

NEW RECORDS OF EPIBIONT CILIATES (CILIOPHORA) FROM INDIAN COAST WITH DESCRIPTIONS OF SIX NEW SPECIES

Tapas CHATTERJEE^{1*}, Gregorio FERNANDEZ-LEBORANS², Darwin RAMTEKE³ and Baban INGOLE⁴

¹⁾Department of Biology, Indian School of Learning, ISM Annexe, P.O. – ISM, Dhanbad 826004, Jharkhand, India, E-mail: drtchatterjee@yahoo.co.in

²⁾Department of Zoology, Faculty of Biology, Pnta 9, Complutense University, 28040 Madrid, Spain, E-mail greg@bio.ucm.es

^{3,4)}Biological Oceanography Division, National Institute of Oceanography (CSIR), Dona Paula, Goa-403004, India. E-mail: baban@nio.org

Abstract: Six epibiont ciliates *Cothurnia palkensis*, *C. nova*, *C. disper*, *C. dovgali*, *C. mannaerensis* and *C. clampi* are described as new for science from the Indian coast. *Acineta truncata* Collin, 1909 and *A. tuberosa* Ehrenberg, 1834 are reported here for first time from the Indian coast.

Résumé: Six ciliates epibiontic *Cothurnia palkensis*, *C. nova*, *C. disper*, *C. dovgali*, *C. mannaerensis* et *C. clampi* sont décrites comme espèces nouvelles le long de la Côte Indienne. *Acineta truncata* Collin, 1909 et *A. tuberosa* Ehrenberg, 1834 sont rapportés pour la première fois le long de la Côte Indienne.

Keywords: Epibiont Ciliates, new species, India

Running Title: New epibiont ciliates from Indian coast

*Corresponding author

Introduction

Epibiosis is a facultative association of two organisms: the epibiont, which colonizes the surface of live substrates, and the basibiont, which hosts the epibionts (Wahl, 1989; Fernandez-Leborans & Gabilondo, 2006). According to Fenchel (1987), it is probable that almost all aquatic metazoans host symbiont protozoa. Peritrich ciliated protozoa live as epibionts on a variety of species of aquatic metazoans, including various groups of invertebrates: sponges, cnidarians, ctenophores, rotifers, tardigrades, freshwater planarians, crustaceans, annelid worms, insect larvae, molluscs; and groups of vertebrates: fishes, tadpoles, and freshwater turtles (Kahl, 1935; Goodrich & Jahn, 1943; Laird, 1959; Baldock, 1986; Foissner et al., 1992, 1999; Regali-Selegim & Godinho, 2004).

Epibionts constitute a significant component of aquatic ecosystems and play an important role in the food chain (Pratt & Cairns, 1985; Baldock, 1986). However, most studies are of morphological and taxonomic nature, and few have taken ecological aspects into consideration (Baldock, 1986; Xu, 1992; Fernandez-Leborans et al., 1997; Cook et al., 1998; Hanamura, 2000). Although studies of records of epibiont ciliates are abundant in the literature, little is known regarding ecological aspects of this relationship in tropical and sub-tropical ecosystems, with the studies by Regali-Selegim & Godinho (2004) deserving mention.

A number of protozoan ciliate species live as epibionts on crustaceans (Sprague & Couch, 1971; Morado & Small, 1995). Among these ciliates, the suctorians include species which have been found as epibionts on many crustacean groups (brachiopods, copepods, cladocera, ostracods, mysids, amphipods, isopods, decapods and others) (Collin, 1912; Guilcher, 1950; Green, 1974; Evans et al., 1979, 1981; Batisse, 1994; Fernandez-Leborans et al., 1996, Fernandez-Leborans & Tato-Porto, 2000a, b), copepods, amphipods and decapods being the crustaceans on which the highest number of suctorian species have been observed (Fernandez-Leborans & Tato-Porto, 2000a). The role of ciliates as epibionts on crustaceans has not been studied as thoroughly as that of other organisms, such as hydrozoans, bryozoans, and polychaetes (Sprague & Couch, 1971).

Epibiont ciliates from Indian coast were studied by Santhakumari & Gopalan (1980), Santhakumari (1985, 1986, 1997), Santhakumari & Nair (1973), Dovgal et al (2008), Ingole et al. (2010). In the present paper we describe here six new species of the genus *Corthunia* viz. *C. palkensis*, *C. nova*, *C. disper*, *C. dovkali*, *C. mannaerensis* and *C. clampi* from Gulf of Mannar and Palk Bay.

Acineta truncata Collin, 1909 and *A. tuberosa* Ehrenberg, 1834 are recorded here for the first time from the Indian coast.

Materials and methods

The sampling was carried out at Gulf of Mannar on the east coast (8°35'–9°25'N and 78°08'–79°30'E), Palk Bay on the east coast (9°7'45"N, 79°27'11"E) and Goa-Dias beach on the west coast (15°27' N; 73° 48'E) (Fig. 1) of India by 3rd and 4th authors (DR &BI). Sampling in the east coast was carried out at five transect at a water depth of 5m, 10m and 30m during pre monsoon (March 2010), monsoon (September–October 2010) and post monsoon (January 2011). Sediment was collected using van Veen grab (28×20×10 cm). On the west coast (Dias beach, Goa), sampling was conducted during the low tide on the intertidal sandy beach. Samples for macro and meiofauna were sieved through 300 and 62 µm mesh, respectively and preserved in 5% neutralized formalin for further analysis.

Sorting of coarse and fine sediments followed the sieve method of Folk (1968). For Sand fractions, a set sieves (> 63 µm) was used and the weight of sand remained in each sieve was measured and the data was subjected to Gradistat 5.

In the laboratory the samples were again washed and sorted and preserved in 70% ethanol for taxonomical identification. Infested organisms were isolated from samples using a binocular microscope. The ciliates were identified using an Image Analysis (Zeiss K 300) system with a Zeiss compound microscope. The measurements of ciliates were made using the computer program ScopePhoto 2.0 for processing the digital images. For slide preparations, the material was stained with Boehmer's hematoxylin and mounted in Canada balsam. In order to identify the protozoan epibionts, they were isolated and treated using the silver carbonate technique, according the procedure described by Fernandez-Leborans & Castro de Zaldumbide (1986), and also with methyl green and neutral red. The permanent slides of infested organisms are deposited in the Museum fur Naturkunde (Invalidenstr. 43, Berlin).

Abbreviations used in figure legends: l, lorica; ma, macronucleus; mi, micronucleus; s, stalk; t, tentacles; en, endostyle; ms, mesostyle

Area Descriptions

Gulf of Mannar situated in the southeastern coast of India extending from Rameswaram in the north to Tuticorin in the south. The area is known for its rich marine biodiversity and consequently was declared

as India's first Marine Biosphere Reserve. The area harbors 21 islands, most of which have luxuriant growth of mangrove in their shores and swampy regions. Gulf of Mannar and Palk Bay are the shallow region with maximum water depth during sampling was 25 m. Few dissimilar hydrographical features exist between two areas, Gulf of Mannar is an open area but Palk bay is a land-locked sea .The inshore region of the Palk Bay is mostly muddy while in the Gulf of Mannar the inshore region is full of rocky patches with small areas of sand- and mud in between. The islands in Gulf of Mannar are mainly coral origin, and broad gaps exist between them which allow water movement in shallow and deep region of the sea. Both areas are independent of each other and the mixing of water between two areas take place through the Pamban bridge connecting mainland and Rameswaram Island and another through Adam's bridge (Jayaraman 1954).

Station-6 (located in Gulf of Mannar: Lat. 9°2'3.4"; Long 78°20'3.696")

This station was located near the shore and the depth at which samples were collected was 5m. The sampling location was 2km away from the shore. The station name is Vembar as the station 6 was located to the coast of Vembar area and the characteristic of substratum was sandy.

STATION NOS.	SAND (%)	% VERY COARSE SAND:	% COARSE SAND:	% MEDIUM SAND:	% FINE SAND:	% VERY FINE SAND:
ST-6	100	38.7%	11.3%	37.2%	12.6%	0.1%
ST-7	100	8.6%	10.0%	13.8%	27.2%	40.4%
ST-8	100	0.0%	4.9%	60.2%	33.3%	1.6%
ST-12	100	23.1%	17.0%	14.3%	22.1%	23.5%
ST-13	100	0.0%	2.1%	59.0%	36.2%	2.7%
ST-16	100	21.3%	40.0%	26.9%	11.5%	0.3%
ST-22	100	46.6%	23.9%	19.1%	9.5%	0.9%

Station-7 and 8 (located in Gulf of Mannar; Stn-7: Lat. $9^{\circ} 11' 28.8''$ N; Long. $78^{\circ} 47' 1.572''$ E. Stn-8: Lat. $9^{\circ} 7' 7.68''$ N; Long. $78^{\circ} 48' 2.412''$ E.) Both these stations were sampled from Kilakarai. At station-7, samples were collected from 5m water depth and at St-8 water depth was 10m. Station-7 was 4 km away from shore whereas St-8, was 8 km away from the shore. The substratum at station-7 was sandy whereas sediment at Stn -8 was dominated by dead shells and sandy pebbles. Appa island (Stn 8): The area is 28.63ha. and is 8km from Kilakarai. The southern portion of the island is highly elevated (6m). The entire southern side of the island is fringed with live coral reef. A good number of dead coral stones, boulders are found on the North West corner of the island from the shore which extends up to the distance of 1.5km.

Station-12 (Lat. $09^{\circ} 14' 40''$ N; Long. $79^{\circ} 05' 22''$ E) was located 2 km off Mandapam at the depth was 5m. A stretch of two islands viz., Musal and Manoli island were present behind the station 6 km away from Mandapam.

Station-13 (Lat. $09^{\circ} 11' 12''$ N; Long. $79^{\circ} 22' 25''$ E) was located south of Rameswaram at the water depth 5m and was 2km away from the shore. The shore of Rameswaram islands both accretional and erosional features were observed. Station 16 was located in Rameswaram (Lat.16: $09^{\circ} 18' 15''$ N; $79^{\circ} 24' 00''$ E.). It is a island and is connected to mainland of Tamil Nadu through Pamban Bridge. The water depth at which sample was collected was 5m and it was 6.8 km away from land. This station is located away from the human inhabiting area in Rameswaram island.

Station 22 (Lat.22: $09^{\circ} 45' 00''$ N; $079^{\circ} 02' 00''$ E.) was located 7 km off Gopalapatnam at the water depth of 5 m.

Goa: Dias beach (Station. 24): Sediment sampling was carried out on a sand flat at Dias Beach (Lat. $15^{\circ} 27' 00''$ N; $73^{\circ} 48' 00''$ E) located near Dona Paula Bay, on the west coast of India and is a protected in the mouth of Zuari estuary. The beach is about 250 m in length and is sheltered and protected on both sides by rocky cliffs. Very fine sand (grain size 63–124 μ m) is the most abundant fraction of the sediment (Table 2). According to Mitbavkar & Anil (2002) sediment on Dias beach is moderate-to-well sorted with a sorting coefficient ranging from 0.32 to 0.58.

Table 2. Sediment texture of station-24 (Dias Beach)					
Station	Sand	Mud	Sand Fractions further divided to		
			Fine Sand	Very fine Sand	Very coarse Silt
Dias Beach	75.6%	24.4%	24.1%	51.5%	24.4%

Systematic

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 de Fromentel, 1874

Genus: *Cothurnia* Ehrenberg, 1831

Diagnosis

Loricated peritrichs with one or two zooids per lorica. Lorica attached aborally by stalk. Lorica without valves or operculum. The inner part of the lorica can present an internal lining or septum that can contain a mesostyle. The zooid may attach to lorica directly or via a endostyle (Warren & Paynter, 1991; Lynn & Small, 2000).

Cothurnia palkensis sp. nov.

(Figs. 2, 16, 17)

Locality

Palk Bay Stn. 22

Etymology

Named after type locality **Palk Bay**.

Host

Tanaidaceans. Epibionts located on body surface, telson and appendages. 16-32 epibionts per basibiont in infested specimens.

Description

Ciliates with a lorica relatively small, and a body that occupied between $\frac{2}{3}$ and $\frac{3}{4}$ of the length of the lorica when contracted. Stalk generally short and broad. Macronucleus “C” shaped located transversally on the anterior half of the body. Frequently with two individuals per lorica (Figs. 2, 16, 17). Measurements: lorica length, 39.0-45.0 μm ; lorica width (maximum), 27.0-35.0 μm ; body length, 24.0-28.5 μm ; body width, 25.5-21.0 μm ; stalk length: 4.5-21.0 μm ; stalk width, 6.0-9.1 μm .

Remarks

Cothurnia plakensis sp. nov. is similar with *C. nereicola* Precht, 1935, *C. parva* (Bock, 1952), *C. subglobosa* Daday, 1911 and *C. trophonicola* (Dons, 1946). *C. nereicola* was reported as epibiont on the polychaete *Nereis diversicolor* (O.F. Müller, 1776) from Bay of Kiel (Germany) (Precht, 1935). *C. parva* found attached to *Ceramium diaphanum* from Bay of Kiel (Germany) (Bock, 1952). *C. subglobosa* recorded as epizoite of the ostracod *Cythereis* sp. from the Antarctic region (Daday, 1911), and *C. trophonicola* as epizoite on the polychaete *Trophonia plumose* (Müller, 1771) (Dons, 1946). Differences between present species and related species are given in table 3.

	Representative of <i>Cothurnia</i> sp.				
	<i>C. nereicola</i>	<i>C. parva</i>	<i>C. subglobosa</i>	<i>C. trophonicola</i>	<i>C. plakensis</i> sp.nov.
Lorica length (μm)	33	46-50	45-50	60-85	39.0-45.0
Lorica width (μm)	30	30-34	46-52	31-35	27.0-35.0
Body length (μm)	65	49-54	-	50	24.0-28.5
Body width (μm)	18	17	-	25	21.0-25.5
Mesostyle	Present	Present	Absent	Present	Present
Endostyle	Absent	Present	Absent	Absent	Absent
Stalk length (μm)	Short	11-14	35-37	5-15	4.5-21.0
Stalk width (μm)	10	-	-	3-4	6.0-9.1
Macronucleus	Straight, Longitudinal	Straight, Anterior	“C” shaped, Longitudinal	Vermiform, Irregular	“C” shaped, Transversal

Macronucleus is longitudinally placed in *C. nereicola* and *C. subglobosa* while in present new species it is transversely placed. Mesostyle is absent in *C. subglobosa*, while present in *C. plakensis* sp nov. Endostyle is present in *C. parva*, while absent in *C. plakensis* sp nov. *C. nereicola* and *C. parva* also differ from the new species in having striations on the three parts of the stalk and with conspicuous pellicular striations.

***Cothurnia nova* sp. nov.**

(Figs 3, 18, 19)

Locality

Palk Bay Stn 16

Etymology

‘Nova’ (latin) means new.

Host

Tanaidaceans: Epibionts located on appendages. 3-49 epibionts per basibiont in infested specimens.

Description

Peritrichs with a broad lorica externally striated. One or two zooids per lorica. Some individuals showed the aperture of the lorica inclined at an angle oblique respect to the main axis. Macronucleus “C” shaped located transversally in the anterior half of the body. The body when contracted is relatively small and can occupy only the posterior area of the lorica. Mesostyle and endostyle are conspicuous and broad. The external stalk was short and attached via a large disk (Figs. 3, 18, 19). Measurements: lorica length, 51.0-55.5 μm ; lorica width (maximum), 27.0-33.2 μm ; body length, 27.2-34.5 μm ; body width, 13.5-21.0 μm ; stalk length: 6.0-7.5 μm ; stalk width, 6.3-10.5 μm ; macronucleus length 15.3-21.2 μm , macronucleus width 4.5-6.3 μm .

Remarks

Cothurnia nova sp. nov. has similarity with *C. aplatita* (Stiller, 1939), *C. apseudophila* (Lang, 1948), *C. ceramicola* (Kahl, 1933), *C. complanata* Precht, 1935, *C. halaricola* Precht, 1935, *C. harpactici* Kahl, 1933, and *C. nitocrae* Precht, 1935. *C. aplatita* found in marine aquaria at Helgoland attached to Campanulariaceae and also in marine aquaria at Plymouth attached to green algae (Stiller, 1939; Felinska, 1965); *Cothurnia apseudophila* reported as epibiont on *Apseudes spinosus* from Swedish coastal waters (Lang, 1948); *C. ceramicola* reported as epibiont on the alga *Ceramium* near Kiel

(Germany) (Kahl, 1933), on the bryozoa *Crisia eburnean* and *Cribilina punctata* (Hassall, 1841), the polychaete *Spirorbis spirorbis* (Linnaeus, 1758), and the cnidarian *Laomedea loveni* Allman, 1859 from Bay of Kiel (Germany) (Precht, 1935); *Cothurnia complanata* found on the polychaete *Pherusa plumosa* (Müller, 1776) (as *Stylarioides plumosa*) from Bay of Kiel (Germany) (Precht, 1935); *C. halaricola* from Kiel, Germany (Precht, 1935); *C. harpactici* as epibiont on the harpacticoid copepods *Cletocamptus confluens* (Schmeil, 1894) and *Mesochra lilljeborgi* Boeck 1864 from Kiel, Germany (Precht, 1935) and *Cothurnia nitocrae* as epibiont on the harpacticoid copepod *Nitocra spinipes* Boeck, 1865 from Kiel channel, Germany (Precht, 1935).

General differences between all above mentioned species and present new species is given in table 4. *Cothurnia nova* sp. nov. differs from above mentioned related species in having “C” shaped macronucleus. *C. aplatita* has two zooids per lorica, external stalk short, mesostyle striated. *C. apseudophila* showed pelicular striations on the body and two zooids per lorica, one larger than the other. *C. ceramicola* has a short external stalk, pellicular striations conspicuous in the body. *C. complanata*, has a slender stalk. *C. nitocrae* has pellicular striations on the body, on all the parts of the stalk.

Table 4. Comparison between <i>C. nova</i> sp. nov. and its related species					
	Representative of <i>Cothurnia</i> sp.				
	<i>C. aplatita</i>	<i>C. apseudophila</i>	<i>C. ceramicola</i>	<i>C. complanata</i>	<i>C. halaricola</i>
Lorica length (µm)	45-65	88-92	65-77	78-81	70
Lorica width (µm)	25-30	29-31	30	32-35	23-35
Body length (µm)	70-80	128-164	80	80	17
Body width (µm)	20-25	17-20	15	24	15
Mesostyle	Present	Present	Present	Present	Present
Endostyle	Present	Present	Present	Present	Present
Stalk length (µm)	-	-	-	-	15
Stalk width (µm)	-	-	-	-	-
Macronucleus	Elongate, longitudinal	Straight, longitudinal	Vermiform, longitudinal	Longitudinal	Straight, longitudinal

Table 4 continued...

	<i>C. harpactic</i>	<i>C. nitocrae</i>	<i>C. nova</i> sp. nov.
Lorica length (µm)	75-88	93-97	51.0-55.5
Lorica width (µm)	28-35	30-35	27.0-33.2
Body length (µm)	105	95	27.2-34.5
Body width (µm)	17-20	20	13.5-21.0
Mesostyle	Present	Present	Present
Endostyle	Present	Present	Present
Stalk length (µm)	15	-	6.0-7.5
Stalk width (µm)	-	-	6.3-10.5
Macronucleus	Longitudinal	Straight	"C" transversal

Cothurnia disper sp. nov.

(Figs. 4, 5, 20, 21)

Locality

Gulf of Mannar Station 7

Etymology

‘disper’ (latin) means different, unlike. This species differ from other.

Host

Isopod. Epibionts located on body surface, posterior area and appendages of the median region. 4-75 epibionts per basibiont in infested specimens.

Description

Peritrichs with a large and short lorica containing one or two zooids. Aperture of lorica was wider in its anterior end. The external stalk was curved. Mesostyle absent and endostyle inconspicuous. The body of the zooid protrude from the lorica until the half of the length. The macronucleus is “C” shaped arranged longitudinally throughout the body (Figs. 4, 5, 20, 21). measurements: lorica length, 18.5-22.5µm; lorica width (maximum), 22.3-23.5µm; body length, 27.0-31.5µm; body width, 15.0-19.5µm; stalk length: 13.5-16.4µm; stalk width, 4.5-5.2µm; macronucleus length, 19.2-21.04µm; macronucleus width, 5.2-6.14µm.

Remarks

Present new species most similar with *Cothurnia innata* O. F. Müller, 1786, *C. peloscolicis* Precht, 1935, and *C. subglobosa* Daday, 1911. *C. innata* found attached to *Hydrobia* from Arctic region

(Hofker, 1930). *C. peloscolicis* was found on the oligochaete *Peloscolex benedeni* Udekem, 1855 from, Bay of Kiel (Germany) (Precht, 1935). *C. subglobosa* has been found as epizoite of the ostracod *Cythereis* sp. from the Antarctic region (Daday, 1911).

Differences between above mentioned species and present new species is given in table 5. *C. peloscolicis*, and *C. subglobosa* have “C” shaped macronucleus, while *C. disper* sp. nov. has straight macronucleus. *C. innata* has mesostyle, while absent in *C. disper*. *C. innata* showed two zooids per lorica, the aperture of the lorica was narrow. *C. peloscolicis* has the lorica compressed dorsoventrally, the external stalk and mesostyle are striated.

Table 5. Comparison between <i>C. disper</i> sp. nov. and its related species				
	Representative of <i>Cothurnia</i> sp.			
	<i>C. innata</i>	<i>C. peloscolicis</i>	<i>C. subglobosa</i>	<i>C. disper</i> sp. nov.
Lorica length (µm)	40-100	81	45-50	18.5-22.5
Lorica width (µm)	20-27	27-41	46-52	22.3-23.5
Body length (µm)	40-50	80	-	27.0-31.5
Body width (µm)	10-15	18-22	-	15.0-19.5
Mesostyle	Present	Absent	Absent	Absent
Endostyle	Absent	Present	Present	Present
Stalk length (µm)	20	20	35-37	13.5-16.4
Stalk width (µm)	-	-	-	4.5-5.2
Macronucleus	Straight, Longitudinal	Straight	“C” shaped, longitudinal	“C” longitudinal

Cothurnia dovgali sp. nov.

(Figs. 6, 22)

Locality

Palk Bay, Stn.16

Host

Tanaidacean. Epibionts located on body surface on median area and posterior appendages 1-3 epibionts per basibiont in infested specimens.

Etymology

Named after Dr. Igor Dovgal, Schmalhausen Institute of Zoology, Ukrain.

Description

Peritrichs showing a lorica with the aperture narrow and the external surface striated. The zooid was short, occupying one third of the volume of the lorica when contracted. There are mesostyle and endostyle. The stalk is irregular. The macronucleus is “C” shaped located transversally (Figs. 6, 22). Measurements: lorica length, 32.4-42.5 μm ; lorica width (maximum), 23.8-26.3 μm ; body length, 15.3-21.4 μm ; body width, 12.3-15.2 μm ; stalk length: 5.2-11.4 μm ; stalk width, 4.2-6.8 μm ; macronucleus length, 15.6-17.2 μm ; macronucleus width, 4.2-6.4 μm .

Remarks

Cothurnia dovgalii sp. nov. has similarities with *C. compressa* Claparède & Lachmann, 1858, *C. curvula* Entz (1876), 1884, *C. cypridicola* Kahl, 1933, *C. cytheridae* Kahl, 1933, *C. mobiusi* (Möbius 1888) Stiller 1939, *C. parva* Bock, 1952, and *C. parvula* Felinska, 1965. *C. compressa* found attached to bryozoa and algae (Claparède & Lachmann, 1858). *C. curvula* found attached to harpacticoid copepods from the Gulf of Neapel (Entz, 1884). *C. cypridicola* found on cyprids from Bay of Kiel (Germany) (Kahl, 1933), on the gastropods *Hydrobia ulvae* (Pennant, 1777) and *H. jenkinsi* E.A. Smith, 1889, and on the ostracod *Cyprideis litoralis* (Brady, 1876) from Bay of Kiel (Germany) (Precht, 1935). *C. cytheridae* epibiont on the hydroid *Cytherea* sp. from Bay of Kiel (Germany) (Kahl, 1933), *C. mobiusi* has been isolated from the North Sea near Helgoland (Stiller, 1939). *C. parva* was found attached to *Ceramium diaphanum* Roth 1806 from Bay of Kiel (Germany) (Bock, 1952). *C. parvula* attached to algae in marine aquaria of Plymouth (Felinska, 1965).

Differences between *Cothurnia dovgalii* sp. nov. and its related species are given in table 6. *C. parvula*, *C. mobiusi*, *C. compressa*, *C. curvula* and *C. cypridicola* have short external stalk. *C. parvula* has mesostyle striated, lorica with irregular ridges and furrows. *C. cytheridae* has a cylindrical lorica. *C. parva* has the stalk and surface of the body striated. *C. curvula* occasionally showed three centrally located annular furrows in the lorica, external stalk with a bulbous thickening at its point of attachment to lorica. The lorica showed irregular ridges and furrows in *C. cypridicola*.

Table 6. Comparison between <i>C. dovgali</i> sp. nov. and its related species				
	Representative of <i>Cothurnia</i> sp.			
	<i>C. compressa</i>	<i>C. curvula</i>	<i>C. cypridicola</i>	<i>C. cytheridae</i>
Lorica length (µm)	100-140	60	50-60	70
Lorica width (µm)	50	30	20-25	35
Body length (µm)	110	60	70-80	45
Body width (µm)	30	8-10	10-12	20
Mesostyle	Absent	Absent	Present	Present
Endostyle	Present	Absent	Present	Present
Stalk length (µm)	-	-	-	35
Stalk width (µm)	-	-	-	-
Macronucleus	-	Straight , longitudinal	-	Curved, longitudinal

Table cont...

	<i>C. parva</i>	<i>C. parvula</i>	<i>C. mobiusi</i>	<i>C. dovgali</i> sp. nov.
Lorica length (µm)	45-50	50-62	50	32.4-42.5
Lorica width (µm)	30-34	24	30	23.8-26.3
Body length (µm)	49-54	55	17	15.3-21.4
Body width (µm)	17	13	15	12.3-15.2
Mesostyle	Present	Present	Absent	Present
Endostyle	Present	Present	Absent	Present
Stalk length (µm)	11-14	-	-	5.2-11.4
Stalk width (µm)	-	-	-	4.2-6.8
Macronucleus	Straight	Longitudinal	"C" transversal	"C" transversal

Cothurnia mannarensis sp. nov.

(Figs. 7, 23)

Locality

Gulf of Mannar stn. 7

Host

Tanaidaceans. Epibionts located on appendages of the median area of the body, 1-23 epibionts per basibiont in infested specimens.

Etymology

Named after type locality Gulf of Mannar.

Descriptions

Peritrichs with a lorica with the anterior end narrow, and its external surface striated. In the posterior third of the lorica there was a conspicuous transversal furrow. Mesostyle and endostyle are present. The zooid occupy between the half and 2/3 of the volume of the lorica when contracted. The stalk was short and broad. Macronucleus "C" shaped located transversally in the body (Figs. 7, 23). Measurements: lorica length, 45.0-52.5µm; lorica width (maximum), 25.5-27.0µm; body length, 16.5-22.5µm; body width, 13.5-16.4 µm; stalk length: 10.4-6.0µm; stalk width, 6.0-7.5 µm; macronucleus length, 16.3-18.0 µm; macronucleus width, 4.5-6.7 µm.

Remarks

The species is most similar with: *C. curvula* Entz (1876), 1884, *C. cyclopis* Kahl, 1933 *C. cypridicola* Kahl, 1933, *C. cytheridae* Kahl, 1933, *C. inflata* Stokes, 1893, *C. maritima* Ehrenberg, 1838, *C. membranoloricata* Stiller, 1868, *C. nodosa* Claparède & Lachmann, 1858, *C. parvula* Felinska, 1965, and *C. triangular* Precht, 1935. *C. curvula* found attached to harpacticoid copepods from the Gulf of Neapel (Entz, 1884). *C. cyclopis* has been found in marine areas attached to harpacticoid copepods from Germany (Kahl, 1933). *C. cypridicola* as reported on the ostracod *Cypriden* sp., *Cyprideis littoralis* (Brady, 1938) and gastropods from Kiel, Germany (Kahl, 1933, Precht, 1935). *C. cytheridae* is epibiont on the hydroid *Cytherea* sp. from Bay of Kiel (Germany) (Kahl, 1933) *C. inflata* was found attached to filamentous algae from Coney Island, New York (Stokes, 1893). *C. maritima* was attached to a variety of substrates. *C. membranoloricata* reported attached to *Cladophora repens* (J. Agardh) Harvey 1849 and *C. heteronema* (C. Agardh) Kützing 1843 in Yugoslavian coastal waters (Stiller, 1968), and on the alga *Spirogyra* from West-dene Dam, Johannesburg (South Africa) (Viljoen & Van As, 1983). *C. nodosa* attached to algae from Valløe, fjord of Christiania (Norway) (Claparède & Lachmann, 1858). *C. triangular* found as epibiont on the halacarid *Copidognathus fabriciusi* and the ostracod *Cythereis tuberculata* from Kiel channel, Germany (Precht, 1935).

Differences between *Cothurnia mannarensis* sp. nov. and its related species are given in table 7. Other differences are: *C. inflata* has an external stalk short and slender, the lorica showed irregular ridges and furrows. *C. maritima* has a lorica with irregular ridges and furrows. *C. membranoloricata* has an endostyle short and broad, the pellicle has striated, without data about the macronucleus. *C. nodosa* has the lorica with one or more annular ridges, without data about macronucleus, external stalk slender, two zooids per lorica. *C. triangula* has an external stalk curved, and all the stalk was striated, with pellicular striations. *C. cyclopis* has lorica with irregular ridges and furrows, external stalk slender, without data about macronucleus.

Table 7. Comparison between <i>C. mannarensis</i> sp. nov. and its related species						
	Representative of <i>Cothurnia</i> sp.					
	<i>C. curvula</i>	<i>C. cyclopis</i>	<i>C. cypridicola</i>	<i>C. cytheridae</i>	<i>C. inflata</i>	<i>C. maritima</i>
Lorica length (µm)	60	60	50-60	70	60	35-56
Lorica width (µm)	30	25	20-25	35	30	28-33
Body length (µm)	60	80	70-80	45	75	60
Body width	8-20	20	10-12	20	12	12-15
Mesostyle	Absent	Present	Present	Present	Absent	Absent
Endostyle	Absent	Present	Present	Present	Present	Present
Stalk length (µm)	-	15	-	35	-	10-15
Stalk width (µm)	-	-	-	-	-	-
Macronucleus	Straight, longitudinal	-	-	Curved, longitudinal	Straight	Straight, longitudinal

Table 7 continued.....

	<i>C. membranoloricata</i>	<i>C. nodosa</i>	<i>C. párvula</i>	<i>C. triangula</i>	<i>C. mannarensis</i> sp.nov.
Lorica length (µm)	40-45	58	50-62	45	45.0-52.5
Lorica width (µm)	18-23	26	24	18	25.5-27.0
Body length (µm)	55-57	70	55	40-45	16.5-22.5
Body width (µm)	12-15	15-18	13	12	13.5-16.4
Mesostyle	Absent	Absent	Present	Present	Present
Endostyle	Present	Present	Present	Present	Present
Stalk length (µm)	8-12	15-55	-	10-15	10.4-6.0
Stalk width (µm)	-	-	-	-	6.0-7.5
Macronucleus	-	-	Longitudinal	Longitudinal	“C”transvsersal

***Cothurnia clampi* sp. nov.**

(Figs. 8, 24-26)

Locality

Gulf of Mannar, Station: 12

Host

Harpacticoid Copepoda. Epibionts located on the ventral surface of the body, until 4 epibionts per basibiont in infested specimens

Etymology

Named after Dr. John C Clamp, North Carolina central University. USA.

Description

These ciliates showed an elongated lorica. The external stalk is short, broad and showed a bulbous structure at the point of junction with the lorica. The external stalk is attached to substrate via a disk-shaped base. The zooid is elongated with the anterior part wider end the apical end sharpened. In several specimens the zooid are attached to the lorica via some membranous components, instead an endostyle. The macronucleus is “C” shaped located transversally in the anterior half of the body (figs. 8, 24). Measurements: lorica length, 53.2-67.8µm; lorica width (maximum), 25.6-31.5µm; body length, 36.1-45.3µm; body width, 21.0-27.4µm; stalk length: 5.3-9.1µm; stalk width, 6.0-10.5µm; macronucleus length, 22.5-28.4µm; macronucleus width, 4.3-8.8µm.

In some basibiont the ciliates are attached each other in a chain forming pseudocolonies (Figs. 25, 26). Similar ability to form chains or pseudocolonies has been described in *Cothurnia variabilis* Kellicot, 1883. In this species, ciliates are grouped in pseudocolonies with individuals attached by loricas to each other through the external stalk, forming chains with several zooids (Warren & Paynter, 1991).

Remarks

Present new species has similarity with *Cothurnia apseudophila* Lang., 1948, *C. cordylophorae* Kahl, 1933, *C. collaris*, Kahl, 1933, *C. nitocrae* Precht, 1935. , *C. stylarioides* Precht, 1935. *C. apseudophila* reported as epibiont on *Apseudes spinosus* from Swedish coastal waters (Lang, 1948). *C. cordylophorae* was found on the cnidarians *Cordylophora* sp., and on *Cordylophora caspia* (Kahl, 1933, Precht, 1935). *Cothurnia collaris* found on algae in laboratory tanks at Kiel (Kahl, 1933). *Cothurnia nitocrae* as epibiont on the harpacticoid copepod *Nitocra spinipes* Boeck, 1865 from Kiel channel, Germany (Precht, 1935). *C. stylarioides* was marine found originally attached to the polychaete *Stylarioides plumosus* (Precht, 1935).

Differences between *Cothurnia clampi* sp. nov. and its related species are given in table 8. Other differences are *C. stylarioides* showed an external stalk long and slender. *C. collaris* showed an aperture inclined and a neck curved, the external stalk was slender.

	Representative of <i>Cothurnia</i> sp.						
	<i>C. apseudophila</i>	<i>C. bipartita</i>	<i>C. collaris</i>	<i>C. cordilophora</i>	<i>C. nitocrae</i>	<i>C. stylarioides</i>	<i>C. clampi</i> sp. nov.
Lorica length (µm)	88-92	78-132	60-100	120	93-97	121	53.2-67.8
Lorica width (µm)	29-31	40-70	30-45	35	30-35	32	25.6-31.5
Body length (µm)	128-164	40-105	70-150	160	95	145	36.1-45.3
Body width (µm)	17-20	29-62	15-25	15	20	20	21.0-27.4
Mesostyle	Present	Absent	Present	Present	Present	Present	Absent
Endostyle	Present	Absent	Present	Present	Present	Present	Absent

Stalk length (µm)	-	20	-	40	-	12	5.3-9.1
Stalk width (µm)	-	0	-	-	-	-	6.0-10.5
Macronucleus	Straight longitudinal	Short, curved or vermiform	Elongate, longitudinal	-	Straight	-	"C" transversal

Cothurnia clampi sp. nov. also has similarity to the genus *Cyclodonta* Matthes, 1958 established based on single species *Cyclodonta bipartita* (Stokes, 1885) found from freshwater, and also on the crayfish *Cambarus affinis* and *Astacus leptodactylus* (Krucinska & Simon, 1968) because these ciliates have a lorica borne upon a short stalk and without valves or other means of closing aperture. Zooid attached to lorica via a series of membranes. Mesostyle and endostyle absents. Single species genus: *C. bipartita* (Warren & Paynter, 1991). *Cyclodonta bipartita* showed a lorica with fine longitudinal striations, the external stalk was curved, the body showed striations with convex ribbing between striations.

Phylum Ciliophora Doflein, 1901

Subphylum Intramacronucleata Lynn, 1996

Class Oligohymenophorea De Puytorac et al., 1974

Subclass Peritrichia Stein, 1859

Order Sessilida Kahl, 1933

Family Zoothamnidae Sommer, 1951

Genus *Zoothamnium* Bory de St. Vincent, 1826

***Zoothamnium* sp.**

(Figs. 9, 27, 28)

Locality

Palk bay, Tanaidaceans stn. Palk Bay, Stn.16; Gulf of Mannar Stn. 7

Host

Tanaidaceans, up to 6 epibionts per appendage in the median region of the body (stn 7); 2-21 epibionts per infested basibiont on the anterior area of the body (stn. 16).

Description

These ciliates have an oval body with a thick peristomial lips in the anterior area. The macronucleus is “C” shaped, located in the middle of the body. The micronucleus, spherical, located near the macronucleus. The stalk contains a contractile myoneme (Figs. 9, 27, 28). Measurements μm : body length , 18.0-22.5 μm .; Body width, 16.5-21.0 μm ; macronucleus length, 16.3-18.1 μm ; macronucleus width, 4.5-6.0 μm ; length of the stalk, 32.4-60.0 μm ; width of the stalk 6.3-8.7 μm .

Phylum Ciliophora Doflein, 1901

Subphylum Intramacronucleata Lynn, 1996

class Oligohymenophorea De Puytorac et al.

subclass Apostomatia Chatton & Lwoff, 1928

Order Apostomatida Chatton & Lwoff, 1928

Ciliates apostomatids

(Figs. 10, 29)

Locality

Gulf of Mannar, Stn: 8, 13

Host

Amphipoda, 10-165 epibionts per infested basibiont located mainly on the appendages of the median area of the body.

Description

The phoronts are observed in almost all specimens. The body is oval, attached to the substrate via a short and broad stalk. The body is surrounded by a thick wall. The macronucleus is elongated, accompanied by a spherical micronucleus (Figs. 10, 29). Measurements: length of the body, 13.5-21.0 μm ; width of the body, 9.2-12.0 μm ; length of the macronucleus, 7.4-10.5 μm ; diameter of the micronucleus, 3.0-4.5 μm ; length of the stalk, 1.5-3.0 μm ; width of the stalk, 3.0-4.3 μm .

Phylum Ciliophora Doflein, 1901

Subphylum Intramacronucleata Lynn, 1996

Class Phyllopharyngea De Puytorac et al., 1974

Subclass Suctorina Claparède & Lachmann, 1858

Order Endogenida Collin, 1912

Family Acinetidae Stein, 1859

Genus *Acineta* Ehrenberg, 1833

These ciliates are characterized by the presence of a lorica, with stalk, capitates tentacles in two fascicles located from two low lobe-like actinophores, body and lorica laterally compressed (Lynn & Small, 2000; Curds, 1985).

Acineta truncata Collin, 1909

(Figs. 11, 30)

Locality

Dias beach, Dona Paula, Goa India

Host

Harpacticoid Copepoda, On average 2 epibionts per basibiont located on the body surface.

Description

Ciliates with a cylindrical body lateral flattened, attached to substrate by a broad stalk. At the anterior end there are two actinophores that do not protrude excessively. Each actinophore has a group of capitates tentacles. A spherical macronucleus located on the anterior half of the body, and near of it a micronucleus is present. The stalk is characteristically broad with a thick external layer and an internal sinuous fibrillar band (Figs. 11, 30). Measurements: body length, 33-39.2 μm ; body width, 22.5-27.8 μm ; stalk length, 18.1-22.5 μm ; stalk width, 12.0-16.5; number of tentacles per actinophore, 7-10 μm ; diameter of the macronucleus, 7.5-10.5 μm .

Remarks

This species was reported earlier as epibiont attached to the gills of gammarid amphipods, on the abdomen and furca of the copepod *Ameira* sp. from Lake Baikal, Russia; Cete and Roscoff, France (Collin, 1912; Kahl, 1934).

Acineta tuberosa Ehrenberg, 1834

(Figs. 12-15; 31-35)

Locality

Dias beach, Dona Paula, Goa India

Host

Harpacticoid Copepoda, 1-82 epibionts per basibiont located on the body surface.

Description

Ciliates laterally flattened with pyriform to bell shape with a stalk of similar length to the body attached via a basal disc. The capitates tentacles are arranged in two fascicles bearing two inconspicuous actinophores. Macronucleus ovoid located in the median are of the body (Figs. 12-15; 31-35). Measurements: body length, 28.5-30.0 μm ; body width, 28.5 μm ; stalk length, 24.0; stalk width, 5.25 μm ; number of tentacles per actinophore, 8-12; diameter of the macronucleus, 30.0-37.5 μm .

Remarks

This ciliate was earlier reported as epibiont on the gammarid amphipods *Gammarus* sp. (marine and fresh water) and *Corophium* sp.; on the isopods *Idotea*, *Asellus*, and *Microcerberus*; on the antennae, maxillae, maxillipeds, pereopods, pleopods, and uropods of the decapod *Astacus leptodactylus* Eschscholtz 1823 (cf. Matthes & Guhl, 1973). On the decapod *Crangon*, on the isopods *Idotea balthica* (Pallas, 1772) (as *I. tricuspidata*) and *Microcerberus remyi* Chappuis, 1953; and on the amphipod *Gammarus locusta* (Linnaeus, 1758) (cf. Curds, 1985), between the spines of the telson on *Gammarus pulex* (Linnaeus, 1758) from Germany (Bierhof & Roos, 1977). Also on the isopod *Asellus aquaticus* (Linnaeus, 1758) (cf. Cook et al. 1998). On the uropod of the decapod *Cambarellus patzcuarensis* Villalobos, 1943, lake Pátzcuaro (Michoacán, Mexico) (Mayen-Estrada & Aladro-Lubel, 1998). On *Liocarcinus depurator* (Linnaeus, 1758), *L. vernalis* (Risso, 1827), *Goneplax rhomboids* (Linnaeus, 1758), *Dardanus arrosor* (Herbst, 1796), *Paguristes oculatus* (Fabricius, 1775), *Pagurus excavates* (Herbst, 1791), and *Pagurus prideaux* Leach, 1815 from N.W. Mediterranean Sea (Fernandez-Leborans, 2003).

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Figure Legends:

Figure 1. Map of the study area and location of the sampling sites.

Figure 1. Carte de la zone d'étude et des sites de prelevement.

Figures 2-9. 2. *Cothurnia palkensis* sp. nov. , 3. *Cothurnia nova* sp. nov. 4-5. *Cothurnia disper* sp. nov. 6. *Cothurnia dovgali* sp. nov. 7. *Cothurnia mannarensis* sp. nov. 8. *Cothurnia clampi* sp. nov. 9. *Zoothamnium* sp.

Figures 10-15. 10. Ciliates apostomatids , 11. *Acineta truncata* 12-15. *Acineta tuberosa*

Figures 16-24. 16-17. *Cothurnia palkensis* sp. nov., 18-19. *Cothurnia nova* sp. nov. 20-21. *Cothurnia disper* sp. nov. 22. *Cothurnia dovgali* sp. nov. 23. *Cothurnia mannarensis* sp. nov. 24 . *Cothurnia clampi* sp. nov.

Figures. 25-35. 25-26. *Cothurnia clampi* sp. nov.(pseudocolonies), 27-28. *Zoothamnium* sp., 29. iliates apostomatids, 30. *Acineta truncata* Collin, 1909,

31-35. *Acineta tuberosa* Ehrenberg, 1834.

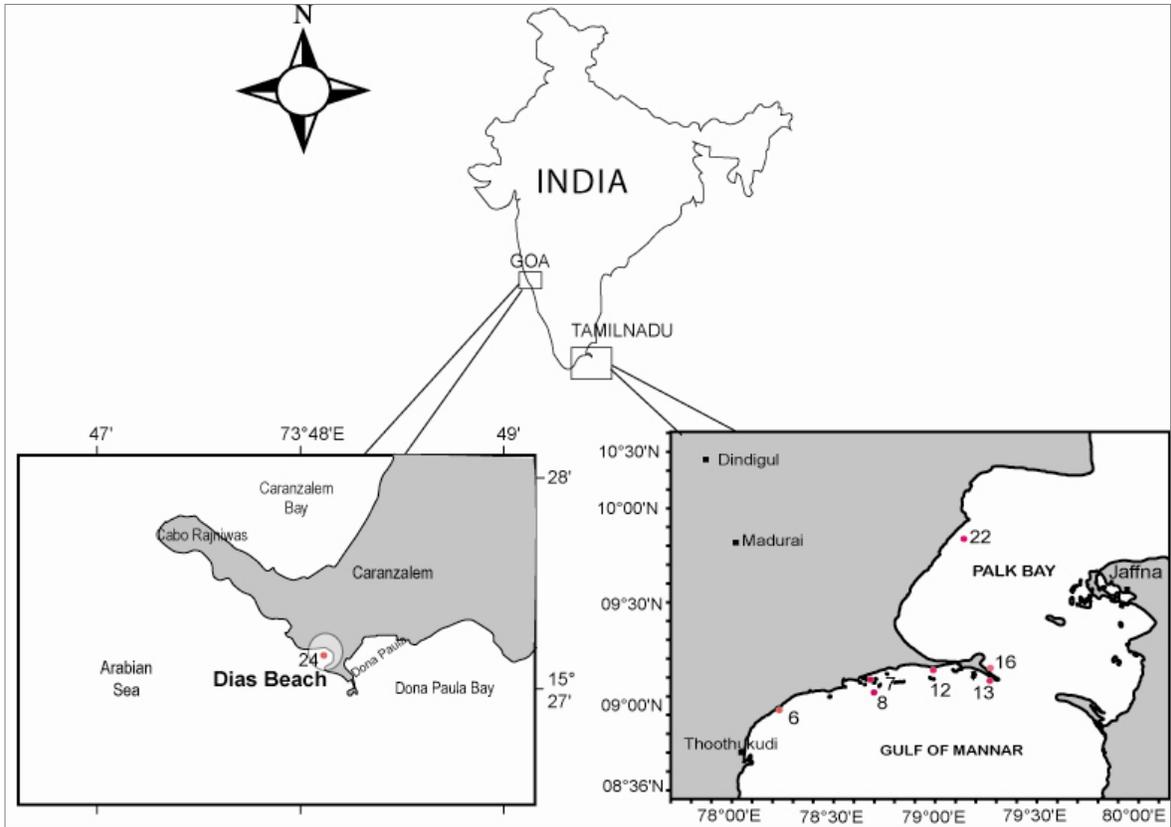


Figure 1

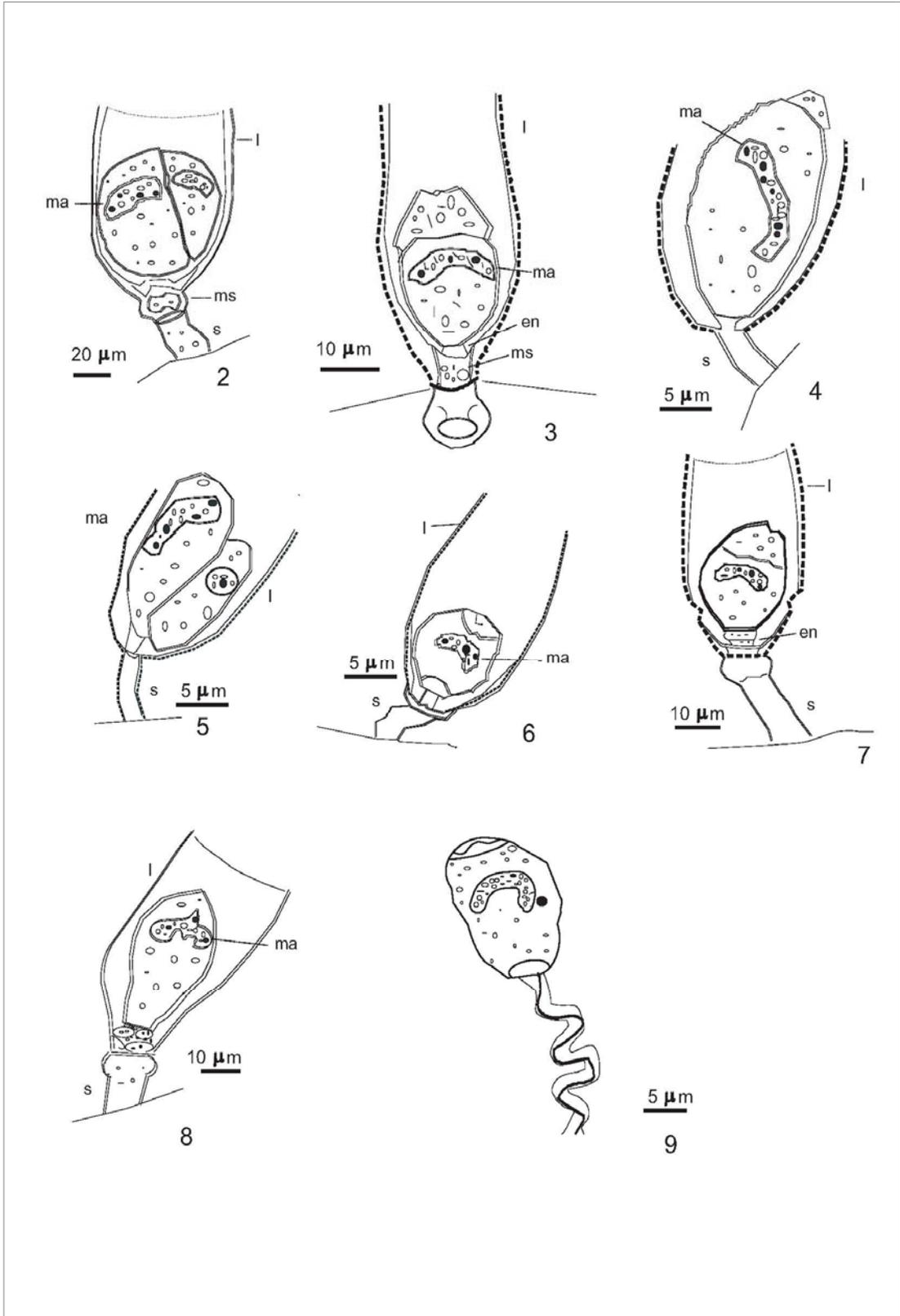


Figure 2-9

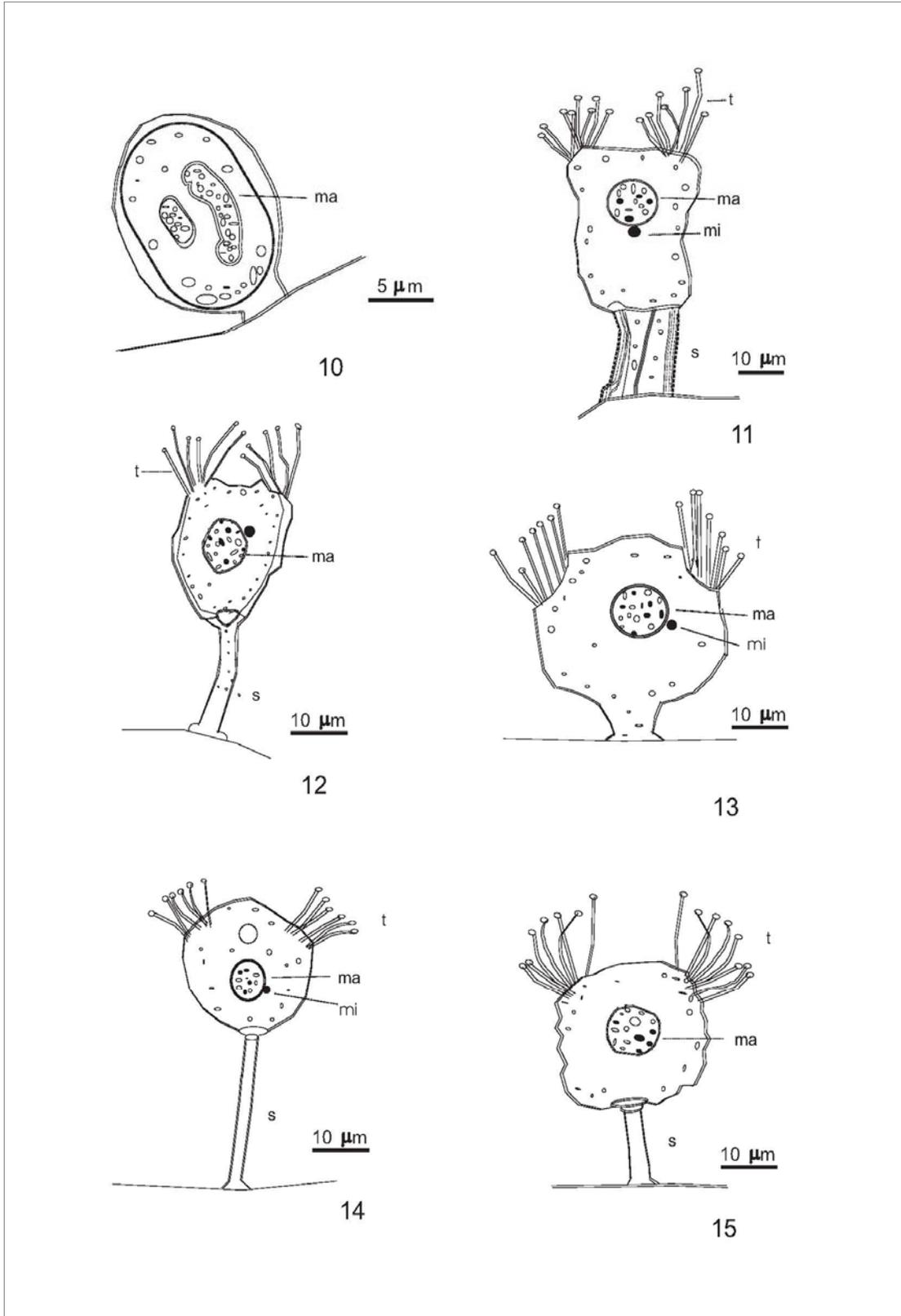


Figure 10-15

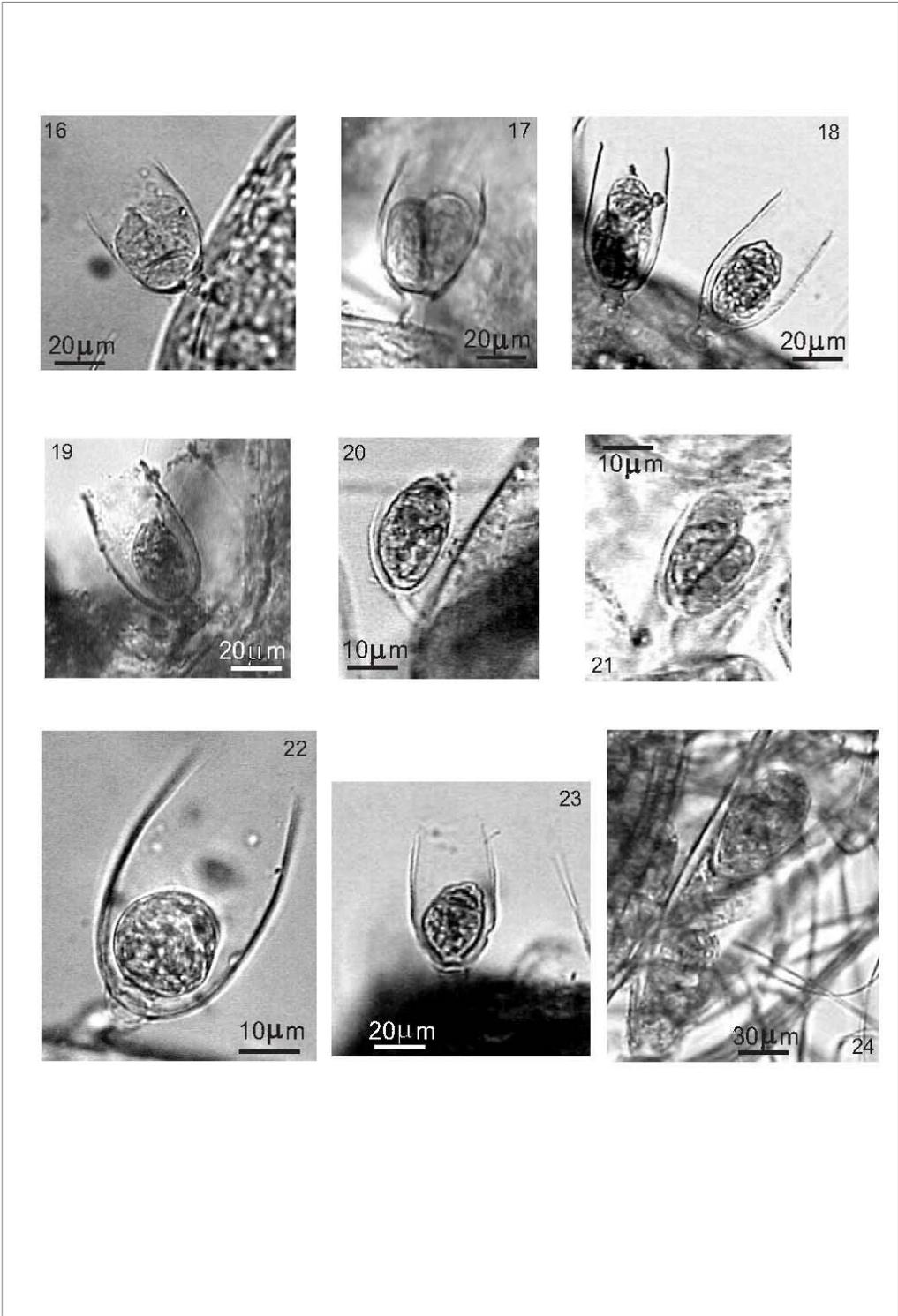


Figure16-24

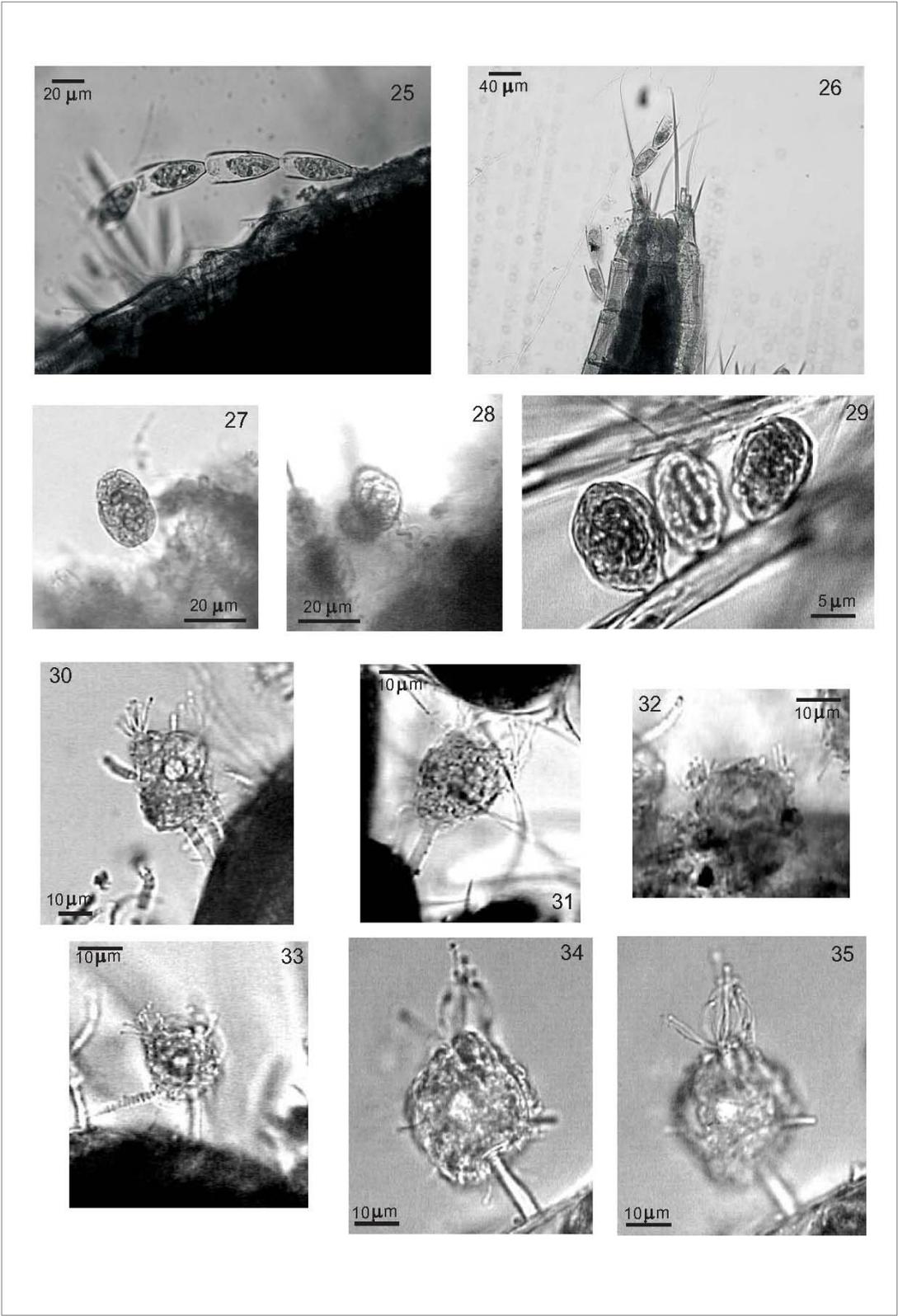


Figure 25-35