surface collected, on June 3, 2009, from the sublittoral zone of Castiglione della Pescaia, Tuscany, Italy (42°45’ N; 10°51’ E). The samples were drawn by hand at a depth of about 0.5 m using 500-ml jars, which were placed in a thermostatic container and brought to the laboratory at the University of Modena and Reggio Emilia to be inspected on the next day for their gastrotrich community. Extraction was carried out by means of the narcotization/decantation technique using a 7% magnesium chloride solution as a narcotic (e.g., Todaro et al. 1992). The fauna-containing supernatant was successively poured directly into 5-cm in diameter Petri dishes and scanned under a Wild M8 dissecting microscope for gastrotrichs. Single specimens were thereafter picked out with a hand-held micropipette, mounted on glass slides, and observed in vivo with Nomarski differential interference contrast optics using a Nikon Eclise 90i microscope. Photomicrograph recording was conducted with a DS-Fi1 Nikon digital camera, and measurements were carried out with the Nikon NIS-F v 4.0 software.

Results and discussion

Previous surveys of gastrotrichs from the sublittoral zone of Castiglione della Pescaia have resulted in the identification of a total of 17 (12 macroaspidyan and 5 chaetonotid) species (Todaro et al. 2001). Three of them, namely Dactylopoda mesotyphle Hummon et al., 1998, Teranchytderma papii Gerlach, 1953, and Paraturbanella teissieri Swedmark, 1954, were found to be largely represented in the samples of this study, collected on June 3, 2009. Among all the specimens preliminarily recognized as P. teissieri, one was spotted to be not fully conformed with the behaviour and standard morphology of the taxon. A trained eye could not fail to notice a reduced motility and, in particular, a rather eccentric shape of the terminal body region. It looked tapered and roundish, instead of bilobed with each lobe provided medially of adhesive tubes as is the case in all species of Paraturbanella (Luporini et al. 1971; Dal Zotto et al. 2018; Todaro et al. 2019c).

To inspect more closely whether this eccentric behaviour and shape reflected some wounding, a case of intraspecific polymorphism, or even a new taxon (see the recent case of Chimaeradasys species; Kieneke & Todaro 2021), the odd specimen was mounted on a glass slide to be observed and photographed at increasing magnifications.

As shown in the set of pictures in Figure 1, the odd specimen soon appeared to be a P. teissieri individual trapped for most of the body extension inside a sort of pouch-like structure delimited by a thin, pliable and “hairy” surface. Only the anteriormost body region down to the protruding accessory adhesive organs appeared to be still free, most likely because these lateral organs represented a mechanical, “spiny” obstacle to a whole encapsulation.

After about 10 minutes of observations, the “hairy pouch” disclosed its nature of predatory organism by suddenly expelling out the no-longer motile, paralysed P. teissieri specimen (body size, 480 × 90 µm), which was observed to suffer a partial degeneration (digestion) of the adhesive tubes on the body rear, and to accommodate a not well-differentiated reproductive apparatus suggestive of a subadult stage.

Once get rid of the prey and re-acquired the proper (not deformed) cell body morphology, the predatory organism (dimensions, 530 × 60 µm) could promptly be identified with a raptorial dileptid ciliate, which was still fully capable of swimming back and forth propelled by the beating of cilia evenly distributed (in “holotrichous” fashion) all over the body surface. A long flexible proboscis of about 130 µm (extended circa one/third the body length) anterior to a large bulged cytostome and a sub-oval trunk tapering with a conic tail represented unequivocal dileptid-specific diagnostic traits.

Yet adequate for a taxonomic recognition with a dileptid ciliate, these traits were clearly insufficient for a solid identification at the species level. This identification would have required to be supported by detailed observations (barred by the practical and accidental availability of a single and largely threatened individual) on, at least, the nuclear apparatus and the patterns of the somatic and oral ciliature.

However, for a tentative identification at the species level, it came of help the exhaustive “Monograph of the Dileptids” by Vďačný and Foissner (2012), which lists and illustrates the 66 species and subspecies that are officially recognized as members of the family Dileptidae. The great majority of these species (representative of six genera) live exclusively in terrestrial/semi-terrestrial and freshwater biotopes. Only six,
namely Apotrichelius multinucleatus (Vďačný, Al-Rasheid & Foissner, 2012), Dileptus estuarinus (Dragesco 1960), Pseudonilicaryon marinum (Kahl, 1933) (possibly distinct between P. marinum marinum and P. marinum minimum), P. massutti (Kahl, 1933), Rimaleptus lacazei (Gourret & Roesser, 1886) and R. tirjakovae (Vďačný & Foissner, 2008), have been reported from brackish waters, the sea and/or saline
soil. Compared with these ecologically related species, the dileptid specimen here at issue came out to be more reliably identifiable with *P. marinum* (Kahl, 1933). First, it is equivalent to *P. marinum* in body dimensions and shape, and bears in common an unusual accumulation of dark granules at the tip of the proboscis. Second, *P. marinum* is the unique marine *Pseudomonilicaryon* species dwelling in European coastal sites, having been isolated from sandy sediments of the Kiel Bay in Germany (Kahl 1933; Bock 1952a, 1952b; Telesh et al. 2008), the mesopasammon of Roscoff in France (Dragesco 1960, 1963), the sublittoral of the Biscay Bay in Spain (Fernandez-Leborans & Novillo 1993), and the Divichinskij estuary in Russia (Agamaliev & Aliev 1983).

Future studies are required to confirm or disprove our identification. Beside the taxonomical issue, the presence of this type of protists along the Italian coastline assumes also faunistic and biogeographic relevance, especially considering the ample geographic distance from previous records of *P. marinus*, and also that no marine raptorial dileptid species phyllogenetically close to *Pseudomonilicaryon* (e.g. *Dileptus* and *Rimaleptus*) are listed in the most recent checklist of Italian marine and brackish Protozoa (Banchetti et al. 2008).

**Conclusions**

Gastrotrichs have been reported to be a food source for a variety of other benthic organisms (Glockling 1997; Balsamo et al. 2014; Kienke & Schmidt-Rhaesa 2015). However, observations accounting for a gastrotrich preyed in nature are mostly unvouchedered and anecdotal. The only reliable report of this predation comes from Bove and Cordell (1971), who finely described, under laboratory conditions, the engulfment and complete digestion of specimens of the freshwater species, *Chaetonotus vulgaris* Brunson, 1950, by the heliozoon *Actinophrys sol* Ehrenberg, 1830, also providing temporal details and nicely drawned drawings.

The case reported here of *P. teissieri* preyed by a dileptid ciliate provides the first documented evidence of a marine macrodasyidan gastrotrich eaten in nature by another organism, a ciliate protist.

Dileptids are well-known voracious predators on a wide spectrum of micro- and macroscopic invertebrates, including cnidarians (*Hydra*), turbellarians (*Planaria, Stenostomum*), rotifers (*Brachionus*), nematodes (*Cephalobus*), branchiobdellids (*Nais*), pond snails (*Physa*), and naupliar stages of copepods (Brown & Jenkins 1962; Fenichel 1996; Vďačný et al. 2011; Vďačný & Foissner 2012). Like other raptorial ciliates, such as *Didinium*, *Coleps*, *Homalozoon* and *Litonotus*, they harpoon and paralyze the prey by means of an array of cell cortex-anchored, membrane-bound ejectable organelles (Verni & Gualtieri 1997). These organelles, collectively designated as extrusomes (Rosati & Modeo 2003), are rich in lytic enzymes (in the first place, acid phosphatase) and noxious compounds (mostly derived from various biogenetic precursors of the primary metabolism) that have raised strong interest from an applied perspective for their cytotoxic activity on a variety of cell systems (Buonanno & Ortenzi 2018). The amazing capacity shown by *P. marinum* to paralyze and engulf *P. teissieri*, a sturdy prey with a large body size, provides further evidence of the remarkably powerful cytotoxic effects of dileptid extrusomes and stimulates research to elucidate the molecular basis of these effects.

**Acknowledgements**

We would like to dedicate this work to the late friend and colleague, Prof. Paolo Tongiorgi, with whom we shared fascination and research interest in little creatures, and warmly thank Prof. Peter Vďačný (University of Bratislava) for valuable advice on dileptid taxonomy. This study was partially supported by a grant ‘Far attrezzatura 2021’ to M.A.T. from the University of Modena e Reggio Emilia, Italy.

**Disclosure statement**

No potential conflict of interest was reported by the author(s).

**ORCID**

M. A. Todaro [http://orcid.org/0000-0002-6353-7281](http://orcid.org/0000-0002-6353-7281)

**References**


Balsamo M, Artios T, Smith JPS, Todaro MA, Guidi L, Leander BS, Van Steenkiste NWL. 2020. The curious and neglected soft-bodied meiofauna: Rouphoozoa (Gastrotricha and
Gastrotrichs prey for ciliates 789


