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Parasitology

**THE FOOD OF *BRANCHIOBELLA* ODIER, 1823 (ANNELIDA)
DWELLING ON CRAYFISH AND THE OCCURRENCE OF
THE FISH PARASITE *ARGULUS* MÜLLER, 1785
(CRUSTACEA) ON THE CARAPACE OF
PONTASTACUS LEPTODACTYLUS (ESCH.)**

**POKARM *BRANCHIOBELLA* ODIER, 1823 (ANNELIDA)
ZASIEDLAJĄCYCH RAKI ORAZ WYSTĘPOWANIE
ARGULUS MÜLLER, 1785 (CRUSTACEA), PASOŻYTA RYB
NA PANCERZU *PONTASTACUS LEPTODACTYLUS* (ESCH.)**

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Gut content of *Branchiobdella* spp. was examined in 83–945 individuals belonging to 4 species, collected from 31 individuals of *Astacus astacus* (L.) and 12 individuals of *Pontastacus leptodactylus* (Esch.) from north-western and southern Poland. The results show the food of *B. hexodonta* Gruber, 1883 dwelling in the crayfish gill cavity to include fragments of the crayfish gills, which identifies the species as a parasite. In contrast, *B. parasita* Henle, 1835, *B. kozarovi* Subchev, 1978 and *B. balcanica sketi* Karaman, 1967 are found on the external covers of the crayfish are not parasitic. They feed on diverse items derived from the ambient environment and are thus epibiontic. Cannibalism was observed in all the species examined. Neither cannibalism nor the presence of larvae-containing cocoons of *Argulus foliaceus* (L.) (Branchiura), a fish parasite, on the crayfish carapace has been recorded in the literature so far.

INTRODUCTION

Species belonging to the genus *Branchiobdella* Odier, 1823 have been most often classified as external parasites of freshwater crayfish (Boldt 1940; Moszyński and Moszyńska 1957; Wojtas 1964; Pop 1965; Schäperclaus 1979; and others). It was only

Nurminen (1966) who recorded *B. pentodonta* Whitman, 1882 as a crayfish epibiont. Subsequent biological studies and research involving ^{51}Cr marking, carried out by Grabda and Wierzbicka (1969) ruled out the parasitic mode of life in the case of *B. parasita* Henle, 1835 while demonstrating *B. hexodonta* Gruber, 1883 to be a crayfish parasite. Karaman (1970) in his description of the morphology of *B. balcanica balcanica* Moszyński, 1937, *B. italica* Canegallo, 1928, and *B. pentodonta* reported on their feeding on algae, protozoans, and insect larvae. Similar information regarding *B. kozarovi* Subchev, 1978 was provided by Boško (1983). However, those authors did not focus on details of feeding of the branchiobdells they were working on. Based on their observations on gut contents, Kahl and Wojtas (1974) suggested those *Branchiobdella* species dwelling in the crayfish gill cavity were parasitic, as opposed to those inhabiting external covers which can be classified among semi-parasites or commensals. In several recent publications (Nobile et al. 1994, 1995), some species including *B. parasita* and *B. pentodonta italica* are again listed as crayfish parasites.

The aim of this work was to analyse in detail the food of four *Branchiobdella* species present in or on Polish crayfish and to describe cocoons found on the external crayfish covers. The ecological aspects of the branchiobdells examined have already been discussed (Śmietana and Wierzbicka 1998). The present paper supplements the information on biology of the four *Branchiobdella* species.

MATERIAL AND METHODS

A total of 31 individuals of *Astacus astacus* (L.) and 12 individuals of *Pontastacus leptodactylus* (Esch.) were collected and examined within 13 August – 20 October 1997. The crayfish were collected in north-western Poland (Szczecin and Koszalin Districts) and in southern Poland (Opole, Rzeszów, and Lublin Districts) (Śmietana and Wierzbicka 1998). Upon delivery to the laboratory, the crayfish were kept in an aquarium or examined the following day.

The branchiobdells dwelling on the external covers of the crayfish were collected from live crustaceans, while those inhabiting the gill cavity and gills were picked out after the crustacean had been narcotised with Propiscin. The branchiobdells in permanent mounts were identified under the light microscope. A total of 83–945 individuals of different species were examined (Tab. 1). The crustacean cocoons found were scraped off from the carapace and fixed in 75% alcohol. The larvae, isolated from the membranes were examined under the microscope. The microphotographs were taken under the Nomarski contrast.

Table 1

Frequency of different food items in various *Branchiobdella* species

	Algae	Diatoms*	Rotifers	Planktonic crustaceans	Chironomidae (larvae)	Branchiobdella	Crayfish gills	Detritus
<i>B. hexodonta</i> n=116	1.7	0.9	0.9	0	0	0.9	6.9	42.2
<i>B. parasita</i> n=172	5.8	1.2	32.6	2.9	8.7	1.2	0	52.3
<i>B. kozarovi</i> n=945	18.1	5.0	5.4	2.1	0	1.8	0	68.6
<i>B. balcanica sketi</i> n=83	7.2	2.4	3.6	0	2.4	1.2	0	65.1

* due to easy identification of cells in the *Branchiobdella* gut content, diatoms were treated as a separate food item

RESULTS

The three *Branchiobdella* species encountered, i.e., *B. parasita* Henle, 1835; *B. Kozarovi* Subchev, 1978; and *B. balcanica sketi* Karaman, 1967 occurred mainly on the external covers of *Astacus astacus* and *Pontastacus leptodactylus*, the fourth species, *B. hexodonta* Gruber, 1883 occurring in the gill cavity of the crayfish.

The guts of all the branchiobdella species were found to contain, among large amounts of detritus (Tab. 1), the Conjugatophyceae algae (Fig. 1a, b), diatoms, and rotifers. Rotifers were most frequently recorded in *B. parasita* (32.6%) and *B. kozarovi* (5.4%), while the Conjugatophyceae occurred most frequently in *B. kozarovi* (18.1%) and *B. balcanica sketi* (7.2%), diatoms being most frequent (5.0%) in *B. kozarovi*. The maximum numbers of 25 and 12 rotifers were recorded in a single gut of adult *B. parasita* and *B. kozarovi*, respectively, the very small forms containing up to 2–8 rotifers. The Conjugatophyceae occurred at amounts ranging from single to numerous or very numerous filament fragments per gut, single diatom cells only being recorded. In addition, guts of *B. parasita* (8.7%) and *B. balcanica sketi* were observed to contain chironomid insect larvae (Fig. 2). The presence of single planktonic crustaceans (copepods and cladocerans) was recorded in *B. parasita* and *B. kozarovi*. All the *Branchiobdella* species examined revealed also incidents of cannibalism (0.9–1.8%) (Fig. 4). The branchiobdella individuals consumed had been digested to a varying degree or only the chitinous jaws were preserved in the gut. Single nematode larvae were found in the body cavity of two individuals and in the gut of one

B. kozarovi specimen (Fig. 3). In addition, the gut of the 1.1% of the latter species' individuals contained single oligochaetes of the genus *Hystericosoma* (Aelosomatidae).

The food of *B. hexodonta* was clearly different from that of *B. parasita*, *B. kozarovi*, and *B. balcanica sketi*. A single *B. hexodonta* individual was recorded to have consumed a rotifer, another individual had apparently ingested a single diatom cell, and two individuals had eaten fragments of filamentous algae (Tab. 1). Besides, particularly noteworthy is the finding of fragments of the crayfish gills in guts of 6.9% individuals of *B. hexodonta*.

The presence of crustacean cocoons was observed on the carapace of one out of the three *P. leptodactylus* individuals collected on 18 October from a pond in the village of Kiełpino near Szczecin. The pond was also inhabited by cyprinid fishes. The cocoons were found to contain larvae of *Argulus foliaceus* (L.) (Branchiura), an external parasite of various freshwater fish species. The larvae were at the second developmental stage (Fig. 5). The cocoons were brighter in colour than the crayfish carapace and were visible with naked eye as cylindrical swellings measuring about 10 mm in length and 2–3 mm in width.

DISCUSSION

Examination of gut contents of *B. parasita*, *B. kozarovi*, and *B. balcanica sketi* demonstrated the three species to ingest very diverse food items belonging to distant taxa. However, the food they ingested was very similar.

A comparison of our results on the food composition of *B. parasita* with data reported by Grabda and Wierzbicka (1969) shows the diet to be very similar in both studies. In addition, our study revealed fairly high amounts of rotifers and incidence of cannibalism, not recorded prior to our research. The gut content of *B. balcanica sketi*, in addition to algae and insect larvae recorded also by Karaman (1970), contained rotifers; a single case of cannibalism was recorded as well. According to Boško (1983), *B. kozarovi* feed on detritus, algae, and chironomid larvae. The materials we examined showed the food spectrum to be much wider; in addition to detritus and algae, we found also rotifers, planktonic crustaceans, and annelids of the genera *Hystericosoma* and *Branchiobdella*. The lack of chironomid larvae in the gut resulted most probably from the fact that one crayfish sample, with abundant *B. kozarovi*, spent a prolonged period of time in the aquarium. The presence of nematode larvae in the body cavity and gut of *B. kozarovi*, not recorded so far, is an additional evidence that the species obtains its food from the ambient medium.

On the other hand, the food of *B. hexodonta* was found to be clearly different from that of the remaining three *Branchiobdella* species and is similar to what was reported in some instances by Grabda and Wierzbicka (1969). The examined guts of the species showed the presence of a single individual of *B. hexodonta* (Fig. 4c), which points to cannibalism. In addition, 6.9% of the individuals contained fragments of crayfish gills. Neither cannibalism

a)

b)

Fig. 1. Conjugatophyceae algae in the gut of *Branchiobdella kozarovi* (a) and *B. parvasita* (b)

Fig. 2. Chironomid larvae in the gut of *Branchiobdella parasita*

Fig. 3. A nematode larva in *Branchiobdella kozarovi*

a)

b)

c)
 Fig. 4. Cannibalism in *Branchiobdella*: a) *B. kozarovi* in the gut of a conspecific; b) *B. parasita* in the gut of a conspecific; c) *B. hexodonta* in the gut of *B. hexodonta*

Fig. 5. An *Argulus foliaceus* larva (isolated from the cocoon)

nor feeding on the crayfish gills had been recorded in the earlier study by Grabda and Wierzbicka (1969).

In the light of the present study, classification for example *B. parasita* as a parasitic form (Nobile et al. 1994, 1995) is not justified. Similarly, the results reported by Grabda and Wierzbicka (1969) do not allow placing *B. parasita* among parasites.

Morphology of the *Argulus foliaceus* larvae II is identical with the description provided by Stammer (1959). Female *A. foliaceus* lay their eggs on submerged plants and other objects. Batches of 2–250 eggs are surrounded by mucous cocoons. According to Stammer (1959), the postembryonic development involves 9 larval stages developing within egg membranes. The larvae attack fish immediately after hatching. Egg laying in cocoons on crayfish carapaces is a new, interesting finding on the use of external crayfish covers as a substrate for *A. foliaceus* larval development.

CONCLUSIONS

1. *B. hexodonta* dwelling in the crayfish gill cavity feeds, i.e., on the crayfish gills, hence can be classified as the crayfish parasite.
2. *B. parasita*, *B. kozarovi*, and *B. balcanica sketi* settle on the external crayfish covers and are not parasitic. They feed on items obtained from the ambient environment and function as epibionts.
3. The presence of cocoons containing larvae of *Argulus foliaceus*, a fish parasite, on the crayfish carapace has not been recorded in the literature so far.

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POKARM *BRANCHIOBELLA* ODIER, 1823 (ANNELIDA) ZASIEDLAJĄCYCH RAKI
ORAZ WYSTĘPOWANIE *ARGULUS MÜLLER*, 1785 (CRUSTACEA) PASOŻYTA RYB
NA PANCERZU *PONTASTACUS LEPTODACTYLUS* (ESCH.)

STRESZCZENIE

Badania pokarmu czterech gatunków *Branchiobdella* przeprowadzono na materiale (83–945 osobników poszczególnych gatunków) zebranych z 31 osobników *Astacus astacus* i 12 *Pontastacus leptodactylus* z północno-zachodniej i południowej Polski. Uzyskane wyniki wskazują, że *B. hexodontia* Gruber, 1883 bytujące w jamie skrzelowej odżywiają się, między innymi, fragmentami skrzeli skorupiaka, a tym samym są jego pasożytami. Gatunki *B. parasita* Henle, 1835, *B. kozarovi* Subchev, 1978 i *B. balcanica sketi* Karaman, 1967 zasiedlają zewnętrzne powłoki raka i nie prowadzą pasożytniczego trybu życia. Odżywiają się one zróżnicowanym pokarmem pochodzącym ze środowiska zewnętrznego i są jedynie epibiontami. U wszystkich badanych gatunków stwierdzono przypadki kanibalizmu. Zjawisko to oraz występowanie kokonów z larwami *Argulus foliaceus* (L.) (Branchiura), pasożyta ryb, na pancerzu raka nie były notowane w piśmiennictwie.

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