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Detrimental effect of peritrich ciliates (*Epistylis* sp.) as epibionts on the survival of the copepod *Acartia bifilosa*

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Abstract. Widespread epibiontic relationship is best known as a commensal relationship, but several studies have shown also harmful influences on hosts by epibionts. A laboratory experiment was carried out to investigate the effect of peritrich ciliates (*Epistylis* sp.) as epibionts on the survival of *Acartia bifilosa* (Copepoda). Copepods were collected from the Gulf of Riga and the trial was made in seawater taken from the same location as the zooplankton samples. Adult copepods were divided into four groups by sex and by infection with epibionts. Results of the trial suggest that animals infested with epibionts were less viable than the uninfested ones. This pattern was significant in the case of females, but not males. Comparison of performance by sexes showed that the survival rate was significantly higher among females than males. The results further suggest that epibiontic protozoans may also influence egg production of copepods, because of shorter life span of females, and therefore may play a substantial role in copepod production and community dynamics.

Key words: *Acartia bifilosa*, epibionts, survival rate.

INTRODUCTION

Epibiosis is a widespread relationship in aquatic environments often involving planktonic microcrustaceans as hosts and a variety of organisms as epibionts, including bacteria, algae, protozoans, or even small metazoans (e.g., Ho & Perkins, 1985; Fernandez-Leborans, 2004). Generally, epibiosis has been viewed as a commensal relationship. However, several studies have shown that epibionts affect their hosts in different ways. They influence feeding due to competition with the hosts (Kankaala & Eloranta, 1987), decrease reproduction (Willey et al., 1990; Threlkeld & Willey, 1993; Weissman et al., 1993), and increase susceptibility to predation, because swimming as well as escape movements are limited (Willey et al., 1990; Chiavelli et al., 1993; Weissman et al., 1993). The last two behavioural

traits influence copepod abundance and therefore affect the prey field of planktivorous fish. Previous studies have verified host preference among epibionts in some cases (Green & Shiel, 2000; Gilbert & Schröder, 2003). In addition, epibionts often occur on planktonic crustaceans under eutrophic conditions, but no associations have been proven between epibiont prevalence on zooplankton and water quality (Manca et al., 1996).

Ciliate epibionts that infest planktonic crustaceans (Fernandez-Leborans & Tato-Porto, 2000) have also been found in the Baltic Sea (Hirche, 1974; Wiktor & Krajewska-Sołtys, 1994). These studies describe temporal distribution of epibionts without any specific further research. A similar investigation was carried out by Utz & Coats (2005) where spatial and temporal patterns of epibiont distribution on copepod populations were studied. However, studies on the impact of epibionts on the survival of the hosts are very scarce (Kankaala & Eloranta, 1987; Xu & Burns, 1991) and there are no relevant studies in the NE part of the Baltic Sea.

The current paper partly aims to fulfill this gap of knowledge by studying the influence of peritrich ciliates as epibionts on mesozooplankton in the Gulf of Riga. In the present study the effect of peritrich ciliates, *Epistylis* sp., was experimentally studied on the survival of adult females and males of the copepod *Acartia bifilosa*. This species was chosen as an object of investigation because it is one of the two dominant copepods in the study area (Line & Sidrevics, 1995).

MATERIAL AND METHODS

The experiment was carried out in July 2004. Copepods for the experiment were collected from Pärnu Bay (NE Gulf of Riga) at station K5 (Fig. 1) by vertical hauls through the whole water column with a Juday net (mouth surface area 0.1 m^2, mesh size 90 μm). Animals used in the experiment were kept in surface water from the sampling station and taken to the laboratory within 1 h.

Only adult stages of *A. bifilosa* males and females were carefully separated from other plankton and detrital material. They were placed into water taken from the sampling station and pre-filtered through a 50-μm mesh net. The animals were used in the experiment within 24 h. Males and females of *A. bifilosa* with epibionts were placed into culture plates, each single individual separately in 0.5 mL of filtered seawater. The same procedure was done with uninfested individuals who did not bear epibionts on their body. The temperature during the 6-day trial was 21 ± 1 °C and the experiment was performed in natural light conditions. The water was not changed during the experiment. Animals were checked every 12 h (8 a.m. and 8 p.m.) and counted for the dead and live individuals for the survival times. The animals were considered dead when they showed no signs of movement. Altogether 242 *A. bifilosa* adult specimens were used in the experiment, which were divided into four groups: males and females with and without epibionts, respectively.

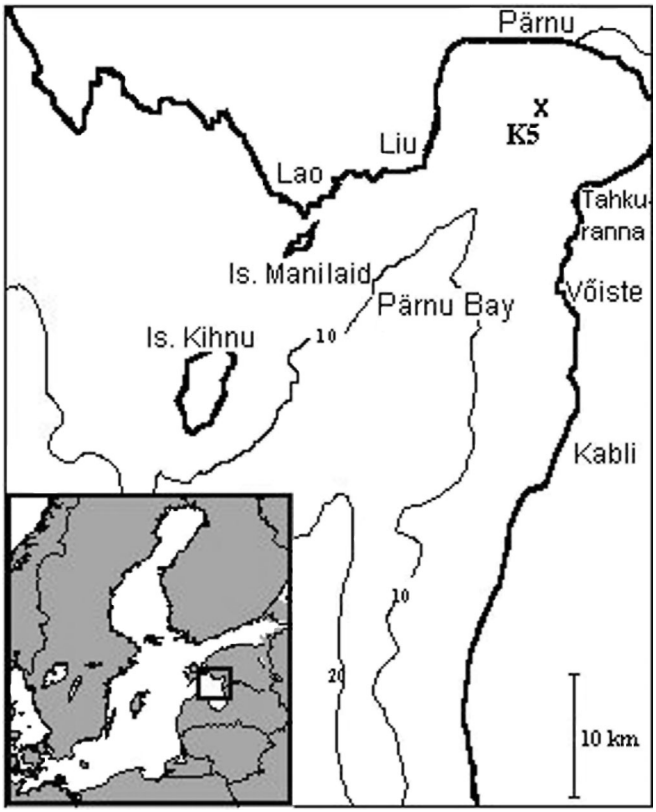

Fig. 1. Location of the sampling station (K5) in Pärnu Bay, NE Gulf of Riga.

After the experiment, *A. bifilosa* mortality percentage was found in the six-day period, which was in turn divided into 12-h periods. In addition average survival times and descriptive statistics (standard error and 95% confidence interval) were calculated. ANOVA Single Factor analysis was done with Statistica 6.1 (Statsoft) to prove the effect of epibionts on *A. bifilosa* specimens.

RESULTS AND DISCUSSION

The experiment showed higher survival among females compared to males (ANOVA: $F = 35.89$, $p < 0.05$). Further, uninfested and infested females had significant differences in their mortality as individuals carrying *Epistylis* sp. died considerably earlier (ANOVA: $F = 9.22$, $p < 0.05$). In contrast to females, the mortality for uninfested and infested males did not exhibit any significant differences (ANOVA: $F = 0.87$, $p > 0.05$). For the males, the most profound difference occurred after 24 h from the beginning of the experiment, but no general dissimilarity was found like with the females (Fig. 2, Table 1).

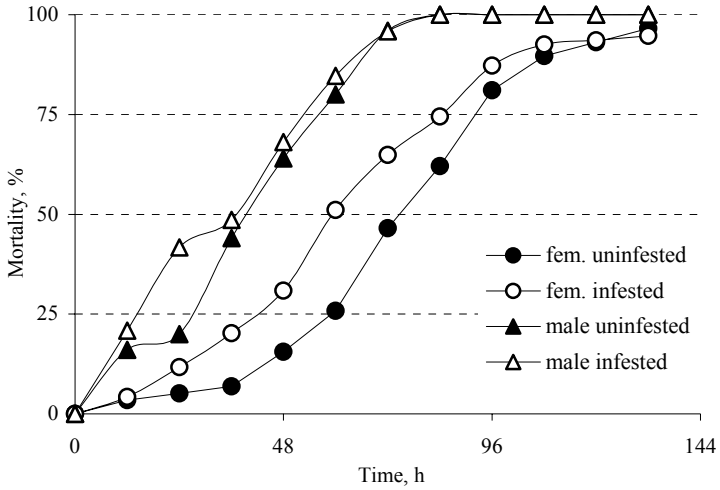

Fig. 2. Mortality of *Acartia bifilosa* during the experiment.

Table 1. Descriptive statistics for average survival of *Acartia bifilosa* with standard error (SE) and confidence intervals (CI) in the experiment

Acartia individuals	Survival, h	Count of animals	SE	CI
Males uninfested	45.6	25	4.2	8.3
Males infested with epibiont	40.8	72	2.6	5.2
Females uninfested	78.6	56	3.5	6.9
Females infested with epibiont	64.7	89	2.9	5.7

Despite the limited effect of epibionts on male survival, the prevalence of epibionts has harmful effects on the animals even if it is not a direct action like with parasitic protozoans, but influences host indirectly. Hindering host's movements and competing for food (Kankaala & Eloranta, 1987) epibionts definitely shorten the life span of their host. These are probably the most influencing factors why the survival was lower among animals bearing epibionts in this experiment. It is likely that animals infested with epibionts are much more visible to predators and therefore easier to capture (Chiavelli et al., 1993).

In this study the examined *A. bifilosa* specimens were colonized by *Epistylis* sp. However, different epibionts can be found on copepods and it is likely that they might influence the survival of their hosts differently than *Epistylis* sp. as found in the current study. *Vorticella* spp. and *Zoothamnium* spp. have been found on copepods in the Gulf of Gdansk (Wiktor & Krajewska-Sołtys, 1994) and from brackish water bays in the USA (Utz & Coats, 2005). In the SW part of the Baltic Sea also *Myoschiston centropagidarum* Precht was found (Hirche, 1974).

The epibiont prevalence has generally been observed at the time when the host species are very abundant and dominate in plankton communities (e.g., Hirche, 1974; Chiavelli et al., 1993). The same is valid for the current study: during the sampling time *A. bifilosa* was the dominating copepod in the NE Gulf of Riga. However, the dominating copepod in spring and early summer in this region is *Eurytemora affinis* (Simm & Ojaveer, 2000; Kotta et al., 2004). Because earlier studies indicate that different epibionts show different preference for various hosts (Green & Shiel, 2000; Gilbert & Schröder, 2003; Utz & Coats, 2005), studies with *E. affinis* would be essentially needed with the following two primary questions: (1) does *E. affinis* have different epibionts on its body than *A. bifilosa*, and (2) what are the sex-specific survival rates? This is also very important from the food-web and fisheries perspective as nauplii of *E. affinis* are the first and primary prey for fish larvae in this region – one of the most important fish spawning and young fish nursery areas in the NE Baltic Sea (Simm & Ojaveer, 2000; Kotta et al., 2004).

In general, *A. bifilosa* individuals die rather quickly and due to this fact, prolonged experiments are difficult to carry out with them. While epibiontic protozoans are mostly sessile, they may be occasionally free-swimming (Manca et al., 1996). Therefore, in the longer-lasting experiments, the count of the infested animals may actually increase because of being potentially infested by the free-swimming forms.

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Aerjalalise *Acartia bifilosa* isenditel esinevate ripsloomadest epibiontide (*Epistylis* sp.) kahjustav mõju

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Epibiontne suhe on enamasti tuntud kommensaalse suhtena, kuid mitmed uuringud näitavad ka epibiontide kahjustavat mõju peremeesorganismile. On läbi viidud laboratoorne eksperiment, uurimaks ripsloomadest epibiontide (*Epistylis* sp.) mõju *Acartia bifilosa* (Copepoda) ellujäämusele. Aerjalalised on kogutud Liivi lahest ja katse on läbi viidud merevees, mis on võetud samast kohast koos zooplanktoniproovidega. Täiskasvanud *A. bifilosa* isendid on jaotatud sooliselt ja epibiontidega nakatumise järgi nelja gruppi. Katse tulemused näitavad, et epibionte kandvad loomad on vähem elujõulised kui terved isendid ja erinevus on oluline emaste, kuid mitte isaste puhul. Sugudevahelisel võrdlusel on selgunud, et ellujäämus on märgatavalt suurem emaste hulgas. Epibiontsed algloomad võivad mõjutada ka aerjalaliste munade produktsiooni, kuna emaste lühem eluiga on aerjalaliste produktsioonis ja dünaamikas oluline.