

Report of epibiont ciliates on benthic seed shrimps (Crustacea: Ostracoda) from subtidal Mumbai coast of India (Arabian Sea) with addendum to the checklist of ciliates inhabiting ostracods

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Abstract:

This article deals with the report of two ciliate species i.e., *Cothurnia* cf. *recurva* Claparède & Lachmann, 1859 and *Acineta poculum* Hertwig, 1876 as epibionts on ostracods from the subtidal zone of Mumbai, west coast of India, Arabian Sea (Indian Ocean). *Acineta poculum* is reported here first time from the Indian Ocean. Both species are reported here first time as epibiont on ostracods. Further, additional information is provided in the checklist of ciliate epibionts of ostracods.

Résumé: Cet article traite du rapport de deux espèces de ciliés à savoir. *Cothurnia* cf. *recurva* Claparède & Lachmann, 1859 et *Acineta poculum* Hertwig, 1876 comme épibiontes sur des ostracodes de la zone subtidale de Mumbai, côte ouest de l'Inde, mer d'Arabie (océan Indien). *Acineta poculum* est signalé ici pour la première fois dans l'océan Indien. Les deux espèces sont signalées ici pour la première fois comme épibiontes sur des ostracodes. De plus, des informations supplémentaires sont fournies dans la liste de contrôle des épibiontes ciliés des ostracodes.

Key words: ciliate epibiont • ostracod basibiont • marine • India • new records

Introduction

The presence of a chitinous bivalved carapace, enclosing the crustacean body entirely is the characteristic feature of ostracodes; the surface of the carapace may be pitted, punctate, wrinkled, or have a reticulate surface (Smith & Delorme, 2010), which provides a comfortable substrate for ciliate epibionts. Several ciliate species have been reported as epibionts on marine and freshwater ostracods (e.g., Matthes, 1990; Claps & Sampóns, 1994; Griffiths & Evans, 1994; Schödel, 2004; Karan-Žnidaršič et al., 2006; Chatterjee et al., 2019). A checklist of ciliate epibionts on fresh and marine water ostracods was given by Chatterjee et al. (2020).

Suctorian species, *Lecanophryella satyanandani* (Santhakumari, 1986) and *Paracineta karunakarani* Santhakumari, 1986 were reported on marine pelagic ostracod *Cypridina dentata* (Müller, 1906) from the Arabian Sea (Santhakumari, 1986; Padmakumar, 2015). Chatterjee et al. (2019) reported *L. satyanandani*, *P. karunakarani*, *Ephelota gemmipara* (Hertwig, 1876), *Acineta foetida* Maupas, 1881 and *Pelagacineta* sp. on marine pelagic ostracods *C. dentata* from the Arabian Sea.

The present paper reports the peritrich species *Cothurnia* cf. *recurva* Claparède & Lachmann, 1859 and a suctorian species *Acineta poculum* Hertwig, 1876 as epibiont on benthic ostracods from the subtidal zone of Mumbai, west coast of India, Eastern Arabian Sea. Additional information is provided in the checklist of ciliate epibionts inhabiting ostracods given by Chatterjee et al. (2020).

Materials and Methods

Undisturbed sediment sample has been collected at the water depth of 10 m and brought on deck in replicates by the deployment of van Veen grab (0.04 m²) along the subtidal region of Mumbai, West Coast of India (Latitude 18° 57' 27.36" N; Longitude 72° 45' 58.32" E) during March 2019 by the second author (SS). The meiofauna samples were collected using syringe cores (dia 3.5 cm and 10 cm in length). The cores were pushed through sediment vertically down to 5-6 cm depth to collect the samples. In the laboratory, the sediment was sieved through 300 µm to remove large fauna (macrofauna) and the fauna retained on 28 µm mesh were considered meiofauna. All meiofauna samples were examined to investigate the ciliates attachment with the invertebrates if any. Shorting and identifications of fauna were carried out using a Stereomicroscope (SMZ18), while images were taken under an upright microscope (Nikon *Ei*) with a camera attachment (digital sight 1000). Measurements of ciliates were made using the software NIS Elements and TopView 3.7 for processing digital images. The terminology and systematic position of suctorian ciliates follows Dovgal (2002,

2013) and Jankowski (2007); while systematic position of peritrich follows Lynn (2008). Specimens are kept in the second author's (SS) collection in CSIR—National Institute of Oceanography, Mumbai.

The abiotic environment of the water at the collected site showed temperature 28.35°C, salinity 34.6 psu, dissolved oxygen concentration 6.1 mg/l, pH 8.2 and turbidity 3.8 NTU. The sediment texture pattern is majorly dominated by silt only.

Results and Discussion

Phylum Ciliophora Doflein, 1901

Subphylum Intramacronucleata Lynn, 1996

Class Oligohymenophorea de Puytorac et al., 1974

Subclass Peritrichia Stein, 1859

Order Sessilida Kahl, 1933

Family Vaginicolidae Fromentel, 1874

Genus *Cothurnia* Ehrenberg, 1831

***Cothurnia cf. recurva* Claparède & Lachmann, 1859**

Material examined

Numerous individuals (more than 10) attached on unidentified ostracods sp. 1 and sp.2 from subtidal region of Mumbai, West Coast of India.

Brief description

Marine and brackish loricate peritrichs, with one zooid per lorica. Aperture border without clefts and with a curved neck. Diameter of the aperture slightly greater than that of lorica. Lorica curved and irregular. External stalk slender and provided with basal disc. Endostyle precise, short and broad. Mesostyle absent. Pellicular striations conspicuous. Macronucleus straight and lies longitudinally in the center of the zooid.

Measurements from present find (in μm)

Morphometric measurements of specimens of *Cothurnia cf. recurva* observed in the present study (based on 9 individuals): Lorica length 51–68, lorica width 22–27, zooid when contracted length 27–47, width 16–23, external stalk length 10–21, endostyle length 3–5, endostyle width 4–6.

Table 1 gives detailed measurements of various parts found in each of the 9 individuals.

Remarks

Earlier it was found as epibionts on cyclopoid and harpacticoid copepods from the North Atlantic Ocean (Kahl 1933; Stiller 1939; Felinska 1965). Miranova *et al.* (2014) reported this from the western Baltic Sea.

Hockin (1984) reported *Cothurnia* sp. (mentioned 'possibly *C. recurva*') as epibiont on harpacticoid copepods *Paronychocamptus curticaudatus* (Boeck, 1864), *Esola typhlops* (Sars, 1908) (Laophontidae), *Stenocaris pygmea* (Cylindropsyllidae) and *Ameira parvula* (Claus, 1866) (Ameiridae) from river Ythan estuary, Aberdeenshire, north east coast of Scotland, North Sea.

This species was reported in the solid surface overgrowth on the experimental glass slides of the eastern coast of the Caspian Sea (Agamaliev, 1974).

This species is reported in the present investigation as an epibiont attached to benthic ostracods collected from the Mumbai coast, India (Arabian Sea). This is also reported here for the first time as epibiont on ostracod.

Warren & Paynter (1991) stated that *Cothurnia recurvata* Kahl, 1928 is very similar to *C. recurva* Claparède & Lachmann, 1859, the principal differences being those of size, host and habitat. Re-examination may show that *C. recurvata* is a junior synonym of *C. recurva*.

Class Suctorea Claparède et Lachmann, 1859

Subclass Endogenia Collin, 1912

Order Acinetida Raabe, 1964

Family Acinetidae Ehrenberg, 1838

Genus *Acineta* Ehrenberg, 1834

***Acineta poculum* Hertwig, 1876**

Material examined

Numerous individuals (more than 10) attached on unidentified ostracods sp. 1 from subtidal region of Mumbai, West Coast of India.

Brief Description

Marine loricate suctorian. Lorica surface smooth, triangular in shape, without transverse folds. Stalk without extensions, joining lorica without special structure. The body does not occupy the entire lorica size; it is located in the area of the aperture. Tentacles are arranged in two bundles at apical body

surface, actinophores not developed. Macronucleus spherical, centrally located, single contractile vacuole situated apically.

Measurements from present find (in μm)

Morphometric measurements of specimens of *Acineta poculum* observed in the present study (based on 10 individuals, in μm): Lorica length 25–43, lorica width 21–29, lorica aperture diameter 19–33, body when contracted length 19–32, width 18–28, stalk length 18–59.

Table 2 gives detailed measurements of various parts found in each of 10 individuals.

Remarks

This species has had a long and rich nomenclatural history. Curds (1985) indicated the name *Acineta poculum* in synonym of *A. tuberosa*. Therefore, in the literature, this species can often be found as *A. tuberosa*.

However, Dovgal (2013) considers the name *Acineta poculum* to be valid.

Precht (1935) misidentified the species as *Acineta foetida*. The specimens described by the later author lacked the characteristic folds of the shell, the body was connected to the shell in the aperture, therefore Dovgal (2013) placed *A. foetida* sensu Precht, 1935 under synonymy of *A. poculum*.

Dovgal (2002) classified *A. simplex* Maskell, 1886 and *A. nieuportensis* Sand, 1899 as valid representatives of the genus *Acineta*. Curds (1985) recognized *Acineta simplex* Maskell, 1886, as a valid species and mentioned *A. nieuportensis* as synonym of *A. simplex*. In turn, *A. simplex* and *A. nieuportensis* were considered as junior synonyms of *A. poculum* by Dovgal (2013).

Acineta poculum was reported from the coast of Helgoland Island, Germany (type locality) as epibiont on thallus of *Ulva* sp. (Hertwig, 1876). Gassowski (1960) also reported this species from Ukraine.

In present find this species is reported as an epibiont attached to benthic ostracods collected from the Mumbai coast, India (Arabian Sea). Present report is the first record of this species from the Arabian Sea and the Indian Ocean. *Acineta poculum* is reported here first time as epibiont on ostracod.

An addendum to the checklist of ciliates inhabiting ostracods

Additional information is given below which was not mentioned in Chatterjee *et al.* (2020) checklist. Following species are added to the checklist of ostracods.

Class Oligohymenophorea De Puytorac et al., 1974

Subclass Peritrichia Stein, 1859

Order Sessilida Kahl, 1933

Family Epistylididae Kahl, 1933

Genus *Epistylis* Ehrenberg, 1830

***Epistylis pygmaeum* (Ehrenberg, 1838)**

Record as epibiont on ostracods

This species was reported as epibiont on several ostracod species (Ehrenberg, 1838; Schödel, 2018).

Record as epibiont on other hosts

This species was reported as epibiont on representatives of rotifers, cladocerans, copepods, isopods and larvae of Ephemeroptera, and also on fishes (Schödel, 2018).

Genus *Nuchterleinella* Matthes, 1990

***Nuchterleinella corneliae* Matthes, 1990**

Record as epibiont on ostracods

This species was also reported on ostracods *Cypria ophthalmica* and *Cyclocypris ovum* from Netherland, England (Griffiths & Evans, 1994; Schödel, 2018).

Genus *Rhabdostyla* Kent, 1881

***Rhabdostyla dubia* Foissner, 1979**

Additional information

After the first description (Foissner, 1979; Chatterjee et al., 2020) the species was also reported on ostracods *Cypria ophthalmica* (Jurine, 1820), *Eucypris elliptica* (Baird, 1846) and *Bradleystrandesia* sp. (Schödel, 2018)

***Rhabdostyla striata* Banina, 1977**

Record as epibiont on ostracods

This species was reported as epibiont on *Cypris* sp. from Russia (Schödel, 2018).

Record as epibiont on other hosts

This species was reported as epibiont on the cladocera *Daphnia pulex* Leydig, 1860 and *Polyphemus pediculus* (Linnaeus, 1761) (Schödel, 2018).

Family Lagenophryidae Bütschli, 1889

Genus *Lagenophrys* Stein, 1852

***Lagenophrys* sp.1**

Record as epibiont on ostracods

The unidentified representative of genus *Lagenophrys* was found on the body of ostracods of the genus *Elpidium* Müller, 1880, in turn inhabiting at the body of the tree frog *Scinaxper pusillus* (Lutz & Lutz, 1939) from the tanks formed by leaf bases of bromeliads *Alcantia reaglaziouana* (Lem.) Leme in the Natural Monument of Morro da Urca and sugar loaf, Rio de Janeiro State, Brazil (Sabagh et al., 2011).

Record as epibiont on other hosts

The genus *Lagenophrys* has a cosmopolitan distribution, occurring on different members of a family or genus of crustaceans (Mayén-Estrada & Clamp, 2016).

***Lagenophrys* sp.2**

Record as epibiont on ostracods

Lagenophrys sp. found on the freshwater ostracod *Cryptocandona* sp. (Ostracoda: Podocopa: Candonidae) from Makkari, Hokkaido, Japan (Keiichi & Mizuho 2022).

Family Operculariidae Fauré-Fremiet in Corliss, 1979

Genus *Orbopercularia* Lust in Guhl, 1979

***Orbopercularia strelkowi* (Shubernetskji & Chorik, 1977)**

= *Pyxidium spasskii* Shubernetskji & Chorik, 1977

Record as epibiont on ostracods

This species was reported on ostracods *Cypris* sp. (Schödel 2018).

Genus *Orbopyxidiella* Lust in Guhl, 1979

***Orbopyxidiella ostracodei* (Banina, 1977)**

= *Pyxidium ostracodei* Banina, 1977

Record as epibiont on ostracods

This species was reported on ostracods *Cypris* sp. (Schödel, 2018).

Genus *Opercularia* Goldfuss, 1820

***Opercularia cylindrata* Wrzesniowski, 1870**

Record as epibiont on ostracods

This species was reported on ostracods (Keiser 1921; Schödel 2018).

Record as epibiont on other hosts

This species was reported as epibiont on copepods (Keiser, 1921; Schödel, 2018).

Family Vaginicolidae Fromentel, 1874

Genus *Cothurnia* Ehrenberg, 1831

***Cothurnia cf. recurva* Claparède & Lachmann, 1859**

Record as epibiont on ostracods

This species is reported as an epibiont attached to benthic ostracods collected from the Mumbai coast, India (Arabian Sea) (Present find).

Record as epibiont on other hosts

This species was reported as epibiont on copepod hosts and experimental glass slides (see earlier text in present paper).

Family Vorticellidae Ehrenberg, 1838

Genus *Carchesium* Ehrenberg, 1831

***Carchesium epistylis* Claparede & Lachmann, 1858**

Record as epibiont on ostracods

This species was reported as epibiont on ostracod *Iliocypris sordidus* (Monard, 1918; Schödel, 2018).

Record as epibiont on other hosts

The species was described from larvae of Phryganeidae (Trichoptera) (Kahl, 1935).

Genus *Pseudocarchesium* Sommer, 1951

***Pseudocarchesium erlangensis* (Nenninger, 1948)**

Record as epibiont on ostracods

This species was reported as epibiont on ostracods (Schödel, 2018).

Record as epibiont on other hosts

This species was reported as epibiont on cladocerans, cyclopoides and amphipods (Chatterjee et al., 2013; Schödel, 2018).

***Pseudocarchesium pyriformis* Banina, 1977**

Record as epibiont on ostracods

This species was reported as epibiont on *Heterocypris incongruens* (Ramdohr, 1808) from Russia (Schödel, 2018).

Genus *Rugaecaulis* Lom & de Puytorac, 1994

***Rugaecaulis invaginatum* (Stokes, 1886)**

Record as epibiont on ostracods

This species was described (Kahl, 1935) from ostracod *Cypris* sp. as *Rhabdostyla invaginata*.

Record as epibiont on other hosts

The species was also found (Kahl, 1935) on *Cyclops* sp. (as *Rhabdostyla invaginata*), in addition on cladocerans *Daphnia* sp. and *Bosmina* sp. (as *Rugaecaulis invaginatum*) (Schödel 2018).

Genus *Vorticella* Linnaeus, 1767

***Vorticella abbreviata* Keiser, 1921**

Record as epibiont on ostracods

This species was reported on ostracods (Schödel, 2018).

Record as epibiont on other hosts

This species was reported as epibiont on Cyclopidae, Mollusca, isopods *Asellus aquaticus*, leech *Haemopsis sanguisuga* (Linnaeus, 1758) and larva of *Cloeon* sp. (Ephemeroptera) (Keiser, 1921; Nenninger, 1948; Foissner & Schiffmann, 1974).

Remarks

Foissner & Schiffmann (1974) re-described the species based on the investigation of argyrome of ciliates found on *Cypris* sp. . It is Warren's (1986) opinion that the *V. abbreviata* is a variety of *V. Infusionum* Dujardin, 1841.

***Vorticella urnula* Nenninger, 1948**

Record as epibiont on ostracods

This species was reported as epibiont on ostracod *Heterocypris* sp. (Shubernetskji & Chorik, 1977; Schödel, 2018)

Record as epibiont on other hosts

This species was reported as epibiont on *Macrocyclus fuscus* (Jurine, 1820) in Germany and on *Cyclops* sp. in Slovakia (Stloukal & Matis, 1997; Schödel, 2018).

Class Suctorea Claparède et Lachmann, 1859

Subclass Endogenia Collin, 1912

Order Acinetida Raabe, 1964

Family Acinetidae Ehrenberg, 1838

Genus *Acineta* Ehrenberg, 1834

***Acineta poculum* Hertwig, 1876**

Record as epibiont on ostracods

This species is reported as an epibiont attached to benthic ostracods collected from the Mumbai coast, India (Arabian Sea) (Present find).

Record as epibiont on other hosts

This species was reported as epibiont on various hosts (see earlier text in the present paper).

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Table 1: Measurements of various parts found in each of 9 individuals of <i>Cothurnia cf. recurva</i> .								
Sample number	Lorica (length), μm	Lorica (width), μm	Lorica aperture (length), μm	Zooid when contracted (length), μm	Zooid when contracted (width), μm	External stalk, μm	Endostyle (length), μm	Endostyle (width), μm
1	59	23	15	27	18	20	3	5
2	51	24	15	29	17	14	4	5
3	58	27	18	30	18	21	4	5
4	59	22	16	29	17	18	4	4
5	59	27	18	26	16	16	3	4
6	68	25	16	47	22	14	4	5
7	68	25	18	45	23	15	4	5
8	57	27	22	40	17	10	4	4
9	63	26	22	35	19	12	5	6

Table 2: Measurements of various parts found in each of 10 individuals of <i>Acineta poculum</i> .						
Sample number	Lorica (length), μm	Lorica (width), μm	Lorica aperture (diameter), μm	Body (length), μm	Body (width), μm	External stalk, μm
1	29	25	25	22	18	24
2	30	27	25	20	18	21
3	30	23	23	22	21	27
4	34	29	33	32	27	25
5	33	21	22	19	23	18
6	25	21	19	23	20	59
7	28	25	27	20	24	20
8	39	28	31	26	27	40
9	31	25	24	19	21	23
10	43	29	25	27	28	24

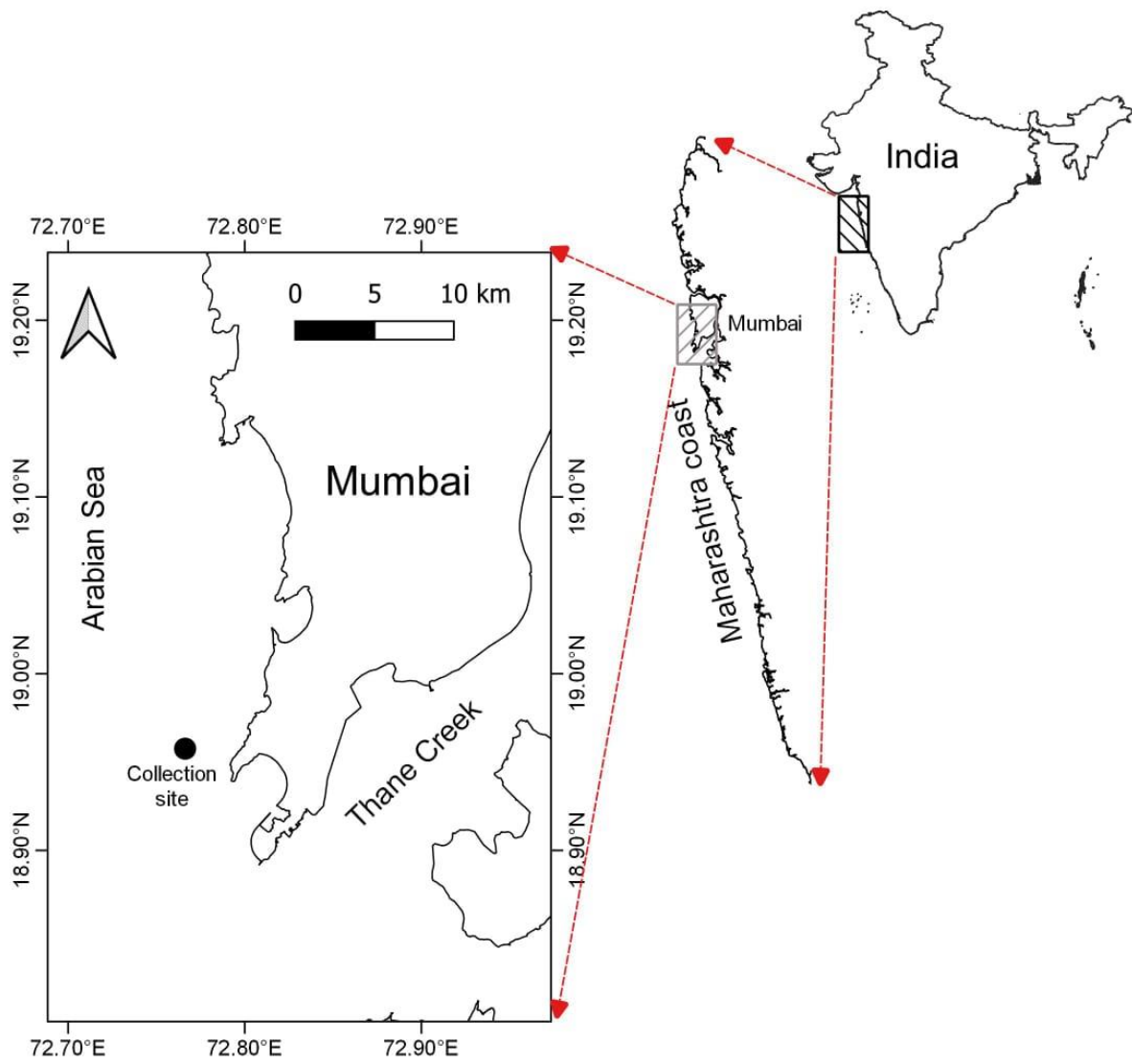


Fig. 1. Map of the study area.

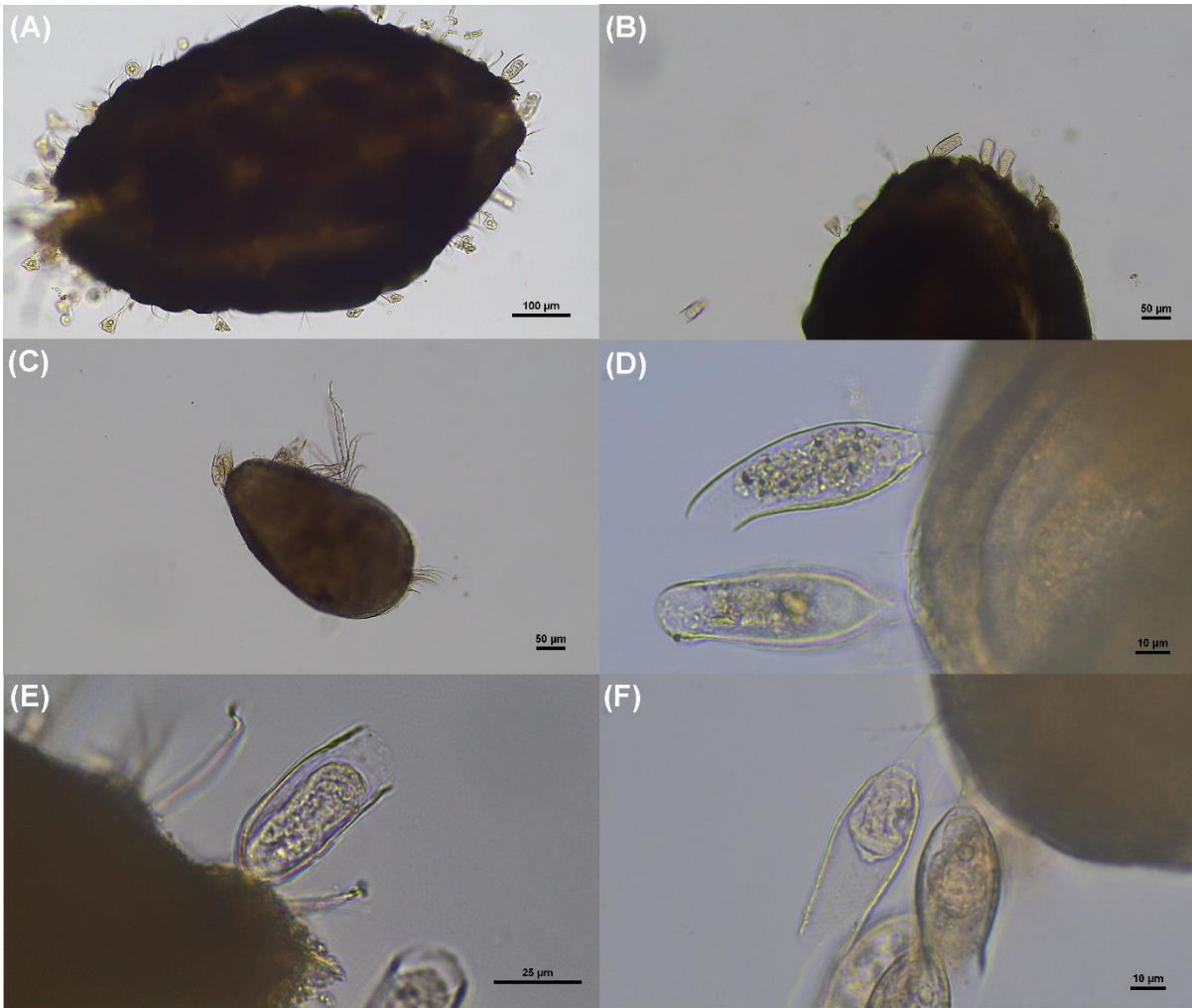


Fig. 2. *Cothurnia* cf. *recurva* Claparède & Lachmann, 1859. **A-C.** Localizations of *C. recurva* at the host body (Fig. A & B consists both *Cothurnia recurva* and *Acineta poculum* as epibionts). **D-F.** Variability in the shape of lorica.

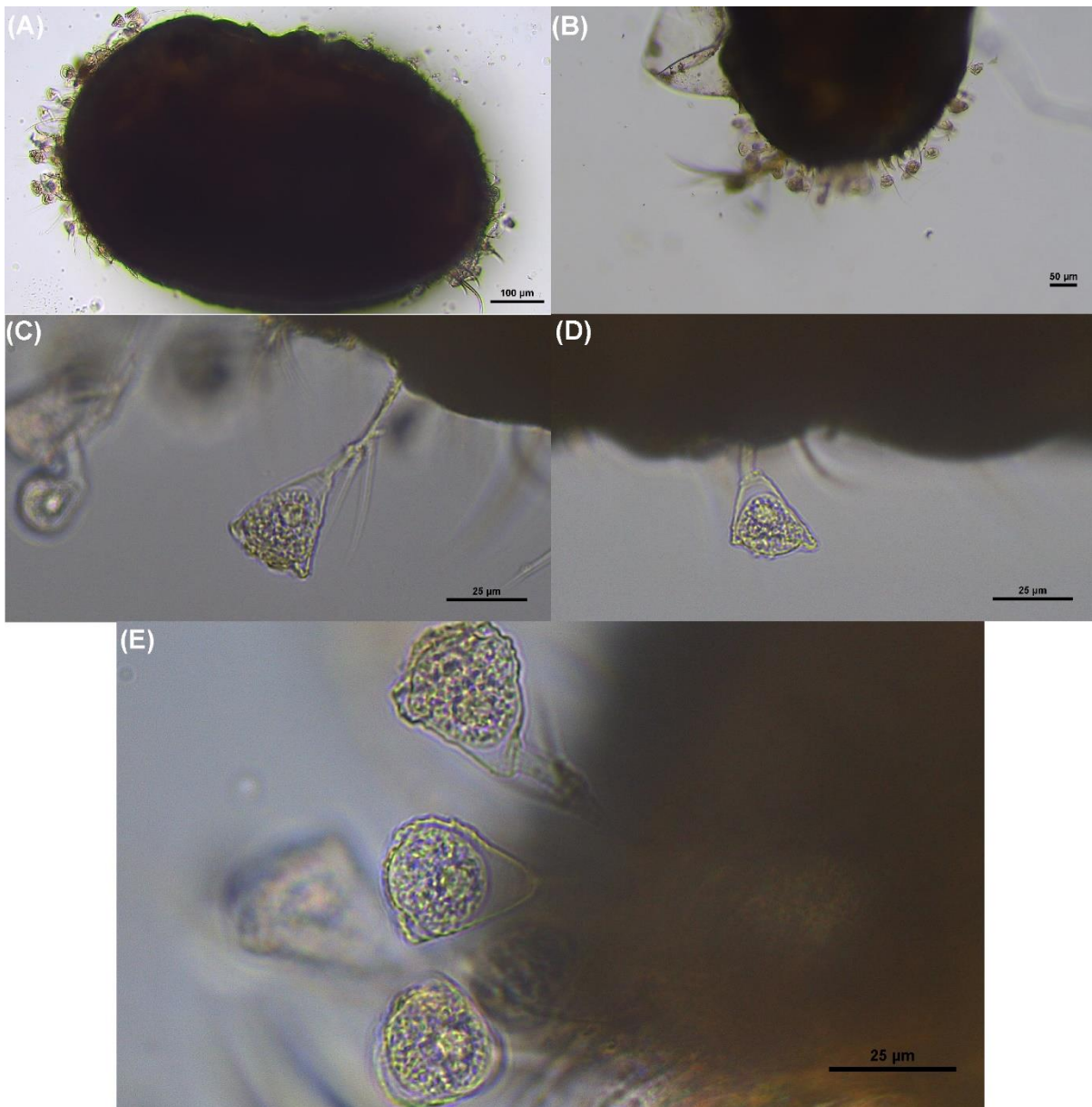


Fig. 3. *Acineta poculum* Hertwig, 1876. **A, B.** Localizations at the host body (consists both *Cothurnia* cf. *recurva* and *Acineta poculum* as epibionts). **C-E.** Variability in the shape of lorica and cell body.