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AN ILLUSTRATED GUIDE TO THE SPECIES OF THE FAMILY STROMBIDIIDAE (OLIGOTRICHIDA, CILIOPHORA), FREE SWIMMING PROTOZOA COMMON IN THE AQUATIC ENVIRONMENT

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ABSTRACT

Ciliated protozoa of the Suborder Oligotrichina are abundant and are considered significant organisms in the microbial food chain in aquatic environments. The taxonomy of these non-loricate forms has been neglected despite the presence of several large genera. An extensive revision has been undertaken of the Family Strombidiidae, one of three families in this suborder. All 134 original descriptions of species reported as belonging to this family were examined. Among these, 117 species and their synonyms were considered as true species, including 5 species designated as the new species or new name, and are described in detail with the aid of diagrams.

CONTENTS

I. INTRODUCTION

The population of microzooplankton less than 200 μm in size is considerable and from early studies it has been demonstrated that these organisms are a significant food source for larger animals in the aquatic environment (Ryder, 1881). Microzooplankton also seems to support the detritus-based food chain processes and helps the heterotrophic microorganisms to take part in higher trophic levels; that is, the food pathway from bacteria to higher animals is known to be mediated by microzooplankton in aquatic habitats (Berk *et al.* 1977; Sorokin, 1981; Maeda *et al.* 1983). Among microzooplankton populations ciliated protozoa are dominant organisms which may exceed 90 per cent of total microzooplankton numbers (Beers *et al.* 1975). According to Beers *et al.* (1971) more than 75 per cent of ciliated protozoa were identified as belonging to the Oligotrichida in samples collected from a Peruvian upwelling seawater area. Endo *et al.* (1983) showed similar results in the subtropical Pacific Ocean. In addition to the taxonomic works which had largely been completed prior to the 1950's, many results on the qualitative distribution of oligotrichs have been reported from a variety of marine habitats (Fauré-Fremiet, 1924; Fenchel, 1968; Borror, 1963, 1965, 1972; Beers, *et al.* 1971; Agamaliev, 1972, 1974; Rassoulzadegan, 1977; Taniguchi, 1984). These oligotrichs were found in the interstitial spaces of the sediment as well as in the water column. These observations have also been extended to the Arctic and Antarctic Ocean by Suzuki (1967), Hada (1970) and Thompson (1972). Despite extensive data on the distribution of oligotrichine ciliates, little information is available on the ecology of these organisms. Such information we have indicates that this group is worthy of further investigation. For example one species, *Strombidium oculatum* Gruber, 1884 is known to exhibit a characteristic tidal rhythm (Fauré-Fremiet, 1948). This rhythm, taking the form of repeated encystation and excystation cycles, enables this ciliate to subsist in large populations in a habitat whose liquid environment is renewed periodically at each tide. There are also species which are ectosymbionts (Jankowski, 1974) and endosymbionts (Yagiu, 1933).

Corliss (1961, 1979) has noted the lack of extensive taxonomic works on this group. Of the two suborders now recognized, the Tintinnina have been served by major, although dated, revisions but the non-loricate forms have clearly been neglected despite the presence of several large genera, such as *Strombidium* and *Strobilidium*. Key features of the Suborder Oligotrichina include an extensive adoral zone of membranelles (AZM), often with two distinguishable parts, a somatic ciliature often reduced to a few widely spaced and shortened rows of specialized cilia or bristles; and an ovoid to elongate non-compressed body, enclosed in a thickened pellicle and sometimes tailed. The first organism that can be attributed to the oligotrichs was described by Müller (1773). *Trichoda grandinella* Müller, 1773 was later placed in the new genus *Halteria* by Dujardin (1841) as *H. grandinella* (Müller, 1773) Dujardin, 1841. Concerning the family Strombidiidae, the first species to be described from the genus *Strombidium* were *S. sulcatum* and *S. turbo* Claparède and Lachmann (1858). When Kent (1881–1882) summarized the species of the Family Strombidiidae, eight species were listed. Awerinzew (1901) listed seven species and a number of synonyms. In the extensive revision of Kahl (1932, 1935) 54 species were described of which many were new.

Since that major work few realistic revisions have been made. Bock (1967) and Bick (1972) attempted a key to species but the important reviews by Fauré-Fremiet (1969) and Corliss (1979) on the systematics of the oligotrichine ciliates alone remain prominent. Kahl's major work omitted some species and others have been described since. Clearly before any attempts are made to understand the role of these ciliates in the aquatic environment, the taxonomy of the group must be given an extensive revision.

In general many ciliates can be seriously damaged or distorted by fixatives, therefore for correct identification it is advisable that living material should be examined whenever possible with the light microscope. Many of these pelagic species move quickly, although some reagents or slowing agents such as nickel sulfate, methyl cellulose and polyethylene oxide are useful for decrease swimming velocity of protozoa, and a fragile, on death they usually fragment. If these factors are not taken into consideration, the observer can easily fail to collect the essential taxonomic features. Silver staining techniques clearly reveal details of the ciliate cortex but for rapid ecological surveys identification using silver impregnation is considered too burdensome. Instead, a video recording system with slow play-back linked to a microscope equipped with Nomarski interference optics is considered essential to store the key information necessary for identification of fast moving species. This instrumentation in combination with an identification guide in the form of a diagnostic key should enable the non-specialist engaged in aquatic ecology to identify these ciliates to the species level.

The family Strombidiidae includes four genera, *Buehringa, Laboea, Strombidium* and *Tontonia* according to Corliss (1979). In this work all the species of the genera *Buehringa* and *Laboea* have been transferred to *Strombidium* and the genus *Metastrombidium* to which one species belonged has been moved to the family Strombidiidae from the family Halteriidae. The genus *Tontonia* includes three species. Therefore the majority of species in this family belong to the genus *Strombidium* of which 70 species are listed here. The descriptions of 134 species were checked in this work, among which were a considerable number of species described by Meunier (1910), Leegaard (1915), Wulff (1919), Busch (1921, 1930, 1950) and Hada (1970), were diagnosed after fixation. Although most of the specimens still retained the key features, they were distorted or constricted in some areas. We included these species until such time as they are redescribed and definite decisions can be taken as to their validity.

A detailed analysis of original diagrams and descriptions has been undertaken with the intention of presenting a taxonomic guide to all species in the Family Strombidiidae. It is hoped that this guide will enable those interested in the taxonomy or ecology of oligotrichine ciliates to identify and gain a better understanding of these protozoa which are abundant in marine and freshwater habitats.

II. GLOSSARY OF TERMS

(Figs. 1, 2, 3 and 4)

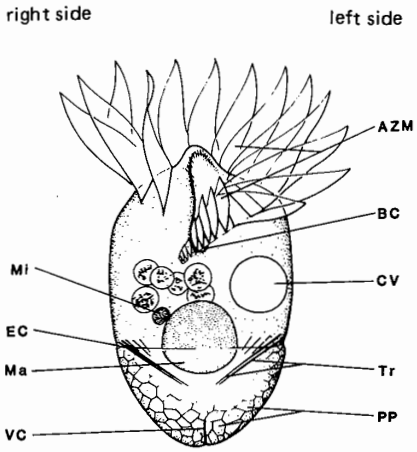

Fig. 1. *Strombidium sulcatum* Claparède and Lachmann, 1858 (after Fauré-Fremiet and Ganier, 1970)

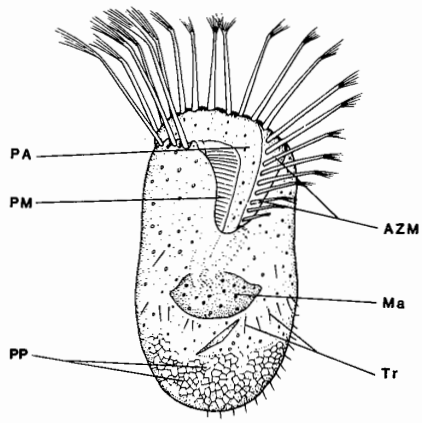

Fig. 2. *Strombidium macronucleatum* Dragesco, 1960 (after Dragesco, 1960)

AZM, Adoral zone of membranelles

Membranelles located in the apical area, around the peristome. They are generally bipartite, one part situated within the buccal cavity and the other on the body surface encircling the anterior pole. Those outside the peristome have been termed "apical membranelles" by some authors.

BC, Buccal cavity

CV, Contractile vacuole

EC, Equatorial cleft

Ma, Macronucleus

Mi, Micronucleus

Pa, Peristomial area

Entire oral area including the buccal cavity

PC, Peristomial collar

Collar-like protrusion located at the apical extremity, surrounding the peristomial area.

Pe, Perilemma

An additional outer membrane covering the pellicle or polygonal cortical platelets.

PM, Paroral membrane

Ciliary organelle lying along the right side or border of the buccal cavity, composed of cilia arising from a single row of kinetosomes.

PP, Polygonal cortical platelet

Thickened pellicle mainly composed of polysaccharide platelets which covers the posterior and in some cases almost the whole body. The terms "polysaccharide plate" and "polysaccharide plaque" are also used.

Tr, Trichite

Unique skeletal structure, hollow, rod-like and of a proteinaceous nature, usually arranged radially beneath the pellicle of the posterior hemisphere of the body.

VC, Ventral cleft

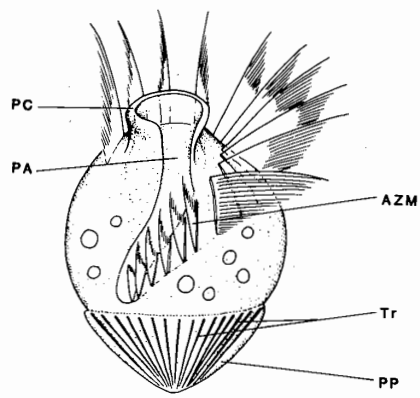

Fig. 3. *Strombidium lagenula* Fauré-Fremiet, 1924 (after Fauré-Fremiet, 1924)

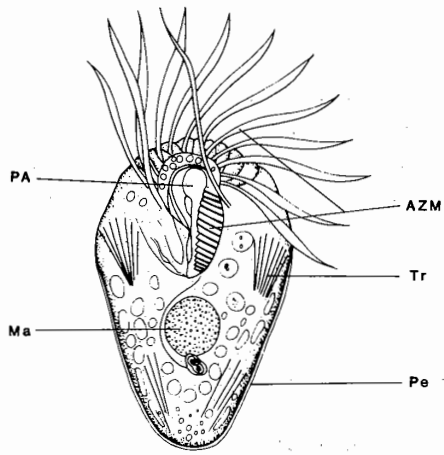

Fig. 4. *Strombidium mirabile* Penard, 1916 (after Penard, 1916)

II. DESCRIPTIONS OF THE SUBORDER OLIGOTRICHINA, FAMILY STROMBIDIIDAE AND GENERA *STROMBIDIUM, TONTONIA AND METASTROMBIDIUM*

Suborder Oligotrichina Bütschli, 1889
(Syn. Strombidiina)

Body typically small, ovoid or posteriorly attenuated, several species with a distinctive tail. Somatic ciliature reduced to a few short rows of bristles or an equatorial belt of short sensory cilia, one genus displays holotrichous ciliation. AZM in two distinct parts, the "somatic" portion used primarily for locomotion. Pellicle may be strengthened by skeletal elements in the form of platelets or rods, predominantly in the posterior half of the body. Perilemma present in some species. Principally marine but freshwater species well documented.

Family Strombidiidae Fauré-Fremiet, 1969
(Syn. Tontoniidae)

Circlet of apical membranelles is more or less oblique and open. Peristomial area apical, extending to the ventral area. Somatic ciliature is absent or very much reduced. Polygonal cortical platelets of polysaccharide composition are present mainly on the posterior half of body. Trichites present, bundles of which make a characteristic band or funnel-shape form in many species. Perilemma present in several species. Most species in marine habitats, but some common fresh water forms present. Three genera *Strombidium* Claparède and Lachmann, 1858, *Tontonia* Fauré-Fremiet, 1914 and *Metastrombidium* Fauré-Fremiet, 1924 are included in this family.

The genus *Laboea* Lohmann, 1908 possesses the characteristic arrangement of polysaccharide plates which display 3 – 6 cone-shaped forms and partly overlap each other at the posterior of the body. Species of the genus *Buehringa* Busch, 1921 possess two different shapes of polysaccharide plates covering the body. All the species of these two genera have been transferred to the genus *Strombidium* because the possession and arrangement of polysaccharide plates is not sufficient reason to erect a new genus.

Genus *Strombidium* Claparède and Lachmann, 1858
(Syn. Strombidion)

Body conical, irregularly ovoid or posteriorly elongated. In most species somatic ciliature is absent, trichites form a characteristic band, and polysaccharide plates or platelets

cover posterior half of body. Predominantly in marine habitats though several common fresh-water forms.

Genus *Tontonia* Fauré-Fremiet, 1914

Large size (80-540μm). Deep peristome is open on the ventral side where AZM is located on the left edge. A characteristic tail is present, originating from the posterior dorsal area. It is contractile and extensible to several times the body length. All species in marine habitats.

Genus *Metastrombidium* Fauré-Fremiet, 1924

The body is globular in shape, slightly depressed anteriorly. The form of the peristomial area is reniform. Adoral membranelles locate at the left area of the perisotme intrude into the buccal cavity. The body has no somatic ciliature. The heterogeneously reticulated cytoplasm contains some oil drop-like granules. One species was described from the marine hatitats.

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IV. SPECIES LIST

V. SPECIES NOT INCLUDED IN THE FAMILY STROMBIDIIDAE

All original descriptions and diagrams of species reported as belonging to the Family Strombidiidae were examined, the total number of which was 134. Among these, 117 species and their synonyms were listed as belonging to this family, the rest were considered either dubious species or were transferred to other genera.

The following ten species were transferred to the genus *Strobilidium*;

Strombidium claparedi Kent, 1882
S. gyrans Stokes, 1887
S. gyrans (Stokes, 1887) var. *transsylvanicum* Lepsi, 1926
S. intermedium Maskell, 1887
S. marinum Fauré-Fremiet, 1910
S. minimum Gruber, 1884
S. mucotectum Busch, 1924
S. spiniferum Leegaard, 1915
S. striatum (Meunier, 1910) Kahl, 1932
Strombidium sp. Meunier, 1910

Strombidium caudatum Lohmann, 1908 has been transferred to the genus *Tontonia*. *S. oblongum* Kellicott, 1885 has been transferred to *Halteria*. *S. comatum* Wulff, 1919 and *S. polymorphum* Eberhard, 1862 clearly belong in other genera. *Laboea globosa* Lohmann, 1908 could be included in the genus *Strombidium*, but its description is not sufficient to give this animal a certain taxonomic position. Busch (1930, 1950) reported 3 *Strombidium* sp. which were described using fixed specimens. Their poor descriptions and diagrams prevent the erection of new names, although their diagrams are shown in this work. Jankowski (1979) proposed a new scheme of classification for the Suborder Oligotrichina, including establishment of the new genera. But as detailed information on these revisions was not given, the Jankowskian scheme of classification was not followed in the present work.

VI. SPECIES DESCRIPTIONS

Strombidium sulcatum **Claparède and Lachmann, 1858**
Syn. *Strombidium minutum* Wulff, 1919
(Figs. 5, 6, and 7)

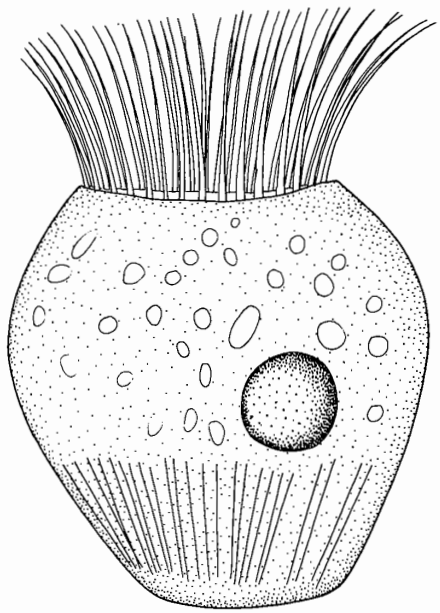

Fig. 5. *Stombidium sulcatum* Claparède and Lachmann, 1858 (after Claparède and Lachmann, 1858)

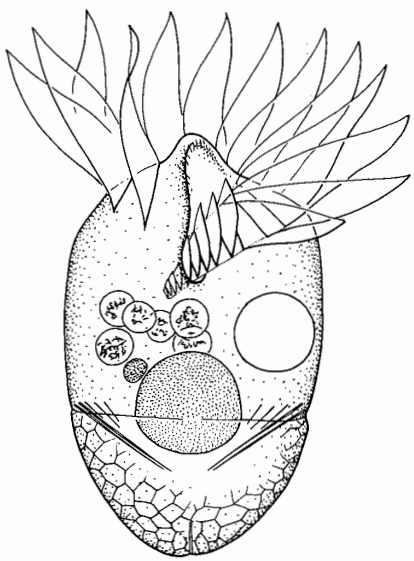

Fig. 6. *Strombidium sulcatum* (Claparède and Lachmann, 1858 (after Fauré-Fremiet and Ganier, 1970)

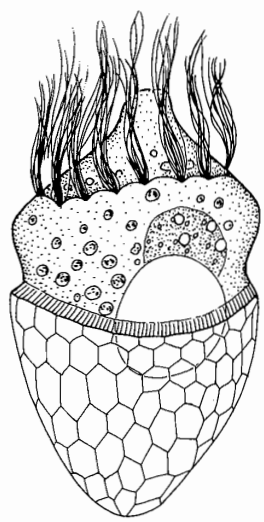

Fig. 7. *Strombidium minutum* Wulff, 1919 (after Wulff, 1919)

Size, 30 – 60 μm and 40 – 50 μm according to Kahl (1932) and Fauré-Fremiet and Ganier (1970), respectively. The form is ovoid and yellowish brown in colour according to Claparède and Lachmann (1858), but the small form just after cell division is short and conical (Kahl, 1932). A protuberance is situated on the apical area, where about 12 membranelles of the adoral zone are massively developed. Conspicuous trichites are located in the posterior one-third of the body, which make a funnel-like arrangement. Polygonal cortical platelets are present but no necessarily conspicuous, and this species possesses a ventral cleft and perilemma. A round macronucleus and a single micronucleus is present. The movement is continuous but not extremely fast. It occurs in saprobic areas in the sea and feeds on bacteria and small diatoms.

According to Fauré-Fremiet and Ganier (1970) it possesses highly differentiated somatic ciliature which is possibly specialized in a sensorial function. The diagram of *Strombidium minutum* displays the dorsal side. The shapes and arrangement of the apical protuberance, polygonal cortical platelets and macronucleus are quite similar to *S. sulcatum* although the size of *S. minutum* (30–40 μm) is slightly smaller, probably because of shrinkage by the fixative employed. *S. minutum* and *S. sulcatum.* have been synonymised.

Strombidium turbo **Claparède and Lachmann, 1858**
(Figs. 8 and 9)

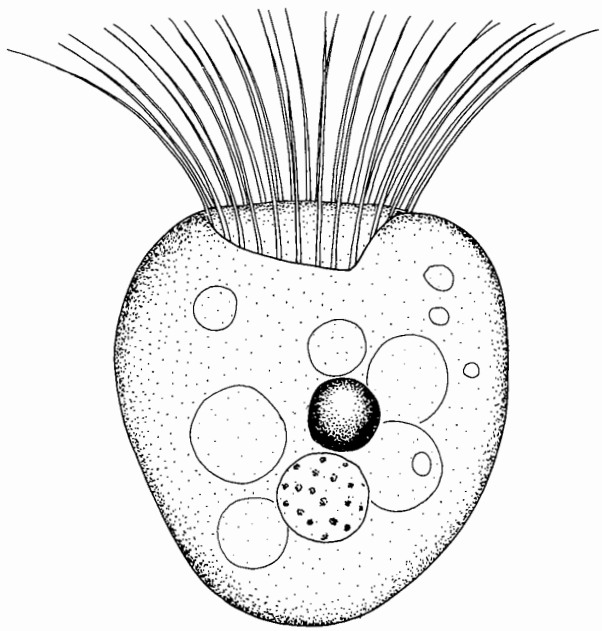

Fig. 8. *Strombidium turbo* Claparède and Lachmann, 1858 (after Claparède and Lachmann, 1858)

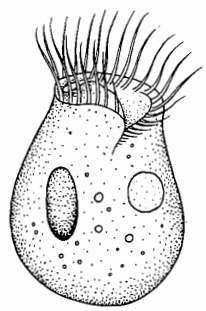

Fig. 9. *Strombidium turbo* Claparède and Lachmann, 1858 (after Roux, 1901)

Size, 35 μm. Body is globose, slightly conical posteriorly. Its surface does not show the furrow-like form of trichites. The circlet of apical membranelles is not completed, but rather forms a spiral arrangement. The peristomial area shows a crescent-shaped cut like the freshwater oligotrich *Halteria grandinella*. Freshwater species.

Claparède and Lachmann (1858) were unsure if this species belonged in the genus *Strombidium*. Kahl (1932) transferred it to the genus *Strombidinopsis*, as a synonym of *S. gyrans*. Based on the description of Claparède and Lachmann (1858) and a diagram of Roux (1901), this species has been placed in the genus *Strombidum*.

Strombidium lagenula **Fauré-Fremiet, 1924**
(Fig. 10)

Size, 60 μm. The peristomial lip-like collar is distinctly projected at the apical end and the peristomial field extends to the posterior one-third of the body on the ventral side. The AZM is thickly developed and is constituted of 16 – 20 membranelles. A band of trichites is situated at the posterior end. Cortical platelets are recognizable. The endoplasm displays a brown colour due to the digestive products. The macronucleus was not observed. This planktonic species is extremely fragile and swims very fast, frequently occurring in the marine environment.

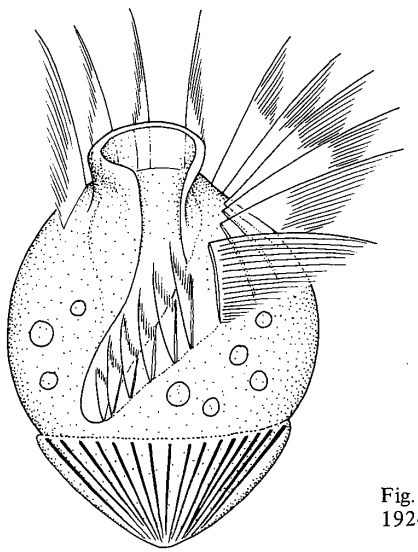

Fig. 10. *Strombidium lagenula* Fauré-Fremiet, 1924 (after Fauré-Fremiet, 1924)

Strombidium turcicum **Hovasse, 1932**
(Fig. 11)

Size, 100 μm. The body shape is ovoid, a peristomial collar present at the anterior end.

The posterior extremity is bluntly pointed. A peristomial field extends almost to the posterior end. Membranelles of the adoral zone are thick. A considerable quantity of granules exists inside the body. Marine species.

This species seems to be similar to *Strombidium lagenula,* but shows a larger size and possesses no transverse cleft or trichites.

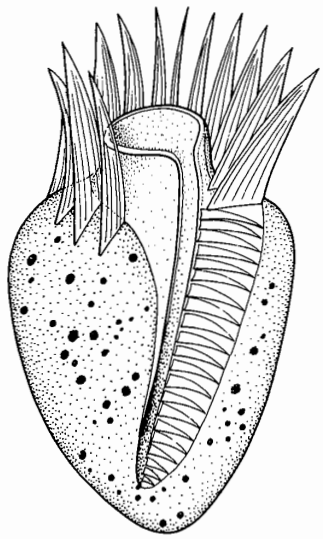

Fig. 11. *Strombidium turcicum* Hovasse, 1932 (after Hovasse, 1932)

Strombidium calkinsi **Fauré-Fremiet, 1932**
(Fig. 12)

Size, 40 μm. The body shape is irregularly ovoid and the basal region, hemispheric. The peristomial area, more developed than in *Strombidium sulcatum* and less deep than in *Strombidium lagenula,* extends towards the middle of the ventral side. Polysaccharide plates and a transverse cleft are distinct. Trichites make a funnel-like arrangement. There are two long dorsal membranelles, 35 – 40 μm, independent of the adoral zone, the ends of which can stick onto a substratum. The ovoid macronucleus lies in the body in the posterior region above the bundle of trichites. The cytoplasm is hyaline, clear, enclosing various digestive vacuoles, and contains some granulations which are refractile. Marine species.

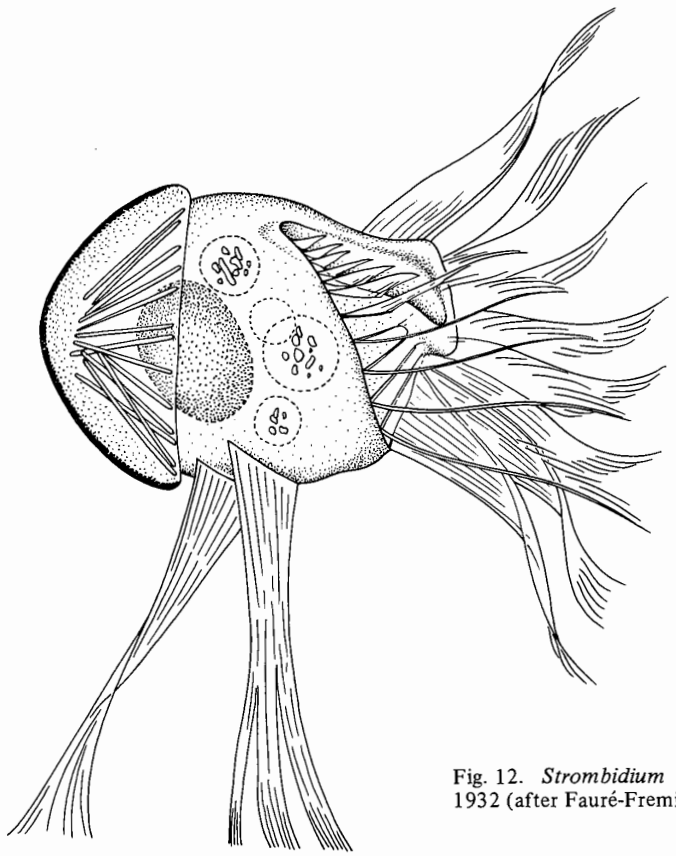

Fig. 12. *Strombidium calkinsi* Fauré-Fremiet, 1932 (after Fauré-Fremiet, 1932)

***Strombidium oculatum* Gruber, 1884**
(Figs. 13 and 14)

Size, 60 – 70 μm. The shape varies from pyriform to ovoid or conical, depending on the amount of green inclusions inside the body. The posterior area is narrowed and shortly rounded at it extremity. There is a blunt protuberance at the anterior end. A roughly triangular truncation of the anterior ventral side follows along the peristomial depression. A bundle of trichites forms an internal armature in the shape of a truncated cone. Polygonal cortical platelets cover half the body. Both equatorial and ventral cleft are present. The macronucleus is round or oval. Marine species.

This species has a characteristic tidal rhythm concerning encystment and excystment reported by Fauré-Fremiet (1948).

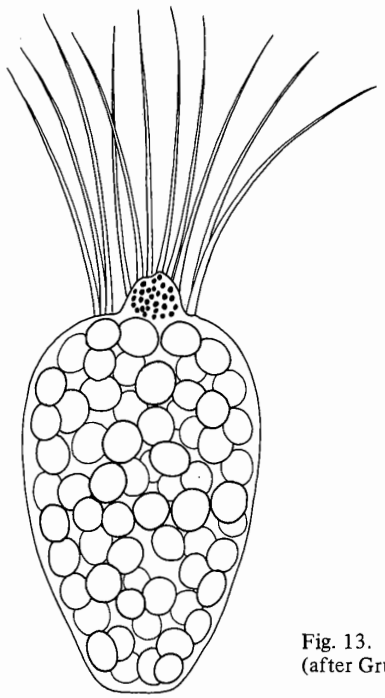

Fig. 13. *Strombidium oculatum* Gruber, 1884 (after Gruber, 1884)

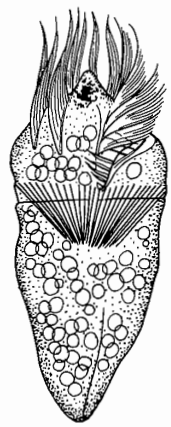

Fig. 14. *Strombidium oculatum* Gruber, 1884 (after Fauré-Fremiet, 1948)

***Strombidium conicum* (Lohmann, 1908) Wulff, 1919**
Syn. *Laboea conica* Lohmann, 1908
(Figs. 15 and 16)

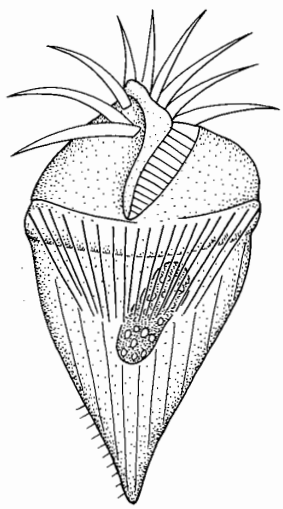

Fig. 15. *Strombidium conicum* (Lohmann, 1908) Wulff, 1919 (after Kahl, 1932)

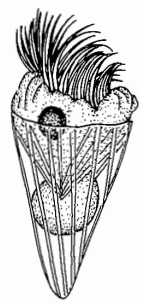

Fig. 16. *Laboea conica* Lohmann, 1908 (after Lohmann, 1908)

Size, 50 – 70 μm according to Kahl (1932). Lohmann (1908), Leegaard (1915) and Wulff (1919) reported its size as 20 – 50 μm, 45 – 75 μm and 30 – 40 μm, respectively. These sizes are smaller than that measured by Kahl (1932) probably because of shrinkage by fixative. The yellow coloured body is relatively wide at the anterior and narrowed posteriorly. The band of trichites makes a funnel-like shape. Cortical plates possess longitudinal lines. There is a cirral row near the posterior extremity. The macronucleus is ovoid. A planktonic marine species.

Strombidium viride **Stein, 1867**
Syn. ***Strombidium nasutum*** **Smith, 1897**
(Figs. 17, 18 and 19)

Size, 60 – 80 μm and 40 – 80 μm according to Penard (1920) and Kahl (1932), respectively. The anterior part of the body is shaped like an inverted cone and there is a blunt, unsharpened protuberance at the anterior extremity. The posterior area is slightly elongated, conical in form. Bundles of trichites make an equatorially encircling band in the middle area of the body and several tubules are encircled with 3 – 4 folds in the same area. Polygonal cortical platelets of polysaccharide composition are extremely small, around 1 – 2 μm in size. Numerous green coloured cells are described, inside the body. Freshwater species.

Stein (1867) did not show a diagram of this animal, however Penard (1920) and Kahl (1932) redescribed it with a detailed diagram, although Penard's (1920) *S. viride* has no

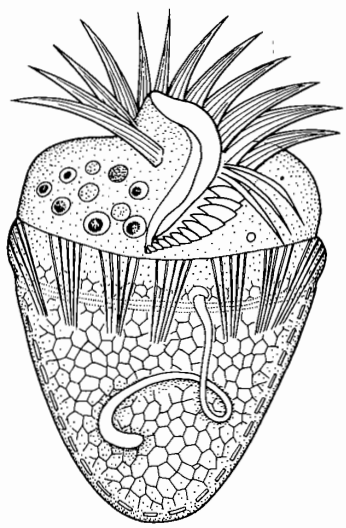

Fig. 17. *Strombidium viride* Stein, 1867 (after Kahl, 1932)

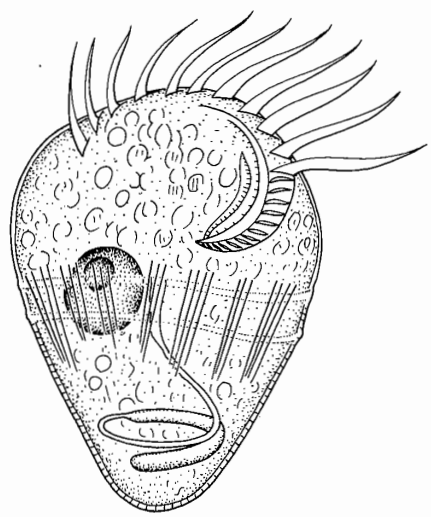

Fig. 18. *Strombidium viride* Stein, 1867 (after Penard, 1920)

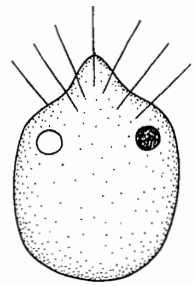

Fig. 19. *Strombidium nasutum* Smith, 1897
(after Smith, 1897)

protuberance in the anterior area. Roux's (1899) *S. viride* is different from Penard's (1920) and Kahl's (1932) on the shape of the AZM and the body. Kahl (1932) observed three types of *S. viride*. (1) Large round form (size, about 80 μm) with dense colour from zoochlorellae, and green algae inside the body. Abundantly distributed among aguatic plants. (2) Slender form, size about 60 μm. The posterior area is gently pointed. Found in deep lakes. A green coloured body with zoochlorellae and their fragments (3) Small and round form, size 40 – 60 μm. Yellow coloured species without zoochlorellae inside the body. Distributed in deep lakes.

Strombidium nasutum was found in pond water, size about 50 μm in length.

***Strombidium mirabile* Penard, 1916**
Syn. *Psilotricha fallax* Zacharias, 1895
***Strombidium fallax* (Zacharias, 1895) Kahl, 1932**
(Figs. 20, 21 and 22)

Size, 60 – 70 μm. A yellowish or green coloured species. Similar in shape to *S. viride* but there is no protuberance at the anterior area. The buccal cavity is deep with a wide lip-like rim on the right side. Small splits are situated at the base of the adoral membranelles. Only 4 bundles of trichites present. Polysaccharide platelets are twice as large as those of *S. viride*. Macronucleus has an oblique cleft. No tubules encircle the middle area of the body, but an "embryo-like" tube is present in the posterior area. The micronucleus is single and large. Usually zoochlorellae and various Chlorophyceae are seen inside the body. Freshwater species.

Strombidium fallax is yellow coloured. Size, 80 μm. The ventral side is slightly and the dorsal side is prominently arched. The middle area of the body equatorially expanded. The peristomial field extends near to the posterior end. Trichites were overlooked by Zacharias (1895) but the transverse furrow at the dorsal side suggests their possible presence. A round shaped macronucleus is situated posteriorly. It feeds on small diatoms and *Peridinium*. Planktonic animals in freshwater habitats.

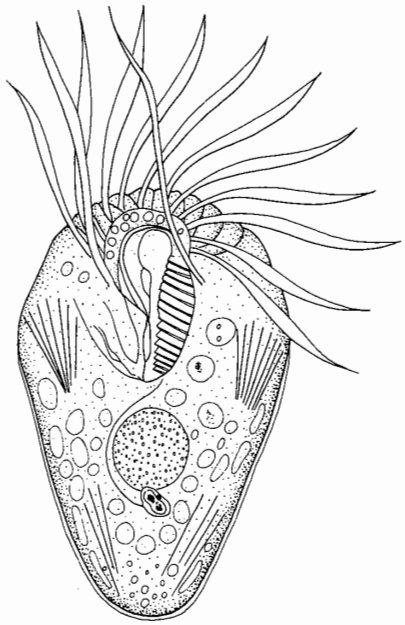

Fig. 20. *Strombidium mirabile* Penard, 1916 (after Penard, 1916)

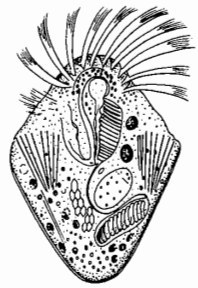

Fig. 21. *Strombidium mirabile* Penard, 1916 (after Penard, 1916)

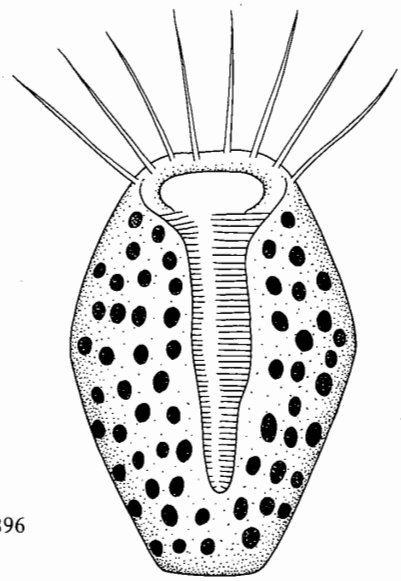

Fig. 22. *Psilotricha fallax* Zacharias, 1896 (after Zacharias, 1896)

Strombidium testaceum Anigstein, 1913
(Fig. 23)

Size, 70 – 84 μm. The body is wide in the anterior region and round or obovate posteriorly. The AZM is distinctive and the ends of the membranelles are frayed. There are narrow creases at the base of the membranelles. Inside the peristome a paroral membrane is present. Bundles of trichites make a equatorial band encircling the body. Polygonal cortical platelets are thick covering the posterior half of the body. The oblique row of short bristles runs from the right side to the left side on the dorsal and extends to the ventral area. The macronucleus is elongate in form. It feeds on small ciliates. A marine species.

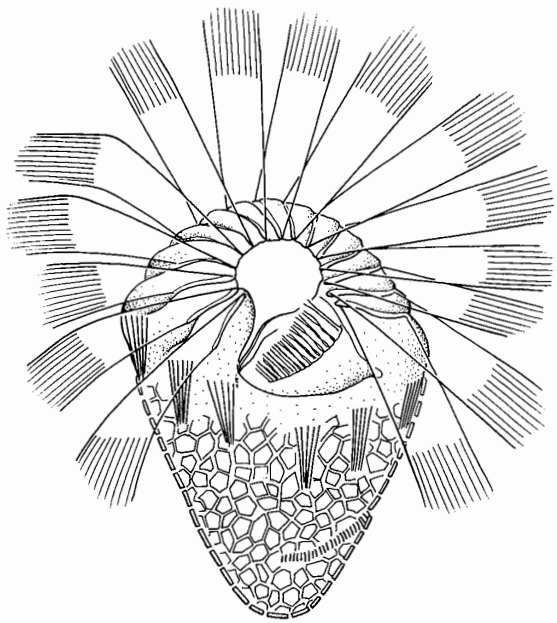

Fig. 23. *Strombidium testaceum* Anigstein, 1913 (after Anigstein, 1913)

***Strombidium purpureum* Kahl, 1932**
(Fig. 24)

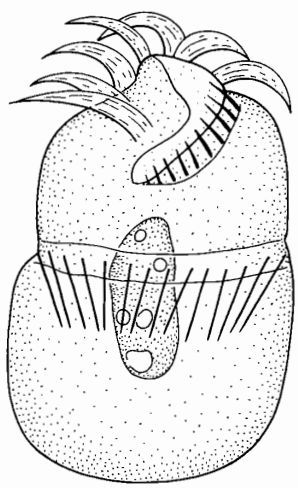

Fig. 24. *Stombidium purpureum* Kahl, 1932 (after Kahl, 1932)

A small species, size 40 – 50 μm. Almost cylindrical in form. The middle area of the body is narrowed where the equatorial cleft is present and the posterior area is wide and rounded. The peristomial field is not very well developed and shows little activity. Trichites are very slender but are distinct and make an equatorial band. Small rod-form purple-bacteria which may be a symbiotic fill the inside of the body. Movement is convulsive but elegant. It occurred in brackish water (salt concentration, 1 – 2%) and saprobic places where H_2S content is high.

Strombidium stylifer **Levander, 1894**
(Figs. 25 and 26)

Size, 70 – 90 μm without the cytoplasmic stylet which is 10 – 25 μm in length. Yellowish green in colour. The frontal area is widened and the posterior part is cone-shaped. There is a small protuberance at the anterior extremity and a long pointed thorn is present at the posterior end. This thorn seems to be used to attach temporarily onto the substratum. Trichites are very dense which form an equatorial band in the middle area. According to Kahl (1932) the posterior region is covered with polygonal cortical platelets which are extremely small and soft, and the ventral cleft is conspicuous just in front of the

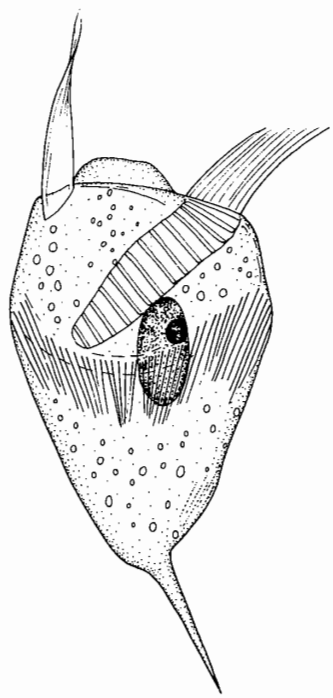

Fig. 25. *Strombidium stylifer* Levander, 1894 (after Levander, 1894)

Fig. 26. *Strombidium stylifer* Levander, 1894 (after Kahl, 1932)

stylet. The macronucleus is oblong in shape. It feeds on various groups of algae and small *Peridinium*. A marine species.

Strombidium minor **(Kahl, 1935) Maeda and Carey, 1985** ***nom. nov.***
Syn. ***Strombidium caudatum*** **Calkins, 1901**
Strombidium calkinsi **Kahl, 1932**
Strombidium styliferum **var.** ***minor*** **Kahl, 1935**
(Fig. 27)

Size, 35 μm without the "thorn-like" tail. The body is pyriform and broadly truncate at the anterior end, the middle of which rises as a small protuberance. The tail is about half as long as the body, structureless, hyaline and sharply pointed. Trichites are abundant in the cortex. The macronucleus is large, spherical and placed in the center of the body. The contractile vacuole lies in the posterior area. This marine species occurs in saprobic places and feeds on *Peridinium*.

According to Kahl (1932), this animal has three distinct long membranelles among the AZM. The name *S. styliferum* var *minor* was erected by Kahl (1932) in place of *S. calkinsi* (Kahl, 1932) which was occupied. Kahl (1932) had proposed the new name *S. calkinsi* after the incorrect identification of a species of *Strombidium* by Calkins (1901).

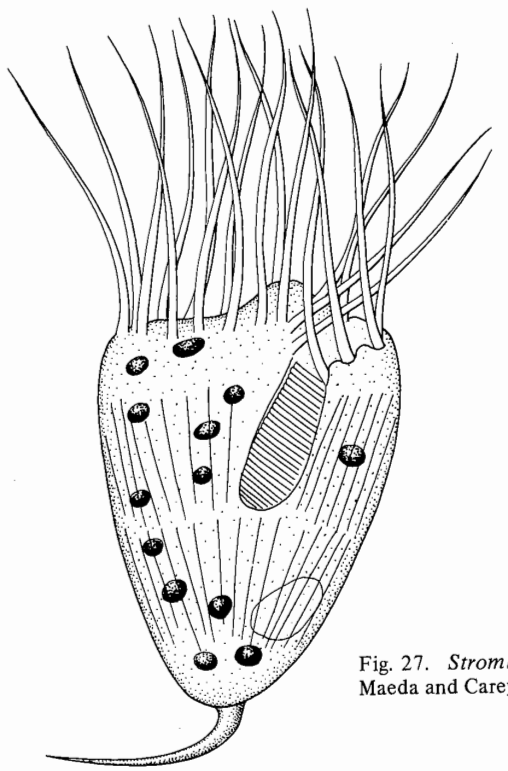

Fig. 27. *Strombidium minor* (Kahl, 1935) Maeda and Carey, 1985 (after Calkins, 1901)

***Strombidium filificum* Kahl, 1932**
(Fig. 28)

Size, 30 – 35 μm not including the thread-like extensions. The peristomial area is conspicuous. Trichites make an equatorial band in the middle of the body. From the short pointed area at the posterior, long threads extends, sometimes 500 μm in length, from which mucous material is produced. Using a such thread the animal attaches to the substratum and rotates or waves freely. This thread can be temporary lost but a new one is easily produced. Another "pin-like" organelle was once observed near the posterior extremity by Kahl (1932). The macronucleus ovoid. A marine species.

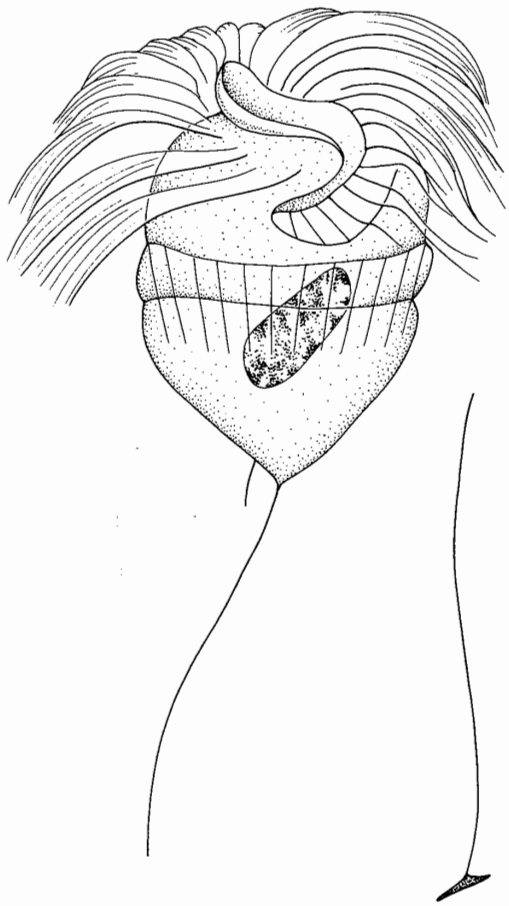

Fig. 28. *Strombidium filificum* Kahl, 1932 (afrer Kahl, 1932)

Strombidium velox **Beardsley, 1902**
(Figs. 29 and 30)

Size, 40 – 50 μm. The form is turbinate, varying to obovate and broadly elliptical. The peristomial field extends along the ventral side to nearly half the body length. Membranelles of the adoral zone are thick, about half as long as the body. The body is colorless and its surface is smooth without supplementary cilia. There is a slender thread at the posterior extremity for fixing to the substratum, this is contractile and contains a gelatinous substance. The macronucleus is irregularly spherical situated sub-centrally, and the round contractile vacuole is in the anterior area. The movement is extremely rapid and erratic, frequently gyrating for a time around a fixed point, then suddenly darting away. The food consists of diatoms. Found in a pond water with *Vaucheria*.

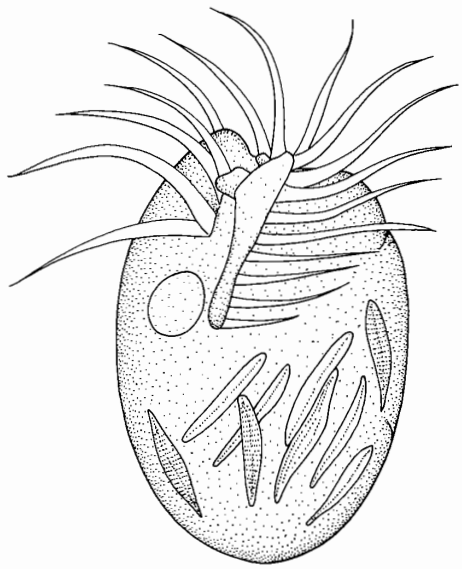

Fig. 29. *Strombidium velox* Beardsley, 1902 (after Beardsley, 1902)

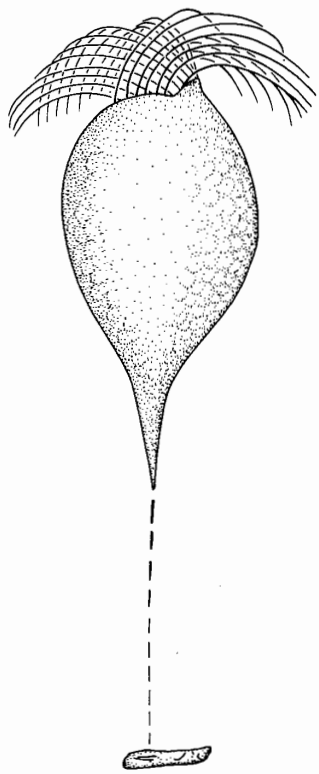

Fig. 30. *Strombidium velox* Beardsley, 1902 (after Beardsley, 1902)

Strombidium tintinnodes **Entz, 1884**
Syn. ***Strombidium acuminatum*** **Stein, 1867**
Strombidium typicum **(Lankester, 1874) Bütschli, 1889**
(Figs. 31 and 32)

A small size species (20 – 40 μm) with a yellow coloured body probably due to ingested foods. The apical area bears a short distinct protuberance which is the characteristic feature of this species. The posterior area is slim and its extremity is pointed, which exhibits an elastic contractile movement. Trichites are present below the middle of the body. The macronucleus is ovoid and the contractile vacuole is round. A marine species.

The description of *Strombidium acuminatum* Stein, 1867 is as follows. The body colour is more or less intensive yellow, and it exhibits a blunt projection at the anterior end and a long cone shape at the posterior. The peristomial area is at the center of the anterior body. Although Stein (1867) did not show the diagram of this animal, *S. acuminatum* has been synonymised with *S. tintinnodes*.

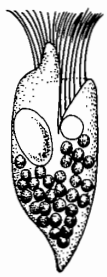

Fig. 31. *Strombidium tintinnodes* Entz, 1884 (after Entz, 1884)

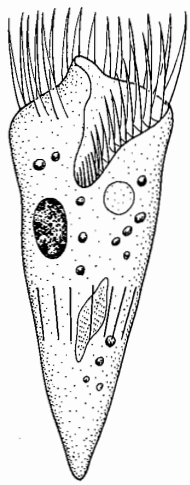

Fig. 32. *Strombidium typicum* (Lankester, 1874) Butschli, 1889 (after Butschli, 1887–1889)

Strombidium arenicola **Dragesco, 1960**
(Fig. 33)

Size, 50 – 100 μm. Body is ovoid. The adoral membranelles are very long and there is a paroral membrane in the peristome. The trichites are long and few in number. The macronucleus is ovoid. It possesses numerous sand grains inside the cell. Found in fine sand in the seashore at Roscoff.

Strombidium fourneleti **(Dragesco, 1960) Maeda and Carey, 1985** ***nom. nov.***
Syn. ***Strombidium sauerbreyae*** **Kahl, 1932 var.** ***fourneleti*** **Dragesco, 1960**
(Fig. 34)

Size, 50 – 65 μm (diagram indicates 70 μm). The body is globular. The peristomial field is confined to the apical area and adoral membranelles are very fine. Two thigmotactic membranelles are present, apart from the AZM. The band of trichites is conspicuous and the posterior area is covered with polygonal cortical platelets. The large vacant space can be seen at the posterior extremity. The macronucleus is oval, with a small and spherical micronucleus. Several sand grains and diatoms are included inside the cell. This organism is frequently found in marine sand and in brackish pools.

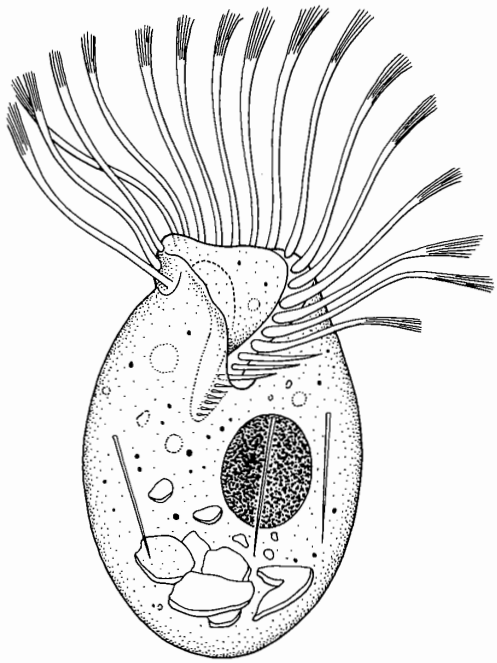

Fig. 33. *Strombidium arenicola* Dragesco, 1960 (after Dragesco, 1960)

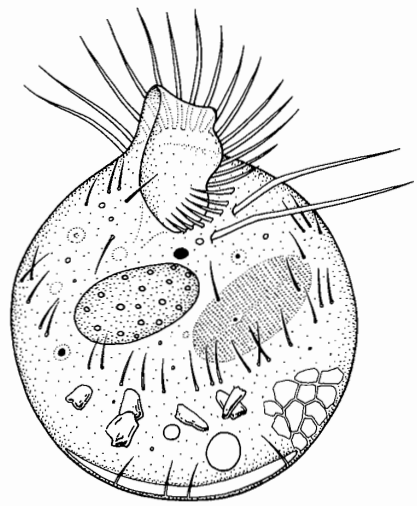

Fig. 34. *Strombidium fourneleti* (Dragesco, 1960) Maeda and Carey, 1985 (after Dragesco, 1960)

Strombidium macronucleatum **Dragesco, 1960**
(Fig. 35)

Size, 80 – 135 μm. The body shape is elliptical. The peristome is large and a thick paroral membrane is present. Trichites are more numerous and smaller than those of *S. arenicola*.

The round posterior area is covered with polygonal cortical platelets. The macronucleus is oval, with a small and spherical micronucleus. Several sand grains and diatoms are included inside the cell. This organism is frequently found in marine sand and in brackish pools.

Strombidium faurei **Dragesco, 1960**
(Fig. 36)

Size, 75 μm (diagram indicates 100 μm). The body is ovoid and a peristomial collar is present. There are two long thigmotactic cirri in addition to the adoral membranelles. Trichites are numerous on the somatic area. The left lateral side is furnished with fine cirri. The macronucleus is oval and several sand grains are included inside the cell. Polygonal cortical platelets are not seen. A marine species found in the fine sand at Roscoff.

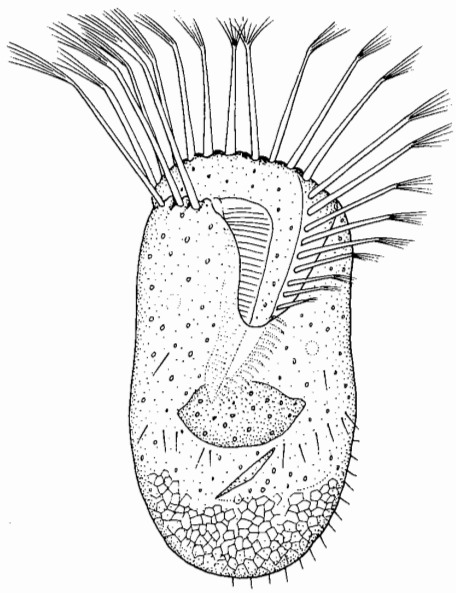

Fig. 35. *Strombidium macronucleatum* Dragesco, 1960 (after Dragesco, 1960)

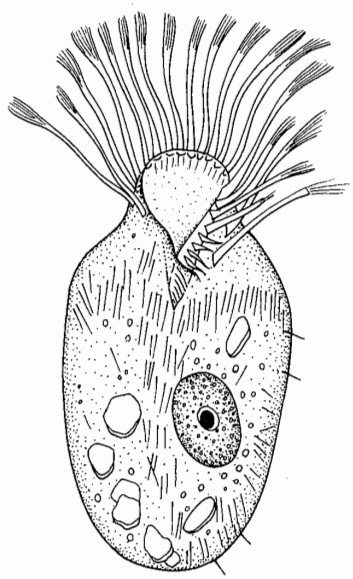

Fig. 36. *Strombidium faurei* Dragesco, 1960 (after Dragesco, 1960)

Strombidium kielum **Maeda and Carey, 1985** ***sp. n.***
(Fig. 37)

This species was described by Kahl (1932) as *Strombidium* sp. Size, 70 – 80 μm. The body is almost cylindrical but slightly wider at the anterior area. The posterior area is round and bluntly pointed at its extremity. The peristome is not extensive. Fine trichite bands

are confined to the lateral areas. The macronucleus is oval. A marine species.

Strombidium cylindromorphum **Perejaslawzewa, 1886**
(Fig. 38)

A cylindrical species and yellow in colour. The size is not mentioned in the original description. According to Kahl's (1932) observation, the body is colorless, 40 μm in length. There is a wreath-like furrow in the posterior area. He also suggested that the shape of this animal is variable in several different circumstances. The contractile vacuole is at the right side of the posterior area. It occurs in saprobic places in the sea. A poorly described species.

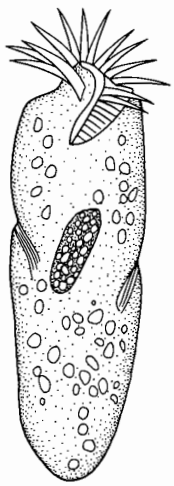

Fig. 37. *Strombidium kielum* Maeda and Carey, 1985 (after Kahl, 1932)

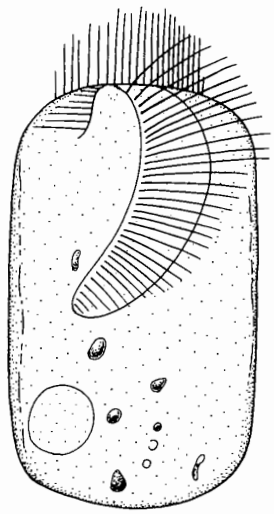

Fig. 38. *Strombidium cylindromorphum* Perejaslawzewa, 1886 (after Perejaslawzewa, 1886)

Strombidium urceolare **Stein, 1867**
(Fig. 39)

This species was described by Stein (1867) without a diagram. Fauré-Fremiet (1932) first produced the diagram of this animal which was sent to him from E. Maupas as a personal communication in 1907.

Size has not been quoted. The body is a bulky, almost pot-like in shape. There is the projected peristomial collar in the apical area. The AZM is abruptly bent to the left side at its posterior half, which includes three characteristic long membranelles for attaching the body to the substratum. The macronucleus is oval. A contractile vacuole is present posteriorly. This species was found in the Baltic Sea.

***Strombidium alveolare* Bullington, 1940**
(Fig. 40)

Size, 54 – 75 μm, average 59 μm. The body is dorso-ventrally flattened, somewhat elongated and bluntly rounded at the anterior and posteior extremities. The middle area is constricted. This species is characterized by its extreme alveolar or vacuolated appearance. The body seems one mass of globules. A nucleus and contractile vacuole have not been described. A marine species.

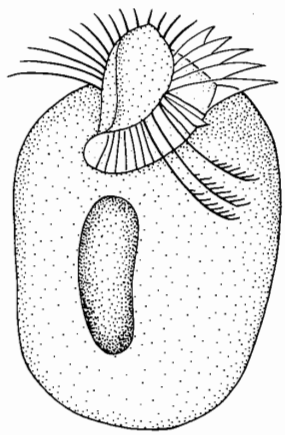

Fig. 39. *Strombidium urceolare* Stein, 1867 (after Faure-Fremiet, 1932)

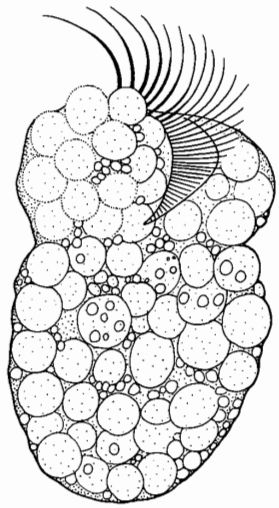

Fig. 40. *Strombidium alveolare* Bullington, 1940 (after Bullington, 1940)

***Strombidium armatum* Burger, 1908**
(Fig. 41)

Size, 50 – 60 μm. The apical protuberance is conspicuous, like a elastic finger in form, usually 9 μm in length. The AZM is wide and pinnate in its anterior half. A dense band of trichites is present at the dorsal side, extending from left to end at the right side near the posterior area. One or two contractile vacuoles and an elliptical macronucleus is present. It feeds on diatoms. A marine species.

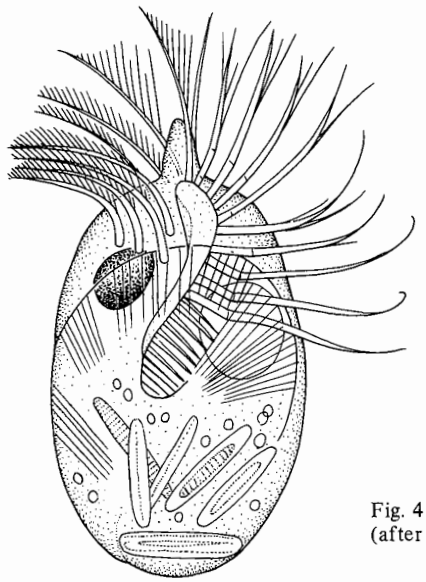

Fig. 41. *Strombidium armatum* Burger, 1908 (after Burger, 1908)

Strombidium sauerbreyae **(Sauerbrey, 1928) Kahl, 1932**
Syn. ***Strombidium coronatum*** **Sauerbrey, 1928**
(Fig. 42 and 43)

Size, 100 μm and 80 – 100 μm according to Kahl (1932) and Fauré-Fremiet (1950), respectively. The yellow coloured body is elliptical and dorso-ventrally flattened. The anterior extremity projects bluntly and the posterior end is sharpened. Membranelles of the adoral zone are well developed, their length may reach one-third to a quarter of the body length. The band of trichites shows a characteristic arrangement, which run from the posterior end to both sides. One band turns around from the right side to the left in the middle area of the ventral side. Another extends to the dorsal side and two bands are appear to cross optically at the center of the body. There are small protrusions at the point at which the trichites turn. Small polysaccharide plaques are present, each of which is about 4 μm in width. The macronucleus is globular. This species moves in circles rapidly, but sometimes attaches to the substratum with two long thigmotactic membranelles adjacent to the AZM, according to Fauré-Fremiet (1950). It feeds on diatoms. Present in marine habitats, especially in sands.

Kahl (1932) and Fauré-Fremiet (1950) mentioned animals with different arrangements of the band of trichites. Fauré-Fremiet (1950) also described two smaller species, one was very flat and posteriorly sharpened in form, size 50 μm and the other was dorso-ventrally flattened and more elliptical, size 75 μm.

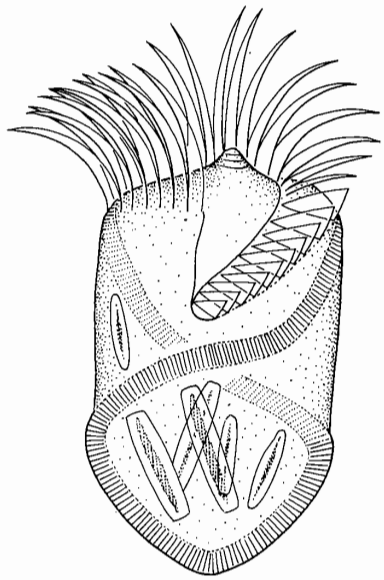

Fig. 42. *Strombidium sauerbreyae* (Sauerbrey, 1928) Kahl, 1932 (after Sauerbrey, 1928)

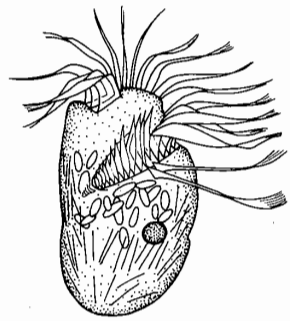

Fig. 43. *Strombidium sauerbreyae* (Sauerbrey, 1928) Kahl, 1932 (after Fauré-Fremiet, 1950)

***Strombidium pseudocinctum* Wang, 1934**
(Fig. 44)

Size, 36 – 55 μm. The body is oblong, more or less flattened dorso-ventrally, slightly convex at its right side and a little concave at its left. The anterior end is broadly truncated in the middle from which rises a process, papillary in form. The posterior end is evenly rounded. The peristomial area extends down obliquely and turns abruptly toward the left into the cytopharynx. The posterior half of the body is furnished with the band of trichites, bordering the periphery to form a distinctly expanded zone which bends from both sides to make an equatorial sash. The macronucleus is elliptical, centrally or subcentrally located. A marine species.

***Strombidium oblongum* (Entz, 1884) Kahl, 1932**
Syn. *Strombidium sulcatum* Entz, 1884
***Clypeolum corsicum* Gourret and Roeser, 1888**
(Fig. 45)

Size, 30 μm according to Entz (1884) but Gourret and Roeser (1888) suggested about 115 μm for *Clypeolum corsicum* although Kahl (1932) was not convinced. The body is slender and ogival. The posterior extremity is pointed. In transverse cross section the body is seen to take a lentic form. Two thigmotactic membranelles are recognized in the AZM

of *C. corsicum*. Bands of trichites are present at the lateral and posterior area but are not conspicuous. A small and round macronucleus is situated at the middle of the body. A marine species.

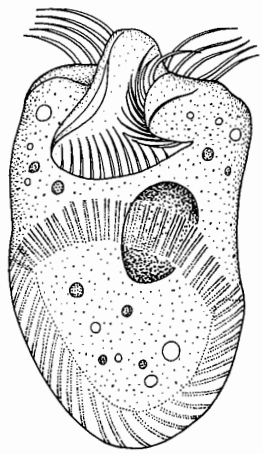

Fig. 44. *Strombidium pseudocinctum* Wang, 1934 (after Wang, 1934)

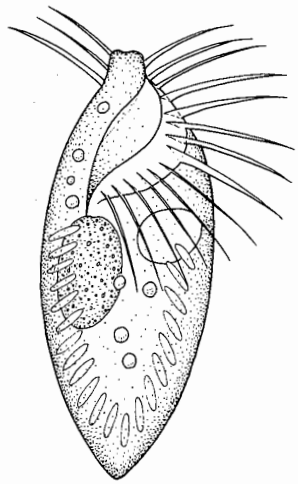

Fig. 45. *Strombidium oblongum* (Entz, 1884) Kahl, 1932 (after Entz, 1884)

***Strombidium latum* Kahl, 1932**
(Figs. 46, 47 and 48)

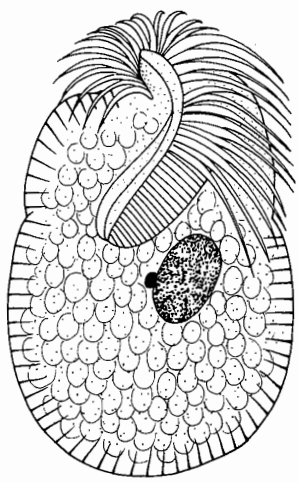

Fig. 46. *Strombidium latum* Kahl, 1932 (after Kahl, 1932)

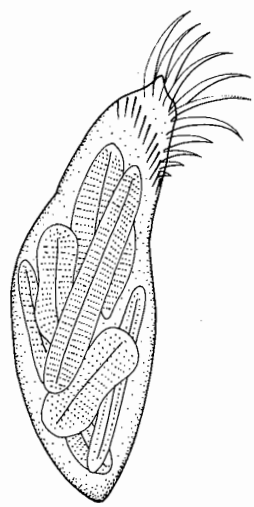

Fig. 47. *Strombidium latum* Kahl, 1932 (after Kahl, 1932)

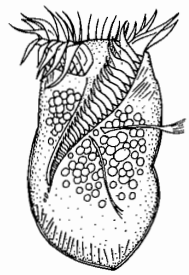

Fig. 48. *Strombidium latum* Kahl, 1932 (after Fauré-Fremiet, 1950)

Size, 100 – 140 μm and 110 – 170 μm according to Kahl (1932) and Fauré-Fremiet (1950), respectively. The ventral side is flat but the dorsal is heightened. The posterior area is wider and rounded. Membranelles of the adoral zone are numerous, 2 or 3 long membranelles are present. Although the band of trichites is not very conspicuous, it surrounds the body. The macronucleus is oval. Numerous diatoms were observed, packed inside. It moves very rapidly and was found occasionally in marine sand.

***Strombidium clavellinae* Buddenbrock, 1922**
(Fig. 49)

Size, 70 – 80 μm. This species has a wide and rounded form, dorso-ventrally flattened. The posterior area is distorted. Membranelles of the adoral zone are rather small, only 1/4 – 1/3 of the body length. Among them there are four characteristic membranelles which are long and pinnate. A band of trichites, which is sometimes inconspicuous, run from the

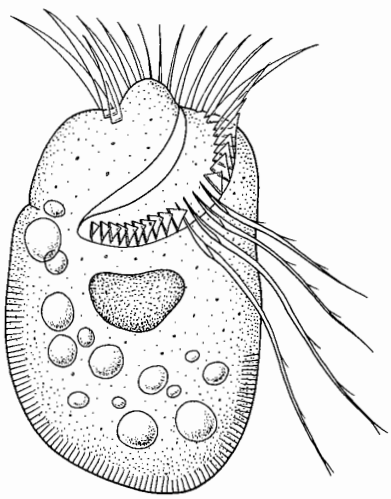

Fig. 49. *Strombidium clavellinae* Buddenbrock, 1922 (after Buddenbrock, 1922)

right to the left lateral side. The macronucleus is reniform. This species is probably a commensal form on *Clavelina* and it usually moves by creeping. It feeds on small flagellates. A marine species.

Strombidium cinctum **Kahl, 1932**
(Figs. 50 and 51)

Size, 40 – 50 μm. Body is slender, obovoid and dorso-ventrally flattened, but the frontal area is thick with about 20 membranelles of the adoral zone. In the AZM 3 or 4 membranelles are pointed. The peristomial area is considerable extending to at least one-third of the body from the posterior end. Trichites are characteristically arranged and make one transverse band from right side to left side in the dorsal area. Macronucleus is an ellipsoid with an associated micronucleus. This animal rotates while advancing and sometimes fixes itself onto the substratum for a considerable time. It feeds on diatoms and is distributed in marine sand and in brackish water.

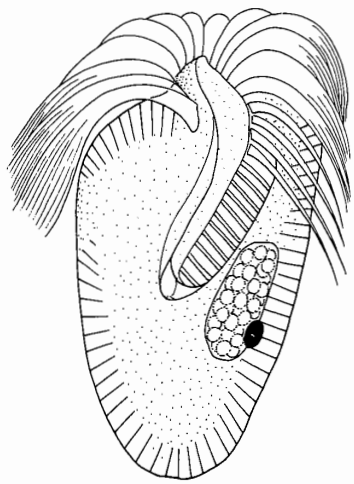

Fig. 50. *Strombidium cinctum* Kahl, 1932 (after Kahl, 1932)

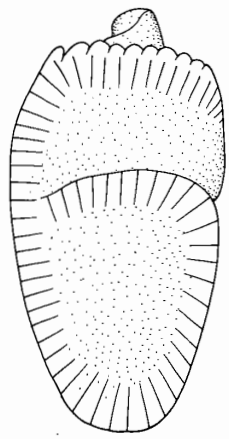

Fig. 51. *Strombidium cinctum* Kahl, 1932 (after Kahl, 1932)

Strombidium elegans **Florentin, 1901**
(Figs. 52 and 53)

Size, 40 – 60 μm. The yellow coloured body is obovoid in form with a projected apical collar. A cytoplasmic pad-like protuberance and a transparent thin plate are attached at the left and right side, respectively. Membranelles of adoral zone are pinnate at their an-

terior extremities. Trichites in a band are present on the dorsal side which runs from the right side, transversely to the left side and extends laterally to the posterior extremity. The macronucleus is round according to Florentin (1901), but Kahl (1932) described it as ellipsoid. It is very active and feeds on diatoms and green algae. A marine species.

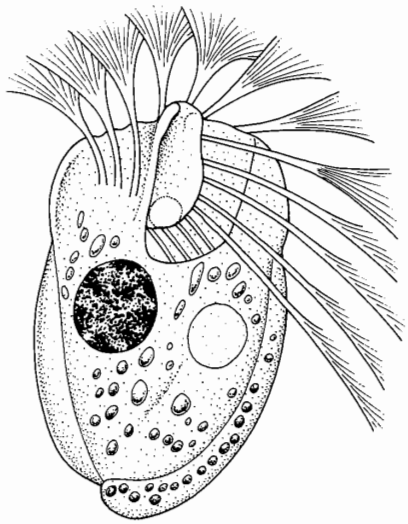

Fig. 52. *Strombidium elegans* Florentin, 1901 (after Florentin, 1901)

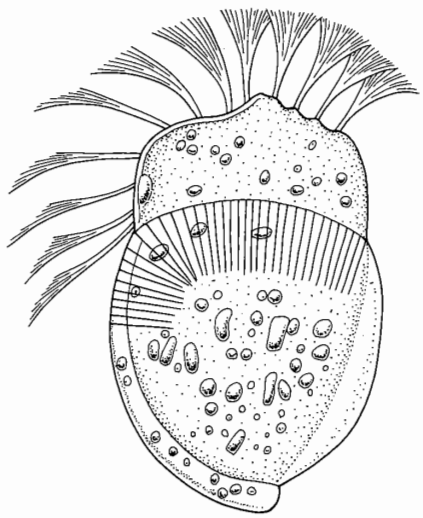

Fig. 53. *Strombidium elegans* Florentin, 1901 (after Florentin, 1901)

Strombidium schizostomum Kahl, 1932
(Fig. 54)

Size, 50 – 70 μm. This species has a slender ellipsoid form, and the frontal area is flat. The peristome is located longitudinally with a thick lip-like protrusion at its right side. Four long membranelles of the AZM are not pinnate at their end. Trichites are present at the left lateral side. The pad-like organ at the right side of the body possesses creases and a cytoproct-like cleft. The macronucleus is oval and in two sections. Found in mesosaprobic seawater, but not a dominant species.

Strombidium kahli Bock, 1952
(Fig. 55)

Size, 70 – 80 μm. The body is ovoid and cylindrical, narrowed posteriorly. There is a protuberance at the anterior extremity. Trichites in a band are situated at the sides of the body. A marine species.

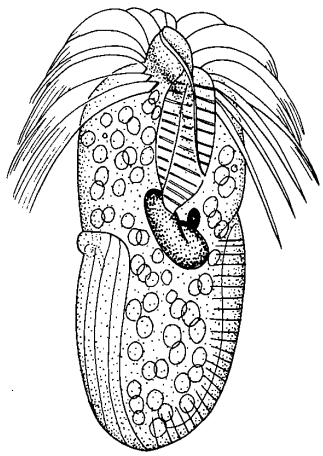

Fig. 54. *Strombidium schizostomum* Kahl, 1932 (after Kahl, 1932)

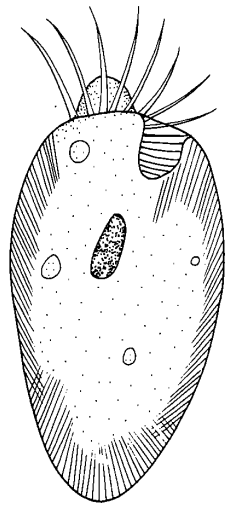

Fig. 55. *Strombidium kahli* Bock, 1952 (after Bock, 1952)

Strombidium grande **Levander, 1894**
(Figs. 56 and 57)

Size, 50 μm according to Czapik (1976). The posteior extremity is slightly pointed. The band of trichites appears like a screwed sash, which starts from the right side of the body, runs obliquely into the dorsal side, and appears again at the posterior extremity of the ventral side. The food consists of brown algae and diatoms. It occurs in brackish water.

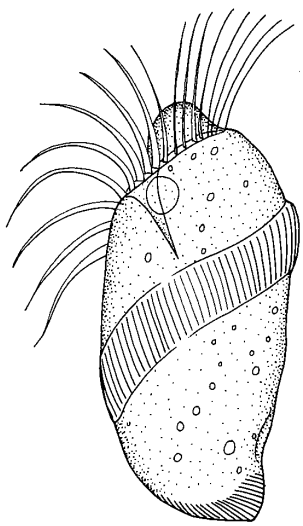

Fig. 56. *Strombidium grande* Levander, 1894 (after Levander, 1894)

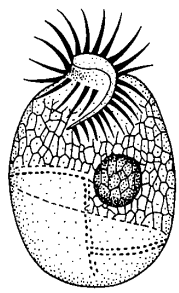

Fig. 57. *Strombidium grande* Levander. 1894 (after Czapik, 1976)

***Strombidium obliquum* Kahl, 1932**
(Figs. 58 and 59)

Size, 50 μm. The ventral side is flat and inclined. The band of trichites arises on the dorsal side and extends to the ventral area. Macronuclei are elongate in shape and separated into two segments. It shows characteristic movement; it waves to and fro and moves convulsively. During locomotion the apical area is not held forward. This species, found in mesosaprobic seawater, is not common. It feeds on flagellates.

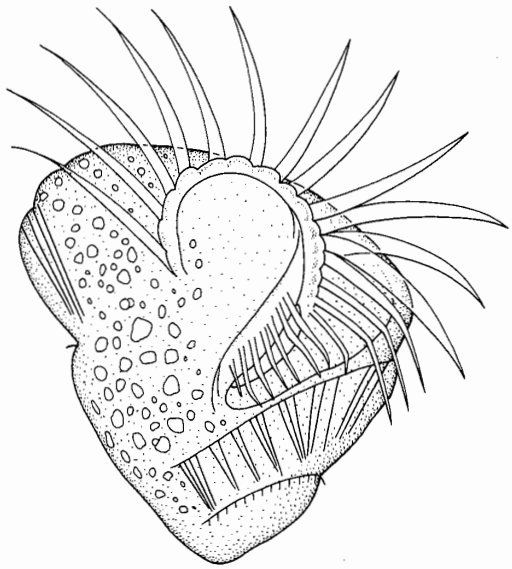

Fig. 58. *Strombidium obliquum* Kahl, 1932 (after Kahl, 1932)

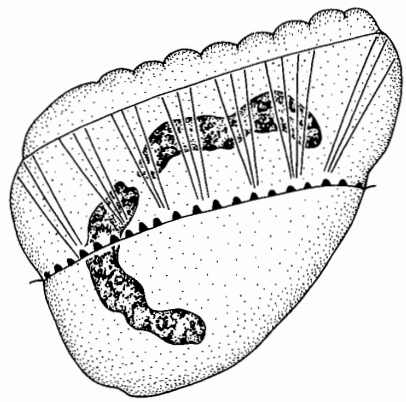

Fig. 59. *Strombidium obliquum* Kahl, 1932 (after Kahl, 1932)

***Strombidium opisthostomum* Tucolesco, 1962**
(Figs. 60 and 61)

Size, 80 – 85 μm. The body is circular or slightly narrowed posteriorly, and dorsoventrally flattened. The peristomial area reaches almost to the posterior extremity. At the right side of perisotme a lip-like protuberance is present. The macronucleus is very long. It was found originally in the North Sea.

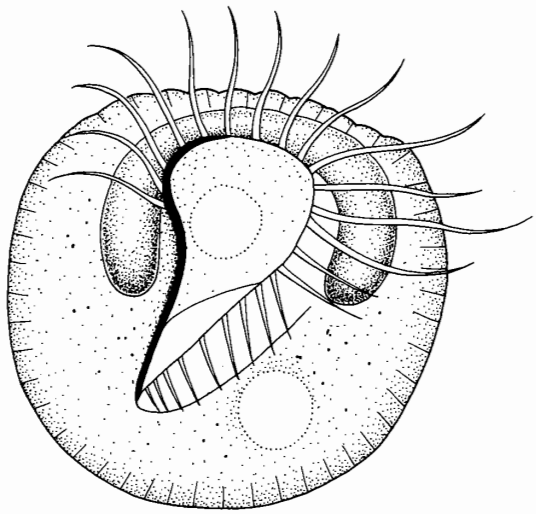

Fig. 60. *Strombidium opisthostomum* Tucolesco, 1962 (after Tucolesco, 1962)

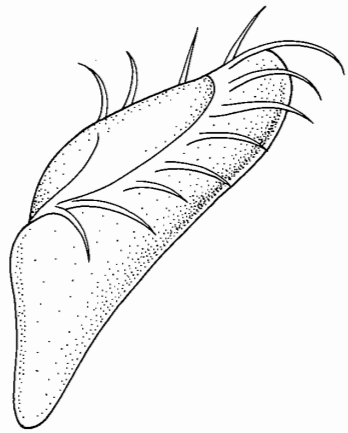

Fig. 61. *Strombidium opisthostomum* Tucolesco, 1962 (after Tucolesco, 1962)

Strombidium costatum **Tucolesco, 1962**
(Figs. 62 and 63)

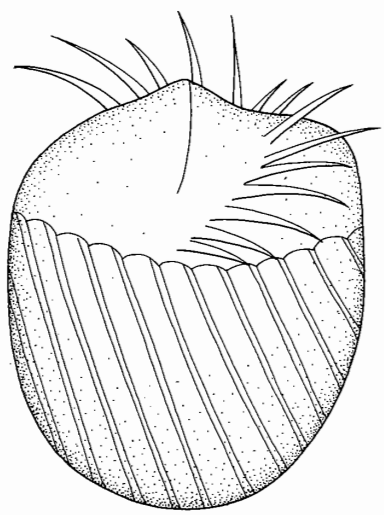

Fig. 62. *Strombidium costatum* Tucolesco, 1962 (after Tucolesco, 1962)

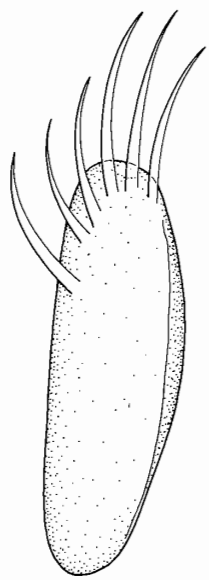

Fig. 63. *Strombidium costatum* Tucolesco, 1962 (after Tucolesco, 1962)

The size is not mentioned. The body is barrel shaped and dorso-ventrally flattened. A very poorly described species. Marine habitats.

***Strombidium strobilum* (Lohmann, 1908) Wulff, 1919**
Syn. *Laboea strobila* Lohmann, 1908
***Conocylis helix* Meunier, 1910**
(Figs. 64 and 65)

Size, 65 – 100 μm and 70 – 110 μm according to Lohmann (1908) and Wulff (1919), respectively. The conical body is surrounded with polygonal cortical platelets with 3 – 6 oblique clefts. The apical collar is low, wide and distinctly retractable. The numbers of macronuclei are 36 – 72 according to Wulff (1919). Widely distributed in the sea.

The genus *Laboea* was established by Lohmann (1908) to include those species that possessed polysaccharide plates or platelets. Fauré-Fremiet (1969) redescribed this genus to include those animals which had a spiral form of polygonal cortical platelets. As Kahl (1932) suggested, the appearance and arrangement of polygonal cortical platelets are not sufficient reason to establish the genus. This species has been retained in the genus *Strombidium* in agreement with Wulff (1919) and Kahl (1932).

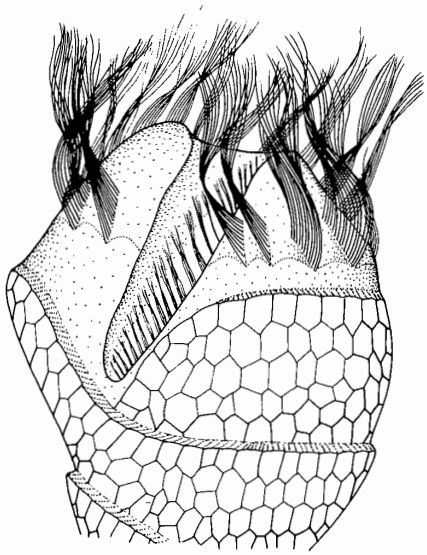

Fig. 64. *Strombidium strobilum* (Lohmann, 1908) Wulff, 1919 (after Wulff, 1919)

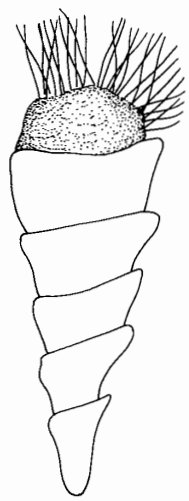

Fig. 65. *Laboea strobila* Lohmann, 1908 (after Lohmann, 1908)

Strombidium rapulum **(Yagiu, 1933) Jankowski, 1974**
Syn. ***Strobilidium rapulum*** **Yagiu, 1933**
(Fig. 66)

Size, 85 – 129 μm. The body is oval, tapering posteriorly and terminating in an elongate tail. The length of the tail varies from 31 μm to 55 μm with a width of about 7 μm at the base. The peristomial area extends to half the length of the body. The adoral membranelles are not thick. Trinchites and polysaccharide plates are not visible. The macronucleus is elongate and situated longitudinally. The micronucleus is single and located in a depression of the macronucleus. There are many food vacuoles in the posterior third of the body, containing fragments of sea weed, bacteria and small diatoms. This animal was found in the intestine of *Anthocidaris crassispina*. When the intestinal contents are teased into seawater, the ciliate is active and often leaves the substratum to swim into the water. The ciliate tends to go forward in fairly straight lines, but frequently stops, back up and then go forward again, these actions are combined with slow rotation on its longitudinal axis. The backing movement is quick and the tail bends easily when it attaches to another substratum. A marine species.

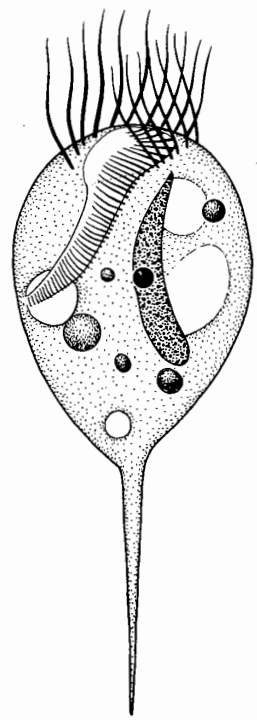

Fig. 66. *Strombidium rapulum* (Yagiu, 1933) Jankowski, 1974 (after Yagiu, 1933)

Strombidium symbioticum **Jankowski, 1974**
(Fig. 67)

Size, 39 – 44 μm. The body is an elongate, slender goblet shape. The posterior extremity is pointed. The pellicle is abruptly thickened on the dorsal side and extends transversally to the ventral side. Membranelles of the adoral zone are large and thick, 30 in number. The macronucleus, irregular in shape, is probably highly polyploid. A series of chromatin droplets of various sizes (0.5 – 8 μm) but mainly large can be stained with hematoxylin. This species was found in *Strongylocentrotus intermedius* as an ectocommensal. An marine species.

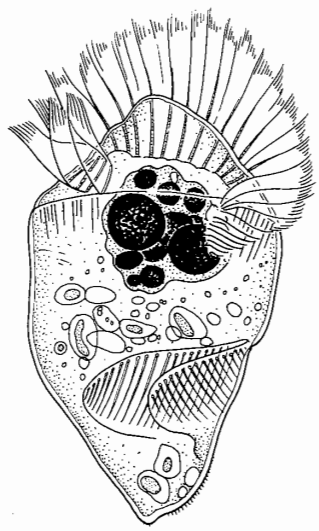

Fig. 67. *Strombidium symbioticum* Jankowski, 1974 (after Jankowski, 1974)

The following species are not clearly described because they were mainly diagnosed using fixed animals. The diagrams indicate the constricted or distorted parts of the bodies in most cases, but they still present significant taxonomic features, such as the body shape, arrangements of AZM and polygonal cortical platelets and size of frontal field. Therefore these species have been included in this work.

***Strombidium globosum* Fromentel, 1874**
(Fig. 68)

Size, 47 μm. The body is transparent and a spherical shape. The AZM is confined to the apical area. There are fine cortical speckles on the surface of the body. Contractile vacuoles are large, two in number, and are located posteriorly. A freshwater species.

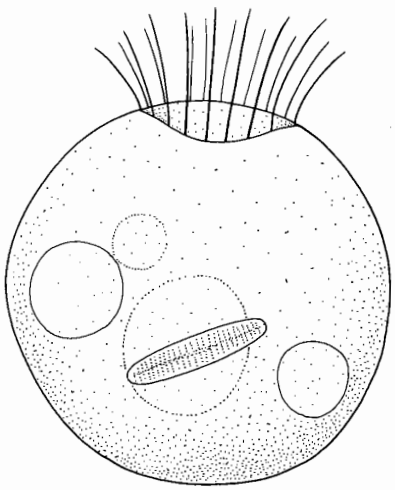

Fig. 68. *Strombidium globosum* Fromentel, 1874 (after Fromentel, 1874)

***Strombidium constrictum* (Meunier, 1910) Wulff, 1919**
Syn. *Conocylis constricta* Meunier, 1910
***Laboea constricta* (Meunier, 1910) Leegaard, 1915**
(Figs. 69 and 70)

Size, 40 – 50 μm and 70 μm according to Wuff (1919) and Leegaard (1915), respectively. The body is slender and a conical shape. The posterior extremity shows a button-like protrusion. According to Wulff (1919), trichites are conspicuous and lie close to the somatic pellicle, and polysaccharide plates consist of 10 – 14 wide longitudinal stripes, among which there are 10 – 12 fine stripes. The macronucleus is elongated in form, separated into two segments. A marine species found in the atlantic Ocean and the North Sea.

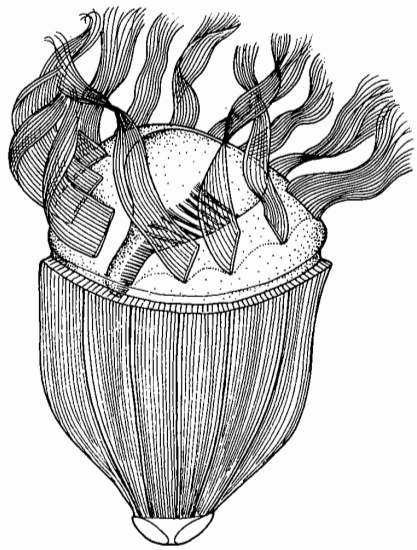

Fig. 69. *Strombidium constrictum* (Meunier, 1910) Wulff, 1919 (after Wulff, 1919)

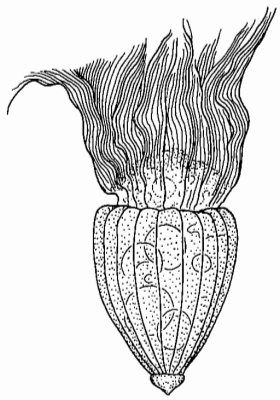

Fig. 70. *Conocylis constricta* Meunier, 1910 (after Meunier, 1910)

***Strombidium virgatum* Wulff, 1919**

Size, 40 – 50 μm. No diagram is available. Very similar to *Strombidium constrictum,* but the button-like protuberance at the posterior extremity is not present. The longitudinal stripes, 4 μm in width, are clearer in the anterior area than those in the posterior. Each sixth stripe extends to the pointed posterior extremity.

***Strombidium wulffi* (Wulff, 1919) Kahl, 1932**
Syn. *Strombidium striatum* Wulff, 1919
(Figs. 71 and 72)

Size. 70 – 90 μm. The body is elongate and conical with stripes in the somatic area. The peristomial field is distinct. Ten to twelve trichites are present situated obliquely near the equatorial cleft. Polygonal cortical platelets cover three quarters of the body. About 18 macronuclei are present. A marine species.

Wulff (1919) described this species under the name *S. striatum.* This was later changed by Kahl (1932) as it was clear that Wulff (1919) had described a new species.

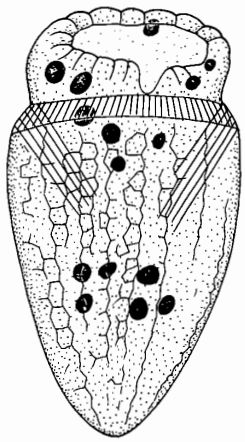

Fig. 71. *Strombidium wulffi* (Wulff, 1919) Kahl, 1932 (after Kahl, 1932)

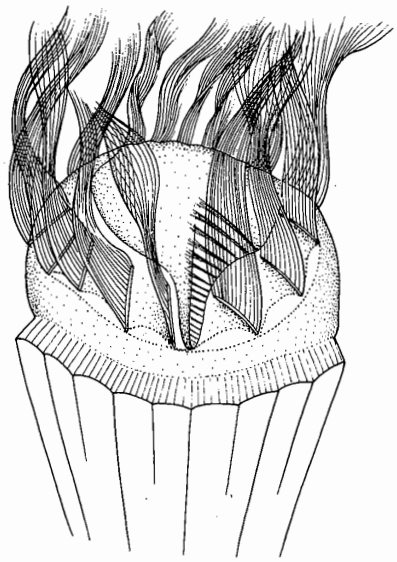

Fig. 72. *Strombidium striatum* Wulff, 1919 (after Wulff, 1919)

Strombidium pulchrum **(Leegaard, 1915) Kahl, 1932**
Syn. ***Laboea pulchra*** **Leegaard, 1915**
(Fig. 73)

Size, 167 μm. The posterior area is slender and narrowed into a cone. In the area where polysaccharide plaques cover the body there are longitudinal stripes and also a long spiral furrow. Macronuclei are present although not clearly described, they may be the dark coloured particles visible, small and oval in shape. Present in the North Sea but rare. Kahl (1932) suggested that the fixative damaged the body, resulting in the formation of the spiral line of polysaccharide plaques.

Strombidium elongatum **(Leegaard, 1915) Kahl, 1932**
Syn. ***Laboea conica*** **var.** ***elongata*** **Leegaard, 1915**
(Fig. 74)

Size, 77 – 100 μm. A slender body with the posterior area tail-like, slightly distorted, probably due to fixation. Polysaccharide plates are stripped and extend to the peristomial area. Many dark coloured granules are present inside the body. A marine species.

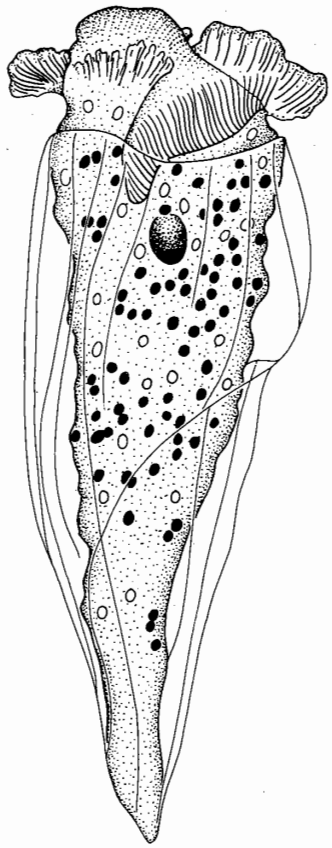

Fig. 73. *Strombidium pulchrum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

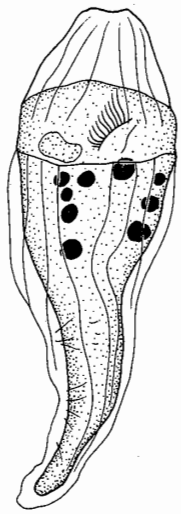

Fig. 74. *Strombidium elongatum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

Strombidium hadai **(Hada, 1970) Maeda and Carey, 1985** ***nom. nov.***
Syn. ***Strobilidium elegans*** **Hada, 1970**
(Fig. 75)

Size, 25 – 45 μm. The body is small and slender. The posterior area is sharply pointed. The surface of the body displays a number of longitudinal stripes, about 10 – 13 in total. The macronucleus is ovoid, located near the center. Found in the Antarctic Ocean.

Hada (1970) failed to differentiate between the genus *Strombidium* and *Strobilidium*.

Strombidium cornutum **(Leegaard, 1915) Kahl, 1932**
Syn. Laboea cornuta **Leegaard, 1915**
(Fig. 76)

Size, 90 – 115 μm. Slender in shape. The posterior area is slightly distorted and its extremity is round. The anterior area is expanded equatorially. Membranelles of the adoral zone are very thick. Polysaccharide plates cover half the body. Trichites are distinct. The protuberance near the posterior extremity indicates a cell just after division. The macronucleus is not described. This species was found in the North Sea and the Atlantic Ocean.

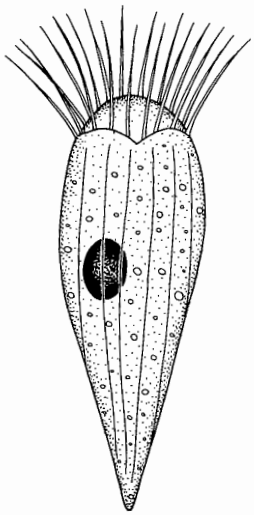

Fig. 75. *Strombidium hadai* (Hada, 1970) Maeda and Carey, 1985 (after Hada, 1970)

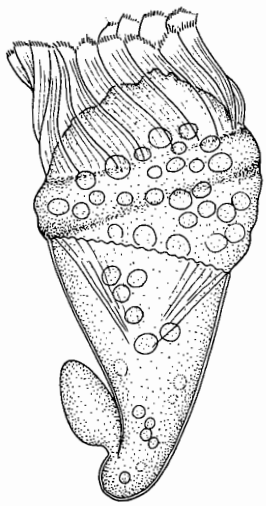

Fig. 76. *Strombidium cornutum* (Leegaard, 1915) Khal, 1932 (after Leegaard, 1915)

Strombidium cornucopiae **(Wailes, 1929) Kahl, 1932**
Syn. ***Laboea cornucopiae*** **Wailes, 1929**
(Fig. 77)

Size, 110 – 200 μm. The body is gradually narrowed from the apical to the posterior area and the posterior extremity is pointed. Membranelles of the adoral zone are pinnate. The surface of polysaccharide plates is smooth, covering almost the entire body. Four longitudinal stripes are observed on the ventral side. Trichites make oblique bands, which are located near the peristomial area. The macronucleus was not described. A marine species.

Kahl (1932) suggested that this species was identical to the slender form of *Strombidium acuminatum* (Leegaard, 1915) Kahl, 1932.

Strombidium coronatum **(Leegaard, 1915) Kahl, 1932**
Syn. ***Laboea coronata*** **Leegaard, 1915**
(Fig. 78)

Size, 100 μm. The posterior area displays a conical shape and its extremity is sharply pointed. The polysaccharide plate which extends to the middle of the body possesses stripes but no obvious cortical platelets. Membranelles of the adoral zone are very thick and of considerable length. The macronucleus is oval. Rarely described, from the North Sea.

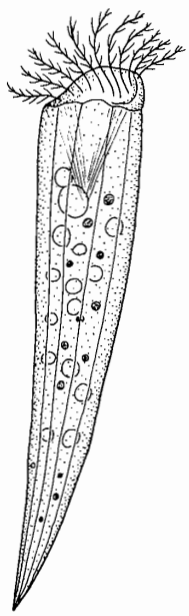

Fig. 77. *Strombidium cornucopiae* (Wailes, 1929) Kahl, 1932 (after Wailes, 1929)

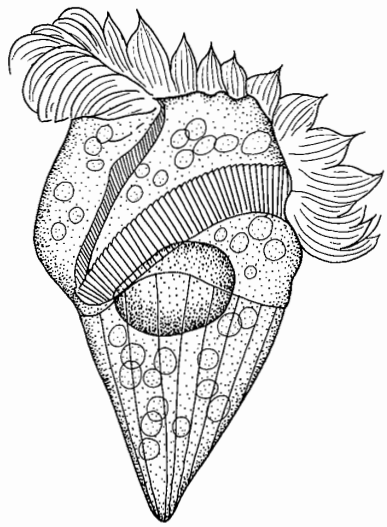

Fig. 78. *Strombidium coronatum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

***Strombidium ovale* (Leegaard, 1915) Kahl, 1932**
Syn. *Laboea ovalis* Leegaard, 1915
***Strombidium oblongum* Leegaard, 1915**
(Figs. 79 and 80)

Size, 60 μm. An elongated form. The whole body below the AZM is covered with polysaccharide plates. The newly formed daughter cell at the posterior area already has an AZM. Found in the North Sea, but rare.

Although *Strombidium oblongum* Leegaard, 1915 does not show polysaccharide plates, it has been synonymised with *S. ovale* because of the resemblance of the body shape and the AZM.

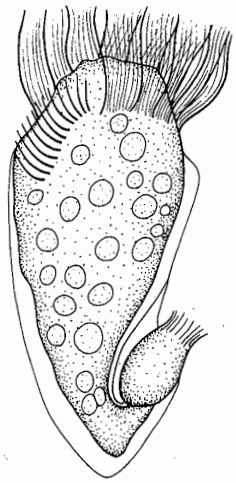

Fig. 79. *Strombidium ovale* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

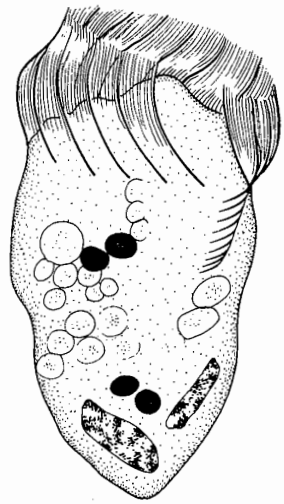

Fig. 80. *Strombidium oblongum* Leegaard, 1915 (after Leegaard, 1915)

***Strombidium acuminatum* (Leegaard, 1915) Kahl, 1932**
Syn. *Laboea acuminata* Leegaard, 1915
(Fig. 81)

Size, 65 – 98 μm. Leegaard (1915) showed two forms, slender and rotund, of this ciliate. The posterior extremity is pointed and membranelles of the adoral zone are short. Distinct polygonal cortical platelets cover the body. The macronucleus is round situated in the posterior area. A marine species found in the Atlantic Ocean and the North Sea.

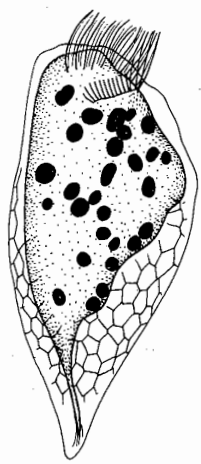

Fig. 81. *Strombidium acuminatum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

Strombidium reticulatum **(Leegaard, 1915) Busch, 1921**
Syn. ***Laboea reticulata*** **Leegaard, 1915**
(Figs. 82 and 83)

Size 62 – 68 μm. The shape is conical and the lateral view where distinct polysaccharide plaques form a covering show straight lines. This species was infrequently recorded from the North Sea.

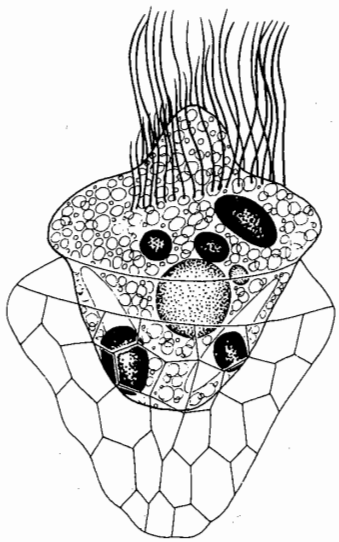

Fig. 82. *Strombidium reticulatum* (Leegaard, 1915) Busch, 1921 (after Busch, 1921)

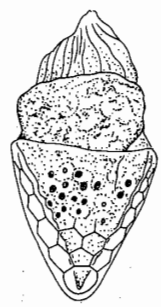

Fig. 83. *Laboea reticulata* Leegaard, 1915 (after Leegaard, 1915)

Strombidium conicoides **(Leegaard, 1915) Kahl, 1932**
Syn. ***Woodania conicoides*** **Leegaard, 1915**
(Fig. 84)

Size, 40 – 50 μm. This animal is easily differentiated from the polysaccharide plate which displays a conical shape. Leegaard (1915) established the new genus *Woodania* with this species. However, Kahl (1932) inferred from the diagram that the cell had shrunk due to fixation. As a result, he transferred it to the genus *Strombidium*. Kahl (1932) mentioned also that this animal resembled *S. sulcatum*. A marine species.

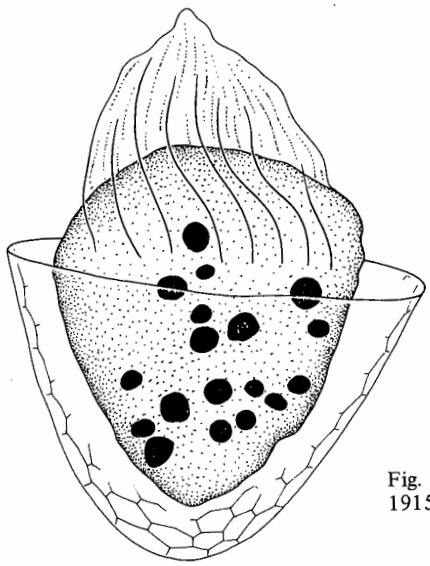

Fig. 84. *Strombidium conicoides* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

***Strombidium vestitum* (Leegaard, 1915) Kahl, 1932**
Syn. *Laboea vestita* Leegaard, 1915
(Figs. 85 and 86)

Size, 28 – 38 μm. A very small form. Almost the whole body is covered with polysaccharide plates. The equatorial region is shallowly constricted. The macronuclei are not conspicuous. This species was found in the various areas of the North Sea.

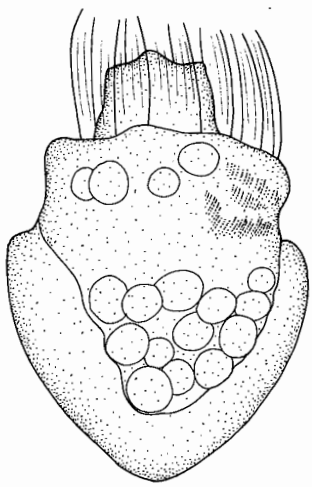

Fig. 85. *Strombidium vestitum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

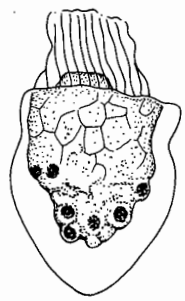

Fig. 86. *Laboea vestita* Leegaard, 1915 (after Leegaard, 1915)

***Strombidium delicatissimum* (Leegaard, 1915) Busch, 1921**
Syn. *Laboea delicatissima* Leegaard, 1915
(Fig. 87)

Size, 19 – 25 μm. A similar form to *S. vestitum*, but this species is smaller. Frequently observed in the North Sea and the Atlantic Ocean.

***Strombidium capitatum* (Leegaard, 1915) Kahl, 1932**
Syn. *Laboea capitata* Leegaard, 1915
(Fig. 88)

Size, 62 – 68 μm. The shape of the posterior area is wide and conical. A transparent peristomial collar is characteristically projected. Membranelles of the adoral zone are thick and deployed over a wide area. Polysaccharide plates show wide stripes, among which finer stripes are observed. The macronucleus was not seen. A species rarely encountered in the Atlantic Ocean and the North Sea.

This species greatly resembles *Strombidium lagenula* Fauré-Fremiet, 1924. The fine stripes at the posterior area appear to be trichites.

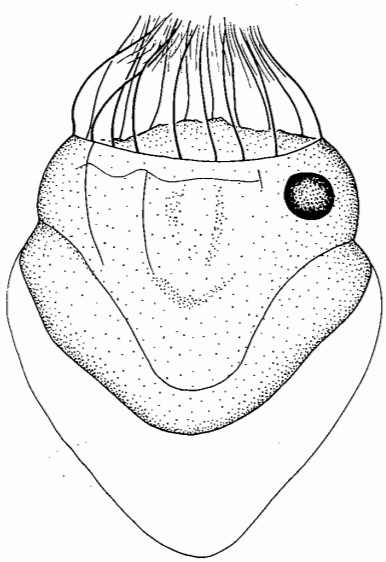

Fig. 87. *Strombidium delicatissimum* (Leegaard, 1915) Busch, 1921 (after Leegaard, 1915)

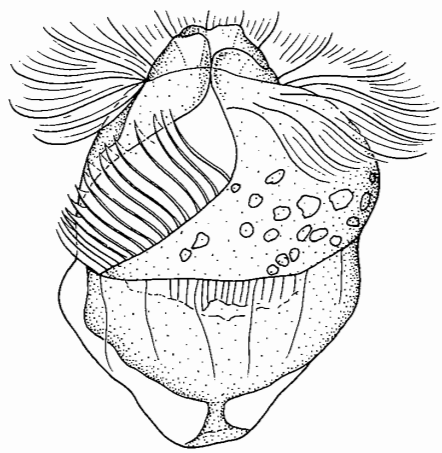

Fig. 88. *Strombidium capitatum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

***Strombidium compressum* (Leegaard, 1915) Kahl, 1932**
Syn. *Laboea compressa* Leegaard, 1915
***Leboea emergens* Leegaard, 1915**
***Strombidium emergens* (Leegaard, 1915) Busch, 1921**
***Strombidium emergens* (Busch, 1921) var. *constanziense* Busch, 1921**
(Figs. 89, 90 and 91)

Size, 47 – 53 μm. This species is very similar to *Strombidium crassulum* but differs in the shape of the membranelles of the adoral zone and the body size. The polysaccharide plate is striped but specimens without stripes were also described. The macronucleus is oval. A rare species from the North Sea.

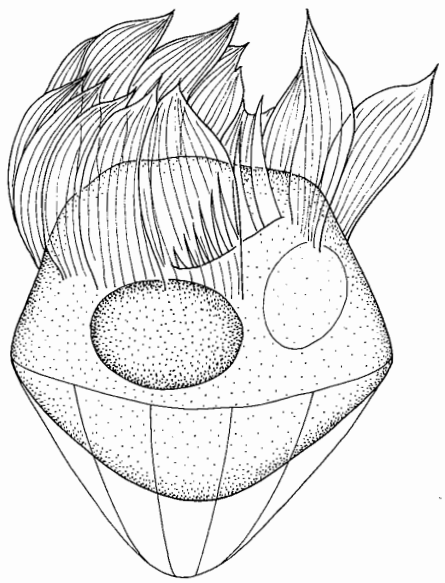

Fig. 89. *Strombidium compressum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

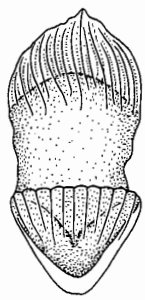

Fig. 90. *Laboea emergens* Leegaard, 1915 (after Leegaard, 1915)

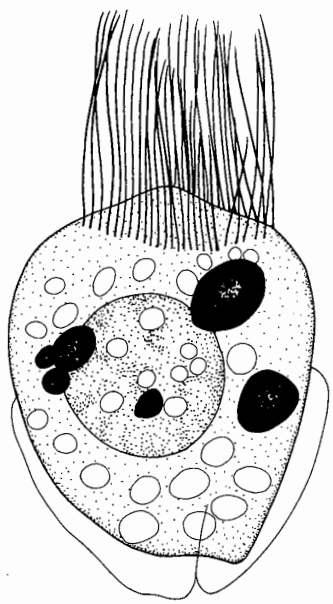

Fig. 91. *Strombidium emergens* (Busch, 1921) var. *constanziense* Busch, 1921 (after Busch, 1921)

Laboea emergens Leegaard, 1915 has been synonymised because of the similarity in shape of the body, AZM and polysaccharide plates. Busch's (1921) fixed specimen, *S. emergens* var. *constanziense,* has a ventral cleft in the posterior area.

***Strombidium crassulum* (Leegaard, 1915) Kahl, 1932**
Syn. *Laboea crassula* Leegaard, 1915
(Fig. 92)

Size, 58 – 70 μm. The body shows approximately the same length and width. The posterior area takes the form of a cone. Membranelles of the adoral zone are thick, long and short membranelles being raised at the same place simultaneously. A polysaccharide plate covers half of the body, and possesses no stripe. An oval macronucleus is present in the middle area of the body. A marine species.

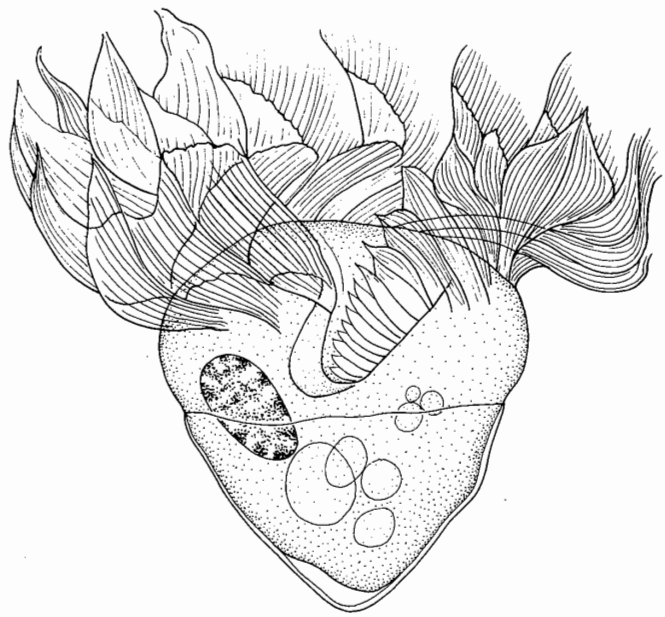

Fig. 92. *Strombidium crassulum* (Leegaard, 1915) Kahl, 1932 (after Leegaard, 1915)

***Strombidium atlantica* (Busch, 1921) Fauré-Fremiet, 1969**
Syn. *Buehringa atlantica* Busch, 1921
(Fig. 93)

Size, 26 μm. The anterior area is oval and the posterior area is slightly shortened and rounded. The anterior extremity is not covered with polysaccharide plates. The anterior

part of the plates is considerably thickened and elongate, rounded at their top. The posterior plates are hexagonal in shape. Near the peristomial field there is a bundle of membranelles in pairs which are probably damaged by the fixative employed. Macronucleus is large and ovoid. This species was frequently found in the Atlantic Ocean.

Busch (1921) placed this species in the new genus *Buehringa*. But the presence of two different polysaccharide plates are not considered sufficient reason to erect the new genus.

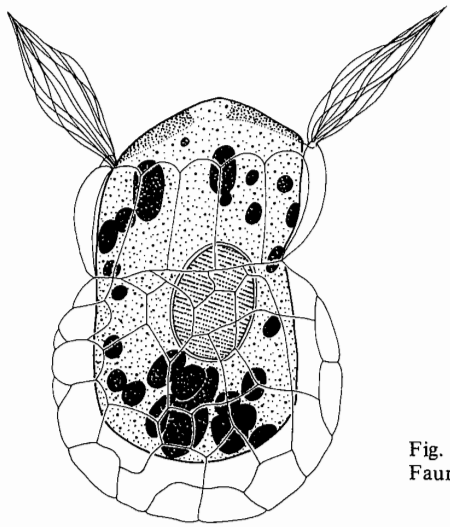

Fig. 93. *Strombidium atlantica* (Busch, 1921) Fauré-Fremiet, 1969 (after Busch, 1921)

***Strombidium antarcticum* (Busch, 1930) Kahl, 1932**
Syn. *Buehringa antarctica* Busch, 1930
(Figs. 94 and 95)

Size, 35 μm. The peristomial field is inclined because of fixation. Hada (1970) showed with normal morphology although he used a fixative as well before describing the animal. The posterior area is "funnel-like" in shape, covered with polysaccharide plates. In the middle area a different kind of polysaccharide plate is present, which are elongated in shape with round edges at the top. Trichites are present. Busch (1930) suggested that the round granule in the anterior area is probably a food vacuole. It was found in seawater of the Antarctic region.

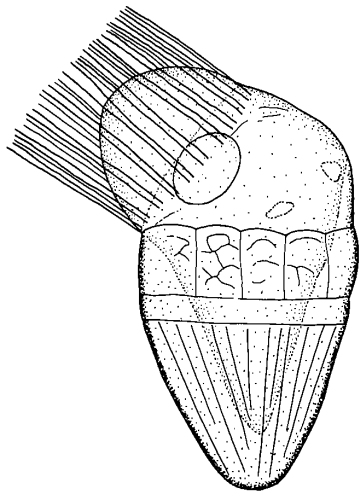

Fig. 94. *Strombidium antarcticum* (Busch, 1930) Kahl, 1932 (after Busch, 1930)

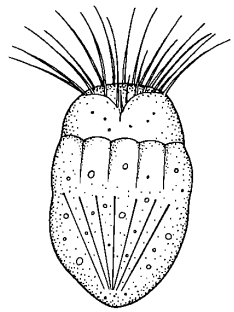

Fig. 95. *Strombidium antarcticum* (Busch, 1930) Kahl, 1932 (after Hada, 1970)

Strombidium syowaensis* (Hada, 1970) Maeda and Carey, 1985 *nom. nov
Syn. *Strobilidium syowaensis* Hada, 1970
(Fig. 96)

Size, 82 – 160 μm. The body is large and ovoid. Well developed trichites form an inverted triangle. The round and conical posterior region contains numerous granules. It was found in the Atlantic Ocean.

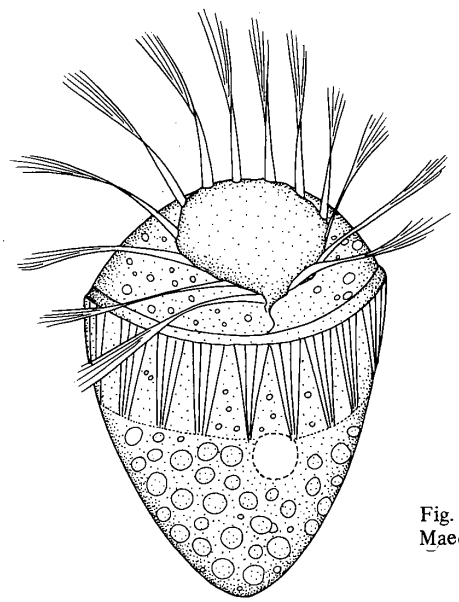

Fig. 96. *Strombidium syowaensis* (Hada, 1970) Maeda and Carey, 1985 (after Hada, 1970)

Strombidium acutum **Leegaard, 1915**
(Fig. 97)

Size, 37 μm. The body is conical, its length and width are approximately the same. Its posterior extremity is pointed. The macronucleus is oval. Rarely found in the Atlantic Ocean and the North Sea.

Strombidium buehringae **Busch, 1921**
(Fig. 98)

Size, 55 μm. The body is irregularly ovoid, bluntly rounded anteriorly and narrowed in the posterior area. The peristomial field is large. Apical membranelles are thin and round at the end, like a "rudder and helm". The end of membranelles are occasionally frayed. Polysaccharide plates or polygonal platelets were present but inconspicuous, from the posterior extremity to the area below the perisotme. The macronucleus is oval, situated under the peristomial area. A marine species.

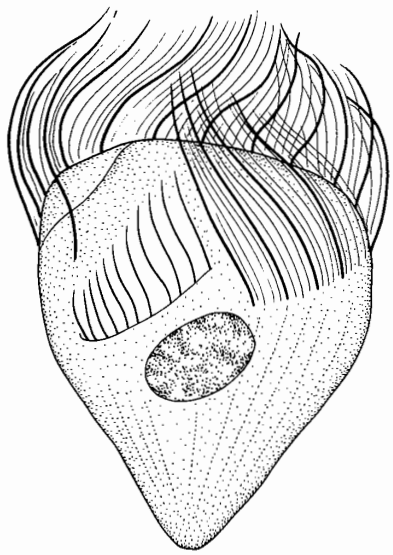

Fig. 97. *Strombidium acutum* Leegaard, 1915 (after Leegaard, 1915)

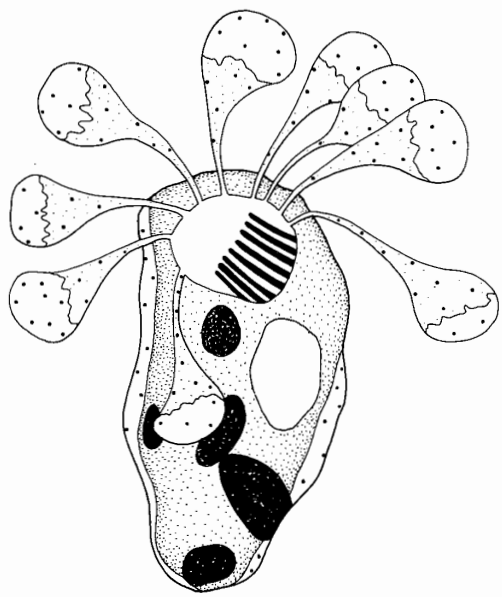

Fig. 98. *Strombidium buehringae* Busch, 1921 (after Busch, 1921)

***Strombidium diversum* Busch, 1930**
(Figs. 99 and 100)

Size, 39 μm. The body is deformed by fixation. The peristomial area is projected outward. Membranelles of the adoral zone are very long. There is a oblique furrow at the surface of the posterior body region. The macronucleus is large and round. It was found in the Antarctic current.

Hada (1970) also reported the same species in the Antarctic Ocean.

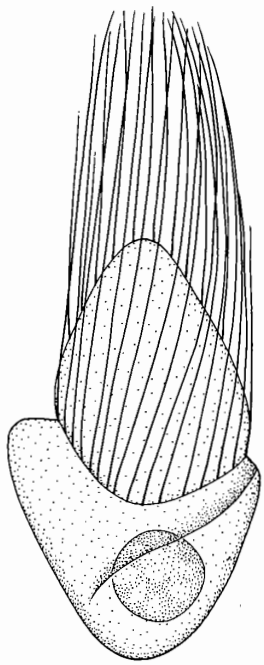

Fig. 99. *Strombidium diversum* Busch, 1930 (after Busch, 1930)

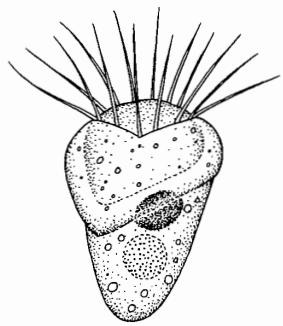

Fig. 100. *Strombidium diversum* Busch, 1930 (after Hada, 1970)

***Strombidium prorogatum* Busch, 1930**
(Fig. 101)

Size, 38 μm. Body is slightly deformed but it is hard to designate this animal to a specific taxon. The area of the apical extremity projects as a swelling. In the somatic area there are a number of granules. It was found in the Antarctic Current.

***Strombidium spirale* Busch, 1950**
(Fig. 102)

The size was not described. The anterior area of the body expands, as a swelling, and is considerably distorted. The posterior area is narrowed where three spiraled furrows without cirri or cilia are present. Found in the Atlantic Ocean.

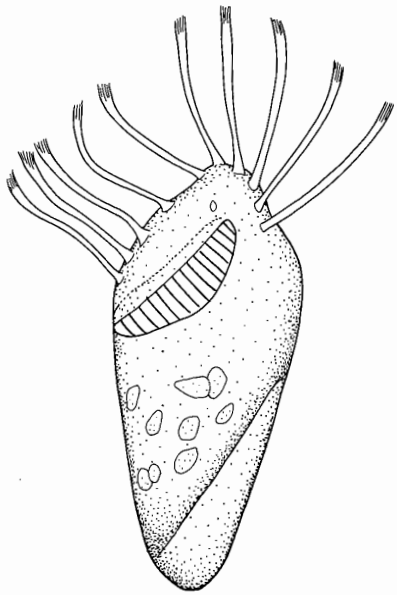

Fig. 101. *Strombidium prorogatum* Busch, 1930 (after Busch, 1930)

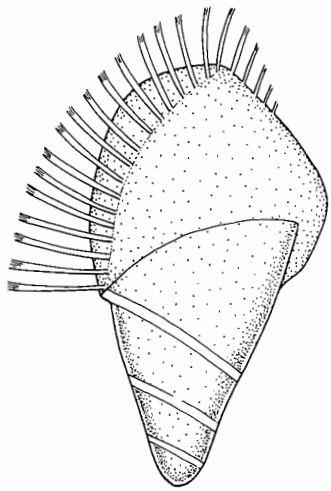

Fig. 102. *Strombidium spirale* Busch, 1950 (after Busch, 1950)

Strombidium caudatum **Fromentel, 1874**
(Fig. 103)

Size, 32 μm without the tail. The body is transparent, wider in anterior area and truncated at its extremity. The posterior area is narrowed and ends in a distinct tail. A contractile vacuole is situated one-third of the way down the body form the posterior end. A freshwater species.

Strombidium longipes **Meunier, 1910**
(Fig. 104)

Size, 80 μm. The body is oval. The posterior area is tail-like, pointed at its extremity. The circlet of apical membranelles is not closed. The macronucleus is oval. A marine species.

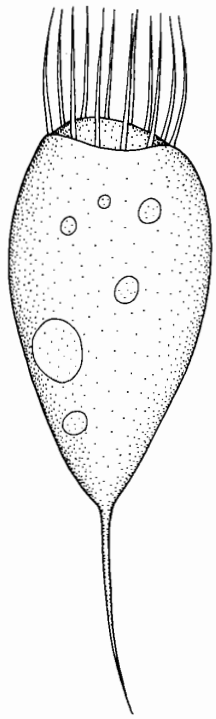

Fig. 103. *Strombidium caudatum* Fromentel, 1874 (after Fromentel, 1874)

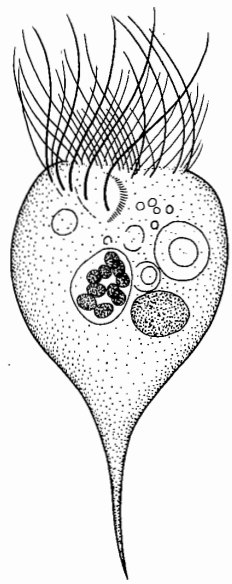

Fig. 104. *Strombidium longipes* Meunier, 1910 (after Meunier, 1910)

The following species were not named and also poorly described. Only diagrams are shown in this work for completeness.

***Strombidium* sp. Busch, 1930**
(Fig. 105)

***Strombidium* sp. Busch, 1930**
(Fig. 106)

***Strombidium* sp. Busch, 1950**
(Fig. 107)

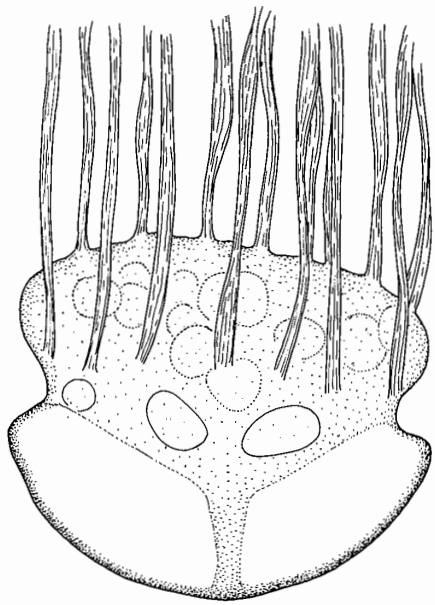

Fig. 105. *Strombidium* sp. Busch, 1930 (after Busch, 1930)

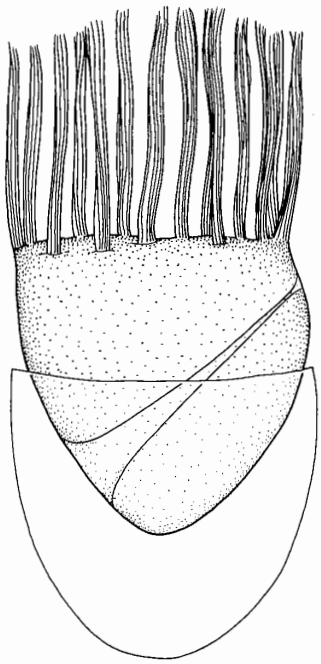

Fig. 106. *Strombidium* sp. Busch, 1930 (after Busch, 1930)

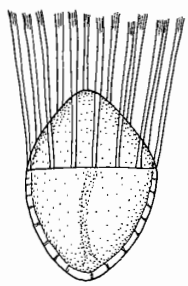

Fig. 107. *Strombidium* sp. Busch, 1950 (after Busch, 1950)

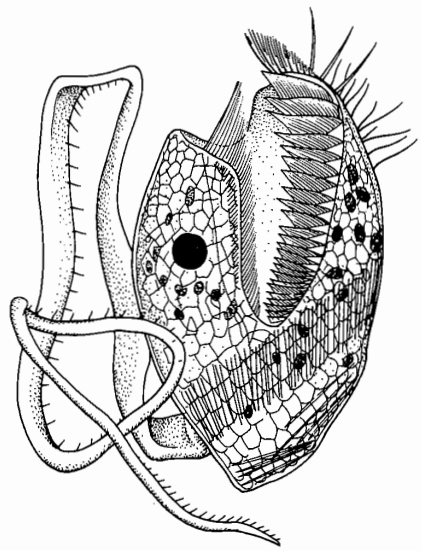

Fig. 108. *Tontonia appendiculariformis* Fauré-Fremiet, 1914 (after Fauré-Fremiet, 1914)

Tontonia appendiculariformis **Fauré-Fremiet, 1914**
(Fig. 108)

Length of body, 140 μm; the tail, 110 – 400 μm. The body shape is irregularly ovoid. The characteristic tail, originating from the posterior area of the dorsal side, is mobile and contractile, a row of small bristles is present on the edge. On the ventral side a very large buccal cavity opens, the AZM is situated on the left edge and a paroral membrane lies on its right side. Four rows of short cilia are present situated longitudinally on the left lateral side of the anterior area. Each row is 30 – 35 μm in length and 6 of these cilia are especially active. In addition on the dorsal side 3 cirri-like filaments are situated. The body is entirely covered with polygonal cortical platelets of polysaccharide, the sizes of which are 3 – 5 μm at the anterior and 7 – 8 μm at the posterior. Helicoid and oblique bands of trichites are found in the middle and posterior areas; size, 20 μm and 60 μm in length, respectively. Macronuclei are numerous, their size varies between 4 – 5 μm. A marine species.

Tontonia caudata **(Lohmann, 1908) Kahl, 1932**
Syn. ***Strombidium caudatum*** **Lohmann, 1908**
(Fig. 109)

Size, 20 μm without the tail. The body is lemon yellow in colour and takes a conical form, bearing a thin wreath of very fine cilia in the anterior area. A peristomial field in the shape of a reversed cone is present inside the wreath. The posterior extremity displays a long whip-like tail, which can be used to move the organism very quickly. A marine species.

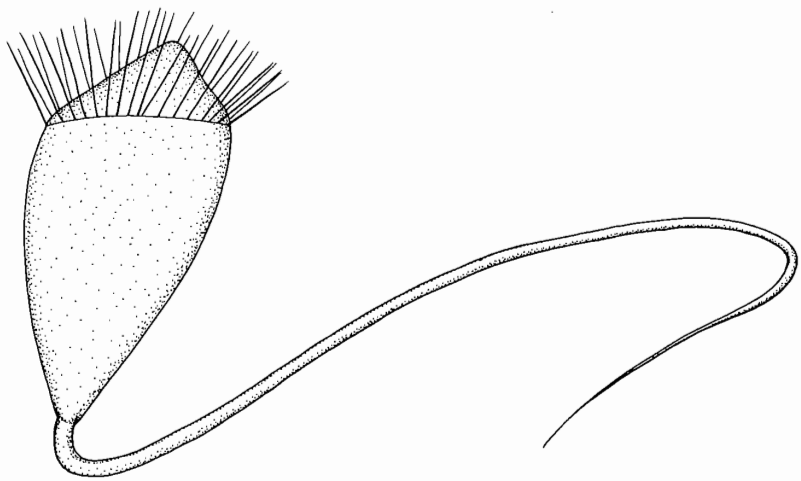

Fig. 109. *Tontonia caudata* (Lohmann, 1908) Kahl, 1932 (after Lohmann, 1908)

Kahl (1932) recognized that the organism described by Lohmann (1908) was not a species of *Strombidium*. He transferred this ciliate with its characteristic tail to the genus *Tontonia*.

***Tontonia gracillima* Fauré-Fremiet, 1924**
(Fig. 110)

The size varies between 48 – 52 μm without the tail. The tail may reach 250 – 300 μm. The body shape is globular with the anterior part narrowed and bole-like, with its extremity truncated. The excavated peristomial area extends to the ventral side where lip-like protuberances are furnished longitudinally on both its sides. The AZM is situated on the left edge of the ventral peristomial field. At the apical extremity a collar-like swelling is extended, below which approximately ten rows of cilia are located longitudinally. These cilia are fine and 15 – 18 μm in length and are not fused membranelles, which could be used for swimming. Fauré-Fremiet (1924) called these cilia a "subordinate frange". The long tail is present at the hemispherical posterior area. It is contractile and also mobile. A row of short bristles are observed on the tail, which are clearly different in structure from the bristles of *T. appendiculariformis*. The macronuclei are numerous, connected to each other like a string of beads. This marine planktonic species feeds on small *Peridinium*.

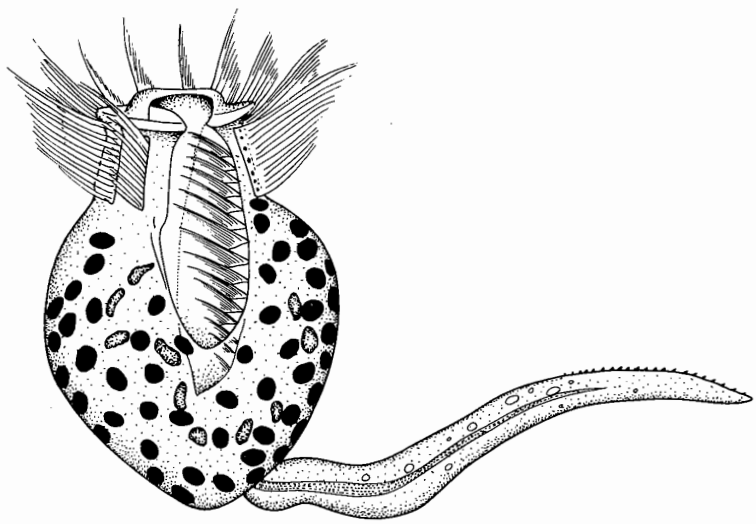

Fig. 110. *Tontonia gracillima* Fauré-Fremiet, 1924 (after Fauré-Fremiet, 1924)

***Metastrombidium sonnifer* Jankowski, 1980**

This species was described by Fauré-Fremiet (1924) as *Metastrombidium* sp. Size, 90 μm. The body is globular in shape, slightly depressed anteriorly. The form of the peristome which is located at the anterior area is reniform. Adoral membranelles at the left area of the peristome intrude into the buccal cavity. Among the membranelles four to five which are located at the left side of the anterior body are smaller than others. The heterogeneously reticulated cytoplasm contains some oil drop-like granules. The body has no somatic ciliature. The macronucleus is cylindrical like a curved "horse-shoe" located under the peristom area. A marine species.

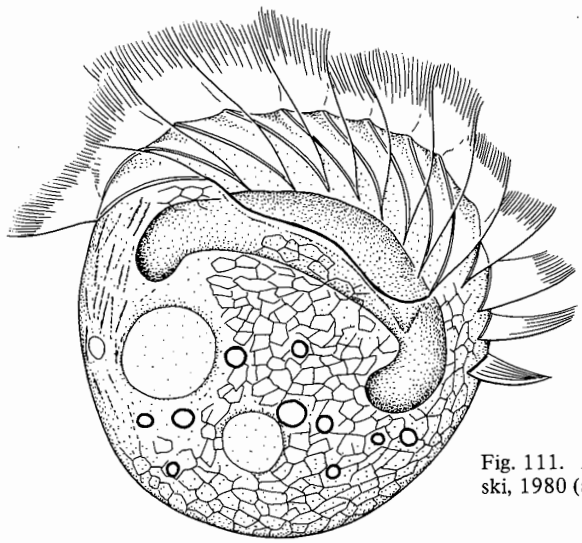

Fig. 111. *Metastrombidium sonnifer* Jankowski, 1980 (after Fauré-Fremiet, 1924)

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VIII. REFERENCES

Agamaliev, F. G. (1972) Ciliates from microbenthos of the islands of Apseronskij and Bakinskij archipelagos of the Caspian Sea. Acta Protozool., 10: 1-27.

Agamaliev, F. G. (1974) Ciliates of the Turkmen Bay (Caspian Sea). Zoologicheskii Zh., 53: 19-24.

Anigstein, L. (1913) Über *Strombidium testaceum* nov. spec. eine marine oligotriche Ciliate. Arch. Protistenk., 32: 79-110.

Awerinzew, S. (1901) Zur Morphologie und Systematik der Famile Halterina Clap. et Lachm. Travaux de la Société Impériale des Naturaliste de St.-Pétersbourg. Section de Zoologie et de Physiologie, 31 (Livr. 4, No. 12): 1-63.

Beardsley, A. E. (1902) Notes on Colorado protozoa, with descriptions of new species. Tr. Amer. Micr. Soc., 23: 49-59.

Beers, J. R., Reid, F. M. H. and Stewart, G. L. (1975) Microplankton of the North Pacific Central Gyre. Population structure and abundance, June 1973. Int. Rev. ges. Hydrobiol., 60: 607-638.

Beers, J. R., Stevenson, M. R., Eppley, R. W. and Brooks, E. R. (1971) Plankton populations and upwelling off the coast of Peru, June 1969. Fisheries Bulletin, U. S. Department of Commerce, 69: 859-876.

Berk, S. G., Brownlee, D. C., Heinle, D. R., Kling, H. J. and Colwell, R. R. (1977) Ciliates as a food for marine planktonic copepods. Microb. Ecol., 4: 27-40.

Bick, H. (1972) Das Zooplankton der Binnengewässer. I. Protozoa. B. Ciliata. Binnengewässer, 26: 31-83.

Bock, K. J. (1952) Über einige holo- und spirotriche Ciliaten aus den marinen Sandgebieten der Kieler Bucht. Zool. Anz., 149: 107-115.

Bock, K. J. (1967) Protozoa. Order: Oligotrichidia. Families: Halteriidae, Strobiliidae. Fich. Ident. Zooplancton, 110: 2-4.

Borror, A. C. (1963) Morphology and ecology of the benthic ciliated protozoa of Alligator Harbor, Florida. Arch. Protistenk., 106: 465-534.

Borror, A. C. (1965) New and little-known tidal marsh ciliates. Trans. Amer. Micros. Soc., 84: 550-565.

Borror, A. C. (1972) Tidal marsh ciliates (Protozoa): morphology, ecology, systematics. Acta Protozool., 10: 29-72.

Buddenbrock, W. V. (1922) Über eine neue *Strombidium*-Art aus Helgoland (*Str. clavellinae*). Arch. Protistenk., 45: 129-132.

Bullington, W. E. (1940) Some ciliates form Tortugas. Pap. Tortugas Lab. Carn. Inst., 32: 179-221.

Bürger, O. (1908) Nuevos estudios sobre Protozoos chilenos del agua dulce. Anales Univ. Santiago de Chile, 122: 137-204.

Busch, W. (1921) Studien über Ciliaten des Nordatlantischen Ozeans und Schwarzen Meeres. Arch. Protistenk., 42: 364-378.

Busch, W. (1924) *Stombidium mucotectum* nov. spec. Arch. Protistenk., 50: 135-138.

Busch, W. (1930) Uber marine Strombidium-Arten am der Antarktische Allgemeinen Ostströmung. Abhandlungen und Berichte aus dem Museum für Natur-und Heimatkunde und dem Naturwissenschaftlichen Verein in Magdeburg, 6: 83-87.

Busch, W. (1950) Beitrag zur Kenntnis mariner Protozoen. Abh. Naturk. u. Vorgesch. Magdeb., 8: 103-106.

Bütschli, O. (1887–1889) Protozoa. Abt. 3. Infusoria und System der Radiolaria. *In* Broon, H. G. (Ed.) Klassen und Ordnungen des Thier-Reichs, Vol. 1, C. F. Winter, Leipzig, pp. 1098-2035.

Calkins, G. N. (1901) Marine protozoa from Woods Hole. Bull. U. S. Fish. Comm., 21: 413-468.

Claparède, E. and Lachmann, J. (1858) Études sur les Infusoire et les rhizopodes. Memoires de l'Institut National Genevois, 6: 261-482 (published in 1859).

Corliss, J. O. (1961) The ciliated protozoa: Characterization, classification, and guide to the literature. Pergamon Press, London. 310 pp.

Corliss, J. O. (1979) The ciliated protozoa: Characterization, classification and guide to the literature, 2nd ed., Pergamon Press, Oxford. 455 pp.

Czapik, A. (1976) *Strombidium grande* Levander. Acta Protozool., 15: 273-275.

Dragesco, J. (1960) Ciliés mésopsammiques littoraux: Systematique, morphologie, ecologie. Des Travaux de la Station Biologique de Roscoff, 12: 1-356 (Nouvelle série).

Dujardin, M. F. (1841) Histoire naturelle des zoophytes, infusoires. Librairie Encyclopédique de Roret, Paris, 684 pp.

Eberhard, E. (1862) *Strombidium polymorphum. In* Zweite Abhandlung uber die Infusorienwelt. Programm der Realschule zu Coburg, Ostern. 1-32.

Endo., Y., Hasumoto, H. and Taniguchi, A. (1983) Microzooplankton standing crop in the western subtropical Pacific off the Bonin Islands in winter, 1980. J. Oceanogr. Soc. Japan, 39: 185-191.

Entz, G. (1884) Uber Infusorien des Golfes von Neapel. Mitt. Zool. Stat. Neapel, 5: 289-444.

Fauré-Fremiet, E. (1910) Le plankton de la Baie de la Hougue. Paris Bul. Soc. Zool., 35: 225-226.

Fauré-Fremiet, E. (1914) Deux infusoire planktoniques, *Tntonia appendiculariformis* (n. gen., n. sp.) et *Climacostomum diedrum* (n. sp.). Arch. Protistenk., 34: 95-107.

Fauré-Fremiet, E. (1924) Conbribution á la connaissance des infusoires planktoniques. Bull. Biol. Fr. Belg., suppl. No. 6, pp. 1-171.

Fauré-Fremiet, E. (1932) *Strombidium calkinsi*, a new thigmotactic species. Biol. Bull., 62: 201-204.

Fauré-Fremiet, E. (1948) Le rythme de marée du *Strombidium oculatum* Gruber. Bull. Biol. Fr. Belg., 82: 3-23.

Fauré-Fremiet, E. (1950) Morphlogie comparée et systematique des ciliés. Bull. Soc. Zool. Fr., 75: 109-122.

Fauré-Fremiet, E. (1969) Remarques sur la systematique des ciliés Oligotrichida. Protistol., 5: 345-352 (published in 1970).

Fauré-Fremiet, E. and Ganier, M. -Cl. (1970) Structure fine du *Strombidium sulcatum* Cl. et L. (Ciliata Oligotrichida). Protistol., 6: 207-223.

Fenchel, T. (1968) The ecology of marine microbenthos, 2. The food of marine benthic ciliates. Ophelia, 5: 73-121.

Florentin, R. (1901) Description de deux infusoires ciliés nouveaux des mares salées de Lorraine suivie de quelques considérations sur la faune des lacs salés. Ann. Sci. Nat., Zool. et Paléontol., (8 sér.) 12: 343-363.

Fromentel, E. de (1874) Etudes sur les microzoaires ou infusoires proprement dits, comprenant de nouvelles recherches sur leur organisation, leur classification, et la description des espèces nouvelles ou peu connues. G. Masson, Paris, 364 pp.

Gourret, P. and Roeser, P. (1888) Contribution à l'étude des protozoaires de la Corse. Arch. Biol., Paris, 8: 139-204.

Gruber, A. (1884) Die Protozoen des Hafens von Genua. Nova Acta Acad. Leopold, 46: 475-539.

Hada, Y. (1970) The protozoan plankton of the Antarctic and Subantarctic seas. Japanese Antarctic Research Expedition Scient. Rep. (ser. E) No. 31: 1-51.

Hovasse, R. (1932) Trois infusoires planktoniques du Bosphore. Arch. Zool. Exp. Gén. Paris, Notes and Revue, 73: 1-8.

Jankowski, A. W. (1974) Commensological sketches. 6. Ectocommensals of *Strongylocentrotus intermedius* in the Busse Lagoon (Southern Sakhalin). Gidrobiologicheskii Zh., 10: 60-68.

Jankowski, A. W. (1978) The revision of the system of Polyhymenophora class (Spirotrichia). Tezisy Dokl. Zool. Inst. Akad. Nauk SSSR, 39-40 pp.

Jankowski, A. W. (1980) Conspectus of a new system of the phylum Ciliopora. Trudy Zool. Inst. Leningr., 94: 103-121.

Kahl, A. (1932) Urtiere oder Protozoa I. Wimpertiere oder Ciliata (Infusoria) 3. Spirotricha. *In* Dahl, F. (Ed.) Die Tierwelt Deutschlands und der angrenzenden Meeresteile. Gustav Fischer, Jena. 25: 399-650.

Kahl, A. (1935) Urtiere oder Protozoa I. Wimpertiere oder Ciliata (Infusoria). Nachtrag I. *In* Dahl, F. (Ed.) Die Tierwelt Deutschlands und der angrenzenden Meeresteile. Gustav Fischer, Jena. 30: 806-842.

Kellicott, D. S. (1885) Observations on some fresh-water Infusoria. Proc. Amer. Soc. Micros., 8: 38-47.

Kent, W. S. (1881–1882) Manual of the Infusoria. David Bogue, London, 2: 473-913 pp.

Lankester, E. R. (1874) *Torquatella typica*; a new type of Infusoria, allied to the Ciliata. Quart. J. Micros. Sci., 14: 272-274.

Leegaard, C. (1915) Untersuchungen über einige Planktonciliaten des Meeres. Nyt Mag. f. Naturv., 53: 1-37.

Lepsi, J. (1926) Über eine Varietät von Strombidium gyrans Stokes (Infusoria). Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt, 75/76: 39-44.

Levander, K. M. (1894) Materialen zur Kenntniss der Wasserfauna in der Umgebung von Helsingfors, Protozoa. Acta Soc. Pro Fauna et Flora Fennica, 12(2): 1-115.

Lohmann, H. (1908) Untersuchungen zur Feststellung des vollständigen Gehaltes des Meeres an Plankton. Wiss. Meeresunters, N. F., 10: 129-370.

Maeda, M., W. J. Lee and N. Taga (1983) Distribution of lipopolysaccharide, an indicator of bacterial biomass, in subtropical areas of the sea. Marine Biology, 76: 257-262.

Maskell, W. M. (1887) On the freshwater Infusoria of the Wellington district. Trans. New Zealand Inst., 20: 3-19.

Meunier, A. (1910) Microplankton des Mers de Barents et de Kara. *In* C. Bulens (Ed.) Duc d'Orleans, Campagne Arctique de 1907. Bulen, Bruxelles, 355 pp.

Müller, O. F. (1773) Vermivm terrestrium et fluviatilium, seu animalium infusorium, helminthicorum et testaceorum, non marinorum, succincta historia. Havniae et Lipsiae, 135 pp.

Penard, E. (1916) Le *Stombidium mirabile*. Mém. Soc. Phys. et Hist. Nat. de Genève. 38: 227-251.

Penard, E. (1920) Observations sur le *Strombidium viride* Stein. Rev. Suisse Zool. Genève, 28: 1-9.

Perejaslawzewa, S. (1886) Protozoa of the Black Sea (in Russian). Memoiren der Neurus ges. der Naturh. zu Odessa, 10: 79-114.

Rassoulzadegan, F. (1977) Évolution annuelle des ciliés pélagiques en Méditerranée nord-occidentale ciliés oligotriches, non tintinnides, (Oligotrichina). Annales Inst. Océanogr. Paris, 53(1): 125-134.

Roux, J. (1899) Observations sur quelques Infusoires ciliés des environs de Genève avec la description de nouvelles espèces. Revue Suisse Zoologie, 6: 557-635.

Roux, J. (1901) Faune infusorienne des eaux stagnantes des environs de Genève. Mémoires de l'Institut National Genevois, 19: 1-148.

Ryder, J. A. (1881) The protozoa and protophytes considered as the primary or indirect source of the food of fishes. Bull. U. S. Fish Commission, 1: 236-251.

Sauerbrey, E. (1928) Beobachtungen über einige neue oder wenig bekannte marine Ciliaten. Arch. Protistenk., 62: 355-407.

Schwiakoff, W. (1892) Ueber die geographische Verbreitung der Süsswasser-Protozoën. Ver. Nat-. Med. ver. Heidelb., (NS) 4: 544-567.

Schewiakoff, W. (1893) Ueber die geographische Verbreitung der Süsswasser-Protozoën. Mémoires de l'Académie Impériale des Sciences de St.-Pétersbourg, (sér. 7) 41: 1-201.

Smith, J. C. (1897) Notices of some undescribed Infusoria from the Infusorial fauna of Louisiana. Tr. Amer. Micr. Soc., 19: 55-68.

Sorokin, Yu. I. (1981) Microheterotrophic organisms in marine ecosystems. *In* Longhurst, A. R. (Ed.) Analysis of marine ecosystems. Academic Press, London, 741 pp.

Stein, F. (1867) Der Organismus der Infusionsthiere nach eigenen Forschungen in Systematischer Reihenfolge Bearbeitet. 2. Leipzig, 355 pp. (monograph on heterotrichs)

Stokes, A. C. (1887) Notices of new American fresh-water Infusoria. J. R. Micr. Soc., 1: 35-40.

Sudzuki, M. and Shimoizumi, J. (1967) On the fresh-water microfauna of the antarctic region. 2. Stability of faunistic composition of antarctic microorganisms. JARE Scient. Rep., Spec. Issue, 1: 216-235.

Taniguchi, A. (1984) Microzooplankton biomass in the arctic and subarctic Pacific Ocean in summer. Memoirs of National Institute of Polar Research, Spec. Issue, (32) 63-76.

Thompson, J. C., Jr. (1972) Ciliated protozoa of the Antarctic peninsula. Antarctic Res. Ser. Washington, 20: 261-288.

Tucolesco, J. (1962) Études protozoologiques sur les eaux Roumaines. I. Espèces nouvelles d'infusoires de la mer Noire et des bassins salés paramarins. Arch. Protistenk., 106: 1-36.

Wailes, G. H. (1929) Marine ciliates of the genus *Laboea* from British Columbia with description of a new species. Ann. Protistol. Paris, 2: 125-126.

Wang, C. C. (1934) Notes on the marine infusoria of Amoy. Mar. Biol. Ass. China, Annual Rep., 3: 50-70.

Wulff, A. (1919) Über das Kleinplankton der Barentssee. Wiss. Meeresunters, Helgoland N. F., 13: 95-124.

Yagiu, R. (1933) Studies on the ciliates from the intestine of *Anthocidaris crassispina* (A. Agassiz). I. *Cyclidium ozakii* sp. nov. and *Strobilidium rapulum* sp. nov. J. Sci. Hiroshima Univ. (Ser. B, Div. 1) 2(13): 211-222.

Zacharias, O. (1895) Faunistische Mittheilungen. Forschungsberichte aus der Biologischen Station zu Plön, 3: 73-96.