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By

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INTRODUCTION

In India, a number of species of marine and estuarine molluscs, gastropods and bivalves, must definitely be considered to be of economic importance since not only are these frequently used as food, but are regularly found in markets to meet other commercial demands. Indeed, molluscs represent one group of marine animals which is already serving to fulfil the the need for proteins by a large percentage of the world's population.

The sole intent of this monograph is to elucidate about the ciliate parasites of commercially important marine and estuarine molluscs of Indian waters. However, as the search of literature progressed, it became increasingly evident that very little is known about the more subtle, yet important, aspects of parasitism among these invertebrate populations. As would be expected, many organisms have been reported to parasitize commercial molluscs and there have been some not too discrete statements as to the pathogenicity and lethality of certain of these parasites including protozoons. Unfortunately, these pieces of information hardly sufficed in assembling a continuous and natural description of parasitism so far as Indian molluscs are concerned. For this reason, the present topic has been chosen to include information that would exemplify the interactions involved in all types of symbiotic or parasitic associations and on all the different types of molluscs, but without losing sight that the estuarine and marine species are of primary concern in this communication.

Several mass mortalities of shellfish, particularly of oysters, throughout the world during the last five decades have aroused the concern of the industry and of the fishery biologists and shell-fishermen. Many natural oysterbeds were wiped out and have yet to recover. In addition to these major mortalities, numerous others have been reported and several zooparasites have been found in oysters and other commercially important pelecypods. Although the cause and effect relationship in most cases has not been established, there is a legitimate concern over such parasites as possible lethal agents.

The other important reason for the interest of shellfish biologists in parasites of marine molluscs lies in the possibility that certain protozoan parasites of predatory molluscs (such as the oyster drills, *Urosalpinx cinerea, Eupleura caudata* and *Thais haemastoma*), may be utilised as biological control agents. Until now, only limited and preliminary studies of this nature have been conducted (Cooley, 1958, 1962) and hence the effectiveness of these parasites as control agents remains unknown for the most part (Carriker, 1955).

The present monograph deals with the observations on the holotrichous ciliates of the orders Hymenostomatida, Thigmotrichida and Peritrichida, including the descriptions of fourteen species, seven new to science, infesting at least eight molluscan hosts : *Littorina (Littorinopsis) scabra scabra*, *L. melanostoma*, *Cerithidea obtusa*, *C. cingulata*, *Crassostrea cuculata*, *Mactra luzonica*, *Modiolus (Modiolus) striatulus* and *Donax lubricus*, inhabiting the littoral waters of Indian coasts.

One new species of *Cristigera* of the family Pleuronematidae (order Hymenostomatida), three species of *Ancistrocoma* and one species of *Rabella* of the family Ancistrocomidae, six species from the family Hemispeiridae distributed over four genera - two each of *Ancistrumina* and *Fenchelia*, and one each of *Boveria* and *Protophrya*, four of these having been proposed to be new to the family, are described in the present monograph. Under the order Peritrichida three species have been described of which two belong to the genus *Scyphidia* of the family Scyphidiidae and one to the genus *Trichodina* of the family Urceolariidae, all the three ciliate parasites, as claimed in this monograph, are new discovery and first report from molluscan hosts from the eastern hemisphere.

The order Thigmotrichida which embraces the family Ancistrocomidae and Hemispeiridae along with six others (Conchophtheridae, Thigmophryidae, Hysterocinetidae, Nucleocorbulidae, Hypocomidae and Sphenophryidae) has been dealt with in details in this monograph with a deliberate purpose. Thigmotrichida, a well established assembly of several families which are characterized by various adaptive changes, may prove to be a convenient material for the study of evolutionary trends in ciliates and which may contribute to elucidate the phylogenetic problems as well. Also, the strong morphological and physiological adaptations to the parasitic life allow to justify the interesting interdependence in the host parasite relations.

The general architecture and orientation of the Thigmotrichida body display great differentiation and many-sided specialisation. Interpretations by various authors as to the orientation of the body are very controversial. In Hymenostomatida as well as in Thigmotrichida occurs a shifting of the cytostome not together with the ends of kineties, but between kineties along a line which constitutes the prolongation of the anterior suture of the kineties.

Just secondarily, some kineties, the nearest to the cytostome, may be involved into its service. As a rule those are the adoral kineties situated on the right of cytostome. In this situation the body side or its margin or more exactly the 'body meridian' along which shifts the cytostome, should be accepted as the ventral one. The opposite margin is consequently the dorsal one and the division of the body into two lateral parts is indicated by : the anterior suture, the 'median' with the cytostome and the posterior suture. This system corresponds to the division of the system of kineties into the right and left parts. The thigmotactic area lies in the anterior part of the left body side and the buccal apparatus tends to shift to the right side. The disposition of kineties support very well and distinctly this orientation. The problem of spiralization is of special importance on account of the meaning of the spiralization directon of the cortical elements for the systematic of ciliates and for some phylogenetic conclusions bound with this problem.

The classification of the described ciliates employed herein for the higher taxa (order and the familial designations) are after R. R. Kudo (1966) or, those of original authors.

HISTORICAL REVIEW

Nearly three centuries ago, Antoni von Leeuwenhoek was probably the pioneer discoverer of ciliates, and O. F. Müller was the first man who, some two hundred years ago, published an extensive treatise on all protozoa, including the ciliates. Müller (1788) first described a ciliate *Tricoda ciliata* in *Mytilus edulis*. Then Ehrenberg produced his monumental, never-to-be-forgotten taxonomic work during the first half of the nineteenth century ; and men like Dujardin, Claparede, Lachmann, Pritchard, Siebold, Wrzesniowski and specially Stein authored influential papers and monographs well before the final quarter of the past century. Otto Bütschli, a great 'architect of protozoology', made an invaluable contribution during 1887—1889 on well organised and exhaustive volume on the 'Infusoria', as the ciliates were for a long time known which represented such a masterful compilation of earlier ideas of his own and others on the systematics of these protozoa.

Quite recently there has been a new surge of interest in modernising the scheme of classification for the Ciliophora, particularly because of the ready availability of new characteristics, including ultrastructural features, judged to be of significance in the comparative systematics of protists assigned to this important group. The laudable and novel Faurean scheme of ciliate classification produced in a brief but classical paper published by Faure-Fremiet in 1950 and soon thereafter expanded and nomenclaturally tidied up a bit by Corliss (1956, 1957, 1961). This came into being largely because 'Monsieur Faure' has been intuitively by the evolutionary possibilities which he immediately sensed once he had thoughtfully compared infraciliary structures of representative members of a number of allegedly distinct orders and classes of the sub-phylum CILIOPHORA.

The new approaches to the taxonomy of the 'phylum Ciliophora' have been introduced in the recent papers of Corliss (1974a, b, 1975, 1977) Jankowski (1967, 1972, 1973a, b) and de Puytorac *et al.* (1974). The corlissian scheme of classification, with its emphasis on ideas and overall advances in the so-called 'changing world of ciliate systematics', left something to be desired from the pragmatic point of view of applicability in the real world of courses in protozoology.

The data playing the major role in the various raised classifications have come from ultrastructural studies (Grain, 1969 ; Grain *et al.*, 1973 ; Pitelka, 1969 ; and works of many other cell biologists), but reviewed attention to morphogenetic patterns (Corliss, 1968 ; 1973 ; Frankel, 1974 ; Sonneborn, 1975 ; Tuffrau *et al.*, 1974) and to nuclear differences (especially macronuclear) has also been a significant factor in recognising a greater degree of diversity among the ciliates. Ecological factors, too, are coming to be viewed as of increasing importance.

The statement in the literature concerning ciliates living in the mantle cavity of lamellibranchs is found in Ehrenberg (1838). He described a big ciliate named *Leucophrys anodontae* from *Anodonta* of the river Ob - Siberia. F. Stein (1861) created for it the genus *Conchohthirus* and described the second species of this genus, namely *C. steenstrupi* from the slime of terrestrial *Pulmonata.* Also Stein (1859, 1867) recognised only four major groups of ciliates the Holotricha, Heterotricha, Hypotricha and Peritricha. Quennerstedt (1867) described a ciliate *Opalina mytili* from *Mytilus edulis* from the West coast of Sweden. Maupas (1883) found this and another species of the same genus in *Mytilus edulis* and *Venus striatula*, respectively, from the Mediterranean and erected the genus *Ancistrum* for them, giving a fine description of their morphology. He also suggested that these ciliates must be derived from the pleuronematine hymenostomes.

J. Roux (1901) erected the genus *Cristigera* and Kahl (1931, 1935) in his review work included the genus under the family Pleuronematidae with a number of 11 species.

Issel's memoir (1903) is the first comprehensive systematical investigation on ciliates from lamellibranchs and gastropods. He found and described several species of *Ancistrum* and *Boveria* and a new genus, *Plagiospira*. These three genera : *Ancistrum*, *Plagiospira* and *Boveria* represent according to him an evolutionary sequence characterized by further spiralization and retrogradation of the two adoral kineties. pickard (1927) who did not know the work of Issel, created for *Boveria* a new family Boveriidae and included it to *Heterotricha*. In the first two decades of the twentieth century several thigmotrich species were described and placed in different orders. Lichtenstein (1921) initiated the studies on 'Hypocomidae' from the gills of molluscs and described *Hypocoma patellarum* with non-concentric ciliature.

Chatton and Lwoff (1921, 1922a, b, c, 1923, 1926, 1929, 1936, 1939a, b) published a long series of papers on the ciliate fauna of molluscs which were included in a memoir on the morphology and systematics of the thigmotrich ciliates (1949, 1950). They created the order Thigmotrichida and demonstrated the monophyletic origin of the order. But the key leadership role fell to a modest high school teacher in Hamburg, Germany, Alfred Kahl (1930—1935, 1934) who is the first author to accept the order Thigmotrichida in a general treatment on ciliates. In the year 1931 he also created the family conchophthiridae among Thigmotrichida for the numerous species of the genus *Conchophthirus*. Also Cheissin in 1931 described an endemic fauna of hemisperids from molluscs in the Baikal sea.

The extensive work of Raabe (1933a, b, 1934, 1935, 1936, 1938, 1947a, b 1949a, b, 1959, 1963, 1965, 1967, 1969, 1970, 1971, 1972), Jarocki (1934, 1935), Jarocki and Raabe (1932), Kidder (1933a, b, c, d, e, 1934a, b), Uyemura (1937), Antipa (1971), Antipa and Small (1971a, b), Pauley *et al.* (1965a, b, 1967), Kozloff (1945a, b, 1946a, b, c, d, 1954, 1955, 1956a, b, 1957, 1960, 1961), Corliss (1952a, b, 1953a, b, 1961, 1974, 1975, 1977), Czapik (1968), Khan (1970), Laval and Tuffrau (1973), Hatzidimitriou and Berger (1977) have enriched our knowledge on thigmotrich and other ciliates considerably.

The basic change occurred in the systematic structure of Hemispeiridae when Kazubski (1958) described a very peculiar species *Thigmocoma acuminata*. He described it from the renal organ of the terrestrial *Pulmonata* and he established for it a separate family Thigmocomidae.

The lack of an ultrastructural study of the whole group of Thigmotrichida was pointed out first by Pitelka (1963) in her book 'Electron microscopic studies of Protozoa' The only work published since then, on the ultrastructure of this group by Lom and Kozloff (1966, 1968). Lom, Corliss and Noirot-Timothee (1968) made the first comparative studies on the buccal apparatus of *Ancistrum* and *Boveria,* in which they recognized certain homologies in the adoral ciliature with peritrichs and hymenostomes. Puytorac (1969), Lom and Kozloff (1969), Khan (1969, 1971) also offered some interesting fine structures for comparision of the genera *Ancistrocoma, Ancistrumina, Ancistrum* and *Boveria.*

Again Kazubski (1963) points out that the range of differentiation of Thigmocomidae and Protophryinae or Hemispeirinae is not higher than that one between the two subfamilies. He suggests the recognition of Protophryinae, Hemispeirinae and Thigmocomidae as three separate but strictly connected families. However, this problem may be approached in another way and the taxa can be recognized as subfamilies of one family Hemispeiridae. Corliss (1961) includes the following families under order Thigmotrichida :

Family : Hemispeiridae König, 1894
Family : Thigmocomidae Kazubski, 1958 pro *Thigmocoma acuminata* Kazubski, 1958
Family Ancistrocomidae Chatton et Lwoff, 1939
Family : Sphenophryidae Chatton et Lwoff, 1921
Family : Hypocomidae Bütschli, 1889, emend. Chatton et Lwoff, 1939 (?)
Family : Conchophthiridae Kahl, 1931, 1934
Family : Thigmophryidae Chatton et Lwoff, 1923
Family : Peniculistomatidae Fenchel, 1965 pro *Peniculistoma mytili* (de Morgan) Janokowski, 1964
Family : Hysterocinetidae Diesing, 1866

These families embrace presently over 50 genera, and 150 species.

Very little, however is known concerning the taxonomy, biology and distribution of parasitic and commensal ciliates of molluscs from the Indian waters. Ghosh (1918, 1921, 1922) described *Conchophthirus elongatus, Conchophthirus lamellidens* from *Lamellidens marginalis* ; *Anoplophrya elongata, Anoplophrya variabilis* from the rectum and intestinal tract of small freshwater Gastropods ; *Nyctotherus kempi, Balantidium depressum* from the rectum of *Pila globosa* and *Anoplophrya cylindrica* from the intestinal canal of common banded pond snail *Vivipara bengalensis.* Chakraborty (1936a, b, 1937), Chakraborty, Mitra and Ray (1959) described *Balantidium depressum* (Ghosh), *Nyctotherus kempi* Ghosh from lannd snail *Pila globossa. Conchophthirus lamellidens, Conchophthirus elongatus* and *Conchophthirus curtus* from fresh water mussel *Lamellidens marginalis.*

Ganapati and Nagabhushanam (1955) described *Boveria teredinidi* from the shipworms at Visakhapatnam and Santhakumari and Nair (1970, 1973) described *Nucleocorbula adherens* gen. & sp. nov. representing a new family. *Nucleocorbulidae* from the mantle cavity of the shipworms *Nausitora hedleyi* and *Teredo furcifera* and also other ciliates from marine woodboring molluscs in the estnarine localities of the south west coast of India.

Kirby (1941) has given a good and valuable review on the biology of parasitic ciliates, not least the thigmotrichs. Raabe (1947b, 1949a, 1956) has treated the morphological adaptation and geographical distribution of the latter group, while Reynoldson (1950, 1951, 1955) and Brouardel (1951) have given highly significant contributions on the ecology of the urceolarids.

In recent years it has been discovered that the peritrich scyphidiids and urceolarids also play a role as commensals in molluscs (Hirshfield, 1949 ; Uzmann and Stichkney, 1954 ; Hampi, 1955 ; Raabe and Raabe, 1959, 1961 ; Fenchel, 1955 ; Lom and Corliss, 1968 ; Stein, 1974 ; Lom, 1977).

In protozoological text books, as in Bhatia (1936), Doflein and Reichenow (1949-1953), Corliss (1961), Mackinnon and Hawes (1961), Kudo (1966) and Manwell (1968), the thigmotrichs have been treated in details and with full acceptance of Chatton and Lwoff's interpretation of the systematics of the group.

Very recently, Berger (1964, 1965), Lynn and Berger (1972, 1973), Berger and Hatzidimitriou (1978) postulate that incipient adaptive radiation prevalents in species of commensal ciliates which can be determined by multivariate morphometric analysis. Kazubski (1977, 1978a, b, c) also noted prevalence of widespread morphological variability among the thigmotrichid ciliates in different molluscan host population based on geographical distribution and various ecological parameters.

MATERIAL AND METHODS

The host material were mainly collected from the mangrove swamps of deltaic Sunderbans of the Hooghly-Matla estuary, South-West coast of

Sagar Island, Digha sea coast, all under the state of West Bengal, Waltair sea coast and Kakinada estuary of Andhra Pradesh, and Miramer and and Korenzalem sea beaches of Goa, on the west coast of India. All the host animals have been identified by the Zoological Survey of India, Calcutta and the British Museum of Natural History, London.

Living ciliates were examined and studied under phase contrast or compound microscope with ordinary light conditions in fresh smears from the mantle cavity, labial pulp, gills or ctenidium, kidney and intestine of the marine and estuarine gastropods and pelecypods. The respective organs diluted with 0.5% saline solution or with body fluid in which the protozoans remained less deformed and more active for a prolonged period. All species were also anaesthetized with 0.4% $NiSo_4$ solution (Bovee, 1958) for detail studies in live condition.

Fixation of the organisms for permanant preparations was accomplished by taking contact smear on a slide and then dropping the smear-slide in a coupline jar containing hot Schaudinn's fluid (about 60°C) and later stained with Heidenhain's iron alum-haematoxylin.

Silver impregnation techniques, which are indispensable for the study of infraciliature and kineties of the ciliates, were emploʎed after Corliss (1953) and Klein (1958).

Sections of the host tissues, to demonstrate different ciliate's preferred microhabitats, were studied by the application of usual histochemical techniques. The different tissues of the molluscan hosts were fixed in Bouin's fluid and 6 μm paraffin embedded sections were cut and stained in iron alum-haematoxylin.

Measurements were made both from living ciliates and from permanent stained slides. The dimensions of the species concerned were based on measurements of twenty five specimens taken at random. Specimens were measured with the help of calibrated occulometer and drawings were made with a camera-lucida. Measurements for trichodin ciliates followed the system as proposed by Lom (1958).

The photomicrograghs were taken with the help of Leica M4-2, Asahi Pentax ME and Carl Zeiss Ultra Fort-II microscope.

Both holotype and paratype preparations of described species have been deposited in the National Zoological Collection of the Zoological Survey of India, Calcutta.

SYSTEMATIC PART

A. Order HYMENOSTOMATIDA Delage and Herouard, 1896
Suborder PLEURONEMATINA Faure-Fremiet in Corliss, 1956

Diagnosis : With a conspicuous undulating membrane ; no vestibule ; cytostome in the middle section on posterior half of body ; body ciliation sparse.

Family (i). PLEURONEMATIDAE Kent, 1882
(for Aphthoniidae ; Syn. Cyclidiidae)

Diagnosis : With the characters of the suborder.

Genus (i). **Cristigera** Roux, 1901

Syn. : *Aulaxella (Aulax)*

1901. *Cristigera* Roux, *Mém. Inst. nat. Genévé.*, pp. 1—148 ; Kahl, 1931, *Teil* **21** : *Holotricha*, pp. 382—386 ; Kahl, 1935, *Teil* **30** : Peritricha and Chonotricha, P. 835 ; Kudo, 1966, *Protozoology*, 5th Edn., Thomas, Springfield, Illinois, 1174 pp.

Diagnosis Small, 15 – 60 μm long ; ovoid ; much compressed ; with a postoral depression ; usually with refractile pellicle ; with a caudal cilium ; peristome closer to mid-ventral line ; on its right edge occurs a membrane which forms a pocket around cytostomal groove and on its left edge either free cilia or a membrane which unites with that on right ; no semicircular swelling on the left side of oral region ; round macronucleus with a micronucleus ; contractile vacuole posterior ; fresh or salt water.

1. **Cristigera susamai** sp. nov.
(Figs. 1—3 ; Plate I Figs. 1—5)

Type-host : *Crassostrea cucullata* (Born).

Type-locality : Meeting point of the Hooghly river with Bay of Bengal, Sagar Island, West Bengal, India.

Type-material : On slides.

Holotype : Z.S.I., Reg. No. Pt. 2042

Paratype : Z.S.I., Reg. No. Pt. 2043—2044

Coll. Dr. Y A. Jamadar.

Morphology : Body ovoid, much compressed, anterior end pointed and posterior end slightly broad with a distinctly convex dorsal surface and a somewhat flattened ventral surface. The cytoplasm of the anterior third of the body contains dense granules by which it differs from the rest of the body. The granules are easily distinguishable in the live materials. Its length is 33.52 μm (25.5—42.5 μm) and width 11.42 μm (8.5—13.6 μm). Macronucleus 5.1—10.2 μm x 3.4—8.5 μm, usually round, rarely ovoidal, typically situated mid-dorsally ; micronucleus 1.7—2.55 μm in diameter, sometime ovoid, usually in front of the macronucleus. Buccal cavity occupies a conspicuous position on the ventral surface of the body, lying just above the macronucleus and extending to the mid-ventral line of the body. The cytostome is located towards the left margin of this cavity and possesses an undulating membranelle that forms a protruded cup like structure. The somatic cilia of the anterior third of the body are 5.1 μm and the posterior ones are 3.7 μm in length. One long caudal cilium (11.9 μm) is present at the tip of the posterior end which is evidently visible in the living condition. Generally the organism moves spirally being assisted with the trailing cilium.

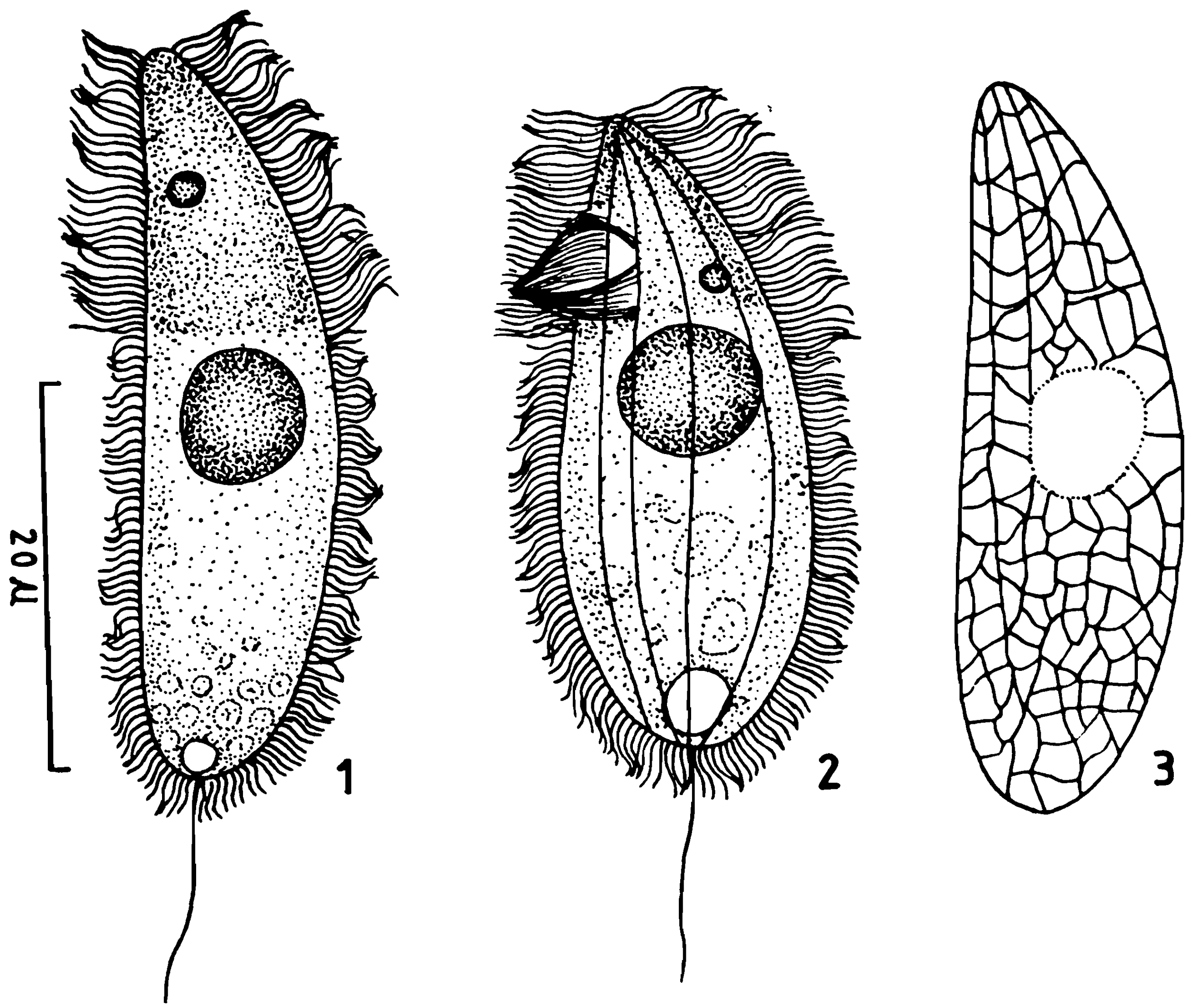


Fig. 1-3. Camera lucida drawings of *Cristigera susamai* sp. nov. from *Crassostrea cucullata* (Born). 1, *Cristigera susamai* sp. nov. ; 2, body showing cytostome with protruded cup, position of contractile vacuole, macro and micronucleus arrangement of kineties ; 3, argentophilic fibrils forming reticulate structure.

Kineties of the general ciliature run more or less meridionally, 8—12 in number. The basal granules are prominent in silver impregnated animals and are seemingly connected to each other by a delicate argentophilic fibrils thus rendering a delicate reticulate structure. The contractile vacuole is a circular, highly refractile organelle located at the posterior middle, slightly on the right side of the body. When examined in living condition it was revealed that the contractile vacuole contracts in sequence from anterior to posterior direction and each rhythmical contraction phase (systole-diastole) takes about 20—30 seconds approximately.

The species multiplies normally by binary fission throughout the season. Conjugation has been observed in the early winter season.

Ecology : The pelecypod host *Crassostrea cucullata* (Born) which harbours the ciliate under report is a resident of brackish water estuarine zone with sufficient marine influence and which experiences a seasonal salinity fluctuation ranging from 0.5% to 32.0%. During the monsoon when salinity drops down to a minimum, the ciliate living as entocommensal becomes scarce to nill showing their least tolerance to low salinity. Prevalence of the ciliates was recorded during the lean period, November to March, when salinity reached the maximum limit.

Occurrence (*Microhabitat*): The ciliate is found to inhabit the gills and labial palps of *Crassostrea cucullata* (Born) but on rare occasions. So far six out of a total of 154 host individuals were found to be infected by this ciliate which have been examined during November 1976 to December 1977.

	Mean in μm	Range in μm
Length of the body	33.52	25.5—42.5
Breadth of the body	11.42	8.5—13.6
Length of the macronucleus	7.54	5.1—10.2
Breadth of the macronucleus	5.67	3.4— 8.5
Diameter of the micronucleus	1.80	1 7— 2.5
Distance of the macronucleus from the anterior end	10.47	5.1—17.0
Length of the cilia of the anterior region of the body	5.10	—
Length of the cilia of the posterior region of the body	3.70	—

Length of the caudalocilium	11.90	—
Number of kineties	—	8—12
Inter-kinetic distance in the middle of the body	1.92	1.7— 3.4

Remarks: Roux erected the genus *Cristigera* in 1901. Kahl (1931) included the genus under the family Pleuronematidae and in his review work (Kahl, 1931, 1935) a total of 11 species have so far been covered under this genus. These are *Cristigera (Aulax) paucisetosa, C. pleuronemoides, C. phoenix C. minor, C. setosa, C. media, C. minuta, C. vestita, C. cirrifora, C. penardi* and *C. sulcata* all of them in the Table 1 being free living ciliates inhabiting fresh or salt water. The present species was recovered from the gills and labial palps of the bivalve host *Crassostrea cucullata* but the infected shells constitute a very insignificant part of the gregareous host population. Surrounding brackish water of the *Crassostrea habitat* has been thoroughly examined during different seasons for the ciliate but with negative results. So the ciliate under consideration is presumed to establish a sort of heterospecific association (commensalism) with the pelecypod molluscan in contrast to the other members of the genus all of which are freeliving. Specific characterisations, morphometric measurements and the geographic distribution of the ciliate with a bivalve host incite to distinguish it obviously from all the other members of the genus *Cristigera* recorded and described so far from different parts of the globe. So, the ciliate from Sagar Island is proposed to be christened with *Cristigera susamai* new species and to be incorporated as the twelfth species under the genus *Cristigera*.

B. Order Thigmotrichida Chatton and Lwoff, 1922
Suborder Rhynchodina Chatton and Lwoff, 1939

Diagnosis: Cytostome lacking, but with anterior suctorial tentacle; body ciliature mostly reduced, absent in some.

Family (ii). Ancistrocomidae Chatton and Lwoff, 1939

Diagnosis: Ovate to pyriform; suctorial tentacle; body and thigmotactic ciliation confined to anterior part of body.

Subfamily Ancistrocominae Chatton and Lwoff, 1939; Raabe, 1967

Diagnosis: Elongated and relatively large body (30—60 μm). The ciliature occupies the great part of the body in longitudinal and in circumferential aspect and consists, as it seems, of partially preserved general ciliature embracing the thigmotactic ciliature as in parentheses ('systéme,

(Measurements : in microus)

Table 1. Survey on data on the Genus *Cristigera* (reproduced from Kahl, 1931, 1933)

Species	Author	Habitat	Body size	Body shape	Macronucleus Length and breadth	Micronucleus diameter	Peristome	Somatic cilia	Caudal cilium	Number of kineties	Inter kineties distance	Position of CV	Host
Cristigera (Aulax) *paucisetosa*	Gourret & R., 1888	Marine	50-60 µ	Small spindle form, ventral side concave	—	—	Peristomial membrane half of the body length	Cilia restricted to anterior and posterior part	Long	—	—	—	—
Cristigera pleuronemoides	Roux, 1901	Marine	60-70 µ	Ovoid, frontal plate not prominent, broken ciliation in the middle region ; cytoplasmic inclusion in the posterior part of the body	—	—	Peristome not extend upto the middle	Cilia restricted to anterior and posterior part	Long	—	—	—	—
C. phoenix	Penard, 1922	Marine	35-50 µ	Long, eliptical	—	—	—	Cilia in middle portion, very small	Long	—	—	Posterior middle in the right side	
C. minor	Penard, 1922	Marine	25-30 µ	Small, eliptical	—	—	Not reaching the middle	Cilia in middle portion, very small	Long	—	—	Posterior middle in the right side	
C. setosa	Kahl, 1928	Marine	26-33 µ	Ovoid body, broad frontal plate	—	—	2/3 of the body length	Cilia restricted to anterior and posterior part	Long	—	—	—	—
C. media	Kahl, 1928	Marine	45-50 µ	Broad and ovoid	—	—	Half of the body length with broad membrane	Cilia throughout the body except the anterior tip	Long	—	—	—	—
C. minuta	Kahl, 1928	Marine	26-33 µ	Small ovoid, frontal plate relatively smaller, plasma with shining granules	—	—	Half of the body length with broad membrane	Cilia throughout the body except the anterior tip	Long	—	—	—	—
C. vestita	Kahl, 1928	Marine	25 µ	Cylindrical, post oral depression small	—	—	Half of the body length with broad membrane	Cilia throughout the body except the anterior tip	Long	—	—	—	—
C. cirrifora	Kahl, 1928	Marine	24-28 µ	Ovoid body with cirri , membrane as long as the body length	—	—	Half of the body length with broad membrane	Cilia restricted to anterior and posterior part	Long	—	—	—	—
C. penardi	Kahl, 1931	Marine	58-70 µ	Post oral depression small	—	—	1/3 of the body length	Cilia restricted to anterior and posterior part	Long	—	—	—	—
C. sulcata	Kahl, 1933	Marine	60 µ	Similar to *phoenix* but more broad conspicuous frontal plate	—	—	Half of the body length	Cilia throughout the body except the anterior tip	Long	—	—	Subterminal right	—
C. susamai sp. nov.	Jamadar, 1979	Brackish water, ento-commensal	28.5-42.5 µm	Ovoid, much compressed, anterior end pointed and posterior end slightly broad with a distinctly convex dorsal surface and a somewhat flattened ventral surface	5.1-10.2 µm 3.4-8.5 µm	1.7-2.55µm	1/3 of the body length	Cilia throughout the body, 5.1µm at the anterior part and 3.7µm at the posterior part of the body	11.9µm	8-12	1.7-3.4µm	Posterior middle in the right side	*Crassostrea cucullata*

sécant'). Lack of differentiated adoral kineties. The nuclear apparatus common. Vacuoles of concrements can occur in the hind part of the body. Parasites of thh mantle cavity of marine and fresh water Bivalvia (After Raabe, 1970).

Genus (2). **Ancistrocoma** Chatton and Lwoff, 1926

1926. *Ancistrocoma* Chatton and Lwoff, *C. r. Acad. Sci.*, Paris, 1975 pp ; Raabe, 1938, *Annls. Mus. Zool. poln.*, **13** : 41—75 ; Kozloff, 1946, *Biol. Bull.*, **89** : 95—102 ; Fench·l, 1965, *Ophelia*, **2** : 71—174 ; Kudu, 1966, *Protozoology*, 5th Edn., Thomas, Springfield, Illinois, 1174 pp.

1936. *Parachaenia* Kofoid and Bush, *Bull. Mus. r. hist. nat. Belg.*, **12** : 1—15.

1950. *Holocoma* Chatton and Lwoff, *Archs. Zool. exp. gen.*, **86** : 393—485.

Diagnosis : Strongly elongated (50 μm), banana-shaped body, slightly depressed in the thigmotactic area. The ciliature covers almost the whole surface of the body, with the exception of longitudinal stripe on the dorsal side and a small sector in the hind part of the body behind the thigmotactic area. The kineties arranged generally in three complexes the middle complex of several thigmotactic kineties reaching half of the body length and both lateral complexes, tho left and the right, consisting of more and more long kineties, arc-like bent and directed with their ends to each other, making then a parenthetical system. The arrangement of kineties is symmetrical to the median line of the ciliature. Macronucleus elongated : in the hind part of the body there occur vacuoles of concrements. Parasites of the mantle cavity of marine Bivalvia.

Type species *Ancistrocoma pelseneeri* Chatton and Lwoff, 1926 (After Raabe, 1970)

2. **Ancistrocoma pelseneeri** Chatton and Lwoff, 1926
(Figs. 4-7 ; Plate II Figs. 6-8)

1926. *Ancistrocoma pholadidis* Chatton and Lwoff, *Bull. Soc. Zool. Fr.* **51** : 345—352.

1936. *Pharachaenia myae* Kofoid and Bush, *Bull. Mus. r. hist. nat. Belg.* **12** : 1—15.

1936. *Ancistrocoma myae* (Kofoid and Bush) ; 1965. Fenchel, *Ophelia.* **2** : 7-174.

1926. *Ancistrocoma pelseneeri* Chatton and Lwoff, *C. r. Acad. Sci. Paris* p. 175 ; Raabe, 1935, *Annls. Mus. Zool. pol.*, **11** : 419—442 ; Kozloff, 1946, *Biol. Bull.*, **91** : 189—199 ; Chatton and Lwoff, 1950, *Arch. Zool. exp. gén*, **86** : 393—485 ; Kudo, 1966, *Protozoology* 5th Edn., Thomas, Springfield, Illinois, 1174 pp ; Khan, 1969, *Acta Protozool.*, **7** : 29—47 ; Sprague, 1970, *Am. Fish. Soc.*, **5** : 511—526 ; Raabe, 1970, *Acta Protozool.*, **7** : 385—463 : Jamadar, 1979, Ph. D. Thesis, Cal. Univ.

Type-host : *Macoma balthica*.

Type-locality : Askö (Baltic sea)
Oresund (Kattegat)

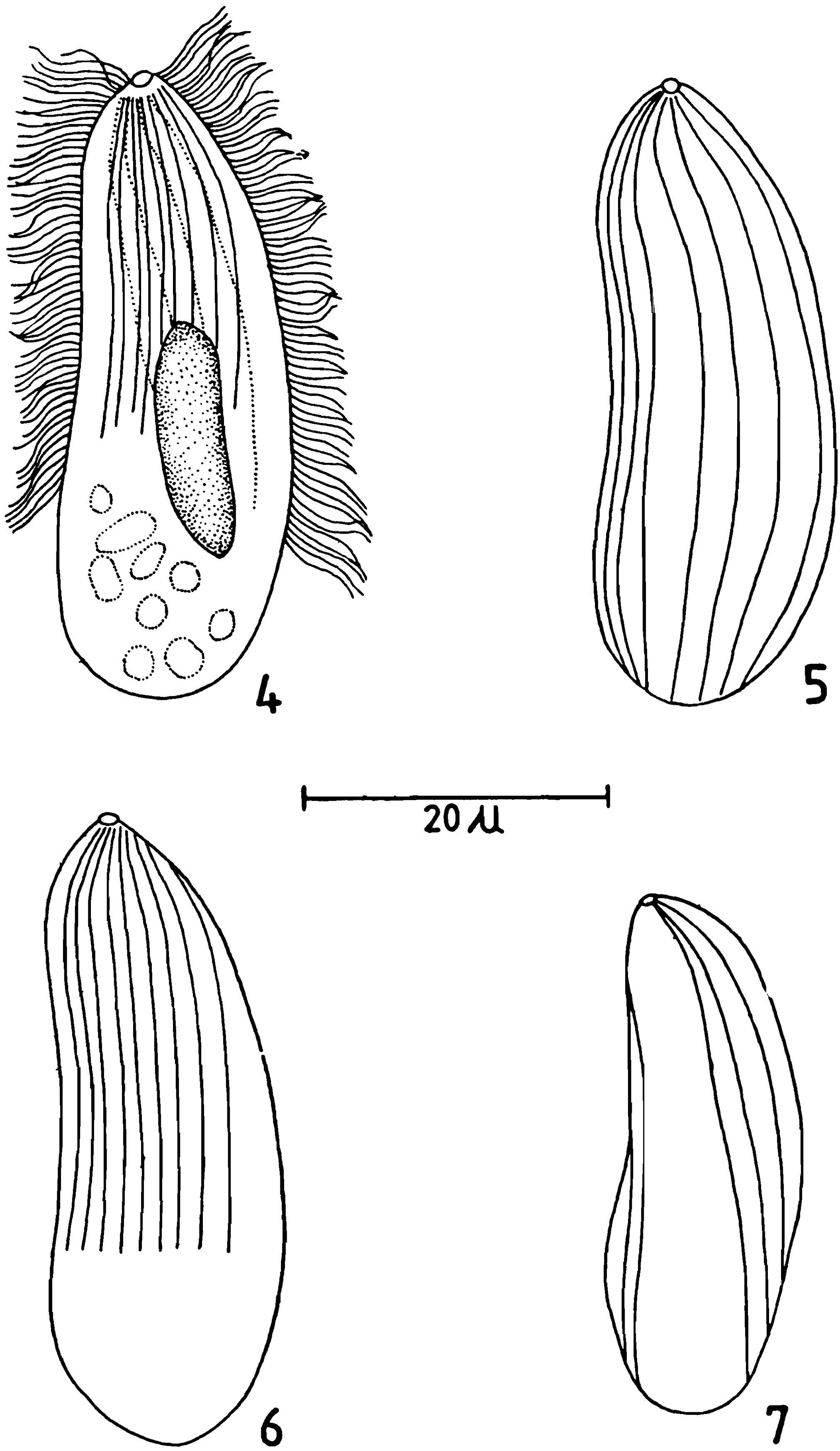


Fig. 4-7. Camera lucida drawing of *Ancistrocoma pelseneeri* from *Mactra luzonica* (Deshayes). 4, *A. pelseneeri* seen from left side ; 5 & 6, specimens seen from the left and right side with kineties ; 7, with ventral ciliature.

Other hosts : Pholas candida, Mya arenaria, Pholadidea penita, Abra nitida, Pterotrochea coronata, Cryptomya californica, Mya truncata, Macoma inconspicua, Macoma nasuta, Macoma irus, Macoma secta, Crassostrea virginica.

Present new host record : Mactra luzonica (Deshayes)

Locality : Digha sea coast, West Bengal, India.

Morphology Body 34.25 μm long x 11.35 μm wide, elongate, somewhat buckled, anterior terminal more or less attenuated banana-shaped, with incurved ventral surface when observed in lateral view. The oblong macronucleus lies in the middle of the animal and measures about 13.5 μm in length and 4.72 μm in width. The micronucleus is spherical and measures 1.15 μm in diameter, lying anterior to the macronucleus. Contractile vacuole in the middle part of the body ; typical food vacuoles in posterior part of the body. Cilia 5.18 μm (5.1—8.5 μm) in length and are absent subsequently in the anterior and posterior ends.

The ciliary system consists of 14-16 kineties. Its thigmotactic central part consists of 4—6 kineties, the right part 2 kineties, the left one 7—9 kineties.

Occurrence : This species are found profusely infected only in 4 host materials out of 33 and they generally occur in gills and palps of the host shell fishes.

	Mean in μm	Range in μm
Length of the body	34.25	27.2—42.5
Breadth of the body	11.35	8.5—13.6
Length of the macronucleus	13.05	10.2—15.3
Breadth of the macronucleus	4.70	3.4— 6.8
Diameter of the micronucleus	1.15	1.7— 3.4
Length of the cilia	7.50	6.8— 8.5
Number of kineties	15	14—16

3. **Ancistrocoma thorsoni** Fenchel, 1965
(Figs. 8—12 ; Plate II Figs. 9—11)

1965. *Ancistrocoma thorsoni* Fenchel, *Ophelia.* **2** : 71—174 ; Raabe 1970, *Acta Protozool.*, **7** (3) : 385—453 ; Jamadar, 1979, Ph. D. Thesis, Cal. Univ.

Morphology : Body elongated, slightly buckled. Length 28.9—47.6 μm, width 8.5—13.6 μm. Macronucleus elongated (15.3—27.2 μm), occupies nearly half of the body length ; micronucleus spindle shaped or spherical

(0.85—3.40μm). Contractile vacuole in the posterior half of the body. Kineties form two systems (according to Fenchel, 1965) a left thigmo tactic system consisting of 11 kineties with a distance of 0.85 μm between-

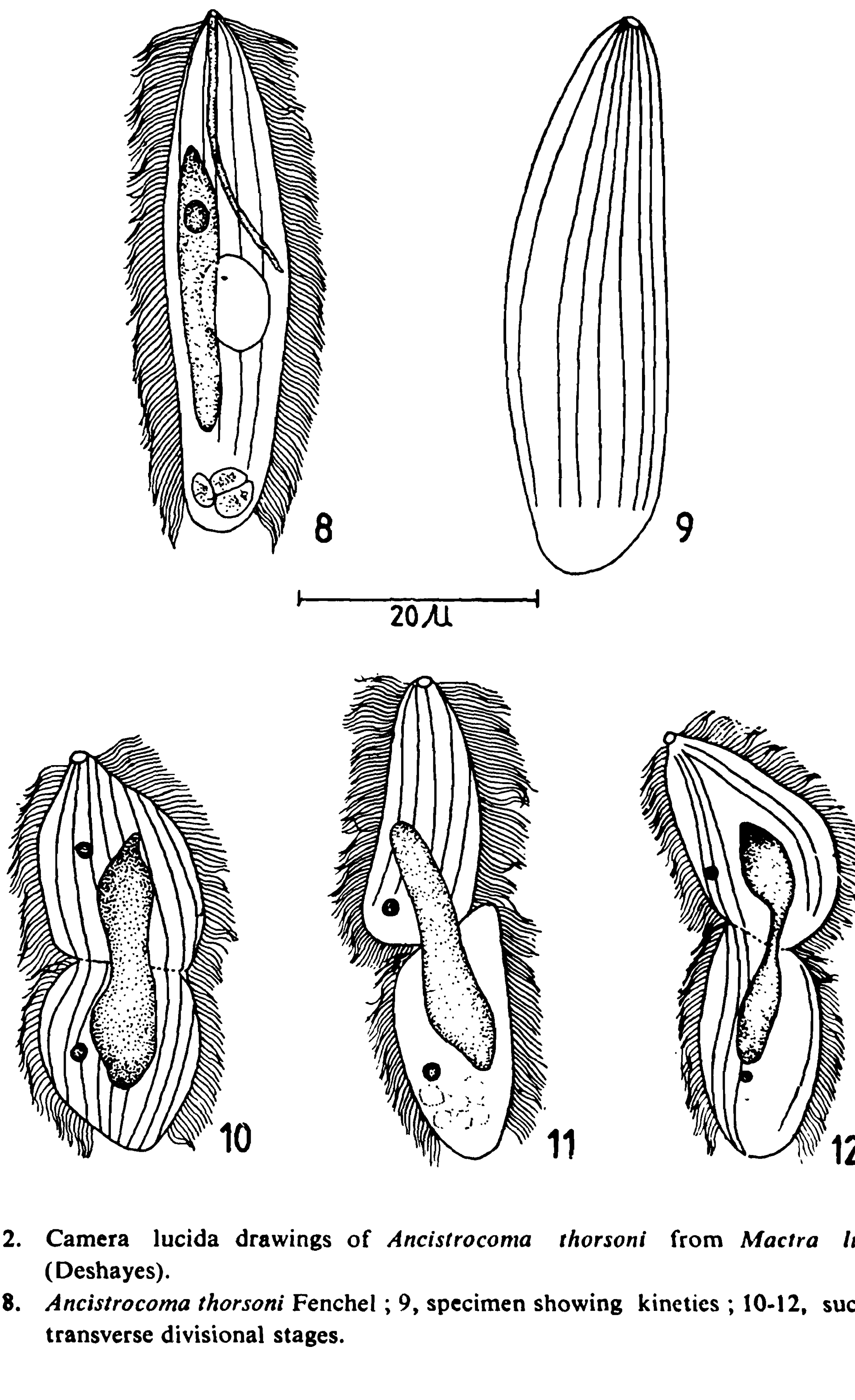


Fig. 8-12. Camera lucida drawings of *Ancistrocoma thorsoni* from *Mactra luzonica* (Deshayes).

8. *Ancistrocoma thorsoni* Fenchel ; 9, specimen showing kineties ; 10-12, successive transverse divisional stages.

them and a right system of 7—9 kineties with a distance of 1.7 μm. Thigmotactic ciliary rows are almost straight but the other kineties slightly curved posteriorly ; all the kineties end at about a distance of one fifth of the body length from the posterior side.

Occurrence Generally this species occurs in gills and labial palps of the hosts and majority host are not infected.

	Mean in μm	Range in μm
Length of the body	37.29	28.9—47.6
Breadth of the body	11.90	8.5—13.6
Length of macronucleus	18.94	15.3—27.2
Breadth of the macronucleus	4.79	3.4—5.1
Diameter of the micronucleus	2.78	0.8—3.4
Length of the cilia	4.95	3.4—8.5
Number of kineties	19	18—20

4. **Ancistrocoma dissimilis** Kozloff, 1946
(Figs. 13—15 ; Plate II Figs. 12 & 13)

1946. *Ancistrocoma dissimilis* Kozloff, *Biol. Bull.* **91** : 189-199 ; Raabe, 1970, *Acta Protozool.*, 7 : (31) : 385-463 ; Jamadar, 1979, Ph. D. Thesis, Cal. Univ.

Type-host : *Pholadidea penita* (Conrad)

Type-locality : California, U.S.A.

Present new host record : *Mactra luzonica* (Deshayes)

Locality Digha sea coast, West Bengal, India.

Morphology : Body elongated, length 27.2—44.2 μm, width 8.5—11.9 μm. Macronucleus rounded, slightly elongated, 5.1—10.2 μm x 5.1—8.5 μm lies just above the posterior third of the body. Micronucleus spherical and measures 1.7 μm in diameter, lying posterior to the macronucleus. Contractile vacuole in the posterior third of the body. The ciliature consists of 12 to 14 kineties. The central thigmotactic complex embraces 5 kineties, more or less equal and reaching almost the posterior extremity of the body ; on the left 3—4, on the right 4—5 kineties, gradually becoming elongated and buckled.

Occurrence : The ciliate occurs in gills and labial palps of the host materials.

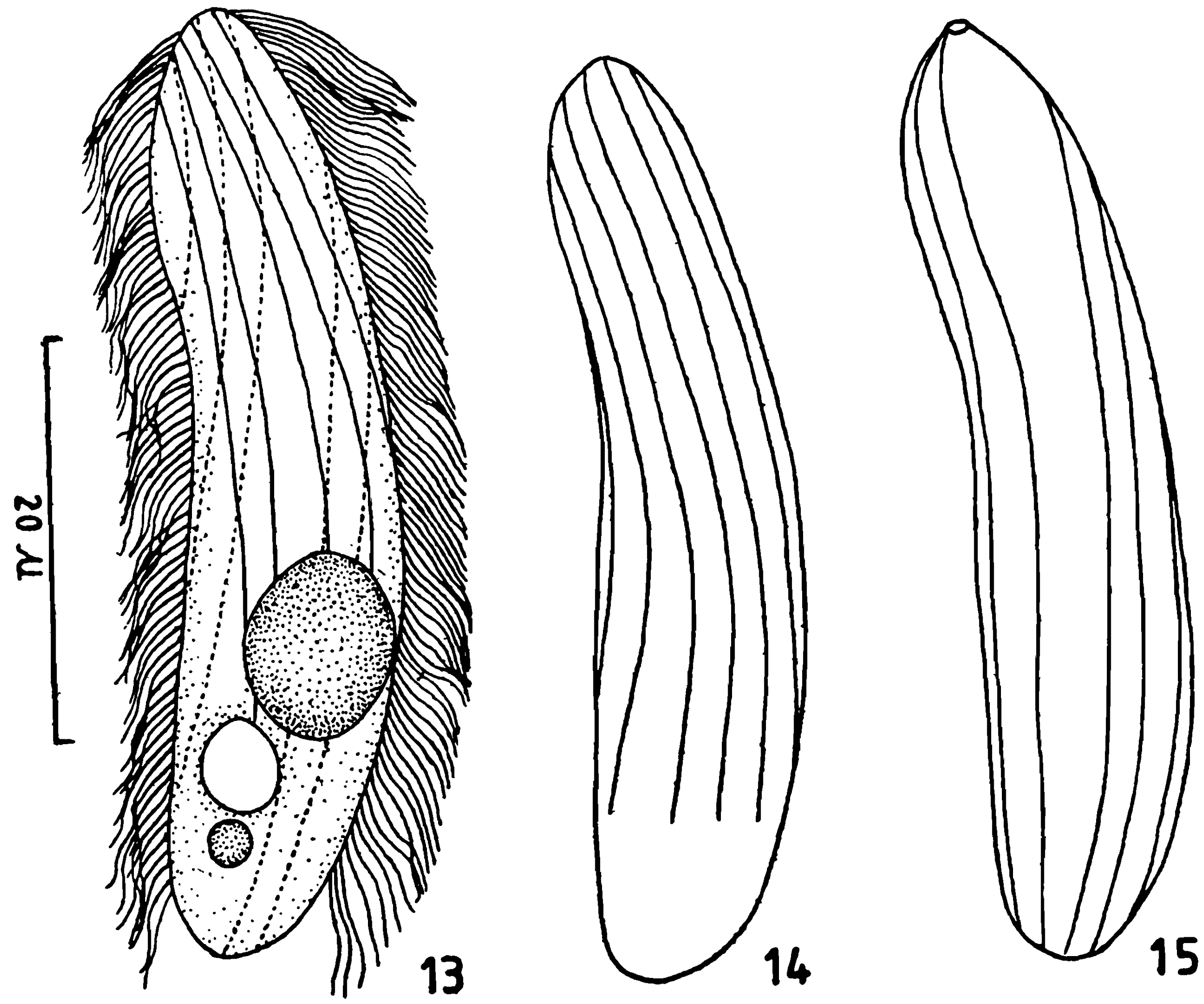


Fig. 13-15. Camera lucida drawings of *Ancistrocoma dissimilis* from *Mactra luzonica* (Deshayes).
13. *A. dissimilis* Kozloff; 14 & 15, specimen seen from the right and the ventral side with kineties.

	Mean in μm	Range in μm
Length of the body	35.39	27.2—44.2
Breadth of the body	9.94	8.5—11.9
Length of the macronucleus	8.97	5.1—10.2
Breadth of the macronucleus	6.66	5.1—8.5
Diameter of the micronucleus	1.70	—
Length of the cilia	6.30	5.1—8.5
Numbes of kineties	—	12—14

Remarks: The genus *Ancistrocoma* was created in 1926 by Chatton and Lwoff while describing two ciliate species viz., *A pelseneeri* and *A. pholadis* from the gills and pulps of *Macoma balthica* (L.) and *Barnea (Pholas) candida* (L.) respectively (Table 2).

During the present investigation the authors have encountered multiple infection of these ancistrocomid ciliates in a single bivalve host species, *Mactra luzonica* (Deshayes) from the costal waters of West Bengal, India. These are : *Ancistrocoma pelseneeri, A. thorsoni* and *A. dissimilis*. Out of a total of 33 host materials only 4 were found to be profusely infected and always with the three ciliate species mentioned above.

Ancistrocoma pelseneeri was originally described in a preliminary nature by Chatton and Lwoff (1926) and were not accompanied by illustrations. Since then a more detailed description together with illustrations, has beed contributed by Raabe (1934, 1938).

In 1936, Kofaid and Bush described *Parachaenia myae* from the pericardial cavity and excurrent siphon of *Mya arenaria*. Kirby (1941) noted that this ciliate is quite similar to *A pelseneeri* in several respects. Kozloff (1946c), as the results of studies on ciliates associated with several species of marine pelecypods in San Francisco and Tomales Bays, California, namely *Mya arenaria, Cryptomya californica, Macoma inconspicua, M. nasuta, M. irus* and *M. secta*, has concluded that *P. myae* is not specific for *Mya arenaria* as claimed by Kofoid and Bush (1936) but is associated with all the six species of molluscs examined. Furthermore, he has pointed out that it is identical with *A. pelseneeri*.

According to Raabe 1938, Kozloff 1946 and Fenchel 1965, the *Ancistrocoma* exaimed by them had the central part of the system of kineties closed in 'systeme secant' which consists of a complex — the central part having 5-6 kineties with a reduced number of kineties (2-3) on the right, and on the left a more numerous complex of these kineties (4—6). This arrangement has been confirmed by the present author with some minor variations by numerous preparations done by the dry silver method.

Based on other workers' observations and interpretations, specially the work of Khan (1969), Raabe (1970) sharply contradicted Chatton and Lwoff and opined that the ciliary system of *A. pelseneeri* was really inverse to their report.

Mackin (1962) has reported the occurrence of *Ancistrocoma pelseneeri* in *Crassostrea virginica* 'distributed over the Atlantic and Gulf coast of the United States'

Ancistrocoma pelseneeri recorded from a new molluscan host *Mactra luzonica* (Deshayes) from a new geography (Hooghly estuary, India) and corroborates with the descriptions presented by Cheng (1967) and Raabe

(1970) so far its body shape, macronucleus and kineties are concerned. One noteworthy difference recorded here is the difference in one morphometric measurement. *A. pelseneeri* from *M. luzonica* is much smaller in size (27.2—42.5 μm x 8.5—13.6 μm) than the measurements given by Fenchel 1965 (50—60 μm x 12—14 μm), Cheng 1967 (50—83 μm x 14—20 μm) and Raabe 1970 (40—80 μm x 10—20μm). The author is tempted to maintain the view that this morphometric variability between the ciliate species recorded from the Indian waters and from the San Francisco and Tomales Bays, European Seas and South Baltic Sea, represents merely its geographic and ecologic variability.

Ancistrocoma thorsoni was first described by Tom Fenchel in 1965 from Scandinavian water (West Sweden) from the gills of *Abra nitida* (Müller). The measurements for this ciliate given by him are : length 53 μm (46—61 μm), width 16 μm (15—17 μm) and macronucleus length 30 μm ; there are 18 kineties, all on the dorsal side. This species recorded by the present authors from the bivalve *Mactra luzonica* from Indian water resembles in its general conformity with that described by Fenchel but is comparatively smaller in size. A comparative mensural data (Table 2) between the ciliate discribed by the present authors and Fenchel's ciliate, it becomes apparent that there are notable variability between the two geographically distant populations harboured by two different bivalve hosts. Different host and ecological exposures are presumed to be responsible for these morphometric variabilities.

Ancistrocoma dissimilis was first described by Kozloff (1946) from the bivalve *Pholadidea penita* (Conrad) from Moss Beach, California. The present authors discovered this species for the first time from the eastern horizon from a bivalve host, *Mactra luzonica* (Deshayes). It is interesting to note that inspite of enormous geographical distance, new host and new ecology, the ciliate parasite communicated hare surprisingly exhibits least morphometric variability with its fellow species described from Moss beach. A comparison of the morphometric measurements (Table 2) of the two populations of *A. dissimilis* from the geographic zones states the smallness of the Indian representative almost in every parameters but keeping in harmony with the original species in diagnostic features, [Kozloff's specimen measures : length 44 μm (33—51 μm), width 13 μm (10.0—14.5 μm), thickness 8—12 μm, and macronucleus 6.8—13.7 x 5.4—7.2 μm].

Mactra luzonica (Deshayes) is recorded as the new pelecypod host for *A. pelseneeri*, *A. thorsoni* and *A. dissimilis* from a new geographical zone.

Table 2. Comparison of the data concerning of *Ancistrocoma* sp. sp. (Raabe, 1970)

(Measurements : in microns)

Name of species	Author	Number of kineties	Scheme of ciliature			Host	Locality
Holocoma primigenius	Chatton et Lwoff, 1950	19-23	6	6-10	7	*Macoma balthica*	France
H. primigenius	Fenchel, 1965	15-17	2-3	6	8	*Macoma balthica*	Baltic Sea
Ancistrocoma pelseneeri	Ch. Lw., 1926	13	2-3	8-9	1	*Macoma balthica*	Boulonge
A. pelseneeri	Ch. Lw., 1950	12-13	7	5	1	*Macoma balthica*	Pas de Calais
A. p. v. pholadis	Ch. Lw., 1950	14(13)	4-5	7	1	*Pholas candida*	Pas de Calais
A. pelseneeri	Raabe, 1938	13-14	3	5	5-6	*Macoma balthica*	Baltic Sea
A. pelseneeri	Kozloff, 1946	14	3	5	6	*Macoma, Mya*	San Francisco Bay
A. pelseneeri	Raabe, actual	13-15	2-3	5-6	4-6	*Macoma balthica*	Baltic Sea
A. pelseneeri	Khan, 1969	14	4	5	5	*Mya truncata*	Swansea
A. pelseneeri	Sprague, 1970	14		—		*Mya arenaria* *M. irus* *M. inconspicua* *M. nasuta* *M. secta* *Cryptomya californica*	Maryland
P. myae	Kofoid et Bush, 1936	15-16		—		*Mya arenaria*	San Francisco Bay
A. myae	Ch. Lw., 1950	—	3	6	3	*Mya arenaria*	Woods Hole
A. myae	Fenchel, 1965	12	3	5	4	*Mya arenaria*	Kristineberg
A. dissimilis	Kozloff, 1946	11(14)	3	4	4-5	*Pholadidea penita*	California
A. thorsoni	Fenchel, 1965	18	2-3	8	7	*Abra nitida*	*Gullimarfjord*
S. pterotrocheae	Ch. Lw., 1950	14	6	2	6	*Pterotrochea coronata*	Méditerrané
A. pelseneeri	Jamadar, 1979	14-16	2	4-6	7-9	*Mactra luzonica*	Digha, West Bengal, India
A. thorsoni	Jamadar, 1979	19-21	2-3	9-11	7	*Mactra luzonica*	Digha, West Bengal, India
A. dissimilis	Jamadar, 1979	11-14	4-5	5	3-4	*Mactra luzonica*	Digha, West Bengal, India

Subfamily HYPOCOMIDINAE Raabe, 1967

Diagnosis : Elongated body, of medium size (20—70 μm). The ciliature consists of a functionally and probably genetically thigmotactic ciliature, limited to the somewhat concave body side, and of elements of the adoral kineties preserved in different grade : two kineties running arc-like from the apical pole, and sometimes, the rudiment of the loop of one of them. Lack of general ciliature. Parasites of the mantle cavity of marine and fresh-water Bivalvia (After Raabe, 1970).

Genus (3). **Raabella** Chatton and Lwoff, 1950

1950. *Raabella* Chatton and Lwoff, *Archs. Zool exp. gen.*, **86** : 393-485.

Diagnosis : Pear-shaped, feebly elongated body (30 μm), with moderately flattened thigmotactic area. The thigmotactic ciliature consists of two complexes : the right complex of a few straight kineties reaching half of the body length, and the left complex of a few arc-like bent kineties reaching more backwards. On the right side there are two arc-like bent, long kineties, reaching far backwards (adoral kineties). Parasites of the mantle cavity of marine Bivalvia.

Type-species *Raabella helensis* Chatton and Lwoff, 1950 (After Raabe, 1970)

5. **Raabella helensis** Chatton and Lwoff, 1950
(Plate III Figs. 14-16)

1922. *Hypocomides mytili* Chatton and Lwoff, *C. r. Acad. Sci.*, Paris. **173** : 1495-1498.
1938. *Hypocomides mytili* Raabe, *Annls Mus. Zool. Poln.*, **13** : 41-75.
1946. *Hypocomides mytili* Kozloff, *Biol. Bull.* **90** : 200-212.
1950. *Raabella helensis* Chatton and Lwoff, *Archs. Zool. exp. gen.* **86** : 393-485 : Fenchel, 1965, *Ophelia*, **2** : 71-174 ; Raabe, 1970, *Acta Protozool.* **7** : 385-463 ; Jamadar, 1979, Ph. D. Thesis, Cal. Univ.

Type-host : *Mytilus edulis.*

Type-locality : Colynia

Other hosts : *Mytilus galloprovineialis, M. minimus.*

Present new host *Modiolus* (*Modiolus*) *striatulus* (Hanley).

Locality : Outram Ghat, Hooghly river, Calcutta, West Bengal and Kakinada Bay, Andhra Pradesh, India.

Morphology : Body pyriform in shape, pointed anteriorly and rounded posteriorly. The anterior end bears suctorial tentacle for the attachment to the body of the host. The length is 29.89 μm (25.5—35.7 μm) and the width 15.86 μm (13. 6—18.7 μm). The ovoid or spherical macronucleus is situated nearly at the centre of the body and measures 8.64 μm (6 8—11.05 μm) in length and 6.30 μm (5.1—7.65 μm) in width. The micronucleus is also spherical and measures 2.55 μm (1.7—3 4 μm) in diameter and is placed anterior to the macronucleus. A solitary spherical contractile vacuole is also located in the vicinity of the macronucleus. The cilia are restricted only at the anterior half of the body and measure between 3.4—5.1 μm in length.

The thigmotactic zone is formed of three ciliary rows. The central complex of 5 kineties running meridionally, also closely with one another, ending meridionally or almost equally and reaching nearly 1/3 of the body length. The left complex embraces 5-6 progressively longer kineties while in the right system there are two long, archly buckled and parallelly running kineties, reaching nearly the body end.

Occurrence : The ciliate occurs sparsely in the gills of *Modiolus* (*Modiolus*) *striatulus* (Hanley).

	Mean in μm	Range in μm
Length of the body	29.89	25.5—35.7
Breadth of the body	15.86	13.6—18.7
Length of the macronucleus	8.64	6.8—11.05
Breadth of the macronucleus	6.30	5.1— 7.6
Dimension of the micronucleus	2.55	1.7— 3.4
Length of cilia	3.64	3.4— 5.1
Length of the central thigmotactic complex	11.61	8.5—15.3
Length of the left thigmotactic kineties	18.36	17.0—20.4
Length of the right thigmotactic kineties	24.82	17.0—32.3

Rmarks : The genus *Raabella* was erected by Chatton and Lwoff in 1950 after Raabe to include *R. helensis*, described by them earlier as *Hypocomides mytili* Ch. Lw. 1922. Raabe found this species in mussels from Golynia, and described it under the name *H. mytili.* Kozloff (1946) found a related form in *Mytilus edulis* from California which he also refferred to the same species.

Raabella helensis was recorded by Fenchel (1965) only occasionally from the mantle cavity of *M. edulis* from Helsinger, Kristineberg and Askö, the number per infected mussel often being as low as 1 or 2. Raabe (1938) distinguished two forms of *R. helensis* occurring together in the populations, but differing between them by dimensions and number of kineties, these are *forma major* and *forma minor*. In his review Raabe (1970) contended that in his own specimens form the Baltic Sea, kineties of the central complex are cut parallelly, but in *R. helensis* from *M. minimum* from Adriatic waters, they really can grow longer from the left to the right.

The present authors have recorded and described *Raabella helensis* from a new host *Modiolus* (*Modiolus*) *striatulus* (Hanley) from the Hooghly estuary, India, where we found the kineties in the following arrangements :

Central—5, Right—2 and Left—5 to 6 and the body dimensions more or less corroborated with that of *Raabella forma major*. We believe that all these forms belong to one species, *R. helensis*, and represents merely its geographic and ecologic variability.

Suborder ARHYNCHODINA Corliss, 1957

Diagnosis : With cytostome in the posterior half of body ; body compressed laterally ; with uniform ciliation.

Family (iii) HEMISPEIRIDAE König, 1894

Diagnosis : Cytostome posterior ; adoral ciliature ; cilia in the anterior portions of somatic rows are thigmotactic ; body ciliation typically thick.

Subfamily ANCISTRINAE Issel, 1903

Syn. : Ancistridae Issel, pro family, Protophryidae Cépéde, 1910, emend Chatton and Lwoff, 1949.

Diagnosis : Thigmotatic area formed by anterior sectors of the kineties of the left part of the general ciliature ; those kineties preserve their normal continuation at the hind part of the body ; lack of the parenthetical system. The adoral kineties, taking in the more primitive forms an almost longitudinal position, tend to retrogradate and spiralize ; in the extreme cases they make around the distal pole a spiral of an arc more than 360° Parasites of the mantle cavity and of the intestine of marine and fresh-water Mollusca and of the water-lungs of Holothuroidea (After Raabe, 1970).

Genus (iv). **Ancistrumina** Raabe, 1959

1910. *Isselina* Cépéde, *Arch. Zool. expér. gén.*, (Ser. 5), **43** : 341-609.
1930. *Ancistrina* Cheissin, *Arch. Protist.*, **70** : 531-618.

1931. *Ancistrina* Cheissin, *Arch. Protist*, 73 : 280-304.
1959. *Ancistrumina* Raabe, *Acta Parasit. Polon.*, 7 : 215-247.

Diagnosis : Relatively scarce ciliature and rather small dimensions of the body (20—40 μm). Number of kineties 12—30. Two adoral kineties begin at the small distance from the apical suture and, running backwards, make a large loop at the distance of about 1/4 from the hind body pole. The argyronemes of the naked peristomal field are scarce ; only two meridional argyronemes. Parasites of the intestine and the mantle cavity of fresh-water and marine Gastropoda and Bivalvia.

Type-species : *Ancistrumina ovata* (Cheissin, 1930—1931) (After Raabe, 1970).

6. **Ancistrumina obtusae** sp. nov.
(Figs. 16, 17, & 18, 19, Plate III Figs. 17—22)

Type-host : *Cerithidea obtusa* (Lamarck)

Type-locality : Sagar Island, Sunderbands, 24 Parganas, West Bengal, India.

Type-material : On slides.

Holotype Z.S.I., Reg. No. Pt. 2056

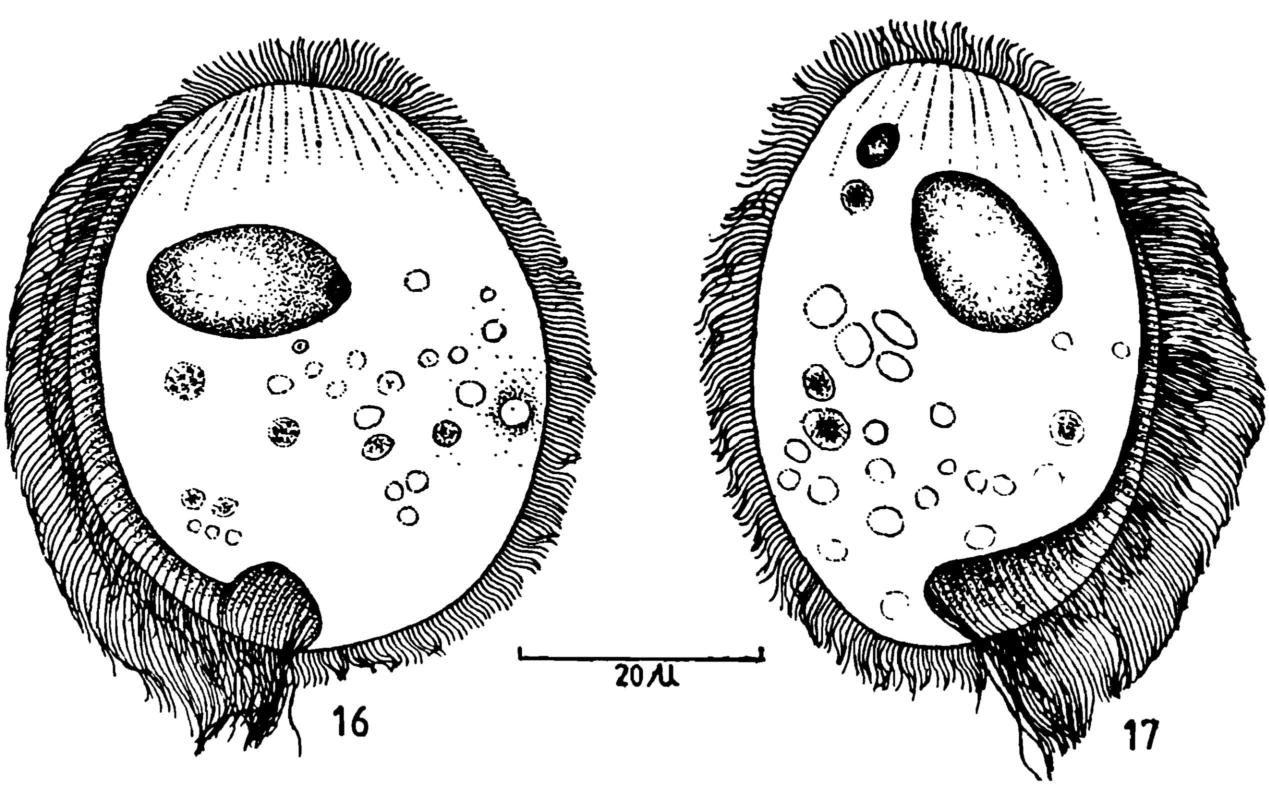


Fig. 16-17. Camera lucida drawings of *Ancistrumina obtusae* sp. nov.
16 & 17, Specimens seen from right and left side.

Paratype : Z. S. I., Reg. No. Pt. 2057—2059

Coll. Dr. Y Jamadar.

Morphology : Ovoid body, and almost rounded at its posterior part. The length is 35.08 μm (27.2 - 40.8 μm) and the width 27.88 μm (20.4—34.0 μm). The macronucleus oval, elongated and measures 14.28 μm in length and 9.45 μm in width in average, situated always in the anterior part of the body. The micronucleus is spherical in shape and measures 1.7—3.4 μm in diameter. It is juxtaposition to the macronucleus. Contractile vacuole posteriorly placed. Food vacuoles of varied sizes, containing large, darkly stained bodies, are visible. The somatic cilia are 4-5 μm long, the adoral one 9—15 μm and the thigmotactic cilia are 5-6 μm long.

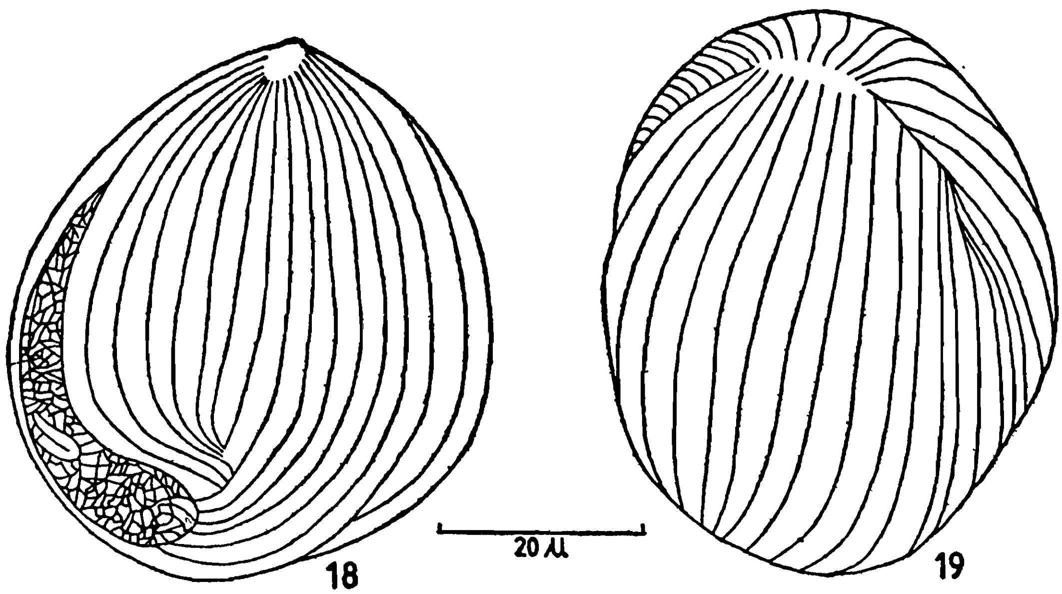


Fig. 18-19. Camera lucida drawings of *Ancistrumina obtusae* sp. nov.
18 & 19, specimens seen from the left and right side showing arrangement of kineties.

The length of the peristome varies from 22.1—35.7 μm (average 29.51 μm) and starts from the one third part of the anterior tip of the body and runs to the posterior extremity of the ventral side. The cytostome measures 3.4—8.5 μm in length and 5.1 - 8.5 μm in width, situated at the posterior end. Normally two long lashing cilia emerge from the extremity of the cytostome which form the end part of the membranellae with the help of adoral cilia.

Kineties of the general ciliature run more or less meridionally, 19—22 in number, 9—10 on the right and 10—12 in the left side of the body. The two adoral kineties originate from near the anterior suture, a little behind the apical pole. Commissural fibrills are rather scarce in number and do not form dense fibrillar network.

Occurrence ; The ciliate occurs within the buccal cavity of *Cerithidea obtusa* (Lamarck).

	Mean in μm	Range in μm
Length of the body	35.08	30.2—40.8
Breadth of the body	26 88	20.4—30.0
Length of the macronucleus	14.28	11.9—18.7
Breadth of the macronucleus	9.45	5.1—11.9
Diameter of the micronucleus	2.57	1.7— 3.4
Distance of the macronucleus	4.89	3.4— 8.5
Distance of the micronucleus	3.31	1.7— 5.1
Distance between micro and macronucleus	0.97	0.88— 1.7
Length of the somatic cilia	3.43	3.4— 4.2
Length of the adoral cilia	7.79	6.8—11.9
Length of the thigmotactic cilia	4.28	3.4— 5.1
Length of the peristome	29.51	22.1—35.7
Length of the cytostome	6.13	3.4— 8.5
Breadth of the cytostome	7.16	5.1— 8.5
Number of kineties	20	19—22
Distance of inter kineties	3.07	1.7— 3.4

7. **Ancistrumina barbata** (Issel, 1903)
(Figs. 20-21 ; Plate IV Fig. 23)

1903. *Ancistrumina barbata* (Issel), *Mitt. Zool. Stn. Neapel*, 16 : 63-108 ; Raabe, 1970, *Acta Protozool.*, 7 (11/12) : 117-180 ; Jamadar, 1979, Ph. D. Thesis, Cal. Univ.

Type-host : *Fusus syracusanus* Lamarck

Type-locality : Neapolitanian Bay

Other host : *Murex syracusanus* Lamarck

Present new host record : *Cerithidea obtusa* (Lamarck)

Locality : Sagar Island, Sunderbans, West Bengal, India.

Morphology : Elongated body, with almost parallel margins and truncated posterior end. The left side of the body nearly straight and the right side is convex. The length measures 28.9-42.5μm and the width 17.0-

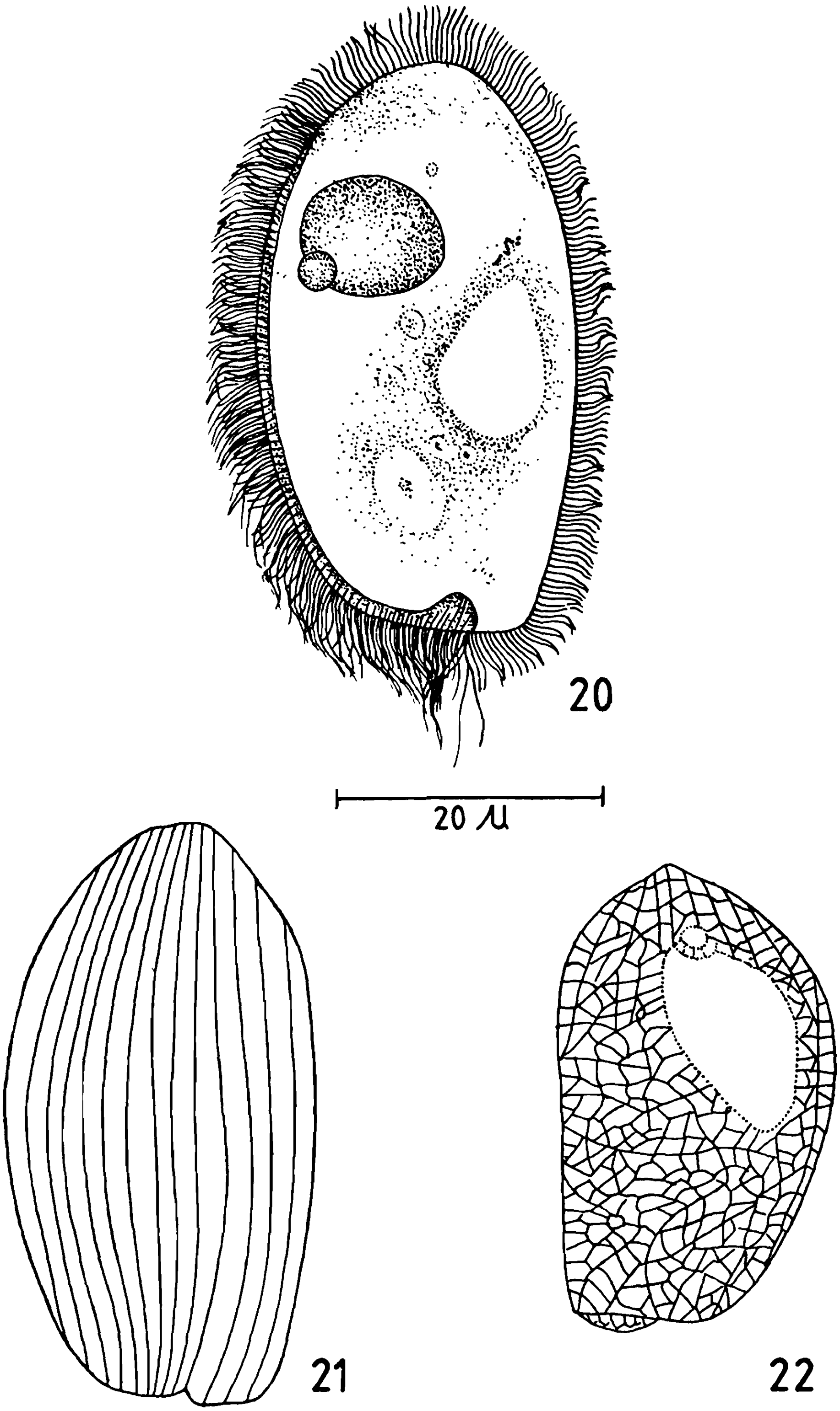


Fig. 20-22. Camera lucida drawings of *Ancistrumina barbata* (Issel, 1903) from *Cerithidea obtusa* (Lamarck).

20, *A. barbata* Issel ; 21, body with arrangement of kineties ; 22, argentophilic fibrils showing reticulate structure.

23.5 μm. There is a great variation in the shape and size of the macronucleus which may be oval or elongated, lying in the median part of the body. The anterior end of the macronucleus is indented to accomodate the micronucleus. The macronucleus measures 8.5-17.0 μm in length and 5.8-11.9 μm in width. The micronucleus is spherical in shape and measures approximately 1.7-3.4 μm in diameter. Contractile vacucle is in the posterior part of the body. Three distinct ciliary regions can be distinguished, (i) the thigmotactic region bearing dense, closely set, short static cilia on the anterior extremity of the left side of the body, (ii) the adoral region consisting of adoral cilia and membranellae and (iii) the general somatic ciliature bearing long metachronally beating cilia. The length of cilia are regionally different. Anterior thigmotactic cilia are 3.94 μm in length, somatic cilia 2.02 μm in length in average and the length of the adoral membranellae range from 7.1-11.9 μm.

The length of the peristome varies from 22.1-28.9 μm (Av. 25.22 μm), starts from near the apical part of the body. The undulating membrane (UM) form a big loop with the help of two long adoral cilia and radially arranged stripes. The cytostome measures 5.1-8.5 μm (Av. 6.39 μm) in length and 3.4-8.5 μm (Av. 6.59μm) in width and is situated far back. There are 20-24 kineties, 9-11 on the right and 10-14 on the left side.

Occurrence : It occurred in abundance in the mantle cavity and buccal mass of *Cerithidea obtusa* (Lemarck)

	Mean in μm	Range in μm
Length of the body	34.61	28.9-42.5
Breadth of the body	19.92	17.0-23.8
Length of the macronucleus	13.39	8.5-17.0
Breadth of the macronucleus	7.95	5.8-11.9
Diameter of the micronucleus	2.14	1.7.- 3.4
Distance of the macronucleus from anterior end	6.73	3.4-10.2
Distance of the micronucleus from anterior end	5.30	3.4- 8.5
Length of the somatic cilia	3.02	1.7- 3.4
Length of the adoral cilia	8.54	7.1-11.9
Length of the thigmotactic cilia	3.94	3.4- 5.1
Length of the peristome	28.96	23.8-35.7
Length of the cytostome	6.39	5.1- 8.5

Breadth of the cytostome	6.59	3.4- 8.5
Number of kineties	22	20-24
Distance of inter kineties	1.07	1.53-2.04

Remarks : The name of the genus *Ancistrumina* was introduced by Raabe (1959) nomen novam for *Ancistrina* Cheissin, 1930, 1931 pre-occupied by the name *Ancistrina* Goede, 1927 (*Lepidoptera*). This is closely allied to the genus *Ancistrum* Maupus, 1883, under which name a considerable number of thigmotrichid ciliate species were formerly united. In his excellent review Raabe (1959,1970) separated off some of these species into the newly created genus *Ancistrumina*, pointing out the doubtful position of a number of others. As Raabe admits and Fenchel (1964) emphasizes, the distribution is blurred by the existence of intermediate forms, but it nevertheless seems taxonomically useful, though rejected by Fenchel (1965). In *Ancistrum* the ciliation is dense and there are 40—60 kineties in addition to the two adoral kineties. The latter strech from the apical suture to the posterior extremity of the body, where they curve round the peristome. The naked peristomial zone has a network of fibres and there are also fine transverse fibres joining the kineties together. In the genus *Ancistrumina*, the body is sparsely ciliated, the number of the general ciliature varying between 12 and 30. The two adoral kineties originate slightly posteriorly to the anterior suture, extend backwards about three-quarters of the length of the body and then curve round the peristome. Very few transverse fibrils are present between the kineties and no fibres are seen in the bare peristomial zone.

According to Raabe's (1970) descriptions, several of thom seem specific for the particular species of hosts and can be distinctly differentiated morphologically. However, the other ones are rather slightly specific, they may occur in many species of hosts, even 'in the species being distant one from the another (i.e., Gastropoda and Bivalvia)' The genus *Ancistrumina* includes presently some 22 species to which the present authors take the privilege to add one more new species, *Ancistrumina obtusae* from the gastropod host Cerithidea obtusa (Lamarck), an ancistrumid ciliate to be presented for the first time from the Indian sub-continent (Table 3). In addition. *Ancistrumina barbata* (Issel, 1903) has been recorded from a new geography and from a new host. The proposed new species *A. obtusae*, having a more or less globular body configuration and with 19-22 general somatic kineties, beg to differ from all other so far described members of the genus *Ancistrumina* not only on the basis of its different host species. microniche and geographically distant locale (and hence different ecological impact) but also on the basis of various morphometric parameters. The name of the proposed new species has been attributed after its host *C. obtusa* (Lamarck).

Ancistrumina barbata (Issel, 1903) recorded by the authors from *C. obtusa* from Sagar Island, West Bengal and Kakinada Bay, Andhra Pradesh, more or less corroborates with the same species described from the hosts, *Fusus syracusanus* L. and *Murex trunculus* L. and the member of kineties falls withinn the range given by the earlier author. Though there is marked variaation in morphometric measurements between the Indian species and the species described from Neapolitanian Bay, the present authors contend that these forms belong to one species and present merely its geographic and ecologic variability.

Genus (5). **Fenchelia** Raabe, 1970

1970. *Fenchelia* Raabe, Acta Protozool., 7 (11/12) : 117—180.

Diagnosis : Elongated, slightly flattened body. Number of kineties, ca 26. Two adoral kineties start about 1/3 of the body length from the anterior pole and make a big loop near the hind body pole. On the dorsal side the body continues posteriad in a coneshape prolongation. Parasites of the mantle cavity of marine Mollusca.

Type species : *Fenchelia crassa* (Fenchel, 1965) comb. nova. (After Raabe, 1970).

8 **Fenchelia sagarica** sp. nov.
(Fig. 23, 24 ; Plate IV Figs. 24-26)

Type-host : *Cerithidea obtusa* (Lamarck)

Type-locality : South-west coast of Sagar Island, Sundarbans, 24, Parganas, west Bengal, India.

Other locality Kakinada Bay, Andhra Pradesh, India.

Type-material : On slides.

Holotype — Z.S.I., Reg. No. Pt. 2060

Paratype — Z.S.I., Reg. No. Pt. 2061—2063

Coll. Dr. Y Jamadar.

Morphology : Body is dorso-ventrally flattened, ovoid or pear-shaped with a little but distinct protrusion on the posterior body pole. Length 39.1—51.0 μm and width 22.1—37.4 μm. Macronucleus with varied shape

Table 3. Comparative account of *Ancistrumina* sp. sp. (Raabe, 1970)

(Measurements in microns)

Name of species	Author	Body dimensions	Number of kineties	Host	Locality
A. arcopagiae	(Fenchel, 1965)	30-32+16-20	12	*Arcopagia crassa*	Gullmarfjord, Sweden
A. ovata	(Cheissin, 1930, 1931)	34-48+15-20	13—16	*Benedictia baicalensis* *B. limneoides, Choanomphalus* sp.	Baikal Lake, Siberia
A. cyclidioides	(Issel, 1903)	24-44+12-24	16—28	*Tellina exigua, Chiton olivaceus, Capsa fragilis, Donax trunculus, Tapes desussata, Natica hebraea, Littorina neritoides, L. punctata*	Neapolitanian Bay
A. cyclidioides f. *minima*	(Raabe, 1936)	—	17	*Mya arenaria*	South Baltic Sea
A. barbata	(Issel, 1903)	37-51+14-20	16—22	*Fusus syracusanus* *Murex tranculus*	Neapolitanian Bay
A. barbata	(Issel, 1903) Recorded from a new host by the present author	28-42+17-23	20—24	*Cerithidea obtusa*	Sagar Island, Sunderbans, West Bengal, India, and Kakinada Bay, Andhra Pradesh, India
A. nuculae	(Fenchel, 1965)	27-36+14-16	19	*Nucula turgida*	Gullmarfjord and Oeresund (Kattegat)
A. venerupis	(Fenchel, 1965)	31-42+14-19	21—22	*Venerupis aurea*	Gullmarfjord, West Sweden
A. hydrobiae	(Raabe, 1936)	28-34+14-17	26	*Hydrobia ulvae, H. ventrosa*	Bays of Gdansk and of Puck, South Baltic Sea
A. macomae	(Chatton and Lwoff, 1949)	—	18	*Macoma (Tellina) tenuis*	Da Costa, Roscoff
A. macomae	(Chatton and Lwoff, 1949) Redescribed and recorded from new host by Fenchel, 1965)	34-42+14-18	18	*Macoma baltica*	Asco (Baltic Sea) Oresund (Kattegat)
A. tellinae	(Issel, 1903)	36-44+14-19	22—25	*Tellina exigua*	Neapolitanian Bay
A. tellinae	(Issel, 1903) (Redescribed and recorded from new host by Raabe, 1936)	30-40+18-22	22—24	*Macoma baltica*	Baltic Sea
A. abrarum	(Fenchel, 1965)	25-36+5-14	20—21	*Abra nitida*	Gullmarfjord, West Sweden
A. abrarum	(Fenchel, 1965) (Redescribed and recorded from new host by Raabe, 1970)	22-30+11-15	22—25	*Abra ovata*	Black Sea at Varna, Bulgaria
A. limnica	Raabe, 1967	20-35+11-18	21—28	*Spiralina vortex, Bathyomphalus contortus, Pulmonata* sp., *Unio* sp., *Anodonta* sp., *Pseudamnicola consociella, P. sturanyi Horatia ochridana, H. brusinae, Lyhnidia gjorgjevici, Gocea ohridana*	European Lowland and Lake Ohrid, Yugoslavia
A. tihanyensis	Raabe, 1950	25-30+13-17	24—28	*Lithoglyphus naticoides*	Lake Balaton, Hungary
A. subtruncata	(Issel, 1903)	37-46+20-25	18—19	*Tapes decussata*	Neapolitanian Bay
A. kofoidi	Bush, 1937	30-70+12-20	15—16	*Petricola pholadiformis*	San Francisco Bay
A. japonica	Uyemura, 1937	55-75+14-29	18—20	*Cyclina sinensis, Meritrix meritrix, Paphia philippinarum, Mactra veneriformis, M. sulcataria, Dosinia bilnulata*	Coasts of Japan
A. purpurae	(Chatton and Lwoff, 1926)	50+18-22	20	*Purpura haemastoma*	Banyuls-sur-Mor, Mediterrane
A. caudata	(Fenchel, 1964)	46-76+17-30	22—23	*Musculus niger, Modiolus modiolus*	Oeresund and Gullmarfjord
A. dosiniae	(Chatton and Lwoff, 1926)	65-80+30-40	—	*Dosinia exoleta*	Aux de Terennés, Baie de Morlaix
A. dosiniae	(Chatton and Lwoff, 1926) Redescribed by Fenchel, 1965	52-65+24-33	30	*Dosinia exoleta*	Gullmarfjord, West Sweden
A. (?) *scrobiculariae*	(Chatton and Lwoff, 1926)	50-60+25-30	28	*Scrobicularia plana*	Da Costa, Vimerux
A. (?) *compressa*	(Issel, 1903)	48-71+18-25	29—34	*Capsa fragilis*	Neapolitanian Bay
A. bulgarica	Raabe, 1970	37-47+15-20	28	*Mytilaster lineatus*	West Black Sea
A. nucellae	Khan, 1970	45-60+15-20	18—20	*Nucella lapillus*	Gower, South Wales
A. obtusae sp. nov.	(Jamadar & Choudhury, 1977)	27-40+20-34	19—22	*Cerithidea obtusa*	Sagar Island, Sunderbans, West Bengal, India and Kakinada Bay, Andhra Pradesh, India

and dimension is always situated at the anterior half of the body. It measures 8.5—17.0 μm in length aud 6.8—17.0 μm in width. The micronucleus is spherical or oval in shape and measures approximately 3.4-5.1 μm in diameter. Generally it is shadowed by the macronucleus and not always readily visible. Large number of dark-stained granules, specially in the thigmotactic

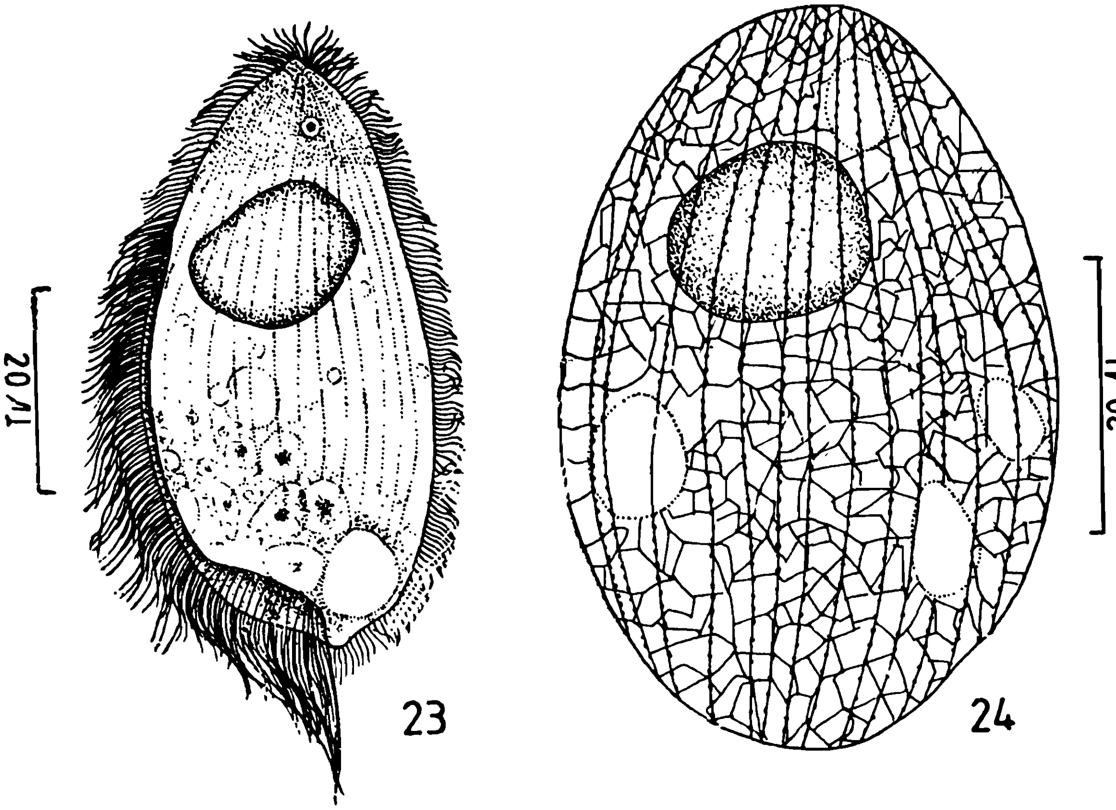


Fig. 23-24. Camera lucida drawings of *Fenchelia sagarica* sp. nov. from *Cerithidea obtusa* (Lamarck).
23, *F. sagarica* sp. nov. seen from left side ; 24, argentophilic fibrils forming reticulate structure.

zone, are found scattered in the cytoplasm. A large contractile vacuole measuring 25.5—42.5 μm diameter, is located posteriorly adjacent to the cytostome. In living specimens under microscope the contractile vacuole exhibits characteristic systolic and diastolic pulsation and enlarge its volume within minutes.

The peristome starts considerably posteriorly from the anterior tip of the body and runs posteriorly along the ventral margin of the body leading to the cytostome which is situated in a depression just in front of the postero-dorsal body protrusion. The length of the peristome varies from 25.5—42.5 μm and the cytostome measures iu average 7.54 μm in diameter. The cytostome is often obscured by the long dense cilia of the membranellae on each side of it.

The infraciliary structure or silver line system consists of 30-32 somatic kineties of which 16-17 on the left and 14-15 on the right side. The two adoral kineties originate at about one third distance from the anterior body pole and extend backwards to make a loop near the hind body pole. Transverse fibrillar junctions are present between the kineties on the left side.

Occurrence : It occurred in abundance in the mantle cavity of *Cerithidea obtusa* (Lamarck).

	Mean in μm	Range in μm
Length of the body	44.55	39.1-51.0
Breadth of the body	28.88	22.1-37.4
Length of the marconucleus	12.92	8.5-17.0
Breadth of the macronucleus	9.93	6.8-17.0
Diameter of the micronucleus	4.25	3.4-5.1
Distance of the macronucleus from the anterior end	8.77	5.1-11.9
Distance of the micronucleus from the anterior end	12.20	6.8-17.0
Length of the somatic cilia	3.46	1.7-6.8
Length of the adoral cilia	7.00	5.4-10.2
Length of the thigmotactic cilia	4.74	4.4-5.1
Length of the peristome	30.84	25.5-35.5
Diameter of cytostome	7.54	5.1-10.2
Distance of contractile vacuole	35.15	25.5-42.5
Number of kineties	31	30-32
Distance of inter-kineties	1.92	1.7-2.5

9. **Fenchelia kapili sp. nov.**

(Fig. 25, 26 Plate IV Fig. 27-29)

Type-host : *Cerithidea obtusa* (Lamarck)

Type-locality : South-west coast of Sagar Island, Sundarbans, 24 Parganas, West Bengal, India.

Other-locality : Kakinada Bay, Andhra Pradesh, India.

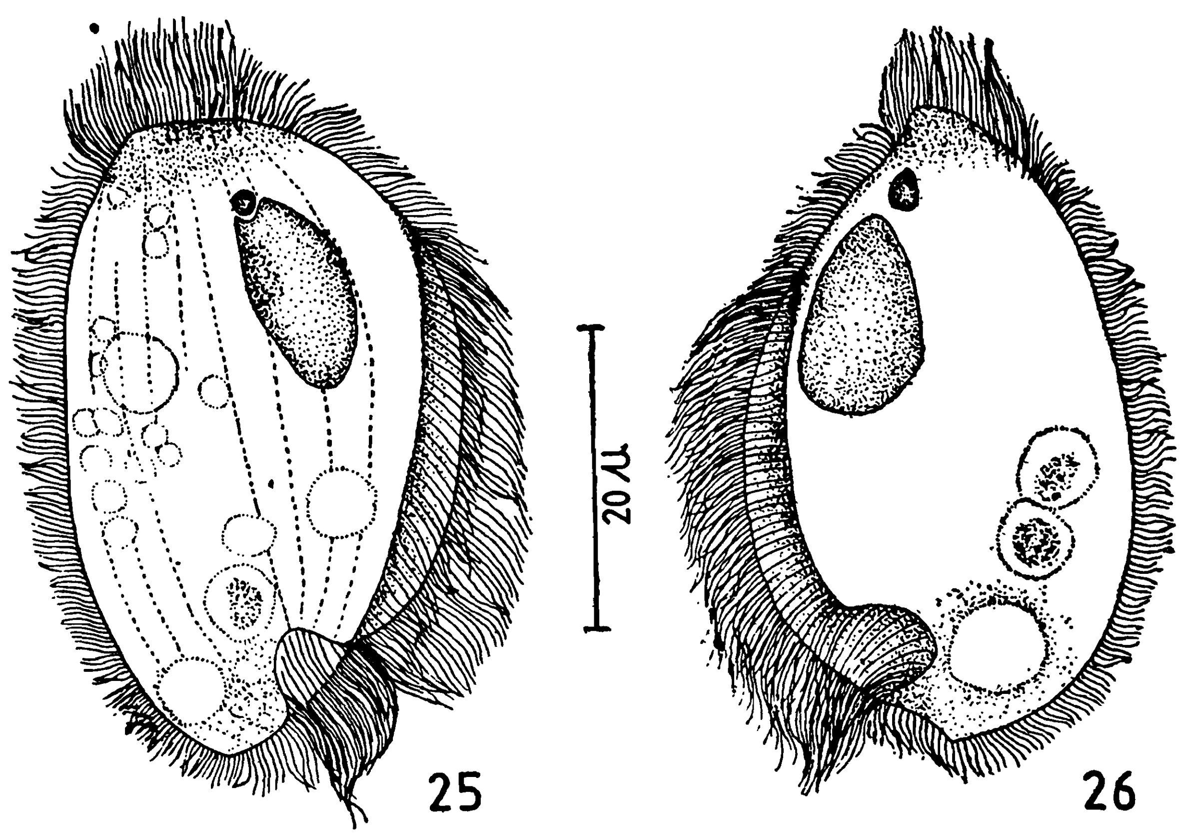
Type-material : On slides.

Holotype—Z. S. I., Reg. No. Pt. 2064

Paratype—Z. S. I., Reg. No. Pt. 2065—2066

Coll. Dr. Y Jamadar.

Morphology Dorso-ventrally flattened ovoid body with a conspicuous coneshaped prolongation of the posterior body pole. Ventral side is comparatively more convex than the dorsal side. Length 25.5—40.8 μm and width 13.6—30.6 μm. Macronucleus is ovoid or oblong and measures 8.5—15.3 μm x 5.1—10.2 μm. The compact spherical micronucleus measuring 1.7-3.4 μm in diameter is situated just in front of the macronucleus. Food vacuoles of varied sizes containing dark-stained bodies, are often visible. Contractile vacuole considerably large, situated posteriorly near the cytostome.



25 26

Fig. 25-26. Camera lucida drawings of *Fenchelia kapili* sp. nov. *Cerithidea obtusa* (Lamarck).
25 & 26, *F. kapili* sp. nov. seen from the right and left side.

The length of the peristome varies from 18.7—23.8 μm which starts beyond one third of the body length from the anterior end. The UM forms a big loop at the posterior end of the peristome with radially arranged stripes. The cytostome measuring 5.66 μm in diameter in average is situated far back in the posterior side just in front of the postero-dorsal prolongation of the body.

There are 21—25 kineties in addition to the two adorals, 9—11 on the right and 12-14 on the left side. Adoral kineties start from the one third part of the anterior suture and extend posteriorly. The length of cilia are regionally different. Anterior thigmotactic cilia are 7.65 μm in average, somatic cilia are 2.7-3.4 μm and the adoral cilia are 5.1—10.5 μm in length antero-posteriorly.

Occurrence : The species occurred in abundance in the ctenidium and scanty in the mantle cavity of *Cerithidea obtusa* (Lamarck).

	Mean in μm	Range in μm
Length of the body	32.94	25.5—40.8
Breadth of the body	21.11	13.6—30.6
Length of the macronucleus	10.84	8.5 – 15 3
Breadth of the macronucleus	7.97	5.1—10.2
Length of the micronucleus	2.61	1.7— 3.4
Breadth of the micronucleus	2.14	1.7— 3.4
Distance of inter kineties	2.05	1.5—3.06
Length of the somatic cilia	2.11	2.7— 3.4
Length of the adoral cilia	7.60	5.1—10.5
Length of the thigmotactic cilia	7 65	6.4— 8.5
Length of peristome	21.21	18.7—23.8
Distance of peristome from the anterior end	12.14	10.2—13.6
Diameter of cytostome	5 66	3.4—8.5
Distance of contractile vacuole	23.56	17.0—34.0
Number of kineties	23	21—25
Distance of inter kineties	2.05	1.5—3.06

Remarks The genus *Fenchelia* was first erected by Raabe in 1970 coined after his Scandinavian colleague and an eminent protozoologist, Tom Fenchel. Raabe was inspired to establish this new genus in order to separate the species *Ancistrum crassum* Fenchel, 1965 which he considered as divergent from other species of the genus *Ancistrum* and *Ancistrumina* in a sufficient degree. Fenchel (1965) himself remarked that *A. Crassum* is in several ways not typical for the genus, ... the adoral rows start relatively far back, about one third of the body length from the anterior end; the UM forms a big loop with radially arranged strips and on the dorsal side the body continues posteriad in a cone-shape prolongation' So far the genus *Fenchelia* Raabe, 1970 is monospecific sheltering the type species *Fenchelia crassa* (Fenchel, 1965).

In this monograph, the authors are pleased to add two more species under the genus *Fenchelia* which are claimed to be new to scienee (Table 4). These are *F. sagarica* sp. nov. and *F. Kapili* sp. nov. inhabiting mantle cavity and ctenidium respectively of the gastropod host *Cerithidea obtusa* (Lamarck). Both these species differ in many respects from the type species of the genus *F. crassa* Raabe, 1970 which was recorded from the molluscan hosts *Venerupis aurea* (Gmelin) and *V pullastra* (Mont.) from near Kristinberg Zoological Station, Kattegat (Table 4). *F.crassa* is elongated oblong in shape and there are 26 kineties of the general ciliature, 12 on the right and 14 on the left body side. In *F. Sagarica* sp. nov. number of kineties is 30-32 of which 16-17 on the left and 14-15 on the right side. In *F. kapili* sp. nov. there are 21—25 kineties, 9-11 on the right and 12-14 on the left side. In both the species from Indian host, the post oral prolongation of the dorsal body is primarily conical in comparison to their European counterpart. In other morphometric measurements, the Indian species are much smaller in size than *F. crassa* and are geographically isolated. The two Indian species, *F. sagarica* and *F. kapili*, though they have common host differ from each other in their number of kineties and preference of microniche : Because *F kapili* lives in between the ciliated epithelium of the host's ctenidium, its thigmotactic field on the left side bears cilia (8 μm) for attachment in comparison to those of *F. sagarica* (5μm) which prefers mantle cavity as its microhabitat.

Genus (6). **Protophrya** Kofoid, 1903 emend. Chatton and Lwoff, 1949

1903. *Protophrya* Kofoid, *Mark Anniv. vol. Harvard Univ.*, P. III

1949. *Protophrya* Chatton and Lwoff, *Arch. Zool. exp. gen.* **86** : 169—253 ; Corliss, 1961, *The ciliated Protozoa*, Pergamon Press, London and New York ; Fenchel, 1965, *Ophelia*, **2** : 71—174 ; Kudo, 1966, *Protozoology*, 5th Edn., Thomas, Springfield, Illinois, 1174 pp. ; Raabe, 1970, *Acta Protozool.* **7** (11/12) : 117-180.

Diagnosis : Strongly flattened body and of oval outline ; the left body side concave. The ciliature dense, the number of kineties of the range of 65° Both adoral kineties begin at a level of 1/3 of the body length from the apical end and form a small are in the hind part of the body. The naked peristomal field is very narrow. Parasites of the cavity (and the brood sac) of marine Gastropoda-Prosobranchia.

Type-species : *Protophrya ovicola* Kofoid, 1903, emend. Chatton and Lwoff, 1949 (After Raabe, 1970).

(This species was described from New Port, North America of *Littorina saxatilis*).

10. **Protophrya indica** sp. nov.
(Fig. 27, plate V—IX Fig. 30—57)

Type-host : *Littorina melanostoma* Gray

Type-locality : Sagar Island, Sunderbans, 24 Parganas, West Bengal, India.

Additional host : *Littorina* (*Littorinopsis*) *scabra scabra* (Linnaeus)

Locality : Waltair, Andhra Pradesh and Dona Paula, Goa the South and West coast of India.

Type-material : On slides.

Holotype—Z. S. I., Reg. No. Pt. 2097

Paratype—Z. S. I., Reg. No. Pt. 2098—3003

Coll. Dr. Y Jamadar.

Morphology Pyriform body, distinctly flattened laterally with concave anterior half on the left side covered with dense cilia. Somatic kineties run meridionally and are provided with dense delicate cilia. The number of kineties range from 60—77. The right and left system of kineties start slightly behind the anterior extremity leaving a narrow space and run posteriorly maintaining a regular arrangement all through till at the end where both the systems of kineties unite in a suture. The peristome is naked and very narrow, starts from the mid region of the body. The adoral kineties run parallel to the kineties of the general ciliature but in the posterior part of the body it sharply curves like an inverted 'C' The cystostome is situated close to the posterior end. The adoral cilia usually form a characteristic UM in front of the cytostome with the help of a long caudal cilium (11.9—17.0 μm) situated on the posterior pole. The thigmotactic cilia are seen in the antero-ventral side, opposite the peristome.

The macronucleus is oval, more or less round, lies somewhat at the anterior part of the body. The spherical micro-nucleus lies above the macronucleus. There is a single contractile vacuole situated beyond the posterior third of the body and is very adjacent to the cytostome. In living specimens systolic and diastolic pulsations could be seen under microscope. Clusters of food varied sizes, containing bacteria or granular substances, are often seen in the posterior part of the body.

Table 4. Comparison of the data concerning of *Fenchelia* sp. sp.

(Measurements : in microns)

Name of species	Author	Body dimensions	Number of kineties	Host	Locality
Fenchelia crassa	(Fenchel, 1965)	63-82+21-24	26	*Venerupis aurea* *Venerupis pullastra*	Kristinberg, Kattegat
Fenchelia sagarica sp. nov.	Jamadar, 1979	39-51+22-37	30-32	*Cerithidea obtusa*	Sagar Island, Marisjhapi Forest, 24 Parganas, W. Bengal and Kakinada Bay, Andhra Pradesh, India
Fenchelia kapili sp. nov.	Jamadar, 1979	25-40=13-30	21-25	*Cerithidea obtusa*	Sagar Island, Marisjhapi Forest, Sunderbans, 24 Parganas, W. Bengal and Kakinada Bay, Andhra Pradesh India

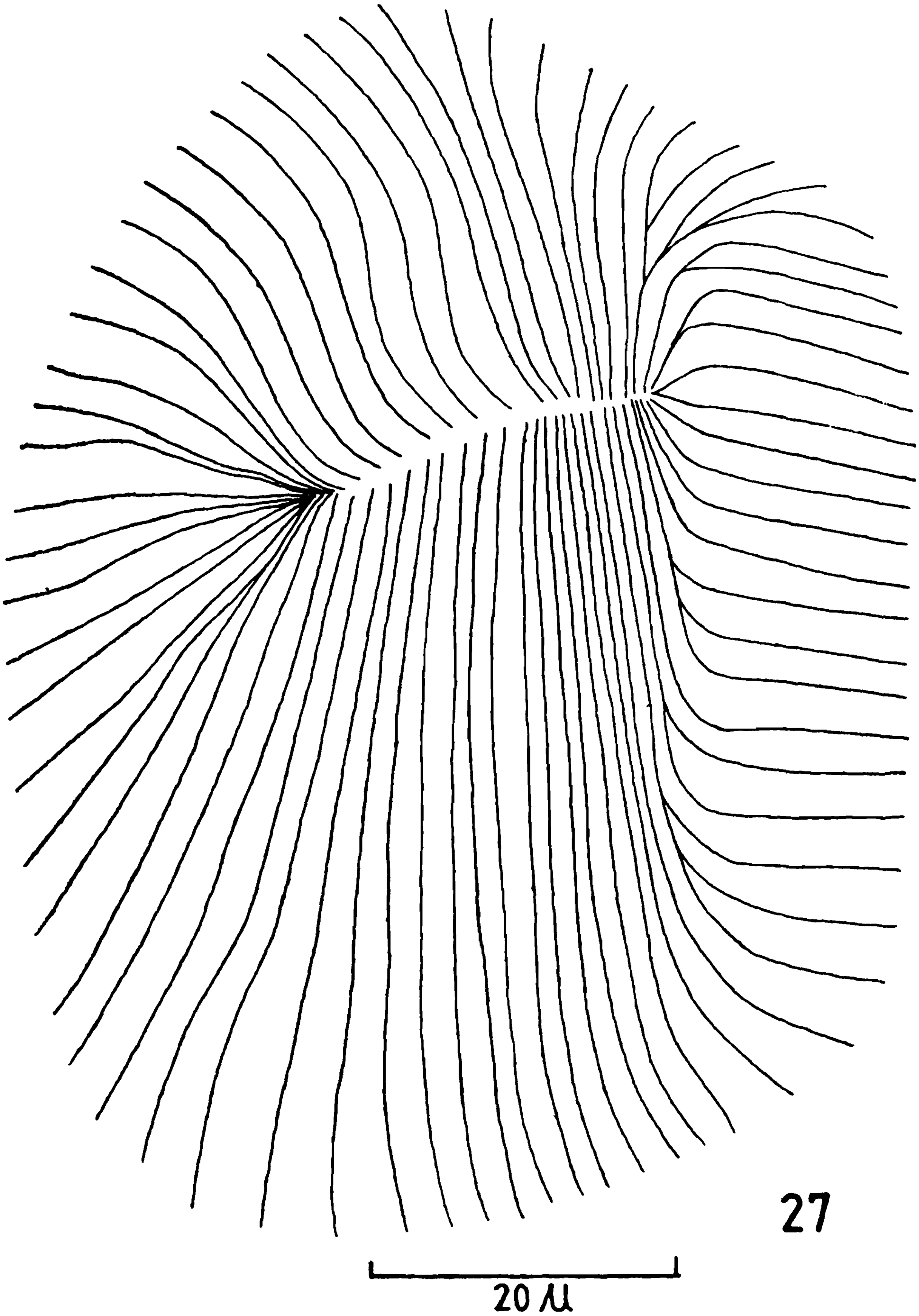


Fig. 27. Camera lucida drawings of *Protophrya indica* sp. nov. from *Littorina melanostoma* Gray and *L.* (*Littorinopsis*) *scabra scabra*.
Figure showing scheme of ciliature in the thterior suture of *Protophrya indica* sp. nov.

The general mensural data of the ciliate based on various morphometric parameters vary, though not significantly, when they are examined from two different hosts preferring two different ecological conditions. *Lttorina melanostoma* prefers exclusively estuarine mangrove habitat and lives on mangrove foliage moving up and down with the tides. *Littorina (Littorinopsis) scabra scabrr* (L.) prefers rocky substratum on the sea shores and remains submerged during the high tides.

Occurrence : It occurred in abundance in mantle cavity and buccal mass of *Littorina melanostoma* and *L.* (Littorinopsis) *scabra scabra*.

Remarks : The genus *Protophrya* was first established by C. A. Kofoid in 1903 based on the solitary species *P. ovicola* described by in the same year from the brood sac of *Littorina saxatilis* from New Port, North America. Later, Cepede (1910), Chatton and Lwoof (1949) and Fenchel (1965) found this species with little variations from several gastropod hosts of the genus *Littorina* from different parts of Europe. However, as Raabe contends, the description and figers of this ciliate reported by the previous workers are subjected to further observations.

So far it is evident from the literature that the genus *Protophrya* is still monospecific and shelters the only species *P. ovicola*. On the basis of data of Chatton and Lwoff (1949) and the supplement of Fenchel (1965), Raabe in 1970 set the diagnosis of the genus *Protophrya* in which he put the number of kineties of the range of 65° Later, in his descriptive part for the species, Raabe (1970) mentioned that there may be probably about 80 kineties of the general ciliature while referring to Fenchel's (1965) count of 35 kineties on the right side of the body.

The morphological data of *Protophrya* (spp) so far collected from the several gastropod hosts in Table 5 by many workers from different parts of the globe have been reported from *Littorina saxatilis* (Olivi). *L. rudis* Don. —New Port, North America, (Kofoid, 1903); *L. littoria* (L.), *L. sxatilis* (Ol.) *L, obtusata* (L.) Roscoff (Chatton and Lwoff, 1949); *L saxatilis* (Ol.), *L. littorea* (L.) Frederikshavn and Gullmarfjord-Kattegat, Scandinevian country (Fenchel, 1965) and *L. melanostoma* (Gray), *L.* (*Littorinopsis*) *scabra scabra* (L.)—Sagar Island, Waltair and Goa—South-east, South and West coast of India, (Jamadar and Choudhury, 1978). The species established by present authors exhibits marked distinctions from that of the type species of the genus both in the pattern of orientation of general somatic ciliatures and in the ratio of macronucleus axis : dorso-ventral diameter of the animalcule while retaining generalised generic characteristics.

The utilisation of the silver impregnation method (Klein, 1958) for demonstrating the somatic kineties in the ciliates proved very useful to make a detailed study of the infraciliature of the buccal apparatus, anterior and posterior sutures, and general body ciliations in the members of the genus *Protophrya* studied from hosts inhabiting geographically isolated global parts. The proposed new protophrian ciliate parasitizes the mantle cavity and buccal mass of the gastropod molluscs, *Littorina melanostoma* living in mangrove swamps of Sunderbans and *L (Littorinopsis) scabra scabra* inhabiting the rocky platforms of Indian coastal waters. The ciliate group occurring in *L. melanostoma* is characterised by greater body dimension and greater number of kineties, whereas the other group from *L. (Littorinopsis) scabra scabra* displays smaller body dimension and smaller number of kineties (Table 5). Comparative morphometric measurement reveals that both these groups of ciliates while maintaining the general body configurations of the genus, as prescribed by Raabe (1970), fall short of *P. ovicola* in size (88—102 μm × 71—77 μm), and macronucleus size in the Indian species is proportionately bigger than *P. ovicola* in relation to their respective body size (Table 6). From the above considerations therefore, the authors are led to believe that the protophrinid ciliate described from Indian subcontinent to be a new species and proposes to name it *Protophrya indica* keeping in view of its geographic identity. It is interesting to note that the two groups of ciliates in Table 5 occurring in two different Indian hosts (*Littorina* sp. sp.) of varied ecological niches showing variations in their mensural data, belong to one species, *Protophrya indica* sp. nov. Possibly, these kind of morphological variablity displayed by the two groups may be due to the exposure to two different host species and diverse ecological conditions.

Genus (7). **Boveria** Stevens, 1901

1901. *Boveria* Stevens, *Proc. Calif. Acad. Sci., 3rd ser. Zool.*, 3 : 1-42 ; Stevens, 1903, *Arch. Protistenk.*, 3 : 1-43 ; Fenchel, 1965, *Ophelia*, 2 : 71-174 ; Raabe, 1970, *Acta Protozool.*,7 (11/12) : 117-180.

Diagnosis : Pear-shaped often strongly elongated body. The ciliature not abundant, number of kineties 20 to 30. Long adoral cilia. Two adoral kineties begin in the vicinity of the enlarged, posterior body pole and make around it a large, involutive spiral, lying then perpendicularly to the kineties of the general ciliature. Parasites of the mantle cavity of marine *Bivalvia* and of the respiratory organ of *Holothurioidea*.

Typus generis *Boveria subcylindrica* Stevens, 1901
(After Raabe, 1970).

(This species was described from Pacific Grove, California of *Holothuria californica* Stimp.)

11. **Boveria teredinidi** Nelson, 1923
(Fig. 28 ; Plate IX Figs. 58—60)

1923. *Boveria teredinidi* Nelson, *Anat. Rac.*, **26** : 356 ; Pickard, 1927, *Univ. Calif. Publ. Zool.*, **29** : 405-428 ; Raabe, 1970, *Acta Protozool.*, **7** (11/12) : 117-180 ; Jamadar, 1979, Ph. D. Thesis, Cal. Univ.

1941. *Boveria xenkewitchi* Levinson, *Zool. Zh., Moskva*, **20** : 55-78.

1965. *Boveria* sp. Fenchel, *Ophelia*, **2** : 71-174.

Type-host *Teredo navalis* L.

Type-locality : Atlantic coast of North America.

Other host : *Bankia gouldi.*

Present new hosts record : *Donax lubricus* Hanley, *Mactra luzonica* (Deshayes)

Locality : Colva Beach, Goa-Western-coast of India aud Digha Beach, West Bengal, East-coast of India.

Morphology : Body more or less conical, with slightly pointed anterior tapering end. The length measures 34.0—57.8 μm (average 42.80 μm) and the width at the oral region 15.3—22.1 μm (average 18.80μm), in the adoral region circa 6.8—13.6 μm (average 10.4 μm). The large, oval macronucleus is centrally placed, varying from 10.2—15.3 μm (average 12.50 μm) in length and 6.8-8.5 μm (average 7.80 μm) in breadth. The spherical micronucleus measures 2.5-3.4 μm (average 3.10 μm) in diameter and is located in the anterior one third part of the body.

The contractile vacuole occupies a position dorsally near the outer terminus of the dorsal ciliary zone. Food vacuoles are 7—12 in number and usually found in the posterior half of the body. Each vacuole contains dark-stained food materials. The structure of the endoplasm is distinctly alveolar, somewhat coarser about the macronucleus than at the ends of the body.

Oral apparatus of *Boveria teredinidi* is represented by the broad discoid peristomal field which is truncated into a special area for securing food. According to Pickard (1927), this area is designated by some investigators as the frontal field which is devoid of cilia but is being girdled by a pair of spirally oriented adoral fibres, anterior and posterior, forming the adoral ciliary zone provided with long adoral cilia. The paired adoral fibres toge-

Table 5. Morphological variation of *Protophrya indica* sp. nov. from the two different hosts (Measurements : in microns)

	L. melanostoma	*L. (Littorinopsis) scabra scabra*
Length of the body	67.04 (59.5—89.9)	60.81 (54.4—68.1)
Breadth of the body	48.34 (35.7—59.5)	39.04 (34.1—47.6)
Length of the macronucleus	22.37 (17.0—28.9)	18.29 (13.6—22.1)
Breadth of the macronucleus	16.80 (10.2—22 1)	13.19 (8.5—15.3)
Diameter of the micronucleus	5.84 (3.4—8.5)	3.23 (2.7—5.0)
Distance of the macronucleus from the apical pole	18.97 (15.3—22.1)	16.52 (13.6—20.0)
Length of the somatic cilia	3.70 (2.5—5.1)	3.40 (2.3—5.1)
Length of the adoral cilia	6.49 (4.2—10.2)	8.30 (6.8—10.2)
Length of the caudal cilium	12.65 (10.8—16.5)	13.83 (11.9—17.0)
Length of the peristome	51.95 (44.2—62.9)	52.49 (45.9—61.2)
Diameter of the cytostome	10.04 (8.5—15.3)	10.06 (8.5—13.6)
Number of kineties	67—77	60—66
Interkinetic distance	1.45	1.23

Table 6. Comparison of the data concerning of *Protophrya* sp. sp. (Reproduced from Raabe, 1970) (Measurements : in microns)

Parameters	*Protophrya ovicola* Kofoid, 1903	*Protophrya ovicola* Kofoid, 1903 Chatton and Lwoff, 1949	*Protophrya ovicola* Kofoid, 1903 Fenchel, 1965	*Protophrya indica* sp. nov. Jamadar, 1979
Length of body	88—102	—	—	54.4—89.9
Breadth of body	71—77	—	—	34.1—59.5
Thickness of body	30—35	—	—	—
Measurements of macronucleus	20—25	—	—	13 6—28.9
Measurements of micronucleus	3—5	—	—	2.7—8.5
Length of peristome	—	—	—	44.2—62.9
Length of cilia	—	—	—	2.5—5.1
Length of adoral cilia	—	—	—	4.2—10.2
Length of caudal cilium	—	—	—	11.9—17.0
Number of kineties	—	—	35 on the right side and 40 on the left side	60—77
Interkinetic distance	—	—	—	1.23—1.45
Body shape	Elipsoidal, distinctly flattened laterally ; concave at its left side	—	Very flattened ; ovoid from the side	Pyriform body, distinctly flattened
Shape and position of macronucleus	Oval ; anterior in position	—	Ovoid ; middle of the body	Oval, more or less rounded ; anterior in position
Position of micronucleus	Near or before the macronucleus	—	—	Spherical ; situated above the macronucleus

ther curve out from their attachments to the micromotorium (Pickard, 1927) forward on the ventral side following the margin of the peristomal field, passing in a dexiotropic spiral (360°) along the dorsal side and terminating in a sharp coil (210°) in a sinistral direction on the ventral side, separated from the floor of the peristomal field by the ventral cleft.

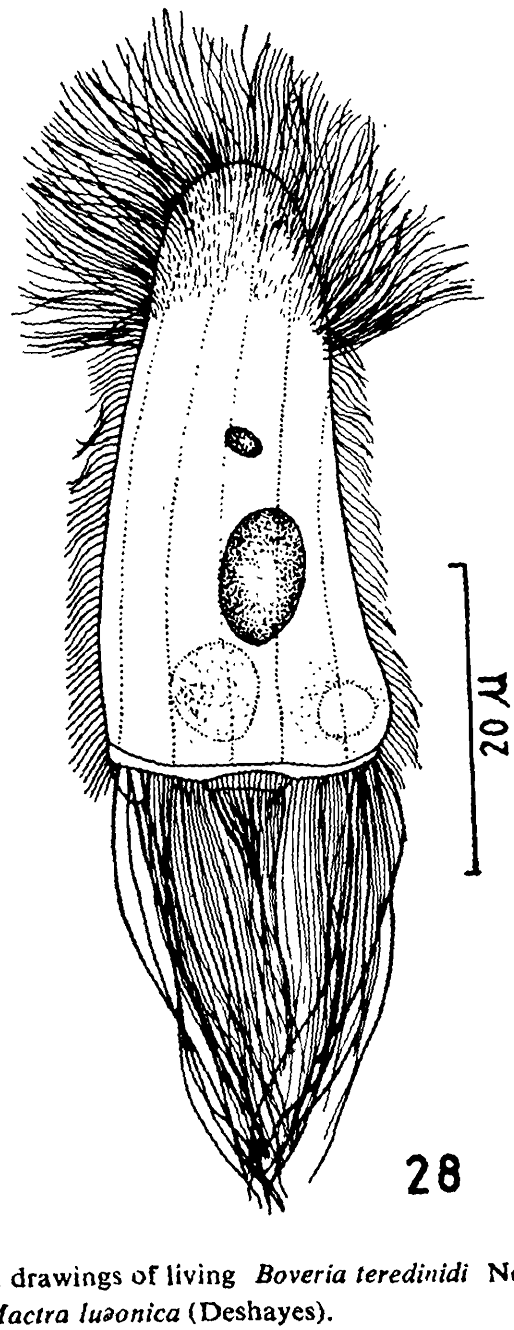


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Fig. 28. Camera lucida drawings of living *Boveria teredinidi* Nelson from *Donax lubricus* Hanley and *Mactra luəonica* (Deshayes).

In the present examination of *B. teredinidi* from Indian bivalv these, authors endorsed Pickard's observations that the cytostome or mouth is not a permanent structure and is only made out or becomes visible during active feeding. 'At such times it appears broad an deep and extending slightly to one side'

The body cilia are of equal length (4.50 μm) except at the oral and aboral regions. The two major lines of cilia distinguishable on the truncate peristomal field are the oral cilia and aboral cilia. The oral cilia measuring 6.8-8.5 μm, closely set in single line, arising from the basal granules connecting the neuromotorium, constitute a circle around the cytostome. The second conspicuous outer set is comprised of the longer adoral cilia (15.3—28.7 μm) arising from basal granules forming a double, parallel, dexiotropic spiral peripherally, proximally connecting with the neuromotorium and ending distally in a 'less extensive leiotropic spiral terminus' The thigmotactic cilia located at the anterior tapering end measure 5.1—8.5 μm. The general somatic ciliature arranged in 20-22 kineties and the interkinetic distance varies from 1.19—1.70 μm.

Occurrence : It occurred in the labial palps and gills of *Donax lubricus* Hanley and *Mactra luzonica* (Deshayes).

	Mean in μm	Range in μm
Length of the body	42.80	34.0 - 57.8
Breadth of the body	18.80	15.3—22.1
Breadth of the adoral region	10.40	6.8—13.6
Length of the macronucleus	12.50	10.2—15.3
Breadth of the macronucleus	7.80	6.8— 8.5
Diameter of the micronucleus	3.10	2.5— 3.4
Length of the somatic cilia	4.50	3.4— 5.1
Length of the thigmotactic cilia	6.30	5.1— 8.5
Length of the oral cilia	6.60	6.8— 8.5
Length of the adoral cilia	23.80	15.3—28.7
Length of the thigmotactic field	8.10	6.8—10.2
Number of somatic kineties	21	20—22
Distance between the inter kineties	1.56	1.1— 1.7

Remarks : The genus *Boveria* under the family Hemispeiridae, subfamily Ancistrinae, was established by N. M. Stevens in 1901 simultaneously with the description of the species *B. subcylindrica* Stevens, 1901, 1903 from the respiratory apparatus of *Holothuria californica*. Since then Issel (1903), Ikeda and Ozaki (1918), Nelson (1923), Pickard (1927), Levinson (1941), and Chatton and Lwoff (1949) have found and described several *Boveria* species from holothurians and lamellibranchs. The particular authors attempt to find specific differences in the compass of the adoral sprial. Stevens (1904), as for example, refers that her *B. subcylindrica* from *Holothuria californica* has a loop describing 'one turn and 290° of a second turn' ; the form from the pelecypod host, *B. subcylindrica* var. *neapolitana* (=*B. subcylindrica* var. *concharum*, Issel, 1903), therefore, is supposed to have a loop describing cone turn and 210° of the second turn' As Raabe (1970) opined, the systematics within the genus *Boveria* was not yet clearly determined and deserved a more detailed revision, similarly as it had been signalised for the genus *Ancistrumina*.

Nelson (1923) described *Boveria teredinidi* from the mantle cavity of *Teredo navalis* L., which was not provided with adequate morphometric measurements. Pickard (1927) redescribed in details the morphology and neuromotorium of *B. teredinidi* from *T navalis* and *Bankia gouldi*. The adoral kineties and the spiral formed by them were described in details by both the authors. According to Pickard (1927) 'The two adoral fibres give rise to the adoral ciliary lines, making a double dexiotropic spiral about the peristomal field which extends distally as a short leiotropic loop of half a spiral turn' Levinson (1941) raised some dispute and difference opinion regarding some biometrical-statistical data in his materials (*B. zenkewitchi*) obtained from the some host *Teredo navalis* from Sevastopol Bay. Ganapati and Nagabhusanam (1955) casually referred the presence of this ciliate in a wood boring mollusc (not identified) from Waltair coast, Andhra Pradesh, India, but did not give any detail.

Boveria teredinidi Nelson, 1923 has also been examined by the present authors from two different lamellibranch hosts inhabiting the littoral waters of Indian subcontinent and the results are communicated in the present monograph. The two hosts, *Mactra luzonica* (Deshayes) and *Donax lubricus* Hanley are not wood boring molluscs and inhabit two distant and distinct ecological niches, Digha in the East-coast, in the Hooghly estuary, and Goa in the West-coast, in Arabean sea, respectively. A morphometric comparison of the Indian materials with those of the Atlantic coast materials (vide Table 7) reveals that there are some obvious differences in the morphometric measurements and number of kineties but as regards the adoral ciliary lines, making a double dexiotropic spiral about the peristomal field and the distal leiotropic loop of half a spiral, more or less corroborate with those of Pickard's observations. These differences are, as the authors contend, are due to wide geographical isolation and new host and new environmental interactions.

C. Order PERITRICHIDA Stein, 1859
Suborder SESSILINA Kahl, 1933

Diagnosis Mature individuals attached to the substrate with contractile or non-contractile stalks ; no body ciliature ; telotroch formation ; often colonial.

Family (iv). SCYPHIDIIDAE Kahl, 1935

Diagnosis Without stalk, but attached to substrate by scopula.

Genus (8). **Scyphidia** Dujardin, 1841

1841. *Scyphidia* Dujardin, *Histoire nat. des zoophytes infusoires* ; Kahl, 1935, *Teil* **30** : Peritricha and Chonotricha : p. 835 ; Hirshfield, 1949, J. Morphol., **85** : 1-38 ; Kudo, 1966, *Protozoology*, 5th Edn., Thomas, Springfield, Illinois,, 1174 pp.

Diagnosis : Cylindrical ; posterior end attached to submerged objects or aquatic animals ; body usually cross-striated ; fresh or salt water (After Kudo, 1966).

Subgenus : **(Gerda)** Kahl, 1935

1935. (*Gerda*) Kahl, *Teil* **30** : Peritricha and Chonotricha : p. 835 ; Hirshfield, 1949, *J. Morphol.*, **85** : 1-38.

Diagnosis : Direct termination of the body with a broad flat bassal disc (After Hirshfield, 1949).

12. **Scyphidia (Gerda) ubiquita** Hirshfield, 1949
(Figs. 29, 30 & 31 ; Plate X Figs. 61-64)

1949. *Scyphidia* (*Gerda*) *ubiquita* Hirshfield, *J. Morphol*,, **85** : 1-33 ; Kudo, 1966, *Protozoology*, 5th Edn., Thomas, Springfield, Illinois, 1174 pp ; Jamadar, 1979, Ph. D. Thesis, Cal. Univ.

Type-host : Limpets

Type-locality : European coast.

Other hosts : Turbans, *Acmea testudinis*.

Present new hosts record *Littorina melanostoma* Gray and *L.* (*Littorinopsis*) *scabra scabra* (*Linnaeus*)

Locality : Sagar Island, Sunderbans, West Bengal, India.

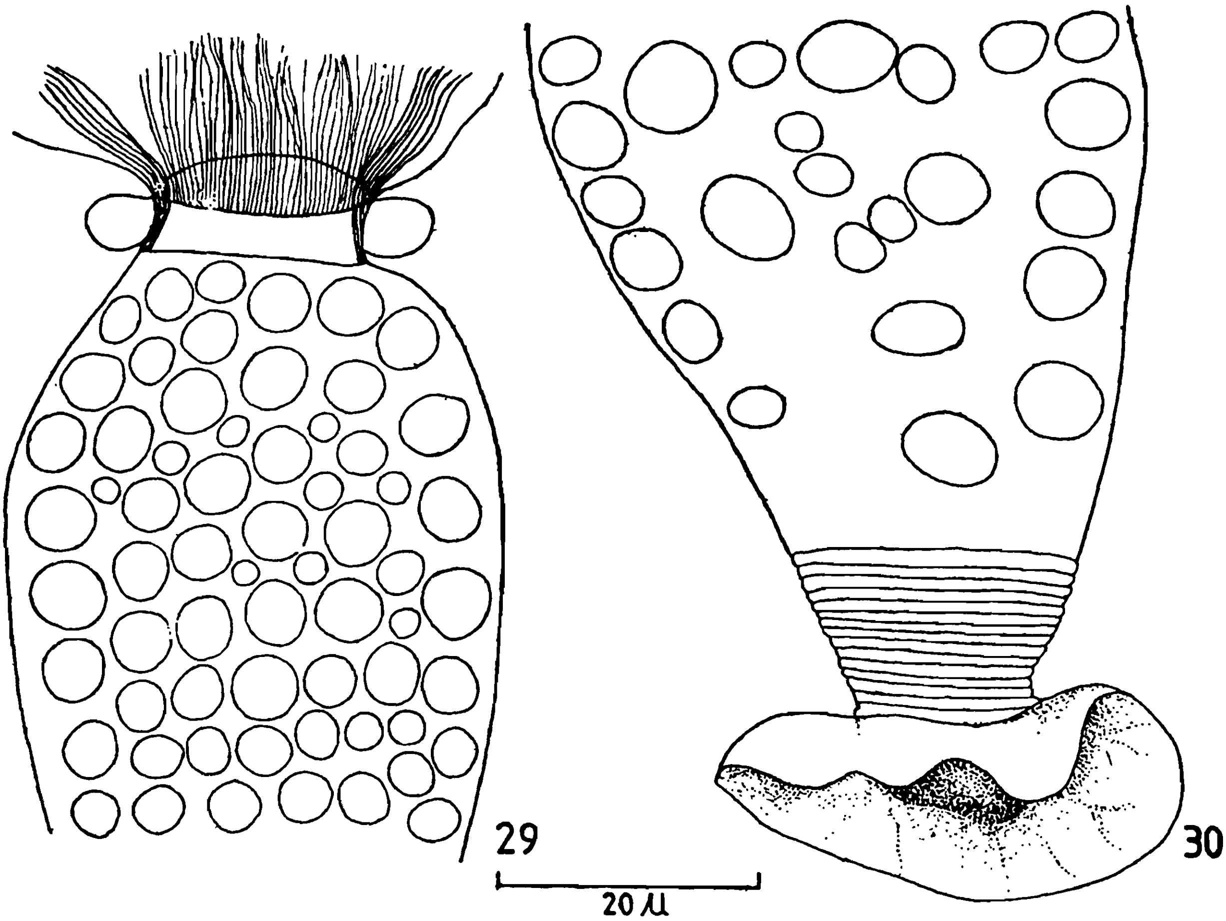
Morphology : The 'vase-shaped' cylindrical body of *Scyphidia* (*Gerda*) *ubiquita* is beautifully sculptured by regular pellicular ridges or transverse

Table 7. Comparative table of known species of *Boveria* sp. sp. (Reproduced from Raabe, 1970)

(Measurements in microns)

	Boveria subcylindrica Stevens, 1901 Syn.: *Boveria tapetis* Delphy, 1938 nomen nudum Raabe, 1947 ; Poljansky, 1951 ; Lom *et. al.*, 1968	*Boveria subcylindrica* var. *Concharum* Issel, 1903 *B. S.* var. *neapolitana* Stevens, 1904, *B. tapetis* Delphy, 1938 n. nudum, Chatton and Lwoff, 1949	*Boveria teredinidi* Nelson, 1923 *Syn* : *B. zenkewitchi* Levinson 1941	*Boveria labialis* Ikeda et Ozaki, 1918	*Boveria* sp. Fenchel, 1965	*Boveria teredinidi* Nelson, 1923 ; Jamadar, 1979
Body shape	Elongate, varying from cylindrical form to that of truncated cone	Elongate, varying from cylindrical form to that of truncated cone	Truncate, subconical	Trumpet-shaped	Cylindric, somewhat broader posteriad	Slightly conical
Aboral end :	Rounded	Pointed	Rounded	Rounded	Obliquely flattened	More or less pointed
Length & Breadth :	Length / Width / Author / Host 54-81 / 19-21 / Stevens 25-90 / — / Poljansky 37-43 / 20-23 / Raabe / *Cucumaria plancki*	Length / Breadth / Host / Authors 37-102 / 19-21 / *Tellina exigua* / Stevens 65-121 / — / *Capsa fragilis* / Stevens 37-51 / 20-26 / *Pinna nobilis* / Issel 32-155 / 20-31 / *Capsa fragilis* / Issel 27-113 / 20-32 / *Tellina exigua* / Issel 58-102 / 20-34 / *Tellina nitida* / Issel 66-169 / 27-33 / *Loripes lacteus* / Issel 50-65 / 20 / *Monia petalliformis* / Fenchel 55-75 / 20-23 / *Arca noae* / Raabe 37-55 / 17-20 / *Anomia ephippium* / Raabe 30-250 / — / *Tapes decussatus* / Delphy *Tapes fuscus* / Delphy	Length / Breadth / Host / Author 27-173 / 12-31 / *Teredo navalis* / Pickard 12-242 / 8-22 / *Teredo navalis* / Levinson	Length / Breadth / Host 31-100 / 16-26 / *Cucumaria* sp. *S. japonicus* *Tellina* sp.	—	34.0-57.8+15.3-22.1
Adoral spiral :	Double row of long coarse cilia united at ends, spiral forms turn of 360° and 290° of second turn	Double row of long coarse cilia united at ends, spiral forms turn of 360° and 200° of second turn	Double parallel dexiotropic ending dorsally in a leiotropic spiral, spiral forms one and a quarter turns	Double row of long coarse cilia, spiral forms turn of 360° and 290° of second turn	—	Paired dexiotropic spiral forms turn of 360° and 260° of second turn
Mouth	At 'posterior' end within loop formed by union of 2 rows of oral cilia at inner end of spiral	At 'posterior' end within loop formed by union of 2 rows of oral cilia at inner end of spiral	Mouth surrounded by oral cilia extended from oral ring	Mouth depression in centre of peristomal field	—	Truncated mouth represented by broad discoid peristomal field
Somatic ciliation :	Arranged in parallel longitudinal rows, Slightly oblique	Arranged in parallel longitudinal rows. Slightly oblique	Arranged in parallel longitudinal rows. Slightly oblique	Arranged in parallel longitudinal rows. Slightly oblique	—	Arranged in parallel longitudinal rows. Slightly oblique
Number of kineties :	20—27	20—27	18—22	20—26	—	20—22
Oral cilia :	1/2 length of body	1/2 length of body	1/3—1/5 length of body	1/3 length of body	—	1/3—1/5 length of body
CV	One , posterior to peristome	Nearer to outer end of spiral	Nearer to outer end of spiral on dorsal side	One	—	One on dorsal side nearer to outer end
Macronucleus :	Oval , centrally placed	Oval , centrally placed	Oval ; centrally placed	Oval , centrally placed	—	Oval , centrally placed
Micronucleus :	With four distinct chromosomes	With four distinct chromosomes	Not determined	Four distinct chromosomes	—	Not determined
Hosts and locality :	*Holothuria californica* Stimp. Pacific Grove, California (Stevens) , *Parastichopus californicus* Friday Harbour on San Juan Island, Washington (Lom *et. al.*, 1968) ; *Stichopus japonicus*, *Cucumaria* sp. sp. Vladivostok (Poljansky) ; *Cucumaria plancki* Brdt. from Split (Yugoslavia—Raabe, 1947)	*Tellina nitida* Poli, *T. planata* L., *T. exigua Poli*, *Capsa fragilis* L., *Donax politus* Poli, *Venus gallina* L., *Tapes decussata* L., *Loripes Lacteus* Blain., *Cardita sulcata* Brug, *Pinna nobilis* L —Napoli (Issel part. Stevens) : *Anomia ephippium* L., *Loripes lacteus* Bl.—Séte (Ch. Lw.) ; *Monia patelliformis* (L.)—Skagerrak (Fenchel) ; *Arca noae* L.—Adriatic and *Anomia ephippium* L.—Monaco (Raabe)	*Teredo navalis* San Francisco Bay (Pickard), Sevastopol Bay (Levinson), Atlantic coast of North America and in *Bankia* (Nelson).	*Cucumaria* sp., *Stichopus japonicus*, *Tellina* sp.	—	*Donax lubricus* (Hanley), Colva beach, Goa, West coast of India ; *Mactra luzonica* (Deshayes), Digha Beach, West Bengal, East coast of India.

striae, from the base or 'scopular disc' to the oral end, with the exception of the peristomial lips-where they are arranged in a rather irregular way. These striae are also rather aberrant at the foot of the scopular disc. In shape and structure the peritrich ciliate examined from the two gastropod hosts, *Littorina melanostoma* and *L.* (*Littorinopsis*) *scabra scabra* proximates almost exactly to that described by Hirshfield (1949) from the European limpet and turban gastropods.



Figs. 29-30. Camera lucida drawings of *Scyphidia* (*Gerda*) *ubiquita* Hirshfield a living specimen found from *Littorina melanostoma* Gray and *L.* (*Littorinopsis*) *scabra scabra* showing anterior and posterior half of the body.

In the motile living state the expanded peristomial disc resembles a pointed 'snout' and there are two earlike projections lateral to the 'snout' which form the edges of the peristomial ridge. The peristome that leads into he gullet, is lined with a single row of cilia. The gullet is very long and extends deep obliquely into the body, for about one third the anterior body part of the ciliate found in *L. melanostoma*, and about half to two third the body length in the ciliate from *L. (Littorinopsis) scabra scabra.* The entire length of the gullet lumen is lined by two rows of cilia opposing each other.

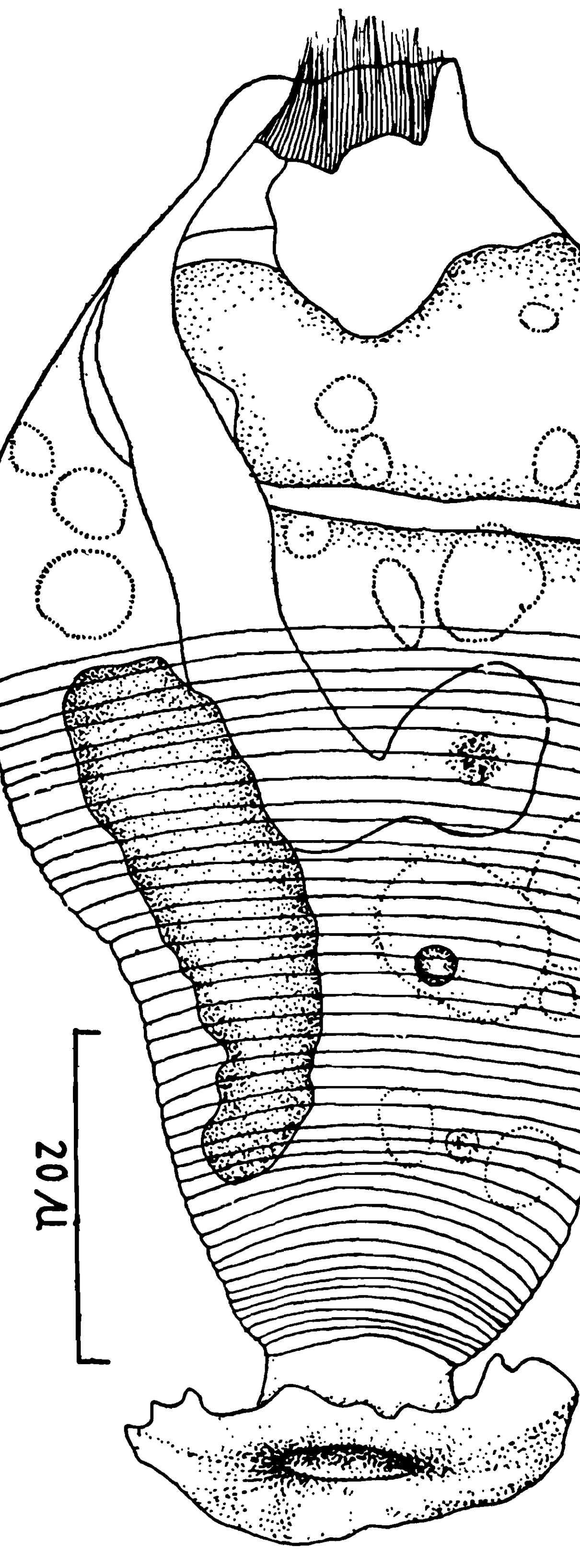


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Fig. 31. Camera lucida drawings of *Scyphidia* (*Gerda*) *ubiquita* Hirshfield, a stained specimen with iron alum-haema-toxylin from a mangrove gastropod, *Littorina* (*Littorinopsis*) *scabra scabra*.

The attachment or 'scopular disc' is more or less flat, very adhesive and is able to clasp the substrate. By 'scopular disc' Lom and Corliss (1968) meant the basal, disc-shaped part of the ciliate's whole body. The scopula itself is its bottom surface, by which the organism adheres to the surface of its host. In attached ciliates it is mostly flat ; if released, it can be contracted, so that its adhesive surface forms a hemisphere or an almost closed sphere. Lom and Corliss (1968) observed in *S. ubiquita*, collected from San Juan Island, Washington, that the constriction is controlled by subpellicular myonemes which reach into the scopular disc. They further note under EM examination, 'In addition to myonemes and some cytoplasmic components found also in the rest of the body, the scopular disc contains very numerous granules 0.2-0.3 μm in greater diameter containing an electron-dense material enclosed in a unit membrane. They strongly remind one of lysosomes. Their role is not clear ; but, since they occur exclusively in the scopular disc, they may in some way be associated with the secretory ability of the scopular disc'

When fully stretched or expanded, the body seems to be smooth and without lateral striations. Wrinkles and lateral striations are there at the basal region of the cylinder just above the scopula. The number of lateral striae is variable in the two populations of *S.* (*Gerda*) *ubiquita* examined from the two gastropod hosts.

The macronucleus is very conspicuous and expanded, sometimes elongated or sausage-shaped and is centrally located. It displays a variety of configurations in the two populations of the ciliate during different states of contractions. Micronucleus is small, spherical to oval, and is located at the anterior proximity of the macronucleus. A contractile vacuole of moderate size is located near the peristomal disc.

Occurrence : This species occurred in abundance in the mantle cavity and buccal mass of *Littorina melanostoma* and *L.* (*Littorinopsis*) *scabra scabra*.

Remarks ; The family scyphidiidae was introduced by Alfred Kahl in 1935 under the suborder Sessilina to shelter some very specialised stalkless peritrichid ciliates. According to the system of Kahl, the family Scyphidiidae includes two genera : *Scyphidia* Dujardin, 1841 and *Glossatella* Butschli, 1889 but, at it was stated by Lom 1966, the generic name *Glossatella* had to be rejected in favour of *Apiosoma*. Classification within the family Scyphiididae is simpler, since Kahl relegated the previous genus *Gerda* (Claparede and Lachmann, 1858-1861) to a subgenus of the genus

Scyphidia. The subgenus (*Gerda*) Kahl, 1935 is characterised by a direct termination of the body with a broad flat basal disc—the scopula, without a stalk.

Hirshfield (1949) made a very good survey of the genus *Scyphidia* covering some twenty three species including two from the Indian subcontinent (Bhatia, 1936). To this list may be added two more species, the one *S. inclinata* described by Lom and Corliss (1968) and the other by the present authors in Table 8, to be followed after this discussion.

Scyphidia (*Gerda*) *ubiquita*, as presented in the present monograph, has been recorded simultaneously from two new gastropod hosts, *L. melanostoma* and *L.* (*Littorinopsis*) *scabra scabra* inhabiting the estuarine mud flats of complex Sunderbans ecosystem crowded with mangrove vegetation. The two hosts show peculiar niche preference, the former is exclusively foliage living avoiding innundation during high tide, and the latter prefers tree trunks or solid substratum periodically enjoying innundation.

The two populations of *S.* (*Gerda*) *ubiquita* examined from two different gastropod hosts display some variability in their morphometric measurements as is evident in Table 8. The authors believe that they belong to the same species and the variabilities are possibly due to different host and habitat exposures.

13. **Scyphidia (Gerda) bengalensis** sp. nov.
(Figs. 32, 33 ; Plate X Figs. 65, 66)

Type-host : *Cerithidea cingulata* (Gmelin)

Type-locality : Mandirtala mud flat, Sagar Island, Sunderbans, 24 Parganas, West Bengal, India.

Type-material : On slides

Holotype—Z.S.I., Reg. No. Pt. 3005

Paratype—Z.S.I., Reg. No. Pt. 3006—3007

Coll. Dr. A. Choudhury

Morphology : Cylindrical vase-shaped organism with a very small attachment disc or scopula. Like *Scyphidia* (*Gerda*) *ubiquita*, the proposed new peritrichid ciliate body is also very beautifully sculptured with concentric pellicular ridges, from the base to the peristomial disc. The

Table 8. Survey of the data concerning of *Scyphidia* sp. sp. (Taken from Hirshfield, 1949)

Species	Author	Subgenus	Habitat	Host	Height	Width	Mac. N. shape	Striae	Body shape	Peristome
S. ubiquita	Hirshfield, Lom	*Gerda*	Marine	Limpets, Turbans ; *Acmea testudinis*(Lom, 1968)	30—100	25—40	Sausage	—	Cylind,	Arched
S. patellae	Cuénot	*Gerda*	Marine	Patella	30—45	—	Beaded	—	Cylind.	Arched
S. fischori	Vayssiere	*Gerda*	Marine	Truncatella	60	—	Ribbon	—	Cylind.	Flat
S. terebellidis	Precht	*Gerda*	Marine	Annelid	45—55	—	Ovoid	+	Cylind.	Flat
S. scorpaenae	Fabre Domergue	*Scyphidia*	Marine	Scorpaena	53	—	Ribbon	+	Broad	Flat
S. variabilis	Dons	*Scyphidia*	Marine	Terebella	60—90	—	Kidney	+	Goblet	Flat
S. hydrobiae	Kahl	*Scyphidia*	Marine	Hydrobia	70	—	Kidney	—	Goblet	Flat
S. spionicola	Precht	*Scyphidia*	Marine	Annelid (Pygospio)	45—65	—	Sausage	+	Goblet	Arched
S. rhizopoda	Lepsi	*Scyphidia*	?	?	51	31	Sausage	—	Cylind.	Raised
S. physarum	Lachmann	*Gerda*	Fresh water	Physa, Neritina	80—100	—	Sausage	+	Cylind.	Arched
S. annulata	Edmonson	*Gerda*	Fresh water	Algae	80	—	Sausage	+	Cylind.	Flat
S. ambigua	Penard	*Gerda*	Fresh water	Sphagnum	65	—	Horse shoe	—	Cylind.	Arched
S. tholiformis	Surber	*Gerda*	Fresh water	Fish	59	35	Band	+	Cylind.	Domed
S. ameiuri	Thompson, *et. al.*	*Gerda*	Fresh water	Fish	34—45	20—34	Band	+	Cylind.	Domed
S. purniensis	Ghosh	*Gerda*	Fresh water	?	?	?	Ribbon	—	Cylind.	Flat
S. limacina	Lachmann	*Scyphidia*	Fresh water	Planorbis	70—100	—	Band	+	Cylind.	Arched
S. rugosa	Dujardin	*Scyphidia*	Fresh water	Detritus	90	21	Round	+	Goblet	Flat
S. constricta	Stokes	*Scyphidia*	Fresh water	Nais	60	—	Oval	+	Goblet	Flat
S. discostyla	Svec	*Scyphidia*	Fresh water	Nais	90	—	Sausage	+	Cylind.	Flat
S. ovata	Kellicott	*Scyphidia*	Fresh water	?	35	42	Sausage	+	Ovoid	Flat
S. lumbriculi	Penard	*Scyphidia*	Fresh water	*Lumbriculus*	70	—	Sausage	+	Goblet	Raised
S. micropteri	Surber	*Scyphidia*	Fresh water	Fish	59	22	Heart	+	Cylind.	?
S. indica	Bhatia	*Scyphidia*	Fresh water	Daphnia	52	25	Round	—	Urn	Flat
S. inclinata	Lom	—	Fresh water	*Cincinnatia cincinnatiensis*	—	—	—	—	—	—
S. ubiquita	Jamadar, 1979	*Gerda*	Estuarine	*Littorina melanostoma, L. (Littorinopsis) Scabra scabra*	40.8—96.9	23.8—64.6	Elongated or sausage	+	Cylind.	Raised
S. bengalensis sp. nov.	Jamadar, 1979	*Gerda*	Estuarine	*Cerithidea cingulata*	40.8—71.4	25.5—61.2	Coiling	+	Cylind. vase shaped	Expanded

ciliate body is highly contractile and in living observation the same animal displays shortening of height at different level. From 25 specimens at different stages of their contractions, the height could be measured with a range between 40.8-71.4 μm and width between 25.5-61.2 μm.

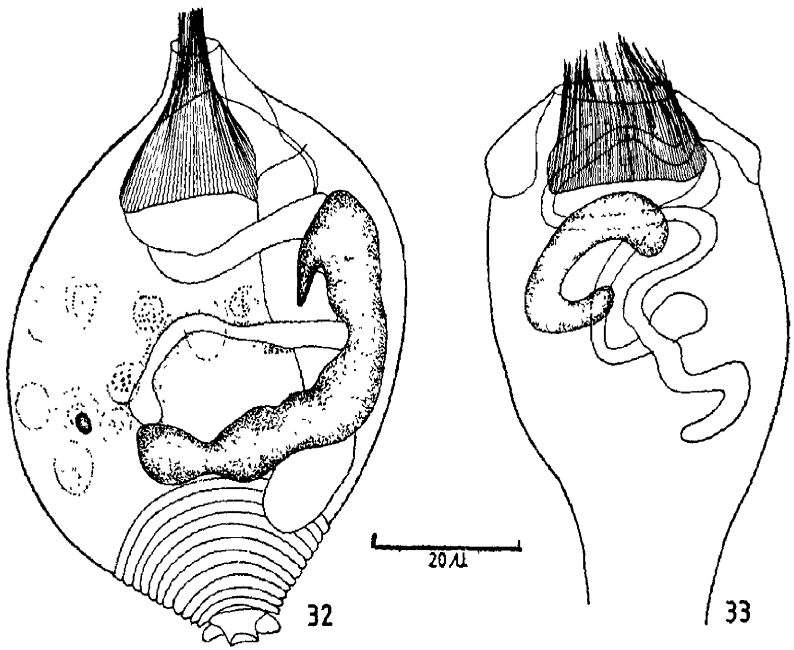

Fig. 32-33. Camera lucida drawings of *Scyphidia* (*Gerda*) *bengalensis* from Cerithidea cingulata (Gmelin).
32, *Scyphidia* (*Gerda*) *bengalensis* sp. nov. ; 33, Peristomial disc with twisted long gullet and peristomial cilia.

The peristomial disc of the ciliate is also very conspicuous. While at rest the peristome is expanded displaying the circlet of long peristomial cilia (10.2-17.0 μm) and in motile state the contracted peristomial disc resembles a sharply pointed 'snout'. The peristome leads to a very long gullet, much twisted and showing different curvatures, ultimately ends in the middle of the cell-body. Entire length of the gullet is lined internally with two rows of cilia opposing each other.

The scopular disc, in comparison to the cell body, is very small and when detached, shows wrinkled margins and having a diameter range of 5.1-11.9 μm. The vase-shaped body while terminating to the scopular disc, sharply and suddenly narrows to a short 'stalk-like' apparatus to be ended ultimately in a short flat disc. When contracted, the concentric pellicular ridges or striae become conspicuous from the base to the peristomial region covering the entire vase-shaped body.

The most conspicuous characteristic of this peritrichid ciliate is its cylindrical macronucleus which exhibits a great variation in its configuration, particularly in shape and length. Sometimes the length of the macronucleus may surpass the total height of the animal body and to ensure comfortable accomodation, the macronucleus undergoes looping upon itself or coiling. The maximum length of the macronucleus recorded is 81.6 μm. The micronucleus with a diameter range of 1.7-3.4 μm is situated towards the oral end. There is a prominent contractile vacuole near the gullet. Other small vacuoles numbering 9-12 are located in the central part of the cell body.

Occurrence : It occurred in abudance in the mantle cavity and buccal mass of *Cerithidea cingnlata* (Gmelin).

Height of the body	59:29	40.8—71.4
Width of the body	43.19	25.5—61.2
Length of the macronucleus	49.40	28.9—81.6
Width of the macronucleus	7.11	5.1— 8.5
Diameter of the micronucleus	2.86	1.7 3.4
Length of the peristomial cilia	12.59	10.2—17.0
Diameter of the scopula or attachment disc	9.63	5.1—11.9

Remarks : The sessiline peritrich ciliate described from the gastropod host *Cerithidea cingulata* (Gmelin) and presented in this monograph is unlike the other members of the genus *Scyphidia* reported so far. It is unique in its configuration and nuclear pattern and dimension in particular. The scopular base is very small in comparison to the boyd size and is firmly adhered to the surface of its hosts. If realeased, it can be contracted to a small disc. This contraction is said to be controlled by subpellicular myonemes which reach into the scopular disc. All these formations may be regarded as genuine adaptations to the ectoparasitic or ectocommensal way of life of the peritrich species under consideration. As it has been observed by authors like Lom and Corliss (1968) that the permanent fixation to a host is uniformly assured by secreted sticky substance, either in the form of simple agglomerations of a mucous material at the posterior end of the body as in *S.* (*Gerda*) *ubiquitra* or by a scopular cilia as in *S. inclinata* Lom and Corliss, 1968.

At the present moment of investigation it was beyond the scope of the authors to demonstrate the fine structure for attachment of the scopular disc in the present ciliate. Yet, from the observations made from the living materials, it can be safely presumed that they had firm associations with their hosts and that they could be separated from the host's surface only by applying physical stress, thereby inflicting some structural damage to the scopular disc.

So, from the literature available upto date, the present scyphidian specimen from the gastropod, *Cerithidea cingulata* (Gmelin) seems to be new to science and hence the name *Scyphidia* (*Gerda*) *bengalensis* sp. nov. is proposed for it to mark its new identity (Table 8).

Suborder MOBILINA Kahl, 1933

Diagnosis : Free swimming, without stalk ; body axis shortended ; with a highly developed attaching organelle on the aboral end (After Kudo, 1966).

Family (v). URCEOLARIIDAE Dujardin, 1841

Diagnosis : Lame as suborder Mobilina.

Genus (9). **Trichodina** Ehrenberg, 1838

1838. *Trichodina* Ehrenberg, Leipzig, 612 pp. ; Faure—Fremiet, 1943. *Bull. Soc. Zool., Fr.*, **75** : 109—122 ; Tripathi, 1948, *Rec. Indian Mus*,. **52** : 221—230 ; Hirshfield, 1949, *J. Morphol* , **85** : 1—33 ; Fenchel, 1965, *Ophelia*, **2** : 71—174 ; Kudo, 1965, *Protozoology*, 5th Edn., Thomas, Springfield, Illinois, 1174 pp.

Diagnosis : Body barrel-shaped ; with well developed adhesive basal disc, and a skeletal ring with radially arranged denticles composed of distally projecting blades and medially extending spines ; adoral ciliary row spirals one to three times ; without cirri ; commensals on, or parasitic in, aquatic animals (After Kudo, 1966).

14. **Trichodina gangetica** sp. nov.
(Figs. 34 ; Plate XI Figs. 67-72)

Type-host : *Modiolus* (*Modiolus*) *striatulus* (Hanley)

Type-locality : Outram Ghat, Hooghly river, Calcutta, India.

Type-material : On slides

Holotype—Z.S.I., Reg. No. Pt. 3008

Paratype—Z.S.I., Reg. No. Pt. 3009—3011

Coll. Dr. Y Jamadar

Morphology: Bell shaped to hemispherical in form and circular in outline with a diameter 40.8-52.7 μm (Length or 'height' variable from 6.8-15.3 μm). Cytostome ventral and slightly anterior to mid body level. The cytostome and cytopharynx lie at the terminal end of a moderately deep and inclined vestibulum.

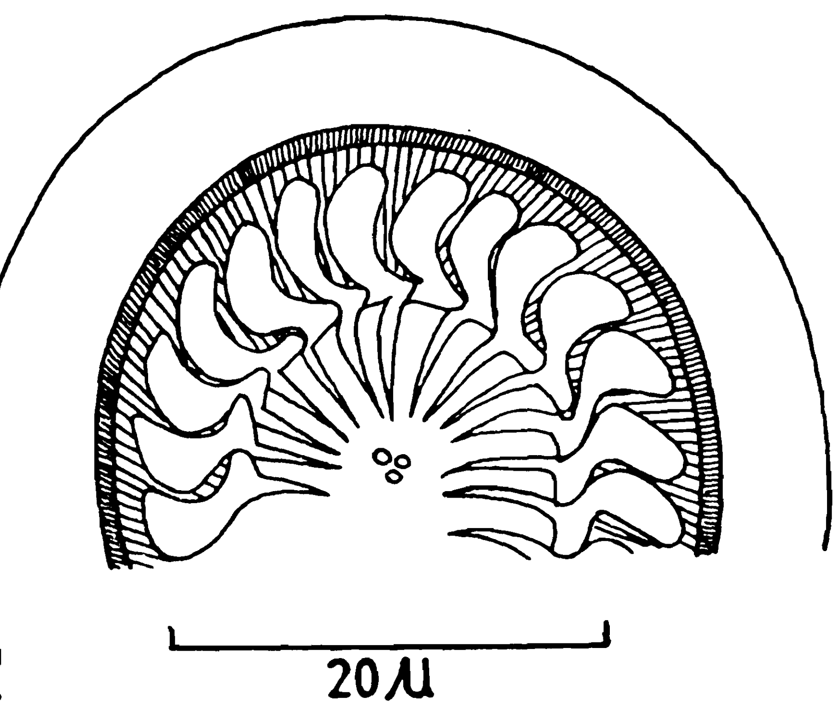

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Fig. 34. Camera lucida drawings of *Trichodina gangetica* sp. nov. from *Modiolus* (*Modiolus*) *striatulus* (Hanley) showing half of the body with denticles, denticulate ring and radial pins.

As viewed from the anterior pole, the adoral ciliary spiral is a complex of two parallel rows of closely set cilia fused for some distance. They arise in the right ventral quadrant of the cell just anterior to the level of the mouth. These paired rows spiral adorally counter clockwise in slight excess of 360° then diverse and enter the immediate region of the cytostome. The row which was formerly the outer ciliary spiral (haplocinetie of Chatton) follows the outer rim or the vestibulum and crosses the median axis of the cytopharynx ; from this point, it completes its circuit about the vestibular tip and plunges sharply inward, in the meanwhile performing a 180s circuit to define the upper left margin of the cytopharynx.

The marginal cilia or anterior circlet are short, fine, loosely spaced ; cilia 3.4-5.1 μm in length. The middle circlet or ciliary girdle is a series of overlapping membranelles. The posterior circlet or inner cilia are closely set, short, and fine, inserted immediately anterior to the border of the basal disc. Velum is most probably lacking like many other trichodinids (Uzmann and Stickney, 1954). The adhesive or basal disc is concave, circular in outline and varies from 25.5-34.0 μm in diameter. It is reinforced by the ring shaped skeletal complex in the middle consisting of a striated membrane, posteriorly underlying denticulate ring and border membrane. Most externally there is a fine pellicle covering the disc.

The denticulate ring is 13.6-18.7 μm in outside diameter containing 21-27 denticles. Each denticle consists of a conical centrum (1.7 μm), a proximal ray (3.4-6.8 μm) and a distal blade (3.4-5.1 μm). Inner rays show thicker margins and thinner middle parts ; the posterior margin of thin outer blades is swelled, clearly visible in living state. The denticle itself is elliptical, terminated with a small sharp tip interposed into the cavity of the preceeding denticle. There are 6-8 radial pins in the distance between two neighbouring denticles.

The macronucleus is large, horse-shoe or arch shaped, 25.8-34.0 μm in diameter and lies just above the adhesive disc. It is so oriented that its open ends are on the side of the body bearing the mouth and contractile vacuole. The micronucleus lies close to the outer curvature at the termination of the right arm of the macronucleus. The contractile vacuole is eccentrically situated and located just anterior to the left arm of the macronucleus. The time sequence between systole and diastole of the contractile vacuole varies from 30 to 50 seconds. Some aggregated globular structures are also observed in the central axis of the cell body of the living materials.

Occurrence : It occurred sparsely in the summer season but abundantly in the winter in the gills and labial palps of *Modiolus* (*Modiolus*) *striatulus* (Hanley).

	Mean in μm	Range in μm
Diameter of the body	46.51	40.8-52.7
Diameter of the adhesive disc	28.83	25.5-34.0
Diameter of the denticulate ring	16.38	13.6-18.7
Number of denticles	22	21-24
Number of radial pins between		

two neighbouring denticles	7	6-8
Diamensions of the denticle :		
length of the thorn	4.69	3.4-6.8
length of the blade	4.11	3.4-5.1
width of the central part	1.70	—
length of the denticle	4.38	3.4-5.1
Diameter of macronucleus	28.90	23.8-34.0
Diameter of micronucleus	1.70	—
Width of the border membrane	1.70	—
'Y' value of the micronucleus	= +Y	

Remarks : Many *Trichodina* species have been described from various hosts, invertebrate and vertebrate, since Ehrenberg's description of *T pediculus* in 1838. The first record of a trichodinid from a marine lamellibranch is that of Delphy (1938) who described hundred years later *Cyclochaeta cardii* from the pallial cavity of *Cardium eduli* from the region of Arcachon on the Bay of Biscay. The present species, *Trichodina gangetica* sp. nov. was first encountered by the present authors in October 1976 in specimens of an estuarine bivalve, *Modiolus* (*Modiolus*) *striatulus*, from the river Ganges (Hooghly river), Outram Ghat, Calcutta, India. The authors enjoy the privilege to be the first to report any trichodin species in molluscan host from the Indian subcontinent. The other trichodin, *T indica* was reported from this sub-continent by Y R. Tripathi (1954) from a fish host.

The general morphology of trichodinids has been reviewed in the excellent studies of Faure-Fremiet (1943), Faure-Fremiet and Thaureux (1944) and Davis (1947). These authors have emphasized and demonstrated the taxonomic importance of the skeletal ring in the problem of specific determination. Faure-Fremiet (1943) presented a systematic review of the family Urceolariidae and provided a workable taxonomic scheme which subsequently embraces the most salient features of the assigned members. Considering six genera (*Vouchomia*, *Uroceolaria*, *Trichodina*, *Cyclochaeta*, *Acyclochaeta* and *Cyplopyrrha*) assigned to the family, Faure-Fremiet retained only two with full rank, *Urceolaria* Stein, 1867 and *Trichodina* Ehrenberge 1838. Forms referable to the genus *Urceolaria* are distinguished from *Trichodina* by the absence of hooks and rays on the elements of the skeletal ring.

Tripathi (1948) endorsed Faure-Fremiet's (1943) assertion and further considered *Vauchomia* a synonym of *Trichodina*. He presented a useful summary of data on many species of *Trichodina* and redesignated several forms previously referred to *Cyclochaeta* and *Vauchomia*. Hirshfield (1949) adopted and delineated the scheme of Faure-Fremiet and agreed with Tripathi in placing *Vauchomia* in strict synonomy with *Trichodina*. Other quiet recent papers of significance include the ecological and taxonomic works by Raabe (1950b, 1959b, c), Raabe and Raabe (1959) and Lom (1962, 1963, 1970), Lom and Stein (1966), Lom *et at.* (1976) and Stein (1962, 1965, 1974).

The trichodinid ciliate communicated in the present dissertation is a record from a new geography and from a pelecypod host, *Modiolus* (*Modiolus*) *striatulus* (Hanley), which colonise in huge population on the surface of the floating 'Boya' in the river Ganges with the help of their byssus threads. The epizoic trichodinid prefer the pulps and gills of this bivalve host to which they remain attached with the help of their adhesive discs.

So far fifteen trichodinid species have been reported, described and redescribed by different authors from various mollusc hosts (gastropods and bivalves) and *Trichodina gangetica* sp. nov. is a new addition to this list (Table 9 and 10).

DISCUSSION

In course of a systematic survey of the ciliate parasites from the marine and estuarine molluscs, pelecypods and gastropods, inhabiting the coastal waters of Indian Peninsula, fourteen species of holotrichous ciliates have been recorded and described in the present treatise of which seven species seem to be new to science. All these fourteen ciliate species belong to a total of five families and nine genera of the orders Hymenostomatida, Thigmotrichida and Peritrichida. They are found to be distributed among eight molluscan hosts, four pelecypods (*Crassostrea cucullata*, *Mactra luzonica*, *Modiolus* (*Modiolus*) *striatulus* and *Donax lubricus*) and four gastropods (*Littorina melanostoma*, *L.* (*Littorinopsis*) *scabra scabra*, *Cerithidea obtusa* and *C. cingulata*). Apart from the presentation of seven new species, seven host records have been included in the present monograph.

The only hymenostome ciliate communicated in this treatise is *Cristigera susamali* sp. nov. of the family Pleuronematidae described from the rock oyster *Crassostrea cucullata* residing in a gregarious population at the meeting point of the river Hooghly with Bay of Bengal. The majority of hymenostome species are free-living fresh water or salt water forms.

Species capable of facultative parasitism also are known (Corliss, 1961). Altogether eleven species of the genus *Cristigera* described so far are all free living, but the one described by the authors and incorporated in this monograph, displayed its marked with the gills and labial pulps of the pelecypod host. The species is identified by its typical subequatorial cytostome, sparse somatic ciliature and a prominent caudal cilium. Fulfilling all the demands of the genus, *C. susamai* sp. nov. seems to be the exclusive member of the genus parasitic in a molluscan host.

All ciliates belonging to the order Thigmotrichida are commensal or parasitic on various molluscs. They walk about on the surfaces of these, particularly inside the mantle, and whilst doing so they seem to cling or adhere to the host epithelium. This pattern of locomotion has often been recognized and termed as thigmotaxis and has been thought of as involving specialized cilia in the ventral or thigmotactic region (Chatton et Lwoff, 1926).

It is now apparent from the ultrastructural studies made by Lom and Kozloff (1968, 1969) and Khan (1969, 1971), that there is nothing morphologically unusual about the ventral cilia and that the only ventral specializations for thigmotaxis are the closeness of the kineties of the thigmotrichid ciliates, the large number of mucigenic bodies associated with them and the microtubular anchoring of the kinetosomes to the remarkably deep pellicular folds. According to M. A. Khan (1969) : 'Mitochondria are numerous ventrally and the cytoplasm here has a rich ribosomal content, with highly active ER and many golgi-like sacs. The organization is therefore very suitable for supporting ciliary activity and mucoprotein secretion'

Ten species of the order Thigmotrichida have been dealt with in the present communication, four of which belong to the family Ancistrocomidae of the suborder Rhynchodina and six to the family Hemispeiridae of the suborder Arhynchodina.

According to Raabe (1970) the family Ancistrocomidae seems to be a distinctly outlined and uniform group. All its representatives have several common features 'an elongated body form, the adhesive-sucking tentacle, the lack of primary mouth and a strongly reduced ciliature in which the thigmotactic ciliature is longest preserved'

Ancistrocomidae are real parasites especially of the respiratory surface of Mollusca, both bivalvia as well as gastropoda, marine and estuarine

Table 9 List of *Trichodina* sp. sp. from Molluscan hosts

Species	Author	Host	Type of host	Habitat	Locality	Localisation
Trichodina breviradiosa	Richards, 1949	—	Gastropoda	Fresh water	—	—
T. chlorophora	Richards, 1949	—	Gastropoda	Fresh water	—	—
T. helisomarum	Richards, 1949	*Helisoma*	Gastropoda	Fresh water	—	—
T. physellarum	Richards, 1949	*Physella*	Gastropoda	Fresh water	—	—
T. tegula	Hirshfield, 1949	*Tegula funebralis*	Gastropoda	Marine	—	-
T. baltica	(Quennerstedt, 1869) Revised by Raabe, 1965	*Theodoxus fluviatilis*	Gastropoda	Marin	Ohrid Lake Macedonia—Yugoslavia)	
T. achatinae	Fantham, 1924	*Achatina zebra*	Gastropoda	Terrestrial	—	—
T. domerguei	(Wallengren, 1897)	*Unio* sp.	Pelecypoda	Fresh water	—	—
T. polandiae	Fenchel, 1965	*Cardium lamarcki*	Pelecypoda	Marine	Asko	Mantle cavity
T. polandiae	Fenchel, 1965 Revised by Stein, 1974	*Chlamys* sp.	Pelecypoda	Marine	Sea of Japan (Gulf of Peter the Great)	Mantle cavity
T. unionis	Hampl, 1955	*Anodonta cygnea*; *Unio* sp. sp.	Pelecypoda	Marine	Erlangen	Mantle cavity
T. unionis	Hampl, 1955 Revised by Raabe and Raabe, 1961	*Unio* sp. sp.	Pelecypoda	Marine	Poland, Hungary and Yugoslavia	—
T. unionis	Hampl, 1955 Revised by Fenchel, 1965	*Anodonta cygnea*	Pelecypoda	Fresh water	Copenhagen	—
T. cardii	Delphy, 1938	*Cardium edule*	Pelecypoda	Marine	Arcachon on the Bay of Biscay	Pallial cavity
T. myicola	Uzmann and Stickney, 1954	*Mya arenaria*	Pelecypoda	Marine	Sagadahoc Bay, Sagadahoc County, Marine and Plum Island Sound, Essex County, Massachusetts (East coast of the U.S. A.)	Epithelial surface in the oral region, outer faces of the palps, on the wall of the visceral body and internal face of the pallial muscle.
T. macomarum	Raabe and Raabe 1959	*Macoma balthica*	Pelecypoda	Marine	Gdynia	—
T. macomarum	Raabe and Raabe, 1959 Revised by Fenchel, 1965	*Macoma balthica*	Pelecypoda	Marine	Asko, Oresund	Mantle cavity
T. cardiorum	Raabe and Raabe, 1959	*Cardium lamarcki*	Pelecypoda	Marine	Polish coast	—
T. pectenis	Stein, 1974	*Pecten vessoensis*	Pelecypoda	Marine	Sea of Japan (Gulf of Peter the Great)	Mantle cavity
T. gangetica sp. nov.	Jamadar, 1979	*Modiolus (Modiolus) striatulus*	Pelecypoda	Estuarine	River Hooghly, (The Ganges), Calcutta	Gills, labial palps

Table 10 Comparison of the data of some *Trichodina* sp. sp. from Molluscs

	Trichodina tegula Hirshfield, 1949	*Trichodina myicola* Uzmann and Stickney, 1954	*Trichodina unionis* Hampl, 1955 (measurements taken from Fenchel, 1965)	*Trichodina macomarum* Raabe and Raabe, 1959 (measurements taken from Fenchel, 1965)	*Trichodina polandiae* Syn. : *T. domergui f. cardii* Raabe and Raabe, 1959 Fenchel, 1965	*Trichodina polandiae* (Measurements taken from Stein, 1974)	*Trichodina* sp. Fenchel, 1965	*Trichodina baltica* Quennerstedt, 1869 (Measurements taken from Raabe, 1965)	*Trichodina pectenis* Stein, 1974	*Trichodina gangetica* sp. nov. Jamadar, 1979
Diameter of the body	55—80 µm	81(62—103) µm	52 (47—60) µm	68 (60—74) µm	52 (47—60) µm	34.0—50.3 µm	52 (44—56) µm	—	—	46.51 (40.8—52.7) µm
Diameter of the adhesive disc	30—55 µm	62 (42—79) µm	—	45 (36—53) µm	—	24.5—35.7 µm	—	42—51 µm	31.4—36.1 µm	28.83 (25.5—34.0) µm
Diameter of the denticulate ring	30—50 µm	53 (44—62) µm	25 (21—29) µm	29 (26—34) µm	25 (21—29) µm	22.4—34.0µm / 14.2—22.4	21 (20—24) µm	25—30 µm	26.2—33.5 µm / 17.5—24.1	16.38 (13.6—18.7) µm
Diameter of the macronucleus	—	—	—	—	—	—	—	—	—	28.90 (23.8—34.0) µm
Number of denticles	22—31	29 (26—36)	21 (19—23)	27 (24—30)	21 (19—23)	24 (20—26)	24 (22—25)	22—26	22—31	22 (21—24)
Number of radial pins to one denticle	8	5—9	7—10	6—8	7—10	6—10	5	—	7—9	6—8
Dimensions of the denticle :										
Length of the thorn	—	—	—	—	—	—	—	—	—	4.69 (3.4—6.8) µm
Length of the blade	—	—	—	—	—	—	—	—	—	4.11 (3.4—5.1) µm
Width of the central part	—	—	—	—	—	—	—	—	—	1.70 µm
Length of the denticle	—	—	—	—	—	—	—	—	—	4.38 (3.4—5.1) µm
Width of the border membrane	—	—	—	—	—	—	—	—	2.6 µm	1.70 µm
Micronucleus (dimensions and the 'Y' value)	—	—	—	—	—	—	—	—	—	1.70 µm and [illegible]
Position of CV	Eccentric	Eccentric— just anterior to the left arm of the macronucleus	—	—	—	—	—	—	—	Eccentr[illegible]

species. The parasites not only cling to the gills or other respiratory surfaces of the hosts by their suctorial tentacle but also are able to tear out and penetrate to these respiratory surfaces (Lom and Kozloff, 1968, 1969 ; Khan, 1969, 1971). When they get free, the ciliature of the thigmotactic surface serves as a locomotoric apparatus in cases of freely floating.

Three ancistrocome ciliates of the subfamily Ancistrocominae, *Ancistrocoma pelseneeri* Chatton et Lwoff, *A. thorsoni* Fenchel and *A. dissimilis* Kozloff, and one hypocomid ciliate, *Raabella helensis* Chatton et Lwoff of the subfamily Hypocomidinae have been reported from India for the first time, and two pelecypod molluscs from Indian waters, *Mactra luzonica* and *Modiolus* (*Modiolus*) *striatulus* have been recorded as new hosts for these parasites.

The pelecypod host *Mactra luzonica* (Deshayes) from Digha sea coast, West Bengal, showed tripple infection by *Ancistrocoma pelseneeri*, *A. thorsoni* and *A. dissimilis*. The various morphometric parameters of these ciliates including the complexities of their kineties have been described, illustrated and compared with their counterparts reported earlier from several pelecypod hosts in the western hemisphere. *Raabella helensis* Chatton et Lwoff which is the typus generis of the genus *Raabella* is being also communicated for the first time from Indian waters and *Modiolus* (*Modiolus*) *striatulus* Hanley from the Hooghly estuary, Calcutta, has been recorded as its new local host. *R. helensis* has also been described from three other hosts of the same genus *Mytilus*, *M. edulis* (Baltic Sea), *M. galloprovincialis* (Adriatic Sea and Black Sea) and *M. minimus* (Adriatic Sea). Raabe (1938) has distinguished two forms in the population *R. helensis*. *forma major* and *forma minor* based on dimensions and number of kineties. The present author also noted the variabilities among all the three ancistrocome and one hypocomid ciliates and contends that these represent merely their geographic and ecologic variability.

The thigmotrichid ciliates comprising the family Hemispeiridae of the suborder Arhynchodina have a distinctly expressed thigmotactism in connection with their life mainly on the respiratory surfaces of Mollusca. Hemispeiridae move fast in general, and the majority of them perform more frequent or scarce circular motions around their axis. This frequency depends on the shape and on the diversity of the ciliature. The displacement of the thigmotactic ciliature to the anterior, and of the adoral spiral to the posterior body pole, as in *Boveria*, involved a different way of movement, namely a rotary gliding one, slightly similar to the movement of Urceolariidae (Peritricha).

Under the family Hemispeiridae, the authors have dealt with six species, all belonging to the subfamily Ancistrinae. These are *Ancistrumina obtusae* sp. nov. from *Cerithidea obtusa* (Lamarck), *A. barbata* Issel, from the same gastropod host, *Protophrya indica* sp. nov. from *Littorina melanostoma* (Lamarck) and *L.* (*Littorinopsis*) *scabra scabra*, *Fenchelia sagarica* sp. nov. and *F. kapili* sp. nov. from *Cerithidea obtusa* (Lamarck), and *Boveria teredinidi* Nelson from *Donax lubricus* Hanley and *Mactra luzonica* (Deshayes). Systematics of the subfamily Ancistrinae rather poses a difficult problem because of the conspicuous differentiating features displayed by various species. Raabe (1959) revised this subfamily and made an effort to separate the genera on the basis of possibly available precision and objectivity, taking into consideration three evolutionary tendencies : the retrogradation of adoral kineties, their spiralization on the posterior body pole and the tendency to rarefy the system of kineties of the general ciliature.

The authors have introduced four new species under this family distributed over three genera, *Ancistrumina barbata* Issel and *Boveria teredinidi* Nelson have been reported from three new hosts, *A. barbata* from a gastropod mollusc *Cerithidea obtusa* (Lamarck) and *B. teredinidi* from two pelecypod hosts, *Donax lubricus* and *Mactra luzonica*. Variability as displayed by the two different populations of *Protophrya indica* sp. nov. from two different gastropod hosts have been enumerated in details and the probable reasons have been outlined. Likewise, the variabilities exhibited by *A. barbata* and *B. teredinidi* with their counterparts having different hosts and different geography, have also been discussed.

Thus from the above discussion it seems, Ancistrocomidae are rather strictly specific to their hosts, attached to their species or genera (Table 11). If even the given species of paras tes in many hosts distant systematically or ecologically, it is possible to distinguish different forms of parasite varying among them mainly by the number of kineties. This occurs, i. e., in the case of *Ancistrocoma pelseneeri*, occurring in *Macoma*, *Mya*, *Pholas* in the western world and *Mactra luzonica* in the eastern world (Indian subcontinent). The species proves a distinct variability in the number and arrangement of kineties even with the compass of the population from one host's individual.

Topographically, the problem of homology of the differentiated kineties in Ancistrocominae-Hypocomidinae with adoral kineties of Hemispeirinae seems less complicated when Hypocomidinae are not compared to *Ancistrumina*. In this species the aboral kineties are continuing with their spiral so far leftwards that the kineties of the general and thigmotactic ciliature break off before them. In this situation the present authors incline to endorse Raabe's contention that Ancistrocomidae are a group strongly modified and in connection with their transition to a really parasitic way of life. Ancistrocomidae lost many structures which could serve to the body orientation of the more plesiomorphic Hemispeiridae. The flat sides of the body were there the lateral ones, the margins on which was the peristomal field and the adoral kineties was the ventral margin, the opposite was the dorsal one. The division on the left and right side of the body was stressed by the arrangement of the anterior and posterior sutures. In subfamily Ancistrinae the thigmotactic field occupied the anterior part of the left side of the body. In Ancistrocomidae the situation is more complicated.

The end part of the treatise deals with three peritrichid ciliate parasites of which two belong to the family Scyphidiidae of the suborder Sessilina and one belong to the family Urceolariidae of the suborder Mobilina. Of three peritrichids, *Scyphidia* (*Gerda*) *ubiquita* Hirshfield has been enumerated with all its morphometric parameters. In a completely unique environmental set up (mangrove ecosystem) two gastropod molluscs *Littorina melanostoma* and *L.* (*Littorinopsis*) *scabra scabra* have been identified and recorded as two new hosts for *S.* (*Gerda*) *ubiquita*. An account of the morphological variability as displayed by the ciliate in the two Indian hosts, as well as in its allied molluscan hosts of the western world, has been communicated. *S.* (*Gerda*) *bengalensis* sp. nov. from another gastropod host *Cerithidea cingulata* is claimed by the authors as a new discovery from the same Mangrove complex and is hoped to be an important addition to the sessilina literature. The third peritrichid ciliate is the *Trichodina gangetica* sp. nov. has also been proposed to be a new species. It has been described from a pelecypod host *Modiolus* (*Modiolus*) *striatulus* which is responsible for marine fouling in this area. The authors also claim to report, for the first time from India, any *Trichodina* species from molluscan host.

Finally, a broad spectral table has been introduced to illustrate the distribution of the parasitic ciliates dealt in the present monograph with their host range (Table 11), in the national and international geography.

VI. Summary

1. Fourteen species of holotrichous ciliates representing three orders, five families and nine genera collected from the mantle cavity, buccal mass, gills and labial pulps of eight molluscan hosts (four gastropod and four pelecypod) have been described.

2. *Cristigera susamai* sp nov. has been introduced as a new parasitic member of the family Pleuronematidae under the order Hymenostomatida. It has been described from the pelecypod host *Crassostrea cucullata.*

3. Under the family Ancistrocomidae, order Thigmotrichida, four species—*Ancistrocoma pelseneeri, A. thorsoni, A. dissimilis* and *Raabella helensis* have been communicated for the first time from the Indian subcontinent. The pelecypod hosts have been recorded as two new hosts, *Mactra luzonica* for the first three Ancistrocomid ciliates and *Modiolus* (*Modiolus*) *striatulus* for *Raabella helensis.*

4. Under the family Hemispeiridae, order Thigmotrichida, six species—*Ancistrumina obtusae* sp. nov. from the gastropod host *Cerithidea obtusa* ; *A. barbata* from the same gastropod host ; *Protophrya indica* sp. nov. from *Littorina melanostoma* and *L.* (*Littorinopsis*) *scabra scabra* ; *Fenchelia sagarica* sp. nov. and *F. kapili* sp. nov. from *Cerithidea obtusa* ; *Boveria teredinidi* from *Donax lubricus* and *Mactra luzonica*, have been communicated in this monograph.

5. Two sesselina peritrichid ciliates of the family Scyphidiidae have been described of which *Scyphidia* (*Gerda*) *ubiquita* have been recorded from two littoral gastropod species sharing two different habitat niches. They are *Littorina melanostoma* and *L.* (*Littorinopsis*) *scabra scabra* which are new host records for *Scyphidia* (*Gerda*) *ubiquita.*

6. *Scyphidia* (*Gerda*) *bengalensis* sp. nov. of the same family has been described from another gastropod host *Cerithidea cingulata* inhabiting lower littoral mudflat zones.

7. The last ciliate to be communicated in the present treatise is *Trichodina gangetica* sp. nov., has described from the pelecypod host *Modiolus* (*Modiolus*) *striatulus.* This ciliate belongs to the family Urceolariidae of the order Peritrichida.

8. Table 11 is included at the end of the monograph to enumerate the distribution of the ciliate species with their mollusc hosts in different parts of the globe.

Table 11 The distribution of the ciliates studied in the present monograph

Ciliates	Hosts	Localities	Authors
Cristigera susamai sp. nov.	*Crassostrea cucullata*	Sagar Island, 24 Parganas, West Bengal	Jamadar, 1979
Ancistrocoma dissimilis	*Pholadidea penita*	Moss Beach, California, U. S. A.	Kozloff, 1946
Ancistrocoma dissimilis	*Mactra luzonica*	Digha, Midnapore, West Bengal, India	Jamadar, 1979
Ancistrocoma thorsoni	*Abra nitda*	Gullmarfjord, West Sweden	Fenchel, 1965
Ancistrocoma thorsoni	*Mactra luzonica*	Digha, Midnapore, West Bengal, India	Jamadar, 1979
Ancistrocoma pelseneeri	*Macoma balthica*	Boulonge	Ch. Lw., 1926
Ancistrocoma pelseneeri	*Macoma balthica*	South Baltic Sea	Raabe, 1938
Ancistrocoma pelseneeri	*Mya arenaria, Cryptomya californica, Macoma inconspicua, M. nasuta, M. irus, M. secta*	San Francisco Bay, Tomales Bay, California, U. S. A.	Kozloff, 1946
Ancistrocoma pelseneeri	*Macoma balthica Mya arenaria*	Pas de Calais and Woods Hole, Mass., U. S. A.	Ch. Lw., 1950
Ancistrocoma p. v. pholadis	*Pholas candida*	Pas de Calais	Ch. Lw., 1950
Ancistrocoma pelseneeri	*Mya arenaria*	Helsinger and Kristineberg, Kattegat	Fenchel, 1965
Ancistrocoma pelseneeri	*Mya truncata*	Swansea, U. K.	Khan, 1969
Ancistrocoma pelseneeri	*Macoma balthica*	Baltic Sea	Raabe, 1970
Ancistrocoma pelseneeri	*Mya arenaria, M. irus, M. inconspicua, M. nasuta, M. secta, Cryptomya californica*	Maryland, U. S. A.	Sprague, 1970
Ancistrocoma pelseneeri	*Mactra luzonica*	Digha, Midnapore, West Bengal, India	Jamadar, 1979
Raabella helensis (Syn. : *Hypocomides mytili*)	*Mytilus edulis*	Hel, Gulf of Danzig, Gdynia	Raabe, 1938
Raabella helensis (Syn. : *Hypocomides mytili*)	*Mytilus edulis*	San Francisco Bay, California, U. S. A.	Kozloff, 1946
Raabella helensis	*Mytilus edulis*	Helsinger Kristineberg and Asko	Fenchel, 1965
Raabella helensis	*Mytilus edulis, M. galloprovincialis, M. minimus,*	Baltic Sea, San Francisco Bay ; Black Sea, Adriatic Sea ; Adriatic Sea	Raabe, 1970
Raabella helensis	*Modiolus (Modiolus) striatulus*	The river Ganges (Hooghly river), Outram Ghat, Calcutta, India	Jamadar, 1979
Ancistrumina obtusae sp. nov.	*Cerithidea obtusa*	Sagar Island and Sunderbans, 24 Parganas, West Bengal, India ; Kakinada Bay, Andhra Pradesh, South India.	Jamadar and Chowdhury, 1977
Ancistrumina barbata	*Fusus syracusanus, Murex trunculus*	Neapolitanian Bay	Issel, 1903
Ancistrumina barbata	*Cerithidea obtusa*	Sagar Island and Sunderbans, 24 Parganas, West Bengal, India ; Kakinada Bay, Andhra Pradesh, South India	Jamadar, 1979
Fenchelia sagarica sp. nov.	*Cerithidea obtusa*	Sagar Island, West Bengal, India and Kakinada Bay, Andhra Pradesh, India	Jamadar, 1979
Fenchelia kapili sp. nov.	*Cerithidea obtusa*	South-West coast of Sagar Island, West Bengal, and Kakinada Bay, Andhra Pradesh, India	Jamadar, 1979
Protophrya indica sp. nov.	*Littorina melanostoma, Littorina (L.) scabra scabra*	Sagar Island, Sunderbans, West Bengal ; Waltair, Andhra Pradesh (South coast) and Dona Paula, Goa (West coast), India	Jamadar, 1979
Boveria teredinidi	*Teredo navalis, Bankia gouldi*	Atlantic coast of North America and Barnegat Bay, New Jersey	Nelson, 1923
Boveria teredinidi	*Teredo navalis*	San Francisco Bay	Pickard, 1927
Boveria teredinidi	*Teredo navalis*	Sevastopol Bay	Levinson, 1941
Boveria teredinidi	*Donax lubricus, Mactra luzonica*	Colva-beach, Goa (West coast), India ; Digha-beach, (East coast) West Bengal, India	Jamadar, 1979
Scyphidia (Gerda) ubiquita	*Limpets, Turbans*	Big Rock Beach ; Crystal Pier ; Flat Rock Beach, (Palos Verdes Estates) ; Playa del Rey, Los Angeles County, California, U. S. A.	Hirshfield, 1949
Scyphidia ubiquita	*Acmea testudinis*	In front of the Friday Harbor Laboratories of the University of Washington on San Juan Island, Washington, U. S. A.	Lom, 1968
Scyphidia (Gerda) ubiquita	*Littorina melanostoma, L. (Littorinopsis) scabra scabra*	Sagar Island, Sunderbans, West Bengal ; Waltair, Andhra Pradesh (South coast) and Dona Paula, Goa (West coast), India	Jamada ; 1979
Scyphidia (Gerda) bengalensis sp. nov.	*Cerithidea cingula*	Mandirtala mud flat, Sagar Island, West Bengal, India	Jamadar, 1979
Trichodina gangetica sp. nov.	*Modiolus (Modiolus) striatulus*	The river Ganges (Hooghly river), Outram Ghat, Calcutta, India	Jamadar, 1979

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PLATES

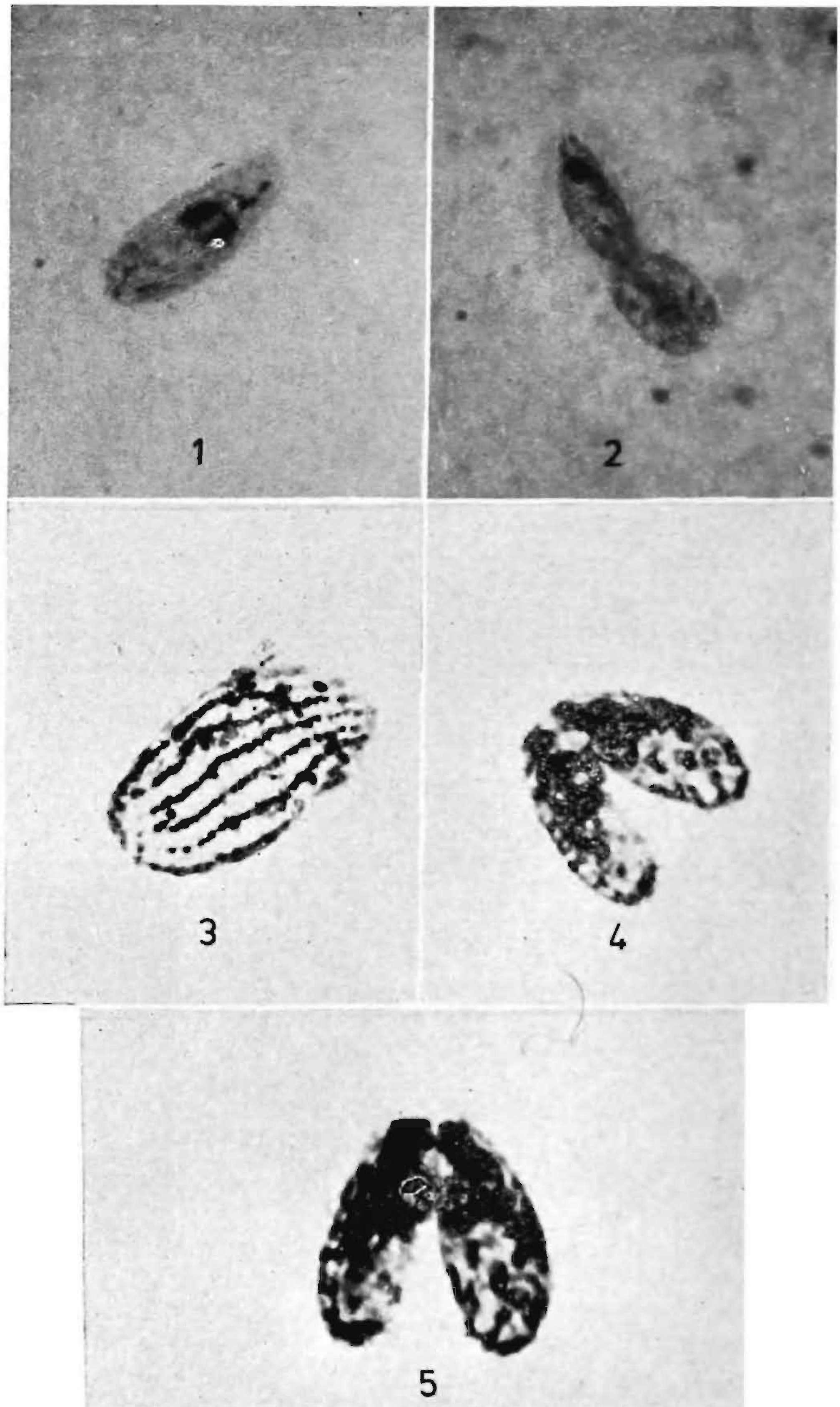

PLATE I

Figs.	1-5.	Photomicrographs of *Cristigera susamai* sp. nov. from *Crassostrea cucullata.*	
Fig.	1.	*Cristigera susamai* sp. nov.	X 760
Fig.	2.	Final stage of transverse binary fission	X 750
Fig.	3.	Somatic kineties of *C. susamai* ; impregnation after Klein	X 1160
Fig.	4.	Conjugation stage showing protoplasmic bridge (Pb)	X 450
Fig.	5.	Enlarged view of conjugation stage of *C. susamai*	X 1000

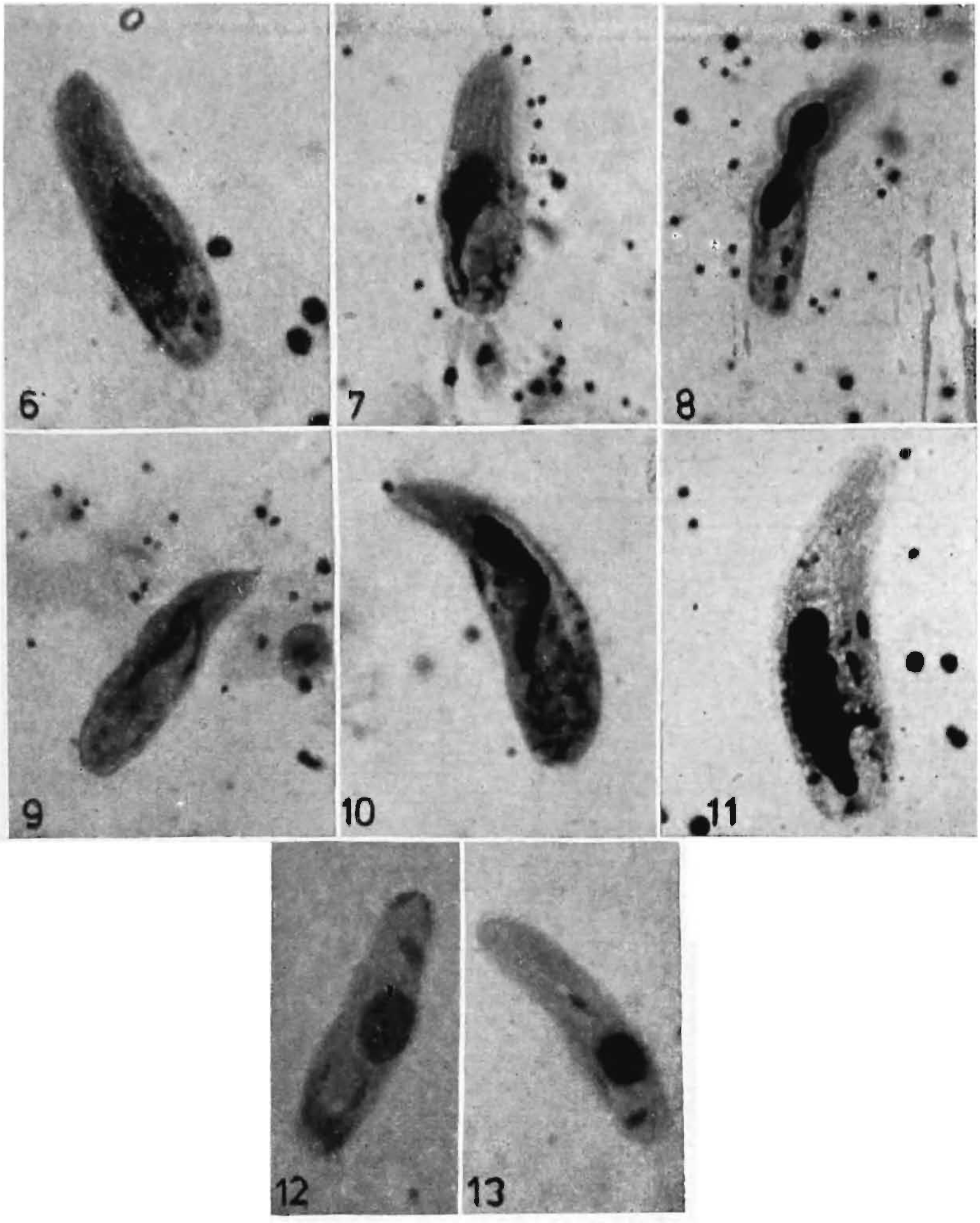

PLATE II

Figs. 6-13. Photomicrographs of *Ancistrocoma pelseneeri*, *A thorsoni* and *A dissimilis*.

Fig. 6.	*A. pelseneeri* Chatton & Lwoff	X 1025
Fig. 7.	Somatic kineties in anterior region of *A. pelseneeri*	X 880
Fig. 8.	Binary fission of *A. pelseneeri*	X 625
Figs. 9 & 10.	Latero-ventral view of *A. thorsoni*	X 1515
Fig. 11.	Enlarged view of *A. thorsoni*	X 2500
Figs. 12 & 13.	Latero-ventral view of *A. dissimilis*	X 720

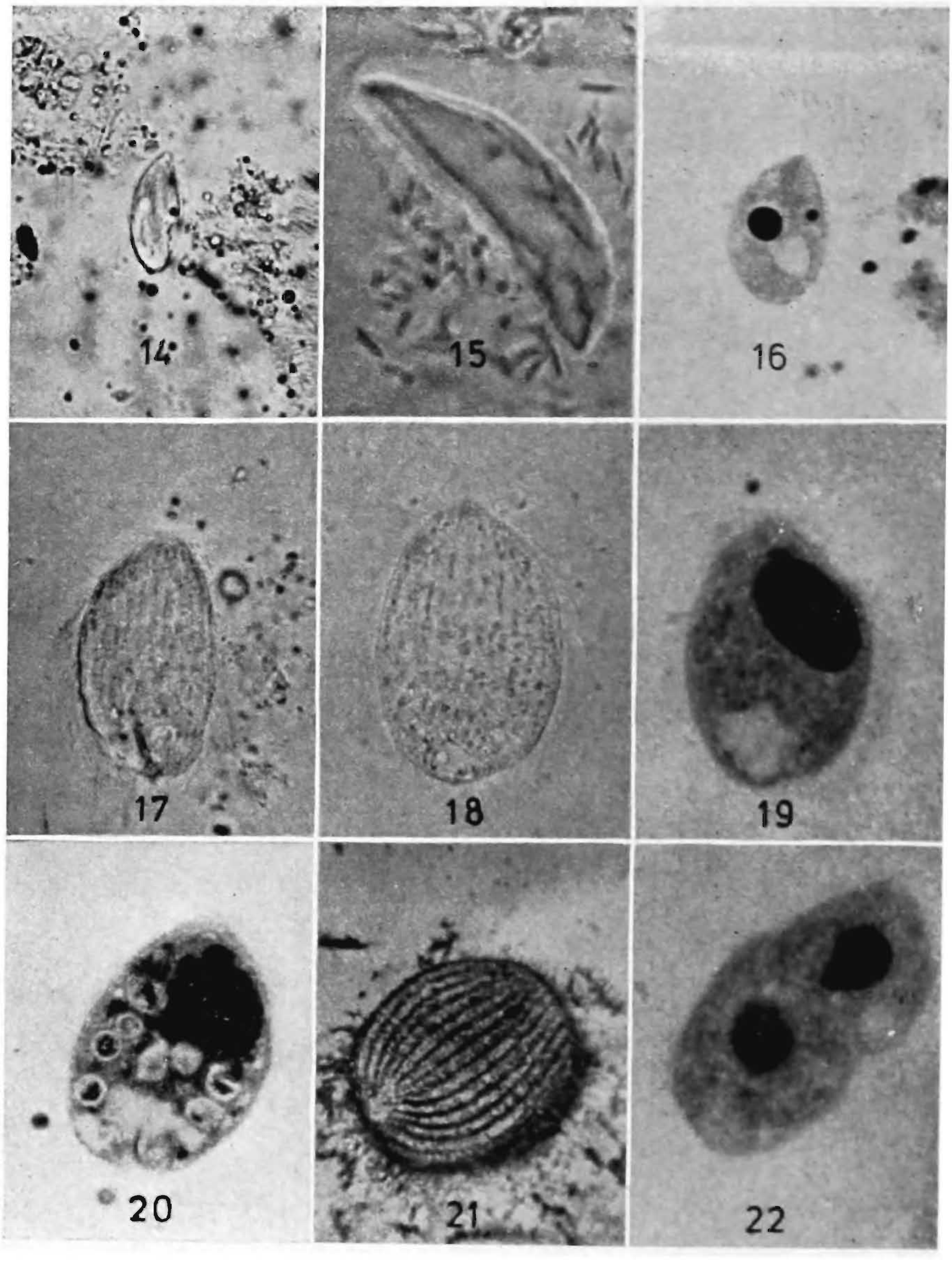

PLATE III

Figs. 14-22. Photomicrographs of *Raabella helensis* Chatton & Lwoff and *Ancistrumina obtusae* sp. nov.

Fig. 14. Dorsal view of live specimen of *R. helensis* from *Mytilus edulis* 460

Fig. 15. Latero-ventral view of live specimen of *R. helensis* from *Mytilus edulis* X 800

Fig. 16. *Raabella helensis* Chatton & Lwoff stained with iron alum-haematoxylin X 1000

Figs. 17 & 18. Ventral and dorsal view of live specimen of *Ancistrumina obtusae* sp. nov. X 1075

Figs. 19 & 20. Dorsal and ventral view of stained specimen of *A. obtusae* sp. nov. X 1150

Fig. 21. Somatic kineties of *A. obtusae* X 1500

Fig. 22. Binary fission of *A. obtusae* X 1000

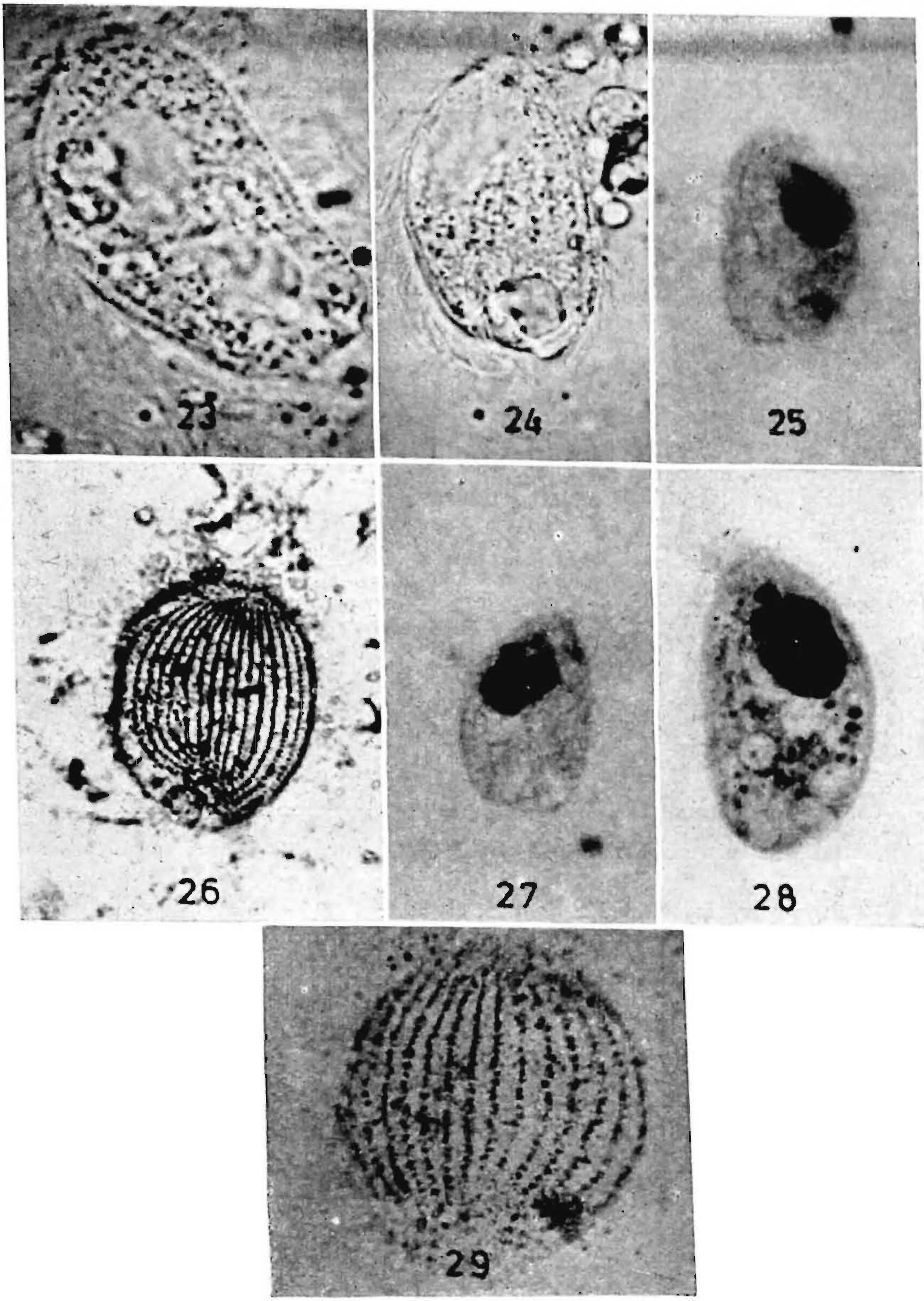

PLATE IV

Figs. 23-29. Photomicrographs of *Ancistrumina barbata* Issel, *Fenchelia sagarica* sp. nov. and *F. kapili* sp. nov. from *Cerithidea obtusa* (Lamarck).

Fig. 23. Ventral view of a live specimen of *A. barbata* (Issel, 1903) X 2725

Figs. 24 & 25. Living and stained specimen seen from ventral and dorsal side of *F. sagarica* sp. nov. X 800

Fig. 26. Silver impregnated specimen of *F. sagarica* sp. nov. X 1445

Figs. 27-29. Ventral, dorsal and silver impregnated specimen of *F. kapili* sp. nov. showing cone-shaped prolongation (Csp) X 610, 1705

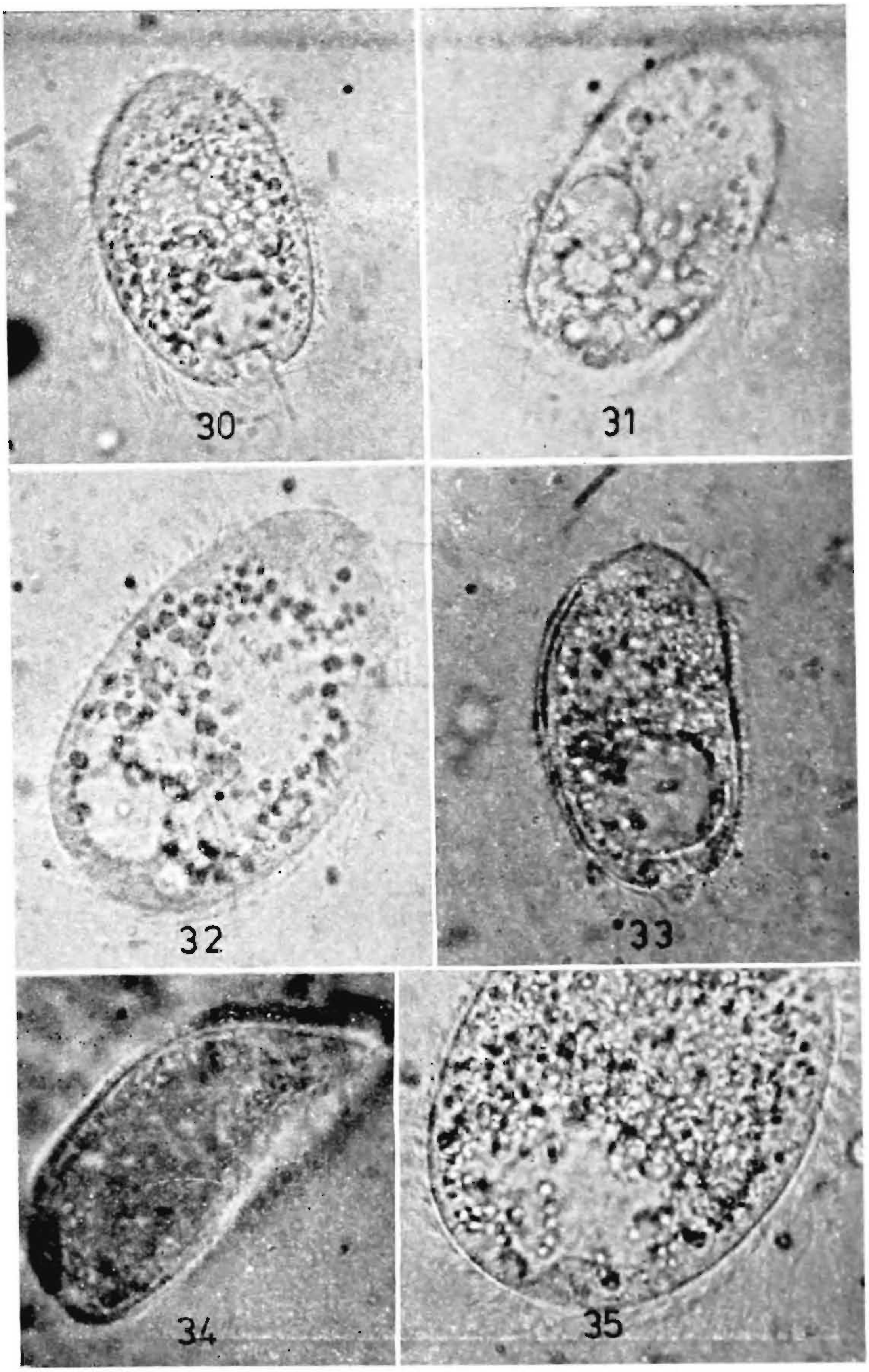

PLATE V

Figs. 30-35. Photomicrographs of *Protophrya indica* sp. nov. from *Littorina melanostoma* and *L.* (*Littorinopsis*) *scabra scabra*.

Figs. 30 & 31. Dorsal and ventral view of *P. indica* seen from living specimens *L. melanostoma* X 790

Figs. 32 & 33. Ventral and dorsal view of living *P. indica* from *L.* (*Littorinopsis*) *scabra scabra* X 640

Figs. 34 & 35. Showing ventral curvature and formation of undulating membrane in living specimens of *P. indica* X 1000

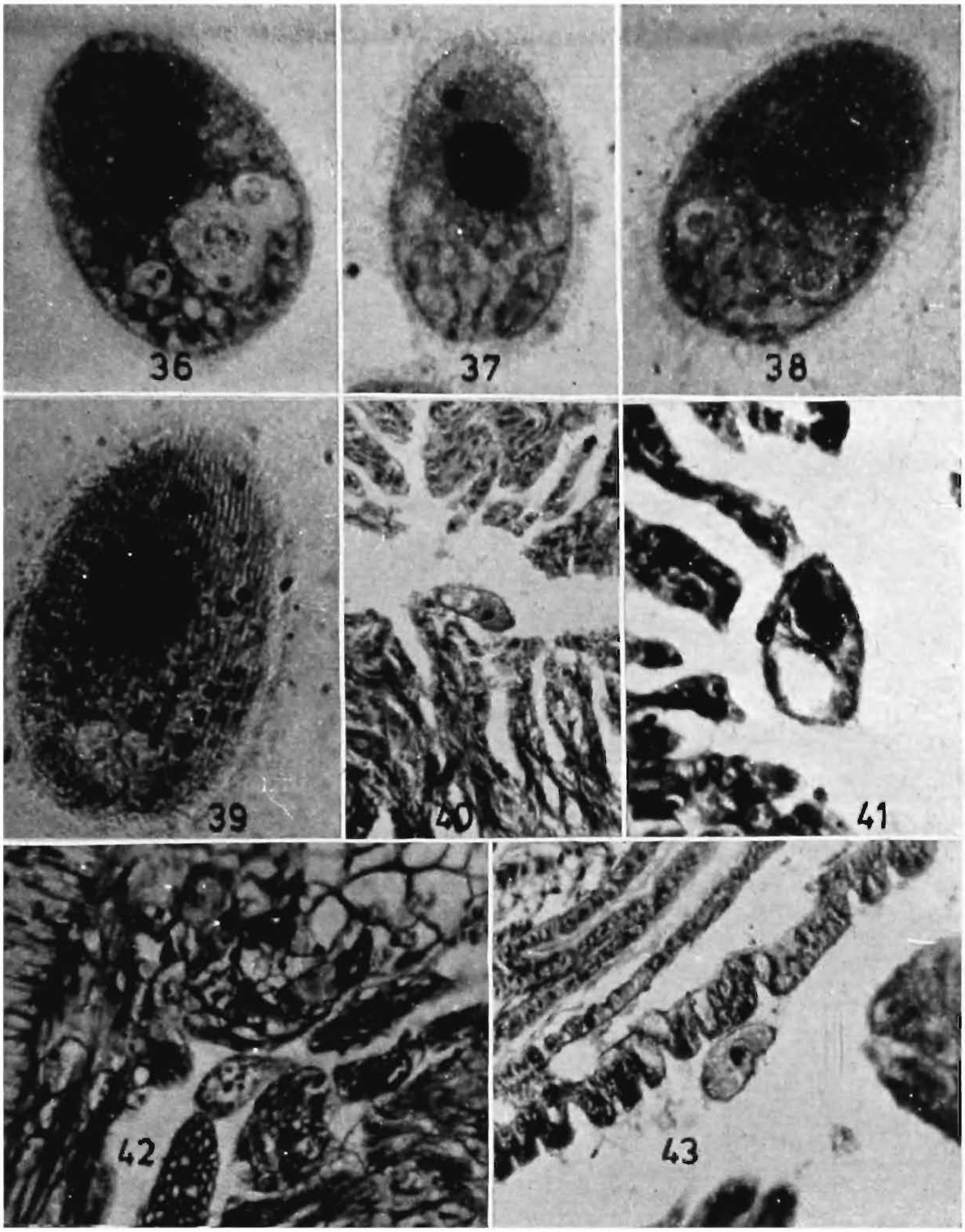

PLATE VI

Figs. 36-43. Stained and sectional view of *Protophrya indica* sp. nov. from *Littorina melanostoma* and *L.* (*Littorinopsis*) *scabra scabra.*

Figs. 36-39. Dorsal and ventral view of *P. indica* from *L. melanostoma* and *L.* (*Littorinopsis*) *scabra scabra* showing macro and micro nucleous, food vacules and somatic kineties X 695

Figs. 40-43. Sectional view of the buccal mass of *L. melanostoma* and *L.* (*Littorinopsis*) *scabra scabra* showing the specimen is closely associated with the tissue X 350

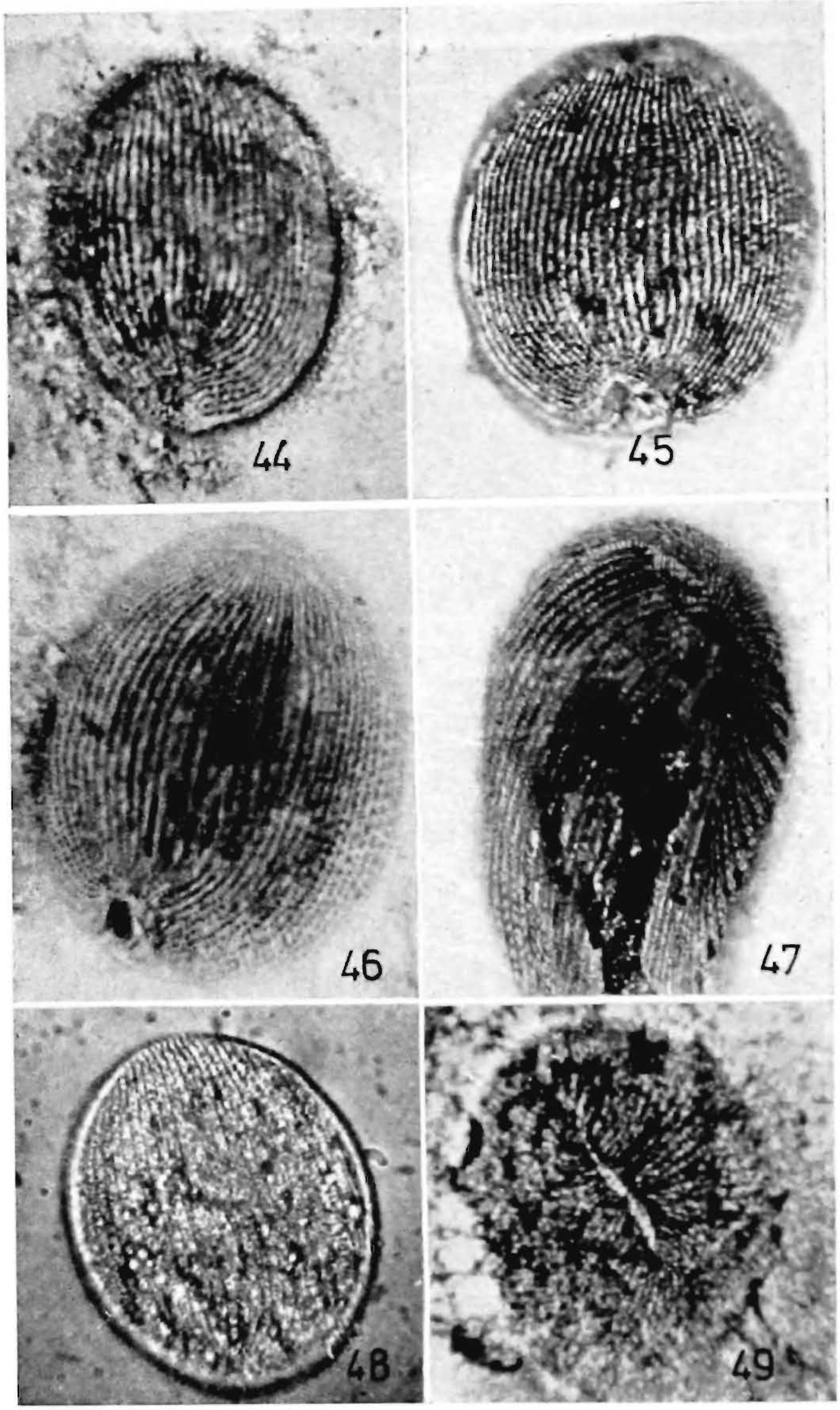

PLATE VII

Figs. 44-49. Photomicrographs of *Protophriya indica* sp. nov. from *L. melanostoma* and *L. (Littorinopsis) scabra scabra.*

Figs. 44 & 45.	Somatic kineties of dorsal and ventral side of the specimen	X 880
Fig. 46.	Anterior suture and membranellae of the cytostome	X 900
Fig. 47.	Somatic kineties of anterior to dorso-ventral side	X 700
Fig. 48.	Somatic kineties of the living specimen	X 775
Fig. 49.	Pattern of somatic kineties of the anterior suture	X 1050

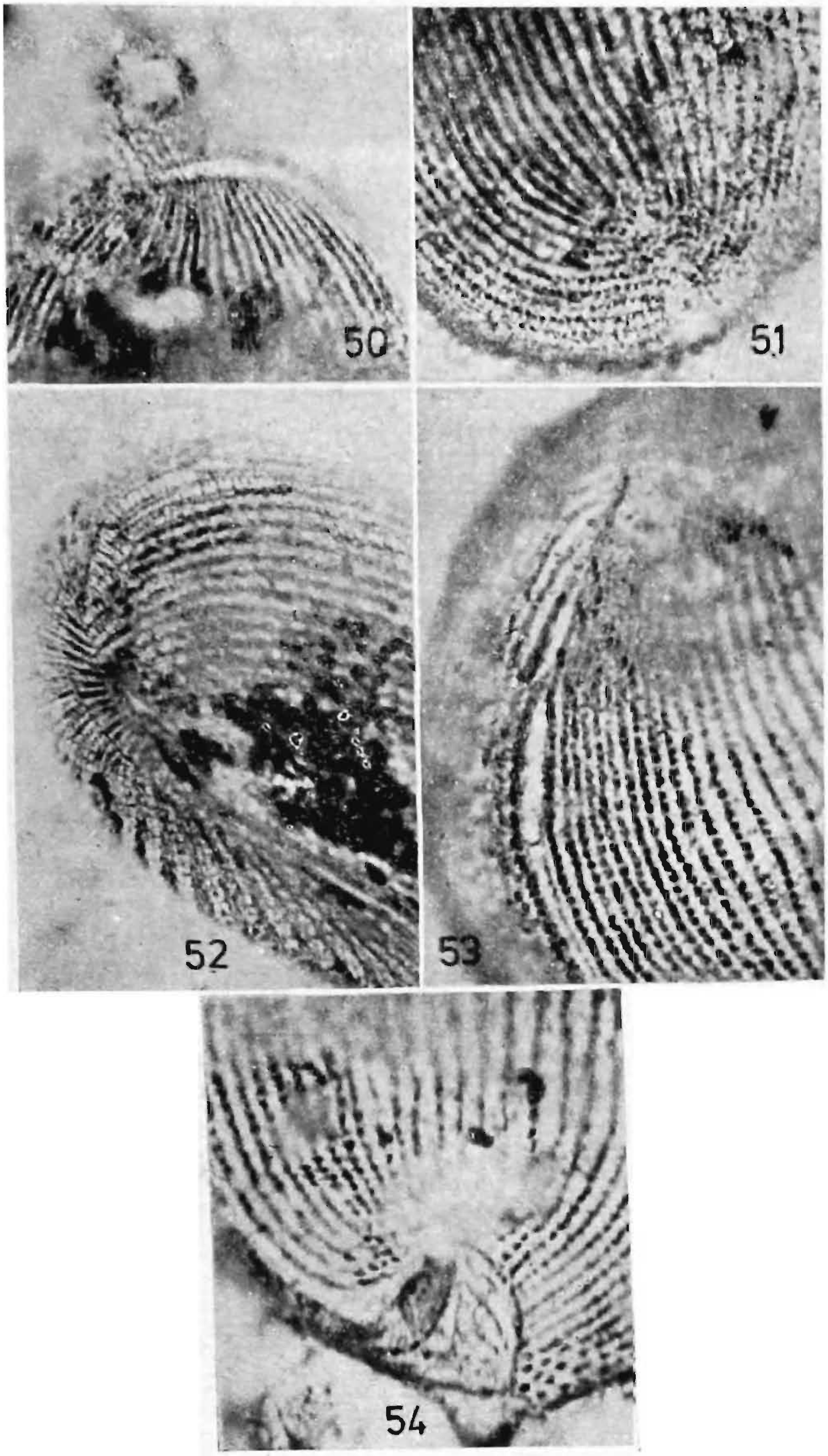

PLATE VIII

Figs. 50-54. Photomicrographs of *Protophrya indica* sp. nov.

Figs. 50 & 51. Enlarged view of the anterior and posterior regions showing the suture and arrangements of kineties and kinetosomes of *P. indica* X 2520

Figs. 52 & 53. Enlarged view of anterior region and the begining of the peristome showing the arrangements of kineties and kinetosomes X 3795

Fig. 54. Enlarged view of the posterior region showing the ventral somatic kineties and membranellae within the cytostome X 4470

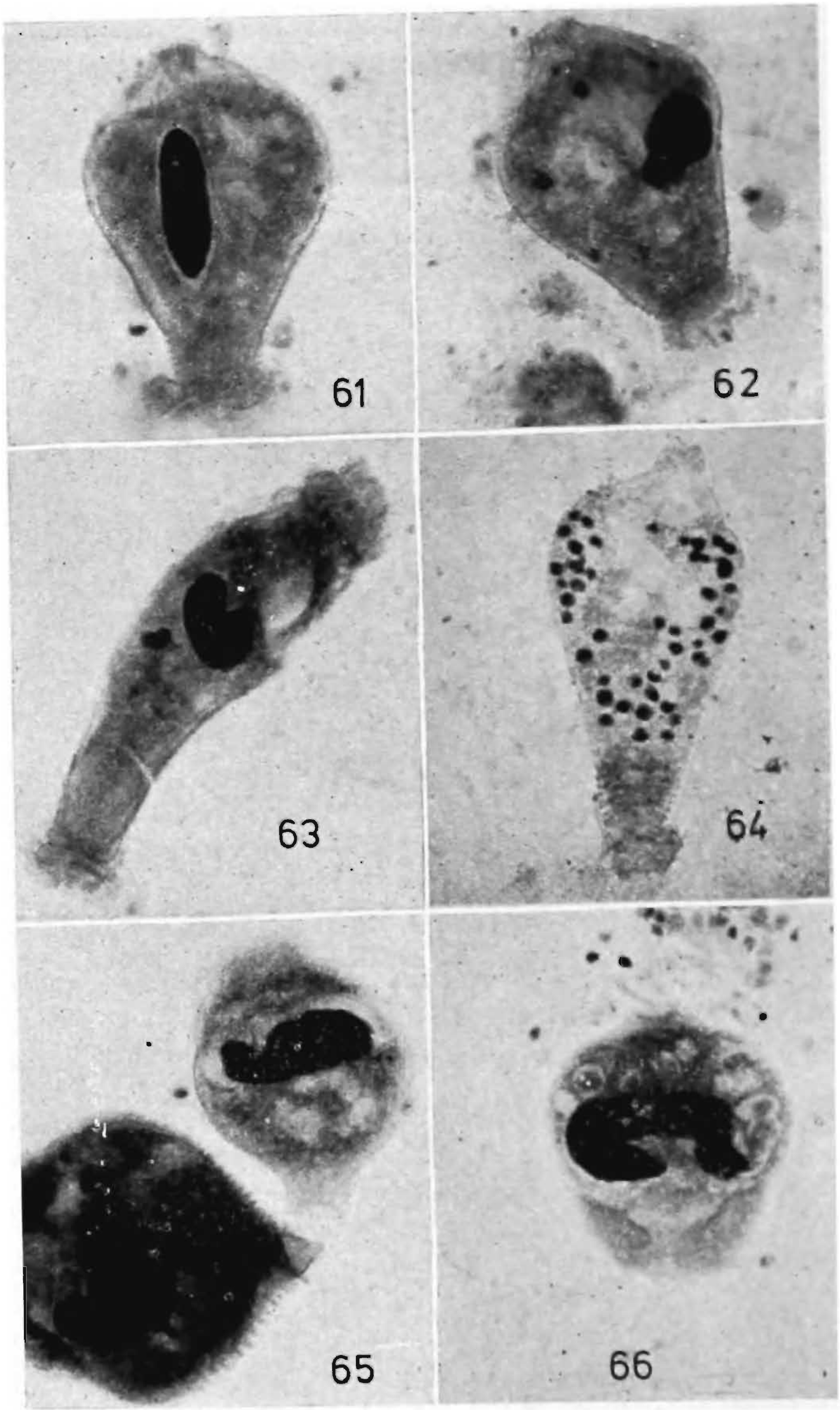

PLATE IX

Figs. 55-60. Photomicrographs of *Protophrya indica* sp. nov. and *Boveria teredinidi* Nelson.

Figs. 55-57.	Successive transverse division of *Protophrya indica* sp. nov.	X 1025
Fig. 58.	Thigmotactic and adoral ciliature of *B. teredinidi* Nelson	X 505
Fig. 59.	Somatic kineties in the anterior region and vacuoles with food materials	X 670
Fig. 60.	Oral apparatus, frontal field and arrangement of adoral cilia of *B. teredinidi*	X 755

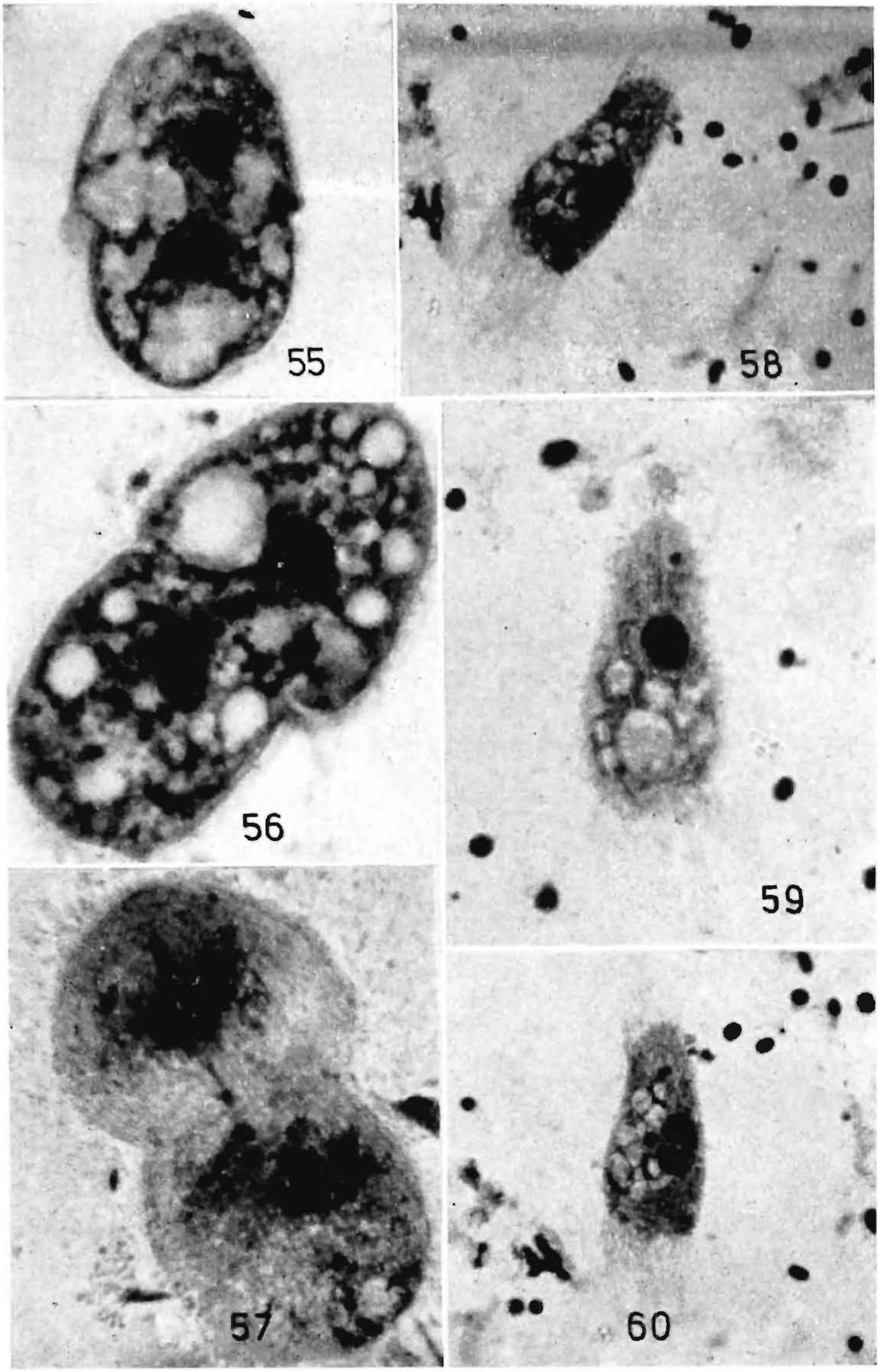

PLATE X

Figs. 61-66. Photomicrographs of *Scyphidia* (*Gerda*) *ubiquita* Hirshfield and *S.* (*Gerda*) *bengalensis* sp. nov.

Figs. 61-63. Contracted, medium expanded and fully expanded specimen of *S.* (*Gerda*) *ubiquita* from *Littorina melanostoma* and *L.* (*L.*) *scabra scabra* X 1130

Fig. 64. Many nuclei in *S.* (*Gerda*) *ubiquita* X 1075

Fig. 65. Closely associated *S.* (*Gerda*) *bengalensis* from *Cerithidea cingulata* (Gmelin) X 630

Fig. 66. Enlarged view of *S.* (*Gerda*) *bengalensis* X 915

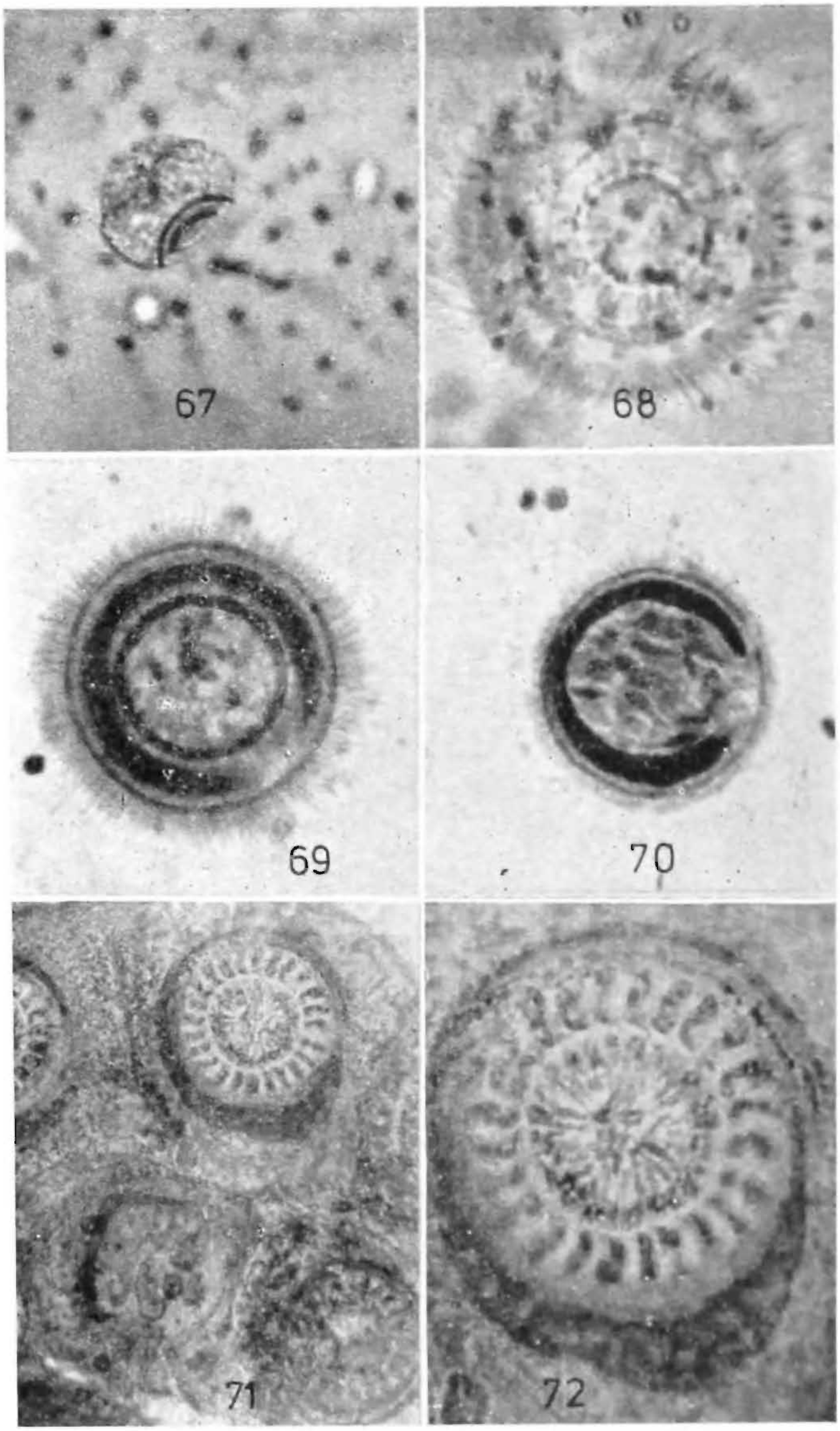

PLATE XI

Figs. 67-72. *Trichodina gangetica* sp. nov. from *Modiolus* (*Modiolus*) *striatulus* (Hanley).

Figs. 67 & 68. Living specimen having adoral ciliary spiral (Acs), denticulate ring, adhesive disc and marginal cilia X 735

Figs. 69 & 70. Stained specimen with iron alum-haematoxylin showing large horse-shoe shaped macronucleus X 840

Fig. 71. Silver impregnated specimen showing denticulate ring, broad distal blade and radial pins X 710

Fig. 72. Enlarged view of the silver impregnated *T. gangetica* sp. nov. X 1650