

Report of epibiotic suctorian ciliate *Acineta karamani* on calanoid copepod from the southeastern Arabian Sea

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Abstract

Acineta karamani, a suctorian ciliate, previously known from the freshwater shrimp in Yugoslavia and southwestern Bay of Bengal was discovered in shelf waters off Kochi, Southeastern Arabian Sea. The report briefs the observation of epibiotic suctoria on calanoid copepod *Labidocera acuta*. The ciliate was represented by its feeding trophont stage and infested the dorsal posterior cephalothorax of the host at a rate of ~ 1–13 numbers per host. The report expands the geographical distribution of the suctoria to the southeastern Arabian Sea.

Introduction

Copepod, the most abundant metazoan in the aquatic ecosystem with a key position in the food web, forms a pivotal component of the marine environment. They play an important role in the aquatic food chain by serving as a food source for larvae of potentially important fishes, forming a link between primary producers and higher trophic levels (Bhandare and Ingole 2008). Comprising more than 90% of the planktonic community, copepods, like other planktonic crustaceans, form an ideal habitat for a plethora of sessile organisms such as bacteria, diatoms, ciliates, dinoflagellates and other protozoans by providing its exoskeleton (carapace) for attachment (Ho and Perkins 1985; Carman and Dobbs 1997). This phenomenon of adhesion is referred to as epibiosis, wherein the host (basibiont) and the epibiont are in facultative association. Epibiont includes organisms that, during the sessile stage of their life, are attached to a living substratum and the basibiont lodges and forms a support for the epibiont (Wahl 1989). However, both counterparts have advantages and disadvantages. The basibiont usually encounters disadvantages such as reduced growth, fecundity and survival, delayed molting, increased mortality, perturbation of locomotion, increased susceptibility to predation, environmental stress and diseases and faster sinking rate (Chatton 1920; Albaina and Irigoien 2006; Skovgaard et al. 2012). On the other hand, the epibionts are benefited mainly by exploiting new surfaces and environments rich in nutrients and oxygen and avoiding predation pressure (Wahl 1989; Fernandez-Leborans 2010). Ecologically, the presence or absence of certain epibiont-basibiont interactions can act as indicator of pollution in a water body (Henebry and Ridgeway 1979).

Epibiosis between ciliated protozoan and crustaceans is widely reported and occurs across most crustacean orders. Ciliates have numerous advantages in evaluating marine environments and can be used as an ideal tool for assessing water quality and the health status of aquatic ecosystems because of their rapid response to environmental conditions (Feng et al. 2015; Jiang et al. 2013; Xu et al. 2009, 2016). Ciliated protozoans mainly belonging to Suctorea, Hymenostomatia, Peritrichia, Chonotrichia, Apostomatia and Spirotrichia (Fernandez-Leborans and Tato-Porto 2000a, b; Lynn 2008; Fernandez-Leborans 2009; Dovgal 2013; Chatterjee et al. 2013; Chatterjee et al. 2019) are the common epibionts of crustaceans. Suctorians form a special group of ciliated protozoans, and these stalked ciliates are documented as epibionts on various freshwater and marine crustacean zooplankton (Fernandez-Leborans and Tato-Porto 2000; Cabral et al. 2010). They tend to establish an association with a wide range of hosts and substrata, most of which are commensals of various water invertebrates and

vertebrates. These stalked ciliates mainly have two distinct life stages, an attached trophont stage for feeding and a free-swimming telotroch stage for dispersal (Gilbert and Shröder 2003). Although several studies point towards the feeding, reproduction and life cycle of the ciliates, quantitative information about the distribution and trophic impacts of these as epibionts remain scarce. The study of ciliates as epibionts in Indian waters began in the 1980s and has since then made its way into the scientific world (Santhakumari 1985, 1986b; Chatterjee et al. 2013, 2019; Padmakumar et al. 2015; Purushothaman et al. 2020)

In recent years, there has been a noticeable increase in reports of new animal groups and species involved in epibiosis, and the majority of this kind of association is from crustacean taxa. This can be attributed to the fact that epibiotic relationships are significant at many levels, including ecological, evolutionary, biodiversity and conservation. The present study signifies the presence of *Acineta karamani*, a suctorian ciliate, epibiotic on calanoid copepod *Labidocera acuta* reported for the first time along off Kochi, southeastern Arabian Sea.

Materials And Methods

Sampling was carried out along the southeastern Arabian Sea onboard FORV *Sagar Sampada* during the southwest monsoon (July 2017) as a part of the Marine Living Resources Programme (MLR Programme) for the plankton biodiversity study. The sampling was conducted along five transects, viz, off Thiruvananthapuram, off Kochi, off Calicut, off Mangalore and off Goa, including 27 stations (Fig. 1) at coastal, shelf and offshore stations. Zooplankton samples were collected from all the stations at different depths by the horizontal hauling of bongo net (200µm) from the surface waters. The samples collected were preserved in 5% formalin and carried to the laboratory for further examination. The samples were first sorted into group levels for initial identification. All the sorted samples were then screened for epibiotic associations using a stereomicroscope. Only one station, Station 11 (off Kochi-Latitude: 9°54.438' N, Longitude: 75°35.575' E), observed the presence of ciliate epibiont on the copepod host. Copepods with epibiotic associations were separated into a different vials using a pasture pipette for further examination. Microscopic analysis of the host and epibiont was done by Leica DM2000 phase contrast microscope. The identification and systematic position of the attached ciliates were done using standard keys (Dovgal 2002b, 2013; Curds 1985). Epibiotic ciliates on copepods were measured and photographed using with Leica Application Suite Version 3.8 (LAS V3.8) scan camera. The host copepods were identified into the species level based on Razouls et al. (2005–2022).

Results And Discussion

The analysis of copepod specimens from the southeastern Arabian sea revealed the presence of epibiotic suctorian ciliate *Acineta karamani* Hadži 1940 from the shelf waters (~ 273m depth) off Kochi on the copepod.

Systematics (Dovgal 2002b)

Phylum: Ciliophora Doflein 1901

Subphylum: Intramacronucleata Lynn 1996

Class: Suctora Claparede & Lachmann 1859

Subclass: Endogenia Collin 1912

Order: Acinetida Raabe 1964

Family: Acinetidae Ehrenberg 1838

Genus: *Acineta* Ehrenberg 1834

Species: *Acineta karamani* Hadži 1940

Acineta karamani was first described by Hadži (1940) from freshwater shrimp *Atyaephyra desmaresti* in Yugoslavia. The family Acinetidae usually has a laterally flattened, trapezium-like, triangular or disc-like body with tentacles arranged on the actinophores in two or three fascicles or rows. The presence of stalks and all types of lorica is characteristic of this family. The species is a common commensal of marine and freshwater invertebrates and plants (Dovgal 2002b)

In the present study, zooplankton samples collected from the off Kochi station observed dominance of copepods (83%) followed by zooplankton groups such as cladocera, decapod larvae, chaetognatha, tunicate, pteropod, etc. Microscopic analysis of ~ 19376 copepods showed seven copepods attached with suctorian ciliate *Acineta karamani* on their exoskeleton. All the host species were identified to be male calanoid copepod, *Labidocera acuta* Dana 1849 (order: Calanoida; Family: Pontellidae). The infestation rate ranged from 1–13 ciliates per basibiont, with the epibionts occupying mainly the urosome and the posterior dorsal cephalothoracic surface.

Genus and Species Diagnosis (Fig. 2–3): The ciliate was represented by its trophont stage and was characterised by the presence of lorica, stalk, and capitata tentacles in two rows located from two lobe-like actinophores. The ciliate has a cylindrical laterally flattened body and was attached to the host exoskeleton with a thick and broad stalk. The anterior end of the body possesses two actinophores that do not protrude excessively (characteristic of the genus), bearing two rows of capitata tentacles. A spherical macronucleus is present in the anterior half of the body with numerous micronucleus surrounded (Curds 1985; Dovgal 2002b; Sahu et al. 2017).

Body measurements of *Acineta karamani* from the present study (based on five specimens): Body length- 130.47-171.45µm; stalk length- 48.153–54.54µm; Body width- 48.417–60.601µm; tentacle length- 29.636–34.997µm. The measurements are in accordance with Curds (1985) and Sahu et al. (2017).

Ciliates of Genus *Acineta* are common marine epibionts, inhabiting the body surface of different marine crustaceans. In India, epibiont ciliates from the western Indian coast were studied by many authors, for

example, Santhakumari (1985, 1986a, b), Chatterjee (1996), Dovgal et al. (2008, 2009), Chatterjee et al. (2013, 2019b, c, 2020c, d, e) and the references therein. The distribution of the genus *Acineta* in Indian waters is rarely interpreted. The species of *Acineta* epibiotic on crustaceans documented in our waters are *Acineta* sp. (Jayasree et al. 2001), *A. euchaeta*, *A. sajirae* (Santhakumari 1985; Chatterjee et al. 2021), *A. truncata*, *A. tuberosa* (Chatterjee et al. 2013), *A. foetida* (Chatterjee et al. 2019c)d *karamani* (Sahu et al. 2017). All these ciliates have been observed as epibiotic on different marine crustaceans, mainly copepods. Major host species includes, *Euchaeta marina*, *E. wolfendeni* (= *E. indica*), *E. concinna*, *Labidocera acuta*, *Calanopia eliptica*, *Eucalanus* sp for *A. euchaeta* (Santhakumari 1985; Chatterjee et al. 2021), *C. eliptica*, *E. wolfendeni* (= *E. indica*), *E. marina*, *L. acuta* for *A. sajirae* (Santhakumari 1985), *Labidocera acuta*, *Acrocalanus gracilis*, *Macrobrachium rosenbergi*, *Metapenaeus dobsoni* for *Acineta* (Vijayalakshmi et al. 2016; Mohanty et al. 2019; Jayasree et al. 2001), Harpacticoid copepod for *A. truncata* and *A. tuberosa* (Chatterjee et al. 2013), ostracod *Cypridina dentata* for *A. foetida* (Chatterjee et al. 2019c)d *acuta* for *A. karamani* (Sahu et al. 2017).

According to Guilcher (1951), the degree of host specificity is much greater in suctorians, which attach to living substrata. Suctorians have a strong tendency for commensalism, and most of them exist as ecto-commensals. Many copepod host species, such as *E. marina*, *C. eliptica*, *L. acuta*, *E. wolfendeni*, etc. (from previous literatures, Table 1), demonstrate the non-species-specific nature of the genus *Acineta*. However, it is quite recommendable from the previous literature that most of the host species for *Acineta* belong to the order Calanoida (with a few exceptions of harpacticoid copepod, ostracod and decapod), but do not show specificity to any calanoid genus or species, which is consistent with our present report. Apart from this, the presence of *A. karamani* on the same host copepod *Labidocera acuta* similar to that reported by Sahu et al. (2017), and since there are no records of other host species, confirms for this calanoid copepod species to be specific to the ciliate. However, there is a paucity of knowledge of the ciliate distribution and its effect on the host species in Indian waters. Crustaceans potentially harbour a variety of associates on their exoskeleton. Investigations on whole communities of species associated with crustaceans can represent an exceptional model to examine diversity patterns from a wide range of geographical regions. Researches examining crustacean epibionts are scarce, and a lot more investigations of these communities are required to understand the basibiont-epibiont interaction, physical and biological factors related to the establishment of epibiosis in the marine ecosystem.

Table 1
Summary of planktonic crustacean hosts of genus *Acineta* from Indian waters

Epibiont (Genus <i>Acineta</i>)	Basibiont (host)	Location	Reference
<i>Acineta euchaetae</i>	<i>Euchaeta marina</i> , <i>E. wolfendeni</i>	Off Ratnagiri,	Santhakumari, 1985
	<i>E. marina</i> , <i>Labidocera acuta</i> , <i>E. concinna</i>	off Karwar	Chatterjee et al. 2021
	<i>Calanopia eliptica</i> , <i>Eucalanus sp.</i> , <i>E. marina</i> , <i>L. acuta</i>	Off Cape Comorin	
	<i>Calanopia eliptica</i> , <i>Centropages remicornis</i>	Off Tuticorin	
	<i>Euchaeta marina</i>	Arabian Sea	
<i>Acineta sajirae</i>	<i>Calanopia eliptica</i> , <i>E. wolfendeni</i> , <i>E. marina</i>	Off Ratnagiri	Santhakumari, 1985
	<i>Labidocera acuta</i> , <i>E. marina</i>	Off Karwar	
<i>Acineta</i> Ehrenberg, 1834	<i>Macrobrachium rosenbergi</i> , <i>Metapenaeus dobsoni</i>	Gosthani estuary	Jayasree et al. 2001
	<i>Labidocera acuta</i>	Coastal waters of Tamil Nadu	Vijayalakshmi et al. 2016
	<i>Acrocalanus gracilis</i>	Kalpakkam, southeast coast of India	Mohanty et al., 2019
<i>Acineta truncata</i> Collin, 1909	Harpacticoid copepod	Dona Paula, Goa	Chatterjee et al. 2013
<i>A. tuberosa</i> Ehrenberg, 1834	Harpacticoid copepod	Dona Paula, Goa	Chatterjee et al. 2013
<i>Acineta foetida</i> Maupas, 1881	<i>Cypridina dentata</i>	Arabian Sea	Chatterjee et al. 2019
<i>Acineta karamani</i> Hadži 1940	<i>Labidocera acuta</i>	Southwestern Bay of Bengal Off Kochi, SEAS	Sahu et al. 2017 Present Study

Conclusion

The report summarises the observation of epibiotic suctorian ciliate *A. karamani* on the male calanoid copepod *L. acuta* from the southeastern Arabian Sea. The ciliate is host specific to the copepod, and a high mass of ciliate may affect the copepod population, thereby interfering in the marine food chain. Hence, more sophisticated examinations are imperative to understand the role of protozoan suctorians in

the marine ecosystem. Studies on species composition, abundance and life history of epibionts are necessary to understand the seasonal occurrences of epibiosis, host-epibiont population dynamics and substrate specificity.

Declarations

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Ethics approval: No animal testing was performed during this study

Availability of data and material: The manuscript has no associated data

Code availability: Not applicable

Authors' contributions: **AP** wrote the manuscript with input from **KBP**. **AP** conducted the field study. **AP** and **KBP** contributed to the taxonomic identification. **KBP** supervised this study and provided research materials.

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Figures

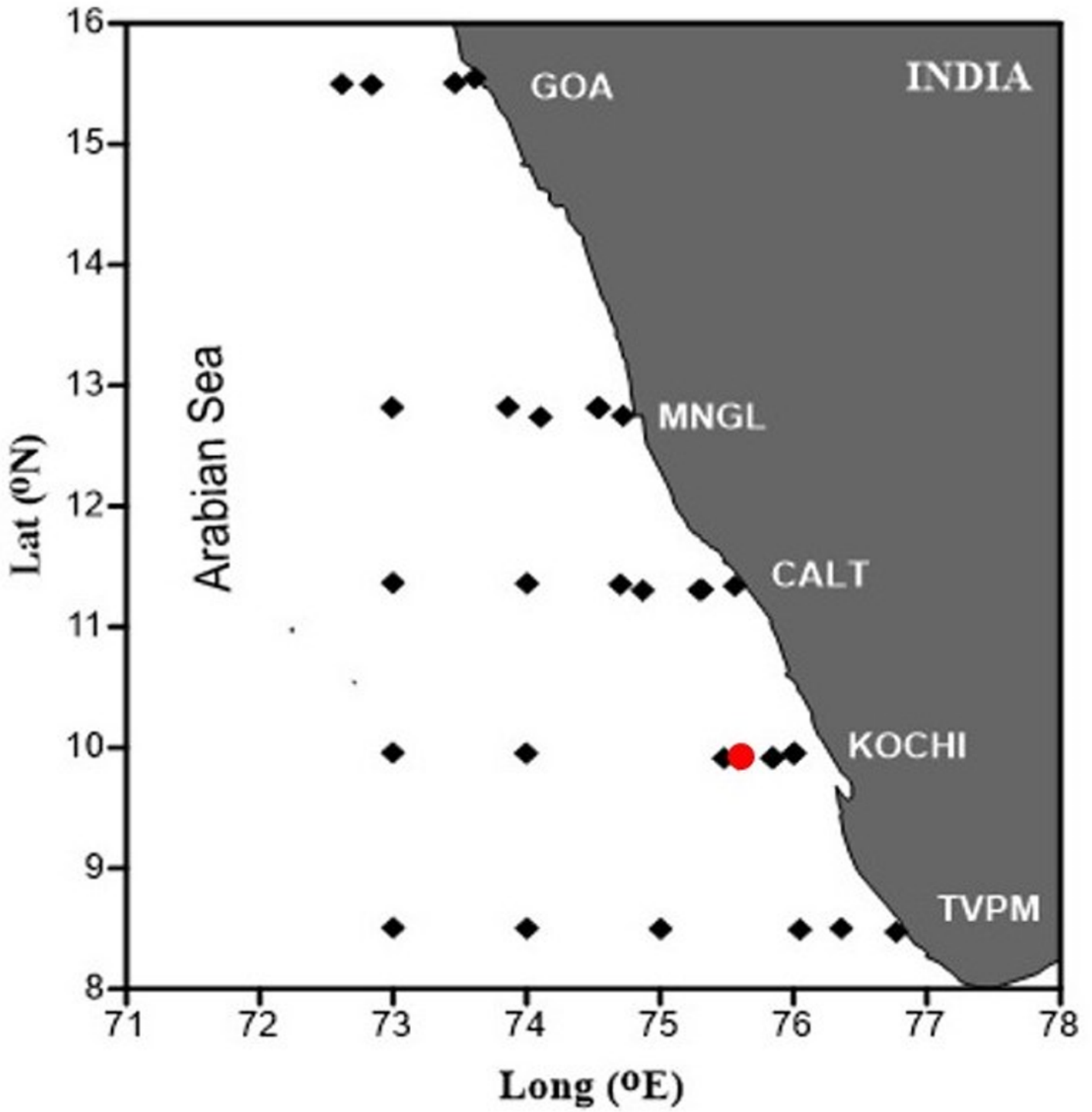


Figure 1

Study area. Red dot indicates the respective station where ciliate-copepod association was observed

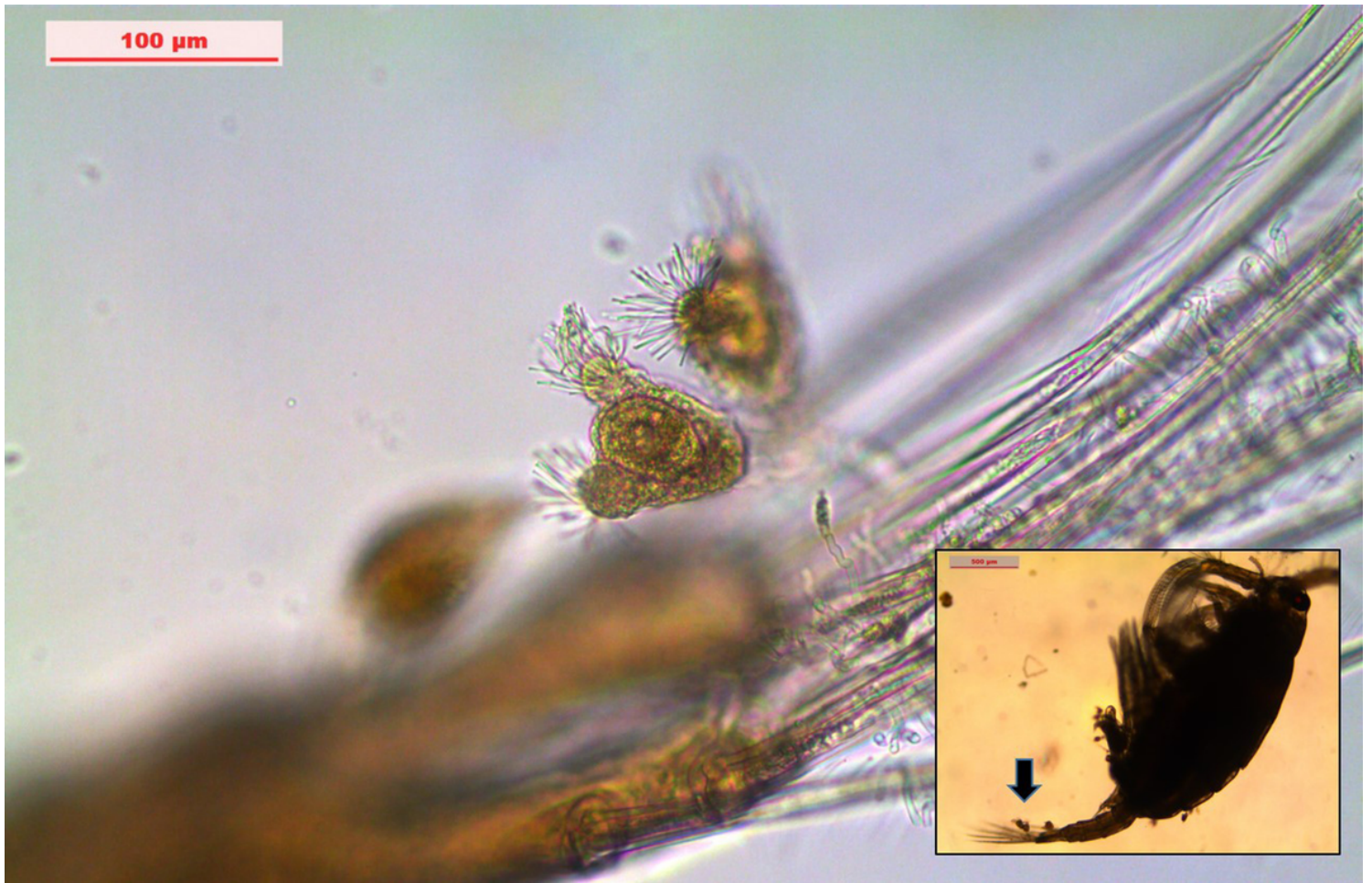


Figure 2

Suctorina *Acineta karamani* on the urosome of copepod *Labidocera acuta* (Inset: Copepod *Labidocera acuta*)



Figure 3

Enlarged image of *Acineta karamani*